Why is Trade Not Free? A Revealed Preference Approach*

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Abstract

A prominent explanation for why trade is not free is politicians' desire to protect some of their constituents at the expense of others. In this paper we develop a methodology that can be used to reveal the welfare weights that a nation's import tariffs implicitly place on different groups of society. Applied in the context of the United States in 2017, this method implies that redistributive trade protection accounts for a significant fraction of US tariff variation and causes large monetary transfers between US individuals, mostly driven by differences in welfare weights across sectors of employment. Perhaps surprisingly, differences in welfare weights across US states play a much smaller role.

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1 Introduction

International trade is decidedly not free. Countries around the world routinely impose tariffs and other barriers to trade. One prominent explanation for why they do is redistributive politics. Even if trade restrictions reduce the size of the pie, they can increase the slice received by some at the expense of others.

The existing literature on the political economy of trade policy reviewed in Rodrik (1995), Gawande and Krishna (2003), and McLaren (2016) is rich with theories explaining why politicians may choose to favor particular constituents of society. Direct democracy may lead politicians to cater to the median voter; competition for electoral-college votes, as in a US presidential election, may bias their preferences towards swing-state voters; and lobbying activities may give a disproportionate weight to politically-organized sectors. In each of these theories, a fully-specified political process is combined with a typically stylized economic environment to generate predictions about the structure of trade protection. Empirical work, in turn, can test whether such specific predictions hold in practice. The influential tariff formula arising from Grossman and Helpman's (1994) protection for sale model and its subsequent test by Goldberg and Maggi (1999) embodies this canonical approach.[1]

In this paper, we propose an alternative approach, grounded in the logic of revealed preference. It is designed to flexibly identify the welfare weights that a nation's import tariffs implicitly place on different members of society, i.e. who the politically-favored are, without imposing any a priori restrictions on the reasons for such favoritism. When implemented in the context of the United States in 2017, our analysis implies that the redistributive motive for trade protection accounts for a large fraction of tariff variation and causes large monetary transfers between US individuals, mostly driven by differences in welfare weights across sectors of employment. Perhaps surprisingly, differences in welfare weights across states play a much smaller role.

The starting point of our revealed-preference approach is a general tariff formula that only relies on the assumption that trade taxes are set via some political process that is constrained Pareto efficient. That is, we assume that, given available policy instruments, politicians' incentives are such that there does not exist a change in trade taxes that could strictly increase the utility of some of their domestic constituents without strictly decreasing the utility of others—a mild requirement satisfied by leading political-economy models, as we discuss further below. For any such political process, our general tariff formula

[1] A non-exhaustive list of empirical papers testing the predictions of Grossman and Helpman (1994) and various extensions of the original "protection for sale" model includes Gawande and Bandyopadhyay (2000), Mitra et al. (2002), Matschke and Sherlund (2006), Bombardini (2008), and Gawande et al. (2009).

states that, for any good g, trade taxes t_g must satisfy

$$t_g = -\sum_n \beta(n) \times \frac{\partial[\omega(n) - \bar{\omega}]}{\partial m_g} + \text{Residual}_g, \tag{1}$$

where the derivative $\partial[\omega(n) - \bar{\omega}]/\partial m_g$ denotes the marginal change in the real earnings of a given individual n, relative to the average earnings change in the population, associated with a marginal increase in the (net) imports m_g of good g. The term $\beta(n)$ denotes the social marginal return of a transfer to individual n that Home's trade policy-making process arrives at, whatever is the underlying process that causes it to "choose" this particular point on the economy's Pareto frontier. Finally, Residual_g captures the effects of non-redistributive motives for protection, namely terms-of-trade manipulation and second-best corrections for distortions, which we also fully characterize.

Empirically, we propose to treat our general tariff formula (1) as a regression equation in which the dependent variable is the trade tax t_g, the regressors are $\{\partial[\omega(n) - \bar{\omega}]/\partial m_g\}$, and the coefficients of interest are (minus) the vector of welfare weights $\{\beta(n)\}$. Intuitively, the choice of a higher tariff on a given good g reveals a stronger preference of society for the individuals whose real income would have been more negatively affected by a marginal increase in good g's imports. Because the estimated welfare weights are valid regardless of the underlying political process that gives rise to them, our revealed-preference approach highlights a natural division of labor in the study of how distributional forces can lead to protectionism. First, we can draw on the vast body of recent work on the general-equilibrium impact of trade, in general, and trade policy, in particular, on earnings and prices in order to construct empirically credible measures of $\{\partial[\omega(n) - \bar{\omega}]/\partial m_g\}$. And second, given the estimated welfare weights, we can go on to evaluate the importance of the redistributive motive for trade policy and explore its political determinants.

We apply our general formula to study the redistributive motive embedded in the trade policy of the United States in 2017—that is, before the changes introduced in 2018 by the Trump administration. To measure $\partial[\omega(n) - \bar{\omega}]/\partial m_g$, we develop a quantitative model of the US economy that features heterogeneous exposure to international trade across US regions and sectors, both directly via exports and imports and indirectly via input-output and domestic trade linkages. Following Fajgelbaum et al. (2020), we model the rest of the world as a series of import demand and export supply curves whose elasticities are estimated from the variation in the prices and quantities of US exports and imports induced by the 2018 tariff changes. We calibrate other model parameters to match available data on trade and production across sectors and states in 2017. This economic model yields estimates of $\{\partial[\omega(n) - \bar{\omega}]/\partial m_g\}$ for all US individuals based on their region and sector of employment, and for thousands of country-product varieties g. Critically, these model-implied estimates are consistent with the differential response of earnings across US regions and sectors to the tariff changes observed during the US-China trade war, as we establish using the testing procedure of Adao et al. (2023).

Armed with estimates of $\{\partial[\omega(n) - \bar{\omega}]/\partial m_g\}$ as well as measures of import tariffs t_g for the United States in 2017, we turn to the estimation of the welfare weights using equation (1). The key assumption in our implementation is that after controlling for a subset of non-redistributive motives for trade protection, such as terms-of-trade manipulation, our measures of the economic return from imports $\{\partial[\omega(n) - \bar{\omega}]/\partial m_g\}$ are orthogonal to the other motives left in Residual_g, such as the correction of domestic distortions. This rules out, for instance, the possibility that import restrictions on goods that favor a subset of individuals also systematically alleviate or worsen externalities due to carbon emissions, since measures of such motives will not be included in our control set.

Our baseline estimates reveal that US individuals employed in different sectors and states differ substantially in their welfare weights, with a long upper tail. They imply that, from society's perspective, a hypothetical \$1 received by an individual at the 90th, 95th, and 99th percentiles of our estimates are equivalent to \$1.08, \$1.53, and \$1.91, respectively, received by an individual at the 10th percentile. These differences are mostly driven by a large dispersion in sector-specific welfare weights, with the dispersion in state-specific welfare weights playing only a minor role. Individuals employed in the three sectors with highest welfare weights, Apparel, Textiles and Metals, have a social marginal utility of income that is 450% higher than the average across all US individuals. In contrast, the social marginal utility of income enjoyed by individuals in Idaho, the state with the highest welfare weight, is only 8% higher than in West Virginia, the state with the lowest welfare weight.

Reassuringly, our baseline estimates are highly correlated with those obtained from a battery of alternative specifications meant to deal, in a theory-consistent way, with the existence of non-tariff measures, domestic taxes, and constraints on US tariffs (such as those due to WTO membership). They are also highly correlated with estimates that account for the presence of reverse causality between tariffs and imports, that allow for censoring of tariffs at zero, and that let welfare weights depend on other demographic characteristics, such as education, gender, and race.

We conclude by using our estimated welfare weights to quantify the importance of redistributive trade policy in the United States and shed light on its primitive determinants. A number of novel insights emerge. First, the redistributive motive accounts for a significant share of the cross-sectional variation in US tariffs: 30% in 2017, out of which 27% derives from sector-specific welfare weights and 3% from state-specific ones. Second, the monetary transfers associated with redistributive trade protection are large. Transitioning to a counterfactual US economy with welfare weights equalized across individuals—and so tariffs purged of their redistributive component—would shift roughly $2,400 per worker annually from region-sector pairs corresponding to the top decile of our estimated welfare weights to those at the bottom decile. Finally, high trade-lobbying sectors are clear winners from redistributive trade protection. They receive almost $5,000 per worker annually, despite spending less than $100 per worker annually on lobbying. Transfers associated with living in a swing state are an order of magnitude smaller.

Related Literature

This paper combines central ideas from the public finance and international trade literatures to shed new light on the nature and importance of redistributive trade protection.

In existing work on the political economy of trade policy, it is standard to commit to a specific model of the political process that generates specific welfare weights, $\beta(n)$. In Grossman and Helpman's (1994) protection for sale model and its numerous extensions, $\beta(n)$ may only take two values depending on whether or not individual n is employed in a sector that is politically organized or not. Our approach proposes to relax such a priori restrictions. From the public finance literature, we borrow the general idea of using observed taxes to flexibly estimate welfare weights, as in, for instance, Werning (2007), Bourguignon and Spadaro (2012), and Jacobs et al. (2017).[2] Given estimates of the redistributive impact of import restrictions, $\{\partial[\omega(n) - \bar{\omega}]/\partial m_g\}$, we ask: Which goods tend to face higher tariffs t_g? Assuming that redistributive motives are orthogonal to other motives, at least after controlling for a subset of them, the slope of a regression of the latter on the former identifies welfare weights.[3]

Flexibly estimating welfare weights presents several advantages. First, it allows us to evaluate the overall importance of redistributive trade protection, either in terms of shaping the variation in tariffs across different goods or generating income transfers across individuals. To the best of our knowledge, these numbers have no counterparts in the ex-

[2] All three papers focus on income taxes to infer welfare weights at different quantiles of the income distribution. In related work, Fajgelbaum et al. (2023) use proposals for California's High-Speed Rail system to infer policymakers' preferences for location-based redistribution.

[3] In abstracting from the details of the political process and focusing on the associated welfare weights, our analysis also relates to Baldwin (1987) who stresses the equivalence between tariffs chosen by lobbying-influenced policy makers and those maximizing a social welfare function with extra weight on profits.

isting trade literature.[4] Second, although we do not model the political process through which tariffs come about, the gaps in the social marginal utility of income between different individuals that we estimate offer natural moments to discriminate between existing political theories, in the same way that "wedges" in the misallocation literature may help identify economic distortions (see e.g. Chari et al., 2007 and Hsieh and Klenow, 2009).

From a theoretical standpoint, our general tariff formula also builds on the type of necessary first-order condition that is common in the public finance literature on optimal commodity taxation, e.g. Diamond and Mirrlees (1971) and Greenwald and Stiglitz (1986). All that is required for our analysis to apply is for politically-chosen trade taxes to be constrained Pareto-efficient, a standard property satisfied by numerous political-economy models in the trade literature, including those featuring direct democracy (as in Mayer, 1984), political contributions by special interests (as in Magee et al., 1989, Grossman and Helpman, 1994, and Dixit et al., 1997), or electoral competition for congressional seats or electoral-college votes (as in Ma and McLaren, 2018). The structure of our formula is most closely related to Costinot and Werning (2023) who also express the optimal tariff on each good as a function of the marginal impact of its imports on a few key sufficient statistics. This provides a Pigouvian perspective on the determinants of trade protection. Pigouvian taxation calls for taxes on any economic activity whose effect on social welfare is not internalized by those directly involved in that activity. We apply this general principle to importing activities, regardless of whether what fails to be internalized is an increase in pollution (as in Markusen, 1975, Kortum and Weisbach, 2021 and Hsiao, 2022), psychosocial costs (as in Grossman and Helpman, 2021), an aggravation of output distortions under imperfect competition (as in Helpman and Krugman, 1989), a change in international prices leading to deteriorated terms of trade (as in de V. Graaff, 1949-1950, Grossman and Helpman, 1995, and Bagwell and Staiger, 1999), or, as is the focus of our empirical analysis, a change in domestic prices redistributing income away from individuals with higher social marginal utility.

From an empirical standpoint, a striking feature of previous work concerning the political economy of trade policy—as reviewed in Rodrik (1995), Gawande and Krishna (2003), and McLaren (2016)—is the limited extent to which it draws on advances in trade modeling and empirical estimation of causal responses of labor market outcomes to trade

[4] As part of his evaluation of the gains from global trade policy coordination, we note that Ossa (2014) does incorporate redistributive trade protection. From a methodological standpoint, he identifies welfare weights across sectors by exactly matching the variation in tariffs across broad sector categories, under the assumption that there is no residual motive for those. In contrast, our approach uses granular tariff variation to estimate differences in welfare weights across both sectors and states under the assumption that redistributive and non-redistributive motives for tariffs are orthogonal.

policy—as reviewed in Goldberg and Pavcnik (2016), Ossa (2016), and Caliendo and Parro (2022). Despite the fact that the existence of heterogeneous causal impacts of changes in imports on earnings is the primary rationale for trade protection in the political economy literature, modern understanding of such impacts is not actually used when attempting to infer the reasons for protectionism. Theoretical tractability rather than empirical credibility drives the way earnings are implicitly assumed to respond to trade protection. In contrast, we infer these responses using a rich quantitative model designed to harness the substantial heterogeneity in exposure to trade across the US population, and then validate our model's predictions against the estimated causal response of US labor markets to the US-China trade war.

2 A General Tariff Formula

The goal of this section is to characterize the structure of Pareto efficient trade taxes. We do so via a general tariff formula that features three generic motives for trade policy: (*i*) redistribution, which will be the main focus of our empirical analysis; (*ii*) terms-of-trade manipulation, which will be controlled for in our regressions; and (*iii*) distortions, which will be treated as a structural residual.

2.1 Environment

We focus on a single country, Home, that can trade with the rest of the world subject to its preferred trade taxes. Home comprises many firms $f \in \mathcal{F}$ and individuals $n \in \mathcal{N}$. Firms and individuals can produce and consume goods $g \in \mathcal{G}$. Goods encompass final goods, intermediate inputs, as well as labor and other primary factors. Both production and consumption may be subject to externalities $z \equiv \{z_k\}$ to be described further below.

Domestic Technology. Firm f's technology is described by a production set $\Upsilon(z; f)$. A production plan consists of a net output vector $y(f) \equiv \{y_g(f)\}$. It is feasible if

$$y(f) \in \Upsilon(z; f).$$

Domestic Preferences. A consumption plan for individual n consists of a vector of goods demanded $c(n) \equiv \{c_g(n)\}$. It delivers utility

$$u(n) = u(c(n), z; n).$$

Prices, Taxes, and Transfers. International transactions are subject to specific trade taxes $t \equiv \{t_g\} \in \mathcal{T}$. Trade taxes create a wedge between the prices $p \equiv \{p_g\}$ faced by domestic firms and individuals and the prices $p^w \equiv \{p_g^w\}$ in the rest of the world. For any good g that is traded between Home and the rest of the world,

$$p_g = p_g^w + t_g. \tag{2}$$

If a good g is imported, $t_g \geq 0$ corresponds to an import tariff, while $t_g \leq 0$ corresponds to an import subsidy. If good g is exported, $t_g \geq 0$ corresponds to an export subsidy, while $t_g \leq 0$ corresponds to an export tax. Trade taxes on a given good are either unrestricted, $t_g \in \mathbb{R}$, or restricted to be zero, $t_g \in \{0\}$. For instance, Home's government may be unable to tax imports of services, for technological reasons, or prohibited from imposing export taxes, for constitutional reasons. We let $\mathcal{G}^T$ denote the set of goods that can be taxed.[5] Tax revenues are rebated to domestic individuals through a uniform lump-sum transfer τ.

Foreign Offer Curve. We summarize trade with the rest of the world by an offer curve $\Omega(p^w, z)$. For given foreign prices p^w, it describes the vector of Home's net imports $m \equiv \{m_g\}$ that the rest of the world is willing to export. A vector of net imports is feasible if

$$m \in \Omega(p^w, z). \tag{3}$$

Externalities. For a given domestic allocation $\{y(f), c(n)\}$, a vector of net imports m, and a vector of domestic and foreign prices (p, p^w), the vector of externalities satisfies

$$z \in \mathcal{Z}(\{y(f), c(n)\}, m, p, p^w). \tag{4}$$

This accommodates financial frictions and knowledge spillovers that affect firms' production sets $Y(z; f)$, carbon emissions that may affect both firms' technologies and individuals' utilities $u(c(n), z; n)$, as well as psychosocial costs that may only affect the latter, as in recent models of identity politics.

[5] Although the choice of numeraire never appears explicitly in our analysis, the numeraire good, whose trade tax can be normalized to zero, is always implicitly excluded from $\mathcal{G}^T$. This convention explains why indeterminacy of trade taxes due to Lerner symmetry plays no role in Proposition 1 below.

2.2 Competitive Equilibrium

Profit Maximization. Each firm f chooses its vector of net output $y(f)$ to solve

$$\max_{y \in \Upsilon(z;f)} p \cdot y, \tag{5}$$

where the dot product $\cdot$ refers to the inner product, $p \cdot y = \sum_g p_g y_g$. We let $\pi(p, z; f)$ denote the value function associated with (5), i.e. the profits of firm f, expressed as a function of the domestic prices p and the externalities z.

Utility Maximization. Each individual n chooses her vector of consumption $c(n)$ to solve

$$\max_c u(c, z; n) \tag{6}$$
$$\text{subject to: } p \cdot c = \pi \cdot \phi(n) + \tau,$$

where $\pi \equiv \{\pi(p, z; f)\}$ is the vector of firms' profits and $\phi(n) \equiv \{\phi(f, n)\}$ is the vector of firms' shares held by individual n. Endowments of goods or factors by individual n correspond to her fully owning simple firms with production sets given by a singleton, as will be the case in the next section. Below we let $y(n) \equiv \{\sum_{f \in \mathcal{F}} y_g(f)\phi(f, n)\}$ denote the vector of output associated with individual n, $\mu(n)$ denote the Lagrange multiplier associated with her budget constraint, and $e(p, z, u; n) \equiv \min_c\{p \cdot c | u(c, z; n) \geq u\}$ denote her expenditure function.

