Dynamic Adjustment to Trade Shocks

Junyuan Chen[*]
UC San Diego

Carlos Góes[†]
World Bank Group

Marc-Andreas Muendler[¶]
UC San Diego

Fabian Trottner[‡]
UC San Diego

March 21, 2026

Abstract

Global trade flows and supply chains adjust gradually. Empirical estimates of the trade elasticity for the short run are a fraction of those for the long run and suggest that trade is subject to substantive dynamic frictions. We develop a tractable framework that provides microfoundations for trade adjustment and rationalizes estimation of a time-varying trade elasticity. The model features forward-looking firms facing sticky sourcing choices and nests a version of the Eaton-Kortum model as a limiting long-run case. We calibrate the model and quantify the impacts of two events: the 2004 EU Eastern enlargement (an anticipated change) and the 2018 US-China trade war (an arguably unanticipated change). Our findings suggest that sourcing frictions and anticipation effects alter the time pattern of specialization, can result in short-term welfare losses but long-term gains, and can drive marked trade adjustments before anticipated shocks occur.

Keywords: International trade; estimation of the elasticity of trade; dynamic trade adjustment; staggered sourcing decision; 2004 EU Enlargement; US-China trade war.

JEL Classification: F11, F14, F17, C51

[*]University of California, San Diego; juc212@ucsd.edu.

[†]IFC, World Bank Group, Washington, DC. cbezerradegoes@ifc.org.

[¶]University of California, San Diego; muendler@ucsd.edu. Further affiliations: University of St. Gallen, NBER, CESifo, ifo, IGC.

[‡]University of California, San Diego; ftrottner@ucsd.edu.

1 Introduction

Innovations and disruptions to global supply chains lead to gradual adjustments in international trade. It has long been recognized that the trade elasticity, a key parameter that captures the substitution between imported goods across countries in response to trade costs, varies by time horizon (e.g. Dekle, Eaton and Kortum 2008). Several recent empirical estimates suggest that the trade elasticity in the long run can substantively differ from the short-run elasticity.[1] This differential suggests substantial frictions in trade adjustment that canonical models do not account for, potentially misstating the consequences and welfare costs of trade barriers. A dynamic framework is needed to estimate the trade elasticity and quantify how trade flows respond to shocks in a mutually consistent approach.

We propose a dynamic general-equilibrium model of trade with many countries and many industries, where forward looking but staggered procurement decisions give rise to horizon-specific trade elasticities. Local traders strive to source products from the lowest-cost global supplier. However, the opportunity to switch to a new supplier arrives only occasionally. As a result, only some traders can reoptimize their sourcing decisions at any point in time. Whenever a trader gets to reoptimize, it anticipates future changes in aggregate prices under perfect foresight and hence takes into account the option value of a trade relationship over its remaining life. In this framework, trade disruptions generate persistent transition dynamics, with sourcing patterns adjusting only gradually.

Our model extends the class of quantitative Ricardian models based on Eaton and Kortum (2002, henceforth EK) to a dynamic context while maintaining tractability. We characterize optimal sourcing decisions under adjustment frictions and the dynamic equilibrium using the hat algebra method (Dekle, Eaton and Kortum 2007, Caliendo, Dvorkin and Parro 2019). The three structural parameters governing the horizon-specific elasticity can be recovered from elasticity estimates by time horizons. The tractability of the framework permits counterfactual experiments with many countries and industries.

Our key innovation is to assign procurement decisions to a group of profit-seeking intermediaries, which we call traders. A friction to supplier choice locks traders into supplier relations chosen in an earlier period, so that not all varieties are sourced from the

[1] Alessandria et al. (2025*a*) estimate the elasticity of Chinese exports with respect to tariff gaps under uncertainty to be 8 in the long run (LR) and 3 in the short run (SR). Anderson and Yotov (2022) specify lag-augmented gravity regressions and estimate trade elasticities of 4.8 (LR) and 0.4 (SR). Boehm, Levchenko and Pandalai-Nayar (2023) combine plausibly exogenous tariff changes with local projections in a dynamic gravity setting and estimate trade elasticities of 2 (LR) and 0.7 (SR).

lowest-cost supplier at a given moment. In anticipation of this lock-in, traders make forward looking sourcing decisions when they have a choice because a supplier selected now may remain in place for multiple periods. As a result, a destination country's expenditure share going to a source country's varieties depends on past, present, and anticipated future trade costs. Nonetheless, the model preserves closed-form expressions for trade shares that generate a gravity equation of trade.

Our model yields an analytical expression for the familiar partial-equilibrium trade elasticity ε_i^h that measures the responsiveness of trade flows at a future time horizon h in response to a change in trade costs $\tau_{sdi,0}$ today:

$$\varepsilon_i^h \equiv \frac{\partial \ln \lambda_{sdi,h}}{\partial \ln \tau_{sdi,0}} = -\theta_i \left[1 - (1-\zeta_i)^{h+1}\right] - (\sigma_i - 1)(1-\zeta_i)^{h+1},$$

where $\lambda_{sdi,h}$ is destination d's expenditure share on goods from source country s in industry i, and $\zeta_i \in (0,1)$ is the *supplier adjustment probability*. The expression combines two forces known from benchmark trade models. On one hand, trade flows for varieties whose suppliers are reset adjust along the extensive margin, governed by the productivity distribution's Fréchet shape parameter θ_i as in EK. On the other hand, legacy varieties from continuing trade relations adjust along the intensive margin, governed by the elasticity of substitution σ_i as in Armington (1969). The supplier adjustment probability ζ_i regulates the relative importance of these two forces by governing the share of adjusted varieties at each horizon, so that the trade elasticity converges in absolute value toward θ_i as more and more legacy relationships turn over.

The forward looking nature of sourcing decisions induces preemptive behavior in response to the announcement of future cost changes, so that our model also gives rise to an anticipatory trade elasticity that measures the responsiveness of trade flows today in response to an anticipated change in trade costs at a future time horizon. Traders preemptively switch suppliers ahead of an anticipated change in trade costs under the extensive-margin elasticity θ_i. Switching prior to a future trade cost reduction raises costs in the short run, however, and induces buyers to temporarily reduce procurement volumes at the intensive margin governed by $\sigma_i - 1$.[2] The model admits a closed-form expression for this novel anticipatory trade elasticity, which intuitively grows in absolute value as the time of the shock approaches and vanishes in the absence of the sourcing friction.

[2]This combination of extensive and intensive-margin forces mirrors the structure of the trade elasticity with respect to bilateral fixed export costs in Chaney (2008), where higher fixed costs screen out less productive exporters and also generate opposing responses at the two margins.

Since the relative importance of the intensive, extensive, and anticipatory margins varies over time and across unanticipated and anticipated shocks, a single static trade elasticity is no longer sufficient to characterize the welfare impact along the transition path. Yet the model admits a horizon-specific welfare formula, which augments the static formula of Arkolakis, Costinot and Rodríguez-Clare (2012) with a dynamic adjustment term that captures the transitory price distortions arising from the sourcing friction. As the economy converges to a new steady state, the adjustment component fades away and the formula converges in the long run to that of Arkolakis, Costinot and Rodríguez-Clare (2012).

To calibrate the model, we use our analytical expression for the familiar trade elasticity to recover the structural parameters underlying the reduced-form specification of Boehm, Levchenko and Pandalai-Nayar (2023, henceforth BLP), who estimate the trade elasticity by time horizon. We interpret the BLP tariff instruments as capturing unanticipated permanent trade cost shocks because the instrumental variables isolate binding MFN tariff changes from the perspective of third countries that stand by as bilateral tariffs change. Our estimates from nonlinear GMM at both the aggregate and industry levels indicate that supplier relationships are highly persistent, with around 93 percent of procurement relationships carrying over year-to-year.

To illustrate the quantitative relevance of our framework, we conduct counterfactual experiments in a world economy with input-output linkages across 34 industries in 77 regions. We study two applications that highlight distinct features of our framework. We simulate the EU's Eastern enlargement in 2004, a pre-announced trade liberalization, and document how forward looking sourcing decisions generate anticipatory trade adjustment. Traders switch suppliers preemptively, so that trade patterns begin shifting at the extensive margin immediately after the 1995 announcement of tariff changes to come in 2004. The anticipatory supply-chain adjustments smooth the economy's transition to the new regime relative to a world without anticipation. With the 2018 US-China trade war, an arguably unanticipated shock, we document a complementary scenario, in which legacy sourcing relationships inherited from before the trade war erode gradually. The US welfare losses deepen over time as pre-war supplier links turn over, while China partially recovers through trade diversion to third countries such as Mexico and Vietnam. In both counterfactual experiments, a direct application of the static welfare formula from Arkolakis, Costinot and Rodríguez-Clare (2012) would yield misleading predictions over finite time horizons because trade flows early in the transition largely reflect sourcing frictions rather than shifts in comparative advantage.

Related literature. Our work relates to several strands of the literature. The wide discrepancy between a low short-run trade elasticity in absolute value in international macroeconomics and a high long-run trade elasticity in international trade has long been documented, among others by Ruhl (2008), who calls it an "international elasticity puzzle," and Fontagné, Martin and Orefice (2018). Several estimation procedures have been proposed to separately identify trade elasticities by time horizon (Fontagné, Guimbard and Orefice 2022, Boehm, Levchenko and Pandalai-Nayar 2023, de Souza et al. 2024, Anderson and Yotov 2022). Our general equilibrium model offers a rationalization of the horizon-specific trade elasticity as a mixture of the Armington and EK elasticities.[3]

A companion quantitative literature studies dynamic trade adjustment and the role of anticipation and uncertainty in models with heterogeneous firms and sunk export costs. Alessandria and Choi (2007) and Alessandria, Choi and Ruhl (2021) develop frameworks with sunk costs of exporting to analyze the welfare gains from trade and the slow response of trade flows to liberalization. Alessandria and Mix (2025) study how anticipation of future trade policy affects current trade flows. Alessandria et al. (2025*a*) and Alessandria et al. (2025*b*) back out the long run and short run trade elasticities from dynamic trade models applied to US-China trade relations. These frameworks, built on monopolistic competition with heterogeneous firms, generate rich firm-level dynamics but remain restricted to a limited number of countries and a single sector in quantitative scope.[4]

Our approach is complementary. We build on the Ricardian structure of EK, for which supply-side dynamics have been explored much less. Our framework accommodates many countries, many industries, and input-output linkages (as in Caliendo and Parro 2015) while delivering closed-form expressions for the horizon-specific trade elasticities and gains from trade. By assigning frictional procurement to traders in an EK-type model, we can account for forward looking behavior on the supply side. The framework also lends itself to tractable extensions with trade policy uncertainty and endogenous duration of supplier-buyer relationships.

The importance of staggered contracts for trade and exchange rate dynamics has been recognized since at least Kollintzas and Zhou (1992) and shares features with staggered pricing (Calvo 1983). We generalize deterministic contract ages to supplier relationships

[3]In a distinct but related contribution, Boehm et al. (2025) show that for a family of firm-level trade models the short-run trade elasticity can co-determine the steady-state gains from trade. In our framework, the steady state is independent of the sourcing friction, so the short-run elasticity matters for welfare only along the transition path.

[4]See Alessandria, Arkolakis and Ruhl (2021) for an extensive review of this literature.

that end stochastically. In a related approach, Arkolakis, Eaton and Kortum (2011) embedded a consumer without knowledge of the identity of the origin countries into an EK model. The consumer can switch to the lowest-cost supplier at random intervals, but cannot act strategically because the supplier is unknown. In comparison, we rationalize consumer behavior by assigning procurement to a special group of profit-seeking traders. This allows us to tractably account for the forward looking formation of supplier-buyer relations and the resulting equilibrium prices by contract age beyond a binary characterization.[5] We can fully derive steady states and transition dynamics. As a result, we obtain a version of the original EK model, in which traders command non-zero profits, as the limit of the equilibria along the transition path.

The remainder of the paper is organized as follows. Section 2 presents the model, with details on mathematical derivations relegated to the Appendix. Section 3 characterizes the dynamic responses of the model to trade cost changes. Section 4 conducts a structural estimation of the key parameters. Section 5 illustrates our framework with quantitative applications to the EU Eastern Enlargement in 2004 and the US-China trade war in 2018. Section 6 concludes.

2 Model

2.1 Fundamentals

The world economy consists of N countries indexed by $s, d \in \mathcal{N} := \{1, \ldots, N\}$ and I industries indexed by $i \in \mathcal{I} := \{1, \ldots, I\}$. Time is discrete and foresight is perfect.[6] Subscripts sdi, t index industry-i goods from source country s shipping to destination country d at time t.

Households. In each period t, a mass of L_d infinitely-lived households in country d inelastically supplies one unit of labor to domestic firms at a competitive wage rate $w_{d,t}$.[7]

[5] The underlying stochastic process shares features with the so-called Sisyphos Process (Montero and Villarroel 2016).

[6] Appendix C.1 extends the model to a stochastic environment where trade costs follow a Markov process and agents form expectations over uncertain future states. The extension nests perfect foresight as a limiting case.

[7] Our model can accommodate dynamic and imperfectly elastic labor supply across industries. Appendix C.2 extends the model to allow for costly forward looking labor allocation across industries, resulting in an upward-sloping labor supply curve by industry.

A representative household in country d derives utility from consuming an aggregate final good $C_{d,t}$ in each period t that bundles industry-specific goods with a Cobb-Douglas aggregator

$$C_{d,t} = \prod_{i \in \mathcal{I}} (C_{di,t})^{\eta_{di}}, \tag{1}$$

where the coefficient η_{di} is the consumption expenditure share of industry i's composite good and satisfies $\sum_{i \in \mathcal{I}} \eta_{di} = 1$. Let $P_{di,t}$ be the price index of industry i's composite good in d at time t. Country d's consumer price index is then $P_{d,t} = \prod_{i \in \mathcal{I}} (P_{di,t}/\eta_{di})^{\eta_{di}}$. Households do not save.

Intermediate goods. Every industry i consists of a continuum of potential producers of intermediate goods $\omega \in [0,1]$. A producer of intermediate good ω in source country s has an individual productivity $z(\omega)$ and operates a constant-returns-to-scale technology to produce the good using domestic labor ℓ and composite goods M_{ji} from other industries with

$$y_i(\omega) = z\,(\ell)^{\alpha_{si}} \prod_{j \in \mathcal{I}} (M_{ji})^{\alpha_{sji}}, \tag{2}$$

where $y_i(\omega)$ is the output of intermediate good ω. The coefficient α_{si} is the value-added share of industry i in country s, and the coefficients $\alpha_{sji} \geq 0$ are such that $\alpha_{si} = 1 - \sum_{j \in \mathcal{I}} \alpha_{sji}$. Intermediate-good producers are the only agents that employ labor.

Intermediate goods can be traded across countries subject to an iceberg transport cost, so that shipping one unit of a good in industry i from country s to country d at time t requires shipping out $u_{sdi,t} \geq 1$ units from s, where $u_{ddi,t} = 1$ for all d. In addition, goods imported by d from s at t may be subject to an *ad valorem* tariff $\bar{\tau}_{sdi,t} \geq 1$. We combine transport costs and tariffs into the single trade cost parameter $\tau_{sdi,t} \equiv u_{sdi,t}\bar{\tau}_{sdi,t}$. Only intermediate goods are traded across country borders.

Given trade costs and technologies, there is a *common unit cost component* at destination d for all intermediate goods produced in country s, which we denote with

$$c_{sdi,t} \equiv \Theta_{si} \tau_{sdi,t} \, (w_{s,t})^{\alpha_{si}} \prod_{j \in \mathcal{I}} (P_{sj,t})^{\alpha_{sji}}, \tag{3}$$

where Θ_{si} is a collection of Cobb-Douglas coefficients. The resulting unit cost of good ω at destination d produced in country s with a productivity $z(\omega)$ is given by $c_{sdi,t}/z(\omega)$.

Production technologies for intermediate goods arrive stochastically and independently at a rate that varies by country and industry. Following EK, the number of potential producers for an intermediate good ω in country s's industry i with a productivity higher than

z follows a Poisson distribution with mean $A_{si} z^{-\theta_i}$, so the distribution of the maximum productivity is Fréchet with shape parameter θ_i.

Assemblers of composite goods. In each industry i, assemblers costlessly bundle intermediate goods ω into a composite good $Y_{di,t}$ for consumption or production using the technology

$$Y_{di,t} = \left(\int_{[0,1]} y_{di,t}(\omega)^{\frac{\sigma_i - 1}{\sigma_i}} \mathrm{d}\omega \right)^{\frac{\sigma_i}{\sigma_i - 1}}, \tag{4}$$

where $y_{di,t}(\omega)$ is the quantity purchased of an intermediate good ω by an assembler in country-industry di, and σ_i is the elasticity of substitution between intermediate goods in industry i. Assemblers take as given the price $p_{di,t}(\omega)$, at which they can purchase an intermediate good ω in destination d. We explain in detail below the exact price at which an intermediate good is available. Cost minimization given (4) yields the assembler's demand for an intermediate good ω

$$y_{di,t}(\omega) = p_{di,t}(\omega)^{-\sigma_i} P_{di,t}^{\sigma_i} Y_{di,t}, \tag{5}$$

where

$$P_{di,t} = \left(\int_{[0,1]} p_{di,t}(\omega)^{-(\sigma_i - 1)} \mathrm{d}\omega \right)^{-\frac{1}{\sigma_i - 1}} \tag{6}$$

is the price of industry i's composite good at destination d.

Traders of intermediate goods. An assembler of a composite good requires specialized local *traders* to transact with the producers of intermediate goods at home and abroad. Concretely, access to each intermediate good variety ω is facilitated by a dedicated local trader at destination d who holds the exclusive license to procure ω from any of the potential global suppliers for assemblers at d. Under the exclusive license, a trader generates profits and therefore has the incentive to engage in forward looking behavior.

The hallmark feature of Ricardian trade is arguably the single-sourcing property at the extensive margin: any destination d procures a given variety ω from a unique source country s.[8] We therefore assign procurement, the economic activity associated with this key

[8] In the original two-industry, two-country benchmark as well as in the two-country, many-industry Dornbusch-Fischer-Samuelson model (1977) any given good is made in one location only, resulting in "bang bang" solutions for countably many imports. In the many-country, many-industry EK framework with a continuum of imports, multiple countries may produce the same variety but a given country purchases each

Ricardian property, to a distinct group of economic agents that we call traders.

A trader requires no labor input and has exclusive access to the competitive global Walrasian market, where the intermediate good ω is sold by producers, granting the trader local monopoly power at destination d over the intermediate good's procurement. Traders exploit this monopoly power to charge a price above marginal cost to assemblers and thereby turn a flow profit in every period, which the local representative household at destination d claims as a dividend. Traders discount future profits at a rate $1/(1+r_t)$. We take the resulting market structure for traders to be monopolistic competition.

2.2 Sourcing

Under the Ricardian trade tenet, a trader seeks to procure an intermediate good from the least costly global supplier. However, a trader only has the opportunity to adjust its choice of supplier at random times under a sourcing friction, which we describe now.

For each intermediate good ω, a trader's choice of source country is governed by an i.i.d. random variable $a_{di,t}(\omega) \in \{0,1\}$ which takes the value of 1 with probability $\Pr[a_{di,t}(\omega)=1] = \zeta_i$, for all $\omega \in [0,1], d \in \mathcal{N}$ and t. If $a_{di,t}(\omega) = 1$, then destination d's trader for an intermediate good ω in industry i has the green light to switch to its preferred source country. Else, if $a_{di,t}(\omega) = 0$, that is if the global draw for intermediate variety ω does not turn to green for the trader, then the trader must purchase variety ω from the same producer as in the preceding period $t-1$. The parameter $\zeta_i \in (0,1)$ is the industry-specific *supplier adjustment probability*, and it measures the frequency at which the sourcing friction is lifted.[9] While the identity of the source country does not change, the quantity procured and the price that the trader pays can differ from the preceding period if the factory gate price moves (because of changing factor costs) or the currently prevailing trade costs move (because of a policy or natural exogenous change).

This formulation of the sourcing friction captures search costs and other impediments that prevent the optimal rematch of supply relationships at a moment in time. The sourcing friction creates a lock-in effect that makes the optimal choice of supplier a dynamic and (in the presence of monopoly profits for traders) forward looking decision. Another implication of the sourcing friction is that price elasticities of demand will differ across

variety only from a unique source country.

[9] The model can accommodate endogenous frequencies of supplier adjustment. We develop this extension in Appendix C.3 by allowing traders to optimally choose the expected relationship duration at a managerial cost. The extension preserves the key aggregation properties that lend the model its tractability.

intermediate goods according to when their suppliers were last chosen. Let $\Omega^k_{di,t}$ denote the set of industry i's intermediate goods whose supplier at time t was last chosen k periods ago:

$$\Omega^k_{di,t} := \left\{\omega : a_{di,t-k}(\omega) = 1,\ \prod_{\varsigma=t-k+1}^{t} a_{di,\varsigma}(\omega) = 0\right\}, \tag{7}$$

where $\cup_{k\in\mathbb{N}_0}\Omega^k_{di,t} = [0,1]$. We call the intermediate goods that were last sourced optimally $k > 0$ periods ago the *legacy varieties*. The sets $\Omega^k_{di,t}$ mutually exclusively and exhaustively partition the unit interval of intermediate goods for each industry i for $k \geq 0$. We show in Appendix A.1 how the assembler's problem can be recast in terms of these partitions.

2.2.1 The trader's problem

We now characterize a trader's optimal choice of supplier for intermediate goods $\omega \in \Omega^0_{di,t}$, beginning with the trader's static and dynamic problem.

Static problem. Consider a trader in industry i at destination d who at time t sources an intermediate good ω from a given supplier in country s, and the given supplier's realized productivity $z_{si}(\omega)$ is at the country's maximum. Under perfect competition among the mass of potential suppliers with $z_{si}(\omega)$ as in EK, the given supplier sells at a price that equals marginal cost $c_{sdi,t}/z_{si}(\omega)$, which in turn depends on equilibrium factor prices and parameters by the common unit cost component (3). Profit maximization subject to demand in (5) then yields the price $p_{sdi,t}(\omega)$ that a trader charges the assembler in destination-industry di for an intermediate good ω procured from source country s:

$$p_{sdi,t}(\omega) = \frac{\sigma_i}{\sigma_i - 1}\frac{c_{sdi,t}}{z_{si}(\omega)}.$$

The trader's instantaneous profit is

$$\pi_{sdi,t}(\omega) = \frac{1}{\sigma_i}\left(\frac{\sigma_i}{\sigma_i - 1}\frac{c_{sdi,t}}{z_{si}(\omega)}\right)^{-(\sigma_i-1)} P^{\sigma_i}_{di,t} Y_{di,t}. \tag{8}$$

Dynamic problem. Under the sourcing friction, the chance to select a supplier at the extensive margin arrives randomly, with probability ζ_i for each trader in country-industry di. For an intermediate good $\omega \in \Omega^0_{di,t}$ that has the green light to be procured from a newly chosen supplier, the following Bellman equations characterize a trader's optimal choice of supplier:

$$V_{di,t}(\omega) = \max_{n \in \mathcal{N}} V_{di,t}(\omega, n), \tag{9}$$

where

$$V_{di,t}(\omega, n) = \pi_{ndi,t}(\omega) + \frac{\zeta_i}{1 + r_t} V_{di,t+1}(\omega) + \frac{1 - \zeta_i}{1 + r_t} V_{di,t+1}(\omega, n), \text{ for } n \in \mathcal{N}, \tag{10}$$

is the net-present value of a trader in d who procures intermediate good ω from country n at time t.

2.2.2 Legacy suppliers

Legacy intermediate goods $\omega \in \Omega^k_{di,t}$ with $k > 0$ receive no green light for optimal procurement at time t. To characterize supplier relations for these legacy intermediate goods, we denote changes over time for a variable x_t succinctly with $\hat{x}_t \equiv x_t / x_{t-1}$. Suppose a trader last optimally sourced intermediate good $\omega \in \Omega^k_{di,t}$ from s at time $t - k$ under the unit cost $c_{sdi,t-k}/z_{si}(\omega)$. If the intermediate good is still sourced from the same producer at time t, its price equals

$$p_{sdi,t}(\omega) = \frac{\sigma_i}{\sigma_i - 1} \frac{c_{sdi,t}}{z_{si}(\omega)} = p_{sdi,t-k}(\omega) \prod_{\varsigma = t-k+1}^{t} \hat{c}_{sdi,\varsigma},$$

which is the initial destination price at time $t - k$ adjusted for the cumulative changes in trade costs and factor prices since $t - k$.

2.2.3 Optimal supplier choice

To characterize the optimal choice of supplier for an intermediate good $\omega \in \Omega^0_{di,t}$ with a green light for optimal procurement, we use the recursive nature of the Bellman equations (9)–(10). As we elaborate in Appendix A.2, forward iteration under a standard set of transversality conditions yields the value of supplier choice for intermediate goods $\omega \in \Omega^0_{di,t}$:[10]

$$V_{di,t}(\omega) = \max_{n \in \mathcal{N}} \left\{ \pi_{ndi,t}(\omega) \left(1 + \Psi_{ndi,t}\right) \right\} + \frac{\zeta_i}{1 - \zeta_i} \sum_{u=1}^{\infty} \frac{(1 - \zeta_i)^u}{\prod_{\varsigma=1}^{u} (1 + r_{t+\varsigma-1})} V_{di,t+u}(\omega), \tag{11}$$

[10]The transversality conditions ensure that the present-value of sourcing from a given country n vanishes in the distant future: $\lim_{T \to \infty} \left[\prod_{\varsigma=1}^{T} (1 - \zeta_i)/(1 + r_{t+\varsigma-1}) \right] V_{di,T}(\omega, n) = 0$.

where

$$\Psi_{ndi,t} \equiv \sum_{\varsigma=1}^{\infty}(1-\zeta_i)^{\varsigma}\left[\prod_{\varsigma'=1}^{\varsigma}\frac{1}{1+r_{t+\varsigma'-1}}\left(\frac{\hat{c}_{ndi,t+\varsigma'}}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)}\hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'}\right]. \tag{12}$$

is a measure of the net rate of appreciation for the current value $\pi_{sdi,t}(\omega)$ of a supply relationship with a producer in country s given anticipated changes in trade costs and factor prices (through $\hat{c}_{ndi,t+\varsigma}/\hat{P}_{di,t+\varsigma}$) and domestic demand (through $\hat{P}_{di,t+\varsigma}\hat{Y}_{di,t+\varsigma}$). We call $\Psi_{sdi,t}$ the *option value of a procurement relation* for traders in destination d with a given source country s. The option value is specific to bilateral trade relationships between source and destination countries nd and common across intermediate goods producers and traders in an industry i at a moment in time t. This option value reflects the lock-in effect generated by the sourcing friction. In particular, if $\zeta_i \to 1$ so that there is no lock-in effect since supply relations fully reset in every period, then $\Psi_{sdi,t} \to 0$ and a procurement relation holds no option value for any pair of countries.

From equation (11), the optimal supplier choice $s^*_{di,t}(\omega) = \arg\max_n V_{di,t}(\omega, n)$ for each of the intermediate varieties $\omega \in \Omega^0_{di,t}$ satisfies

$$s^*_{di,t}(\omega) = \arg\min_{n\in\mathcal{N}} \frac{c_{ndi,t}}{z_{ni}(\omega)}\left(1+\Psi_{ndi,t}\right)^{-\frac{1}{\sigma_i-1}}.$$

In words, if the choice of supplier for intermediate good ω falls on a producer from country s, then the combination of the producer's productivity, the current unit cost in the source country s, the current trade costs between s and d, and the anticipated future trajectories of these costs must make the supplier the most profitable at time t. We refer to the term $[c_{ndi,t}/z_{ni}(\omega)]\left(1+\Psi_{ndi,t}\right)^{-1/(\sigma_i-1)}$ as the *net present cost*.

Similar to EK, our distributional assumptions imply that the productivity $z_{si}(\omega)$ of a potential supplier in country s has a country-industry specific Fréchet distribution given by[11]

$$\Pr\left[z_{si}(\omega) \leq z \mid A_{si}, \theta_i\right] = \exp\left\{-A_{si}z^{-\theta_i}\right\}.$$

As a consequence, the fraction of intermediate goods $\omega \in \Omega^0_{di,t}$, for which a trader in

[11]The model can also accommodate productivity change over time with a country-industry-time specific Fréchet distribution and resulting $z_{si,t}(\omega)$ realizations that vary over time and across the sets $\Omega^k_{i,t}$. Appendix C.4 develops this extension formally. To focus on adjustments to policy induced or geography related trade cost changes, we do not specify time-varying productivity shocks in the main text.

destination d optimally chooses a supplier from source country s, satisfies

$$\upsilon^0_{sdi,t} \equiv \Pr\left[\omega \in \Omega^0_{i,t} : s^*_{di,t}(\omega) = s\right] = \frac{A_{si} c^{-\theta_i}_{sdi,t} \left(1 + \Psi_{sdi,t}\right)^{\frac{\theta_i}{\sigma_i - 1}}}{\Upsilon_{di,t}}, \tag{13}$$

where

$$\Upsilon_{di,t} \equiv \sum_n A_{ni} c^{-\theta_i}_{ndi,t} \left(1 + \Psi_{ndi,t}\right)^{\frac{\theta_i}{\sigma_i - 1}} \tag{14}$$

is a measure of destination d's market access for intermediate goods $\omega \in \Omega^0_{di,t}$, given current and future trade cost along with factor prices behind the common unit cost component $c_{sdi,t}$ and the option value $\Psi_{sdi,t}$. We report the derivation of these results in Appendix A.2.

Equation (13) states the extensive margin demand at destination d for sources s of intermediate goods $\omega \in \Omega^0_{di,t}$ in explicit form. The familiar EK characterization of the optimal supplier choice follows as a limiting case when $(1 - \zeta_i)/(1 + r_{t+\varsigma-1}) \to 0$ so that $\Psi_{sdi,t} \to 0$ for all s. Except for that limiting case, optimal supplier choices also incorporate future changes in procurement costs to account for the lock-in effect generated by the sourcing friction.

2.3 Trade Flows

We now describe demand for intermediate goods in each set $\Omega^k_{di,t}$, including legacy varieties ($k > 0$). We begin with varieties whose supply relationships are formed optimally ($k = 0$). To obtain well defined relationships, we assume that the shape parameter of the productivity distribution exceeds the elasticity of substitution in all industries: $\theta_i > \sigma_i - 1$.

2.3.1 Demand for intermediate goods with newly formed supply relationships

Under forward looking procurement, a trader's optimal choice of supplier depends on future costs in addition to current costs. However, the prices that traders charge local assemblers reflect the prevailing cost of procurement. As a result, the distribution $G^0_{sdi,t}$ of prices paid by a local assembler for goods $\omega \in \Omega^0_{di,t}$ sourced from country s at time t generally differs from the cost distribution underlying the trader's optimal supplier choice.

On the cost side, it follows from the Fréchet distribution of maximum productivity that the net present cost of goods $\omega \in \Omega^0_{di,t}$ is identically distributed across source countries s

because differences in option value do not matter in expectation:

$$\Pr\left[\frac{c_{sdi,t}}{z_{si}(\omega)}\left(1+\Psi_{sdi,t}\right)^{-\frac{1}{\sigma_i-1}} \le \nu \,\middle|\, s^*_{di,t}(\omega)=s\right] = 1-\exp\left\{-\Upsilon_{di,t}\nu^{\theta_i}\right\}.$$

Also see Appendix A.2.

On the price side in contrast, if option values $\Psi_{sdi,t}$ vary between source countries s, then so will the distributions of prices paid by assemblers because traders pass current cost through to assemblers. We show in Appendix A.3 that the distribution of prices is

$$\begin{aligned} G^0_{sdi,t}(p) &= \Pr\left[p_{d,t}(\omega)\le p \,\middle|\, s^*_{di,t}(\omega)=s\right] \\ &= 1-\exp\left\{-\left(\frac{\sigma_i}{\sigma_i-1}\right)^{-\theta_i}\left(1+\Psi_{sdi,t}\right)^{-\frac{\theta_i}{\sigma_i-1}}\Upsilon_{di,t}p^{\theta_i}\right\}. \end{aligned} \tag{15}$$

If the option value for a country s is high, then traders are more likely to source goods from suppliers that are not currently the least expensive, so the current average price for goods procured from country s by forward looking traders will be higher than the choice of a myopic agent would be. Formally, if $\Psi_{sdi,t} > \Psi_{s'di,t}$, then $G_{sdi,t} \succ_1 G_{s'di,t}$, so the distribution of prices paid across goods sourced from s first-order stochastically dominates that of goods procured from s'. If $\Psi_{sdi,t} = \Psi_{s'di,t}$, then the distribution of the prices paid will be the same for countries s and s', as is the case in EK.

From the distributions of prices paid in (15), we can readily derive a destination d's expenditure share for each potential source country s across intermediate goods $\omega \in \Omega^0_{di,t}$:

$$\lambda^0_{sdi,t} = \frac{A_{si}c^{-\theta_i}_{sdi,t}\left(1+\Psi_{sdi,t}\right)^{\frac{\theta_i}{\sigma_i-1}-1}}{\Phi^0_{di,t}}, \tag{16}$$

where

$$\Phi^0_{di,t} \equiv \sum_{n\in\mathcal{N}} A_{ni}c^{-\theta_i}_{ndi,t}\left(1+\Psi_{ndi,t}\right)^{\frac{\theta_i}{\sigma_i-1}-1} \tag{17}$$

is the measure of country d's market access for intermediate goods $\omega \in \Omega^0_{di,t}$ based on current trade costs and factor prices. See Appendix A.3.

Equation (16) clarifies how current and future costs impact trade flows differently, depending on the underlying margins of adjustment. Note that the option value $\Psi_{sdi,t}$ is exclusively based on anticipated future unit cost changes by (12), relative to the preceding unit cost, while the current level of the unit cost component $c_{sdi,t}$ only matters at the present time t. At the extensive margin, trade flows therefore respond to current cost, as in EK, with an elasticity of $-\theta_i$. For intermediate goods in the set $\Omega^0_{sdi,t}$, with a green light for optimal procurement, the partial-equilibrium elasticity of trade flows with respect to the current trade cost is governed by the familiar Fréchet shape parameter:

$$\left.\frac{\partial \ln \lambda^0_{sdi,t}}{\partial \ln \tau_{sdi,t}}\right|_{\Phi^0_{di,t},\Psi_{sdi,t}} = -\theta_i.$$

In contrast, anticipated procurement choices in response to changes in future unit costs can result in uneven shifts in prices across source countries and can therefore trigger additional anticipated adjustments along the intensive margin. Suppose trade costs increase permanently after a future horizon h (for all $h' > h$), and that the interest rate is constant ($r_t = r$). For intermediate goods in the set $\Omega^0_{sdi,t}$, the partial-equilibrium response of trade flows to future trade costs is governed by the elasticity of substitution σ_i at the intensive margin, in addition to the Fréchet shape parameter at the extensive margin, and by a horizon-h specific discount factor:

$$\left.\frac{\partial \ln \lambda^0_{sdi,t}}{\partial \ln \{\tau_{sdi,t+h'}\}_{h'>h}}\right|_{\Phi^0_{di,t},c_{sdi,t}} = -\left[\theta_i - (\sigma_i - 1)\right]\left(\frac{1-\zeta_i}{1+r}\right)^h \frac{\Psi_{sdi,t+h}}{1+\Psi_{sdi,t}}.$$

The future option value $\Psi_{sdi,t+h}$ incorporates the permanent change in trade costs after h (for all $h' \geq h$).