Market Clearing and Government's Budget Balance. Total demand by domestic individuals equals total supply by domestic firms and total exports from the rest of the world,

$$\sum_{n \in \mathcal{N}} c(n) = \sum_{f \in \mathcal{F}} y(f) + m. \tag{7}$$

Finally, the budget constraint of the domestic government is

$$t \cdot m = N\tau, \tag{8}$$

where N is the total number of individuals at Home.

Competitive Equilibrium. We are now ready to define a competitive equilibrium.

Definition 1. *A competitive equilibrium with trade taxes $t \in \mathcal{T}$ is a vector of domestic and* *foreign prices (p, p^w), a vector of net imports m, a vector of externalities z, a domestic allocation $\{y(f), c(n)\}$, and a transfer τ such that: (i) (p, p^w) satisfy (2); (ii) m satisfies (3); (iii) z satisfies (4); (iv) $y(f)$ solves (5) for all $f \in \mathcal{F}$; (v) $c(n)$ solves (6) for all $n \in \mathcal{N}$; (vi) all markets clear, as described in (7); and (vii) the government's budget is balanced, as described in (8).*

2.3 Pareto-Efficient Trade Taxes

It is standard in the literature on the political economy of trade policy to model explicitly various features of the political process, from the nature of electoral competition to the possibility of lobbying. We propose instead to remain agnostic about these considerations and only require that trade taxes be (constrained) Pareto-efficient.

Definition 2. *A vector of trade taxes t^* is Pareto-efficient if there exists an individual n_0 and a vector of utility $\{\underline{u}(n)\}_{n \neq n_0}$ such that t^* solves*

$$\begin{aligned} &\max_{t \in \mathcal{T}} \max_{\{u(n)\}} \; u(n_0) \\ &\text{subject to: } u(n) \geq \underline{u}(n) \text{ for } n \neq n_0, \\ &\qquad \{u(n)\} \in \mathcal{U}(t), \end{aligned}$$

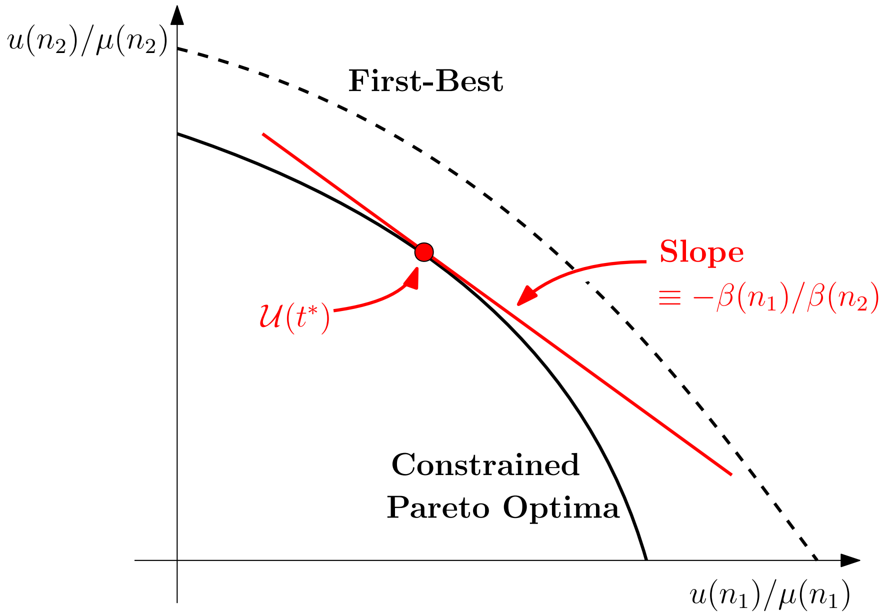
where $\mathcal{U}(t)$ is the set of utility profiles attainable in a competitive equilibrium with trade taxes t.

In our analysis, the different utility levels $\{\underline{u}(n)\}$ implicitly reveal the relative importance of various political forces, such as voters from some US states being more likely to be pivotal in presidential elections or firms from some industries being more likely to lobby. We let $\nu(n)$ denote the Lagrange multiplier associated with the utility constraint of individual n, with the convention $\nu(n_0) = 1$. Hence the social marginal utility of n's income is $\lambda(n) \equiv \mu(n)\nu(n)$, the average social marginal utility of income is $\bar{\lambda} \equiv \sum_{n \in \mathcal{N}} \lambda(n)/N$, and the social marginal return of a hypothetical lump-sum transfer to individual n is $\beta(n) \equiv \lambda(n)/\bar{\lambda}$. Figure 1 illustrates how the choice of Pareto-efficient trade taxes $t^* \in \mathcal{T}$ implicitly reveals those social marginal returns.

To characterize Pareto efficient trade taxes, it is convenient to treat equilibrium variables as functions of the vector of taxable imports $m^T \equiv \{m_g\}_{g \in \mathcal{G}^T}$ rather than the vector of trade taxes $t \in \mathcal{T}$.[6] Under this convention, the vectors of partial derivatives

[6] Formally, if $\tilde{x}(t)$ denotes the equilibrium value of a variable x as a function t, then the function of imports $x(m)$ that we consider is defined as $x(m^T) \equiv \tilde{x}(t^{-1}(m^T))$, with $t^{-1}(m^T)$ the vector t that solves: $\tilde{m}_g(t) = m_g$ for all $g \in \mathcal{G}^T$. Throughout we assume that, local to the observed equilibrium, the inverse $t^{-1}(m^T)$ exists and is unique. We view this as a mild requirement that rules out extreme environments, such as those where preferences over net imports are Leontief and so multiple vector of trade taxes t may be associated with the same import vector m^T.

Figure 1: Pareto-efficient trade taxes



Notes: This figure plots the constrained Pareto frontier (solid line) between two individuals n_1 and n_2 that obtains as one varies the trade taxes $t \in \mathcal{T}$ applied in a competitive equilibrium. The slope of the constrained Pareto frontier at the chosen trade taxes t^* reveals the ratio of social marginal returns $\beta(n_1)/\beta(n_2)$. The first-best frontier (dashed line) is the set of Pareto optima that would arise if only technological and resource constraints applied. Due to the presence of externalities, the two frontiers may not be tangent.

$\partial p/\partial m_g$, $\partial p^w/\partial m_g$, and $\partial z/\partial m_g$ then refer to the changes in domestic prices, foreign prices, and externalities, respectively, associated with whatever change in trade taxes induces a marginal increase in the net imports of any given good $g \in \mathcal{G}^T$, holding fixed the imports of all other goods in $\mathcal{G}^T$. In particular, let $\partial\omega(n)/\partial m_g \equiv [y(n) - c(n)] \cdot (\partial p/\partial m_g)$ denote the change in individual n's real income caused by the increase in net imports of good g via its impact on domestic prices p; let $\partial\bar{\omega}/\partial m_g \equiv \sum_{n\in\mathcal{N}}[\partial\omega(n)/\partial m_g]/N$ denote its average across the population; and let $\partial(\omega - \bar{\omega})/\partial m_g \equiv \{\partial(\omega(n) - \bar{\omega})/\partial m_g\}$ denote the vector of deviations from the average.

Our main proposition shows how the previous statistic, together with the changes in foreign prices $\partial p^w/\partial m_g$ and externalities $\partial z/\partial m_g$, shapes Pareto efficient trade taxes.

Proposition 1. *Pareto efficient trade taxes satisfy*

$$t_g^* = \underbrace{-\beta \cdot \frac{\partial(\omega - \bar{\omega})}{\partial m_g}}_{\textit{redistribution}} + \underbrace{m \cdot \frac{\partial p^w}{\partial m_g}}_{\textit{terms-of-trade}} + \underbrace{\epsilon \cdot \frac{\partial z}{\partial m_g}}_{\textit{distortions}} \quad \textit{for all } g \in \mathcal{G}^T, \tag{9}$$

where $\beta \equiv \{\beta(n)\}$ denotes the social marginal returns of transfers to different individuals; and

$\epsilon \equiv \sum_{n \in \mathcal{N}} \beta(n)[e_z(n) - \pi_z(n)]$ denotes the social marginal cost of externalities, with $e_z(n) \equiv \{\partial e(p, z, u(n); n)/\partial z_k\}$ and $\pi_z(n) \equiv \{\sum_{f \in \mathcal{F}} \phi(f, n) \partial \pi(p, z; f)/\partial z_k\}$.

Proposition 1 derives from the following necessary first-order condition,

$$-t^* \cdot dm = \beta \cdot d(\omega - \bar{\omega}) - m \cdot dp^w - \epsilon \cdot dz.$$

It states that at a constrained Pareto optimum, the marginal cost of any tax change in terms of fiscal revenues, $-t^* \cdot dm$, should be equal to its marginal benefit in terms of redistribution, $\beta \cdot d(\omega - \bar{\omega})$, and allocative efficiency, $-m \cdot dp^w - \epsilon \cdot dz$. Equation (9) then specializes this condition to changes in trade taxes that only affect the imports of a single good $g \in \mathcal{G}^T$, as shown in Appendix A.1. According to our general tariff formula, there are three broad reasons why Home's government may want to tax the net imports of a given good g.

First, restricting net imports may affect real incomes via changes in domestic prices. Thus, a government may engineer as-if transfers from individuals with low social marginal return (i.e. a low $\beta(n)$) towards individuals with high social marginal return (i.e. a high $\beta(n)$). This is the redistributive motive captured by the first term, $-\beta \cdot \partial(\omega - \bar{\omega})/\partial m_g$, which will be at the core of our empirical analysis. Note that the redistributive motive is zero if $\partial(\omega - \bar{\omega})/\partial m_g = 0$, which occurs if changes in imports do not differentially affect real earnings in the population, or if $\beta(n) = 1$ for all n, which occurs if individuals have identical quasi-homothetic preferences and Home's government is utilitarian, a standard benchmark in the trade literature.

Second, restricting net imports may lower Home's import prices and increase its export prices. This is the terms-of-trade motive captured by the second term, $m \cdot \partial p^w/\partial m_g$, which we will use as a control in our main specification. As usual, this second term is zero in the case of a small open economy that may manipulate domestic prices p, but not foreign prices p^w. Note that given our change of variables, the terms-of-trade motive takes a particularly simple form in equation (9). It is akin to the classical optimal tariff formula that obtains in a two-good environment—in which the optimal tariff is equal to the inverse of the elasticity of the foreign export supply curve—despite the fact that we impose no restrictions on the number of goods (nor on preferences and technology).

Third, restricting net imports may reduce negative externalities or raise positive ones. This is the typical second-best motive for trade protection captured by the third term, $\epsilon \cdot \partial z/\partial m_g$. Again, due to our change of variables, this third motive can be expressed in an intuitive manner as the sum of the marginal change in distortionary activities caused by one extra unit of import of good g, each multiplied by the social cost of that activity.

In a competitive equilibrium, domestic individuals and firms do not internalize any of the three previous considerations. Following a general Pigouvian logic, the optimal trade tax on a given good g requires them to pay, at the margin, for the potential negative impact of that good's imports on social welfare, a perspective emphasized in Costinot and Werning (2023). This is true regardless of whether import restrictions may affect social welfare via redistribution or efficiency considerations.

2.4 Extensions

Below we will use Proposition 1 to estimate the role played by the redistributive motive for trade protection. Before we do so, we discuss its robustness to a number of considerations from which we have abstracted. Formal proofs can be found in Appendix A.2.

Other Policy Instruments. While the economic environment considered in Section 2.1 is general along many dimensions, it restricts the policy instruments available to the domestic government to specific trade taxes. As is well-known, the restriction to specific rather than ad-valorem trade taxes is without loss of generality under perfect competition. The critical assumption is that the government can create a wedge between foreign prices p^w—which affect the decision of foreigners via (3)—and domestic prices p—which affect the decisions of domestic firms and individuals via (5) and (6). The specific or ad-valorem nature of the trade tax through which the wedge comes about is irrelevant.

In practice, a government may also choose to restrict trade flows via various non-tariff measures, from product standards to anti-dumping duties. If such barriers do not generate fiscal revenues, as would be the case for product standards, then Proposition 1 is unchanged. That is, the existence of standards may affect the particular values of the sufficient statistics entering equation (9), but not the fact that equation (9) must continue to hold.[7] If instead non-tariff measures act as another trade tax, as would be the case for anti-dumping duties, then the associated fiscal externalities should be accounted for, as shown in equation (A.6).

The same issue arises more broadly in the presence of domestic taxes, such as producer taxes, that may have also been used to help achieve the government's redistributive objectives. For our estimates of β to be unbiased, fiscal externalities associated with these taxes, if any, should either be orthogonal to the changes in real earnings associated with

[7] Similarly, tariffs that are conditional on the use of production techniques, such as the rules-of-origin restrictions that often appear in trade agreements (Conconi et al., 2018), can be handled by defining goods on the basis of such techniques.

different goods or explicitly controlled for in our regressions, as can be seen from equation (A.13).[8] In the presence of income taxes, one should further take into account how domestic taxes affect the ultimate incidence of transfers engineered by trade restrictions. Specifically, changes in real earnings should be adjusted by the marginal income tax rates faced by each individual, as can also be seen from equation (A.13).

Constrained Trade Taxes. A government may be unable to set all trade taxes freely. Tariffs on some goods may be fixed at some exogenous level due to prior trade agreements or they may be constrained to be constant across subsets of goods—for instance, they may be prohibited from varying across goods from different origin countries. In the former case, the existence of non-zero, but fixed trade taxes implies another source of distortions due to fiscal externalities, as changes in the subset of trade taxes controlled by the government may now also affect the fiscal revenues generated by exogenous trade taxes on other goods, as described in equation (A.14). In the latter case, Proposition 1 continues to hold provided that marginal changes in imports are aggregated at the level at which trade taxes can vary, e.g. total imports of a given product from all WTO countries in the case of the most-favored-nation (MFN) clause, as also shown in equation (A.14).

Negotiated Trade Taxes. The tariff formula in Proposition 1 hinges on a strict dichotomy between domestic individuals, whose utility the domestic government takes into account when setting trade taxes, and foreigners, who are absent from the government's problem in Definition 2. In practice, various rounds of trade negotiations and bargaining may lead governments to, at least partly, internalize the impact of their preferred trade taxes on foreigners' welfare. Accordingly, it is common in the trade literature to model negotiated tariffs, such as those arising from GATT negotiations, as Pareto efficient from a world standpoint (e.g. Bagwell and Staiger, 2002).

From the point of view of Home, the only difference between the structure of Pareto efficient trade taxes that we consider and those that would arise from "trade talks" derives from the treatment of the terms-of-trade motive, $m \cdot \partial p^w / \partial m_g$ in equation (9). Under the assumption that the domestic government takes into account the aggregate real

[8] In theory, not controlling for such considerations may lead to severe omitted variable bias. Consider, for instance, the case of a small open economy in which individuals have identical quasi-homothetic preferences and there are no distortions. If the domestic government can freely choose producer taxes t^y in this environment, then it will set the fiscal externality associated with producer taxes, $t^y \cdot \partial y^{\text{total}} / \partial m_g$, to be exactly equal to the redistributive term, $-\beta \cdot \partial(\omega - \bar{\omega}) / \partial m_g$. According to equation (A.13), one would therefore observe $t^* = 0$ and wrongly infer from equation (9) that $\beta = 0$. We thank Bob Staiger for suggesting this example. In practice, though, we note that producer taxes are seldom used relative to trade taxes (see e.g. Rodrik, 1995 for an early discussion).

income of foreigners, the coefficient in front of $m \cdot \partial p^w / \partial m_g$ is now equal to $1 - \lambda_F / \bar{\lambda}$ instead of 1, with λ_F the social marginal utility (still from the point of view of Home's government) of foreigners' income. The general logic behind our formula is unchanged. The key observation is that Home's government now not only values redistribution towards various domestic individuals, as reflected in $-\beta \cdot \partial(\omega - \bar{\omega})/\partial m_g = \sum_{n \in \mathcal{N}} (1 - \lambda(n)/\bar{\lambda})(\partial \omega(n)/\partial m_g)$, but also redistribution towards foreigners, as reflected in $(1 - \lambda_F/\bar{\lambda})(\partial \omega_F / \partial m_g)$, with $\partial \omega_F / \partial m_g \equiv m \cdot \partial p^w / \partial m_g$ the change in foreigners' real income. Since some of the tariffs that we consider in our empirical analysis have been negotiated, we will allow the coefficient in front of the terms-of-trade motive, $m \cdot \partial p^w / \partial m_g$, to differ from 1 in our baseline regressions. More generally, if Home places different weights on different foreign countries indexed by i (perhaps due to preferential trade agreements), this can be allowed for by controlling more flexibly for separate terms, $m(i) \cdot \partial p^w / \partial m_g$, where $m(i)$ denotes the net imports from country i, as shown in equation (A.17).[9]

Other Distortions. We conclude by noting that Proposition 1 assumes that the only source of distortions is externalities in an otherwise perfectly competitive environment. In Appendix A.2, we show how general distortions due to imperfect competition may be incorporated in our tax formula. Since this formula reflects a necessary first-order condition, this new source of distortions enters additively, as the extra social cost of firms' output distortions, as shown in equation (A.21). In the case where firms only produce a single good and the social marginal utility of income is equalized across individuals, this is simply equal to the change in the final output of the firm multiplied by the difference between its price and marginal cost, as is standard in the literature on misallocation. For our purposes, it is enough to note that such extra considerations would appear as part of our structural residual and would only matter to the extent that they are systematically correlated with changes in real earnings $\partial(\omega - \bar{\omega})/\partial m_g$.

3 Measuring the Sensitivity of Real Earnings to Imports

The goal of our empirical analysis is to use equation (9) to go from observed US trade taxes t to the welfare weights β and, in turn, to explore the importance and nature of

[9]A similar observation applies to changes in foreign welfare due to redistribution among foreign individuals from the same country. If Home places different weights on different individuals n located in i (perhaps due to political forces in i influencing its trade negotiations with Home, as in Grossman and Helpman, 1995), then controls may be further broken down into $m(i,n) \cdot \partial p^w / \partial m_g$, with $m(i,n) \equiv c(i,n) - y(i,n)$ the net imports of foreign individual n. This is equally straightforward in theory, though disaggregated data on $m(i,n)$ would now have to be collected for all relevant foreign countries.

redistributive trade protection. Doing so requires measures of the sensitivity of real earnings to the imports of any given good g, $\partial(\omega - \bar{\omega})/\partial m_g$, holding constant the imports of all other goods. Direct estimation without a priori restrictions would require estimating as many derivatives $\partial(\omega(n) - \bar{\omega})/\partial m_g$ as there are individual-good pairs (n, g) in the US, which is infeasible. To arrive at such estimates we therefore propose to build a quantitative model of the US economy using a specific version of the general environment from Section 2. We will then demonstrate that this estimated model can successfully account for the causal impact of observed tariff shocks on relative earnings, which raises confidence in the belief that the model can also be used to provide an accurate measure of $\partial(\omega - \bar{\omega})/\partial m_g$.

3.1 A Quantitative Model of the US Economy

The specific environment that we rely on for the rest of our analysis is an extension of the model in Fajgelbaum et al. (2020) (FGKK), which we will calibrate using data from 2017.

Regions, Sectors, Products, and Trade Partners. A domestic individual n may live in one of many regions $r \in \mathcal{R}_H$ and work in one of many sectors $s \in \mathcal{S}$. Given data availability, we take the set of domestic regions $\mathcal{R}_H$ to be the 50 US states, plus the District of Columbia, and the set of sectors $\mathcal{S}$ to be 21 tradable industries based on 3-digit NAICS industries, plus 2 non-tradable sectors. To these 51×23 groups of individuals, we add a "residual" individual whose pattern of (net) expenditure will allow our model to match data from 2017 and whose behavior we hold fixed throughout our analysis.[10]

We let N_{rs} denote the fixed number of individuals living in region r and working in sector s.[11] Each individual is endowed with one unit of equipped labor, which she sells to firms f in that region and sector at a wage w_{rs}.[12] Firms hire labor and buy intermediate goods from other domestic firms and foreigners in order to produce differentiated products $h \in \mathcal{H}_s$, which they sell to foreigners, other domestic firms, and individuals. The set

[10]We also assume that the residual individual's social marginal utility of income is equal to the average in the US population. Hence, its existence does not create any further motive for redistribution. Like exogenous lump-sum transfers in quantitative trade and spatial models, the only role of the residual individual is to rationalize imbalances observed in the data (e.g. between countries or states). This specific modeling choice has little effect on the welfare weights that we estimate, as described in Appendix Figure C.11.

[11]Following FGKK, this specification does not allow for mobility across sectors and regions. As such, it should be thought of an approximation for the short-run impact of tariffs on earnings.

[12]As already discussed in Section 2.1, factor endowments can be interpreted in the context of our general environment as full ownership of simple firms that produce factor services without any additional inputs. Under perfect competition and constant returns to scale, as we assume below, factor endowments will be individuals' only source of income.

of all products $\mathcal{H} \equiv \cup_{s \in \mathcal{S}} H_s$ is based on the 6-digit HS system, resulting in 5,299 products with positive trade in 2017.

Foreigners may be located in one of many countries $i \in \mathcal{R}_F$. We take the set of foreign countries $\mathcal{R}_F$ to be the top 100 US trade partners, plus the rest of the world treated as a single country; the top 100 partners account for 99.0% of US exports and 99.6% of its imports. A good g in the general notation of Section 2 either corresponds to labor from a given region-sector pair (r, s) or to an origin-destination-product triplet (o, d, h), where each origin o and destination d is either a domestic region r or a foreign country i. We let $\mathcal{R} \equiv \mathcal{R}_H \cup \mathcal{R}_F$ denote the set of all locations.

Trade Taxes. In terms of policy instruments, we assume that there are no export taxes or subsidies. The only US trade taxes are specific import tariffs t_{ih} that may vary across foreign origins $i \in \mathcal{R}_F$ and products $h \in \mathcal{H}$.[13] All tariff revenues are rebated uniformly across individuals. Note that since a tradable good g is an origin-destination-product triplet, trade taxes are constrained to be equal across all domestic destinations, i.e. different US regions cannot impose different tariffs. As discussed in Section 2.4, our general formula still holds in this case provided that marginal changes in imports now refer to total changes in Home's imports of product h from country i, $m_{ih} \equiv \sum_{r \in \mathcal{R}_H} m_{irh}$, where m_{irh} denotes bilateral imports to each region $r \in \mathcal{R}_H$, as described in equation (A.14).

Sensitivity of Real Earnings to Imports. For any individual n endowed with one unit of labor from region r and sector s, the change in real earnings associated with an increase in imports of product h from a foreign country i reduces to

$$\frac{\partial \omega(n)}{\partial m_{ih}} = \frac{\partial w_{rs}}{\partial m_{ih}} - \sum_{o \in \mathcal{R}, v \in \mathcal{H}} c_{orv}(n) \frac{\partial p_{orv}}{\partial m_{ih}}, \tag{10}$$

where $c_{orv}(n)$ is the consumption of product v from origin o by individual n from region r in the competitive equilibrium with trade taxes t and p_{orv} denotes the domestic price of that good. The first term on the right-hand side, $\partial w_{rs} / \partial m_{ih}$, is the change in the individual's earnings, whereas the second term, $\sum_{o \in \mathcal{R}, v \in \mathcal{H}} c_{orv}(n)(\partial p_{orv} / \partial m_{ih})$, is the change in her expenditure. Next, we describe the parametric restrictions that we impose on domestic technology, domestic preferences, and foreign offer curves to compute the sensitivity

[13] In practice, the vast majority of import tariffs imposed by the United States are ad-valorem rather than specific. As already discussed in Section 2, there is no loss of generality in focusing on an environment where all import tariffs are assumed to be specific instead. One can always go from the competitive equilibrium with specific tariffs to one with ad-valorem tariffs by letting the specific tariffs be equal to the ad-valorem ones times the price of US imports (pre-tariff) in that equilibrium.

of real earnings to imports in (10), with further details about analytical derivations relegated to the Online Supplement (available on the authors' websites).

3.2 Parametric Restrictions

Our parametric restrictions build on those in FGKK. Production and utility functions are nested CES, with the nesting structure chosen to allow a flexible pattern of substitution across origins, products, and sectors subject to the availability of production and trade data.

Domestic Technology. For each region $r \in \mathcal{R}_H$, destination $d \in \mathcal{R}$, and product $h \in \mathcal{H}_s$ from sector $s \in \mathcal{S}$, there is a representative firm f whose gross output $q(f)$ is

$$q(f) = \theta_{rds}[\ell_{rs}(f)]^{\alpha_s} \prod_{k \in \mathcal{S}} [Q_{rk}(f)]^{\alpha_{ks}}, \tag{11}$$

$$Q_{rk}(f) = \left[\sum_{c=H,F} (\theta^c_{rk})^{\frac{1}{\kappa}} [Q^c_{rk}(f)]^{\frac{\kappa-1}{\kappa}} \right]^{\frac{\kappa}{\kappa-1}}, \tag{12}$$

$$Q^c_{rk}(f) = \left[\sum_{v \in \mathcal{H}_k} (\theta^c_{rkv})^{\frac{1}{\eta}} [Q^c_{rkv}(f)]^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{13}$$

$$Q^c_{rkv}(f) = \left[\sum_{o \in \mathcal{R}_c} (\theta^c_{orkv})^{\frac{1}{\sigma}} [q_{orv}(f)]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{14}$$

where $\ell_{rs}(f)$ denotes labor from region r and sector s used by firm f and $q_{orv}(f)$ denotes its use of intermediate inputs of product v from origin o delivered to region r.[14] As in FGKK, $\kappa \geq 0$ is the elasticity of substitution between domestic consumption and imports, within any given sector; $\eta \geq 0$ is the elasticity of substitution between products, within any of these two nests; and $\sigma \geq 0$ is the elasticity of substitution between different domestic or foreign origins, within any given product. Since we only observe product-level trade flows between domestic regions and foreign countries, but not between pairs of domestic regions, we impose $\theta^H_{rkv} = \bar{\theta}^H_{rk}$ and $\theta^H_{orkv} = \bar{\theta}^H_{ork}$. Finally, we normalize input demand shifters so that $\alpha_s + \sum_{k \in \mathcal{K}} \alpha_{ks} = \sum_{c=H,F} \theta^c_{rk} = \sum_{v \in \mathcal{H}_k} \theta^c_{rkv} = \sum_{o \in \mathcal{R}_c} \theta^c_{orkv} = 1$. Note that trade costs, of the standard iceberg form, are implicitly embedded in demand

[14] In terms of the general notation of Section 2, the associated vector of net output $y(f)$ is obtained by entering gross output with a positive sign for good $g = (r, d, h)$ and entering all inputs with a negative sign. This vector is then feasible, $y(f) \in Y(z; f)$, if (11)-(14) hold. Note that there are no externalities in production in our quantitative model, a point we return to below.

shifters. If a product v from sector k is non-tradable from an origin o to region r, then $\theta^c_{orkv} = 0$.

Domestic Preferences. In each region $r \in \mathcal{R}_H$, the utility $U(n)$ of any individual n is

$$U(n) = E(z,n) \prod_{s \in \mathcal{S}} [C_{rs}(n)]^{\gamma_s}, \tag{15}$$

$$C_{rs}(n) = \left[\sum_{c=H,F} (\theta^c_{rs})^{\frac{1}{\kappa}} [C^c_{rs}(n)]^{\frac{\kappa-1}{\kappa}} \right]^{\frac{\kappa}{\kappa-1}}, \tag{16}$$

$$C^c_{rs}(n) = \left[\sum_{h \in \mathcal{H}_s} (\theta^c_{rsh})^{\frac{1}{\eta}} [C^c_{rsh}(n)]^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{17}$$

$$C^c_{rsh}(n) = \left[\sum_{o \in \mathcal{R}_c} (\theta^c_{orsh})^{\frac{1}{\sigma}} [c_{orh}(n)]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{18}$$

where $E(z,n)$ denotes the impact of externalities on the utility of individual n. Except for the Cobb-Douglas parameters $\{\gamma_s\}$ that may differ from $\{\alpha_{ks}\}$ in equation (11), note that all other demand shifters as well as elasticities in equations (16)-(18) are the same as in equations (12)-(14). That is, both domestic firms and individuals demand the same "sector composite," a standard data-driven restriction in quantitative trade models. In line with our treatment of technology, we impose the normalization $\sum_{s \in \mathcal{S}} \gamma_s = 1$. Lastly, we let ξ_{rs} denote the residual individual's net spending on all products from a sector s and domestic region $r \in \mathcal{R}_H$, which we treat as an exogenous preference shifter.[15]

Foreign Offer Curve. For each foreign country $i \in \mathcal{R}_F$, domestic region $r \in \mathcal{R}_H$, and product $h \in \mathcal{H}$, its gross exports $q^{X,F}_{irh}$ and gross imports $q^{M,F}_{rih}$ satisfy

$$p^{X,F}_{irh} = \theta^{X,F}_{irh} (q^{X,F}_{irh})^{\psi^{X,F}}, \tag{19}$$

$$p^{M,F}_{rih} = \theta^{M,F}_{rih} (q^{M,F}_{rih})^{-\psi^{M,F}}, \tag{20}$$

where $p^{X,F}_{irh}$ is the price received by foreign sellers of product h in country i that serves region r and $p^{M,F}_{rih}$ is the price paid by foreign buyers of product h from region r in country i. Since products are differentiated by origin, foreign gross exports are also equal to domestic net imports of these goods, $q^{X,F}_{irh} = m_{irh}$, whereas foreign gross imports are equal

[15] As per standard practice, fixed net spending can be microfounded via a combination of log and quasi-linear preferences.

to minus domestic net imports, $q_{rih}^{M,F} = -m_{rih}$.[16] The first elasticity $\psi^{X,F} \geq 0$ denotes the inverse of foreigners' export supply elasticity, whereas the second $\psi^{M,F} \geq 0$ denotes the inverse of their import demand elasticity. Provided that either of these two elasticities is different from zero, then Home may affect world prices $p^w \equiv \{p_{irh}^{X,F}, p_{rih}^{M,F}\}$.

Externalities. Externalities only affect the utility of US individuals, and they do so leaving individuals' marginal rates of substitution unchanged, as can be seen from the impact of $E(z, n)$ in (15). This implies that the only role of externalities in the rest of our analysis will be to provide a rationale for, and interpretation of, the structural residual in our regressions. Accordingly, we do not impose further restrictions on the externalities included in the vector z nor on their determinants in equation (4).

3.3 Baseline Calibration

The last piece of information needed to measure the sensitivity of real earnings to imports in equation (10) consists of the values of the structural parameters that determine the competitive equilibrium of our quantitative model in 2017. These parameters comprise: the five elasticities, $\{\kappa, \eta, \sigma, \psi^{X,F}, \psi^{M,F}\}$; the technology shifters, preference shifters, and labor endowments, $\{\alpha_s, \alpha_{ks}, \gamma_s, \xi_{rs}, \theta_{rds}, \theta_{rs}^c, \theta_{rsh}^c, \theta_{orsh}^c, \theta_{irh}^{X,F}, \theta_{rih}^{M,F}, N_{rs}\}$; and the US import tariffs, $\{t_{ih}\}$. We now describe how we calibrate each of them.

Elasticities. We set the values of the five elasticities $\{\kappa, \eta, \sigma, \psi^{X,F}, \psi^{M,F}\}$ equal to FGKK's estimates.[17] Specifically, we set the elasticity of substitution across domestic and foreign inputs to $\kappa = 1.19$, the elasticity of substitution across imports from different products within sectors to $\eta = 1.53$, and the elasticity of substitution across origins of the same product to $\sigma = 2.53$.[18] In line with FGKK's empirical analysis, we further assume that foreigners' export supply to the US is perfectly elastic, so that $\psi^{X,F} = 0$, and set the inverse of foreigners' import demand elasticity to $\psi^{M,F} = 0.96$.

Technology Shifters, Preference Shifters, and Labor Endowments. We set the values of $\{\alpha_s, \alpha_{ks}, \gamma_s, \xi_{rs}, \theta_{rds}, \theta_{rs}^c, \theta_{rsh}^c, \theta_{orsh}^c, \theta_{irh}^{X,F}, \theta_{rih}^{M,F}, N_{rs}\}$ to match US data from 2017 on: value added and employment by US region and sector; domestic trade flows by US region and

[16]The vector of net imports $m = \{q_{irh}^{X,F}, -q_{rih}^{M,F}\}$ is feasible, $m \in \Omega(p^w, z)$, if equations (19) and (20) hold.

[17]Despite our quantitative model being more general than FGKK's original model—since it allows product differentiation across US regions—FGKK's estimating equations remain consistent with the parametric assumptions imposed in Section 3.2 because they rely on tariff variation that is common across regions.

[18]This is the value of the elasticity of substitution across foreign origins estimated by FGKK. In our model, it is assumed to be the same as the elasticity of substitution across domestic origins.

sector; and international trade flows by US region, foreign country, and product. In our baseline calibration, we further normalize all domestic prices $\{p_{odh}\}$ to one. This amounts to a choice of units of account that ultimately pins down the levels of $\{\theta_{rds}, \theta_{irh}^{X,F}, \theta_{rih}^{M,F}\}$, without further implications for the rest of our analysis.[19] We briefly describe the various data sources used in this procedure below and offer further details about data construction and calibration in Appendix B and the Online Supplement.

Value-added and employment by US region and sector. We combine the BEA's national and regional accounts to obtain value-added at the region-sector level. We begin with nationwide data on value-added by sector, which are available from the BEA's make-use tables (before redefinitions) at the 3-digit NAICS level. Within each sector, we then assign these national value-added amounts to each region in proportion to its share of sectoral value-added in the BEA regional accounts.[20] We directly obtain total employment by region-sector from the BEA regional accounts.

International trade flows by US region, foreign country, and product. We obtain foreign imports and exports of products by US region from the US Census. These flows by foreign country are available at the 6-digit HS level, which we concord to our sector classification. Due to lack of data, we assume that 2 sectors, Wholesale and Services, are non-tradable and have zero international trade flows. For each of the 21 tradable sectors, we rescale regional trade flows to match aggregate imports and exports in the national accounts.

Domestic trade flows by US region and sector. To measure the value of flows from any domestic region-sector to any other, we first compute domestic sales as gross output minus exports for each producing region and sector. We then use Commodity Flow Survey microdata to apportion domestic sales across purchasing regions and use national input-output tables to apportion regional purchases across different sectors as well as final demand. In the case of Services, for which we also lack CFS data, we assume zero domestic trade flows.[21]

[19]Given domestic prices $\{p_{odh}\}$, foreign export prices $\{p_{irh}^{X,F}\}$ and foreign import prices $\{p_{rih}^{M,F}\}$ are pinned down by the non-arbitrage condition (2).

[20]It is worth emphasizing that we do not decompose value-added into labor and capital payments, hence the reference to "equipped labor" in the description of our quantitative model in Section 3.1. In our subsequent analysis, earnings of individuals from a given region and sector therefore always refers to total value added, not just the wage bill.

[21]For expositional convenience, we simply refer to Wholesale and Services as the 2 non-tradable sectors in our analysis, but it should be noted that in contrast to Services, Wholesale may be traded domestically.

US Import Tariffs. We also use US Census data to calculate the applied ad valorem tariff charged by the United States on each 6-digit HS product h from each foreign country i in 2017. We take the ratio of calculated duties to the FOB import value, which we denote t_{ih}^{av}, as the ad valorem tariff for a given product-country pair. Under our price normalization, the associated specific import tariff is therefore equal to $t_{ih} = t_{ih}^{\text{av}}/(1 + t_{ih}^{\text{av}})$. For a given product h, t_{ih} may differ across origin countries due to country i being part of a preferential or regional trade agreement with the United States—e.g. the Generalized System of Preferences or NAFTA—and non-MFN ("column two") treatment of non-WTO members.