Importantly, the response of trade flows to anticipated future trade costs reflects not just the extensive-margin adjustment but also adjustment of volume at the intensive margin. For $\theta_i > \sigma_i - 1$, the elasticity of substitution σ_i reduces the prevailing elasticity θ_i at the extensive margin and dampens the impact of future trade cost on current trade flows. The role of the option value for a trade-flow response mirrors the effect of fixed operation costs in heterogeneous-firm models with monopolistic competition when there is no firm entry. In fact, equation (16) coincides with the gravity equation in a Melitz (2003)-Chaney (2008) model with no entry and Pareto-distributed firm-level productivity, where the endogenous gross option value $(1 + \Psi_{sdi,t})$ replaces the bilateral fixed export costs from Chaney (2008).

2.3.2 Demand for intermediate goods with legacy supply relationships

Legacy intermediate goods $\omega \in \Omega^k_{di,t}$ with $k > 0$ are purchased from a supplier that was last optimally chosen at time $t - k$. We show in Appendix A.4 that country d's expenditure share by source country across intermediate goods $\omega \in \Omega^k_{di,t}$ equals

$$\lambda^k_{sdi,t} = \frac{\lambda^0_{sdi,t-k}\left(\prod_{\varsigma=t-k+1}^{t}\hat{c}_{sdi,\varsigma}\right)^{-(\sigma_i-1)}}{\Phi^k_{di,t}}, \tag{18}$$

where

$$\Phi^k_{di,t} = \sum_{n\in\mathcal{N}} \lambda^0_{ndi,t-k}\left(\prod_{\varsigma=t-k+1}^{t}\hat{c}_{ndi,\varsigma}\right)^{-(\sigma_i-1)} \tag{19}$$

reflects the mean price paid for the set of intermediate goods $\Omega^0_{di,t-k}$ at time $t-k$ given trade shares $\{\lambda^0_{ndi,t-k}\}_{n\in\mathcal{N}}$.

A comparison of equations (16) and (18) shows how the effect of unit costs on trade flows differs by the timing of the procurement relationship. If a trader can optimally source an intermediate good at time t, the effect of the cost change on trade flows is governed by the Fréchet shape parameter θ_i in (16), and trade flows reflect the effects of current and future changes to comparative advantage patterns. Conversely, if a trader is unable to switch suppliers, then the extensive margin of adjustment is inoperative. The only remaining margin of adjustment is the intensive one, which is governed by the terms that collect the cumulative changes in past unit costs under the elasticity of substitution σ_i in (18). In effect, trade flows follow a pattern as if the varieties were differentiated by country of origin and time of last procurement choice, where the measure of varieties from each origin and procurement time is defined by legacy partition $\Omega^k_{di,t}$. For each legacy partition $\Omega^k_{i,t}$ with $k>0$, Armington (1969) forces determine trade flows. The partial-equilibrium response of trade flows with respect to a concurrent trade cost change is governed by the elasticity of substitution σ_i:

$$\left.\frac{\partial \ln \lambda^k_{sdi,t}}{\partial \ln \hat{\tau}_{sdi,t}}\right|_{\Phi^k_{di,t},\lambda^0_{sdi,t-k}} = -(\sigma_i-1).$$

To close the model, we now show how aggregate demand for the composite good of industry i follows from the aggregation of trade shares in (16) and (18).

2.4 Aggregation

To derive aggregate demand, we rely on the homotheticity of assembly. The partial price index for the composite of legacy intermediate goods purchased at time t from suppliers chosen $t-k$ periods ago satisfies $(P^k_{di,t})^{-(\sigma_i-1)} = \int_{\omega\in\Omega^k_{i,t}} p_{di,t}(\omega)^{-(\sigma_i-1)}\mathrm{d}\omega$. The sets $\Omega^k_{di,t}$

exhaustively partition industry i's product space, so we can obtain country d's price index for industry i goods at time t by aggregating these partial price indices across all partitions and find $P_{di,t}^{-(\sigma_i-1)} = \sum_k (P_{di,t}^k)^{-(\sigma_i-1)}$.

We establish in Appendix A.5 that the partial price index for the set of intermediate goods whose suppliers are chosen optimally at time t takes the form

$$P_{di,t}^0 = \gamma_i \left(\mu_{di,t}(0) \frac{\Phi_{di,t}^0}{\Upsilon_{di,t}} \right)^{-\frac{1}{\sigma_i - 1}} (\Upsilon_{di,t})^{-\frac{1}{\theta_i}}, \tag{20}$$

where $\gamma_i \equiv [\sigma_i/(\sigma_i - 1)]\,\Gamma([\theta_i - (\sigma_i - 1)]/\theta_i)^{-1/(\sigma_i-1)}$, $\Upsilon_{di,t}$ is given by (14), $\Phi_{di,t}^0$ is given by (17), and $\mu_{di,t}(0)$ denotes the measure of the set $\Omega_{di,t}^0$. The measure $\mu_{di,t}(0)$ captures the gains from specialization at the extensive margin in the price index. The endogenous market access term $\Upsilon_{di,t}$ represents the mean present value of the newly formed supply relationships to traders in d at time t, and $\Phi_{di,t}^0$ is the value that these relationships provide to assemblers. The proportion of $\Phi_{di,t}^0$ to $\Upsilon_{di,t}$ therefore informs the transitory price effects of the sourcing friction between goods in the basket $\Omega_{di,t}^0$.

The measure $\mu_{di,t}(k)$ evolves recursively over time according to a stochastic process that governs the traders' optimal procurement decisions, similar to the so-called Sisyphos Process (Montero and Villarroel 2016):

$$\mu_{di,t}(k) = \begin{cases} \zeta_i & \text{for } k = 0, \\ (1 - \zeta_i)\mu_{di,t-1}(k-1) & \text{for } k > 0. \end{cases} \tag{21}$$

The parameter $\zeta_i \in (0,1)$ is the supplier adjustment probability, and it determines the share of traders from industry i that can switch suppliers.

We also establish in Appendix A.5 that the partial price index across legacy intermediate goods, whose suppliers were chosen at time $t-k$, satisfies

$$P_{di,t}^k = P_{di,t-k}^0 \left(\frac{\mu_{di,t}(k)}{\mu_{di,t-k}(0)} \Phi_{di,t}^k \right)^{-\frac{1}{\sigma_i - 1}}, \tag{22}$$

which is the period $t-k$ price index of the basket of intermediate goods $\Omega_{i,t-k}^0$ adjusted for subsequent changes in variety composition, captured by $\mu_{di,t}(k)$, and prices, captured by $\Phi_{di,t}^k$.

Given equations (20) and (22), we can solve for the composite price index of industry i

goods in country d at time t

$$P_{di,t} = P^0_{di,t} \left[1 + \sum_{k=1}^{\infty} \frac{\mu_{di,t}(k)}{\mu_{di,t}(0)} \left(\frac{P^0_{di,t-k}}{P^0_{di,t}} \right)^{-(\sigma_i - 1)} \Phi^k_{di,t} \right]^{-\frac{1}{\sigma_i - 1}} \tag{23}$$

as well as for country d's expenditure share on industry i goods sourced from country s

$$\lambda_{sdi,t} = \sum_{k=0}^{\infty} \left(\frac{P^k_{di,t}}{P_{di,t}} \right)^{-(\sigma_i - 1)} \lambda^k_{sdi,t}, \tag{24}$$

where $\lambda^k_{sdi,t}$ is given by (16) if $k = 0$ and by (18) if $k > 0$. Appendix A.6 provides details.

The set of trade shares $\{\lambda_{sdi,t}\}_{s,d \in \mathcal{N}, i \in \mathcal{I}}$ fully characterizes the demand in the world economy at time t. To close the model, we now describe the conditions for market clearing and define general equilibrium.

2.5 Equilibrium

We denote total spending of a final good assembler in destination-industry di at time t by $E_{di,t} = P_{di,t} Y_{di,t}$. Under constant markup pricing, the traders in di keep a share $1/\sigma_i$ of these expenditures (their sales) as profit and pay the remainder to their suppliers (foreign and domestic producers). The total profit $\Pi_{di,t}$ and the total procurement cost $X_{di,t}$ across all traders for sector i varieties in d can thus be expressed as $\Pi_{di,t} = E_{di,t}/\sigma_i$ and $X_{di,t} = (1 - 1/\sigma_i) E_{di,t}$.

Global procurement payments $\{X_{di,t}\}_{d \in \mathcal{N}}$ of traders, routed through bilateral trade shares $\{\lambda_{sdi,t}\}_{s,d \in \mathcal{N}}$, generate sales revenue $R_{si,t}$ for producers in source country s:

$$R_{si,t} = \sum_d \lambda_{sdi,t} X_{di,t} = \sum_d \lambda_{sdi,t} \left(1 - \frac{1}{\sigma_i} \right) E_{di,t}.$$

In equilibrium, the total labor income and the total profit income in each country therefore is a function of trade shares (24) and composite good expenditures $\{E_{di,t}\}_{d \in \mathcal{N}, i \in \mathcal{I}}$:

$$w_{s,t} L_s = \sum_{i \in \mathcal{I}} \alpha_{si} \left(1 - \frac{1}{\sigma_i} \right) \sum_d \lambda_{sdi,t} E_{di,t} \tag{25}$$

and

$$\Pi_{s,t} = \sum_i \Pi_{si,t} = \sum_i \frac{E_{si,t}}{\sigma_i}. \tag{26}$$

The final good expenditure of a country is the sum of its factor income, profit income, and trade deficit so that $F_{d,t} = w_{d,t}L_{d,t} + \Pi_{d,t} + D_{d,t}$, under the adding-up constraint $\sum_{d\in\mathcal{N}} D_{d,t} = 0$. We follow the conventional approach in the international trade literature and treat aggregate trade deficits as exogenous transfers. Under Cobb-Douglas preferences and sales revenue $R_{si,t}$ of producers in source country s given above, the market clearing condition for each industry i's composite good in country s can be written as

$$E_{si,t} = \eta_{si}F_{s,t} + \sum_{j\in\mathcal{I}} \alpha_{sij} \sum_{d\in\mathcal{N}} \left(1 - \frac{1}{\sigma_j}\right) \lambda_{sdj,t}E_{dj,t}. \tag{27}$$

We are now ready to define a dynamic general equilibrium and a steady state.[12]

Definition 1 (Equilibrium and Steady State)**.** *An economy is a set of time-invariant technologies, preferences and factor endowments* $\overline{\boldsymbol{\Theta}} \equiv \{\theta_i, \sigma_i, \{A_{di}, \eta_{di}, \{\alpha_{dji}\}_{j\in\mathcal{I}}, L_d\}_{d\in\mathcal{N}}\}_{i\in\mathcal{I}}$, *sourcing frictions* $\overline{\boldsymbol{\zeta}} \equiv \{\zeta_i\}_{i\in\mathcal{I}}$, *as well as measures* $\overline{\boldsymbol{\mu}}_0 \equiv \{\mu_{di,\varsigma}(k)\}_{d\in\mathcal{N},i\in\mathcal{I},k\in\mathbb{N}_0,\varsigma\leq t_0}$ *(of the sets of industry* i*'s intermediate goods whose supplier to destination* d *at time* ς *was last chosen* k *periods ago) for some* t_0*. Given a path of trade costs* $\boldsymbol{\tau} \equiv \{\boldsymbol{\tau}_\varsigma\}_{\varsigma\in\mathbb{Z}} = \{\tau_{sdi,\varsigma}\}_{s,d\in\mathcal{N},i\in\mathcal{I},\varsigma\in\mathbb{Z}}$ *and interest rates* $\boldsymbol{r} \equiv \{r_\varsigma\}_{\varsigma\in\mathbb{Z}}$*:*

1. *A static equilibrium at time* t *is a vector of wages* $\boldsymbol{w}_t = w\left(\boldsymbol{w}_{-t}, \overline{\boldsymbol{\Theta}}, \boldsymbol{\tau}, \boldsymbol{r}, \overline{\boldsymbol{\mu}}_0, \overline{\boldsymbol{\zeta}}\right)$ *that jointly solves equations* (24)*,* (25)*,* (26)*, and* (27) *for all* $s, d \in \mathcal{N}$*,* $i \in \mathcal{I}$*,* $\boldsymbol{w}_{-t} \equiv \{w_{d,\varsigma}\}_{d\in\mathcal{N},\varsigma\in\mathbb{Z}\setminus\{t\}} \in \mathbb{R}_+^{N\times(\mathbb{Z}\setminus\{t\})}$*, and* $\{\mu_{sdi,t}(k)\}_{s,d\in\mathcal{N},i\in\mathcal{I},t>t_0}$ *given by* (21)*.*

2. *A dynamic equilibrium is a path of wages* $\{\boldsymbol{w}_t\}_{t\in\mathbb{Z}}$ *so that, for all* t*, the wage satisfies* $\boldsymbol{w}_t = w\left(\boldsymbol{w}_{-t}, \overline{\boldsymbol{\Theta}}, \boldsymbol{\tau}, \boldsymbol{r}, \overline{\boldsymbol{\mu}}_0, \overline{\boldsymbol{\zeta}}\right)$*.*

3. *A dynamic equilibrium is a steady state if* $\boldsymbol{w}_{t'} = \boldsymbol{w}_t$ *for all* $t' > t$*.*

2.6 Dynamic Hat Algebra

The model economy hosts many industries in each country with varying absolute advantage. However, by leveraging the well-known hat algebra technique (Dekle, Eaton and

[12]The definition allows for the possibility that, up to t_0, the evolution of measures $\{\mu_{di,t}(k)\}$ can have been governed by an arbitrary supplier adjustment probability ζ_i, so we can accommodate shocks to supplier adjustment.

Kortum 2007), there is no need to explicitly back out the productivity parameters $\{A_{di}\}_{di}$ or trade costs $\{\tau_{sdi,t}\}_{sdi,t}$. It suffices to compute the proportional changes of all variables relative to the initial steady state levels along the entire paths following the shocks. Appendix E.1 restates the equilibrium conditions in terms of relative changes.

3 Dynamic Adjustment to Trade Shocks

We now use the model to study the economy's dynamic response to current and anticipated future changes in trade costs. We derive a new structural estimating equation for the trade elasticity at different time horizons and a new formula for the dynamic welfare gains from trade. To anchor the dynamics, we first turn to steady state. For the steady state to be well defined, we consider a time invariant interest rate r from now on.

3.1 Steady State

Transitory effects of trade disruptions arise in our model because opportunities to switch suppliers are limited in the short run and because traders are forward looking. Traders get to optimally adjust their supply relationships in the long run, so in the limit of the equilibria along the transition path we obtain a version of the static EK model with profit seeking monopolistic traders.

Formally, define $\mathbf{1}_\infty^\top$ as a row vector of ones with infinite dimension. Our framework accommodates a version of the static EK model: a frictionless economy with $\zeta_i = 1$ for all industries i, time-invariant bilateral trade costs $\overline{\boldsymbol{\tau}} = \boldsymbol{\tau}_0 \otimes \mathbf{1}_\infty^\top$ and a constant interest rate $\overline{\boldsymbol{r}} = r_0 \mathbf{1}_\infty^\top$. Denoting the equilibrium wages in this frictionless EK economy with $\boldsymbol{w}^{EK}$, we establish

Proposition 1 (Steady State.)**.** *If $\boldsymbol{w}^*$ is a steady state equilibrium, then*

1. *For any $\overline{\boldsymbol{\zeta}}, \overline{\boldsymbol{\mu}}$ and $\overline{\boldsymbol{\mu}}'$, $w\left(\boldsymbol{w}^* \mathbf{1}_\infty^\top, \overline{\boldsymbol{\Theta}}, \overline{\boldsymbol{\tau}}, \overline{\boldsymbol{r}}, \overline{\boldsymbol{\mu}}, \overline{\boldsymbol{\zeta}}\right) = w\left(\boldsymbol{w}^{EK} \mathbf{1}_\infty^\top, \overline{\boldsymbol{\Theta}}, \overline{\boldsymbol{\tau}}, \overline{\boldsymbol{r}}, \overline{\boldsymbol{\mu}}', \mathbf{1}_I\right)$.*

2. *For all $k \in \{0, 1, ...\}$, the measure of goods $\omega \in \Omega_{di,t}^k$ equals $\mu_i^*(k) = \zeta_i (1 - \zeta_i)^k$ for all $d \in \mathcal{N}$, and trade flows are given by $\lambda_{sdi,*}^k = \lambda_{sdi}^{EK}$ where λ_{sdi}^{EK} denotes the trade shares in the frictionless economy.*

Proof. See Appendix A.7. $\square$

The first statement establishes that steady-state wages are invariant to the supplier adjustment probability ζ_i, implying that the magnitude of the sourcing friction has no bearing on the steady state behavior of the economy. For estimation, this insight implies that some structural parameters can only be identified from changes that move an economy out of steady state. The second statement characterizes the steady state age distribution of supplier relationships, which follows a geometric distribution with parameter ζ_i, and affirms that expenditure shares equalize across varieties regardless of when a supplier was last chosen. We later employ these properties in our quantitative analysis to calibrate the initial steady state from observed trade shares and to compute counterfactual transition dynamics.

3.2 Trade Elasticities by Time Horizon

We begin by showing how the trade elasticity (the elasticity of trade flows with respect to current transport cost) varies by time horizon in our model. The trade elasticity $\varepsilon^h_{sdi,t}$ at time horizon h is defined as

$$\varepsilon^h_{sdi,t} \equiv \left. \frac{\partial \ln X_{sdi,t+h}}{\partial \ln \tau_{sdi,t}} \right|_{\{\Phi^k_{di,t+\varsigma}, \Psi_{sdi,t+\varsigma}\}_{t\leq\varsigma\leq h,k}} \quad \text{for } h \geq 0 \tag{28}$$

and trade flows in industry i from country s to d at time $t+h$ after a permanent trade cost change at time t. Here $X_{sdi,t} \equiv \lambda_{sdi,t} E_{di,t}$ denotes tariff-inclusive bilateral expenditure. The elasticity measures the proportional change in trade flows $X_{sdi,t+h}/X_{sdi,t-1}$, compared to the pre-shock period, with respect to the change in trade costs at t, $\mathrm{d} \ln \tau_{sdi,t} = \ln \hat{\tau}_{sdi,t}$. The elasticity definition holds fixed the general equilibrium terms that summarize changes in current market access and future procurement cost for industry i goods at destination d. Proposition 2 provides an analytical characterization of this elasticity.

Proposition 2 (Trade Elasticities)**.** *Suppose the economy is in steady state at* $t = -1$*. Then, up to first order, the elasticity of the horizon-*h *trade flows with respect to a shock to trade cost at time* $t = 0$ *is*

$$\varepsilon^h_i = -\theta_i \left[1 - (1-\zeta_i)^{h+1}\right] - (\sigma_i - 1)(1-\zeta_i)^{h+1}. \tag{29}$$

If $\zeta_i \in (0,1)$*, then* $\lim_{h\to\infty} \varepsilon^h_i = -\theta_i$*, and the rate of convergence equals*

$$\lim_{h\to\infty} \frac{\varepsilon^{h+1}_i + \theta_i}{\varepsilon^h_i + \theta_i} = 1 - \zeta_i.$$

Proof. See Appendix A.8. □

As $h \to \infty$, the trade elasticity $\varepsilon_i^h > -\theta_i$ strictly decreases toward the long-run limit of $-\theta_i$ (strictly increases over time in absolute value) if $\theta_i > \sigma_i - 1$. In the long-run, the trade elasticity equals the Fréchet parameter θ_i in absolute value. The rate of convergence to the industry's long-run elasticity depends on the industry-specific supplier adjustment probability ζ_i, the frequency at which assemblers can establish a new sourcing relationship.

The definition of the horizon-specific trade elasticity in (28) is consistent with reduced-form estimates at varying time horizons as in BLP. For estimation, we will leverage this equivalence to identify the structural parameters governing the trade elasticity.

3.3 Anticipatory Trade Adjustment

We now describe how trade flows respond to anticipated changes in future trade cost. The anticipatory trade elasticity is defined as

$$\varepsilon_{sdi,t}^{-h} = \left.\frac{\partial \ln X_{sdi,t}}{\partial \ln \hat{\tau}_{sdi,t+h}}\right|_{\{\Phi^0_{sdi,t+\varsigma}\}_{\varsigma \geq t}} \quad \text{for } h > 0 \tag{30}$$

and source-industry-destination sdi trade flows at time t and an anticipated change in trade cost at time $t+h$. This elasticity captures the partial equilibrium response of trade flows in the present to an anticipated permanent shift in trade cost h periods in the future. The following proposition provides an analytical characterization of this partial equilibrium elasticity.

Proposition 3 (Anticipatory Trade Elasticities)**.** *Suppose the economy is in steady state at $t = -1$. Then, up to first order, the elasticity of trade flows at $t = 0$ with respect to an anticipated change in future trade cost at time $h > 0$ is*

$$\varepsilon_i^{-h} = -\left[\theta_i - (\sigma_i - 1)\right] \zeta_i \left(\frac{1-\zeta_i}{1+r}\right)^{h+1}. \tag{31}$$

Proof. See Appendix A.9. □

Equation (31) highlights the economic forces that govern anticipatory supplier switching. The anticipatory trade elasticity ε_i^{-h} decreases in absolute value with the elasticity of substitution. Intuitively, anticipating a future cost reduction means sourcing today from suppliers who are currently more expensive, which sacrifices current profits as demand substitutes toward cheaper varieties. The elasticity also decreases in both the interest rate r and the anticipation horizon h, since both reduce the present discounted value of the future cost savings that motivate anticipatory switching.

The expression also clarifies that ε_i^{-h} varies non-monotonically in ζ_i because of two opposing forces. At the extremes, no anticipation occurs: if $\zeta_i = 0$ then no trader can adjust and demand shifts only along the intensive margin; if $\zeta_i = 1$ then all traders adjust instantaneously every period and there is no value to switching in anticipation of a future shock. In the intermediate range, a higher ζ_i increases the mass of adjusting traders $\Omega^0_{di,t}$, favoring anticipation, but also raises the probability of adjustment before shock arrival, reducing the value of current adjustment. The second force dominates at longer horizons, as the discount factor $\left[(1-\zeta_i)/(1+r)\right]^{h+1}$ makes explicit.

From this discussion, it follows that temporary shocks evoke a smaller trade response than the permanent shocks characterized in Proposition 2. This is because the anticipation of shock reversal diminishes the option value of switching suppliers, leading traders to retain existing relationships rather than switch to the currently cheapest supplier. Appendix C.1 provides a formal derivation and shows that qualitatively similar effects arise under uncertainty about shock duration.[13]

3.4 Welfare Gains by Time Horizon

Having identified the forces that govern the transitory dynamics of trade flows in partial equilibrium, we now turn to the general equilibrium welfare implications of these trade dynamics. We show that our model admits a dynamic welfare formula that generalizes existing sufficient statistic results for the welfare gains from trade in static models with CES demand to incorporate forward looking behavior and gradual formation of supply relationships.

Proposition 4 (Real Wage and Real Profits)**.** *Suppose the economy is in steady state at $t=-1$. Then the change of the real wage $\hat{W}_d^h = \frac{w_{d,h}/P_{d,h}}{w_{d,-1}/P_{d,-1}}$ in country d at time horizons $h=\{0,1,...\}$ in response to an arbitrary convergent sequence of trade shocks satisfies*

$$\hat{W}_d^h = \prod_{j\in\mathcal{I}} \left[\left(\frac{\lambda_{ddj,h}}{\lambda_{ddj,-1}}\right)^{-\frac{1}{\theta_j}} \left(\Xi_{dj,h}\right)^{\frac{1}{\sigma_j-1}} \right]^{\sum_{i\in\mathcal{I}} \bar{a}_{dji}\eta_i}, \tag{32}$$

[13] In particular, we show that a constant hazard of shock reversal uniformly dampens the trade elasticity across horizons. Similarly, under perfect foresight the dampening effect strengthens as horizons approach the anticipated reversal date.

where

$$\Xi_{dj,h} \equiv (1-\zeta_j)^{h+1}\left(\frac{\lambda_{ddj,-1}}{\lambda_{ddj,h}}\right)^{\frac{\theta_j-\sigma_j+1}{\theta_j}} + \sum_{\varsigma=0}^{h}\zeta_j(1-\zeta_j)^{\varsigma}\left(\frac{\upsilon^0_{ddj,h-\varsigma}}{\lambda_{ddj,h}}\right)^{\frac{\theta_j-\sigma_j+1}{\theta_j}} \tag{33}$$

and $\bar{a}_{dji}$ is the (j,i)-th element of the Leontief inverse $(\mathbf{I}-\boldsymbol{A}_d)^{-1}$ with the elements of $\boldsymbol{A}_d$ given by α_{dji}.

The change of real profits per capita satisfies

$$\frac{\Pi_{d,h}/(P_{d,h}L_d)}{\Pi_{d,-1}/(P_{d,-1}L_d)} = \hat{W}_d^h \cdot \frac{\kappa_{d,h}/(1-\kappa_{d,h})}{\kappa_{d,-1}/(1-\kappa_{d,-1})} \cdot \frac{1+D_{d,h}/(w_{d,h}L_d)}{1+D_{d,-1}/(w_{d,-1}L_d)}, \tag{34}$$

where $\kappa_{d,t} \equiv \sum_i E_{di,t}/(\sigma_i F_{d,t})$ is the ratio of aggregate profits to final expenditure.

Proof. See Appendix A.10. □

Equation (32) decomposes real wage changes into the standard Arkolakis, Costinot and Rodríguez-Clare (2012, henceforth ACR) term based on domestic trade shares and correction factors $\Xi_{dj,h}$ that capture terms of trade distortions by horizon h. The terms $\Xi_{dj,h}$ depend on model objects that are not directly observable, so the formula does not yield a reduced-form sufficient statistic. It does, however, make transparent the forces that shape welfare along a transition path, and why the welfare-relevant trade elasticity differs from its structural counterpart in (29).[14]

The aggregate change in a country's real wage incorporates shifts in realized comparative advantage through the terms $(\lambda_{ddj,h}/\lambda_{ddj,-1})^{-1/\theta_j}$. Since the Fréchet parameter θ_j represents the price elasticity of demand for newly sourced goods, these terms measure the change in an industry's consumer price index as if all varieties were sourced optimally. For finite horizons $h<\infty$, the sourcing friction distorts the home expenditure shares $\lambda_{ddj,h}$. Only as $h\to\infty$, when all goods are optimally sourced, do home expenditure shares capture the entire real wage response as in EK.

The terms $(\Xi_{dj,h})^{1/(\sigma_j-1)}$ reflect distortions in a country's terms of trade from two sources. First, legacy varieties that have not been optimally sourced between $t=0$ and $t=h$ have current home expenditure shares $\lambda_{ddj,h}$ that deviate from the initial steady state at $t=-1$. Second, for legacy varieties that were optimally sourced at some point between

[14]The quantitative applications in Section 5 solve for transition dynamics exactly using dynamic hat algebra, assuming that the economy starts in steady state, and evaluate welfare using the full nonlinear transition path rather than the first-order approximations in Propositions 2 and 3.

$t = 0$ and $t = h$, assemblers' current home expenditure shares deviate from the extensive margin demand $\upsilon^0_{ddj,h-\varsigma}$ that prevailed when traders last chose suppliers. Rearranging equations (13) and (16) shows how the importance of these two effects varies across legacy varieties depending on when their current supplier was chosen:

$$\frac{\upsilon^0_{ddi,h-\varsigma}}{\lambda_{ddi,h}} = \frac{\Phi^0_{di,h-\varsigma}}{\Upsilon_{di,h-\varsigma}}(1 + \Psi_{ddi,h-\varsigma})\frac{\lambda^0_{ddi,h-\varsigma}}{\lambda_{ddi,h}}, \quad \text{for } 0 \leq \varsigma \leq h.$$

The first two terms on the right capture how traders' choices to procure goods based on option values rather than from the least expensive global supplier at time $t = h-\varsigma$ continue to distort prices paid for goods $\omega \in \Omega^{\varsigma}_{di,h}$ at time $t = h$. The ratio $\lambda^0_{ddi,h-\varsigma}/\lambda_{ddi,h}$ traces how the impact of these initial extensive margin distortions on a country's terms of trade evolves over time, as supplier relationships turn over.

While real wages reflect a country's terms of trade, real profits also depend on the country's domestic expenditure absorption. As equation (34) shows, shifts in real profits per capita thus adjust shifts in real wages for how movements in the aggregate profit ratio $\kappa_{d,t}$ and the real deficit per capita $D_{d,t}/(w_{d,t}L_d)$ alter the ratio of profit income to wage income. Intuitively, nominal wage growth in a country with a trade deficit erodes the real value of the deficit, reducing its contribution to domestic absorption and compressing profits relative to wages. Conversely, a reallocation of expenditure toward industries with higher markups raises the aggregate profit share $\kappa_{d,t}$, increasing the fraction of final expenditure funded by profit income.

Since both $\kappa_{d,t}$ and $D_{d,t}/(w_{d,t}L_d)$ vary along the transition path and across steady states, real profits generally diverge from real wages in response to trade shocks. Combining equations (32) and (34), we can compactly describe the associated welfare implications:

$$\frac{C_{d,h}}{C_{d,-1}} = \hat{W}^h_d \cdot \frac{\Gamma_{d,h}}{\Gamma_{d,-1}}, \quad \text{where} \quad \Gamma_{d,t} \equiv \frac{1 + D_{d,t}/(w_{d,t}L_d)}{1 - \kappa_{d,t}}. \tag{35}$$

In the absence of sourcing frictions ($\Xi_{dj,h} = 1$) and profits ($\kappa_{d,t} = 0$), equation (35) reduces to ACR's static welfare formula with exogenous deficits (Costinot and Rodríguez-Clare 2014). Away from this special case, the gains from trade vary over time and depend on the point in time when the economy in transition is observed. We estimate the structural parameters that govern these dynamics in the next section.

4 Estimation

This section estimates the structural parameters θ, σ, and ζ that govern the horizon-specific trade elasticity. The next section will use these estimates to quantify how the 2004 EU enlargement and the 2018 US-China trade war affected trade, production and welfare.

4.1 Empirical Strategy

To estimate the structural parameter vector $\Theta_i \equiv \{\theta_i, \sigma_i, \zeta_i\}$ that governs the horizon-specific trade elasticities, we exploit the analytical characterization (29) from Proposition 2. Intuitively, σ_i governs the short-run trade elasticity, θ_i informs its long-run level, and ζ_i determines the speed of convergence from short to long run. Because Proposition 2 is derived for unanticipated and permanent tariff changes, our empirical strategy restricts attention to plausibly exogenous and persistent shocks.

Let p denote an HS6-level product in industry i. Using Proposition 2, the structural equation for the h-horizon elasticity of tariff-exclusive bilateral exports $\tilde{X}_{sdp,t+h}$ to an unanticipated change in tariffs $\ln \bar{\tau}_{sdp,t}/\bar{\tau}_{sdp,t-1}$ at year t is

$$\ln\left(\frac{\tilde{X}_{sdp,t+h}}{\tilde{X}_{sdp,t-1}}\right) = \left(\epsilon^h\left(\Theta_i\right) - 1\right) \ln\left(\frac{\bar{\tau}_{sdp,t}}{\bar{\tau}_{sdp,t-1}}\right) + K'_{sdp,t}\gamma_i^h + \delta_{si,t+h} + \delta_{di,t+h} + u_{sdp,t+h}, \quad (36)$$

where $\epsilon^h(\Theta_i)$ is the horizon-specific trade elasticity, written as a function of the structural parameter vector Θ_i using equation (29); $K_{sdp,t}$ denotes a vector of lagged controls for trade volumes and tariff changes

$$K_{sdp,t} \equiv \left[\ln\left(\frac{\tilde{X}_{sdp,t-1}}{\tilde{X}_{sdp,t-2}}\right), \ \ln\left(\frac{\bar{\tau}_{sdp,t-1}}{\bar{\tau}_{sdp,t-2}}\right)\right] \quad (37)$$

following BLP; δ denotes fixed effects; and $u_{sdp,t+h}$ is a residual.[15]

The BLP identification strategy naturally fits within our framework. BLP use as instrument binding changes in most favored nation (MFN) tariffs that affect non-major trade partners. While policymakers may adjust MFN tariffs with specific partners in mind, such changes affect all trade partners by construction. From the perspective of third countries

[15]Subtraction of one from the trade elasticity ($\epsilon^h\left(\Theta_i\right) - 1$) is necessary because the trade data exclude tariff payments while the model-consistent definition of the trade elasticity requires inclusion of tariff payments in trade flows.

that were not the target of the policy change, the tariff change is plausibly unanticipated and exogenous.[16] MFN tariff changes are also unlikely to revert, making them a plausible empirical counterpart to the permanent shocks in our model.[17]

Adopting the BLP instrument, we form standard GMM moment conditions for each horizon:

$$m^h_{sdp,t}(\Theta_i) \equiv \mathrm{E}[u_{sdp,t+h} Z_{sdp,t}] = 0,$$

where $Z_{sdp,t}$ denotes the instrumental variable. Estimation amounts to solving a nonlinear GMM problem with the moment conditions $\{m^h_{sdp,t}\}_{h \in \mathcal{H}}$ for a set $\mathcal{H}$ of at least three horizons. The estimating equation is linear in the independent variables, so we residualize to partial out exporter and importer fixed effects by industry and time before running GMM. Our baseline specification pools industries to estimate a common Θ.

4.2 Data

We use the same data sources as BLP. Bilateral trade volumes at the HS6 level (tariff-exclusive, 1995–2018) come from BACI (Gaulier and Zignago 2010), which harmonizes COMTRADE data. Tariff data come from the United Nations Trade Analysis Information System (TRAINS), accessed via the World Integrated Trade Solution (WITS) platform.

We follow the BLP replication package in processing the trade and tariff data and constructing the instrumental variable. The only additional requirement is a balanced panel, since the GMM procedure requires each source-destination-product triplet to have valid observations over all horizons used in estimation.

4.3 Results

We now present estimates from pooling industries, then show estimates by industry group.

4.3.1 Pooled estimation across industries

Table 1 presents the estimates. Each row reports the specification with the lowest J-statistic for a given number of moment conditions. To select our preferred specification, we use the GMM-BIC criterion of Andrews (1999). For a given $\mathcal{H}$, the GMM-BIC criterion equals

[16] The instrument is binding MFN tariff changes for destination countries that are not among the source country's top five trade partners, either in aggregate or for a given product. See Section 2.3 of BLP for details.

[17] In Appendix C.1, we show that if shocks revert with positive probability, the estimated elasticity is attenuated. The MFN tariff changes used by BLP are less susceptible to this concern.

Table 1: Structural Parameter Estimation

Selection of horizons (moment conditions)	θ	$\sigma - 1$	$1 - \zeta$	Hansen's J-statistic	F-stat. over horizons 1–3
1–10 (all horizons)	5.46	0.70	0.96	14.62	45.81
	(14.31)	(0.37)	(0.13)	[0.04]	[0.00]
Excluding horizon 3	**3.51**	**0.52**	**0.93**	8.00	44.81
	(3.45)	(0.38)	(0.12)	[0.24]	[0.00]
Excluding horizons 2–3	4.20	0.41	0.94	3.07	46.49
	(5.11)	(0.38)	(0.11)	[0.69]	[0.00]
1, 4, 5, 9, 10	2.97	0.30	0.88	0.51	48.84
	(1.43)	(0.41)	(0.11)	[0.77]	[0.00]
2, 5, 9	2.04	0.22	0.85		39.61
	(1.11)	(0.59)	(0.20)		[0.00]

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Continuous updating GMM. Moment (horizon) selection based on Andrews (1999). θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model). Hansen's J statistic for validity of overidentifying restrictions; F statistic for joint equality of zero for the elasticities over the first 3 horizons. Standard errors in parentheses (cluster-robust at level of importer-exporter-HS4 triplets); p-values in brackets (for Hansen's J and F-statistics). Preferred estimates selected by GMM-BIC criterion in orange and boldface.

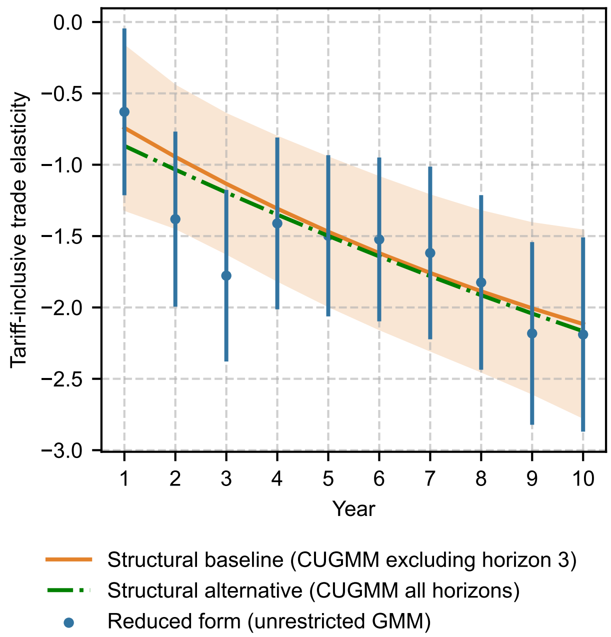
the Hansen J-statistic minus $(|\mathcal{H}| - 3)\ln n$, penalizing the mechanical increase in J from additional overidentifying restrictions.[18] The preferred specification (orange and boldface) uses nine horizons, excluding $h = 3$, and the estimates are stable to inclusion of the omitted horizon or exclusion of nearby horizons.[19]

Our estimates of θ imply a long-run trade elasticity between 2 and 6 in absolute value, consistent with benchmark estimates (Simonovska and Waugh 2014). Across specifications, $\hat{\sigma}$ ranges from 1.2 to 1.7, indicating limited expenditure switching at the intensive

[18] For a recent application of the GMM-BIC criterion, see Handbury (2021). We restrict estimation to sets that include at least one short-run ($h \leq 3$) and one long-run ($h \geq 7$) horizon, require $\hat{\theta} \geq \hat{\sigma} - 1 \geq 0$ and a J-statistic p-value above 0.2. We find that none of the restrictions binds for pooled estimation but any may bind at the industry level. See Appendix B for details.

[19] Appendix D investigates robustness. Tables D.1 and D.2 report results from alternative moment selections and one-step GMM, respectively. Table D.3 excludes observations where the MFN tariff change exceeds 0.15 in absolute value to account for the possibility that large tariff movements may be anticipated or inaccuracy of the first-order approximation underlying equation (36) may cause imprecise estimates. Table D.4 re-estimates the model after implementing the data corrections proposed by Teti (2024) to account for missing MFN tariff records and selection bias from zero-trade observations. The baseline estimates remain qualitatively robust throughout.

Figure 1: Trade Elasticities



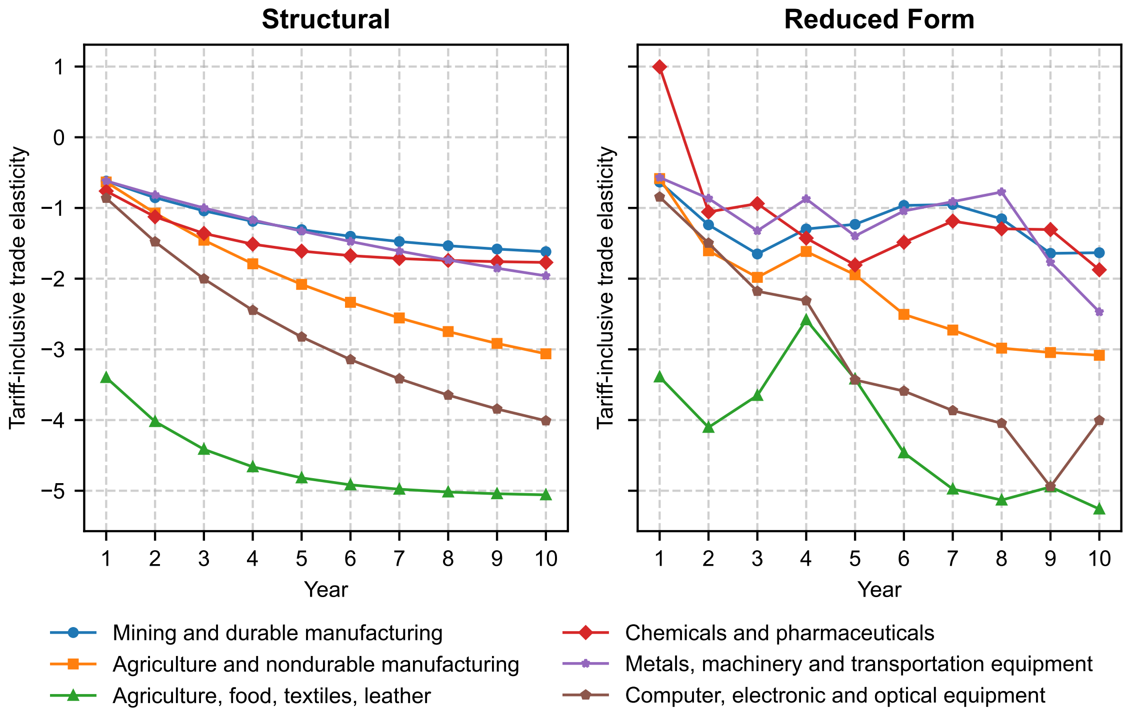
Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Structural trade elasticities inferred using Table 1 estimates of Proposition 2: baseline estimates (orange solid) exclude horizon-3 moment; alternative estimates (green dotted) use all 10 horizon moments. Reduced-form trade elasticity estimates (blue points) from unrestricted linear GMM estimation using (36). Bars (blue) and shaded area (orange) represent 95% confidence intervals based on variance-covariance estimates (cluster-robust at the level of importer-exporter-HS4 triplets), using Delta method for structural estimates.

margin. Our estimates of $\hat{\zeta}$ range from 6% to 15% per annum, so that 85% to 94% of trade volumes flow through preexisting supply relationships in steady state, in line with empirical evidence from firm-to-firm trade data.[20]

While $\hat{\zeta}$ and $\hat{\sigma}$ are precisely estimated, the standard errors on $\hat{\theta}$ are sizeable. The horizon profile of the implied trade elasticities is nonetheless precisely estimated. We can soundly reject the hypothesis that the implied trade elasticities over the initial three horizons, when elasticities are smallest in magnitude, are jointly equal to zero (F statistics in final column of Table 1). Figure 1 graphically documents this significance pattern by plotting the horizon-specific trade elasticities $\epsilon^h(\hat{\Theta})$ for the baseline specification (orange solid

[20]Monarch and Schmidt-Eisenlohr (2023) and Heise (2025) report that over 80% of U.S. import values flow through preexisting firm-to-firm relationships, and Bernard, Bøler and Dhingra (2018) find 83% for Colombia.

Figure 2: Trade Elasticities by Industry Group



Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Structural trade elasticities (left panel) inferred using industry-specific parameter estimates (Appendix Table B.2) in Proposition 2. Moment (horizon) selection based on Andrews (1999) by industry group. Reduced-form trade elasticities (right panel) from group-specific unrestricted linear GMM estimation using (36).

line, with 95% confidence intervals in the shaded area) alongside reduced-form estimates from an unrestricted linear GMM specification that targets each horizon separately (blue dots, with 95% confidence intervals). The structural and reduced-form profiles are closely aligned across all horizons targeted in the preferred specification. Including the horizon-3 moment, which the GMM-BIC criterion selects out, steepens the structural trade elasticity profile (green dash-dotted line) and worsens the fit to the reduced-form estimates at short horizons, while leaving the long-horizon elasticities largely unchanged.

4.3.2 Estimation by industry group

We aggregate HS codes to 19 non-service ISIC Rev. 4 two-digit industries, matching the industry classification used for quantitative analysis, and then consolidate them into six estimation groups because not all industries provide sufficient identifying variation in the instrumental variable. Appendix B.2 details the consolidation procedure. For each industry group, we apply the moment selection procedure outlined above applying the GMM-BIC criterion independently.

Table B.2 reports the parameter estimates for each industry group, and Figure 2 plots the implied structural trade elasticities (left panel) alongside their reduced-form counterparts (right panel). Although less precisely estimated, the parameters reveal economically intuitive variation across industries. Agriculture, food, and textiles have the highest long-run trade elasticity ($\hat{\theta} \approx 5.1$), the highest short-run substitutability ($\hat{\sigma} \approx 3.4$), and fast supplier turnover ($\hat{\zeta} \approx 0.37$), consistent with standardized products. At the other extreme, the estimates for metals, machinery, and transportation equipment imply lower substitutability on both margins ($\hat{\theta} \approx 3.3$, $\hat{\sigma} \approx 1.4$) and slow supplier turnover ($\hat{\zeta} \approx 0.07$), consistent with differentiated capital goods and relationship-specific sourcing.

5 Quantitative Applications

We apply the model to two episodes, the 2004 Enlargement of the European Union (EU) and the 2018 US-China trade war. The EU Enlargement was pre-announced years in advance, allowing us to examine how anticipation and sourcing frictions interact to shape the dynamic response of trade flows, production and incomes. The US-China trade war, arriving without anticipation, isolates the role of sourcing frictions alone.

In practice, episodes of trade integration or disintegration also involve corporate reallocation and multinational production shifts (Ding et al. 2022, Arkolakis, Eckert and Shi 2023, Freund et al. 2024), migration (Caliendo et al. 2021), and innovation (Góes and Bekkers 2022). We hold those forces constant and quantify the welfare consequences of tariff changes in the presence of anticipation and sourcing frictions. We take observed trade flows as resulting from an initial steady state, feed a path of tariff shocks into the dynamic model, and compute endogenous variables that satisfy all equilibrium conditions in every period of the transition until convergence to a new steady state. Appendix E.2 explains the computational algorithm.

5.1 Calibration

As in benchmark quantitative trade and spatial models (Dekle, Eaton and Kortum 2007, Redding and Rossi-Hansberg 2017, Caliendo, Dvorkin and Parro 2019), solving for counterfactual transition paths in response to a sequence of shocks in our framework requires a set of structural elasticities, ($\theta_i, \sigma_i, \zeta_i$ here), together with country-industry level trade and production data. For the trade elasticities, we use the estimates from subsection 4.3.2, assigning merchandize industries to their estimation group and service industries to the pooled estimates; Table D.5 lists the full mapping. For the remaining technology and preference parameters, we calibrate the initial steady state to match bilateral trade shares, sectoral intermediate input cost shares, as well as final expenditure and value added for 78 countries and 34 industries from the OECD Inter-Country Input-Output (ICIO) tables (OECD 2023), using 1995 as the initial steady state for the EU enlargement exercise and 2017 for the US-China trade war.

The intermediate input cost shares and final expenditure shares in the ICIO tables identify $\{\alpha_{sij}/(1-\alpha_{si})\}$ and $\{\eta_{di}\}$ directly. The production value added shares $\{\alpha_{si}\}$ cannot be taken directly from the ICIO tables because value added in our model includes trader-generated profits among the factor payments.[21] We therefore choose $\{\alpha_{si}\}$ so that observed final use, trade shares, and value added at the country-industry level are mutually consistent with equations (25)–(27), defining a fixed point we solve by iteration, with trade deficits $\{D_d\}$ implied by the budget constraint.

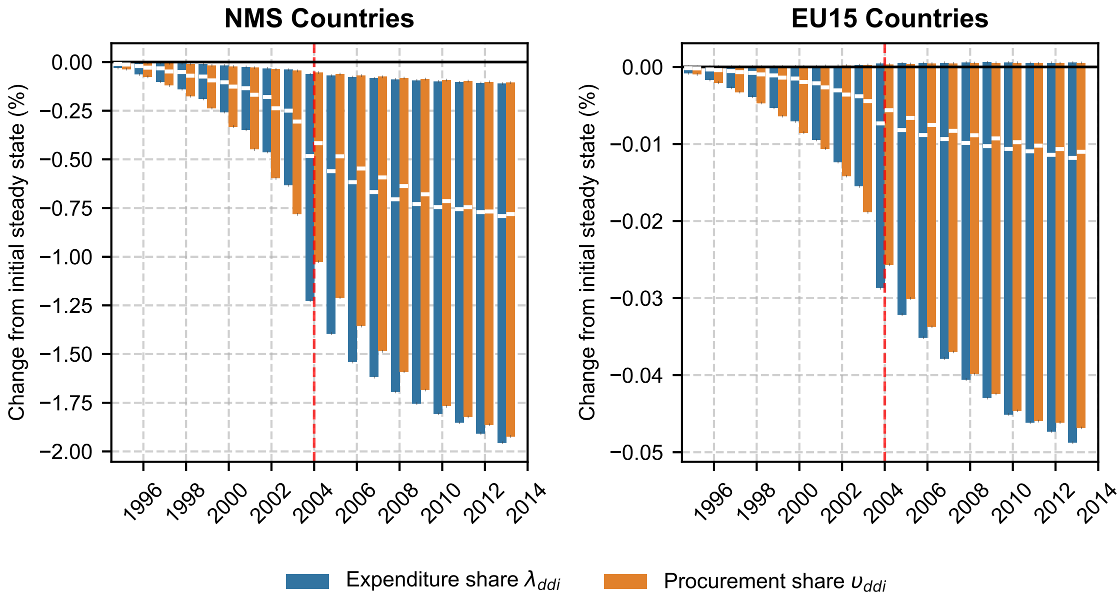
When computing counterfactuals, we assume that tariff revenue $G_{d,t}$ is rebated lump-sum to households and enters final expenditure $F_{d,t}$. Simulated profits therefore satisfy

$$\Pi_{d,t} = \frac{\kappa_{d,t}}{1-\kappa_{d,t}} \left(w_{d,t} L_d + D_d + G_{d,t} \right), \tag{38}$$

where $\kappa_{d,t}$ is defined in Proposition 4.

[21] If value added accrued entirely from domestic production, α_{si} would equal the share of observed value added in gross output. In our model, value added also includes trader profits from imports, $VA_{si} = \alpha_{si} R_{si} + \Pi_{si}$, where $\Pi_{si} = E_{si}/\sigma_i$. Spending of a final good assembler E_{si} therefore depends on $\{\alpha_{si}\}$ because it includes a part that traders keep as profits (and domestic households receive as income), so there is no closed-form mapping from data to α_{si} in general.

Figure 3: 2004 EU Eastern Enlargement—Expenditure and Procurement Shares



Notes: Simulations of scheduled tariff changes for 2004 EU Eastern enlargement (dashed red line), treated as announced in 1995. Annual interquartile ranges (medians in white) of changes in country-industry level expenditure shares $\lambda_{ddi,t} - \lambda_{ddi,1995}$ and country-industry level procurement shares $\upsilon_{ddi,t} - \upsilon_{ddi,1995}$, where $\upsilon_{ddi,t} \equiv \sum_{k\geq 0} \mu_i^*(k)\, \upsilon^0_{ddi,t-k}$ using Proposition 1.

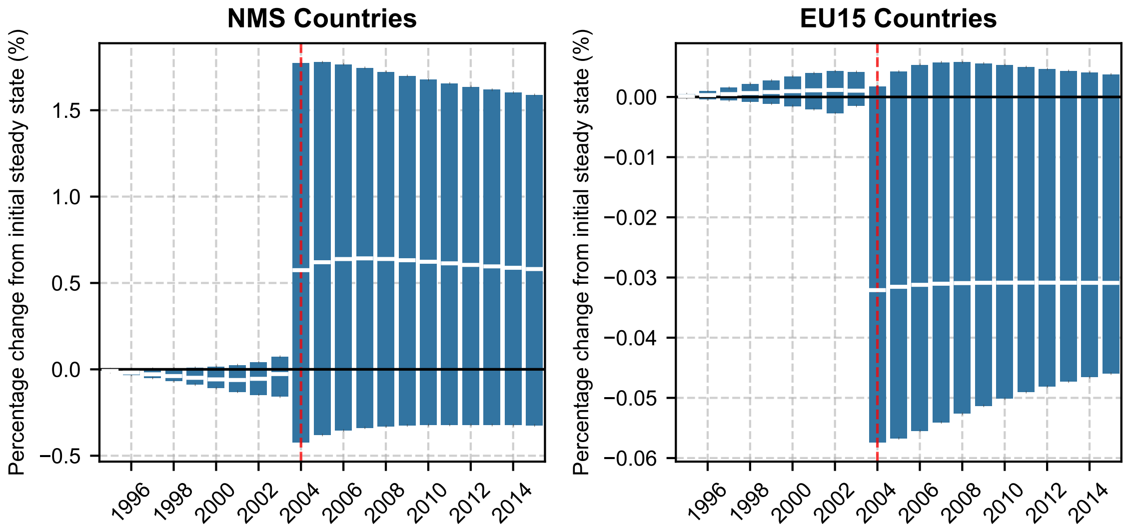
5.2 The 2004 Eastern Enlargement of the European Union

Measuring the shock. In 1995, the EU's 15 pre-enlargement member states (EU15) and the 10 new member states (NMS) announce a multilateral free trade agreement that will be adopted in 2004. To isolate purely anticipatory behavior, we assume that bilateral tariff rates remain unchanged except in 2004, when tariffs involving the NMS countries are lifted completely. The median ad valorem tariff reduction equals 4.0 percentage points for EU15 imports from NMS and 2.7 percentage points for NMS imports from EU15; Appendix Table E.1 reports additional summary statistics.

Effects on trade flows. Figure 3 plots the interquartile ranges of changes in domestic expenditure shares $\{\lambda_{ddi,h} - \lambda_{ddi,1995}\}_h$ and domestic procurement shares $\{\upsilon_{ddi,h} - \upsilon_{ddi,1995}\}_h$ across industries and destinations relative to the initial steady state.

Until 2004, domestic expenditure and procurement shares decline gradually as sourcing reorients toward foreign suppliers in anticipation of the 2004 tariff cut. Procurement shares

Figure 4: 2004 EU Eastern Enlargement—Prices



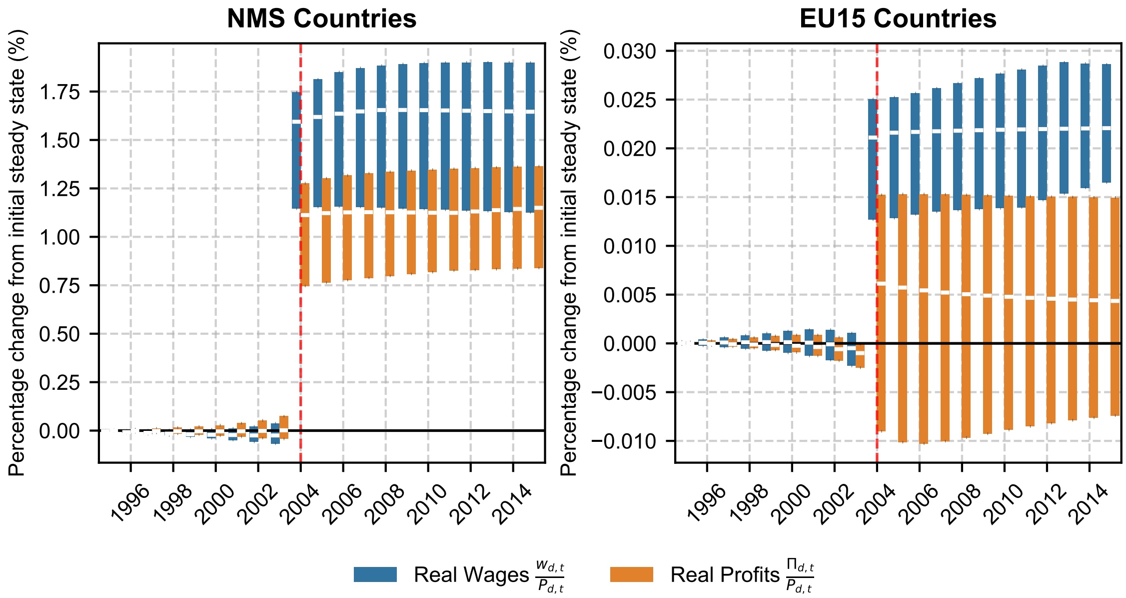
Notes: Simulations of scheduled tariff changes for 2004 EU Eastern enlargement (dashed red line), treated as announced in 1995. Annual interquartile ranges (medians in white) of changes in country level ideal (CPI) price indices $\ln P_{d,t} - \ln P_{d,1995}$.

decline more strongly than expenditure shares because the early chosen foreign suppliers are more expensive at prevailing tariffs, so the intensive margin compensates for the early switches at the extensive margin. By 2003, nearly half of the total extensive-margin adjustment (captured by $\upsilon_{ddi,h}$) has materialized at the median, compared to about one-third for expenditures.

In 2004, when liberalization takes effect, domestic expenditure shares decline sharply in favor of expenditure on foreign intermediates, exceeding the changes in procurement shares as the intensive margin now reinforces the extensive margin. Anticipatory sourcing adjustment amplifies the extensive-margin response at implementation. With fewer varieties locked into outdated supply relationships than in the absence of anticipation effects, more of the tariff cut passes through to trade volumes, and the transition is shorter than it would be in the absence of anticipation effects because fewer legacy relationships remain.

Effects on prices. Figure 4 plots the counterfactual path of country-level prices. Before 2004, median price changes remain close to zero in both country groups, because anticipatory demand shifts only have second-order effects on equilibrium prices. At implementation in 2004, NMS prices increase by 0.5 percent at the median because tariff removals

Figure 5: 2004 EU Eastern Enlargement—Real Wages and Real Profits



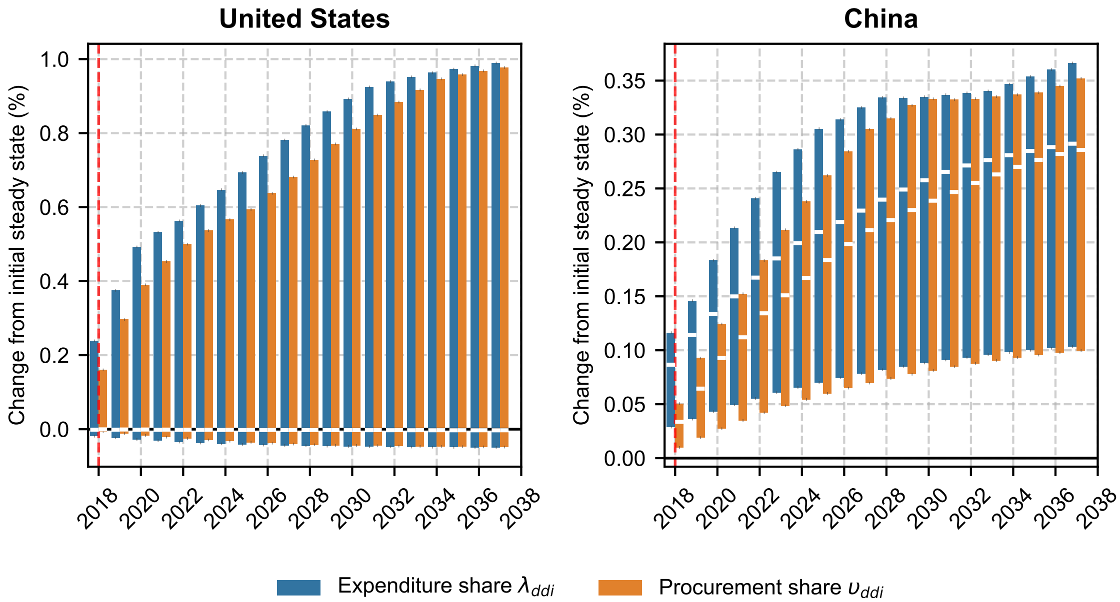
Notes: Simulations of scheduled tariff changes for 2004 EU Eastern enlargement (dashed red line), treated as announced in 1995. Annual interquartile ranges (medians in white) of changes in country level real wages $\ln(w_{d,t}/P_{d,t}) - \ln(w_{d,1995}/P_{d,1995})$ and country level real profits $\ln(\Pi_{d,t}/P_{d,t}) - \ln(\Pi_{d,1995}/P_{d,1995})$.

increase foreign demand for NMS goods and bid up factor costs. Prices remain elevated thereafter, declining only slightly in the transition to steady state. In the EU15, where the enlargement primarily acts as a shock to import supply, the median consumer price index falls by 0.03 percent at implementation and remains close to that level thereafter.

Effects on real wages and profits. Figure 5 shows that median real wages and median real profits slightly decline in both country groups before 2004, reflecting the increase in sourcing costs from anticipatory supplier switching. Once tariffs fall in 2004, real wages and real profits rise sharply, by 1.6 and 1.1 percent at the NMS median and 0.022 and 0.005 percent at the EU15 median, with limited subsequent adjustment. Real wages rise by more than real profits because liberalization eliminates the tariff revenue that supports profits in equation (38); for some EU15 countries with trade surpluses this revenue loss is large enough so that real profits decline in the long run.

Notably, anticipation decouples trade flows from welfare along the transition path, consistent with Proposition 4. Shifts in option values move trade flows directly, but with

Figure 6: 2018 US-China Trade War—Expenditure and Procurement Shares



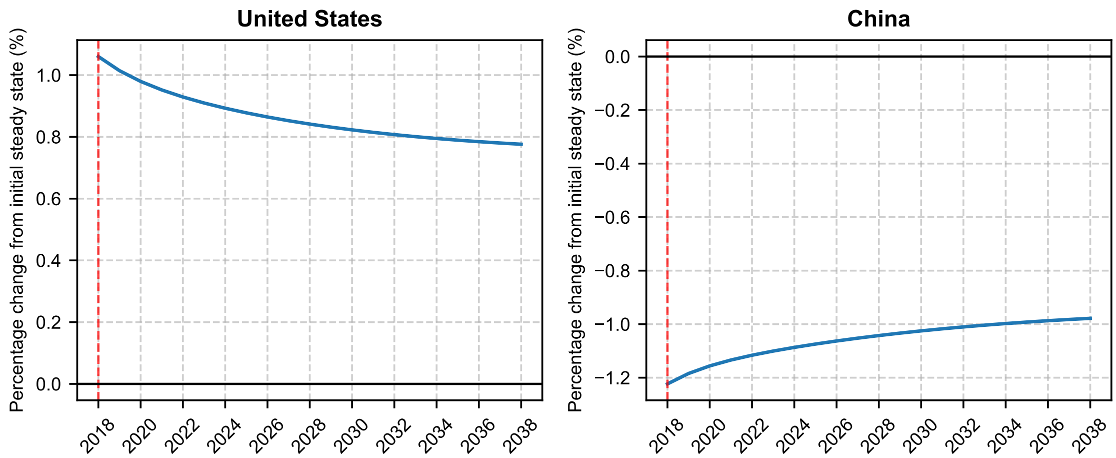
Notes: Simulations of unanticipated tariff changes during 2018 US-China trade war (dashed red line). Annual interquartile ranges (medians in white) of changes in industry level expenditure shares $\lambda_{ddi,t} - \lambda_{ddi,2017}$ and industry level procurement shares $\upsilon_{ddi,t} - \upsilon_{ddi,2017}$, where $\upsilon_{ddi,t} \equiv \sum_{k\geq 0} \mu_i^*(k)\, \upsilon_{ddi,t-k}^0$ using Proposition 1.

price and welfare effects that remain second-order until tariff changes materialize, at which point they are amplified by the pre-emptive supplier adjustment. While this decoupling is strongest for anticipated shocks, sourcing frictions also alter the time profile of trade and welfare responses to unanticipated shocks, as we illustrate in the next simulation exercise.

5.3 The 2018 US-China Trade War

Measuring the shock. We take HS8-level tariff changes during the US-China trade war from Fajgelbaum et al. (2020) and aggregate to ISIC4 2-digit industries using 2017 bilateral trade volumes as weights. We assume that all tariff changes become effective simultaneously in 2018 and are not anticipated in advance. For US imports from China, this assumption implies a permanent and unanticipated increase in average import tariffs of 15 percentage points across industries, while tariffs on US exports to China increase by an average of 18 percentage points. Appendix E.4 provides further detail on the tariff changes by industry.

Figure 7: 2018 US-China Trade War—Prices



Notes: Simulations of unanticipated tariff changes during 2018 US-China trade war (dashed red line). Changes in country level ideal (CPI) price indices $\ln P_{d,t} - \ln P_{d,2017}$.

Effects on trade flows. Figure 6 plots industry-level changes in domestic expenditure and procurement shares relative to the pre-war steady state. Sourcing gradually reorients toward domestic suppliers, with less than one-fifth of the total adjustment taking place on impact.[22] As with EU enlargement after 2004, expenditure shares lead procurement shares along the transition to steady state, but without prior sourcing adjustment the transition lasts longer.

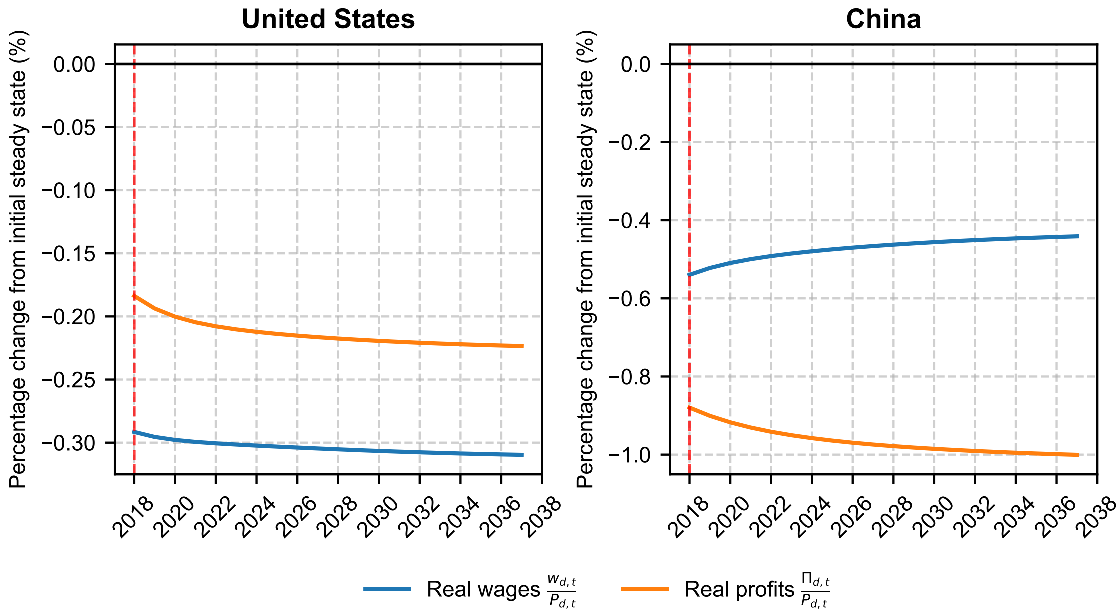
Effects on prices. Figure 7 shows the price effects. In the United States, the aggregate price index rises by about 1 percent on impact, reflecting complete tariff pass-through into border prices and amplification through input-output linkages and factor price responses.[23] Prices surge most on impact, before extensive-margin turnover reduces dependence on tariff-affected suppliers, and settle at 0.8 percent above the pre-war level in the new steady state.

In China, the aggregate price index falls by 1.2 percent on impact, as lower export demand reduces domestic wages. The decline is largest in the short run, when Chinese

[22]The median US response is close to zero because tangible increases in domestic shares are confined to the 16 goods industries most affected by tariff changes. In China, general equilibrium factor price responses produce broad-based trade reallocation and a visibly positive median.

[23]For evidence on complete tariff pass-through during the 2018 trade war, see Fajgelbaum et al. (2020), Amiti, Redding and Weinstein (2019), Amiti, Redding and Weinstein (2020).

Figure 8: 2018 US-China Trade War—Real Wages and Real Profits



Notes: Simulations of unanticipated tariff changes during 2018 US-China trade war (dashed red line). Changes in country level real wages $\ln(w_{d,t}/P_{d,t}) - \ln(w_{d,2017}/P_{d,2017})$ and country level real profits $\ln(\Pi_{d,t}/P_{d,t}) - \ln(\Pi_{d,2017}/P_{d,2017})$.

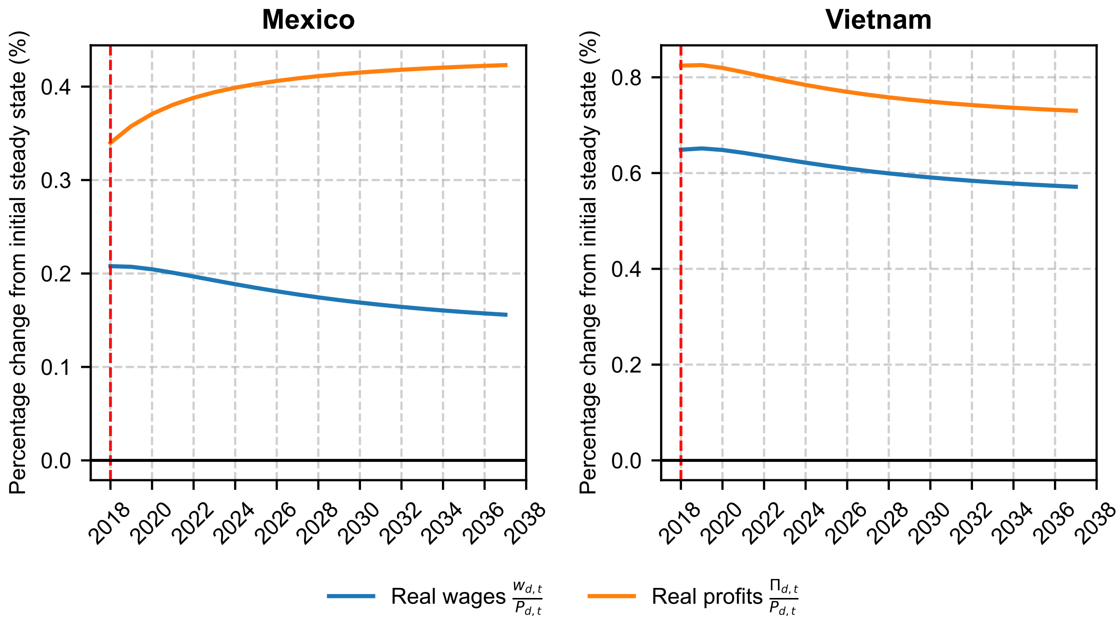
exporters cannot immediately redirect to alternative markets, and partially recovers to about 1.0 percent below the pre-war level as trade diversion materializes.[24]

Effects on real wages and profits. Figure 8 shows the counterfactual responses of real wages and real profits. Absent anticipation, both adjust gradually as supply relationships turn over, with the terms-of-trade distortions in Proposition 4 shaping the time profile of real wages and initial trade balances governing the relative response of profits.