3.4 Model-Implied Sensitivity of Real Earnings to Imports

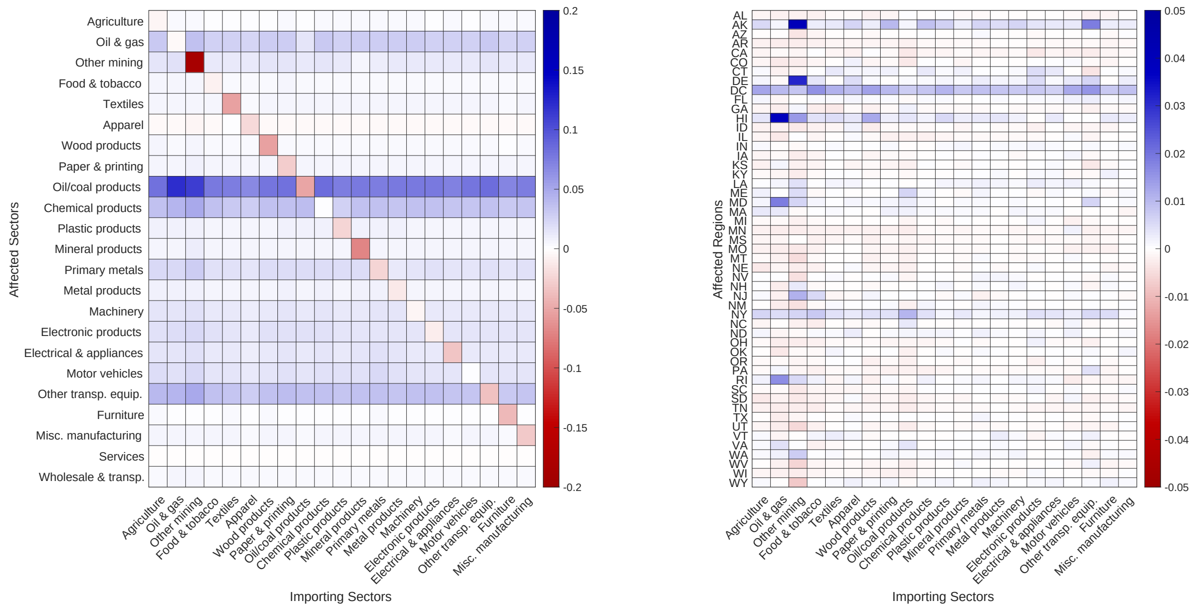
Given the parametric restrictions from Section 3.2 and the calibration from Section 3.3, we use equation (10) to compute the changes in real earnings associated with imports. For each region-sector (r, s) and each country-product (i, h), we let $\partial\omega_{rs}/\partial m_{ih}$ denote the change in real earnings associated with imports of product h from country i for all individuals living in region r and working in sector s. The resulting Jacobian matrix $\{\partial\omega_{rs}/\partial m_{ih}\}$ has $51 \times 23 = 1,173$ rows, one for each region-sector pair $(r, s) \in \mathcal{R}_H \times \mathcal{S}$, and $5,299 \times 101 = 535,199$ columns, one for each country-product pair $(i, h) \in \mathcal{R}_F \times \mathcal{H}$.

We will use the entries of the Jacobian matrix $\{\partial\omega_{rs}/\partial m_{ih}\}$ to construct the right-hand side variables in our regressions. To help visualize the variation that will allow us to identify welfare weights in Section 4, Figure 2 summarizes how changes in real earnings across sectors $s \in \mathcal{S}$ and regions $r \in \mathcal{R}_H$ (measured in dollars per worker) are differentially affected by changes in imports from various tradable sectors k (measured in million dollars of imports). In Figure 2a, each cell (s, k) reports the average change in real earnings $\partial(\omega_s - \bar{\omega})/\partial m_k$ for individuals employed in sector s associated with imports of goods in sector k minus the average change in real earnings for all US individuals.[22] Red colors, which indicate negative entries, are primarily on display when $s = k$. This is the result of the natural force of protection: individuals tend to gain less from an increase in imports in their own sectors, relative to the US average, since the firms employing them also have to compete directly against foreign goods. Turning to $s \neq k$, we see that individuals em-

[22] When averaging across imported products from any given sector k in Figure 2, we restrict ourselves to country-pair products (i, h) whose value of US imports in 2017 is greater than \$100,000, which leaves us with a total of 71,688 country-product pairs across all sectors. These are the same country-product pairs that we will focus on in the empirical analysis of Section 4. Denoting $\mathcal{G}_k$ the set of country-product pairs (i, h) above that cut-off in sector k, we therefore have $\frac{\partial(\omega_s - \bar{\omega})}{\partial m_k} = \frac{1}{|\mathcal{G}_k|} \sum_{(i,h) \in \mathcal{G}_k} \left[\sum_{r \in \mathcal{R}_H} \frac{N_{rs}}{N_s} \frac{\partial\omega_{rs}}{\partial m_{ih}} - \sum_{r \in \mathcal{R}_H, s' \in \mathcal{S}} \frac{N_{rs'}}{N} \frac{\partial\omega_{rs'}}{\partial m_{ih}} \right]$, with N_s the total US employment in sector s.

Figure 2: Sensitivity of real earnings to imports

(a) Across sectors, $\partial(\omega_s - \bar{\omega})/\partial m_k$ **(b)** Across regions, $\partial(\omega_r - \bar{\omega})/\partial m_k$



Notes: Figure 2a plots estimates of how a marginal change in imports of goods in the sector shown on the x-axis affects the difference between the average real earnings of individuals employed in each of the sectors shown on the y-axis and the average real earnings of all US individuals. Figure 2b plots the same estimates for the average real earnings of individuals living in each of the regions shown on the y-axis. Import units are chosen so that each cell reports the 2017 dollar average change in real earnings associated with a one million 2017 dollar increase in US import values.

ployed in the two non-tradable sectors (in the bottom rows) also tend to gain less from imports relative to the US average. This reflects the fact that intermediate inputs from tradable sectors tend to be a much smaller fraction of costs in non-tradable sectors: 7% in Services and Wholesale compared to 41% on average across all tradable sectors.

Figure 2b turns to analogous effects across states. Each cell (r, k) now reports the average change in real earnings for individuals living in region r associated with imports from sector k minus the average change in real earnings for all US individuals, which we denote $\partial(\omega_r - \bar{\omega})/\partial m_k$. The three most positive values are the impact of mining imports on Alaska and Delaware, and the impact of oil and gas imports on Hawaii. Increases in mining imports tend to increase incomes in Alaska, whereas mining imports in Delaware and oil and gas imports in Hawaii tend to reduce the cost of living. This suggests that the heterogeneity in the impact of imports across states does not merely reflect differences in industry composition.

A quick comparison of Figures 2a and 2b shows that in response to a change in imports from a given sector k, there is typically less dispersion in the changes in real earnings across regions r than across sectors s. The previous conclusion, however, abstracts from substantial heterogeneity in the responses to changes in the imports from different origin countries and products within any given sector k, as can be seen from Appendix Figure C.1. In fact, the standard deviation of $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$, computed for each region r and averaged across all regions, is more than twice that of $\partial(\omega_s - \bar{\omega})/\partial m_{ih}$, again computed for each sector s and averaged across all sectors. This is precisely the dispersion in the regressors that we will use to estimate welfare weights below.[23]

3.5 Validating Model-Implied Sensitivity of Real Earnings to Imports

Before turning to the identification of welfare weights by combining our tariff formula with the values of $\{\partial(\omega_{rs} - \bar{\omega})/\partial m_{ih}\}$ implied by our quantitative model, we propose to validate our model's predictions. Although one cannot directly estimate the Jacobian matrix $\{\partial(\omega_{rs} - \bar{\omega})/\partial m_{ih}\}$—which would amount to separately identifying $1,173 \times 535,199$ local causal effects—one can focus on a subset of exogenous changes in imports that have been observed in the data and ask whether, for these changes, the causal responses of earnings predicted by our model are "close" to observed ones.

Given our objective to identify US welfare weights in 2017, the ideal experiment would focus on plausibly exogenous tariff changes affecting the US economy around that time. As a proxy for such an experiment, we use the tariff changes implemented in 2018 by the Trump administration as well as the retaliatory tariffs applied by US trading partners. The logic is that these tariff changes derive from exogenous changes in the welfare weights of US policymakers rather than changes to the economic fundamentals of the US economy, consistent with the absence of pre-trends documented by FGKK. Following Adao et al. (2023) (ACD) we put our quantitative model to the test by comparing predicted and observed changes in earnings, up to a projection on an instrumental variable (IV) constructed from tariff changes observed during the trade war. Under the null that our quantitative model's predictions are correct, the two projections should be the same.[24]

[23] For the interested reader, Appendix Figure C.2 further reports the R^2 of a regression, done separately for each region r, of $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ on the set of variables $\{\partial(\omega_s - \bar{\omega})/\partial m_{ih}\}_{s \in \mathcal{S}}$. For most regions, we find a low R^2, which indicates that our region- and sector-level measures of real earnings sensitivity to imports capture different sources of variation across origin-product pairs (i, h) because, for example, imports into the same sector across regions entail different products and foreign countries.

[24] Estimates of elasticities from FGKK rely on the impact of the same exogenous tariff changes on the prices and quantities of imports to and exports from the United States. Since these estimates are already used in the calibration of our model, one may wonder whether additional testing can be conducted. As discussed in ACD, the answer is yes. The reason is that our model relies additionally on a large number of untested assumptions, from the structure of domestic input-output linkages to a lack of factor mobility across regions and sectors. ACD's IV-based test implicitly sheds light on the overall credibility of those assumptions by using extra moment conditions, distinct from those already used in estimation. We also note that our test relies on responses for outcomes that FGKK do not use in estimation; namely, earnings

Formally, we estimate the following two linear regressions:

$$\Delta \log w_{rs}^{\text{obs.}} = \alpha_0^{\text{obs.}} + \alpha_1^{\text{obs.}} z_{rs} + \varepsilon_{rs}^{\text{obs.}}, \tag{21}$$

$$\Delta \log w_{rs}^{\text{pred.}} = \alpha_0^{\text{pred.}} + \alpha_1^{\text{pred.}} z_{rs} + \varepsilon_{rs}^{\text{pred.}}, \tag{22}$$

where $\Delta \log w_{rs}^{\text{obs.}}$ is the log-change in earnings per worker observed in region r and sector s between 2017 and 2019, measured as value-added per worker in the BEA regional accounts; $\Delta \log w_{rs}^{\text{pred.}}$ is the counterpart predicted by our model in response to the US-China trade war, up to a first-order approximation; and z_{rs} is a shift-share IV whose shifters are the (demeaned) changes in US and foreign tariffs and the shares are the associated derivatives in our model of changes in earnings per worker in region r and sector s.[25] Both regressions are weighted by initial employment, consistent with our tariff formula that requires employment-weighted changes in earnings, as can be seen from equation (24). Because of other shocks occurring between 2017 and 2019, $\Delta \log w_{rs}^{\text{obs.}}$ and $\Delta \log w_{rs}^{\text{pred.}}$ may differ, but since these shocks are assumed to be mean-independent from tariff changes, the difference between the two regression coefficients $\alpha_1^{\text{obs.}}$ and $\alpha_1^{\text{pred.}}$ should be zero.

Table 1 reports our estimates. Columns (1) and (2) show that both observed and predicted changes in earnings per worker are positively related to our IV, with precisely estimated coefficients that are similar in magnitude. Column (3), in turn, reports the difference between the two coefficients, which corresponds to the coefficient of a regression of $\Delta \log w_{rs}^{\text{obs.}} - \Delta \log w_{rs}^{\text{pred.}}$ on the IV z_{rs}. Estimates indicate that we cannot reject that the two projections are the same at usual levels, with a p-value of 0.27 for the test that the estimated coefficient in column (3) is zero.[26] This helps to strengthen the empirical credibility of our model's predictions about the causal impact of tariffs on earnings per workers across US sectors and regions.

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per worker across regions and sectors. This should further ease concerns of mechanical fit.

[25]Since we are interested in the empirical credibility of the Jacobian matrix $\{\partial \omega_{rs}/\partial m_{ih}\}$, we have chosen to focus on a first-order approximation of our model here as well. Specifically, we set

$$\Delta \log w_{rs}^{\text{pred.}} \equiv \sum_{i,h} \frac{\partial \log \tilde{w}_{rs}}{\partial \log(1+t_{ih}^{\text{av}})} \Delta \log(1+t_{ih}^{\text{av}}) + \sum_{i,h} \frac{\partial \log \tilde{w}_{rs}}{\partial \log(1+t_{ih}^{F,\text{av}})} \Delta \log(1+t_{ih}^{F,\text{av}}),$$

where $t_{ih}^{F,\text{av}}$ is the ad-valorem tariff imposed by a foreign country i on US exports of product h. Our IV z_{rs} is the analog of $\Delta \log w_{rs}^{\text{pred.}}$ computed with the demeaned shifters, $\Delta \log(1+t_{ih}^{\text{av}}) - \mu$ and $\Delta \log(1+t_{ih}^{F,\text{av}}) - \mu$, with μ the simple average of US and foreign tariffs changes across all i and h. Note that although we have not introduced foreign tariffs explicitly in our quantitative model, equation (20) implies that the impact of $\Delta \log(1+t_{ih}^{F,\text{av}})$ is equivalent to that of $\Delta \log \theta_{oih}^{M,F} = -\Delta \log(1+t_{ih}^{F,\text{av}})$ for all $o \in \mathcal{R}_H$. In line with our analysis in Section 3.4, we only include tariff changes for country-product pairs with at least \$100,000 of US imports or exports in 2017, yielding 71,688 tariff shifters for imports and 107,994 for exports.

[26]Appendix Figure C.3 reports bin-scatter plots illustrating the estimates in columns (1)-(3) of Table 1.

Table 1: Changes in earnings per worker during the US-China trade war: a test

Outcome:	Log-change in			
	earnings per worker			employment
	observed	predicted	obs. - pred.	observed
	(1)	(2)	(3)	(4)
Estimate	1.792	1.173	0.620	-0.481
St. error	(0.548)	(0.020)	(0.567)	(0.356)
p-value	0.001	0.000	0.274	0.177
R^2	0.015	0.994	0.001	0.006

Notes: Sample of 1,055 region-sector pairs with positive employment and value-added in 2017 and 2019. All specifications include a constant and are weighted by employment in 2017. Observed outcomes in columns (1), (3) and (4) correspond to changes between 2017 and 2019; predicted outcomes in columns (2) and (3) correspond to our model's predictions for the impact of US and foriegn tariff changes between 2017 and 2019. Standard errors in parentheses computed with ACD's version of inference for shift-share specifications clustered by 6-digit HS product.

Finally, we note that, according to our quantitative model, earnings per worker should vary because of changes in total earnings, not changes in the number of workers, which is assumed to be fixed. Since we measure earnings per capita as value-added divided by employment, one may worry that observed changes in earnings per worker are actually driven by changes in employment rather than value-added, in contrast to what our model predicts. Column (4) investigates this issue by returning to (21), but using the observed changes in employment as the dependent variable. Reassuringly, we estimate a coefficient that is much smaller in magnitude and non-significant at usual levels.[27]

4 Putting the Formula to Work

4.1 Empirical Specification

We now return to the empirical specification suggested by Proposition 1: that a regression of tariffs on a measure of the sensitivity of individuals' real earnings to imports reveals the social marginal return of transfers to individuals, and hence the strength and nature of redistributive motives for protectionism.

For empirical purposes, we assume that welfare weights are an additively separable

[27]This finding echoes those of Autor et al. (2023) and Flaaen and Pierce (2021), who estimate small US employment effects due to the US-China trade war using variation across regions and sectors, respectively.

function of the "socioeconomic groups" $j \in \mathcal{J}$ to which individuals $n \in \mathcal{N}$ may belong,

$$\beta(n) = \sum_{j \in \mathcal{J}} \text{Dummy}_j(n) \times \beta_j, \tag{23}$$

where $\text{Dummy}_j(n)$ is an indicator variable that takes the value of one if individual n is a member of group j and zero otherwise, and β_j is the social marginal return of transfers to members of group j. Note that any individual can be a member of multiple groups. Note also that since $\sum_{n \in \mathcal{N}} \beta(n) = 1$, as established in Section 2, we must also have $\sum_{j \in \mathcal{J}} N_j \beta_j = 1$, with $N_j \equiv \sum_{n \in \mathcal{N}} \text{Dummy}_j(n)$ the number of individuals in group j.

In our baseline analysis, we focus on the scope for redistribution based on individuals' sectors and regions. In particular, we model socio-economic groups that are defined according to two considerations: "working in sector s," with welfare weights $\{\beta_s\}_{s \in \mathcal{S}}$, and "residing in region r," with welfare weights $\{\beta_r\}_{r \in \mathcal{R}_H}$, respectively.[28] Thus, using the notation from Section 3, we can write our general tariff formula (9) as

$$t_{ih} = -\sum_{s \in \mathcal{S}} \beta_s N_s \frac{\partial(\omega_s - \bar{\omega})}{\partial m_{ih}} - \sum_{r \in \mathcal{R}_H} \beta_r N_r \frac{\partial(\omega_r - \bar{\omega})}{\partial m_{ih}} + \text{Controls}_{ih} + \varepsilon_{ih}, \tag{24}$$

where t_{ih} denotes the tariff on the 6-digit HS product h from foreign country i applied by the US in 2017, measured in dollars per unit of imports as described in Section 3.3. We restrict our sample to the 71,688 country-product pairs with US imports in 2017 above \$100,000.