In the United States, real wages fall by 0.28 percent on impact because the sourcing friction keeps importers locked into pre-war suppliers. Once supply relationships turn over, this cushion fades and real wages decline to 0.31 percent below the pre-war level in the long run. Real profits fall by less, between 0.18 percent on impact and 0.23 percent in the long run, because the US trade deficit and tariff revenue provide additional support by

[24]The U.S. "raised tariffs on import transactions corresponding to about 2.6 percent of GDP [...] trade partners imposed retaliations on exports corresponding to about 1 percent of US GDP" (Fajgelbaum and Khandelwal 2022).

Figure 9: 2018 US-China Trade War—Real Wages and Real Profits in Third Countries



Notes: Simulations of unanticipated tariff changes during 2018 US-China trade war (dashed red line). Changes in country level real wages $\ln(w_{d,t}/P_{d,t}) - \ln(w_{d,2017}/P_{d,2017})$ and country level real profits $\ln(\Pi_{d,t}/P_{d,t}) - \ln(\Pi_{d,2017}/P_{d,2017})$.

equation (38).

In China, the short-run distortions from the sourcing friction have the opposite effect on the time path of real wages. Real wages fall by 0.55 percent on impact, as the sourcing friction prevents Chinese exporters from redirecting to alternative markets and locked-in US exports shrink at the intensive margin, but partially recover to 0.43 percent below the pre-war level as China can divert exports. In contrast to the United States, real profits fall by more than wages, declining from 0.9 percent on impact to approximately 1.0 percent below the initial steady state, because China's trade surplus drags down profits rather than boosting them.

Effects on third countries. Figure 9 shows the responses of real wages and real profits in Mexico and Vietnam. Both countries benefit from redirected trade: real wages rise by 0.65 percent on impact in Vietnam and 0.21 percent in Mexico. The difference in magnitude arises because Vietnam gains market shares in both China and the United States, whereas Mexico primarily gains on the US side. In both Mexico and Vietnam, real wage gains peak on impact and decline over the transition path as rising domestic factor costs and recovering Chinese trade erode the initial advantage.

The time profile of real profits differs. In Mexico, profits rise from 0.34 percent on impact to 0.43 percent in the long run, because rising nominal wages erode the real value of Mexico's trade surplus, pushing profits progressively above wages even as real wages decline. In Vietnam, where trade is relatively more balanced, profits peak at a 0.83 percent boost and decline to a 0.73 percent boost, mirroring the time profile of real wages.

6 Concluding Remarks

To account for frictions in the formation of global supply chains, we develop a Ricardian trade framework with staggered contracting decisions that arise because assemblers can only switch suppliers at stochastic intervals. We establish a novel estimation equation for horizon-specific trade elasticities, obtain extended formulas for welfare changes in response to trade cost changes over time, and calibrate the model with a production network involving many industries and countries. Our key feature of forward-looking and profitable firms within the Ricardian trade framework lays the ground for rigorous future treatments of inventories, distributional considerations, and potentially firm turnover within industries. Counterfactual experiments based on the 2004 Eastern enlargement of the EU and the 2018 US-China trade war demonstrate rich anticipatory behavior and considerable short-term reallocations in response to tariff changes, with dynamic welfare implications not captured in static models without forward-looking agents and without sourcing frictions.

References

Alessandria, George A., Costas Arkolakis, and Kim J. Ruhl. 2021. “Firm Dynamics and Trade.” *Annual Review of Economics*, 13: 253–280.

Alessandria, George, and Carter Mix. 2025. “Trade Policy Is Real News: Theory and Evidence.” Working Paper.

Alessandria, George, and Horag Choi. 2007. “Do Sunk Costs of Exporting Matter for Net Export Dynamics?” *Quarterly Journal of Economics*, 122(1): 289–336.

Alessandria, George, Horag Choi, and Kim J. Ruhl. 2021. “Trade Adjustment Dynamics and the Welfare Gains from Trade.” *Journal of International Economics*, 131: 103458.

Alessandria, George, Shafaat Yar Khan, Armen Khederlarian, Kim J. Ruhl, and Joseph B. Steinberg. 2025*a*. “Trade Policy Dynamics: Evidence from 60 Years of US-China Trade.” *Journal of Political Economy*, 133(3): 713–749.

Alessandria, George, Shafaat Yar Khan, Armen Khederlarian, Kim J. Ruhl, and Joseph B. Steinberg. 2025*b*. “Trade War and Peace: U.S.-China Trade and Tariff Risk from 2015–2050.” *Journal of International Economics*, 155: 104048.

Amiti, Mary, Stephen J. Redding, and David E. Weinstein. 2019. “The Impact of the 2018 Tariffs on Prices and Welfare.” *Journal of Economic Perspectives*, 33(4): 187–210.

Amiti, Mary, Stephen J. Redding, and David E. Weinstein. 2020. “Who’s Paying for the U.S. Tariffs? A Longer-Term Perspective.” *AEA Papers and Proceedings*, 110(0): 541–46.

Anderson, James E., and Yoto V. Yotov. 2022. “Estimating Gravity from the Short to the Long Run: A Simple Solution to the ’International Elasticity Puzzle’.” *NBER Working Paper*, 30809.

Andrews, Donald W. K. 1999. “Consistent Moment Selection Procedures for Generalized Method of Moments Estimation.” *Econometrica*, 67(3): 543–564.

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

Arkolakis, Costas, Fabian Eckert, and Rowan Shi. 2023. "Combinatorial Discrete Choice: A Quantitative Model of Multinational Location Decisions." *NBER Working Paper*, 31877.

Arkolakis, Costas, Jonathan Eaton, and Samuel Kortum. 2011. "Staggered Adjustment and Trade Dynamics." Yale University, unpublished manuscript.

Armington, Paul S. 1969. "A Theory of Demand for Products Distinguished by Place of Production." *International Monetary Fund Staff Papers*, 16(1): 159–178.

Bernard, Andrew B., Esther A. Bøler, and Swati Dhingra. 2018. "Firm-to-Firm Connections in Colombian Imports." In *World Trade Evolution*. Routledge.

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.

Boehm, Christoph E., Andrei A. Levchenko, Nitya Pandalai-Nayar, and Hiroshi Toma. 2025. "Dynamic Models, New Gains from Trade?" *NBER Working Paper*, 32565.

Buera, Francisco J., and Ezra Oberfield. 2020. "The Global Diffusion of Ideas." *Econometrica*, 88(1): 83–114.

Caliendo, Lorenzo, and Fernando Parro. 2015. "Estimates of the Trade and Welfare Effects of NAFTA." *Review of Economic Studies*, 82(1): 1–44.

Caliendo, Lorenzo, Luca David Opromolla, Fernando Parro, and Alessandro Sforza. 2021. "Goods and Factor Market Integration: A Quantitative Assessment of the EU Enlargement." *Journal of Political Economy*, 129(12): 3491–3545.

Caliendo, Lorenzo, Maximiliano Dvorkin, and Fernando Parro. 2019. "Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock." *Econometrica*, 87(3): 741–835.

Calvo, Guillermo A. 1983. "Staggered Prices in a Utility-Maximizing Framework." *Journal of Monetary Economics*, 12(3): 383–398.

Chaney, Thomas. 2008. "Distorted Gravity: The Intensive and Extensive Margins of International Trade." *American Economic Review*, 98(4): 1707–21.

Costinot, Arnaud, and Andrés Rodríguez-Clare. 2014. "Trade Theory with Numbers: Quantifying the Consequences of Globalization." In *Handbook of International Economics*. Vol. 4, , ed. Elhanan Helpman, Kenneth Rogoff and Gita Gopinath, Chapter 4, 197–261. Amsterdam: Elsevier.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum. 2007. "Unbalanced Trade." *American Economic Review: Papers and Proceedings*, 97(2): 351–55.

Dekle, Robert, Jonathan Eaton, and Samuel Kortum. 2008. "Global Rebalancing with Gravity: Measuring the Burden of Adjustment." *IMF Staff Papers*, 55(3): 511–540.

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: in press.

Ding, Haoyuan, Kees G. Koedijk, Tong Qi, and Yanqing Shen. 2022. "U.S.-China Trade War and Corporate Reallocation: Evidence from Chinese Listed Companies." *World Economy*, 45(12): 3907–3932.

Dornbusch, Rudiger, Stanley Fischer, and Paul A. Samuelson. 1977. "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods." *American Economic Review*, 67(5): 823–39.

Eaton, Jonathan, and Samuel Kortum. 2002. "Technology, Geography, and Trade." *Econometrica*, 70(5): 1741–79.

Fajgelbaum, Pablo D., and Amit K. Khandelwal. 2022. "The Economic Impacts of the US-China Trade War." *Annual Review of Economics*, 14: 205–228.

Fajgelbaum, Pablo D., Pinelopi K. Goldberg, Patrick J. Kennedy, and Amit K. Khandelwal. 2020. "The Return to Protectionism." *Quarterly Journal of Economics*, 135(1): 1–55.

Fontagné, Lionel, Houssein Guimbard, and Gianluca Orefice. 2022. "Tariff-based Product-level Trade Elasticities." *Journal of International Economics*, 137: 103593.

Fontagné, Lionel, Philippe Martin, and Gianluca Orefice. 2018. "The International Elasticity Puzzle Is Worse Than You Think." *Journal of International Economics*, 115(0): 115–29.

Freund, Caroline L., Aaditya Mattoo, Alen Mulabdic, and Michele Ruta. 2024. "Is US Trade Policy Reshaping Global Supply Chains?" *Journal of International Economics*, 152(104011): 1–10.

Gaulier, Guillaume, and Soledad Zignago. 2010. "BACI: International Trade Database at the Product-Level. The 1994-2007 Version." CEPII Working Papers 2010-23.

Góes, Carlos, and Eddy Bekkers. 2022. "The Impact of Geopolitical Conflicts on Trade, Growth, and Innovation." *WTO Staff Working Paper ERSD-2022-09*, ERSD-2022-09.

Handbury, Jessie. 2021. "Are Poor Cities Cheap for Everyone? Non-Homotheticity and the Cost of Living Across U.S. Cities." *Econometrica*, 89(6): 2679–2715.

Hansen, Lars Peter, John Heaton, and Amir Yaron. 1996. "Finite-Sample Properties of Some Alternative GMM Estimators." *Journal of Business & Economic Statistics*, 14(3): 262–280.

Heise, Sebastian. 2025. "Firm-to-Firm Relationships and the Pass-Through of Shocks: Theory and Evidence." *Review of Economics and Statistics*. forthcoming.

Kollintzas, Tryphon, and Ruilin Zhou. 1992. "Import Price Adjustments with Staggered Import Contracts." *Journal of Economic Dynamics and Control*, 16(2): 289–315.

Kortum, Samuel S. 1997. "Research, Patenting, and Technological Change." *Econometrica*, 65(6): 1389–1419.

Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695–1725.

Monarch, Ryan, and Tim Schmidt-Eisenlohr. 2023. "Longevity and the Value of Trade Relationships." *Journal of International Economics*, 145: 103842.

Montero, Miquel, and Javier Villarroel. 2016. "Directed Random Walk with Random Restarts: The Sisyphus Random Walk." *Physical Review E*, 94(3): 1–10.

OECD. 2023. "OECD Inter-Country Input-Output Database."

Redding, Stephen J., and Esteban Rossi-Hansberg. 2017. "Quantitative Spatial Economics." *Annual Review of Economics*, 9: 21–58.

Ruhl, Kim J. 2008. "The International Elasticity Puzzle." University of Texas at Austin, unpublished manuscript.

Simonovska, Ina, and Michael E. Waugh. 2014. "The Elasticity of Trade: Estimates and Evidence." *Journal of International Economics*, 92(1): 34–50.

Teti, Feodora A. 2024. "Missing Tariffs." *CESifo Discussion Paper*.

A Model and Proofs

A.1 Ideal Price Indexes and Generic Trade Shares

An assembler in industry j makes the composite good $Y_{dj,t}$ with production function (4). For an exhaustively partitioned product space $\Omega_j = \bigcup_{k=0}^{\infty} \Omega^k_{dj,t}$, the assembler's cost minimization problem becomes

$$\begin{aligned}
\min_{\{y_{dj,t}(\omega)\}_{\omega\in\Omega_{j,t}},\{Y^k_{dj,t}\}} P_{dj,t}Y_{dj,t} &= \sum_{k=0}^{\infty} P^k_{dj,t}Y^k_{dj,t} \\
s.t. \qquad Y_{dj,t} &= \left[\sum_{k=0}^{\infty} \left(Y^k_{dj,t}\right)^{\frac{\sigma_j-1}{\sigma_j}}\right]^{\frac{\sigma_j}{\sigma_j-1}}, Y^k_{dj,t} \equiv \left(\int_{\Omega^k_{dj,t}} y_{dj,t}(\omega)^{\frac{\sigma_j-1}{\sigma_j}} \mathrm{d}\omega\right)^{\frac{\sigma_j}{\sigma_j-1}}, \\
P^k_{dj,t}Y^k_{dj,t} &= \int_{\Omega^k_{dj,t}} p_{dj,t}(\omega)y_{dj,t}(\omega)\,\mathrm{d}\omega,
\end{aligned}$$

where we define the partial composite good $Y^k_{dj,t} \equiv (\int_{\Omega^k_{dj,t}} y_{dj,t}(\omega)^{(\sigma_j-1)/\sigma_j}\mathrm{d}\omega)^{\sigma_j/(\sigma_j-1)}$ for each partition k as a helpful construct for derivations and implicitly define the associated partial ideal price index $P^k_{dj,t}$ that satisfies $P^k_{dj,t}Y^k_{dj,t} = \int_{\Omega^k_{dj,t}} p_{dj,t}(\omega)y_{dj,t}(\omega)\mathrm{d}\omega$. Given homotheticity of the assembler's production function, this problem can be solved in two steps. First, the assembler decides which share of cost it allocates to each partial composite good $Y^k_{dj,t}$. Given those choices, the assembler then decides the optimal cost for each intermediate good $y_{dj,t}(\omega)$. Optimal demand satisfies

$$\begin{aligned}
Y^k_{dj,t} &= \left(\frac{P^k_{dj,t}}{P_{dj,t}}\right)^{-\sigma_j} Y_{dj,t} \quad \text{and} && \text{(A.1)}\\
y^k_{dj,t}(\omega) &= \left(\frac{p_{dj,t}(\omega)}{P^k_{dj,t}}\right)^{-\sigma_j} Y^k_{dj,t} = \left(\frac{p_{dj,t}(\omega)}{P_{dj,t}}\right)^{-\sigma_j} Y_{dj,t} \quad \text{for each } \omega \in \Omega^k_{dj,t}, && \text{(A.2)}
\end{aligned}$$

where the last equality also shows that the partitioned solution equals the standard solution under a constant elasticity of substitution. Replacing the demand functions above in the definition of the budget constraint delivers the ideal price indices:

$$P_{dj,t} = \left(\int_{[0,1]} p_{dj,t}(\omega)^{1-\sigma_j}\mathrm{d}\omega\right)^{\frac{1}{1-\sigma_j}}, \qquad P^k_{dj,t} = \left(\int_{\Omega^k_{dj,t}} p_{dj,t}(\omega)^{1-\sigma_j}\mathrm{d}\omega\right)^{\frac{1}{1-\sigma_j}}. \quad \text{(A.3)}$$

The partitioned product space admits well-behaved demand functions that can be analyzed within each set and then aggregated. We define expenditure shares within each partition k as

$$\lambda^k_{sdj,t} \equiv \frac{X^k_{sdj,t}}{X^k_{dj,t}} = \frac{\int_{\Omega^k_{dj,t}} \mathbf{1}_d \left\{ s \text{ is } \omega\text{'s source country} \right\} p_{dj,t}(\omega) y_{dj,t}(\omega)\, \mathrm{d}\omega}{\sum_n \int_{\Omega^k_{dj,t}} \mathbf{1}_d \left\{ n \text{ is } \omega\text{'s source country} \right\} p_{dj,t}(\omega) y_{dj,t}(\omega)\, \mathrm{d}\omega}. \quad \text{(A.4)}$$

A.2 Optimal Sourcing

A.2.1 Value functions

For $k = 0$, traders have the option to adjust their extensive margin decision. Recall from Section 2.2.1 that a trader's value function is

$$V_{di,t}(\omega) = \max_{n \in \mathcal{N}} V_{di,t}(\omega, n), \quad \text{(A.5)}$$

where

$$V_{di,t}(\omega, n) = \pi_{ndi,t}(\omega) + \frac{\zeta_i}{1 + r_t} V_{di,t+1}(\omega) + \frac{1 - \zeta_i}{1 + r_t} V_{di,t+1}(\omega, n), \text{ for } n \in \mathcal{N}, \quad \text{(A.6)}$$

is the net-present value of a trader in d that procures an intermediate good ω from a country n at time t. Equations (A.5) and (A.6) restate the value functions (9) and (10) from the main text. Substituting $V_{di,t+1}(\omega, n)$ into $V_{di,t}(\omega)$ and iterating forward up to period T yields

$$\begin{aligned} V_{di,t}(\omega) = \max_{n \in \mathcal{N}} \Bigg\{ & \pi_{ndi,t}(\omega) + \sum_{\varsigma=1}^{T} \left(\prod_{\varsigma'=1}^{\varsigma} \frac{1 - \zeta_i}{1 + r_{t+\varsigma'-1}} \right) \pi_{ndi,t+\varsigma}(\omega) \\ & + \sum_{\varsigma=1}^{T} \left(\frac{\zeta_i}{1 + r_{t+\varsigma-1}} \right) \left(\prod_{\varsigma'=1}^{\varsigma-1} \frac{1 - \zeta_i}{1 + r_{t+\varsigma'-1}} \right) V_{di,t+\varsigma}(\omega) \\ & + \left(\prod_{\varsigma=1}^{T} \frac{1 - \zeta_i}{1 + r_{t+\varsigma-1}} \right) V_{di,T}(\omega, n) \Bigg\}. \end{aligned}$$

We can express a trader's anticipated profits for procuring intermediate good ω from source country n as

$$\begin{aligned}
\pi_{ndi,t+\varsigma}(\omega) &= \tfrac{1}{\sigma_i}\left(\tfrac{p_{ndi,t+\varsigma}(\omega)}{P_{di,t+\varsigma}}\right)^{-(\sigma_i-1)} P_{di,t+\varsigma}Y_{di,t+\varsigma} \\
&= \tfrac{1}{\sigma_i}\left(\tfrac{p_{ndi,t}(\omega)}{P_{di,t}}\right)^{-(\sigma_i-1)} P_{di,t}Y_{di,t}(\omega)\cdot\textstyle\prod_{\varsigma'=1}^{\varsigma}\left(\tfrac{\hat{p}_{ndi,t+\varsigma'}(\omega)}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)} \hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'} \\
&= \pi_{ndi,t}(\omega)\cdot\textstyle\prod_{\varsigma'=1}^{\varsigma}\left(\tfrac{\hat{p}_{ndi,t+\varsigma'}(\omega)}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)} \hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'} \\
&= \pi_{ndi,t}(\omega)\cdot\textstyle\prod_{\varsigma'=1}^{\varsigma}\left(\tfrac{\hat{c}_{ndi,t+\varsigma'}}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)} \hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'},
\end{aligned}$$

where the last equality follows from the fact that

$$\hat{p}_{ndi,t+\varsigma}(\omega) \equiv \frac{p_{ndi,t+\varsigma}(\omega)}{p_{ndi,t+\varsigma-1}(\omega)} = \frac{\sigma_i}{\sigma_i-1}\frac{c_{ndi,t+\varsigma}}{z_{ndi}(\omega)}\left(\frac{\sigma_i}{\sigma_i-1}\frac{c_{ndi,t+\varsigma-1}}{z_{ndi}(\omega)}\right)^{-1} = \frac{c_{ndi,t+\varsigma}}{c_{ndi,t+\varsigma-1}} = \hat{c}_{ndi,t+\varsigma}.$$

We can therefore write the limit $T\to\infty$ of the value function as

$$\begin{aligned}
V_{di,t}(\omega) \;=\; \max_{n\in\mathcal{N}}\Bigg\{&\pi_{ndi,t}(\omega)\left[1+\textstyle\sum_{\varsigma=1}^{\infty}\left(\prod_{\varsigma'=1}^{\varsigma}\tfrac{1-\zeta_i}{1+r_{t+\varsigma'-1}}\left(\tfrac{\hat{c}_{ndi,t+\varsigma'}}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)}\hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'}\right)\right] \\
&+\textstyle\sum_{\varsigma=1}^{\infty}\left(\tfrac{\zeta_i}{1+r_{t+\varsigma-1}}\right)\left(\prod_{\varsigma'=1}^{\varsigma-1}\tfrac{1-\zeta_i}{1+r_{t+\varsigma'-1}}\right)V_{di,t+\varsigma}(\omega) \\
&+\lim_{T\to\infty}\left(\textstyle\prod_{\varsigma=1}^{T}\tfrac{1-\zeta_i}{1+r_{t+\varsigma-1}}\right)V_{di,T}(\omega,n)\Bigg\}. \qquad \textbf{(A.7)}
\end{aligned}$$

We invoke the transversality condition $\lim_{T\to\infty}\left(\prod_{\varsigma=1}^{T}\frac{1-\zeta_i}{1+r_{t+\varsigma-1}}\right)V_{di,T}(\omega,n)=0$, to ensure that the present anticipated continuation value of having source country n as the origin of variety ω vanishes infinitely many periods into the future. As stated in equation (12), we define the option value of a procurement relation between a trader in destination d and the variety producer in source country n with

$$\Psi_{ndi,t} \equiv \sum_{\varsigma=1}^{\infty}(1-\zeta_i)^{\varsigma}\left[\prod_{\varsigma'=1}^{\varsigma}\frac{1}{1+r_{t+\varsigma'-1}}\left(\frac{\hat{c}_{ndi,t+\varsigma'}}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)}\hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'}\right].$$

Using the transversality conditions and the option values for countries n in the value function above, we arrive at equation (11) in the text

$$V_{di,t}(\omega) = \max_{n \in \mathcal{N}} \left\{ \pi_{ndi,t}(\omega) \left(1 + \Psi_{ndi,t}\right) \right\} + \sum_{\varsigma=1}^{\infty} \tfrac{\zeta_i}{1+r_{t+\varsigma-1}} \left(\prod_{\varsigma'=1}^{\varsigma-1} \tfrac{1-\zeta_i}{1+r_{t+\varsigma'-1}} \right) V_{di,t+\varsigma}(\omega),$$

which only depends on n through flow profits $\pi_{ndi,t}(\omega)$ and the option value $\Psi_{ndi,t}$. For $k > 0$, define $V_{di,t}^k(\omega, n)$ as the value function of a trader in destination d who sources intermediate good $\omega \in \Omega_{di,t}^k$ from the same supplier in source country n since time period $t-k$. $V_{di,t}^k(\omega, n)$ can be expressed in terms of past changes in trade cost, factor prices and demand as

$$\begin{aligned} V_{di,t}^k(\omega, n) &= \pi_{ndi,t-k}(\omega) \left[\prod_{\varsigma=t-k+1}^{t} \left(\frac{\hat{c}_{ndi,\varsigma}}{\hat{P}_{di,\varsigma}} \right)^{-(\sigma_i-1)} \hat{P}_{di,\varsigma} \hat{Y}_{di,\varsigma} \right] \\ &\quad + \frac{\zeta_i}{1+r_t} V_{di,t+1}(\omega) + \frac{1-\zeta_i}{1+r_t} V_{di,t+1}^{k+1}(\omega, n). \end{aligned}$$

A.2.2 Sourcing probability

The second term in the value function (A.7) is independent of the trader's choice of source country at time t, and the third term vanishes by the transversality conditions. The trader's optimal choice of supplier $s_{di,t}^*(\omega)$ therefore solves

$$s_{di,t}^*(\omega) = \arg\max_{n \in \mathcal{N}} \left\{ \pi_{ndi,t}(\omega) \left(1 + \Psi_{ndi,t}\right) \right\} = \arg\min_{n \in \mathcal{N}} \left\{ \frac{c_{ndi,t}}{z_{ni}(\omega)} \left(1 + \Psi_{ndi,t}\right)^{-1/(\sigma_i-1)} \right\},$$

where flow profits are given by (8). The probability that a trader in country d sources an intermediate good $\omega \in \Omega_{di,t}^0$ from source country s hence equals

$$\begin{aligned} \upsilon_{sdi,t}^0 &= \Pr\left[\arg\min_{n \in \mathcal{N}} \left\{ \frac{c_{ndi,t}}{z_{ni}(\omega)} \left(1 + \Psi_{ndi,t}\right)^{-\frac{1}{\sigma_i-1}} \right\} = s \right] \\ &= \Pr\left[\frac{c_{sdi,t} \left(1 + \Psi_{sdi,t}\right)^{-\frac{1}{\sigma_i-1}}}{z_{si}(\omega)} \leq \frac{c_{ndi,t} \left(1 + \Psi_{ndi,t}\right)^{-\frac{1}{\sigma_i-1}}}{z_{ni}(\omega)} \ \forall n \neq s \right] \\ &= \Pr\left[\frac{\nu_{sdi,t}}{z_{si}(\omega)} \leq \frac{\nu_{ndi,t}}{z_{ni}(\omega)} \ \forall n \neq s \right], \end{aligned}$$

using the shorthand

$$\nu_{sdi,t} \equiv c_{sdi,t} (1 + \Psi_{sdi,t})^{-1/(\sigma_i-1)}.$$

As in EK, the Poisson arrival rate of Pareto distributed productivity implies that the highest realized productivity $z_{si}(\omega)$ for an intermediate good ω in a country-industry si is an i.i.d. Fréchet distributed random variable with the distribution function

$$\Pr\left[z_{si}(\omega) \leq z\right] = \exp\left\{-A_{si} z^{-\theta_i}\right\}.$$

Maximum productivity $z_{si}(\omega)$ is distributed Fréchet, so the random variable

$$c_{sdi,t}\left(1+\Psi_{sdi,t}\right)^{-1/(\sigma_i-1)} \big/ z_{si}(\omega) = \nu_{sdi,t}/z_{si}(\omega)$$

is Weibull distributed with the distribution function

$$\Pr\left[\frac{c_{sdi,t}\left(1+\Psi_{sdi,t}\right)^{-\frac{1}{\sigma_i-1}}}{z_{si}(\omega)} \leq v\right] = \Pr\left[z_{si}(\omega) \geq \nu_{sdi,t}/v\right] = 1-\exp\left\{-A_{si}(\nu_{sdi,t})^{-\theta_i} v^{\theta_i}\right\}.$$

The minimum from a draw of N i.i.d. Weibull distributed random variables with common shape parameter θ_i is also Weibull distributed with the same shape parameter and

$$F_{di,t}(v) = \Pr\left[\min_{n\in\mathcal{N}} \frac{\nu_{ndi,t}}{z_{ni}(\omega)} \leq v\right] = 1-\exp\left\{-v^{\theta_i}\Upsilon_{di,t}\right\},$$

where

$$\Upsilon_{di,t} = \textstyle\sum_{n\in\mathcal{N}} A_{ni}(\nu_{ndi,t})^{-\theta_i}.$$

The properties of the Weibull distribution then yield the probability that an intermediate good $\omega \in \Omega^0_{di,t}$ in destination d is optimally sourced from a supplier in country s

$$\begin{aligned}
\upsilon^0_{sdi,t} = \Pr\left[\frac{\nu_{sdi,t}}{z_{si}(\omega)} \leq \frac{\nu_{ndi,t}}{z_{ni}(\omega)}\ \forall n \neq s\right] &= \frac{A_{si}(\nu_{sdi,t})^{-\theta_i}}{\sum_{n\in\mathcal{N}} A_{ni}(\nu_{ndi,t})^{-\theta_i}} \\
&= \frac{A_{si} c_{sdi,t}^{-\theta_i}(1+\Psi_{sdi,t})^{\frac{\theta_i}{\sigma_i-1}}}{\sum_{n\in\mathcal{N}} A_{ni} c_{ndi,t}^{-\theta_i}(1+\Psi_{ndi,t})^{\frac{\theta_i}{\sigma_i-1}}} \\
&= \frac{A_{si} c_{sdi,t}^{-\theta_i}(1+\Psi_{sdi,t})^{\frac{\theta_i}{\sigma_i-1}}}{\Upsilon_{di,t}}.
\end{aligned}$$

By the law of large numbers, the probability $\upsilon^0_{sdi,t}$ coincides with the share of intermediate goods $\omega \in \Omega^0_{di,t}$ that a destination d optimally procures from a country s at time t. As another implication of the Weibull distribution, the term $\Upsilon_{di,t}$ encodes the average net return per unit sold across intermediate goods $\omega \in \Omega^0_{di,t}$:

$$\int_{\Omega^0_{di,t}} \max_n \frac{z_{ni}(\omega)}{\nu_{ndi,t}} \, \mathrm{d}\omega = \int_0^\infty v \, \mathrm{d}(1 - F_{di,t}(v)) = \Gamma\left(\frac{\theta_i - (\sigma_i - 1)}{\theta_i}\right) \Upsilon_{di,t}.$$

A.3 Demand for Optimally Sourced Intermediate Goods

Consider the partition $k = 0$, where traders can adjust their sourcing choice. Under constant markup pricing, the distribution of prices paid by an assembler in d for goods $\omega \in \Omega^0_{di,t}$ sourced from country s is characterized by the distribution of prices paid by traders:

$$\begin{aligned} \tilde{G}^0_{sdi,t}(p) &= \Pr\left(\frac{c_{sdi,t}}{z_{si}(\omega)} \le p \,\middle|\, s^*_{di,t}(\omega) = s\right) \\ &= \Pr\left(\frac{c_{sdi,t}}{z_{si}(\omega)} \le p \,\middle|\, \arg\min_n \left\{\frac{\nu_{ndi,t}}{z_{ni}(\omega)}\right\} = s\right). \end{aligned}$$

The distribution $\tilde{G}^0_{sdi,t}$ of prices paid differs from the distribution $F_{di,t}$ of net present costs, unless $\nu_{ndi,t} = c_{ndi,t}$ for all n. This corresponds to myopic supplier choice, where $\Psi_{ndi,t} = 0$. To characterize $\tilde{G}^0_{sdi,t}$ when $\nu_{ndi,t} \neq c_{ndi,t}$ due to anticipation effects, we first establish

Lemma 1 (Conditional Weibull distribution under heterogeneous scaling)**.** *Let* $\{a_n\}_{n=1}^N > \mathbf{0}$ *be a vector of non-negative constants and* $\{X_n\}_{n=1}^N$ *a vector of i.i.d. Weibull-distributed random variables, each with cumulative distribution function* $\Pr[X_n \le x] = 1 - \exp\{-T_n x^\theta\}$. *Then the distribution of* X_s *conditional on* s *being the minimum realization among a set of draws from* $\{a_n X_n\}_{n=1}^N$ *is given by*

$$\Pr\left[X_s \le x | \arg\min_n \{a_n X_n\} = s\right] = 1 - \exp\left\{-x^\theta a_s^\theta \sum_n T_n a_n^{-\theta}\right\}.$$

Proof. Fix an arbitrary $s \in \{1, ..., N\}$. For any $n \in \{1, ..., N\} \setminus \{s\}$ and $x > 0$, the counter-cumulative distribution function of the random variable $\frac{a_n}{a_s} X_n$ is given by $\Pr\left[X_n \ge x \frac{a_s}{a_n}\right] = \exp\left\{-T_n \left(\overline{x} \frac{a_s}{a_n}\right)^\theta\right\}$, for $\overline{x} > 0$. Hence, the distribution of the minimum among a set of draws from $\{\frac{a_n}{a_s} X_n\}_{n \neq s}$ is given by

$$\Pr\left[X_n \ge \overline{x} \frac{a_s}{a_n} \; \forall n \neq s\right] = \prod_{n \neq s} \Pr\left[X_n \ge \overline{x} \frac{a_s}{a_n}\right] = \exp\left\{-\overline{x}^\theta \sum_{n \neq s} T_n \left(\frac{a_n}{a_s}\right)^{-\theta}\right\}.$$

Noticing that $\Pr\left[X_n \geq x\frac{a_s}{a_n}\ \forall n\neq s\right] = \Pr\left[s = \arg\min_n\{a_n X_n\} \mid X_s = x\right]$, we can therefore state the joint probability that $X_s \leq x$ and $s = \arg\min_n\{a_n X_n\}$ as

$$\begin{aligned}
\Pr\left[X_s \leq x, s = \arg\min_n\{a_n X_n\}\right] &= \int_0^x \Pr\left[s = \arg\min_n\{a_n X_n\} \mid X_s = t\right] \tfrac{\mathrm{d}\Pr[X_s \leq t]}{\mathrm{d}t}\,\mathrm{d}t \\
&= \int_0^x T_s \theta t^{\theta-1} \exp\left\{-t^\theta T_s\right\} \exp\left\{-t^\theta \textstyle\sum_{n\neq s} T_n (\frac{a_n}{a_s})^{-\theta}\right\} \mathrm{d}t \\
&= \int_0^x T_s \theta t^{\theta-1} \exp\left\{-t^\theta a_s^\theta \textstyle\sum_n T_n a_n^{-\theta}\right\} \mathrm{d}t.
\end{aligned}$$

Using Bayes' rule and the fact that $\Pr\left[s = \arg\min_n\{a_n X_n\}\right] = (T_s a_s^{-\theta})/(\sum_n T_n a_n^{-\theta})$, the conditional distribution $\Pr\left[X_s \leq x | \arg\min_n\{a_n X_n\} = s\right]$ hence satisfies

$$\begin{aligned}
\Pr\left[X_s \leq x \mid \arg\min_n\{a_n X_n\} = s\right] &= \frac{\Pr\left[\arg\min_n\{a_n X_n\} = s \mid X_s \leq x\right] \cdot \Pr\left[X_s \leq x\right]}{\Pr\left[\arg\min_n\{a_n X_n\} = s\right]} \\
&= \frac{\Pr\left[X_s \leq x, s = \arg\min_n\{a_n X_n\}\right]}{\Pr\left[\arg\min_n\{a_n X_n\} = s\right]} \\
&= \tfrac{\sum_n T_n a_n^{-\theta}}{T_s a_s^{-\theta}} \int_0^x T_s \theta t^{\theta-1} \exp\left\{-t^\theta a_s^\theta \textstyle\sum_n T_n a_n^{-\theta}\right\} \mathrm{d}t \\
&= \int_0^x \theta t^{\theta-1} \left[a_s^\theta \textstyle\sum_n T_n a_n^{-\theta}\right] \exp\left\{-t^\theta a_s^\theta \textstyle\sum_n T_n a_n^{-\theta}\right\} \mathrm{d}t \\
&= 1 - \exp\left\{-x^\theta a_s^\theta \textstyle\sum_n T_n a_n^{-\theta}\right\}.
\end{aligned}$$

This completes the proof. $\square$

Using Lemma 1 and substituting $x = p$, $T_n = A_{ni} c_{ndi,t}^{-\theta_i}$, $a_n = (1 + \Psi_{ndi,t})^{-\frac{1}{\sigma_i - 1}}$, the distribution of intermediate-goods prices paid by traders becomes

$$\begin{aligned}
\tilde{G}_{sdi,t}^0(p) &= 1 - \exp\left\{-p^{\theta_i} \left(1 + \Psi_{sdi,t}\right)^{-\frac{\theta_i}{\sigma_i - 1}} \sum_n A_{ni} c_{ndi,t}^{-\theta_i} \left(1 + \Psi_{ndi,t}\right)^{\frac{\theta_i}{\sigma_i - 1}}\right\} \\
&= 1 - \exp\left\{-p^{\theta_i} \left(1 + \Psi_{sdi,t}\right)^{-\frac{\theta_i}{\sigma_i - 1}} \Upsilon_{di,t}\right\}.
\end{aligned}$$

Under constant markup pricing, the price distribution facing local assemblers follows directly from the distribution of prices paid by traders:

$$\begin{aligned}
G_{sdi,t}^0(p) &= \tilde{G}_{sdi,t}^0\left(\frac{\sigma_i - 1}{\sigma_i} p\right) \\
&= 1 - \exp\left\{-p^{\theta_i} \left(\tfrac{\sigma_i - 1}{\sigma_i}\right)^{\theta_i} \left(1 + \Psi_{sdi,t}\right)^{-\frac{\theta_i}{\sigma_i - 1}} \Upsilon_{di,t}\right\}.
\end{aligned}$$

To derive country $d's$ expenditure share for every potential source country of goods $\omega \in$

$\Omega^0_{di,t}$, we can invoke the law of large numbers and show

$$
\begin{aligned}
\lambda^0_{sdi,t} &= \frac{\int_{\omega\in\Omega^0_{di,t}} \mathbf{1}_d\left\{s^*_{di,t}(\omega)=s\right\} p(\omega)^{-(\sigma_i-1)}\,\mathrm{d}\omega}{\sum_n \int_{\omega\in\Omega^0_{di,t}} \mathbf{1}_d\left\{s^*_{di,t}(\omega)=n\right\} p(\omega)^{-(\sigma_i-1)}\,\mathrm{d}\omega} \\
&= \frac{A_{si}\nu^{-\theta_i}_{sdi,t}\int_0^\infty p^{-(\sigma_i-1)}\,\mathrm{d}G_{sdi,t}(p)}{\sum_n A_{ni}\nu^{-\theta_i}_{ndi,t}\int_0^\infty p^{-(\sigma_i-1)}\,\mathrm{d}G_{ndi,t}(p)},
\end{aligned}
\tag{A.8}
$$

where

$$\nu_{sdi,t} \equiv c_{sdi,t}(1+\Psi_{sdi,t})^{-1/(\sigma_i-1)}.$$

Use a change in variables

$$x = p^{\theta_i}\left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\theta_i}(1+\Psi_{ndi,t})^{-\frac{\theta_i}{\sigma_i-1}}\,\Upsilon_{di,t}, \quad \text{so } \mathrm{d}x = \theta_i p^{\theta_i-1}\left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\theta_i}(1+\Psi_{ndi,t})^{-\frac{\theta_i}{\sigma_i-1}}\,\Upsilon_{di,t}\,\mathrm{d}p.$$

Plug these results into the conditional distribution $G^0_{sdi,t}(p)$ above to find

$$
\begin{aligned}
\int_0^\infty p^{-(\sigma_i-1)}\,\mathrm{d}G^0_{sdi,t}(p) &= \int_0^\infty p^{-(\sigma_i-1)}\,\theta_i p^{\theta_i-1}\left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\theta_i}(1+\Psi_{sdi,t})^{-\frac{\theta_i}{\sigma_i-1}}\,\Upsilon_{di,t} \\
&\qquad \cdot\exp\left\{-p^{\theta_i}\left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\theta_i}(1+\Psi_{sdi,t})^{-\frac{\theta_i}{\sigma_i-1}}\,\Upsilon_{di,t}\right\}\mathrm{d}p \\
&= \int_0^\infty \left(\frac{x}{\left(\frac{\sigma_i-1}{\sigma_i}\right)^{\theta_i}\left(1+\Psi_{sdi,t}\right)^{-\frac{\theta_i}{\sigma_i-1}}\Upsilon_{di,t}}\right)^{-\frac{\sigma_i-1}{\theta_i}} e^{-x}\,\mathrm{d}x \\
&= \left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\sigma_i-1}(1+\Psi_{sdi,t})^{-1}\left(\Upsilon_{di,t}\right)^{\frac{\sigma_i-1}{\theta_i}}\int_0^\infty x^{-\frac{\sigma_i-1}{\theta_i}}e^{-x}\,\mathrm{d}x \\
&= \left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\sigma_i-1}(1+\Psi_{sdi,t})^{-1}\left(\Upsilon_{di,t}\right)^{\frac{\sigma_i-1}{\theta_i}}\Gamma\left(\tfrac{\theta_i-(\sigma_i-1)}{\theta_i}\right).
\end{aligned}
$$

Using this solution in $\lambda^0_{sdi,t}$ above establishes equation (16) in the text. From equation (16) we can compute the partial elasticity of trade flows for goods $\omega\in\Omega^0_{di,t}$ with respect to a permanent change in trade cost $\tau_{sdi,t}$ from time t on. We ignore the general-equilibrium response of factor prices and isolate trade cost changes from unit cost $c_{si,t}$, we condition on market access $\Phi^0_{di,t}$, and we hold the future path of factor costs and prices behind the option value $\Psi_{sdi,t}$ constant, so

$$\left.\frac{\partial\ln\lambda^0_{sdi,t}}{\partial\ln\tau_{sdi,t}}\right|_{\Phi^0_{di,t},\Psi_{sdi,t}} = -\theta_i.$$

Agents have perfect foresight. Beyond the concurrent effect of a change in trade costs on trade flows, we can therefore also derive the effect of a future trade cost change by Δ percent on trade flows today. Suppose that, starting at horizon $t+h+1$, trade costs permanently increase. To compute the partial-equilibrium response of trade flows at time t to such a future change from equation (16), we condition on current market aggregates $\{\Phi^0_{di,t}, c_{sdi,t}\}$ and on changes in trade and unit cost at horizons $0 < h' < h+1$:

$$\left.\frac{\partial \ln \lambda^0_{sdi,t}}{\partial \ln\{\tau_{sd,t+h'}\}_{h'>h}}\right|_{\Phi^0_{di,t}, c_{sdi,t}} = \frac{\theta_i - (\sigma_i - 1)}{\sigma_i - 1} \left.\frac{\partial \ln (1+\Psi_{sdi,t})}{\partial \ln\{\tau_{sdo,t+h'}\}_{h'>h}}\right|_{\Phi^0_{di,t}},$$

where

$$\begin{aligned}
\left.\frac{\partial \ln\left(1+\Psi_{sdi,t}\right)}{\partial \ln\{\tau_{sdi,t+h'}\}_{h'>h}}\right|_{\Phi^0_{di,t}} &= \lim_{\Delta\to 0} \frac{\partial \ln\left[1+\sum_{\varsigma=1}^{\infty}\left(\frac{1-\zeta_i}{1+r}\right)^{\varsigma}\left(X_\varsigma \prod_{\varsigma'=1}^{\varsigma}\left(\frac{\hat{c}_{sdi,t+\varsigma'}}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)}\hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'}\right)\right]}{\partial \ln(1+\Delta)} \\
&= -\frac{\sum_{\varsigma=h+1}^{\infty}\left(\frac{1-\zeta_i}{1+r}\right)^{\varsigma}\left(\prod_{\varsigma'=1}^{\varsigma}\left(\frac{\hat{c}_{sdi,t+\varsigma'}}{\hat{P}_{di,t+\varsigma'}}\right)^{-(\sigma_i-1)}\hat{P}_{di,t+\varsigma'}\hat{Y}_{di,t+\varsigma'}\right)}{1+\Psi_{sd,t}}(\sigma_i-1) \\
&= -\left(\frac{1-\zeta_i}{1+r}\right)^h \frac{\Psi_{sdi,t+h}}{1+\Psi_{sdi,t}}(\sigma_i-1)
\end{aligned}$$

for $X_\varsigma \equiv \left((1+\Delta)^{\mathbf{1}\{\varsigma\geq h+1\}}\right)^{-(\sigma_i-1)}$.

A.4 Demand for Legacy Intermediate Goods

We turn to the partitions $k>0$, where traders cannot adjust their sourcing choice. For goods $\omega \in \Omega^k_{di,t}$ with $k>0$, traders last chose the optimal supplier $t-k$ periods ago. Suppose that in period $t-k$ intermediate good ω was optimally sourced from country s to d in industry i. The destination price in period t is

$$p_{sdi,t}(\omega) = \frac{\sigma_i}{\sigma_i-1}\frac{c_{sdi,t}}{z_{si}(\omega)} = \frac{\sigma_i}{\sigma_i-1}\frac{\prod_{\varsigma=t-k+1}^{t} c_{sdi,t-k}\,\hat{c}_{sdi,\varsigma}}{z_{si}(\omega)} = p_{sdi,t-k}(\omega)\prod_{\varsigma=t-k+1}^{t}\hat{c}_{sdi,\varsigma}, \quad \text{(A.9)}$$

which is the initial destination price adjusted for the cumulative changes in trade costs and factor costs. Using this result, we can derive country d's expenditure share by source country across intermediate goods $\omega \in \Omega^k_{di,t}$

$$
\begin{aligned}
\lambda^k_{sdi,t} &= \frac{\int_{\Omega^k_{di,t}} \mathbf{1}_d \left\{s = s^*_{di,t-k}(\omega)\right\} p_{sdi,t-k}(\omega)^{-(\sigma_i-1)} \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{sdi,\varsigma}\right)^{-(\sigma_i-1)} \, \mathrm{d}\omega}{\sum_n \int_{\Omega^k_{di,t}} \mathbf{1}_d \left\{n = s^*_{di,t-k}(\omega)\right\} p_{ndi,t-k}(\omega)^{-(\sigma_i-1)} \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{ndi,\varsigma}\right)^{-(\sigma_i-1)} \, \mathrm{d}\omega} \\
&= \frac{\left[A_{si} \nu^{-\theta_i}_{sdi,t-k} \int_0^\infty p^{-(\sigma_i-1)} \, \mathrm{d}G^0_{sdi,t-k}(p)\right] \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{sdi,\varsigma}\right)^{-(\sigma_i-1)}}{\sum_n \left[A_{ni} \nu^{-\theta_i}_{ndi,t-k} \int_0^\infty p^{-(\sigma_i-1)} \, \mathrm{d}G^0_{ndi,t-k}(p)\right] \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{ndi,\varsigma}\right)^{-(\sigma_i-1)}} \\
&= \frac{\lambda^0_{sdi,t-k} \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{sdi,\varsigma}\right)^{-(\sigma_i-1)}}{\sum_n \lambda^0_{ndi,t-k} \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{ndi,\varsigma}\right)^{-(\sigma_i-1)}},
\end{aligned}
$$

where $\mu_{di,t}(k)$ is the measure of the set $\Omega^k_{di,t}$ and $\nu_{sdi,t} \equiv c_{sdi,t}(1 + \Psi_{sdi,t})^{-1/(\sigma_i-1)}$. The final equality follows from using (A.8) for $\lambda^0_{sdi,t-k}$ after dividing both numerator and denominator by $\sum_m A_{mi} \nu^{-\theta_i}_{mdi,t} \int_0^\infty p^{-(\sigma_i-1)} \, \mathrm{d}G_{mdi,t}(p)$.

A.5 Price Indices

To characterize the price index for goods $\omega \in \Phi^0_{di,t}$, we use our previous results to show that

$$
\begin{aligned}
\left(P^0_{di,t}\right)^{-(\sigma_i-1)} &= \int_{\Omega^0_{di,t}} \sum_n \mathbf{1}_d \left\{n = s^*_{di,t}(\omega)\right\} p_{di,t}(\omega)^{-(\sigma_i-1)} \, \mathrm{d}\omega \\
&= \mu_{di,t}(0) \sum_n \frac{A_{ni} \nu^{-\theta_i}_{ndi,t}}{\Upsilon_{di,t}} \int_0^\infty p^{-(\sigma_i-1)} \, \mathrm{d}G^0_{ndi,t}(p) \\
&= \mu_{di,t}(0) \left(\frac{\sigma_i-1}{\sigma_i}\right)^{\sigma_i-1} \Gamma\left(\frac{\theta_i-(\sigma_i-1)}{\theta_i}\right) \sum_n \frac{A_{ni} \nu^{-\theta_i}_{ndi,t}}{\Upsilon_{di,t}} \left(1 + \Psi_{ndi,t}\right)^{-1} \left(\Upsilon_{di,t}\right)^{\frac{\sigma_i-1}{\theta_i}} \\
&= \mu_{di,t}(0) \, \gamma_i^{-(\sigma_i-1)} \frac{\Phi^0_{di,t}}{\Upsilon_{di,t}} \left(\Upsilon_{di,t}\right)^{\frac{\sigma_i-1}{\theta_i}},
\end{aligned}
$$

where $\nu_{sdi,t} \equiv c_{sdi,t}(1 + \Psi_{sdi,t})^{-1/(\sigma_i-1)}$, $\gamma_i \equiv \frac{\sigma_i}{\sigma_i-1} \Gamma\left(\frac{\theta_i-(\sigma_i-1)}{\theta_i}\right)^{-1/(\sigma_i-1)}$. Alternatively, we can use the fact that $\lambda^0_{ddi,t} = \left[A_{di} c^{-\theta_i}_{ddi,t} \left(1 + \Psi_{ddi,t}\right)^{\frac{\theta_i}{\sigma_i-1}-1}\right] / \left(P^0_{di,t}\right)^{-(\sigma_i-1)}$ to obtain:

$$
\left(P^0_{di,t}\right)^{-(\sigma_i-1)} = c^{-\theta_i}_{ddi,t} \left(1 + \Psi_{ddi,t}\right)^{\frac{\theta_i}{\sigma_i-1}-1} \frac{A_{di}}{\lambda^0_{ddi,t}}.
$$

By the properties of CES demand, the ideal price index for goods in the partition $\Omega^k_{di,t}$ follows from the initial price $P^0_{di,t-k}$ at time $t-k$ and subsequent changes in prices and varieties:

$$
\begin{aligned}
\left(P^k_{di,t}\right)^{-(\sigma_i-1)} &= \int_{\Omega^k_{di,t}} \sum_n \mathbf{1}_d \left\{n = s^*_{di,t-k}(\omega)\right\} p_{ndi,t}(\omega)^{-(\sigma_i-1)} \,\mathrm{d}\omega \\
&= \mu_{di,t}(k) \left(\tfrac{\sigma_i-1}{\sigma_i}\right)^{\sigma_i-1} \sum_n \Bigg[\tfrac{A_{ni}\nu^{-\theta_i}_{ndi,t-k}}{\Upsilon_{di,t-k}} \int_0^\infty p^{-(\sigma_i-1)} \,\mathrm{d}G^0_{ndi,t-k}(p) \\
&\qquad\qquad\qquad\qquad\qquad\qquad \times \prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{ndi,\varsigma}\right)^{-(\sigma_i-1)} \Bigg] \\
&= \tfrac{\mu_{di,t}(k)}{\mu_{di,t-k}(0)} \left(P^0_{di,t-k}\right)^{-(\sigma_i-1)} \sum_n \lambda^0_{ndi,t-k} \left(\prod_{\varsigma=t-k+1}^{t} \left(\hat{c}_{ndi,\varsigma}\right)^{-(\sigma_i-1)}\right) \\
&= \tfrac{\mu_{di,t}(k)}{\mu_{di,t-k}(0)} \left(P^0_{di,t-k}\right)^{-(\sigma_i-1)} \Phi^k_{di,t}.
\end{aligned}
$$

A.6 Aggregation

The aggregate price index of good i combines the partial price indices across composites purchased from suppliers chosen $t-k$ periods ago:

$$
\begin{aligned}
P_{di,t} &= \left[\int_{[0,1]} p_{d,t}(\omega)^{-(\sigma_i-1)} \,\mathrm{d}\omega\right]^{-\frac{1}{\sigma_i-1}} = \left(\sum_{k=0}^\infty \left(P^k_{di,t}\right)^{-(\sigma_i-1)}\right)^{-\frac{1}{\sigma_i-1}} \\
&= P^0_{di,t} \left[1 + \sum_{k=1}^\infty \tfrac{\mu_{di,t}(k)}{\mu_{di,t}(0)} \left(\tfrac{P^0_{di,t-k}}{P^0_{di,t}}\right)^{-(\sigma_i-1)} \Phi^k_{di,t}\right]^{-\frac{1}{\sigma_i-1}}.
\end{aligned}
$$

Under CES demand, total expenditure shares are simply the weighted average of trade shares across partitions:

$$
\lambda_{sdi,t} = \sum_{k=0}^\infty \left(\frac{P^k_{di,t}}{P_{di,t}}\right)^{-(\sigma_i-1)} \lambda^k_{sdi,t}.
$$

A.7 Proof of Proposition 1

In an economy that is in steady state factor prices and trade costs are constant so $\hat{c}_{sdi,t} = 1$ and $1 + \Psi_{sdi,t} = (1+r)/(r+\zeta_i)$. Then, a destination d's sourcing probability for different source countries s across intermediate goods $\omega \in \Omega^0_{i,t}$ equals its expenditure shares, $\upsilon^0_{sdi,t} = \lambda^0_{sdi,t} = \lambda^0_{sdi,t-1} = \cdots = \lambda^0_{sdi,0}$. For traders who cannot adjust their suppliers in steady state ($k > 0$), we can evaluate (24) using the same logic as above: $\lambda^k_{sdi,t} = \lambda^0_{sdi,t-k} = \lambda^0_{sdi,0}$ for all k. From (24), it is straightforward to recognize that $\upsilon^0_{sdi,t} = \lambda_{sdi,t} = \lambda^0_{sdi,t}$, which coincides with the static equilibrium of an EK economy with the same fundamentals $\boldsymbol{\Theta}$, the same trade costs $\boldsymbol{\tau}$, and no sourcing frictions ($\boldsymbol{\zeta} = \mathbf{1}$). To derive the stationary distribution of partition measures, start with the case $k = 0$. Note that $\mu_i^*(0) = \Pr\left[\omega \in \Omega_{di,t}^0\right] = \zeta_i$ does not vary across destinations or over time. Now consider cases $k > 0$. Note that

$$\begin{aligned}
\mu_i^*(k) = \Pr\left[\omega \in \Omega_{di,t}^k, k > 0\right] &= \sum_{\ell=0}^{\infty} \Pr\left[\omega \in \Omega_{di,t}^k, k > 0 \middle| \omega \in \Omega_{di,t-1}^{\ell}\right] \Pr\left[\omega \in \Omega_{di,t-1}^{\ell}\right] \\
&= (1-\zeta_i) \Pr\left[\omega \in \Omega_{di,t-1}^{k-1}\right].
\end{aligned}$$

The remaining proof for $k > 0$ then follows by induction. For $k = 1$, $\Pr\left[\omega \in \Omega_{di,t}^1\right] = (1-\zeta_i)\zeta_i$, and for $k = 2$, $\Pr\left[\omega \in \Omega_{di,t}^2\right] = (1-\zeta_i)\Pr\left[\omega \in \Omega_{di,t}^1\right] = (1-\zeta_i)^2\zeta_i$, and so forth recursively. For an arbitrary $k > 0$ we must therefore have $\Pr\left[\omega \in \Omega_{di,t}^k\right] = (1-\zeta_i)^k\zeta_i$. This is the probability density function of a geometric distribution with mean $(1-\zeta_i)/\zeta_i$ and standard deviation $\sqrt{1-\zeta_i}/\zeta_i$. By the Markov property, the distribution of partition measures is stationary for all $k \in \mathbb{N}_0$ with $\mu_i^*(k) = \zeta_i\left(1-\zeta_i\right)^k$.

A.8 Proof of Proposition 2

For ease of notation, we suppress industry subscripts throughout the derivation. Denote $\left\{\lambda_{sd,t-1}^k\right\}_{k=0}^{\infty}$ the vector of destination $d's$ expenditure shares for a source country s across goods in each of the partitions $\left\{\Omega_{d,t}^k\right\}_{k=0}^{\infty}$ at time t. Now, consider a one-time permanent change in trade costs such that $\hat{\tau}_{sd,t} \neq 1$ and $\hat{\tau}_{sd,t+h} = 1\ \forall h > 0$. To characterize the partial trade elasticity at horizon h, we first characterize the elasticity for trade shares of each partition, then aggregate them up using the consumption shares derived from the CES preferences over partitions. The change in expenditure shares on intermediate goods in the k-th partition in period $t+h$, relative to period t is given by

$$\ln \frac{\lambda_{sd,t+h}^k}{\lambda_{sd,t-1}^k} = \begin{cases}
-(\sigma-1)\ln\hat{\tau}_{sd,t} \\
\quad + \ln \frac{\lambda_{sd,t+h-k}^0}{\lambda_{sd,t-1}^k}\left(\frac{(c_{s,t+h}/P_{d,t+h}^k)}{(c_{s,t+h-k}/P_{d,t+h-k}^k)}\right)^{-(\sigma-1)} & ,k > h \\
\ln \frac{\lambda_{sd,t+h-k}^0}{\lambda_{sd,t-1}^k}\left(\frac{c_{s,t+h}/P_{d,t+h}^k}{c_{s,t+h-k}/P_{d,t+h-k}^k}\right)^{-(\sigma-1)} & ,1 \leq k < h \\
\ln \frac{\lambda_{sd,t+h-1}^0}{\lambda_{sd,t-1}^k}\left(\frac{c_{s,t+h}/\Phi_{d,t+h}^0}{c_{s,t-1}/\Phi_{d,t-1}^0}\right)^{-\theta} \times \left(\frac{1+\Psi_{sd,t+h}}{1+\Psi_{sd,t-1}}\right)^{\theta/(\sigma-1)} & ,k = 0
\end{cases}$$

The first line denotes intermediate goods that have not updated suppliers since the shock arrived. For such intermediate goods, changes in expenditure shares still explicitly depend on the shock to trade costs. The remaining intermediate goods have updated at least once, and a "new" optimal sourcing share $\lambda_{sd,t+h-k}^0$ from a time period between t and $t+h$

encodes the "initial price index" relative to which changes in expenditure shares are updated as well as the effect of the shock in trade costs. Unit costs are the relevant GE variables. To capture general equilibrium effects, we introduce the variables

$$\Delta \boldsymbol{G}^{EK}_{sd,t,t+h} = -\theta \ln \prod_{\varsigma=0}^{h} \frac{\hat{c}_{sd,t+\varsigma}}{\hat{P}^{0}_{d,t+\varsigma}},$$

and

$$\Delta \boldsymbol{G}^{\Psi}_{sd,t-1,t+h} = \frac{\theta}{\sigma-1} \ln \prod_{\varsigma=0}^{h} \left(1+\widehat{\Psi_{sd,t+\varsigma}}\right) \left(\approx \frac{\theta}{\sigma-1}\left(\Psi_{sd,t+h}-\Psi_{sd,t-1}\right)\right)$$

to summarize how current and future changes in unit cost affect trade flows for optimally sourced goods, respectively; and

$$\Delta \boldsymbol{G}^{k}_{sd,\varsigma,t+h} = (1-\sigma) \ln \prod_{\varsigma'=\varsigma+1}^{t+h} \frac{\hat{c}_{sd,\varsigma'}}{\hat{P}^{k}_{d,\varsigma'}},$$

to summarize how past changes in unit cost continue to affect trade flows for goods sourced from suppliers chosen at $t-k$. Then we can solve backwards to express all changes in trade shares above in terms of $\lambda^{0}_{sd,t-1}$, if possible:

$$\ln \frac{\lambda^{k}_{sd,t+h}}{\lambda^{k}_{sd,t-1}} = \begin{cases} -(\sigma-1)\ln \hat{\tau}_{sd,t} + \ln \frac{\lambda^{0}_{sd,t+h-k}}{\lambda^{k}_{sd,t-1}} + \Delta \boldsymbol{G}^{k}_{sd,t,t+h} & ,k > h \geq 0 \\ -\theta \ln \hat{\tau}_{sd,t} + \ln \dfrac{\lambda^{0}_{sd,t-1}}{\lambda^{k}_{sd,t-1}} + \Delta \boldsymbol{G}^{EK}_{sd,t,t+h-k} & \\ \quad + \Delta \boldsymbol{G}^{\Psi}_{sd,t,t+h-k} + \Delta \boldsymbol{G}^{k}_{sd,t+h-k+1,t+h} & ,1 \leq k < h \\ -\theta \ln \hat{\tau}_{sd,t} + \Delta \boldsymbol{G}^{EK}_{sd,t,t+h} + \Delta \boldsymbol{G}^{\Psi}_{sd,t,t+h} & ,k = 0 \end{cases}$$

Using the fact that the outcomes determined at $t-1$ and earlier do not respond to the change in trade costs, the elasticity of $\lambda^k_{sd,t+h}$ with respect to a change in trade costs at t satisfies,

$$\frac{\mathrm{d}\ln(\lambda^k_{sd,t+h}/\lambda^k_{sd,t-1})}{\mathrm{d}\ln\tau_{sd,t}} = \begin{cases} -(\sigma-1) + \frac{\mathrm{d}\Delta \boldsymbol{G}^k_{sd,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} & , k > h \geq 0 \\ -\theta + \dfrac{\mathrm{d}\Delta \boldsymbol{G}^{EK}_{sd,t-1,t+h-k}}{\mathrm{d}\ln\tau_{sd,t}} + \dfrac{\mathrm{d}\Delta \boldsymbol{G}^{\Psi}_{sd,t-1,t+h-k}}{\mathrm{d}\ln\tau_{sd,t}} & \\ \quad + \dfrac{\mathrm{d}\Delta \boldsymbol{G}^{k}_{sd,t+h-k+1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} & , 1 \leq k < h \\ -\theta + \frac{\mathrm{d}\Delta \boldsymbol{G}^{EK}_{sd,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} + \frac{\mathrm{d}\Delta \boldsymbol{G}^{\Psi}_{sd,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} & , k = 0 \end{cases}$$

To derive the change in trade flows across all goods $\omega \in [0,1]$, define the short-hand

$$\Delta \boldsymbol{G}^{P^k}_{d,t-1,t+h} \equiv \ln \frac{P^k_{d,t+h}/P_{d,t-1}}{P^k_{d,t-1}/P_{d,t+h}}.$$

To a first order, the change in overall expenditures at time $t+h$ caused by a one-time permanent shock to trade costs at t $d\ln\tau_{sd,t} = \ln\hat{\tau}_{sd,t}$ is given by

$$\begin{aligned}
\frac{\mathrm{d}\ln\frac{\lambda_{sd,t+h}}{\lambda_{sd,t-1}}}{\mathrm{d}\ln\tau_{sd,t}} &= \sum_{k=0}^{\infty}\omega_k \left\{ \frac{\mathrm{d}\ln\lambda^k_{sd,t+h}/\lambda^k_{sd,t-1}}{\mathrm{d}\ln\tau_{sd,t}} + (1-\sigma)\frac{\mathrm{d}\Delta \boldsymbol{G}^{P^k}_{d,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} \right\} \\
&= \sum_{k=0}^{h}\omega_k \Bigg\{ -\theta + \frac{\mathrm{d}\Delta \boldsymbol{G}^{EK}_{sd,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} + \frac{\mathrm{d}\Delta \boldsymbol{G}^{\Psi}_{sd,t-1,t+h-k}}{\mathrm{d}\ln\tau_{sd,t}} \\
&\qquad\qquad + \frac{\mathrm{d}\Delta \boldsymbol{G}^{k}_{sd,t+h-k+1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} + (1-\sigma)\frac{\mathrm{d}\Delta \boldsymbol{G}^{P^k}_{d,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} \Bigg\} \\
&\quad + \sum_{k=h+1}^{\infty}\omega_k \left\{ (1-\sigma) + \frac{\mathrm{d}\Delta \boldsymbol{G}^{k}_{sd,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} + (1-\sigma)\frac{\mathrm{d}\Delta \boldsymbol{G}^{P^k}_{d,t-1,t+h}}{\mathrm{d}\ln\tau_{sd,t}} \right\} \\
&= -\theta\sum_{k=0}^{h}\omega_k + (1-\sigma)\sum_{k=h+1}^{\infty}\omega_k + \mathcal{R}\big(\{\Delta \boldsymbol{G}^{EK}\}, \{\Delta \boldsymbol{G}^{\Psi}\}, \{\Delta \boldsymbol{G}^{k}\}\big)\,,
\end{aligned}$$

where $\omega_k \equiv \frac{\mu_t(k)\lambda^k_{sd,t}}{\sum_k \mu_t(k)\lambda^k_{sd,t}}$ and

$$\mathcal{R}(\cdot) \equiv \sum_{k=0}^{h} \omega_k \left\{ (1-\sigma)\frac{\mathrm{d}\Delta \boldsymbol{G}^{P^k}_{d,t-1,t+h}}{\mathrm{d}\ln \tau_{sd,t}} + \frac{\mathrm{d}\Delta \boldsymbol{G}^{EK}_{sd,t-1,t+h}}{\mathrm{d}\ln \tau_{sd,t}} + \frac{\mathrm{d}\Delta \boldsymbol{G}^{\Psi}_{sd,t-1,t+h}}{\mathrm{d}\ln \tau_{sd,t}} + \frac{\mathrm{d}\Delta \boldsymbol{G}^{k}_{sd,t+h-k+1,t+h}}{\mathrm{d}\ln \tau_{sd,t}} \right\}$$
$$+ \sum_{k=h+1}^{\infty} \omega_k \left\{ (1-\sigma)\frac{\mathrm{d}\Delta \boldsymbol{G}^{P^k}_{d,t-1,t+h}}{\mathrm{d}\ln \tau_{sd,t}} + \frac{\mathrm{d}\Delta \boldsymbol{G}^{k}_{sd,t-1,t+h}}{\mathrm{d}\ln \tau_{sd,t}} \right\}$$

collects the general equilibrium terms that depend on changes in unit costs and price indices along the transition. If $t-1$ was a steady state, then $\omega_k = \mu^*(k) = \zeta\,(1-\zeta)^k$ (following Proposition 1). Conditioning on $\Delta \boldsymbol{G}^{EK} = \Delta \boldsymbol{G}^{\Psi} = \Delta \boldsymbol{G}^{k} = \Delta \boldsymbol{G}^{P^k} = 0$ eliminates $\mathcal{R}(\cdot)$, and the partial horizon-h trade elasticity equals:

$$\begin{aligned}
\varepsilon^{t+h}_{sd} &\equiv \frac{\partial \ln \lambda_{sd,t+h}}{\partial \ln \tau_{sd,t}} = \frac{\mathrm{d}\ln(\lambda_{sd,t+h}/\lambda_{sd,t})}{\mathrm{d}\ln \tau_{sd,t}}\bigg|_{\Delta \boldsymbol{G}^{EK}, \Delta \boldsymbol{G}^{\Psi}, \{\Delta \boldsymbol{G}^{k}\}, \{\Delta \boldsymbol{G}^{P^k}\}=0} \\
&= -\theta \sum_{k=0}^{h} \mu(k) + (1-\sigma) \sum_{k=h+1}^{\infty} \mu^*(k) \\
&= -\theta \left[1 - (1-\zeta)^{h+1}\right] + (1-\sigma)\,(1-\zeta)^{h+1}.
\end{aligned}$$

The limiting cases and rate of convergence follow as stated in the main text.