According to (24), the tariff t_{ih} is a function of four terms. The first two terms are our objects of primary interest. They capture redistribution to or from individuals based on their sectors of employment and states of residence. The unknown sets of parameters, β_s and β_r, represent the social marginal return of transfers to the individuals in any given sector s and region r. The corresponding regressors $\partial(\omega_s - \bar{\omega})/\partial m_{ih}$ and $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ capture the sensitivity of the average real earnings of individuals working in a sector s of region r (relative to the US average $\bar{\omega}$) to a change in the quantity of imports m_{ih} in product h from foreign country i. The measurement of such sensitivities was the focus of Section 3, with Figure 2 summarizing the variation in these regressors. The third term in (24) refers to additional factors that we control for, beyond sector- and region-based redistributive motives. Our baseline analysis populates this set with an intercept and

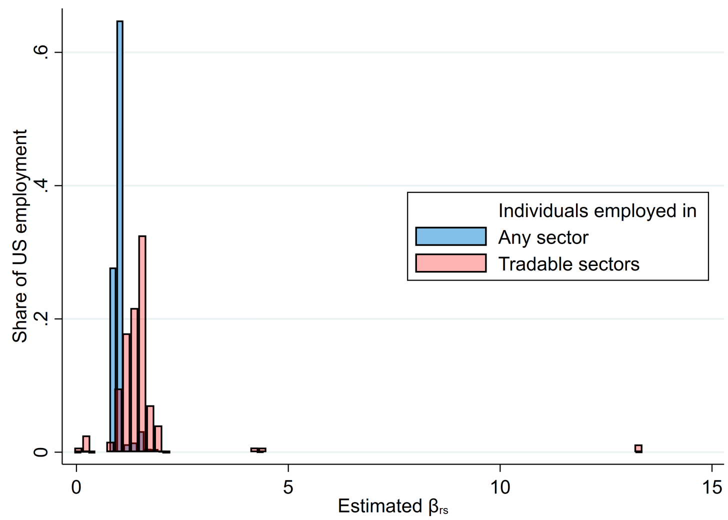
[28]This interest is motivated, in part, by the contrasting predictions of models based on sectoral mechanisms, such as Grossman and Helpman (1994), and regional mechanisms, such as Ma and McLaren (2018). While separate values of β_j for each region-sector combination are formally identified, we pursue a version with separate sector- and region-specific effects for reasons of parsimony, i.e. $|\mathcal{R}_H| + |\mathcal{S}|$ parameters to estimate rather than $|\mathcal{R}_H| \times |\mathcal{S}|$.

the term $m \cdot (\partial p^w / \partial m_{ih})$, which captures the terms-of-trade motive for trade protection. Finally, the fourth term ε_{ih} captures the impact of trade protection on distortions as well as any measurement error in trade taxes or misspecification. It is the unobserved error term in our regression.

We begin by estimating equation (24) via OLS. This requires $\partial(\omega_s - \bar{\omega})/\partial m_{ih}$ and $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ to be uncorrelated with the residual ε_{ih}, after controlling for an intercept and terms-of-trade motives. Potential violations from such an orthogonality requirement may arise from the existence of non-tariff measures (NTMs), domestic taxes, exogenous constraints on US tariffs, misspecification of terms-of-trade controls due to negotiated trade taxes, reverse causality between tariffs and imports, censoring of tariffs at zero, and the existence of other demographic characteristics affecting welfare weights. In Section 4.3, we show that alternative specifications meant to deal, in a theory-consistent way, with such concerns deliver estimates that are highly correlated with those obtained from our baseline specification.

A distinct challenge arises from the component of tariffs that may derive from attempts to correct externalities—the term $\epsilon \cdot (\partial z / \partial m_{ih})$ in equation (9). The plausibility of our orthogonality assumption inherently depends on the types of externalities that are thought to be empirically important. For instance, in the case where the consumption of various imported goods may generate different health hazards, so that $z = \{m_{ih}\}$ and the externality experienced by each individual is $E(\{m_{ih}\}, n) = \sum_{i,h} E_{ih} m_{ih}$—as is often considered in the product standards literature—our exclusion restriction requires no systematic correlation between health damage E_{ih} and the sensitivity of real earnings with respect to imports across country-product pairs. A second type of externality that has featured prominently in the study of distortion-correcting tariff policy concerns foreign externalities due to carbon emissions (e.g. Kortum and Weisbach, 2021 and Hsiao, 2022), which are a function of total production abroad and work through the world price p^w. While the vector $\partial p^w / \partial m_{ih}$ is too high-dimensional to control for directly, it seems likely that our flexible approach to controlling for terms-of-trade motives, discussed below, may do much to mitigate this concern. Finally, in the case of social identity in Grossman and Helpman (2021), the psychosocial cost externality is assumed to be a linear function of changes in others' real earnings, and thus our estimates would no longer measure the direct impact of a transfer to an individual, but instead its total impact, both direct and indirect via its effects on other individuals' psychosocial utility.

Figure 3: Distribution of estimated welfare weights



Notes: This figure displays the histogram of estimates of welfare weights across regions and sectors, $\hat{\beta}_{rs} = \hat{\beta}_s + \hat{\beta}_r$, weighted by employment N_{rs}, where $\hat{\beta}_s$ and $\hat{\beta}_r$ denote the OLS estimates of β_s and β_r in (24). The blue bars correspond to all US individuals, and the red bars correspond to the 8.9% of US individuals employed in tradable sectors. Appendix Figure C.4 displays this distribution truncated at $\hat{\beta}_{rs} \leq 2.1$.

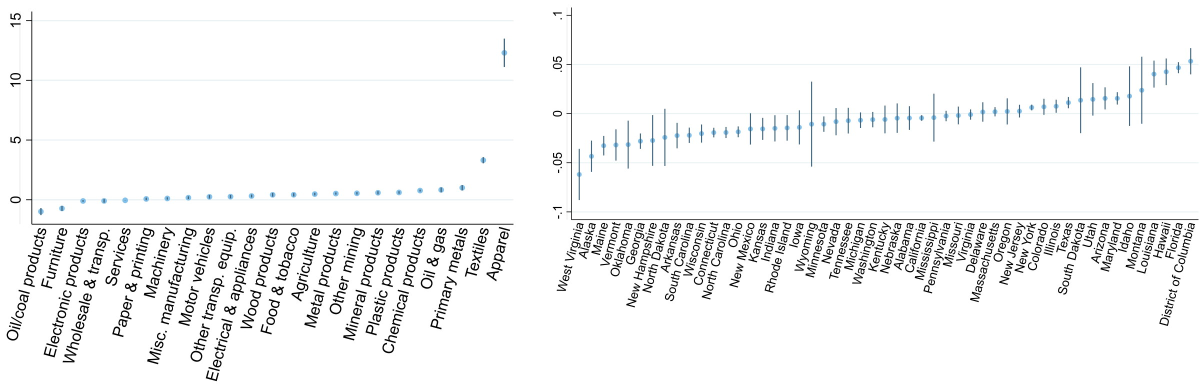
4.2 Baseline Estimates

Using the OLS estimates of β_s and β_r in equation (24), we can compute the welfare weights $\hat{\beta}_{rs} \equiv \hat{\beta}_s + \hat{\beta}_r$ for any of the N_{rs} individuals working in a given sector s and region r. Figure 3 reports the distribution of welfare weights across all US individuals, in blue, as well as for the subset of individuals employed in tradable sectors, in red. Three features are immediately apparent.

First, the fact that the blue distribution is shifted to the left implies that individuals in non-tradable sectors, who do not directly receive trade protection, tend to have lower social marginal utilities of income. Second, there is substantial dispersion in welfare weights across the US population, with a long upper tail. Compared to individuals at the 10th percentile of our estimates, those located at the 90th, 95th, and 99th percentiles enjoy social marginal utilities of income that are 8%, 53%, and 91% higher, respectively. This underscores a clear sense in which trade policy is far from redistribution-neutral, since a world in which trade protection is not used to achieve redistributive goals would display no estimated welfare weight dispersion. Third, despite the wide range of these estimates, all but 21 out of 1,173 of the welfare weights $\hat{\beta}_{rs}$ we estimate are positive. Moreover, none of the negative estimates are statistically different from zero at standard significance levels; in fact, the smallest t-statistic is -0.33. This lends credence to the constrained Pareto

Figure 4: Estimates of welfare weights across sectors and regions

(a) $\hat{\beta}_s$ estimates **(b)** $\hat{\beta}_r$ estimates



Notes: Figure 4a displays estimates of the sectoral component of welfare weights, $\hat{\beta}_s$, for each sector s, as obtained from the OLS estimation of (24) and normalized such that the mean of $\hat{\beta}_s$ across s is zero. Figure 4b displays estimates of the regional component of welfare weight, $\hat{\beta}_r$, for each region r, as obtained from equation (24) and normalized such that the mean of $\hat{\beta}_r$ across r is zero. Blue dots correspond to point estimates and bars denote 95% confidence intervals. Standard errors are clustered at the product-level.

efficiency assumption underlying our methodology, which requires non-negative welfare weights for all individuals.

To explore further the determinants of welfare weights, Figure 4 reports separately our sector- and region-based estimates, $\hat{\beta}_s$ and $\hat{\beta}_r$, each normalized to have an employment-weighted mean of zero.[29] 95% confidence intervals for these estimates are also shown. Across sectors, estimates of $\hat{\beta}_s$ range from -0.99 for Oil/Coal products to 12.3 for Apparel, and while Apparel is a clear outlier, even the second- and third-largest values, 3.3 for Textiles and 1.0 for Metals, are considerably higher than, and statistically different from, that of Oil/Coal products.[30] As can be seen from Figure 4b, the region-level estimates $\hat{\beta}_r$ are also precisely estimated—for the reasons discussed at the end of Section 3.4—and reveal significant dispersion across regions, but these estimates are of a strikingly smaller scale than the sector-specific ones, ranging from -0.06 for West Virginia to 0.05 for DC.

One way to evaluate the economic magnitude of the previous estimates is to consider the average welfare weights within each sector and region, $\bar{\beta}_s \equiv \sum_r (N_{rs}/N_s)\hat{\beta}_{rs}$ and $\bar{\beta}_r \equiv \sum_s (N_{rs}/N_r)\hat{\beta}_{rs}$, which we report in Appendix Figure C.5.[31] By construction, these welfare weights adjust for compositional differences in how individuals employed in dif-

[29]A normalization, such as this one, is necessary given that, even though the sum $\beta_r + \beta_s = \beta_{rs}$ is identified—via the restriction $\sum_{r,s} \beta_{rs} N_{rs} = 1$—the two parameters β_r and β_s remain only identified up to a constant.

[30]Not surprisingly, Apparel has the largest average ad-valorem tariffs of any sector by a wide margin. Appendix Figure C.6 contains a version of Figure 4a without Apparel for greater clarity.

[31]Since $\hat{\beta}_{rs}$ is identified, both $\bar{\beta}_s$ and $\bar{\beta}_r$ are identified as well, unlike $\hat{\beta}_s$ and $\hat{\beta}_r$.

ferent sectors are distributed across regions as well as how individuals from different states are distributed across sectors. Quantitatively, our estimates imply that individuals employed in Textiles, Apparel, and Metals, which combine to comprise 0.4% of total employment and 4.7% of tradable sector employment, enjoy an average social marginal utility of income that is 450% higher than the average across all US individuals. This means that, from society's perspective, giving \$1 to an individual in one of these three sectors is equivalent to giving \$4.50 to any randomly-chosen individual in the United States. In contrast, giving \$1 to an individual in the state with the highest social marginal utility of income is only equivalent to \$1.08 given to someone in the bottom state. This asymmetry between sectors and states explains the blue spike in Figure 3, which corresponds to the 91.1% of US individuals employed in non-tradable sectors. It also foreshadows the greater importance of sector- rather than region-based considerations in accounting for US trade protection, as we demonstrate in Section 5 below.

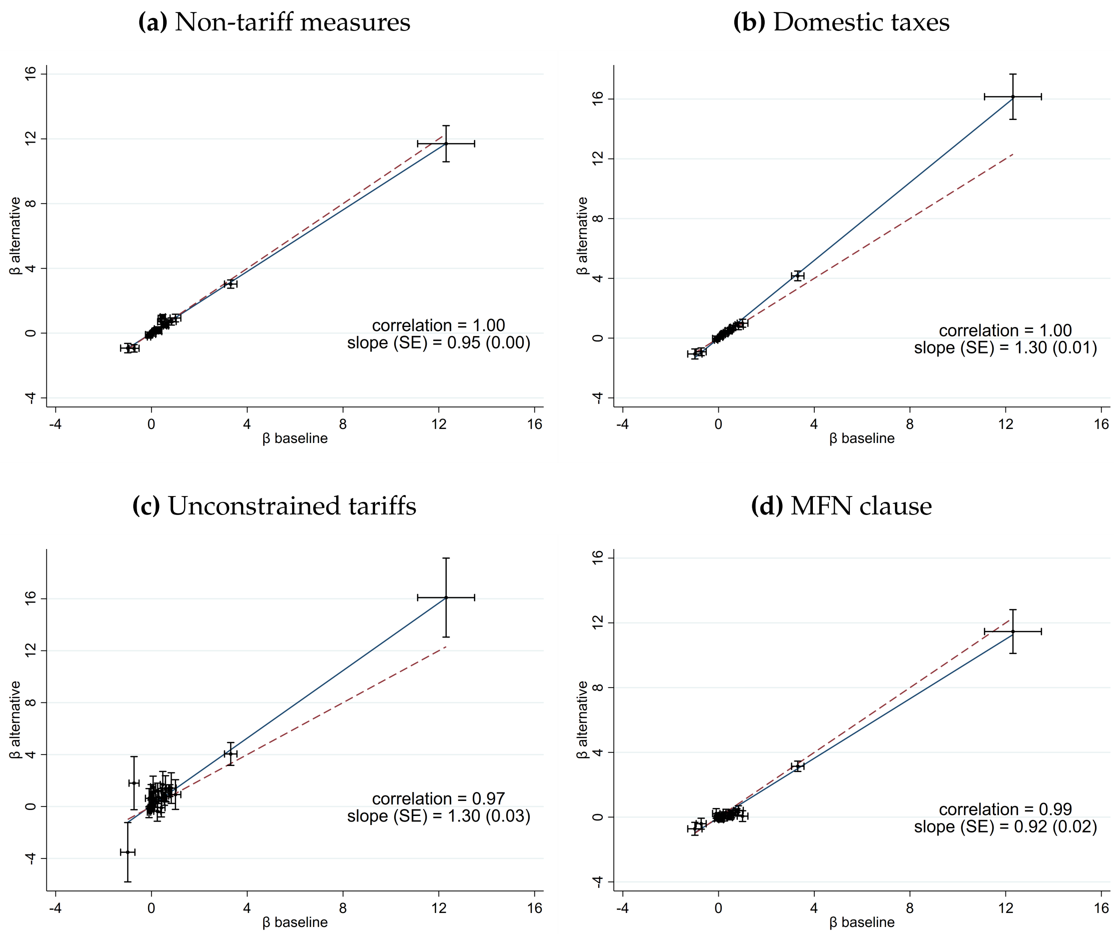
4.3 Sensitivity Analysis

The baseline estimates reported in Section 4.2 were obtained under a number of assumptions that we now probe further. Figures 5 and 6 summarize the resulting estimates of $\hat{\beta}_s$ and $\hat{\beta}_r$ that we obtain, for each sector s and region r, under eight alternative specification choices. In each case we display a scatter plot of our baseline values of these estimates (on the x-axis) against estimates of the same objects obtained under alternative assumptions (on the y-axis). Where these extensions draw on auxiliary data those sources are described in Appendix B.2.[32]

Other Policy Instruments. As discussed in Section 2.4, our baseline tariff formula (9) can be augmented to allow for the presence of additional policy instruments. For example, equation (A.6) incorporates the presence of non-tariff measures (NTMs) by including a term related to the fiscal externality associated with the revenue potentially generated by such instruments. Under the assumption that each type of NTM features its own (unknown) propensity to generate tax revenue (but one that is otherwise constant across products and origin countries) the effect of NTMs can be captured by controlling for a set of indicator variables for whether each type of NTM is applied to imports of product h from origin i or not. Figure 5a implements this idea using the six types of NTMs available

[32] Appendix Table C.1 contains a deeper exploration of the results of such sensitivity analyses, reporting comparisons between baseline and alternative estimates weighted by employment and dropping the outlier Apparel sector. In all such cases we find that the conclusions we discuss here, in relation to Figures 5 and 6, are similar.

Figure 5: Sensitivity analysis



(a) Non-tariff measures

(b) Domestic taxes

(c) Unconstrained tariffs

(d) MFN clause

Notes: Each figure displays the relationship between baseline estimates (of $\hat{\beta}_r$ and $\hat{\beta}_s$ across all regions r and sectors s) on the x-axis and estimated values obtained under alternative assumptions (described in the text) on the y-axis. The solid blue line illustrates the line of best fit (whose slope and standard error are reported) and the dashed red line indicates the 45-degree line. Bars indicate 95% confidence intervals.

from the TRAINS and Temporary Trade Barriers (Bown et al., 2020) databases. It shows little sensitivity of our estimates of welfare weights to the addition of such controls.[33]

Turning to domestic policy instruments, we have shown in equation (A.13) how to incorporate income taxes into our general tariff formula. Doing so requires marginal changes in real earnings to be evaluated post-taxes.[34] Using state-specific data on income

[33] Appendix Figure C.7 presents two further sets of estimates that explore the role of NTMs. First, Figure C.7a confirms that we obtain similar results when using only the subsample of 26.2% of observations in which there is no NTM in place at all. And second, Figure C.7b incorporates the variable extent of antidumping and countervailing duties by adding to our measure of tariffs t_{ih} an estimate of such duties in 2017; again, baseline and alternative estimates are highly correlated.

[34] Recall that labor supply is assumed to be inelastic in our analysis, hence there are no fiscal externalities associated with income taxes.

tax schedules from TaxSim and microdata from the American Community Survey (ACS), Figure 5b reports the estimates that we obtain from the analog of (24) with the regressors adjusted by the (income-weighted) average of marginal tax rates faced by individuals within each state-sector pair. Despite non-trivial variation in these taxes, we see that new estimates of welfare weights remain highly correlated with our baseline estimates, though the fact that post-tax changes in earnings are less dispersed than pre-tax ones—due to positive marginal income taxes—implies that the weights required to rationalize the same observed variation in tariffs are now more dispersed.