A.9 Proof of Proposition 3

We again suppress industry subscripts throughout the derivations. Let $\left\{\lambda^k_{sd,t-1}\right\}_{k=0}^{\infty}$ denote the equilibrium vector of destination $d's$ expenditure shares for a source country s across goods in each of the partitions $\left\{\Omega^k_{d,t-1}\right\}_{k=0}^{\infty}$ at time $t-1$, given a path $\boldsymbol{\tau} = \boldsymbol{\tau}_{t,-} \cup \tau_t \cup \boldsymbol{\tau}_{t,+}$ for trade cost. Now, at time t, suppose that there is a change in the path of trade cost to $\boldsymbol{\tau}'_f$ so that $f = \{t : \tau_t \neq \tau'_t\}$. To characterize the anticipatory trade elasticity, let h denote the horizon between t and the evaluation date $t+h$, where $0 \leq h < f$, so that the anticipated shock at $t+f$ lies $f-h > 0$ periods ahead of the evaluation date. We follow steps similar to those we took to establish Proposition 2. For $0 < h < f$, we have that

$$\frac{\lambda^k_{sd,t+h}}{\lambda^k_{sd,t-1}} = \begin{cases} \frac{\lambda^0_{sd,t+h-k}}{\lambda^k_{sd,t-1}} \Delta \boldsymbol{G}^k_{sd,t,t+h} & , k > h \geq 0 \\ \left(\dfrac{1+\Psi_{sd,t+h-k}}{1+\Psi_{sd,t-1}} \right)^{\frac{\theta+1-\sigma}{\sigma-1}} \dfrac{\lambda^0_{sd,t-1}}{\lambda^k_{sd,t-1}} & \\ \quad \times \Delta \boldsymbol{G}^{EK}_{sd,t-1,t+h-k} \Delta \boldsymbol{G}^k_{sd,t+h-k+1,t+h} & , 1 \leq k \leq h \\ \left(\frac{1+\Psi_{sd,t+h}}{1+\Psi_{sd,t-1}} \right)^{\frac{\theta+1-\sigma}{\sigma-1}} \Delta \boldsymbol{G}^{EK}_{sd,t,t+h} & , k = 0 \end{cases},$$

where $\Delta \boldsymbol{G}^{EK}$ and $\Delta \boldsymbol{G}^k$ are defined as in the proof of Proposition 2. The first line denotes intermediate goods that have not updated suppliers since time t. For such goods, changes in expenditure shares depend only on general equilibrium cost adjustments encoded in $\Delta \boldsymbol{G}^k$, with no direct tariff effect since the anticipated shock has not yet materialized. The remaining goods have updated at least once since t, and the ratio of option values $(1+\Psi_{sd,t+h-k}) / (1+\Psi_{sd,t-1})$ captures how the anticipation of the future shock at $t+f$ alters sourcing decisions at the time of re-optimization. Using the expression for $\partial \ln(1+\Psi_{sd,t}) / \partial \ln\{\tau_{sd,t+h'}\}_{h' \geq f}$ derived earlier, we obtain

$$\frac{\partial \ln \left(\lambda^0_{sd,t+h} / \lambda^0_{sd,t-1} \right)}{\partial \ln\{\tau_{sd,t+h'}\}_{h' \geq f}} = (-\theta + \sigma - 1) \frac{\Psi_{sd,t+f}}{1+\Psi_{sd,t+h}} \left(\frac{1-\zeta}{1+r} \right)^{f-h}, \quad \text{for } 0 \leq h < f-1.$$

For $k > 0$, approximating up to a first order around an initial steady state yields:

$$\begin{aligned} \frac{\partial \ln \lambda^k_{sd,t+h} / \lambda^k_{sd,t-1}}{\partial \ln\{\tau_{sd,t+h'}\}_{h' \geq f}} &\approx \begin{cases} 0, & \text{if } k > h \\ \dfrac{\partial \ln \left(\lambda^0_{sd,t+h-k} / \lambda^0_{sd,t-1} \right)}{\partial \ln\{\tau_{sd,t+h'}\}_{h' \geq f}} & \\ \quad + \dfrac{\partial \ln \frac{\lambda^0_{sd,t-1}}{\lambda^k_{sd,t-1}} \prod_{\varsigma=t+h-k+1}^{t+h} \hat{c}^{-(\sigma-1)}_{sd,\varsigma} / \Phi^0_{d,\varsigma}}{\partial \ln\{\tau_{sd,t+h'}\}_{h' \geq f}}, & \text{if } 0 < k \leq h \end{cases} \\ &= \begin{cases} 0, & \text{if } k > h \\ -(\theta + 1 - \sigma) \frac{\Psi_{sd,t+f}}{1+\Psi_{sd,t+h-k}} \left(\frac{1-\zeta}{1+r} \right)^{f-h+k}, & \text{if } 0 < k \leq h \end{cases} \end{aligned}$$

The partial equilibrium response of bilateral expenditures at time $t+h$ to a one-time permanent shock to anticipated trade cost at time $t+f$ can then be written

$$\frac{\partial \ln(\lambda_{sd,t+h}/\lambda_{sd,t-1})}{\partial \ln\{\tau_{sd,t+h'}\}_{h'\geq f}} = -\left(\theta+1-\sigma\right)\frac{\Psi_{sd,t+f}}{1+\Psi_{sd,t-1}}\left(\frac{1-\zeta}{1+r}\right)^{f-h} \times \sum_{k=0}^{h}\omega_k\left(\frac{1-\zeta}{1+r}\right)^{k}\frac{\Psi_{sd,t-1}}{\Psi_{sd,t+h-k}}$$

where $\omega_k \equiv \frac{\mu_t(k)\lambda_{sd,t}^k}{\sum_k \mu_t(k)\lambda_{sd,t}^k}$. To obtain equation (30) from the main text, we set $h=0$ and take $t-1$ to be a steady state, so that $\omega_k = \mu^*(k) = \zeta\left(1-\zeta\right)^k$ and $\frac{\Psi_{sd,t+f}}{1+\Psi_{sd,t-1}} = \frac{\Psi^*}{1+\Psi^*} = \frac{1-\zeta}{1+r}$:

$$\varepsilon_i^{-f} = -\left(\theta+1-\sigma\right)\left(\frac{1-\zeta}{1+r}\right)^{f+1}\zeta.$$

A.10 Proof of Proposition 4

We begin by rearranging equation (24) to express the prices of composite goods in terms of expenditure shares and cost ratios.

$$\begin{aligned}
\tfrac{\lambda_{ddi,t}}{\gamma_i}P_{di,t}^{1-\sigma_i} &= \mu_i(0)\frac{\Phi^0_{di,t}}{\Upsilon_{di,t}}\left(\Upsilon_{di,t}\right)^{\frac{\sigma_i-1}{\theta_i}}\lambda^0_{ddi,t} + \sum_{k\geq 1}\mu_i(k)\frac{\Phi^0_{di,t-k}}{\Upsilon_{di,t-k}}\left(\Upsilon_{di,t-k}\right)^{\frac{\sigma_i-1}{\theta_i}}\Phi^k_{di,t}\lambda^k_{ddi,t}\\
&= \mu_i(0)\tfrac{\Phi^0_{di,t}}{\Upsilon_{di,t}}\left(\Upsilon_{di,t}\right)^{\frac{\sigma_i-1}{\theta_i}}\lambda^0_{ddi,t}\\
&\quad + \textstyle\sum_{k\geq 1}\mu_i(k)\tfrac{\Phi^0_{di,t-k}}{\Upsilon_{di,t-k}}\left(\Upsilon_{di,t-k}\right)^{\frac{\sigma_i-1}{\theta_i}}\lambda^0_{ddi,t-k}\left(\tfrac{c_{ddi,t}}{c_{ddi,t-k}}\right)^{-(\sigma_i-1)}\\
&= \mu_i(0)\left(\tfrac{c^{-\theta_i}_{ddi,t}}{\upsilon^0_{ddi,t}}\right)^{\frac{\sigma_i-1}{\theta_i}}\upsilon^0_{ddi,t} + \textstyle\sum_{k\geq 1}\mu_i(k)\left(\tfrac{c^{-\theta_i}_{ddi,t-k}}{\upsilon^0_{ddi,t-k}}\right)^{\frac{\sigma_i-1}{\theta_i}}\upsilon^0_{ddi,t-k}\left(\tfrac{c_{ddi,t}}{c_{ddi,t-k}}\right)^{-(\sigma_i-1)},
\end{aligned}$$

where the third equality obtains from substituting $\frac{\upsilon^0_{ddi,t}}{\lambda^0_{ddi,t}} = \frac{\Phi^0_{di,t}}{\Upsilon_{di,t}}\left(1+\Psi_{ddi,t}\right)$ and $\Upsilon_{di,t}$ as defined in (14). Factoring out $c_{ddi,t}^{(1-\sigma_i)}(\upsilon^0_{ddi,t})^{(1-\sigma_i)/\theta_i}$ and simplifying yields

$$P_{di,t}^{1-\sigma_i} = c_{ddi,t}^{1-\sigma_i}\left(\upsilon^0_{ddi,t}\right)^{\frac{1-\sigma_i}{\theta_i}}\frac{1}{\lambda_{ddi,t}}\gamma_i\left[\mu_i(0)\upsilon^0_{ddi,t} + \sum_{k\geq 1}\mu_i(k)\left(\frac{\upsilon^0_{ddi,t}}{\upsilon^0_{ddi,t-k}}\right)^{\frac{\sigma_i-1}{\theta_i}}\upsilon^0_{ddi,t-k}\right],$$

which expresses the price index in terms of unit cost, the share of domestic expenditures on domestically produced goods and the allocation of extensive margin demand across source countries in each of the goods baskets $\{\Omega^k_{i,t}\}_{k=0}^{\infty}$. With the unit cost under Cobb-Douglas technology, the above equation can be rewritten as

$$\frac{P_{di,t}}{w_{d,t}} = \left(\upsilon^0_{ddi,t}\right)^{\frac{1}{\theta_i}} \left(\lambda_{ddi,t}\right)^{1/(\sigma_i-1)} \left(\gamma_i \xi_{di,t}\right)^{-1/(\sigma_i-1)} \alpha_{di}^{-\alpha_{di}} \prod_j \left(\frac{P_{dj,t}}{\alpha_{dji} w_{d,t}}\right)^{\alpha_{dji}}$$

where

$$\xi_{di,t} \equiv \mu_i(0)\upsilon^0_{ddi,t} + \sum_{k\geq 1} \mu_i(k) \left(\frac{\upsilon^0_{ddi,t}}{\upsilon^0_{ddi,t-k}}\right)^{\frac{\sigma_i-1}{\theta_i}} \upsilon^0_{ddi,t-k}.$$

Taking logs yields

$$\ln \frac{P_{di,t}}{w_{d,t}} = \ln B_{di,t} + \sum_j \alpha_{dji} \ln \frac{P_{dj,t}}{w_{d,t}},$$

where $B_{di,t} \equiv \alpha_{di}^{-\alpha_{di}} \left(\prod_j \alpha_{dji}^{-\alpha_{dji}}\right) \left(\upsilon^0_{ddi,t}\right)^{\frac{1}{\theta_i}} \left(\lambda_{ddi,t}\right)^{1/(\sigma_i-1)} \left(\gamma_i \xi_{di,t}\right)^{-1/(\sigma_i-1)}$. In matrix notation, this leads to

$$(\mathbf{I} - A_d) \ln \hat{\boldsymbol{P}}_{d,t} = \ln \boldsymbol{B}_{d,t},$$

where $A_d = \{\alpha_{dji}\}$ and $\ln \hat{\boldsymbol{P}}_{d,t}$ and $\ln \boldsymbol{B}_{d,t}$ are $I \times 1$ vectors. Inverting this system of equations, we obtain

$$\frac{P_{di,t}}{w_{d,t}} = \prod_j B_{dj,t}^{\bar{a}_{dji}},$$

where $\bar{a}_{dji}$ is the (j, i) entry of the Leontief matrix $(\mathbf{I} - A_d)^{-1}$. The consumer price index in country d can be written as

$$P_{d,t} = \prod_i \left(P_{di,t}\right)^{\eta_i} = w_{d,t} \prod_{i,j} B_{dj,t}^{\bar{a}_{dji}\eta_i} = w_{d,t} \prod_j B_{dj,t}^{\sum_i \bar{a}_{dji}\eta_i}$$

It follows that the real wage is

$$W_{d,t} \equiv \frac{w_{d,t}}{P_{d,t}} = \prod_j B_{dj,t}^{-\sum_i \bar{a}_{dji}\eta_i}.$$

Taking the ratio between real wages in $t-1$ and $t+h$ yields

$$\frac{W_{d,t+h}}{W_{d,t-1}} = \prod_j \left[\left(\frac{\upsilon^0_{ddj,t+h}}{\upsilon^0_{ddj,t-1}}\right)^{-\frac{1}{\theta_j}} \left(\frac{\lambda_{ddj,t+h}}{\lambda_{ddj,t-1}}\right)^{-\frac{1}{\sigma_j-1}} \left(\frac{\xi_{dj,t+h}}{\xi_{dj,t-1}}\right)^{\frac{1}{\sigma_j-1}}\right]^{\sum_i \bar{a}_{dji}\eta_i}.$$

If $t-1$ is a steady state, then $\upsilon^0_{ddj,t-1} = \lambda^k_{ddj,t-1} = \lambda_{ddj,t-1}$ for all $k \in \{0,1,2,...\}$ and the above expression simplifies to

$$\begin{aligned}
\frac{W_{d,t+h}}{W_{d,t-1}} &= \prod_j \left[\left(\frac{\upsilon^0_{ddj,t+h}}{\lambda_{ddj,t-1}} \right)^{-\frac{1}{\theta_j}} \left(\frac{\lambda_{ddj,t+h}}{\xi_{dj,t+h}} \right)^{-\frac{1}{\sigma_j - 1}} \right]^{\sum_i \bar{a}_{dji}\eta_i} \\
&= \prod_j \left[\left(\frac{\lambda_{ddj,t+h}}{\lambda_{ddj,t-1}} \right)^{-\frac{1}{\theta_j}} \left(\frac{\upsilon^0_{ddj,t+h}}{\lambda_{ddj,t+h}} \right)^{-\frac{1}{\theta_j}} \left(\frac{\lambda_{ddj,t+h}}{\xi_{dj,t+h}} \right)^{-\frac{1}{\sigma_j - 1}} \right]^{\sum_i \bar{a}_{dji}\eta_i} \\
&= \prod_j \left[\left(\frac{\lambda_{ddj,t+h}}{\lambda_{ddj,t-1}} \right)^{-\frac{1}{\theta_j}} \left(\Xi_{dj,h} \right)^{\frac{1}{\sigma_j - 1}} \right]^{\sum_i \bar{a}_{dji}\eta_i}, \qquad \text{(A.10)}
\end{aligned}$$

where

$$\begin{aligned}
\Xi_{dj,h} &\equiv \frac{\xi_{dj,t+h}}{\lambda_{ddj,t+h}} \left(\frac{\upsilon^0_{ddj,t+h}}{\lambda_{ddj,t+h}} \right)^{\frac{1-\sigma_j}{\theta_j}} \\
&= \left(\frac{\upsilon^0_{ddj,t+h}}{\lambda_{ddj,t+h}} \right)^{\frac{1-\sigma_j}{\theta_j}} \left\{ \zeta_j \frac{\upsilon^0_{ddj,t+h}}{\lambda_{ddj,t+h}} + \sum_{k\geq 1} \zeta_j (1-\zeta_j)^k \left(\frac{\upsilon^0_{ddj,t+h}}{\upsilon^0_{ddj,t+h-k}} \right)^{\frac{\sigma_j - 1}{\theta_j} - 1} \frac{\upsilon^0_{ddj,t+h}}{\lambda_{ddj,t+h}} \right\} \\
&= \sum_{k=0}^h \zeta_j (1-\zeta_j)^k \left(\frac{\upsilon^0_{ddj,t+h-k}}{\lambda_{ddj,t+h}} \right)^{\frac{\theta_j - \sigma_j + 1}{\theta_j}} + (1-\zeta_j)^{h+1} \left(\frac{\lambda_{ddj,t-1}}{\lambda_{ddj,t+h}} \right)^{\frac{\theta_j - \sigma_j + 1}{\theta_j}}
\end{aligned}$$

follows from combining the last two factors in the second line of (A.10). This establishes equations (32)–(33). To derive equation (34), we solve for industry-level expenditure $E_{di,t}$ as a function of final expenditure $F_{d,t}$. Define

$$M_{di,t} \equiv \sum_{j\in\mathcal{I}} \alpha_{dij} \left(1 - \frac{1}{\sigma_j} \right) \sum_{s\in\mathcal{N}} \lambda_{dsj,t} E_{sj,t}.$$

Then $E_{di,t} = \eta_{di} F_{d,t} + M_{di,t}$. In matrix form, letting $\mathbf{E}_t$ denote the vector of expenditures $\{E_{di,t}\}_{d,i}$ and $\mathbf{F}_t$ the vector of final expenditures, we can write

$$\mathbf{E}_t = \boldsymbol{\eta}\mathbf{F}_t + \mathbf{S}_t \mathbf{E}_t,$$

where $\mathbf{S}_t$ is a matrix with elements capturing input-output linkages, trade shares and markups. Solving yields

$$\mathbf{E}_t = (\mathbf{I} - \mathbf{S}_t)^{-1} \boldsymbol{\eta}\mathbf{F}_t.$$

Using the solution for $E_{di,t}$, profits can be expressed as

$$\Pi_{d,t} = \sum_{i \in \mathcal{I}} \frac{E_{di,t}}{\sigma_i} = \sum_{i \in \mathcal{I}} \frac{1}{\sigma_i} \left[(\mathbf{I} - \mathbf{S}_t)^{-1} \boldsymbol{\eta} \mathbf{F}_t \right]_{di}.$$

Define $\kappa_{d,t} \equiv \Pi_{d,t}/F_{d,t} = \sum_i E_{di,t}/(\sigma_i F_{d,t})$ as the profit share of final expenditure. Since $F_{d,t} = w_{d,t}L_{d,t} + \Pi_{d,t} + D_{d,t}$, we have $\Pi_{d,t} = \kappa_{d,t}(w_{d,t}L_{d,t} + \Pi_{d,t} + D_{d,t})$, so that

$$\Pi_{d,t} = \frac{\kappa_{d,t}}{1 - \kappa_{d,t}} (w_{d,t}L_{d,t} + D_{d,t}).$$

Dividing by $P_{d,t}L_d$, taking ratios between $t+h$ and $t-1$, and substituting the real wage change from (A.10) establishes equation (34) and completes the proof. To characterize changes in real consumption, substitute for profits in $F_{d,t} = w_{d,t}L_{d,t} + \Pi_{d,t} + D_{d,t}$ to obtain

$$C_{d,t} = \frac{F_{d,t}}{L_{d,t}P_{d,t}} = \frac{w_{d,t}}{P_{d,t}} \cdot \Gamma_{d,t},$$

with $\Gamma_{d,t}$ defined as in the main text.

B Details on Estimation Procedure

B.1 Moment Selection

Following BLP, we estimate trade responses over 10-year horizons, (excluding the year when tariff changes occur), $\mathcal{H} = \{1, \ldots, 10\}$, using continuous updating GMM (Hansen, Heaton and Yaron 1996). For robustness, Table D.2 reports the results obtained from a one-step GMM estimation with an identity weighting matrix.[25]

For moment selection, we use the GMM-BIC criterion of Andrews (1999). For each candidate set of horizons $\mathcal{H}$, the criterion equals the Hansen J statistic minus $(|\mathcal{H}| - 3)\ln n$, where n is the sample size. The subtracted term grows with the number of included moments, offsetting the mechanical increase in J from additional overidentifying restrictions. We search over all horizon combinations with a minimum horizon weakly below 3 and a maximum horizon weakly above 7, ensuring sufficient variation across horizons to identify

[25] The one-step GMM estimator can be viewed as a special case of the iterative GMM estimator where the weight matrix across the moment conditions is externally specified. Running the iterative GMM estimator until convergence leads to estimates similar to those from the CUGMM in most of the cases we have explored.

all structural parameters. Among specifications with the same number of horizons, we select the one that minimizes GMM-BIC, subject to two additional restrictions: the J-statistic p-value must exceed 0.2, and $\hat{\zeta} > 0.01$. The first restriction guards against specifications where the overidentification test is marginal. The second ensures sufficient curvature in the elasticity profile to separately identify θ and σ; when ζ is very small, the long-run response lies well beyond the observed 10-year window and θ is poorly pinned down.

Table B.1: IV variation By Industry

Industry in Model (Non-Service)	Observations with Nonzero IV	Aggregation Level for Elasticity Estimation
Agriculture	297	Agriculture, food, textiles, leather
Mining	0	Mining and durable manufacturing
Food	2,239	Agriculture, food, textiles, leather
Textiles and leather	13,377	Agriculture, food, textiles, leather
Wood	180	Agriculture and nondurable manufacturing
Paper and printing	1,882	Agriculture and nondurable manufacturing
Coke and petroleum	10	Agriculture and nondurable manufacturing
Chemicals	7,542	Chemicals and pharmaceuticals
Pharmaceuticals	207	Chemicals and pharmaceuticals
Rubber and plastics	8,166	Agriculture and nondurable manufacturing
Non-metallic minerals	1,276	Mining and durable manufacturing
Basic metals	1,329	Metals, machinery and transportation equipment
Fabricated metals	5,875	Metals, machinery and transportation equipment
Computer and electronics	3,565	Computer and electronics
Electrical equipment	13,083	Mining and durable manufacturing
Machinery	13,135	Metals, machinery and transportation equipment
Motor vehicles	1,668	Metals, machinery and transportation equipment
Other transport equipment	46	Metals, machinery and transportation equipment
Furniture and others	4,166	Mining and durable manufacturing

Notes: Extensive margin IV variation for ISIC4 industries, based on import-weighted aggregation of Boehm, Levchenko and Pandalai-Nayar's 2023 instrumental variable using ISIC-HS concordances provided by WITS.

B.2 Estimation by Industry Group

We first map HS codes to ISIC Rev. 4 industries to match the industry classification in the ICIO tables used for steady state calibration.

Not all industries allow us to separately estimate the parameters. We screen each of the 19 non-service industries in two steps.

Step 1. An industry passes if the instrumental variable has at least 1,000 nonzero observations (Table B.1).

Step 2. For industries that pass Step 1, we estimate unrestricted linear GMM specifications that allow for a separate elasticity parameter at each horizon, without imposing the structural restriction from Proposition 2. A sector passes if its unrestricted estimates exhibit a discernible downward trend across horizons, consistent with the convergence profile implied by the model. Industries with estimates that are too noisy to identify a time pattern do not yield meaningful structural parameter values.

Step 3. We then consolidate all 19 industries into estimation groups. We partition them into two broad categories: "agriculture and nondurable manufacturing" and "mining and durable manufacturing." Within each category, subsets of related industries whose constituent sectors all pass both steps may break out into their own estimation group. One subgroup breaks out of the first category (agriculture; food; textiles; and leather) and three break out of the second (chemicals and pharmaceuticals; metals, machinery, and transportation equipment; computer, electronic, and optical equipment). Industries that fail either step are estimated jointly with the remaining industries in their broad category. This procedure yields six estimation groups. Table B.1 reports IV variation by model industry group; Table B.2 reports the resulting estimates.

Service industries, which are not covered by the trade data, are assigned the pooled aggregate estimates for quantification.

Table B.2: Estimates of Structural Parameters By Industry

	Full Sample			F-stat over	Exclude Large IV Variation		
Aggregation Level	θ	$\sigma-1$	$1-\zeta$	Horz. 1–3	θ	$\sigma-1$	$1-\zeta$
Mining and durable manufacturing	1.76	0.32	0.79	25.19	2.54	0.67	0.81
	(0.71)	(0.59)	(0.23)	[0.00]	(0.81)	(0.63)	(0.18)
Agriculture and nondurable manufacturing	4.06	0.13	0.87	7.99	4.92	0.43	0.86
	(1.92)	(0.66)	(0.11)	[0.02]	(1.82)	(0.69)	(0.10)
Agriculture, food, textiles, leather	5.08	2.41	0.63	43.93	5.69	3.40	0.82
	(0.91)	(2.15)	(0.45)	[0.00]	(1.75)	(1.27)	(0.28)
Chemicals and pharmaceuticals	1.79	0.20	0.65	0.55	3.78	0.68	0.93
	(1.66)	(5.18)	(1.23)	[0.76]	(21.17)	(2.04)	(0.71)
Metals, machinery and transportation equipment	3.33	0.40	0.93	0.14	3.33	0.40	0.93
	(9.22)	(0.97)	(0.33)	[0.93]	(9.22)	(0.97)	(0.33)
Computer, electronic and optical equipment	4.94	0.14	0.85	0.69	4.70	0.10	0.85
	(3.89)	(1.72)	(0.24)	[0.71]	(4.32)	(1.77)	(0.27)

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Continuous updating GMM. Moment (horizon) selection based on Andrews (1999), applied independently by industry. θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model). F statistic for joint equality of $(\theta, \sigma - 1, 1 - \zeta)$ to zero. Standard errors in parentheses (cluster-robust at level of importer-exporter-HS4 triplets); p-values in brackets (for F-statistics). Right panel excludes observations where IV is larger than 0.15 in absolute value.

C Theoretical Extensions

C.1 Stochastic Dynamic Equilibrium

This section extends the baseline model to a stochastic environment where future trade costs follow a general Markov process, nesting perfect foresight as the degenerate case where transition probabilities equal either 0 or 1.

C.1.1 Stochastic Equilibrium

Let $s_t \in \mathcal{S}$ denote the vector of exogenous fundamental states (e.g., bilateral trade costs) at time t. We assume s_t evolves according to a first-order Markov process with transition kernel $Q(s_{t+1}|s_t)$.

Letting $s^t = (s_0, s_1, \ldots, s_t)$ denote the history of shocks up to time t, we can define an equilibrium as follows.

Definition C.1. *A dynamic stochastic equilibrium consists of history-dependent functions for wages $w_d(s^t)$, price indices $P_{di}(s^t)$, aggregate trade shares $\lambda_{sdi}(s^t)$, and option values $\Psi_{sdi}(s_t)$ such that:*

1. *In state s_t, traders in di evaluate the expected option value of a relationship with a supplier from s according to*

$$\Psi_{sdi}(s_t) = \textstyle\sum_{u=1}^{\infty} \left(\frac{1-\zeta_i}{1+r}\right)^u \mathbb{E}\left[\prod_{k=1}^{u} \left(\frac{\hat{c}_{sdi}(s^{t+k})}{\hat{P}_{di}(s^{t+k})}\right)^{-(\sigma_i-1)} \hat{P}_{di}(s^{t+k})\hat{Y}_{di}(s^{t+k}) \middle| s_t\right]$$

   where $\hat{x}(s^{t+k}) \equiv x(s^{t+k})/x(s^{t+k-1})$ is the growth rate of variable x. The expectation $\mathbb{E}[\cdot|s_t]$ is taken over all future histories s^{t+u} generated by the transition kernel $Q(\cdot|\cdot)$.

2. *Expenditure shares among traders who reset suppliers at time t depend on the current realized cost $c(s_t)$ and the forward-looking option value $\Psi(s_t)$:*

$$\lambda^0_{sdi}(s^t) = \frac{A_{si}[c_{sdi}(s_t)]^{-\theta_i}[1+\Psi_{sdi}(s_t)]^{\frac{\theta_i}{\sigma_i-1}-1}}{\Phi^0_{di}(s_t)}$$

3. *Aggregate trade shares for history s^t satisfy:*

$$\lambda_{sdi}(s^t) = \textstyle\sum_{k=0}^{\infty} \zeta_i(1-\zeta_i)^k \lambda^0_{sdi}(s^{t-k}) \prod_{j=0}^{k-1} \left(\frac{\hat{c}_{sdi}(s^{t-j})}{\hat{P}_{di}(s^{t-j})}\right)^{-(\sigma_i-1)}$$

4. *Goods and factor markets clear for each history s^t. Producer revenues satisfy*

$$R_{si}(s^t) = \sum_{d \in \mathcal{N}} \lambda_{sdi}(s^t) \left(1 - \frac{1}{\sigma_i}\right) E_{di}(s^t),$$

composite good markets clear with

$$E_{si}(s^t) = \eta_{si} F_s(s^t) + \sum_{j \in \mathcal{I}} \alpha_{sij} \sum_{d \in \mathcal{N}} \left(1 - \frac{1}{\sigma_j}\right) \lambda_{sdj}(s^t) E_{dj}(s^t),$$

where final expenditure equals $F_d(s^t) = w_d(s^t) L_d + \Pi_d(s^t) + D_d(s^t)$, profits satisfy

$$\Pi_d(s^t) = \sum_{i \in \mathcal{I}} \frac{E_{di}(s^t)}{\sigma_i},$$

and factor markets clear:

$$w_d(s^t) L_d = \sum_{i \in \mathcal{I}} \alpha_{di} \left(1 - \frac{1}{\sigma_i}\right) \sum_{n \in \mathcal{N}} \lambda_{dni}(s^t) E_{ni}(s^t).$$

A steady state is a dynamic stochastic equilibrium where the exogenous state is constant ($s_t = \bar{s}$ for all t). In this state, history dependence vanishes, and all aggregate variables are constant, $\hat{c} = 1, \hat{P} = 1, \hat{Y} = 1$; option values satisfy

$$1 + \Psi^* = \sum_{u=0}^{\infty} \left(\frac{1 - \zeta_i}{1 + r}\right)^u = \frac{1 + r}{r + \zeta_i},$$

and trade shares are identical across all cohorts: $\lambda^0 = \lambda^k$, for all $k > 0$.

C.1.2 Trade Elasticity under Uncertainty

We define the trade elasticity $\varepsilon_i^h(s^h)$ at horizon h, conditional on a realized history s^h, as

$$\varepsilon_i^h(s^h) \equiv \left.\frac{\partial \ln \lambda_{sdi}(s^h)}{\partial \ln \tau_{sdi,0}}\right|_{\{\hat{w}_d(s^t)\hat{P}_{di}(s^t)\}_{t=1}, \{\hat{Y}_{di}(s^t)\}_{t=1}} \tag{C.1}$$

where we evaluate the partial derivative starting from steady state at $t = -1$. While we evaluate this elasticity along a specific realized path s^h, the value of $\lambda_{sdi}(s^h)$ depends on traders' expectations over all future histories via the option value.

To derive closed-form expressions, we focus on a persistent shock with a constant hazard of reversal. The state space $\mathcal{S} = \{s_{high}, s_{low}\}$, where s_{low} corresponds to the initial steady state. At time $t = 0$, trade costs increase by Δ as the economy transitions to s_{high}. The state evolves according to a Markov process with transition kernel $Q(s'|s)$: the high-cost state persists with probability $Q(s_{high}|s_{high}) = \rho$ and reverts to the absorbing steady state with probability $Q(s_{low}|s_{high}) = 1 - \rho$. Once the economy reverts to s_{low}, it remains there permanently.

Proposition C.1. *Starting from steady state and up to a first-order approximation, the partial equilibrium trade elasticity $\varepsilon_i^h(s^h)$ at horizon h, conditional on a history s^h where the economy reverts to the steady state at period T_{rev}, equals:*

$$\varepsilon_i^h(s^h) = \begin{cases} -\,(\sigma_i - 1)(1-\zeta_i)^{h+1} & \\ \quad + \left[1-(1-\zeta_i)^{h+1}\right]\left(-\theta_i + (\theta_i - \sigma_i + 1)\dfrac{\frac{1-\zeta_i}{1+r}(1-\rho)}{1 - \frac{1-\zeta_i}{1+r}\rho}\right) & \textit{if } s_h = s_{high} \\ \left[(1-\zeta_i)^{h-T_{rev}+1} - (1-\zeta_i)^{h+1}\right] & \\ \quad \times \left(-\theta_i + (\theta_i - \sigma_i + 1)\dfrac{\frac{1-\zeta_i}{1+r}(1-\rho)}{1 - \frac{1-\zeta_i}{1+r}\rho}\right) & \textit{if } s_h = s_{low} \end{cases}$$

Proof. See Section C.1.4. $\square$

Proposition C.1 characterizes the trade elasticity across two regimes distinguished by whether the shock remains active.

When the shock is active ($s_h = s_{high}$), the elasticity comprises three components. The first two terms capture the response to a permanent shock: legacy cohorts that have not yet adjusted respond along the intensive margin with elasticity $-(\sigma_i - 1)$, while cohorts that have adjusted respond along the extensive margin with elasticity $-\theta_i$. The third term captures stochastic dampening. For $\rho < 1$, traders anticipate that the high-cost state may revert to s_{low}, generating an option value to maintaining existing supplier relationships. This dampening term is positive because $\partial \ln(1 + \Psi(s_{high}))/\partial \ln \tau_0 > 0$: a larger initial tariff increase makes future reversal more costly for traders who have already switched away from the tariff-burdened source, reducing the incentive to switch in the first place. The trade elasticity is therefore smaller in absolute value than under a permanent shock. As $\rho \to 1$, the dampening term vanishes and the elasticity converges to the permanent shock benchmark.

When the shock has reverted ($s_h = s_{low}$), the elasticity remains non-zero due to persistence. Cohorts that adjusted during the high-cost state but have not yet re-optimized continue to depress trade flows. The first factor captures the mass of these surviving cohorts, which shrinks geometrically as h grows. The second factor captures their adjustment elasticity, combining the extensive margin response $-\theta_i$ with the dampening from anticipated reversal. As $h \to \infty$, the surviving mass vanishes and the economy returns to steady state.

C.1.3 Comparison to Perfect Foresight

While the baseline model incorporates anticipation effects, agents in that environment know exactly when the reversal will occur. To isolate the distinct role of uncertainty, we compare the trade elasticity derived above to the response of trade flows to a trade shock with a certain reversal date.

We analyze the partial equilibrium response to a deterministic shock where trade costs increase by Δ at $t = 0$ and revert to the steady state at a known date $t = T$. To ensure comparability, we set the stochastic survival probability to $\rho = 1 - 1/T$, equating the expected duration under uncertainty to the fixed duration T under perfect foresight.

Proposition C.2. *Under perfect foresight with a fixed shock duration T, the partial equilibrium trade elasticity ε^h_{PF} equals:*

$$\varepsilon^h_{PF} = \begin{cases} -(\sigma_i - 1)(1-\zeta_i)^{h+1} - [1-(1-\zeta_i)^{h+1}]\theta_i \\ \quad + \zeta_i(\theta_i - \sigma_i + 1)\left(\frac{1-\zeta_i}{1+r}\right)^{T-h} \dfrac{1 - \left[\frac{(1-\zeta_i)^2}{1+r}\right]^{h+1}}{1 - \frac{(1-\zeta_i)^2}{1+r}} & h < T \\ -\left[(1-\zeta_i)^{h-T+1} - (1-\zeta_i)^{h+1}\right]\theta_i \\ \quad + \zeta_i(\theta_i - \sigma_i + 1)\left(\frac{1-\zeta_i}{1+r}\right)^{T-h} \dfrac{\left[\frac{(1-\zeta_i)^2}{1+r}\right]^{h-T+1} - \left[\frac{(1-\zeta_i)^2}{1+r}\right]^{h+1}}{1 - \frac{(1-\zeta_i)^2}{1+r}} & h \geq T \end{cases}$$

Proof. See Section C.1.4. □

Propositions C.1 and C.2 share identical structure in the permanent shock terms. They differ only in the anticipation component: under uncertainty, the memoryless reversal hazard implies a constant anticipation effect across all adjusting cohorts, permitting full factorization; under perfect foresight, the anticipation effect varies with time-to-reversal, so cohorts adjusting at different times carry different elasticities.

To quantify this difference, define $\Delta^h(\rho, T) \equiv |\varepsilon^h_{PF}| - |\varepsilon^h_i(s^h)|$ to index the relative strength of trade adjustment under perfect foresight relative to uncertainty at a horizon h in the active phase. Setting $\rho = 1 - 1/T$ to equate expected shock durations yields

$$\Delta^h(1-1/T,\, T) = (\theta_i - \sigma_i + 1)\Bigg[\big[1 - (1-\zeta_i)^{h+1}\big]\frac{\frac{1-\zeta_i}{1+r}\frac{1}{T}}{1 - \frac{1-\zeta_i}{1+r}(1-\frac{1}{T})} \\ - \zeta_i\big(\tfrac{1-\zeta_i}{1+r}\big)^{T-h}\frac{1 - \left[\frac{(1-\zeta_i)^2}{1+r}\right]^{h+1}}{1 - \frac{(1-\zeta_i)^2}{1+r}}\Bigg]$$

The two terms in the bracket decompose how anticipation operates under each shock structure. Under uncertainty, the constant reversal hazard $1/T$ generates a time-invariant dampening of adjustment. Under perfect foresight, dampening depends on the distance to the known reversal date through $(\frac{1-\zeta_i}{1+r})^{T-h}$. At short horizons this factor is small; and perfect foresight traders adjust almost as under a permanent shock, while the constant hazard already restrains adjustment under uncertainty ($\Delta^h > 0$). As h approaches T, perfect foresight anticipation grows rapidly and eventually dominates, reversing the ranking ($\Delta^h < 0$).

C.1.4 Proofs

Proof of Proposition C.1. We begin by determining the elasticity of varieties whose suppliers adjust in the active state s_{high}. Under the constant shock reversal hazard,

$$\frac{\partial \ln \lambda^0(s_{high})}{\partial \ln \tau_0} \equiv \varepsilon^0 = -\theta_i + \left(\frac{\theta_i}{\sigma_i - 1} - 1\right)\frac{\partial \ln(1 + \Psi(s_{high}))}{\partial \ln \tau_0} \\ = -\theta_i + (\theta_i - \sigma_i + 1)\frac{\frac{1-\zeta_i}{1+r}(1-\rho)}{1 - \frac{1-\zeta_i}{1+r}\rho} \tag{C.2}$$

The aggregate elasticity equals the weighted sum of cohorts. If $s_h = s_{high}$, all cohorts $k \leq h$ adjusted under s_{high} and respond with ε^0. Legacy cohorts ($k > h$) respond with $-(\sigma_i - 1)$. If $s_h = s_{low}$ (reverted at T_{rev}), only cohorts who adjusted during the window $0 \leq t < T_{rev}$ and survived contribute. Their mass equals $(1-\zeta_i)^{h-T_{rev}+1} - (1-\zeta_i)^{h+1}$. Summing these components yields Proposition C.1.

Proof of Proposition C.2. For $h < T$, the shock remains active. The aggregate elasticity equals the sum of deviations across all cohorts k:

1. For each legacy variety $\omega \in \Omega^k_{t+h}$ with $k > h$, trade flows adjust with elasticity $-(\sigma_i - 1)$.

2. Adjusting Cohorts ($0 \leq k \leq h$): The elasticity for varieties with supplier adjustment at time $t = h - k$ equals $\varepsilon^t_{PF} = -\theta_i + (\theta_i - \sigma_i + 1)\left(\frac{1-\zeta_i}{1+r}\right)^{T-t}$.

Aggregating these responses across varieties using the stationary mass $\mu^*_i(k) = \zeta_i(1-\zeta_i)^k$ yields:

$$\varepsilon^h_{PF} = -(1-\zeta_i)^{h+1}(\sigma_i - 1) + \sum_{k=0}^{h} \mu^*_i(k)\left[-\theta_i + (\theta_i - \sigma_i + 1)\left(\frac{1-\zeta_i}{1+r}\right)^{T-(h-k)}\right]$$

Separating the $-\theta_i$ term and computing the geometric sum for the anticipation term yields the $h < T$ expression.