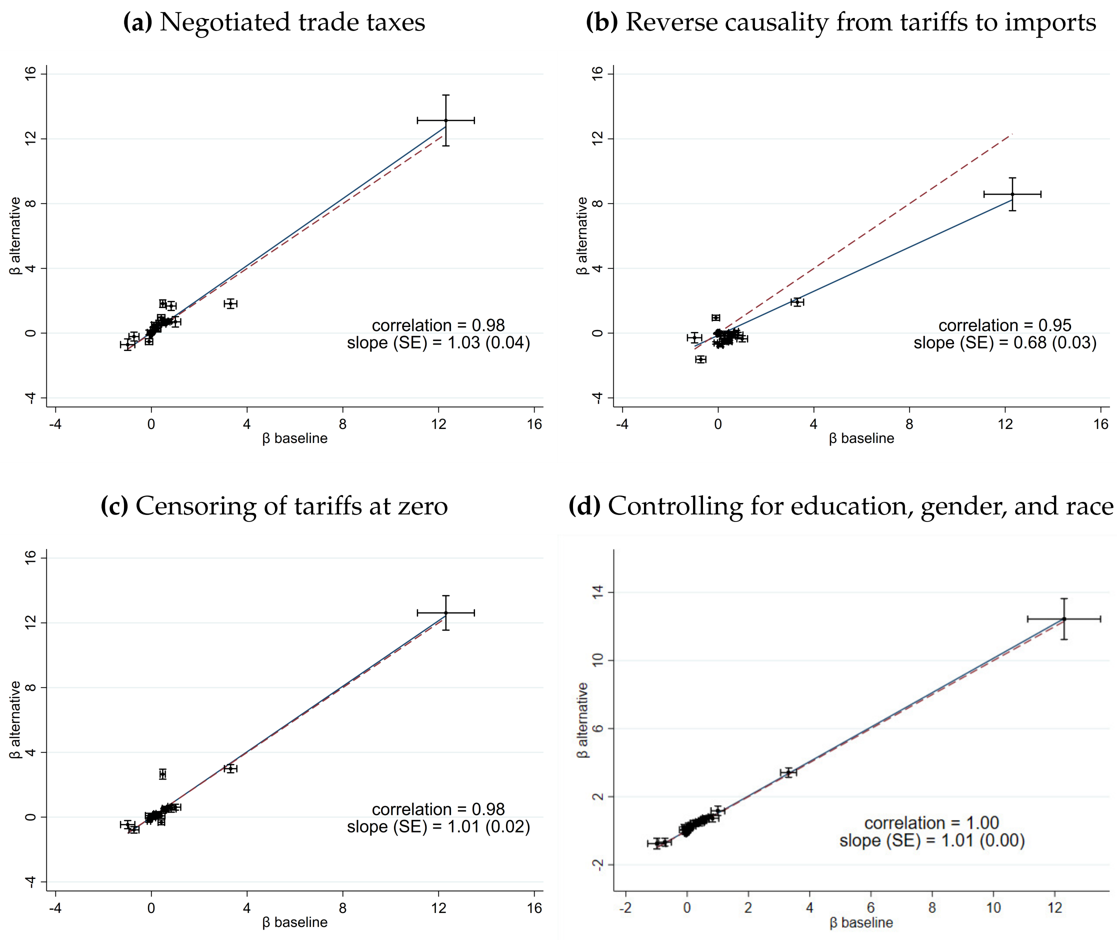
Constrained Trade Taxes. A generic concern associated with a revealed-preference approach such as ours is that the observed choices, here US tariffs, may reflect constraints on the decision-maker's choice set rather than underlying preferences. Our baseline analysis assumes away such constraints, implicitly treating the decision of the US to abide by WTO rules or enter a preferential trade agreement as choices that reveal social preferences. Although we view the series of import tariffs imposed by the Trump administration as prima facie evidence that abiding by such rules is always a choice, one may alternatively treat these rules as constraints that predate the choices of 2017 US tariffs.[35]

The generalized formula presented in equation (A.14) suggests two complementary approaches to dealing with constraints. The first one drops 96.4% of our sample and focuses on the 3.6% of origin-product pairs (i,h) for which constraints on tariffs are plausibly absent or non-binding. This is the case if two conditions are satisfied: (a) variety ih is associated with a country i without a trade agreement with the US; and (b) either country i is not a WTO member or country i is a WTO member, but the US MFN tariff on product h is strictly below its WTO bound (i.e., there is "overhang"). Following equation (A.14), we then further augment the specification to include the fiscal externality associated with goods whose trade taxes are constrained and adjust the calculation of $\partial(\omega_s - \bar{\omega})/\partial m_{ih}$ and $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ to incorporate the fact that the set of goods whose imports are held constant only includes those inside the unconstrained set. The results from this procedure in Figure 5c show that these alternative estimates, although accompanied by larger standard errors due to the smaller sample, are highly correlated with our baseline. This suggests that constraints on US trade policy do not appear to restrict appreciably its ability to use such policy to achieve redistributive goals.

Our second approach focuses on the impact of WTO's MFN clause. This clause requires member countries, such as the US, to charge the same tariff on all origin members

[35]For the interested reader, Appendix Figure C.8 reports the differences in the estimates of welfare weights revealed by the changes in US tariffs between 2017 and 2019.

Figure 6: Sensitivity analysis (continued)



(a) Negotiated trade taxes

(b) Reverse causality from tariffs to imports

(c) Censoring of tariffs at zero

(d) Controlling for education, gender, and race

Notes: Each figure displays the relationship between baseline estimates (of $\hat{\beta}_r$ and $\hat{\beta}_s$ across all regions r and sectors s) on the x-axis and estimated values obtained under alternative assumptions (described in the text) on the y-axis. The solid blue line illustrates the line of best fit (whose slope and standard error are reported) and the dashed red line indicates the 45-degree line. Bars indicate 95% confidence intervals.

unless preferential agreements are in place. Equation (A.14) describes how such group-based constraints can be handled simply by considering trade with the aggregated group. In the context of the MFN clause, this requires measuring the dependent variable as the (trade-weighted) average tariff on product h among all WTO countries and using the earnings response to their total imports, $M_{\text{WTO}h} \equiv \sum_{i \in \text{WTO}} m_{ih}$, to compute the regressors. Figure 5d again shows similar estimates.

Negotiated Trade Taxes. In addition to imposing extra constraints, trade negotiations may affect the extent to which Home internalizes changes in foreign welfare. Our baseline specification, which controls for the terms-of-trade motive via $m \cdot (\partial p^w / \partial m_{ih})$, is valid if Home places the same welfare weight on each foreign country (including zero weight, as is commonly assumed). But if these weights differ, e.g. depending on whether foreign countries are part of a preferential trade agreement with the US or not, then the appropriate set of controls would involve $m(j) \cdot (\partial p^w / \partial m_{ih})$, where $m(j) \equiv \{\sum_{r \in \mathcal{R}_H} x_{rjh}, -m_{jh}\}$ denotes country j's vector of exports from and imports into Home, in line with our generalized formula in equation (A.17).[36] Figure 6a presents results when we control for 101 distinct terms-of-trade motives, one for each of the 101 foreign countries in our analysis. Our estimates of $\hat{\beta}_s$ and $\hat{\beta}_r$ are again largely unaffected by this flexible approach to the terms-of-trade motive, with a correlation of 0.98 with our baseline.[37]

Alternative Econometric Specifications. We turn now to three potential concerns with our empirical model. First, a natural concern regarding the OLS estimates discussed above arises from the fact that tariffs (the dependent variable) may have their own causal impact on imports and, in turn, the sensitivity of imports on real earnings (the independent variable). Simultaneity bias of this form has been stressed in prior work. The predominant solution seeks to construct IVs for the dependent variables that predict trade due to forces other than trade policy. A natural candidate, in our context, is our model's predicted value of the regressors, but constructed from a counterfactual economy with zero tariffs. Namely, we predict the impact of imports on real earnings and terms-of-trade on the basis of primitive economic forces that are assumed to be independent from tariffs, in the same spirit as Trefler (1993) and Goldberg and Maggi (1999). As seen in Figure 6b, our IV and OLS estimates are similar to one another (correlation of 0.95, slope of 0.68), indicating that any bias caused by simultaneity is relatively weak.

Second, equation (24) models the outcome t_{ih} as a continuous variable with full support, despite the fact that we do not observe US import subsidies, i.e. negative values of t_{ih}. As in analogous procedures used by Trefler (1993) and Goldberg and Maggi (1999), one can explore the role of such censoring with the use of a Tobit model under the extra assumption that latent tariffs are normally distributed. Figure 6c displays these results, which suggests that OLS bias due to limited dependent variable issues is very minor.

Finally, we consider the potential misspecification involved in modeling each individual's welfare weight $\beta(n)$ on the basis of her state and sector of employment alone. Specifically, we add eight socioeconomic groups to (23) formed from the interactions between three binary categories associated with education (college-educated and not), gen-

[36] Recall that in our quantitative model, all trade is either from or into a US region. Hence we continue to abstract from terms-of-trade effects associated with international exchanges between two foreign countries. Adao et al. (2023) offer evidence supporting the predictions of our model about the US terms-of-trade.

[37] For completeness, Appendix Figure C.9 shows that our estimates are also similar when we either drop the constant or terms-of-trade motives from the baseline control set.

der, and race (white or non-white). Figure 6d demonstrates that the estimates of $\hat{\beta}_r$ and $\hat{\beta}_s$ obtained when allowing for these extra demographic considerations—using ACS data on the composition of the workforce within each region and sector—are remarkably unchanged.[38]

5 How Important is Redistributive Trade Protection?

5.1 Cross-Sectional Variation in Tariffs

A first way to evaluate the importance of the redistributive motive for trade protection is to ask how much of the observed cross-sectional variation in US tariffs in 2017 can be explained by the combination of the sector- and region-based redistributive motives.

To answer this question, we carry out an Owen-Shapley regression decomposition that returns the share of the variance explained by the first two sets of regressors in (24). The results of this decomposition are displayed in Figure 7. Two findings are evident. First, although we aim to explain the variation in 71,688 tariff lines using changes in real earnings across 51 regions and 23 sectors, the redistributive motives, either due to sector- or region-based considerations, account for about one third (29.2%) of the total variation in US trade policy. Second, sector-based motives for redistribution explain the lion's share of total redistributive motives (27.2%), implying that region-based considerations are indeed relatively minor (2.0%).[39]

5.2 Gains from Redistributive Trade Protection

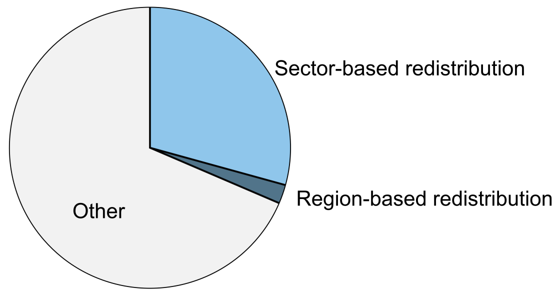
Another way to evaluate the importance of redistributive protection is to ask, from an economic rather than a statistical standpoint: how large are the monetary transfers caused by redistributive trade protection?

To provide estimates of the causal impact of redistributive tariffs on the real income of different individuals, we return to the quantitative model from Section 3 to construct a counterfactual US economy with trade taxes purged of the redistributive component that

[38] Appendix Figure C.10 also reports the average welfare weight of individuals of different education, gender, and race. We acknowledge, though, that since our measures of real earnings responses only vary at the region-sector level, these extra weights can only be identified via the additive separability of socioeconomic characteristics in (23).

[39] One can also use the same Owen-Shapley regression decomposition to assess the importance of terms-of-trade considerations. We find that 7% of the variance is explained by the terms-of-trade motive $m \cdot (\partial p^w / \partial m_{ih})$. This reflects in part the fact that the estimated coefficient for this regressor is significantly lower than one in all our regressions, consistent with the idea that negotiated US tariffs may partly internalize terms-of-trade considerations on the rest of the world.

Figure 7: Variance decomposition of US tariffs in 2017



Notes: This figure plots the share of variance in US tariffs t_{ih} in 2017 that can be explained, according to estimates of equation (24), due to each of three components: redistribution based on individuals' sector of employment; redistribution based on individuals' state of residence; and other factors. The decomposition of variance reported is computed using the Owen-Shapley method.

we have estimated in Section 4. Formally, we consider counterfactual trade taxes t'_{ih} that are equal to

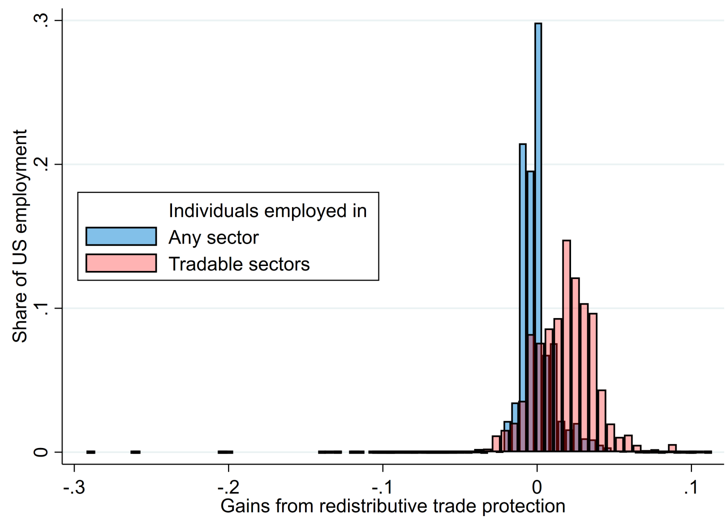
$$t'_{ih} = t_{ih} + \sum_{s \in \mathcal{S}} \hat{\beta}_s N_s \frac{\partial(\omega_s - \bar{\omega})}{\partial m_{ih}} + \sum_{r \in \mathcal{R}_H} \hat{\beta}_r N_r \frac{\partial(\omega_r - \bar{\omega})}{\partial m_{ih}}, \tag{25}$$

with t_{ih} the observed US tariff and $\hat{\beta}_s$ and $\hat{\beta}_r$ our baseline estimates of the welfare weights. This is equivalent to considering a counterfactual US economy in which social marginal returns to different individuals have been equalized, holding fixed the other motives for trade protection.[40] We then calculate the counterfactual changes in real income of all individuals in the economy. Gains from redistributive trade protection are equal to minus these real income changes. They can be interpreted as the as-if transfer, either positive or negative, that each individual receives as a result of the redistributive motive embedded in the US tariff schedule of 2017.

Figure 8 displays the distribution of the gains from redistributive trade protection across all US individuals, in blue, as well as for the subset of individuals employed in tradable sectors, in red. Not surprisingly, gains tend to be concentrated among those employed in tradable sectors, with the red distribution to the right of the blue one. In line with the substantial dispersion in welfare weights seen in Figure 4, some individuals experience sizable gains from redistributive trade protection. For individuals located at

[40] In theory, terms-of-trade and distortion motives may change in this counterfactual scenario. Given our small estimated coefficient for the terms-of-trade control $m \cdot (\partial p^w / \partial m_{ih})$, accounting for changes in terms-of-trade motives using our quantitative model has very little effect on our analysis. In the absence of systematic empirical evidence on $\epsilon \cdot (\partial z / \partial m_{ih})$, we view our "no change" assumption as a useful starting point. It is consistent, for instance, with the health hazards associated with imports —$z = \{m_{ih}\}$ and $E(\{m_{ih}\}, n) = \sum_{i,h} E_{ih} m_{ih}$, as discussed in Section 4.1—as well as a good approximation for any type of externality driven by changes in world prices—such as those associated with foreign carbon emissions—since world prices vary little in our model.

Figure 8: Distribution of gains from redistributive trade protection



Notes: This figure reports the histogram of the gains from redistributive trade protection across regions and sectors, weighted by employment N_{rs}. Gains are defined as minus the log-change in real earnings that results from a counterfacual US economy in which US tariffs are taken from their observed 2017 values to the value that would obtain in the absence of redistributive motives, as described in equation (25). The blue bars correspond to all US individuals, and the red bars correspond to the 8.9% of US individuals who are employed in tradable sectors.

the 90th, 95th, and 99th percentiles of the overall distribution, the changes in real income caused by the redistributive component of the US tariffs is 1.0, 2.4 and 4.1 percentage points higher, respectively, than the US average. In dollar terms, these differences represent transfers—from the region-sector employing individuals at the 10th percentile to the region-sector employing individuals at the 90th percentile—of $2,400 per worker annually.[41]

5.3 Winners and Losers from Redistributive Trade Protection

Up to this point, we have remained agnostic about the specific dimensions of the US political process that may be driving redistributive tariffs. All that matters for our estimates of the welfare weights β_s and β_r, as well as for the associated gains from redistributive tariffs, is that this process arrives at some Pareto-efficient outcome. To conclude our analysis, we return to two leading explanations for the existence of tariffs in the previous political-economy literature—sectors' ability to lobby and states' ability to swing presidential elections—and use our previous estimates to evaluate the extent of redistributive

[41] The difference is roughly the same when comparing individuals at the top and bottom deciles of our estimated welfare weights instead, namely $2,450.

trade protection associated with these two characteristics.

For this final exercise, we divide sectors of employment into two groups based on their trade lobbying activities. The focus on two groups is motivated by the earlier work of Goldberg and Maggi (1999) and others who classify sectors as either politically organized or not, in line with Grossman and Helpman's (1994) protection for sale model. In their original work, Goldberg and Maggi (1999) defined a sector as politically organized if its campaign contributions were above a certain threshold, with the threshold suggested by a natural break in the data. In the same spirit, we define sectors as "high-" or "low-trade lobbying" based on LobbyView data (Kim, 2018) that allow us to compute total lobbying expenditures during 2000-2016 on filings that cite trade policy as their primary issue, as further described in Appendix B.2.[42] To find a natural break in the data, we then use a k-means clustering procedure, with $k = 2$, based on the log of trade-lobbying spending per worker. The sectors in the "high" group are: Apparel, Chemical products, Electronic products, Electrical and appliances, Food, Machinery, Mining (except oil and gas), Mineral products, Other transportation equipment, Oil and coal products, Primary Metals, and Wood products.