For $h \geq T$, the shock has reverted. Only cohorts who adjusted during the active window ($0 \leq t < T$) and have not yet re-adjusted drive the deviations. A cohort aged k at time h adjusted at $t = h - k$. The condition $0 \leq t < T$ implies $h - T < k \leq h$. Summing over this age range:

$$\varepsilon^h_{PF} = \sum_{k=h-T+1}^{h} \mu^*_i(k)\left[-\theta_i + (\theta_i - \sigma_i + 1)\left(\frac{1-\zeta_i}{1+r}\right)^{T-(h-k)}\right]$$

The mass of surviving cohorts equals $(1-\zeta_i)^{h-T+1} - (1-\zeta_i)^{h+1}$, which multiplies $-\theta_i$. Computing the geometric sum for the anticipation term yields the $h \geq T$ expression.

C.2 Imperfect factor mobility across industries

This section develops an extension that allows for gradual trade adjustment based on frictions to labor mobility across industries.

C.2.1 Households

Following Caliendo, Dvorkin and Parro (2019), we assume that households choose their employment industry one period in advance, with full information on economic conditions in all industries and subject to time-varying mobility costs. A household in country s

begins each period t working in an industry i chosen during the previous period $t-1$. In period t, this household supplies its unit of labor at the competitive industry-wide wage $w_{di,t}$, consumes the local final good, and then chooses which industry to work for in the subsequent period $t+1$. The value of a d resident employed in industry i at time t equals:

$$u_{di,t} = \ln\left(\frac{w_{di,t}}{P_{d,t}}\right) + \max_{j\in\mathcal{I}}\left\{\beta\mathbb{E}\left[u_{dj,t+1}\right] - m_{dij,t} + \chi\epsilon_{dj,t}\right\},$$

where $m_{dij,t}$ denotes the utility cost of moving from industry i to j facing each household in country d at time t, and $\epsilon_{dj,t}$ represents stochastic i.i.d. preference shocks drawn from a Gumbel distribution with zero mean and dispersion parameter equal to 1. This value function implicitly assumes that workers hold log preferences over consumption of the aggregate final good, whose local price $P_{d,t}$ follows from the main text.

Under the well-known characterization of the optimal random discrete choice for Gumbel distributed shocks, the expected lifetime utility of a worker employed in country d's industry i at time t equals

$$\overline{u}_{di,t} \equiv \mathbb{E}\left[v_{di,t}\right] = \ln\left(\frac{w_{di,t}}{P_{d,t}}\right) + \chi\ln\left(\sum_{j\in\mathcal{I}}\exp\left(\beta\overline{u}_{dj,t+1} - m_{dij,t}\right)^{1/\chi}\right). \tag{C.3}$$

Moreover, the share of households in d transitioning from employment in industry i to industry j is given by

$$\varphi_{dij,t} = \frac{\exp\left(\beta\overline{u}_{dj,t+1} - m_{dij,t}\right)^{1/\chi}}{\sum_{k\in\mathcal{I}}\exp\left(\beta\overline{u}_{dk,t+1} - m_{dik,t}\right)^{1/\chi}}. \tag{C.4}$$

The initial distribution of labor across industries and the labor flows at time t determine labor supply at $t+1$:

$$L_{di,t+1} = \sum_{j\in\mathcal{I}}\varphi_{dji,t}L_{dj,t}.$$

C.2.2 Industry-level trade flows and prices

Under the same formulation of preferences and technologies as in the main text, the vector of trade shares $\{\lambda_{sdi,t}\}_{s\in\mathcal{N}}$ in (24) and the price index $P_{di,t}$ in (23) continue to characterize each destination d's optimal within-period demand for industry-i goods. The unit costs underlying these demand outcomes now incorporate industry-specific wage rates:

$$c_{sdi,t} = \Theta_{si}\tau_{sdi,t}\left(w_{si,t}\right)^{\alpha_{si}}\prod_{j\in\mathcal{I}}\left(P_{sj,t}\right)^{\alpha_{sji}},$$

for all $s, d \in \mathcal{N}$, $i \in \mathcal{I}$ and t.

C.2.3 Within-period market clearing

At time t, the vector of labor supply $\{L_{di,t}\}_{i\in\mathcal{I}}$ is predetermined by the optimal labor allocation decisions of households in the prior period, as described by (C.2.1).

The vector of wages $\{w_{di,t}\}_{d\in\mathcal{N},i\in\mathcal{I}}$ is concurrently determined with the vector of trade shares $\{\lambda_{sdi,t}\}_{s,d\in\mathcal{N},i\in\mathcal{I}}$. To define the conditions for within-period factor and goods market clearing, we follow the exposition in the main text and express the total value of each industry's sales $X_{si,t}$ as

$$X_{si,t} = \sum_{d\in\mathcal{N}}\lambda_{sdi,t}\left[\eta_{di}E_{d,t} + \sum_{j\in\mathcal{I}}\alpha_{dij}X_{dj,t}\right], \tag{C.5}$$

Destination d's total consumption expenditures now incorporate industry-specific wages and labor supplies:

$$E_{d,t} = \sum_{i}\left\{w_{di,t}L_{di,t} + \Pi_{di,t}\right\} + D_{d,t}. \tag{C.6}$$

Each destination's profit income derives from the sales of local assemblers:

$$\Pi_{d,t} = \sum_{i\in\mathcal{I}}\frac{1}{\sigma_i}\left[\eta_{di}E_{d,t} + \sum_{j\in\mathcal{I}}\alpha_{dij}X_{dj,t}\right]. \tag{C.7}$$

Wages solve the following set of factor market clearing conditions:

$$w_{di,t}L_{di,t} = \alpha_{di}\frac{\sigma_i - 1}{\sigma_i}X_{di,t}, \text{ for } i \in \mathcal{I} \tag{C.8}$$

C.2.4 Equilibrium

Definition C.2. *An economy is described by a set of time-invariant parameters summarizing technologies, preferences,* $\boldsymbol{\Theta} = \{\theta_i, \sigma_i, \{\alpha_{dji}\}_{j\in\mathcal{I}}, \varphi_{di}, A_{di}, \eta_{di},\}_{i\in\mathcal{I}}$*, sourcing frictions* $\boldsymbol{\zeta} = \{\zeta_i\}_{i\in\mathcal{I}}$ *as well as measures* $\boldsymbol{\mu}_0 = \{\mu_{di,t_0}(k)\}_{i\in\mathcal{I},d\in\mathcal{N},k\in\mathbb{N}_0}$ *and* $\boldsymbol{L}_0 = \{L_{di,t_0}\}_{i\in\mathcal{I},d\in\mathcal{N}}$

for some t_0. Given a path for trade costs $\boldsymbol{\tau} \equiv \{\tau_t\}_{t\in\mathbb{N}} = \{\tau_{sdi,t}\}_{s,d\in\mathcal{N},i\in\mathcal{I},t\in\mathbb{N}}$:

1. *A static equilibrium at time t is a vector of wages $\boldsymbol{w}_t = w\left(\tau_t, \hat{\boldsymbol{w}}_{-t}, \hat{\boldsymbol{\tau}}_{-t}, \boldsymbol{\Theta}, \boldsymbol{\zeta}, \boldsymbol{\mu}_0, \boldsymbol{L}_t\right)$ that solves equations (24), (27), (26) and (C.8) for all $s, d \in \mathcal{N}$, $i \in \mathcal{I}$, given $\boldsymbol{L}_t$, $\hat{\boldsymbol{w}}_{-t} = \{\hat{w}_{di,\varsigma}\}_{d\in\mathcal{N},i\in\mathcal{I},\varsigma\in\mathbb{N}\setminus\{t\}}$ and $\hat{\boldsymbol{\tau}}_{-t} = \{\hat{\tau}_{sid,\varsigma}\}_{s,d\in\mathcal{N},i\in\mathcal{I},\varsigma\in\mathbb{N}\setminus\{t\}}$.*
2. *A dynamic equilibrium is a path of wages $\{\boldsymbol{w}_\tau\}_{\tau\in\mathbb{N}}$ and labor allocations $\{\boldsymbol{L}_\tau\}_{\tau\in\mathbb{N}}$ satisfying $\boldsymbol{w}_\tau = w\left(\tau_\tau, \hat{\boldsymbol{w}}_{-\tau}, \hat{\boldsymbol{\tau}}_{-\tau}, \boldsymbol{\Theta}, \boldsymbol{\zeta}, \boldsymbol{L}_\tau, \boldsymbol{\mu}_0\right)$ and (C.2.1) for all τ.*
3. *A dynamic equilibrium is a steady state if $\boldsymbol{w}_\tau = \boldsymbol{w}_{\tau'}$ and $\boldsymbol{L}_\tau = \boldsymbol{L}_{\tau'}$ for all $\tau' > \tau$.*

C.3 Endogenous Supplier Turnover

In this section we extend the model to allow traders to optimally choose the expected duration of newly formed supplier relationships. To retain tractability, we posit a contract structure in which traders choose the adjustment probability ζ when forming a new supplier relationship. The chosen rate remains fixed for the duration of the relationship but may vary across destination countries, industries, and formation dates. Conditional on the turnover rate, optimal supplier choices and trade shares then retain the same closed-form expressions as in the main text. However, aggregation must now account for heterogeneity in turnover rates across legacy relationships, and equilibrium computation requires jointly determining optimal turnover rates and trade shares within each period.

C.3.1 Relationship-Management and Supplier Turnover

Consider destination country d and industry i at time t, and suppose the trader for good ω receives the opportunity to reset its choice of supplier. We posit that this trader must now choose the supplier turnover rate $\zeta \in (0, 1)$ before learning the productivities $\{z_{ni,t}(\omega)\}_{n\in\mathcal{N}}$ of their potential suppliers through an i.i.d. draw from Fréchet distributions with scale parameters A_{ni} and dispersion parameter θ_i. Conditional on this choice, the subsequently formed relationship will terminate with probability ζ in each period, implying an expected duration of $1/\zeta$.

Traders are endowed with one unit of managerial time allocated between extracting monopoly rents and searching for new suppliers. Higher turnover (ζ) requires diverting a fraction $\kappa_i(\zeta) \in (0, 1)$ of managerial time toward search, yielding net flow profit

$$\tilde{\pi}_{ndi,t}(\omega; \zeta) = (1 - \kappa_i(\zeta))\pi_{ndi,t}(\omega),$$

where the gross flow profit $\pi_{ndi,t}(\omega)$ is defined as in the main text.

We take $1-\kappa_i(\zeta)$ to be strictly concave with a unique maximizer $\bar{\zeta}_i \in (0,1)$. A convenient functional form is

$$1-\kappa_i(\zeta) = \exp\left(-\frac{\phi_i}{2}(\zeta-\bar{\zeta}_i)^2\right), \qquad \phi_i > 0. \tag{C.9}$$

The parameter $\bar{\zeta}_i$ represents a baseline turnover rate determined by technological and institutional norms in industry i. The quadratic cost structure captures symmetric costs of deviating from this baseline, and ϕ_i governs how tightly turnover is constrained.[26] The limit $\phi_i \to \infty$ effectively pins down turnover at $\bar{\zeta}_i$, thereby nesting the exogenous-turnover benchmark.

C.3.2 The Trader's Dynamic Problem

Let $V_{di,t}(\omega)$ denote the value of a trader for variety ω upon receiving a green light at time t, and let $V_{di,t}(\omega, n; \zeta)$ denote the value of an active relationship with supplier n and turnover rate ζ. These satisfy

$$V_{di,t} := V_{di,t}(\omega) = \max_{\zeta\in(0,1)} \mathbb{E}_t\left[\max_{n\in\mathcal{N}} V_{di,t}(\omega,n;\zeta)\right], \tag{C.10}$$

$$\begin{aligned} V_{di,t}(\omega,n;\zeta) = {} & (1-\kappa_i(\zeta))\pi_{ndi,t}(\omega) \\ & + \frac{1}{1+r_t}\big[(1-\zeta)V_{di,t+1}(\omega,n;\zeta)+\zeta V_{di,t+1}\big]. \end{aligned} \tag{C.11}$$

Forward iteration yields

$$V_{di,t}(\omega,n;\zeta) = (1-\kappa_i(\zeta))\pi_{ndi,t}(\omega)(1+\Psi_{ndi,t}(\zeta)) + CV_{di,t}(\zeta), \tag{C.12}$$

where $\Psi_{ndi,t}(\zeta)$ is defined as in the main text (with the endogenous turnover rate replacing the exogenous ζ_i), and

$$CV_{di,t}(\zeta) = \sum_{u=1}^{\infty} \zeta(1-\zeta)^{u-1} \prod_{\varsigma=1}^{u} \frac{1}{1+r_{t+\varsigma-1}} V_{di,t+u}(\omega)$$

[26] For example, industries with long validation cycles and substantive qualification requirements for suppliers (e.g., defense) can be thought of as having a lower $\bar{\zeta}_i$ and a higher ϕ_i, while industries producing standardized products in thick markets (e.g., textiles) can exhibit a higher $\bar{\zeta}_i$ and a lower ϕ_i.

denotes the trader's continuation value. Notice that $CV_{di,t}(\zeta)$ depends on the turnover rate but is common across suppliers and varieties at the time the relationship is formed.

Optimal Supplier Choice Because $CV_{di,t}(\zeta)$ is common across suppliers, it does not affect supplier ranking. Conditional on ζ, the optimal supplier choice for $\omega \in \Omega^0_{di,t}$ satisfies

$$s^*_{di,t}(\omega) = \arg\min_{n\in\mathcal{N}} \frac{c_{ndi,t}}{z_{ni}(\omega)} \left(1 + \Psi_{ndi,t}(\zeta)\right)^{-1/(\sigma_i-1)},$$

as in the main text.

Expenditure Allocations Because ζ is chosen prior to productivity draws, the optimal rate $\zeta^*_{di,t}$ is common across all varieties resetting at time t, so all varieties in $\Omega^0_{di,t}$ share the same option values $\{\Psi_{ndi,t}(\zeta^*_{di,t})\}_{n\in\mathcal{N}}$.

The Fréchet structure implies that sourcing probabilities and expenditure shares take the same form as in the main text. Define $\Upsilon_{di,t}(\zeta)$ and $\Phi^0_{di,t}(\zeta)$ with $\Psi_{ndi,t}$ evaluated at the endogenous turnover rate:

$$\Upsilon_{di,t}(\zeta) \equiv \sum_{n\in\mathcal{N}} A_{ni} c_{ndi,t}^{-\theta_i} \left(1 + \Psi_{ndi,t}(\zeta)\right)^{\frac{\theta_i}{\sigma_i-1}},$$

$$\Phi^0_{di,t}(\zeta) \equiv \sum_{n\in\mathcal{N}} A_{ni} c_{ndi,t}^{-\theta_i} \left(1 + \Psi_{ndi,t}(\zeta)\right)^{\frac{\theta_i}{\sigma_i-1}-1}.$$

Then

$$\upsilon^0_{sdi,t} = \frac{A_{si} c_{sdi,t}^{-\theta_i} \left(1 + \Psi_{sdi,t}(\zeta^*_{di,t})\right)^{\frac{\theta_i}{\sigma_i-1}}}{\Upsilon_{di,t}(\zeta^*_{di,t})}, \tag{C.13}$$

$$\lambda^0_{sdi,t} = \frac{A_{si} c_{sdi,t}^{-\theta_i} \left(1 + \Psi_{sdi,t}(\zeta^*_{di,t})\right)^{\frac{\theta_i}{\sigma_i-1}-1}}{\Phi^0_{di,t}(\zeta^*_{di,t})}.$$

Optimal Supplier Turnover Rate Let $\zeta^*_{di,t}$ denote the common optimal turnover rate for varieties in $\Omega^0_{di,t}$, determined by the first-order condition

$$\left.\frac{\partial CV_{di,t}(\zeta)}{\partial \zeta}\right|_{\zeta=\zeta^*_{di,t}} = -\frac{\partial}{\partial \zeta}\mathbb{E}_t\left[\max_{n\in\mathcal{N}}(1-\kappa_i(\zeta))\pi_{ndi,t}(\omega)(1+\Psi_{ndi,t}(\zeta))\right]\Bigg|_{\zeta=\zeta^*_{di,t}}. \tag{C.14}$$

Increasing ζ raises the value of the reset option $CV_{di,t}(\zeta)$ but reduces the value of the incumbent relationship by shortening its expected duration and reallocating managerial resources away from relationship maintenance.

Under (C.9) and Fréchet aggregation, equation (C.14) obtains $\zeta^*_{di,t}$ as a linear deviation from $\bar{\zeta}_i$,[27]

$$\zeta^*_{di,t} - \bar{\zeta}_i = \frac{1}{\phi_i} \frac{\Phi^0_{di,t}(\zeta)/\Upsilon_{di,t}(\zeta)}{1-\kappa_i(\zeta)} \frac{\partial CV_{di,t}(\zeta)}{\partial \zeta} \\ + \frac{1}{\phi_i} \sum_{n \in \mathcal{N}} \upsilon^0_{ndi,t} \frac{\partial \ln(1+\Psi_{ndi,t}(\zeta))}{\partial \zeta} \Bigg|_{\zeta=\zeta^*_{di,t}}, \quad \text{(C.15)}$$

Here, the ratio $\Phi^0_{di,t}/[\Upsilon_{di,t}(1-\kappa_i)]$ normalizes $\partial CV/\partial\zeta$ by the expected flow profit of a representative resetting variety, so that the first term measures the marginal value of flexibility through changes in the continuation value, given by

$$\frac{\partial CV_{di,t}(\zeta)}{\partial \zeta} = \sum_{u=1}^{\infty} \frac{\zeta(1-\zeta)^{u-1}}{\prod_{\varsigma=1}^{u}(1+r_{t+\varsigma-1})} \left(\frac{1}{\zeta} - \frac{u-1}{1-\zeta}\right) V_{di,t+u}. \quad \text{(C.16)}$$

The coefficient $\left(\frac{1}{\zeta} - \frac{u-1}{1-\zeta}\right)$ captures the marginal effect of turnover on the weight assigned to horizon $t+u$ in the continuation value. This coefficient is positive for small u and negative for large u, so higher turnover reallocates weight toward near-term re-optimization dates and away from distant ones. The sign of (C.16) therefore depends on when the value of re-optimization $V_{di,t+u}$ is highest. If this value is concentrated at short horizons, then $\frac{\partial CV_{di,t}(\zeta)}{\partial\zeta} > 0$, favoring $\zeta^*_{di,t}$ above $\bar{\zeta}_i$. Conversely, if the value of re-optimization is higher at distant horizons, then higher turnover is counterproductive because it increases the likelihood of premature re-optimization.

The second term on the right-hand side of (C.15) represents the value of commitment. It aggregates changes in option values across potential source countries using the sourcing probabilities $\upsilon^0_{ndi,t}$ as weights, placing greater emphasis on countries with larger initial sourcing shares. The derivative of the option value satisfies

$$\frac{\partial \ln(1+\Psi_{ndi,t}(\zeta))}{\partial \zeta} = -\frac{1}{1-\zeta} \frac{\Psi_{ndi,t}(\zeta)}{1+\Psi_{ndi,t}(\zeta)} \sum_{u=1}^{\infty} \omega_{ndi,t}(u;\zeta)\, u, \quad \text{(C.17)}$$

[27]For ϕ_i sufficiently large, the right-hand side of (C.15) defines a contraction mapping, ensuring this choice is unique.

where

$$\omega_{ndi,t}(u;\zeta) \equiv \frac{(1-\zeta)^u \prod_{\varsigma=1}^{u}(1+r_{t+\varsigma-1})^{-1}\left(\frac{\hat{c}_{ndi,t+\varsigma}}{\hat{P}_{di,t+\varsigma}}\right)^{-(\sigma_i-1)}\hat{P}_{di,t+\varsigma}\hat{Y}_{di,t+\varsigma}}{\Psi_{ndi,t}(\zeta)},$$

with $\sum_{u=1}^{\infty}\omega_{ndi,t}(u;\zeta)=1$. The weighted sum $\sum_u \omega_{ndi,t}(u;\zeta)\,u$ captures the option-value-weighted expected remaining duration of the supplier relationship. Intuitively, raising the supplier turnover rate reduces the value of an incumbent relationship more strongly when its continuation value is driven by profits at longer horizons.

The above discussion implies that anticipation of future market conditions shapes the expected duration of newly formed relationships through two channels. Suppose traders anticipate sourcing costs to fall or demand to rise over time. Because the option values of incumbent relationships place greater weight on distant horizons when future profits are elevated, this incentivizes commitment ($\zeta^*_{di,t}\downarrow$) by raising the cost of turnover via (C.17). On the other hand, anticipation of rising flow profits raises the value of re-optimization $V_{di,t+u}$ for more distant horizons u, lowering the value of flexibility ($\zeta^*_{di,t}\downarrow$) via (C.16). The latter effect reflects how higher turnover would cause traders to re-optimize too early, before the anticipated improvements in market conditions materialize.

C.3.3 Trade Flows for Legacy Varieties

For a legacy cohort $\Omega^k_{di,t}$ with $k>0$, trade flows adjust only along the intensive margin:

$$\lambda^k_{sdi,t} = \frac{\lambda^0_{sdi,t-k}\left(\prod_{\tau=t-k+1}^{t}\hat{c}_{sdi,\tau}\right)^{-(\sigma_i-1)}}{\sum_{n\in\mathcal{N}}\lambda^0_{ndi,t-k}\left(\prod_{\tau=t-k+1}^{t}\hat{c}_{ndi,\tau}\right)^{-(\sigma_i-1)}}.$$

The initial trade shares $\lambda^0_{sdi,t-k}$ were determined under the cohort-specific turnover rate $\zeta^*_{di,t-k}$ at time $t-k$, creating heterogeneity in legacy trade shares across cohorts even conditional on the same cumulative cost changes.

C.3.4 Aggregation and Equilibrium

Given the sequence of optimal turnover rates $\{\zeta^*_{di,\tau}\}_{\tau \leq t}$, cohort measures evolve according to

$$\mu_{di,t}(k) = (1 - \zeta^*_{di,t-k})\mu_{di,t-1}(k-1), \qquad k > 0, \tag{C.18}$$

$$\mu_{di,t}(0) = \sum_{k=1}^{\infty} \zeta^*_{di,t-k}\mu_{di,t-1}(k-1). \tag{C.19}$$

Aggregate trade shares $\lambda_{sdi,t}$ and price indices $P_{di,t}$ are obtained by weighting cohort-specific objects by $\{\mu_{di,t}(k)\}_{k\geq 0}$, as in the main text.

Definition C.3 (Dynamic equilibrium with endogenous supplier turnover)**.** *Given a path of fundamentals, an initial state*

$$\Big\{\{\mu_{di,0}(k)\}_{d\in\mathcal{N},i\in\mathcal{I}},\ \{\lambda^0_{sdi,-k}, \upsilon^0_{sdi,-k}, \zeta^*_{di,-k}\}_{s,d\in\mathcal{N},i\in\mathcal{I}}\Big\}_{k\geq 0},$$

and an exogenous interest-rate path $\{r_t\}_{t\geq 0}$*, a* dynamic equilibrium *is a sequence of wages* $\{\boldsymbol{w}_t\}_{t\geq 1} = \{w_{d,t} : d \in \mathcal{N}\}_{t\geq 1}$ *such that, for all* $t \geq 1$*:*

1. $\{\boldsymbol{V}_t, \boldsymbol{\zeta}^*_t, \boldsymbol{\upsilon}^0_t, \boldsymbol{\lambda}^0_t\} = \{V_{di,t}, \zeta^*_{di,t}, \upsilon^0_{sdi,t}, \lambda^0_{sdi,t}\}_{s,d\in\mathcal{N},i\in\mathcal{I}}$ *satisfy equations* (C.10)–(C.15)*, given* $\{\boldsymbol{V}_{t+u}, \hat{\boldsymbol{P}}_{t+u}, \hat{\boldsymbol{c}}_{t+u}\}_{u\geq 1}$.

2. $\boldsymbol{\mu}_t = \{\mu_{di,t}(k)\}_{d\in\mathcal{N},i\in\mathcal{I},k\geq 0}$ *satisfies equations* (C.18)–(C.19)*.*

3. *Equilibrium aggregates* $\boldsymbol{w}_t, \boldsymbol{\lambda}_t, \boldsymbol{P}_t = \{w_{d,t}, \lambda_{sdi,t}, P_{di,t}\}_{s,d\in\mathcal{N},i\in\mathcal{I}}$ *satisfy the same aggregation and market clearing conditions as in the main text.*

Relative to the baseline, endogenous turnover introduces three computational complications. First, the state space expands: each cohort k carries its own turnover rate $\zeta^*_{di,t-k}$, so the evolution equations (C.18)–(C.19) depend on the entire history $\{\zeta^*_{di,t-k}\}_{k\geq 0}$. Second, $\zeta^*_{di,t}$ and $\lambda^0_{sdi,t}$ must be determined jointly within each period. This creates an additional within-period fixed point that must be solved at each date. Third, first-order condition (C.15) requires solving for the path of traders' value functions $\{V_{di,t+u}\}_{u\geq 1}$.

As an implication, the convenient hat-algebra approach from the main text requires modification. In the baseline model, counterfactual equilibria can be computed in terms of changes $\hat{x}_t \equiv x_t/x_{t-1}$ without solving for the levels of structural fundamentals. With endogenous turnover, the optimal turnover rate $\zeta^*_{di,t}$ is a level that must be solved for directly, as it enters nonlinearly in the option values and cohort evolution equations. However, conditional on a path of optimal turnover rates $\{\zeta^*_{di,t}\}_{t\geq 0}$, the remaining equilibrium objects can still be computed using hat algebra.

C.3.5 Steady State

The steady state retains the same properties as in the baseline model. Evaluating the first-order condition (C.14) in steady state yields $\kappa_i'(\zeta_i^*) = 0$, which under (C.9) has the unique solution $\zeta_i^* = \bar{\zeta}_i$. The stationary cohort distribution is geometric with parameter $\bar{\zeta}_i$,

$$\mu^*_{di}(k) = \bar{\zeta}_i(1-\bar{\zeta}_i)^k, \qquad k = 0, 1, 2, \ldots$$

and Proposition 1 continues to hold: trade shares, price indices, wages, and the stationary distribution of supplier relationships are identical to the baseline model. In particular, ϕ_i does not affect the steady state and cannot be identified from steady-state data alone. Identification of ϕ_i requires observing transition dynamics or exploiting cross-sectional variation in the timing or magnitude of trade cost shocks.

C.3.6 Implications for Transitional Dynamics

Although the steady states coincide, the transitional dynamics of the two models can differ. In the baseline, the supplier turnover rate is fixed at ζ_i throughout the adjustment path. With endogenous turnover, traders optimally adjust $\zeta^*_{di,t}$ in response to changes in sourcing conditions along the transition. However, the following result shows that in partial equilibrium the endogenous turnover extension does not alter the trade elasticity.

Proposition C.3 (Partial-equilibrium invariance of the trade elasticity)**.** *Suppose the economy is in steady state at $t = -1$ and a permanent unanticipated shock to trade costs occurs at $t = 0$. In partial equilibrium, holding factor prices, price indices, and expenditures fixed at their post-shock levels, the optimal supplier turnover rate satisfies $\zeta^*_{di,t} = \bar{\zeta}_i$ for all $d \in \mathcal{N}$, $i \in \mathcal{I}$, and $t \geq 0$. The partial-equilibrium trade elasticity from Proposition 2 therefore holds exactly as in the baseline model.*

Proof. See Section C.3.7 □

The proposition establishes that the partial-equilibrium trade elasticity characterized in Proposition 2 carries over unchanged, with $\bar{\zeta}_i$ replacing ζ_i. The reason is that, in partial equilibrium, a permanent shock followed by constant factor prices leaves the trader's problem stationary, so the marginal value of flexibility (through the continuation value) and the marginal cost of commitment (through the option value) exactly offset at the baseline turnover rate. Because the estimation strategy in Section 4 exploits variation in trade flows across horizons following plausibly unanticipated tariff changes—precisely the partial-equilibrium variation governed by Proposition 2—it recovers $\bar{\zeta}_i$ regardless of whether turnover is endogenous. The adjustment cost parameter ϕ_i does not affect the partial-equilibrium trade elasticity and cannot be identified from this variation alone.

Any deviation of $\zeta^*_{di,t}$ from $\bar{\zeta}_i$ arises through general equilibrium effects along the transition path. As factor prices, price indices, and expenditures adjust, option values $\Psi_{ndi,t}(\zeta)$ become time-varying and heterogeneous across source countries n, breaking the stationarity that pins $\zeta^*_{di,t}$ at $\bar{\zeta}_i$. The two terms in (C.15) then govern the direction of the deviation. The commitment term ($\partial \ln(1+\Psi)/\partial\zeta$) is always negative: higher turnover shortens relationships and reduces their option value. The flexibility term ($\partial CV/\partial\zeta$) is positive when the value of re-optimization is front-loaded. After an unanticipated tariff increase, factor price adjustments raise the near-term value of switching suppliers, so the flexibility term dominates and traders accelerate turnover ($\zeta^*_{di,t} > \bar{\zeta}_i$), with larger acceleration in destinations more exposed to the tariff change.

The quantitative importance of this channel depends on ϕ_i. When ϕ_i is small, deviations from $\bar{\zeta}_i$ are inexpensive and optimal turnover can vary substantially over the transition. In the limit $\phi_i \to \infty$, turnover is effectively fixed at $\bar{\zeta}_i$ and the baseline dynamics obtain.

C.3.7 Proof of Proposition C.3

Proof. In partial equilibrium after a permanent shock, all future changes in unit costs, price indices, and expenditures equal unity: $\hat{c}_{ndi,t+\varsigma} = \hat{P}_{di,t+\varsigma} = \hat{Y}_{di,t+\varsigma} = 1$ for all $\varsigma \geq 1$. The trader's environment is therefore stationary from $t = 0$ onward. Option values reduce to

$$\Psi_{ndi,t}(\zeta) = \sum_{\varsigma=1}^{\infty} \left(\frac{1-\zeta}{1+r}\right)^{\varsigma} = \frac{1-\zeta}{r+\zeta},$$

which is common across source countries n and constant over time, and the continuation value becomes $CV_{di,t}(\zeta) = \zeta\, V_{di}/(r+\zeta)$, where V_{di} denotes the stationary value of re-optimization. Let $\bar{\Pi}_{di} \equiv \mathbb{E}[\max_n \pi_{ndi,t}(\omega)]$ denote the expected per-variety flow profit after Fréchet aggregation. Because Ψ is common across sources, $(1 + \Psi(\zeta))$ factors out of the expectation, and the value function satisfies

$$V_{di} = (1 - \kappa_i(\zeta))\,\bar{\Pi}_{di}\,(1 + \Psi(\zeta)) + CV_{di}(\zeta).$$

Substituting $1 + \Psi(\zeta) = (1 + r)/(r + \zeta)$ and $CV_{di}(\zeta) = \zeta\,V_{di}/(r + \zeta)$ and solving yields the identity

$$(1 - \kappa_i(\zeta))\,\bar{\Pi}_{di} = \frac{r\,V_{di}}{1 + r}. \tag{C.20}$$

The original first-order condition (C.14) in this stationary environment reads

$$\begin{aligned} 0 &= \frac{\partial}{\partial \zeta}\big[(1 - \kappa_i(\zeta))\,\bar{\Pi}_{di}\,(1 + \Psi(\zeta)) + CV_{di}(\zeta)\big] \\ &= -\kappa_i'(\zeta)\,\bar{\Pi}_{di}\,(1 + \Psi(\zeta)) + (1 - \kappa_i(\zeta))\,\bar{\Pi}_{di}\,\Psi'(\zeta) + CV'(\zeta). \end{aligned}$$

The last two terms cancel. To see this, note that $\Psi'(\zeta) = -(1+r)/(r+\zeta)^2$ and $CV'(\zeta) = r\,V_{di}/(r+\zeta)^2$, so

$$(1 - \kappa_i(\zeta))\,\bar{\Pi}_{di}\,\Psi'(\zeta) + CV'(\zeta) = \frac{r\,V_{di}}{1 + r}\cdot\frac{-(1 + r)}{(r + \zeta)^2} + \frac{r\,V_{di}}{(r + \zeta)^2} = 0,$$

where the first equality uses (C.20). The first-order condition therefore reduces to $\kappa_i'(\zeta^*)\,\bar{\Pi}_{di}\,(1+\Psi(\zeta^*)) = 0$. Since $\bar{\Pi}_{di}(1+\Psi) > 0$, we obtain $\kappa_i'(\zeta^*) = 0$, which under (C.9) has the unique solution $\zeta^*_{di,t} = \bar{\zeta}_i$ for all $d \in \mathcal{N}$, $i \in \mathcal{I}$, and $t \geq 0$. □

C.4 Technological Change

This section develops an extension that allows for time-varying supplier productivity. Under this extension, the highest-realized productivity $z_{si,t}(\omega)$ among the potential producers of a good ω may evolve for two reasons: innovation by the current lowest-cost producer, or producer entry. As we demonstrate once we integrate this theory into our model, the distinction between within- and across-producer technological change becomes important when supplier adjustment occurs gradually over time.

C.4.1 Innovation and Diffusion

At time $t = 0$, the highest-realized productivity $z_{si,0}(\omega)$ among all potential producers for a good ω in country-industry si follows a Fréchet distribution:

$$F_{si,0}(z) = \Pr[z_{si,0}(\omega) < z] = e^{A_{si,0}z^{-\theta_i}}.$$

Two processes govern the evolution of $F_{si,0}(z)$. The first process determines the productivity of new potential producers, while the second governs the productivity of the incumbent producer behind the realization $z_{si,t}(\omega)$. We describe each process in turn, beginning with the arrival process for new potential producers.

Productivity of new potential producers. Following Kortum (1997) and Buera and Oberfield (2020), new potential producers arrive stochastically and exogenously. A new potential producer for a good ω in industry i arriving in location s at time t draws a productivity $z = q(z')^{\beta_{i,E}}$ that has two random components. First, an insight derived from an existing technique, z', drawn from the distribution $F_{si,t-1}$; and second, an original component q drawn from an exogenous distribution. We assume that the arrival rate of new techniques with original component greater than q' follows a Poisson distribution with mean $\alpha_{si,E}q'^{-\theta_i}$.

The diffusion parameter $\beta_{i,E} \in [0, 1)$ governs the importance of existing knowledge for entrant productivity. The parameter $\alpha_{si,E}$ controls the contribution of entrants to overall technological progress.

Productivity shocks to incumbent producers. We extend Buera and Oberfield (2020) to allow for innovation by incumbent producers. Unlike entrants, incumbent producers receive multiple potential ideas for productivity improvements.

When a new idea arrives to an incumbent at time t, productivity z equals $q[z']^{\beta_{i,I}}$, where the existing component $z' \sim F_{si,t-1}$, $\beta_{i,I} \in [0, 1)$, and the original component q is drawn from an exogenous distribution. For incumbents, the arrival rate of new ideas with original component greater than q' follows a Poisson distribution with mean $\alpha_{si,I}q'^{-\theta_i}$, where $\alpha_{si,I}$ governs the contribution of incumbents to overall technological progress.

Evolution of the frontier of knowledge. We characterize the evolution of supplier productivity for intermediate goods in each partition $\{\Omega_{i,t}\}_{k=0}^{\infty}$. Let $F^k_{si,t+\Delta}(z)$ denote the probability that an incumbent in period $t-k$ achieves productivity less than z at time $t+\Delta$; this coincides with source country s's productivity distribution for potential suppliers across goods $\omega \in \Omega^{k}_{i,t+\Delta}$.

Given the frontier distribution at time $F^{0}_{si,t}$, the exogenous arrival rate of new producers $\alpha_{si,E} z^{-\theta_i}$, and the exogenous arrival rate of ideas to incumbents $\alpha_{si,I} z^{-\theta_i}$, the frontier distribution at time $t+\Delta$ satisfies

$$1 - F^{0}_{si,t+\Delta}(z) = 1 - F^{0}_{si,t}(z) + \Delta F^{0}_{si,t}(z) \int_0^{\infty} \left[\alpha_{si,E} \left(z / z'^{\beta_{i,E}} \right)^{-\theta_i} + \alpha_{si,I} \left(z / z'^{\beta_{i,I}} \right)^{-\theta_i} \right] dz'$$

The fraction of goods for which the frontier productivity exceeds z at $t+1$ comprises those for which the frontier exceeds z at t, $1 - F^{0}_{si,t}(z)$, plus, among the remainder, those for which either an entrant or an incumbent receives a new idea with productivity exceeding z between t and $t+1$. To derive the arrival rate of these ideas, note that given an insight z', the arrival rate of ideas that would produce productivity greater than z equals $\alpha_{si,E} \left(z / z'^{\beta_{i,E}} \right)^{-\theta_i}$ for entrants and $\alpha_{si,I} \left(z / z'^{\beta_{i,I}} \right)^{-\theta_i}$ for incumbents. Integrating over possible insights yields the arrival rate of ideas with productivity greater than q.

By the same logic, the productivity distribution among potential producers in country s for a good $\omega \in \Omega^{k}_{i,t+\Delta}$ with $k > 0$ satisfies

$$1 - F^{k}_{si,t+1}(z) = 1 - F^{k-1}_{si,t}(z) + \Delta F^{k-1}_{si,t}(z) \int_0^{\infty} \left[\alpha_{si,I} \left(z / z'^{\beta_{i,I}} \right)^{-\theta_i} \right] dz', \text{ for } k > 0.$$

Using Proposition 1 in Buera and Oberfield (2020) to evaluate this functional difference equation for $F^{k}_{si,t-1}$ at the limit $\Delta \to 0$ shows that $F^{k}_{si,t}$ follows a Fréchet distribution for all k. For $k = 0$,

$$F^{0}_{si,t}(z) = e^{-z^{-\theta_i} A_{si,t-1} \hat{A}^{0}_{si,t}},$$

where

$$\hat{A}^{0}_{si,t} = 1 + \frac{1}{A^{0}_{si,t-1}} \int_0^1 \left[\alpha_{si,E} \Gamma(1-\beta_{i,E}) \left(A^{0}_{si,t-\Delta} \right)^{\beta_{i,E}} + \alpha_{si,I} \Gamma(1-\beta_{i,I}) \left(A^{0}_{si,t-\Delta} \right)^{\beta_{i,I}} \right] d\Delta,$$

and, for $k > 0$, we find

$$F_{si,t}^{k}(z) = e^{-z^{-\theta_i} A_{si,t-k}^{0} \prod_{\varsigma=t-k+1}^{t} \hat{A}_{siI,\varsigma}},$$

where

$$\hat{A}_{siI,t} = 1 + \Gamma(1-\beta_{i,I}) \frac{\alpha_{si,I}}{A_{si,t-1}^{0}} \int_{0}^{1} \left(A_{si,t-\Delta}^{0}\right)^{\beta_{i,I}} d\Delta$$

This framework flexibly accommodates country-industry-time-specific Fréchet productivity distributions across the partitions $\{F_{si,t}^{k}\}_{k=0}^{\infty}$. A model in which incumbents alone drive technological change corresponds to the special case where $F_{si,t}^{k} = F_{si,t}$ for all k. A model in which producer entry is the sole driver of technological change corresponds to the special case where $F_{si,t}^{k} = F_{si,t-k}^{0}$ for all $k > 0$.

These results motivate the following reduced-form specification for the evolution of producer-level productivity across intermediate goods $\omega \in \Omega_{si,t}^{k}$:

$$F_{si,t}^{k} = \Pr\left[\omega \in \Omega_{i,t}^{k} : z_{si,t}(\omega) < z\right] = \begin{cases} e^{-z^{-\theta_i} A_{si,t}^{0}}, & k = 0 \\ e^{-z^{-\theta_i} A_{si,t-k}^{0} \prod_{\varsigma=t-k+1}^{t} \hat{A}_{si,\varsigma}^{k}}, & k > 0 \end{cases},$$

C.4.2 Equilibrium Characterization

Demand for optimally sourced goods. Under evolving producer productivity, the option value of supply relations to country s for industry-i traders in d takes the form:

$$\Psi_{sdi,t} = \sum_{u=1}^{\infty} \left(\frac{1-\zeta_i}{1+r}\right)^{u} \left\{ \prod_{\varsigma=1}^{u} \left(\hat{A}_{si,t+\varsigma}^{u}\right) \left(\frac{\hat{c}_{sdi,t+\varsigma}}{\hat{P}_{di,t+\varsigma}}\right)^{1-\sigma_i} \hat{P}_{di,t+\varsigma} \hat{Y}_{di,t+\varsigma} \right\}.$$

Given these option values, each country d's extensive margin demands $\{\upsilon_{sdi,t}^{0}\}_{s\in\mathcal{N},i\in\mathcal{I}}$ and expenditure allocations $\{\lambda_{sdi,t}^{0}\}_{s\in\mathcal{N},i\in\mathcal{I}}$ across intermediate goods $\omega \in \Omega_{di,t}$ follow as in the main text. The price index $\{P_{di,t}^{0}\}_{d\in\mathcal{N},i\in\mathcal{I}}$ becomes:

$$\left(P_{di,t}^{0}\right)^{-(\sigma_i-1)} = c_{ddi,t}^{-\theta_i} \left(1 + \Psi_{ddi,t}\right)^{\frac{\theta_i}{\sigma_i-1}-1} \frac{A_{di,t}^{0}}{\lambda_{ddi,t}^{0}}.$$

Demand for legacy goods. To obtain destination d's trade shares and ideal price index for industry-i legacy varieties with $k > 0$, we now also adjust the shares $\{\lambda_{sdi,t-k}^{0}\}_{s\in\mathcal{S}}$ and price indices $P^0_{di,t-k}$ at time $t-k$ for subsequent changes in incumbent productivity:

$$\lambda^k_{sdi,t} = \frac{\lambda^0_{sdi,t-k}\prod_{\varsigma=t-k+1}^{t}\hat{A}^k_{si,\varsigma}\left(\hat{c}_{sdi,\varsigma}\right)^{1-\sigma_i}}{\Phi^k_{di,t}}, k>0$$

and

$$P^k_{di,t} = P^0_{di,t-k}\left(\frac{\mu_{i,t}(k)}{\mu_{i,t-k}(0)}\Phi^k_{di,t}\right)^{1/(1-\sigma_i)}, k>0$$

where

$$\Phi^k_{di,t} = \sum_n \lambda^0_{ndi,t-k}\left[\prod_{\varsigma=t-k+1}^{t}\hat{A}^k_{ni,\varsigma}\left(\hat{c}_{ndi,\varsigma}\right)^{1-\sigma_i}\right], k>0.$$

Aggregation and equilibrium. Given the trade shares and price index for the goods in each set $\{\Omega^k_{i,t}\}^{\infty}_{k=0}$, the vector of trade shares $\{\lambda_{sdi,t}\}_{s\in\mathcal{N}}$ in (24) and the price index $P_{di,t}$ in (23) characterize each destination d's total demand for industry-i goods. The conditions for goods and factor market clearing within each period t therefore remain unchanged, as given by equations (25)-(27).

D Additional Results from Estimation

Table D.1: Additional Estimation Results

Selection of horizons (moment conditions)	θ	$\sigma - 1$	$1 - \zeta$	Hansen's J-statistic	F-stat. over horizons 1–3
1–10 (All)	5.46	0.70	0.96	14.62	45.81
	(14.31)	(0.37)	(0.13)	[0.04]	[0.00]
Excluding horizon 3	**3.51**	**0.52**	**0.93**	8.00	44.81
	(3.45)	(0.38)	(0.12)	[0.24]	[0.00]
Excluding horizons 2–3	4.20	0.41	0.94	3.07	46.49
	(5.11)	(0.38)	(0.11)	[0.69]	[0.00]
1, 4, 5, 6, 7, 8, 10	4.17	0.45	0.94	1.71	43.30
	(5.61)	(0.38)	(0.12)	[0.79]	[0.00]
1, 5, 6, 7, 8, 10	6.05	0.46	0.96	1.03	43.91
	(15.13)	(0.38)	(0.12)	[0.79]	[0.00]
1, 4, 5, 9, 10	2.97	0.30	0.88	0.51	48.84
	(1.43)	(0.41)	(0.11)	[0.77]	[0.00]
2, 3, 5, 9	1.95	0.20	0.83	0.10	40.24
	(0.84)	(0.62)	(0.19)	[0.75]	[0.00]
2, 5, 9	2.04	0.22	0.85		39.61
	(1.11)	(0.59)	(0.20)		[0.00]

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Continuously updated GMM. Moment (horizon) selection based on Andrews (1999). θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model). Hansen's J statistic for validity of overidentifying restrictions; F statistic for joint equality of zero for the elasticities over the first 3 horizons. Standard errors in parentheses (cluster-robust at level of importer-exporter-HS4 triplets); p-values in brackets (for Hansen's J and F-statistics). Preferred estimates selected by GMM-BIC criterion in orange and boldface.

Table D.2: Structural Parameter Estimates under One-Step GMM

Selection of horizons (moment conditions)	θ	$\sigma - 1$	$1 - \zeta$
1–10 (All)	5.16	0.88	0.97
	(16.78)	(0.38)	(0.16)
Excluding horizon 3	8.86	0.73	0.98
	(53.30)	(0.37)	(0.14)
Excluding horizons 2–3	5.53	0.50	0.96
	(11.90)	(0.38)	(0.12)
1, 4, 5, 6, 7, 8, 10	3.74	0.48	0.93
	(4.22)	(0.39)	(0.12)
1, 5, 6, 7, 8, 10	5.65	0.46	0.96
	(13.06)	(0.38)	(0.12)
1, 4, 5, 9, 10	3.07	0.33	0.89
	(1.61)	(0.41)	(0.11)
2, 3, 5, 9	1.97	0.22	0.83
	(0.89)	(0.61)	(0.19)
2, 5, 9	2.05	0.22	0.85
	(1.11)	(0.59)	(0.20)

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: One-Step GMM. Moment (horizon) selection based on Andrews (1999). θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model). Standard errors in parentheses (cluster-robust at level of importer-exporter-HS4 triplets).

Table D.3: Structural Parameter Estimation For Top-Coded IV

Selection of horizons (moment conditions)	θ	$\sigma - 1$	$1 - \zeta$	Hansen's J-statistic	F-stat. over horizons 1–3
1–10 (All)	5.56	0.91	0.95	12.35	72.57
	(7.07)	(0.40)	(0.10)	[0.09]	[0.00]
Excluding horizon 10	2.95	0.25	0.88	10.74	65.15
	(1.28)	(0.33)	(0.10)	[0.10]	[0.00]
Excluding horizons 3, 7	**7.52**	**0.85**	**0.96**	4.04	72.28
	(16.01)	(0.40)	(0.10)	[0.54]	[0.00]
1, 4, 5, 6, 8, 9, 10	6.78	0.73	0.96	2.07	73.43
	(10.67)	(0.41)	(0.10)	[0.72]	[0.00]
1, 4, 5, 6, 9, 10	5.76	0.69	0.94	0.94	74.46
	(6.23)	(0.42)	(0.09)	[0.82]	[0.00]
1, 4, 5, 9, 10	4.50	0.63	0.91	0.06	75.15
	(2.72)	(0.43)	(0.10)	[0.97]	[0.00]
1, 4, 5, 10	4.52	0.64	0.91	0.02	70.30
	(2.84)	(0.44)	(0.10)	[0.89]	[0.00]
2, 5, 9	2.67	0.13	0.81		68.78
	(0.80)	(0.71)	(0.15)		[0.00]

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Continuous updating GMM. Sample restricted to observations where $|Z_{sdp,t}| \leq 0.15$. Moment (horizon) selection based on Andrews (1999). θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model). Hansen's J statistic for validity of overidentifying restrictions; F statistic for joint equality of zero for the elasticities over the first 3 horizons. Standard errors in parentheses (cluster-robust at level of importer-exporter-HS4 triplets); p-values in brackets (for Hansen's J and F-statistics). Preferred estimates selected by GMM-BIC criterion in orange and boldface.

Table D.4: Structural Parameter Estimation Accounting for Missing Tariffs

Selection of horizons (moment conditions)	θ	$\sigma - 1$	$1 - \zeta$	Hansen's J-statistic	F-stat. over horizons 1–3
Excluding horizons 1, 2, 6	**3.54**	**0.13**	**0.98**	4.20	13.14
	(65.21)	(0.35)	(0.34)	[0.38]	[0.00]
3, 4, 5, 7, 8, 10	3.14	0.13	0.98	4.20	13.33
	(47.59)	(0.35)	(0.33)	[0.24]	[0.00]
3, 4, 5, 9, 10	3.19	0.14	0.98	1.38	12.60
	(67.83)	(0.41)	(0.43)	[0.50]	[0.00]
3, 4, 5, 10	4.40	0.15	0.99	1.26	11.58
	(167.64)	(0.44)	(0.49)	[0.26]	[0.00]

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018. WTO Regional Trade Agreement Database.

Notes: Continuous updating GMM. WITS tariff data corrected for missing MFN tariffs and selection bias from zero-trade observations following Teti (2024). Observations with absolute tariff changes in IV greater than 15 percent are dropped. Moment (horizon) selection based on Andrews (1999). θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model). Hansen's J statistic for validity of overidentifying restrictions; F statistic for joint equality of zero for the elasticities over the first 3 horizons. Standard errors in parentheses (cluster-robust at level of importer-exporter-HS4 triplets); p-values in brackets (for Hansen's J and F-statistics). Preferred estimates selected by GMM-BIC criterion in orange and boldface.

Table D.5: Estimates of Structural Parameters by Model Industry

Industry in Model	θ	$\sigma - 1$	$1 - \zeta$
Agriculture, forestry and fishing	5.08	2.41	0.63
Mining and quarrying	1.76	0.32	0.79
Food products, beverages and tobacco	5.08	2.41	0.63
Textiles, textile products, leather and footwear	5.08	2.41	0.63
Wood and products of wood and cork	4.06	0.13	0.87
Paper products and printing	4.06	0.13	0.87
Coke and refined petroleum products	4.06	0.13	0.87
Chemicals and chemical products	1.79	0.20	0.65
Pharmaceuticals, medicinal and botanical products	1.79	0.20	0.65
Rubber and plastics products	4.06	0.13	0.87
Other non-metallic mineral products	1.76	0.32	0.79
Basic metals	3.33	0.40	0.93
Fabricated metal products	3.33	0.40	0.93
Computer, electronic and optical equipment	4.94	0.14	0.85
Electrical equipment	1.76	0.32	0.79
Machinery and equipment	3.33	0.40	0.93
Motor vehicles, trailers and semi-trailers	3.33	0.40	0.93
Other transport equipment	3.33	0.40	0.93
Furniture and other manufacturing	1.76	0.32	0.79
All 15 service industries	3.51	0.52	0.93

Sources: BACI (HS6 tariff-exclusive trade flows), TRAINS (WITS, HS6 tariffs); 1995-2018.
Notes: Continuously updated GMM. Moment (horizon) selection based on Andrews (1999), industry by industry. θ is the Fréchet shape parameter of the productivity distribution and the long-run trade elasticity; σ is the elasticity of substitution between varieties and governs the short-run trade elasticity; ζ is the hazard rate of supplier switching ($\zeta = 1$ in a canonical static trade model).

E Details on Quantitative Applications

The quantitative analysis calibrates the model economy to an initial steady state, then feeds a path of shocks and computes the counterfactual path of all endogenous outcomes.

E.1 Dynamic Hat Algebra

We restate the equilibrium conditions at time t in terms of past sourcing probabilities, trade shares, expenditures, exogenous changes in trade costs, and endogenous changes in factor prices.

Bilateral trade shifters.

$$\hat{c}_{sdi,t} = \hat{\tau}_{sdi,t} \left(\hat{w}_{s,t}\right)^{\alpha_{si}} \prod_{j \in \mathcal{I}} \left(\hat{P}_{sj,t}\right)^{\alpha_{sji}}, \tag{E.1}$$

$$\widehat{1+\Psi}_{sdi,t} = \frac{1+\Psi_{sdi,t}}{1+\Psi_{sdi,t-1}} = \frac{1+\sum_{u=1}^{\infty}\left(\frac{1-\zeta_i}{1+r}\right)^u \prod_{u'=1}^{u}\left[\hat{c}_{sdi,t+u'}^{-(\sigma_i-1)} \hat{P}_{di,t+u'}^{\sigma_i} \hat{Y}_{di,t+u'}\right]}{1+\sum_{u=1}^{\infty}\left(\frac{1-\zeta_i}{1+r}\right)^u \prod_{u'=1}^{u}\left[\hat{c}_{sdi,t+u'-1}^{-(\sigma_i-1)} \hat{P}_{di,t+u'-1}^{\sigma_i} \hat{Y}_{di,t+u'-1}\right]}. \tag{E.2}$$

Supplier choice, trade flows and prices for optimally sourced goods.

$$\hat{\upsilon}_{sdi,t}^{0} = \frac{\hat{c}_{sdi,t}^{-\theta_i} (\widehat{1+\Psi}_{sdi,t})^{\frac{\theta_i}{\sigma_i-1}}}{\hat{\Upsilon}_{di,t}}, \tag{E.3}$$

$$\hat{\Upsilon}_{di,t} = \sum_{n} \upsilon_{ndi,t-1}^{0} \hat{c}_{ndi,t}^{-\theta_i} (\widehat{1+\Psi}_{ndi,t})^{\frac{\theta_i}{\sigma_i-1}}, \tag{E.4}$$

$$\hat{\lambda}_{sdi,t}^{0} = \frac{\hat{c}_{sdi,t}^{-\theta_i} (\widehat{1+\Psi}_{sdi,t})^{\frac{\theta_i}{\sigma_i-1}-1}}{\hat{\Phi}_{di,t}^{0}}, \tag{E.5}$$

$$\hat{\Phi}_{di,t}^{0} = \sum_{n} \lambda_{ndi,t-1}^{0} \hat{c}_{ndi,t}^{-\theta_i} (\widehat{1+\Psi}_{ndi,t})^{\frac{\theta_i}{\sigma_i-1}-1}, \tag{E.6}$$

$$\hat{P}_{di,t}^{0} = \left(\hat{\Upsilon}_{di,t}\right)^{-1/\theta_i} \left(\frac{\hat{\Phi}_{di,t}^{0}}{\hat{\Upsilon}_{di,t}}\right)^{-1/(\sigma_i-1)}. \tag{E.7}$$

Trade flows for legacy goods with $k > 0$.

$$\lambda_{sdi,t}^{k} = \frac{\lambda_{sdi,t-k}^{0} \prod_{\varsigma=t-k+1}^{t} \hat{c}_{sdi,\varsigma}^{-(\sigma_i-1)}}{\Phi_{di,t}^{k}}, \tag{E.8}$$

$$\Phi_{di,t}^{k} = \sum_{n} \lambda_{ndi,t-k}^{0} \prod_{\varsigma=t-k+1}^{t} \hat{c}_{ndi,\varsigma}^{-(\sigma_i-1)}, \tag{E.9}$$

$$\left(P_{di,t}^{k}\right)^{-(\sigma_i-1)} = \left(P_{di,t-k}^{0}\right)^{-(\sigma_i-1)} \frac{\mu_{i,t}(k)}{\mu_{i,t-k}(0)} \Phi_{di,t}^{k}. \tag{E.10}$$

Industry price index and trade flows.

$$\hat{P}_{di,t} = \hat{P}_{di,t}^{0} \frac{\left[1 + \sum_{k=1}^{\infty} \frac{\mu_{i,t}(k)}{\mu_{di,t}(0)} \left(\frac{P_{di,t-k}^{0}}{P_{di,t}^{0}}\right)^{-(\sigma_i-1)} \Phi_{di,t}^{k}\right]^{-1/(\sigma_i-1)}}{\left[1 + \sum_{k=1}^{\infty} \frac{\mu_{di,t-1}(k)}{\mu_{di,t-1}(0)} \left(\frac{P_{di,t-k-1}^{0}}{P_{di,t-1}^{0}}\right)^{-(\sigma_i-1)} \Phi_{di,t-1}^{k}\right]^{-1/(\sigma_i-1)}}. \tag{E.11}$$

Market clearing conditions.

$$X_{si,t} = \sum_{d\in\mathcal{N}} \lambda_{sdi,t-1}\hat{\lambda}_{sdi,t-1} \left[\eta_{di} E_{d,t-1}\hat{E}_{d,t} + \sum_{j\in\mathcal{I}} \alpha_{dij} X_{di,t}\right], \tag{E.12}$$

$$\Pi_{d,t} = \sum_{i} \frac{1}{\sigma_i} \left[\eta_{di} E_{d,t-1}\hat{E}_{d,t} + \sum_{j} \alpha_{dij} X_{di,t}\right], \tag{E.13}$$

$$\hat{E}_{d,t} = \frac{w_{d,t-1}\hat{w}_{d,t}L_d + \Pi_{d,t} + D_{d,t}}{E_{d,t-1}}, \tag{E.14}$$

$$w_{d,t-1}\hat{w}_{d,t}L_d = \sum_{i\in\mathcal{I}} \alpha_{di} \left(1 - \frac{1}{\sigma_i}\right) \sum_{s\in\mathcal{N}} \lambda_{sdi,t} E_{di,t}. \tag{E.15}$$

E.2 Computational Algorithm

Given a path of changes in tariffs $\{\hat{\tau}_{sdi,t}\}_{t=0}^{H}$ from time 0 to H, the counterfactual outcomes are obtained by solving a nested system of nonlinear equations that determine four sets of equilibrium paths: (1) the country-industry-level total expenditure $\{X_{dj,t}\}_{t=0}^{H}$; (2) the changes in country-industry-level price indices faced by producers $\{\hat{P}_{dj,t}\}_{t=0}^{H}$; (3) the changes in country-level wages $\{\hat{w}_{d,t}\}_{t=0}^{H}$; and (4) the changes in country-industry-level option value of supplier relations $\{\widehat{1+\Psi_{sdi,t}}\}_{t=0}^{H}$. The computational algorithm is outlined below.

Step 0 Start with an initial guess of $\{X_{dj,t}\}_{t=0}^{H}$, $\{\hat{w}_{d,t}\}_{t=0}^{H}$, and $\{\widehat{1+\Psi_{sdi,t}}\}_{t=0}^{H}$. We use the values attained in the initial steady state as a starting point.

Step 1 For each period t from 0 to H, solve $X_{dj,t}$, $\hat{P}_{dj,t}$, and $\hat{w}_{d,t}$ sequentially, given $\{\widehat{1+\Psi_{sdi,t}}\}_{t=0}^{H}$ and following the steps below.

- **Step PW0** Given the shocks $\{\hat{\tau}_{sdi,t}\}_{t=0}^{H}$, $\{\hat{P}_{dj,t}\}_{t=0}^{H}$, and $\{\hat{w}_{d,\varsigma}\}_{\varsigma=0}^{t}$ obtained for any earlier period, compute the cumulative changes in unit cost for each variety with legacy $k > 0$, $\{\prod_{\varsigma=t-k}^{t} \hat{c}_{sdi,\varsigma}\}_{t=0}^{H}$.
- **Step PW1** Update the changes in price indices $\hat{P}_{dj,t}$ and wages $\hat{w}_{d,t}$ for the current period using a fixed-point solver.
- **Step PW2** Compute the changes in unit cost $\hat{c}_{sdi,t}$ for the current period using Equation (E.1).
- **Step PW3** Compute the legacy-specific trade shares $\lambda_{sdi,t}^{k}$ for varieties with legacy $k \geq 0$, using Equations (E.5), (E.6), (E.8) and (E.9).
- **Step PW4** Compute the shares of varieties from country s chosen by traders in each destination country d, $\upsilon_{sdi,t}$, using Equations (E.3) and (E.4).
- **Step PW5** Compute the implied legacy-specific price indices $P_{di,t}^{k}$ for each k and country-industry-level price indices $\hat{P}_{dj,t}$ using Equations (E.7), (E.10) and (E.11).
- **Step PW6** Compute the country-industry-level trade shares $\lambda_{sdi,t}$ based on $\lambda_{sdi,t}^{k}$, $P_{di,t}^{k}$, and $P_{dj,t}$.
- **Step PW7** Compute the country-industry-level expenditures on goods for final use $E_{d,t} - \sum_j \Pi_{dj,t}$ based on the income computed from the guess on wage changes, trade deficits, before counting profits from traders using Equation (E.14).
- **Step PW8** Solve $X_{dj,t}$ with the variables computed so far using Equation (E.12) and a fixed-point solver.
- **Step PW9** Compute the country-industry-level output $Y_{si,t}$ based on trade shares, expenditures, tariffs and markup.

Step PW10 Compute the profits earned by traders, wage income earned by workers and the implied wage changes $\hat{w}_{d,t}$ using Equation (E.15).

Step PW11 Compare the price indices $\hat{P}_{dj,t}$ from **Step PW5** and wages $\hat{w}_{d,t}$ from **Step PW10** with the previous updates from **Step PW1**. If they are not sufficiently close, go back to **Step PW1** and repeat.

Step 2 Update aggregate price indices faced by households based on preferences.

Step 3 Compute the changes in country-industry-level option value of supplier relations $\{\widehat{1+\Psi_{sdi,t}}\}_{t=0}^{H}$ using variables computed so far and Equation (E.2).

Step 4 Compare the $\{\widehat{1+\Psi_{sdi,t}}\}_{t=0}^{H}$ obtained from **Step 3** with those from **Step 1**. If they are not sufficiently close, update the guess for $\{\widehat{1+\Psi_{sdi,t}}\}_{t=0}^{H}$ using a fixed-point solver and go back to **Step 1**.

E.3 2004 EU Enlargement Tariffs

Table E.1: Counterfactual Tariff Changes

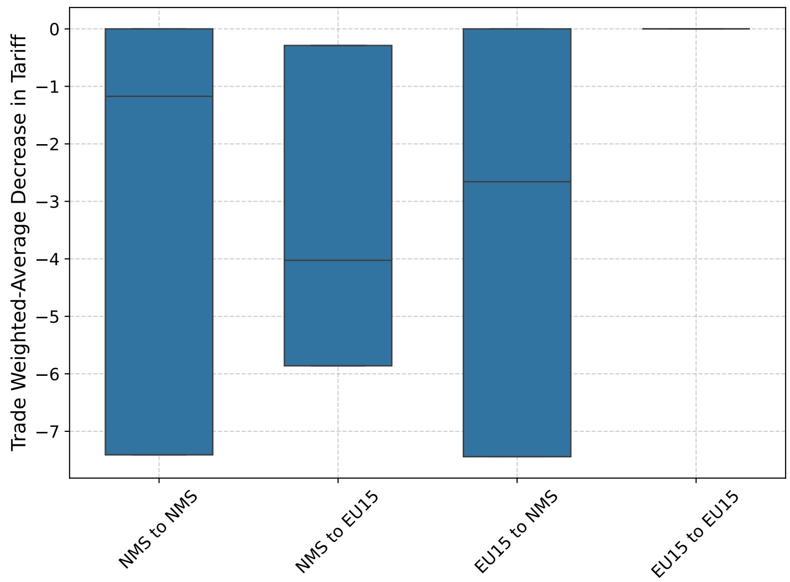
source $\rightarrow$ destination	Mean	Std. Dev.	min	Q1	Q2	Q3	max
NMS $\rightarrow$ NMS	4.2	6.0	0.0	0.0	1.2	7.4	60.0
NMS $\rightarrow$ EU15	4.0	3.2	0.0	0.3	4.0	5.9	13.4
EU15 $\rightarrow$ NMS	4.3	5.2	0.0	0.0	2.7	7.4	84.2
EU15 $\rightarrow$ EU15	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: WITS.
Notes: Mean, standard deviation, min, max, and top boundaries for the first, second, and third quartiles of the tariff shock source-destination-industry tuples. MFN and Preferential Tariffs filled according to the procedure described in the replication file. Missing data for 1995 replaced with data from the closest year available in the sample.

E.4 2018 US China Trade War Tariffs

For model calibration, we rely on the OECD ICIO data, which reconciles trade data with national accounts. To obtain tariff changes at the same level of aggregation, we use 8-digit HS-code level trade data from the US Census as weights. Minor discrepancies in import and export volumes arise from differences in industry classifications between OECD ICIO and the US Census.

Figure E.1: Distribution of Counterfactual Tariff Changes



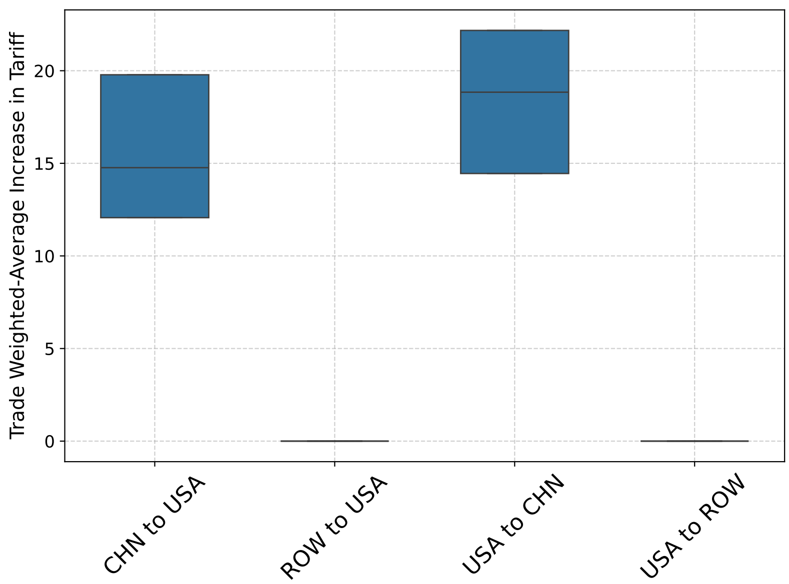
Source: WITS.
Notes: Range of anticipated 2004 source-destination-industry level tariff changes, in percentage points. MFN and Preferential Tariff filled according to the procedure described in the replication file. Missing data for 1995 replaced with data from the closest year available in the sample. More detailed summary statistics can be found in Table E.1 in the Appendix.

Table E.2: Distribution of Tariff Increases Across Source-Destination Tuples

source $\rightarrow$ destination	Mean	Std. Dev.	min	Q1	Q2	Q3	max
CHN $\rightarrow$ USA	15.6	7.4	0.1	12.1	14.8	19.8	31.3
ROW $\rightarrow$ USA	0.6	2.0	0.0	0.0	0.0	0.0	20.0
USA $\rightarrow$ CHN	17.3	6.4	0.1	14.5	18.8	22.2	24.7
USA $\rightarrow$ ROW	0.5	2.8	0.0	0.0	0.0	0.0	24.3

Sources: Fajgelbaum et al. (2020).
Notes: Mean, standard deviation, min, max, and top boundaries for the first, second, and third quartiles of the cumulative 2018–2020 source-destination-industry level tariff changes used to simulate the China-US trade war, in percentage points.

Figure E.2: Tariff Changes for Trade War Counterfactuals



Sources: Fajgelbaum et al. (2020).
Notes: Interquartile range of cumulative 2018–20 source-destination-industry level tariff changes, in percentage points.

Table E.3: Tariff Increases on US Imports from China

	2017 Imports in Total (%)		Cumulative Increases in Tariffs (%)		
Industry	OECD ICIO	US Census	2018	2019	2020–
Agriculture, forestry and fishing	0.5	0.6	2.5	14.7	20.6
Mining and quarrying	0.0	0.1	1.0	5.6	7.4
Food products, beverages and tobacco	1.9	0.8	2.6	15.5	22.3
Textiles, textile products, leather and footwear	17.7	12.8	0.6	6.6	13.8
Wood and products of wood and cork	1.3	0.8	2.9	16.4	22.1
Paper products and printing	1.2	1.3	2.1	11.0	15.8
Coke and refined petroleum products	0.2	0.1	2.4	14.2	20.5
Chemical and chemical products	3.2	3.1	2.7	12.7	17.7
Pharmaceuticals, medicinal and botanical products	1.3	0.5	0.0	0.1	0.1
Rubber and plastics products	3.7	3.6	2.2	10.9	15.1
Other non-metallic mineral products	2.4	1.7	2.1	12.3	17.4
Basic metals	1.0	0.9	8.8	22.4	24.5
Fabricated metal products	3.8	4.1	3.4	15.0	20.0
Computer, electronic and optical equipment	29.0	36.3	2.0	8.1	11.2
Electrical equipment	9.1	8.9	3.9	14.9	18.8
Machinery and equipment, nec	6.9	7.3	6.1	18.3	22.3
Motor vehicles, trailers and semi-trailers	4.2	3.2	4.7	19.3	24.7
Other transport equipment	0.8	0.7	7.2	20.5	24.0
Furniture and other manufacturing	11.7	13.3	1.1	7.1	11.0

Sources: OECD ICIO, US Census, Fajgelbaum et al. (2020).
Notes: "Imports in Total" is an industry's share in total US imports from China. Aggregation of tariff changes from HS6 to ISIC4 2-digit level uses import weights calculated from the US Census data.

Table E.4: Retaliatory Tariff Increases on US Exports to China

	2017 Exports in Total (%)		Cumulative Increases in Tariffs (%)		
Industry	OECD ICIO	US Census	2018	2019	2020–
Agriculture, forestry and fishing	14.7	15.1	11.9	31.1	31.3
Mining and quarrying	7.7	7.0	3.5	11.2	14.0
Food products, beverages and tobacco	4.2	2.8	10.4	19.9	21.0
Textiles, textile products, leather and footwear	0.4	0.9	2.5	12.1	15.3
Wood and products of wood and cork	1.5	1.5	2.7	12.9	16.3
Paper products and printing	2.0	2.5	2.1	7.7	8.8
Coke and refined petroleum products	2.6	1.0	10.2	26.0	26.0
Chemical and chemical products	10.6	9.6	3.7	12.5	14.3
Pharmaceuticals, medicinal and botanical products	2.5	2.8	0.3	1.6	2.7
Rubber and plastics products	1.4	1.3	2.3	10.0	12.4
Other non-metallic mineral products	0.6	0.8	4.0	13.7	15.8
Basic metals	10.7	1.9	4.1	15.4	18.9
Fabricated metal products	1.2	1.4	2.5	10.9	13.3
Computer, electronic and optical equipment	10.4	13.8	2.4	9.3	11.2
Electrical equipment	1.4	2.5	3.8	15.8	19.4
Machinery and equipment, nec	6.0	8.0	2.1	9.1	11.1
Motor vehicles, trailers and semi-trailers	8.6	11.0	10.5	21.5	21.7
Other transport equipment	12.4	13.3	0.0	0.1	0.1
Furniture and other manufacturing	1.1	2.8	4.1	12.8	14.2

Sources: OECD ICIO, US Census, Fajgelbaum et al. (2020).
Notes: "Exports in Total" is an industry's share in total US exports to China. Aggregation of tariff changes from HS6 to ISIC4 2-digit level uses export weights calculated from the US Census data.