Likewise, we divide US regions into two groups based on margins of victory in past elections. The focus on two groups is motivated by the importance of "swing states" in US presidential elections, as emphasized by Ma and McLaren (2018) and Bown et al. (2023). Specifically, we focus on presidential elections between 2000 and 2016 and compute the absolute difference between the average voting shares of Democrat and Republican candidates in each state over that time period, as also described in Appendix B.2. Following the aforementioned papers, we then define a US region as a swing state if the margin of victory is below 5%. The swing states are: Colorado, Florida, Iowa, Ohio, Nevada, New Hampshire, Pennsylvania, Virginia, and Wisconsin.

As a simple way to evaluate how lobbying sectors and swing states shape redistributive trade protection, we propose to project the welfare weights (estimated in Section 4.2) and the gains from redistributive trade protection (computed in Section 5.2) on two dummy variables, one for whether or not individuals are employed in high trade-lobbying sectors and one for whether or not they are located in a swing state. The results of these OLS regressions are presented in Table 2. Column (1) focuses on the welfare weights, whereas column (2) focuses on the gains from redistributive trade protection. We see that those in high trade-lobbying sectors have statistically significantly higher wel-

[42]Our decision to focus on lobbying expenditure data, which were first used to study trade policy in Bombardini and Trebbi (2012), reflects the fact that such expenditures can be linked to specific policy issues as well as the arguments about the long-standing monetary dominance of this form of political influence voiced in Bombardini and Trebbi (2020).

Table 2: **Winners and losers from redistributive trade protection**

Outcome:	Estimated welfare weight	Estimated protection gain
	(1)	(2)
High trade-lobbying sector	0.675	0.018
	(0.104)	(0.002)
Swing state	0.000	0.001
	(0.014)	(0.002)
R^2	0.091	0.095

Notes: Sample of 1,080 region-sector pairs with positive employment in 2017. All specifications include a constant and are weighted by employment in 2017. In column (1), the dependent variable is the estimated welfare weight of each region-sector, $\hat{\beta}_{rs} = \hat{\beta}_s + \hat{\beta}_r$ where $\hat{\beta}_s$ and $\hat{\beta}_r$ denote the OLS estimates of β_s and β_r in (24); in column (2), it is the estimated gain from redistributive trade protection defined as minus the log-change in real earnings that result from a counterfacual US economy in which US tariffs are taken from their observed 2017 values to the value that would obtain in the absence of redistributive motives, as described in equation (25). Robust standard errors in parentheses.

fare weights and redistributive protection gains. From an economic standpoint, workers employed in high trade-lobbying sectors enjoy an average social marginal utility that is 68% higher than the US average. And the coefficient in column (2) implies that redistributive trade protection generates a transfer towards high-lobbying sectors that amounts to $4,994 per worker annually, despite these sectors spending only $93 per worker annually on lobbying devoted to all issues combined. In contrast, consistent with our earlier variance decomposition highlighting the importance of sector- relative to region-based characteristics, we find no statistically significant effect of being in a swing state. Quantitatively, per-worker transfers towards swing states are an order of magnitude smaller.[43]

6 Concluding Remarks

Why is trade not free? A prominent answer to this question is redistributive politics. In this paper we have developed a revealed-preference approach to identify who the politically-favored are and, in turn, to quantify the importance of redistributive tariffs.

Our approach builds on a general tariff formula that emerges from any political process provided that such a process results in policies that are constrained Pareto efficient. It highlights a simple sense in which the redistributive motives behind the tariff observed on any good should be the product of two considerations: the as-if welfare weights of

[43] As we show in Appendix Table C.2, similar conclusions continue to hold when we control for employment and use alternative definitions of sectoral lobbying intensity and swing states.

different constituents of society and the marginal impact of that good's imports on the real income of these constituents. Inverting this logic, a simple regression of tariffs on estimates of the marginal welfare impact of imports can reveal the point on society's Pareto frontier that the political process arrives at.

We have applied the previous methodology to US trade policy in 2017 and estimated welfare weights across individuals from 50 states, plus Washington DC, and 23 sectors. Our estimates imply that redistributive trade protection among these broad groups accounts for almost one third of the variance in US tariffs observed across thousands of products and origin countries. The monetary transfers caused by redistributive tariffs are large as well, with the estimated difference between gains at the 90th percentile and losses at the 10th percentile approximately equal to $2,400 per worker annually. Perhaps surprisingly, the previous conclusions are mainly driven by differences in welfare weights across sectors, with differences across states only playing a minor role.

While trade is decidedly not free, import tariffs are by no means the only policy tools available to governments seeking to help some of their constituents at the expense of others. Environmental policy, competition policy, and financial regulation are all areas to which the approach developed in this article would be straightforward to apply. In all such cases, we hope that our analysis can offer a blueprint for identifying who the politically-favored are and for evaluating the economic importance of the political favors they receive.

References

Adao, Rodrigo, Arnaud Costinot, and Dave Donaldson, "Putting Quantitative Models to the Test: An Application to Trump's Trade War," 2023. NBER working paper no. 31321.

Autor, David, Anne Beck, David Dorn, and Gordon Hanson, "Help for the Heartland? The Employment and Electoral Effects of the Trump Tariffs in the United States," 2023. Unpublished manuscript.

Bagwell, Kyle and Robert W. Staiger, "An Economic Theory of GATT," *American Economic Review*, 1999, *89* (1), 215–248.

_ and _ , *The Economics of the World Trading System*, MIT press, 2002.

Baldwin, Richard, "Politically Realistic Objective Functions and Trade Policy," *Economics Letters*, 1987, *24*, 287–290.

Bombardini, Mathilde, “Firm heterogeneity and lobby participation,” *Journal of International Economics*, 2008, *75* (2), 329–348.

Bombardini, Matilde and Francesco Trebbi, “Competition and political organization: Together or alone in lobbying for trade policy?,” *Journal of International Economics*, 2012, *97* (1), 18–26.

__ **and** __ , “Empirical models of lobbying,” *Annual Review of Economics*, 2020, *12*, 391–413.

Bourguignon, Francois and Amedeo Spadaro, “Tax-benefit revealed social preferences,” *The Journal of Economic Inequality*, 2012, *10* (75-108).

Bown, Chad, Paola Conconi, Aksel Erbahar, and Lorenzo Trimarchi, “Politically Motivated Trade Protection,” 2023. Unpublished manuscript.

Bown, Chat, Milla Cieszkowsky, Aksel Erbahar, and Jose Signoret, *Temporary Trade Barriers Database*, Washington, D.C.: World Bank, 2020.

Caliendo, Lorenzo and Fernando Parro, “Trade policy,” in Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 5, Elsevier, 2022, pp. 219–295.

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

Chari, V. V., Patrick J. Kehoe, and Ellen C. McGrattan, “Business Cycle Accounting,” *Econometrica*, 2007, *75*, 781–836.

Conconi, Paola, Manuel García Santana, Laura Puccio, and Roberto Venturini, “From Final Goods to Inputs: The Protectionist Effect of Preferential Rules of Origin,” *American Economic Review*, 2018, *108* (8), 2335–2365.

Costinot, Arnaud and Ivan Werning, “Lerner Symmetry: A Modern Treatment,” *American Economic Review: Insights*, 2019, *1* (1), 13–26.

__ **and** __ , “Robots, Trade, and Luddism: A Sufficient Statistics to Optimal Technology Regulation,” *Review of Economic Studies*, 2023, *90* (5), 2261–2291.

de V. Graaff, J., “On Optimum Tariff Structures,” *The Review of Economic Studies*, 1949-1950, *17* (1), 47–59.

Diamond, Peter A. and James A. Mirrlees, "Optimal Taxation and Public Production II: Tax Rules," *American Economic Review*, 1971, *61* (3), 261–278.

Dixit, Avinash, Gene M. Grossman, and Elhanan Helpman, "Common Agency and Coordination: General Theory and Application to Government Policy Making," *Journal of Political Economy*, 1997, *105* (4), 752–769.

Dixit, Avinash K. and Victor Norman, *Theory of International Trade*, Cambridge University Press, 1980.

Fajgelbaum, Pablo D., Cecile Gaubert, Nicole Gorton, Eduardo Morales, and Edouard Schaal, "Political Preferences and the Spatial Distribution of Infrastructure: Evidence from California's High-Speed Rail," 2023. NBER working paper no. 31438.

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

Flaaen, Aaron and Justin R. Pierce, "Disentangling the effects of the 2018-2019 tariffs on a globally connected US manufacturing sector," 2021. FEDS Working paper no. 2019-86.

Gawande, K. and U. Bandyopadhyay, "Is protection for sale? Evidence on the Grossman-Helpman theory of endogenous protection," *Review of Economics and Statistics*, 2000, *82* (1), 139–152.

_, P. Krishna, and M. Olarreaga, "What Governments Maximize and Why: The View from Trade," *International Organization*, 2009, *63*, 491–532.

Gawande, Kishore and Pravin Krishna, "The Political Economy of Trade Policy: Empirical Approaches," in E. Kwan Choi and James Harrigan, eds., *Handbook of International Trade*, Blackwell Publishing, 2003.

Goldberg, Penny and Giovanni Maggi, "Protection for Sale: An Empirical Investigation," *American Economic Review*, 1999, *89* (5), 1135–1155.

Goldberg, Pinelopi K. and Nina Pavcnik, "The Effects of Trade Policy," in Kyle Bagwell and Robert W. Staiger, eds., *Handbook of Commercial Policy*, Vol. 1, Elsevier, 2016.

Greenwald, Bruce C. and Joseph E. Stiglitz, "Externalities in Economies with Imperfect Information and Incomplete Markets," *Quarterly Journal of Economics*, 1986, *101* (2), 229–264.

Grossman, Gene M. and Elhanan Helpman, "Protection for Sale," *American Economic Review*, 1994, *84* (4), 833–850.

— **and** — , "Trade Wars and Trade Talks," *Journal of Political Economy*, 1995, *103* (4), 675–708.

— **and** — , "Identity politics and trade policy," *The Review of Economic Studies*, 2021, *88* (3), 1101–1126.

Helpman, Elhanan and Paul R. Krugman, *Trade Policy and Market Structure*, Cambridge, Massachussetts: MIT Press, 1989.

Hsiao, Allan, "Coordination and Commitment in International Climate Action: Evidence from Palm Oil," 2022. Unpublished manuscript.

Hsieh, Chang-Tai and Peter J. Klenow, "Misallocation and Manufacturing TFP in China and India," *Quarterly Journal of Economics*, 2009, *124* (4), 1403–1448.

Jacobs, Bas, Egbert L.W. Jongen, and Floris T. Zoutman, "Revealed social preferences of Dutch political parties," *Journal of Public Economics*, 2017, *156*, 81–100.

Kim, In Song, "LobbyView: Firm-level Lobbying & Congressional Bills Database," 2018. Unpublished manuscript.

Kortum, Samuel and David Weisbach, "Optimal Unilateral Carbon Policy," 2021. Cowles Foundation Discussion Paper No. 2311.

Ma, Xiangjun and John McLaren, "A swing-state theorem, with evidence," 2018. NBER working paper no. w24425.

Magee, Stephen P., William A. Brock, and Leslie Young, *Black Hole Tariffs and Endogenous Policy Formation*, Cambridge: MIT Press, 1989.

Markusen, James R., "International Externalities and Optimal Tax Structures," *Journal of International Economics*, 1975, *5*, 15–29.

Matschke, X. and S.M. Sherlund, "Do labor issues matter in the determination of US trade policy? An empirical reevaluation," *American Economic Review*, 2006, *96*, 405–421.

Mayer, Wolfgang, "Endogenous Tariff Formation," *American Economic Review*, 1984, *74*, 970–985.

McLaren, John, "The Political Economy of Commercial Policy," in Kyle Bagwell and Robert W. Staiger, eds., *Handbook of Commercial Policy*, Elsevier, 2016.

Mitra, D., D.D. Thomakos, and M.A. Ulubasoglu, ""Protection for sale" in a developing country: democracy vs. dictatorship," *Review of Economics and Statistics*, 2002, *84* (3), 497–508.

Ossa, Ralph, "Trade Wars and Trade Talks with Data," *American Economic Review*, 2014, *114* (12), 4104–46.

_ , "Quantitative Models of Trade Policy," in Kyle Bagwell and Robert W. Staiger, eds., *Handbook of Commercial Policy*, Elsevier, 2016, pp. 207–260.

Rodríguez-Clare, Andres, Mauricio Ulate, and Jose P. Vasquez, "Trade with Nominal Rigidities: Understanding the Unemployment and Welfare Effects of the China Shock," 2022. NBER working paper no. 27905.

Rodrik, Dani, "Political Economy of Trade Policy," in Gene M. Grossman and Kenneth Rogoff, eds., *Handbook of International Economics*, Vol. 3, Elsevier, 1995.

Trefler, Daniel, "Trade liberalization and the theory of endogenous protection: an econometric study of US import policy," *Journal of Political Economy*, 1993, *101* (1), 138–160.

Werning, Ivan, "Pareto Efficient Income Taxation," 2007. Unpublished manuscript.

A Online Theoretical Appendix

A.1 Proof of Proposition 1

Proof. Start from the Lagrangian associated with the government's problem,

$$\mathcal{L} = u(c(n_0), z; n_0) + \sum_{n \neq n_0} \nu(n)[u(c(n), z; n) - \underline{u}(n)],$$

with $\nu(n) \geq 0$ the Lagrange multiplier associated with the utility constraint of individual n. Consider a small change in Home's trade taxes, $dt \equiv \{dt_g\}_{g \in \mathcal{G}^T}$. Let $du(n)$ denote the change in the utility of individual n. If trade taxes are constrained Pareto efficient at $t = t^*$, the following necessary first-order condition must hold,

$$\sum_{n \in \mathcal{N}} \nu(n) du(n) = 0, \tag{A.1}$$

where we use the convention $\nu(n_0) = 1$.

In a competitive equilibrium, utility maximization by individual n, as described in (6), and the government's budget balance, as described in (8), imply

$$e(p, z, u(n); n) = \pi \cdot \phi(n) + \frac{1}{N}(t^* \cdot m).$$

Differentiating and invoking the Envelope Theorem, we can express the change in n's utility as

$$du(n) = \mu(n)\{\phi(n) \cdot d\pi - c(n) \cdot dp - e_z(n) \cdot dz + \frac{1}{N}[t^* \cdot dm + m \cdot (dp - dp^w)]\}, \tag{A.2}$$

where we have used $\mu(n) = 1/e_{u(n)}$, with $e_{u(n)} \equiv \partial e(p, z, u(n); n)/\partial u(n)$ and $e_z(n) \equiv \{\partial e(p, z, u(n); n)/\partial z_k\}$.

Next, consider profit maximization by firm f, as described in (5). By the same envelope argument, the change in firm f's profits satisfies

$$d\pi(f) = y(f) \cdot dp + \pi_z(f) \cdot dz, \tag{A.3}$$

with $\pi_z(f) \equiv \{\partial \pi(p, z; f)/\partial z_k\}$. Substituting into (A.2), we then obtain

$$du(n) = \mu(n)\{d\omega(n) + [\pi_z(n) - e_z(n)] \cdot dz + \frac{1}{N}[t^* \cdot dm + m \cdot (dp - dp^w)]\},$$

with $d\omega(n) \equiv [y(n) - c(n)] \cdot dp$, $y(n) \equiv \{\sum_{f \in \mathcal{F}} y_g(f)\phi(f,n)\}$, and $\pi_z(n) \equiv \{\sum_{f \in \mathcal{F}} \phi(f,n)\pi_z(f)\}$.

From the good market clearing condition (7), we know that $m = \sum_{n \in \mathcal{N}} c(n) - \sum_{f \in \mathcal{F}} y(f)$. Since $\sum_{n \in \mathcal{N}} \phi(f,n) = 1$, it follows that $m \cdot dp = -\sum_{n \in \mathcal{N}} d\omega(n)$ and, in turn, that

$$du(n) = \mu(n)\{d\omega(n) - d\bar{\omega} + [\pi_z(n) - e_z(n)] \cdot dz + \frac{1}{N}[t^* \cdot dm - m \cdot dp^w]\},$$

with $d\bar{\omega} \equiv \sum_{n \in \mathcal{N}} d\omega(n)/N$. Substituting into (A.1) we get

$$t^* \cdot dm = -\beta \cdot d(\omega - \bar{\omega}) + m \cdot dp^w + \epsilon \cdot dz.$$

with $\beta \equiv \{\beta(n)\}$, $\beta(n) \equiv \lambda(n)/\bar{\lambda}$, $\lambda(n) \equiv \mu(n)\nu(n)$, $\bar{\lambda} \equiv \sum_{n \in \mathcal{N}} \lambda(n)/N$, and $\epsilon \equiv \sum_{n \in \mathcal{N}} \beta(n)[e_z(n) - \pi_z(n)]$.

The previous condition implies

$$t^* \cdot \frac{\partial \tilde{m}}{\partial t_g} = -\beta \cdot \frac{\partial(\tilde{\omega} - \tilde{\bar{\omega}})}{\partial t_g} + m \cdot \frac{\partial \tilde{p}^w}{\partial t_g} + \epsilon \cdot \frac{\partial \tilde{z}}{\partial t_g}, \text{ for all } g \in \mathcal{G}^T,$$

where tildes reflect the fact that all equilibrium variables are expressed as a function of t, including $\partial(\tilde{\omega}(n) - \tilde{\bar{\omega}})/\partial t_g \equiv [y(n) - c(n)] \cdot [\partial \tilde{p}/\partial t_g]$. In matrix notation, we have

$$(t^{*T})' D_t \tilde{m}^T = -\beta' D_t(\tilde{\omega} - \tilde{\bar{\omega}}) + m' D_t \tilde{p}^w + \epsilon' D_t \tilde{z}^w,$$

with $t^{*T} \equiv \{t_g^*\}_{g \in \mathcal{G}^T}$ the vector of potentially non-zero trade taxes and $m^T \equiv \{m_g\}_{g \in \mathcal{G}^T}$ the associated vector of imports.

Finally, multiply both sides by $(D_t \tilde{m}^T)^{-1}$ and use the fact that for any function $x(m^T) \equiv \tilde{x}(t^{-1}(m^T))$, $(D_{m^T} x) = (D_t \tilde{x})(D_t \tilde{m}^T)^{-1}$ to get

$$(t^{*T})' = -\beta' D_{m^T}(\omega - \bar{\omega}) + m' D_{m^T} p^w + \epsilon' D_{m^T} p^w.$$

Expressed good by good, this is equivalent to

$$t_g^* = -\beta \cdot \frac{\partial(\omega - \bar{\omega})}{\partial m_g} + m \cdot \frac{\partial p^w}{\partial m_g} + \epsilon \cdot \frac{\partial z}{\partial m_g} \text{ for all } g \in \mathcal{G}^T.$$

This concludes the proof of Proposition 1. $\square$

A.2 Extensions of Proposition 1

Other Policy Instruments (a): Non-Tariff Measures. Consider a generalized version of the environment of Section 2.1 in which Home's government may also impose two types of non-tariff measures. The first one $s^{NTM} \in \mathcal{S}^{NTM}$ is a potentially high-dimensional vector that captures all product standards, environmental regulations, labor standards, and quantity restrictions that the government may decide to impose on domestic firms, domestic individuals, and foreign firms. Such non-tariff measures may affect domestic firms' production sets, $Y(z, s^{NTM}; f)$; domestic individuals' utility, $u(c(n), z, s^{NTM}; n)$; as well as Foreign's offer curve $\Omega(p^w, z, s^{NTM})$. The second type of non-tariff measures $t^{NTM} \equiv \{t_g^{NTM}\} \in \mathcal{T}^{NTM}$ are extra charges such as anti-dumping and countervailing duties.[44] Although such non-tariff measures are legally distinct from tariffs, they affect prices and the government's revenues in the exact same way. That is, the non-arbitrage condition (2) generalizes to

$$p_g = p_g^w + t_g + t_g^{NTM}, \tag{A.4}$$

whereas the domestic government's budget constraint (8) becomes

$$m \cdot (t + t^{NTM}) = N\tau. \tag{A.5}$$

In the presence of non-tariff measures, Proposition 1 generalizes as follows.

Proposition 1 (Non-Tariff Measures)**.** *Suppose that Home's government has access to non-tariff measures $s^{NTM} \in \mathcal{S}^{NTM}$ and $t^{NTM} \in \mathcal{T}^{NTM}$. Then Pareto efficient trade taxes satisfy*

$$t_g^* = -\beta \cdot \frac{\partial(\omega - \bar{\omega})}{\partial m_g} + m \cdot \frac{\partial p^w}{\partial m_g} + \epsilon \cdot \frac{\partial z}{\partial m_g} - t_g^{NTM} \text{ for all } g \in \mathcal{G}^T. \tag{A.6}$$

Proof. For given non-tariff measures $s^{NTM} \in \mathcal{S}^{NTM}$ and $t^{NTM} \in \mathcal{T}^{NTM}$, the same arguments as in the proof of Proposition 1 imply

$$(t^* + t^{NTM}) \cdot dm = -\beta \cdot d(\omega - \bar{\omega}) + m \cdot dp^w - \epsilon \cdot dz, \tag{A.7}$$

where we have used the fact that t and t^{NTM} only enter equilibrium conditions through their sum, as can be seen from (A.4) and (A.5). Equation (A.6) then follows from (A.7) for the same reasons as in the proof of Proposition 1. □

[44] Quotas may belong to either the first or the second type of non-tariff measures depending on whether or not the domestic government sells importing rights.

Other Policy Instruments (b): Domestic Taxes. Consider a generalized version of the environment of Section 2.1 in which, in addition to trade taxes, the government may now impose producer taxes $t^y \equiv \{t_g^y\} \in \mathcal{T}^y$, as well as income tax schedules $T(\cdot;n) \in \mathcal{T}(n)$. Note that income tax schedules may vary across individuals, perhaps because of differences in marital status or state of residence. Let p denote the vector of prices faced by domestic individuals and q the vector of prices faced by domestic firms. The non-arbitrage condition (2) now generalizes to

$$p_g = p_g^w + t_g, \tag{A.8}$$

$$q_g = p_g^w + t_g + t_g^y. \tag{A.9}$$

In turn, the profit maximization problem of a given firm f is

$$\max_{y \in \Upsilon(z;f)} q \cdot y, \tag{A.10}$$

with $\pi(q, z; f)$ the associated value function. Income taxes, in turn, affect the budget constraint of individuals

$$p \cdot c(n) = \pi \cdot \phi(n) - T[\pi \cdot \phi(n); n] + \tau, \tag{A.11}$$

as well as the budget constraint of the domestic government,

$$t \cdot m + t^y \cdot y^{\text{total}} + \sum_{n \in \mathcal{N}} T[\pi \cdot \phi(n); n] = N\tau, \tag{A.12}$$

where $y^{\text{total}} \equiv \{\sum_{f \in \mathcal{F}} y_g(f)\}$ denotes the total output of domestic firms. All other equilibrium conditions are unchanged.

Let $t(n) \equiv T'[\pi \cdot \phi(n); n]$ denote the marginal income tax rate faced by individual n and let $\partial \omega_{\text{post-tax}}(n)/\partial m_g \equiv [1 - t(n)] \times [y(n) \cdot \partial q/\partial m_g] - c(n) \cdot \partial p/\partial m_g$ denote the after-tax change in individual n's real income caused by the increase in net imports of good g via its impact on domestic prices p and q. In line with our previous analysis, let $\partial \bar{\omega}_{\text{post-tax}}/\partial m_g \equiv \sum_{n \in \mathcal{N}} [\partial \omega_{\text{post-tax}}(n)/\partial m_g]/N$ denote the average change in post-tax real incomes across the population and let $\partial(\omega - \bar{\omega})_{\text{post-tax}}/\partial m_g \equiv \{\partial(\omega_{\text{post-tax}}(n) - \bar{\omega}_{\text{post-tax}})/\partial m_g\}$ denote the vector of deviations from the average. Using this new notation, we can state our next generalization of Proposition 1 as follows.

Proposition 1 (Domestic Taxes). *Suppose that Home's government has access to producer taxes*

$t^y \in \mathcal{T}^y$ and income tax schedules $T(\cdot;n) \in \mathcal{T}(n)$. Then Pareto efficient trade taxes satisfy

$$t_g^* = -\beta \cdot \frac{\partial(\omega - \bar{\omega})_{\textit{post-tax}}}{\partial m_g} + m \cdot \frac{\partial p^w}{\partial m_g} + \tilde{\epsilon} \cdot \frac{\partial z}{\partial m_g} - t^y \cdot \frac{\partial y^{\textit{total}}}{\partial m_g} \textit{ for all } g \in \mathcal{G}^T, \tag{A.13}$$

where $\tilde{\epsilon} \equiv \sum_{n\in\mathcal{N}} \beta(n)[e_z(n) - [1-t(n)]\pi_z(n)] - \sum_{n\in\mathcal{N}} t(n)\pi_z(n)$ denotes the social marginal cost of externalities in the presence of income taxation.

Proof. For given producer taxes $t^y \in \mathcal{T}^y$ and income tax schedules $T(\cdot;n) \in \mathcal{T}(n)$, utility maximization by individual n, subject to the new budget constraint (A.11), and the government's budget balance, as described in (A.12), imply

$$e(p,z,u(n);n) = \pi \cdot \phi(n) - T[\pi \cdot \phi(n);n] + \frac{1}{N}(t^* \cdot m + t^y \cdot y^{\text{total}} + \sum_{n'\in\mathcal{N}} T[\pi \cdot \phi(n');n']).$$

Differentiating the previous expression and following the same steps as in the proof of Proposition 1 implies

$$\begin{aligned} du(n) = \mu(n)\{&d\omega_{\text{post-tax}}(n) - d\bar{\omega}_{\text{post-tax}} + \{[1-t(n)]\pi_z(n) - e_z(n)\} \cdot dz \\ &+ \frac{1}{N}\{t^* \cdot dm - m \cdot dp^w + t^y \cdot dy^{\text{total}} + \sum_{n'\in\mathcal{N}} t(n')[\pi_z(n') \cdot dz]\}\}, \end{aligned}$$

with $d\omega_{\text{post-tax}}(n) \equiv [1-t(n)][y(n) \cdot dq] - c(n) \cdot dp$ and $d\bar{\omega}_{\text{post-tax}} \equiv \sum_{n\in\mathcal{N}} d\omega_{\text{post-tax}}(n)/N$. Substituting this expression in the first-order condition (A.1) and following again the same steps as in the proof of Proposition 1 implies (A.13). □

It is worth noting that there are no fiscal externalities associated with income taxes in (A.13). This reflects our assumption that individuals only earn income through ownership of firms. This formulation allows for fixed factor endowments, but not elastic factor supply.

Constrained Trade Taxes. Consider a generalized version of the environment of Section 2.1 in which trade taxes are constrained in two ways. First, for goods $g \in \mathcal{G} - \mathcal{G}^T \equiv \mathcal{G}^{-T}$, we assume that trade taxes are fixed at some level $\bar{t} \equiv \{\bar{t}_g\}_{g\in\mathcal{G}^{-T}}$, perhaps because of some prior trade agreements. Second, for goods $g \in \mathcal{G}^T$, we assume that trade taxes are coarse and must now take the same values across subsets of goods, for instance because the domestic government may not discriminate between different foreign origins. Formally, we assume that that there is a partition of the set of goods $g \in \mathcal{G}^T$ into groups indexed by G such that $t_g = \hat{t}_G$ for all goods in group G. Except for the previous constraint, the government can freely choose the level of the tax $\hat{t}_G$ on each group G. The environment of Section 2.1 corresponds to the special case in which $\bar{t} = 0$ and each group G consists of a single good. In this alternative environment, Proposition 1 extends as follows.

Proposition 1 (Constrained Trade Taxes)**.** *Suppose that: (i) $t_g = \bar{t}_g$ for all $g \in \mathcal{G}^{-T}$, with $\bar{t}_g$ exogenously given, and (ii) $t_g = \hat{t}_G$ for all $g \in \mathcal{G}^T$ in group G, with $\hat{t}_G$ freely chosen by the government. Then Pareto efficient trade taxes satisfy*

$$t_g^* = -\beta \cdot \frac{\partial(\omega - \bar{\omega})}{\partial M_G} + m \cdot \frac{\partial p^w}{\partial M_G} + \epsilon \cdot \frac{\partial z}{\partial M_G} - \bar{t} \cdot \frac{\partial \bar{m}}{\partial M_G} \text{ for all } g \text{ in group } G, \tag{A.14}$$

with M_G the total imports of goods from group G and $\bar{m} \equiv \{m_g\}_{g \in \mathcal{G}^{-T}}$ the vector of imports associated with exogenous trade taxes.

Proof. Let $\hat{t}^* \equiv \{\hat{t}_G^*\}$ denote the vector of trade taxes that the government can freely impose across different groups of goods G. The same arguments as in the proof of Proposition 1 now imply

$$(\hat{t}^*)' D_t \tilde{M} + (\bar{t})' D_t \tilde{\bar{m}} = -\beta' D_t (\tilde{\omega} - \tilde{\bar{\omega}}) + m' D_t \tilde{p}^w + \epsilon' D_t \tilde{z},$$

with $\tilde{M} \equiv \{\tilde{M}_G\}$ the vector of total imports from each group G and $\tilde{\bar{m}} \equiv \{\tilde{m}_g\}_{g \in \mathcal{G}^{-T}}$ the vector of imports of goods with fixed trade taxes, both expressed as a function of the freely chosen vector of trade taxes $\hat{t}$. Multiplying both sides by $(D_t \tilde{M})^{-1}$, we obtain (A.14). □

Negotiated Trade Taxes. Consider a variation of the environment of Section 2.1 in which Foreign comprises multiple countries indexed by i. In each country, a representative agent chooses her vector of net imports $m(i)$ in order to solve

$$\max_{m(i)} u(m(i); i) \tag{A.15}$$
$$\text{subject to: } p^w \cdot m(i) = 0.$$

Foreign's offer curve is such that Home's net imports $m \in \Omega(p^w, z)$ if and only if $m = -\sum_i m(i)$ with $m(i)$ that solves (A.15).[45] Because of trade negotiations, we assume that

[45] As is well-known, (A.15) holds if there exist a representative agent in country i who chooses $c(i)$ to maximize her utility taking prices p^w as given, perfectly competitive firms abroad that choose $y(i)$ to maximize their profits, and country i's net imports are equal to $m(i) = c(i) - y(i)$. The maximand $u(m(i); i)$ is what Dixit and Norman (1980) refer to as the "Meade utility function."

Pareto efficient trade taxes at Home now solve

$$\begin{aligned}
&\max_{t \in \mathcal{T}} \max_{\{u(n),u(i)\}} u(n_0) && \text{(A.16)}\\
&\quad \text{subject to: } u(n) \geq \underline{u}(n) \text{ for } n \neq n_0,\\
&\qquad\qquad\qquad u(i) \geq \underline{u}(i) \text{ for all } i,\\
&\qquad\qquad\qquad \{u(n), u(i)\} \in \tilde{\mathcal{U}}(t),
\end{aligned}$$

where $\tilde{\mathcal{U}}(t)$ denotes the set of domestic and foreign utilities attainable in a competitive equilibrium with trade taxes t. In this alternative environment, Proposition 1 extends as follows.

Proposition 1 (Negotiated Trade Taxes)**.** *Suppose that there are foreign representative agents whose utility the domestic government cares about, as summarized by equations* (A.15) *and* (A.16)*. Then Pareto efficient trade taxes satisfy*

$$t_g^* = -\beta \cdot \frac{\partial(\omega - \bar{\omega})}{\partial m_g} - \sum_i [1 - \beta(i)] \left[m(i) \cdot \frac{\partial p^w}{\partial m_g} \right] + \epsilon \cdot \frac{\partial z}{\partial m_g} \textit{ for all } g \in \mathcal{G}^T, \tag{A.17}$$

with $\beta(i) \equiv \lambda(i)/\bar{\lambda}$ and $\lambda(i)$ the social marginal utility of country i's income (from Home's perspective).

Proof. The Lagrangian associated with (A.16) is

$$\mathcal{L} = u(c(n_0), z; n_0) + \sum_{n \neq n_0} \nu(n)[u(c(n), z; n) - \underline{u}(n)] + \sum_i \nu(i)[u(m(i); i) - \underline{u}(i)],$$

with $\nu(i) \geq 0$ the Lagrange multiplier associated with the utility constraint of the representative agent in country i. The first-order condition (A.1) in the proof of Proposition 1 therefore generalizes to

$$\sum_{n \in \mathcal{N}} \nu(n) du(n) + \sum_i \nu(i) du(i) = 0, \text{ for all } g \in \mathcal{G}^T. \tag{A.18}$$

Starting from (A.15) and invoking the Envelope Theorem, we get

$$du(i) = -\mu(i)[m(i) \cdot dp^w], \tag{A.19}$$

with $\mu(i) \geq 0$ the Lagrange multiplier associated with the foreign representative agent's budget constraint in (A.15). Starting from (A.18) and (A.19) and following the same steps as in the proof of Proposition 1, we then obtain (A.17), with $\lambda(i) \equiv \mu(i)\nu(i) \geq 0$ the social marginal utility of foreign income (from Home's perspective). $\square$

Imperfect Competition. Consider a variation of the environment of Section 2.1 with imperfect competition. To fix ideas, suppose that each domestic firm $f \in \mathcal{F}$ chooses a correspondence $\sigma(f) \in \Sigma(f)$ that describes the set of quantities $y(f)$ that it is willing to supply and demand at every domestic price vector p, as in Costinot and Werning (2019). The feasible set $\Sigma(f)$ reflects both technological constraints and the strategic nature of competition. It may restrict a firm to choose a vertical schedule, i.e., fixed quantities, as under Cournot competition, or a horizontal schedule, i.e., fixed prices, as under Bertrand competition. For each strategy profile $\sigma \equiv \{\sigma(f)\}$, an auctioneer then selects domestic and foreign prices $(P(\sigma), P^w(\sigma))$, a vector of net imports $M(\sigma)$, a vector of externalities $Z(\sigma)$, a domestic allocation $\{Y(\sigma, f), C(\sigma, n)\}$ and a transfer $\tau(\sigma)$ such that the equilibrium conditions (i), (ii), (iii), (v), (vi), and (vii) in Definition 1 hold. Firm f solves

$$\max_{\sigma(f)\in\Sigma(f)} P(\sigma)\cdot Y(\sigma, f), \tag{A.20}$$

taking the correspondences of other firms $\{\sigma(f')\}_{f'\neq f}$ as given. Under these alternative assumptions about market structure, Proposition 1 extends as follows.

Proposition 1 (Imperfect Competition). *Suppose that firms are imperfectly competitive, as described in equation (A.20). Then constrained Pareto efficient trade taxes satisfy*

$$t_g^* = -\beta\cdot\frac{\partial(\omega-\bar{\omega})}{\partial m_g} + m\cdot\frac{\partial p^w}{\partial m_g} + \epsilon^z\cdot\frac{\partial z}{\partial m_g} - \sum_{f\in\mathcal{F}}\epsilon^y(f)\cdot\frac{\partial y(f)}{\partial m_g} \text{ for all } g\in\mathcal{G}^T, \tag{A.21}$$

where $\epsilon^z \equiv \sum_{n\in\mathcal{N}}\beta(n)e_z(n)$ denotes the social marginal cost of externalities and $\epsilon^y(f) \equiv [\sum_{n\in\mathcal{N}}\beta(n)\phi(f,n)]p$ denotes the social marginal cost of distortions in firm f's output.

Proof. Compared to the proof of Proposition 1, equations (A.1) and (A.2) continue to hold. Given (A.20), however, equation (A.3) becomes

$$d\pi(f) = y(f)\cdot dp + p\cdot dy(f), \tag{A.22}$$

with $\pi(f)$ the equilibrium profits of firm f. Substituting (A.22) into (A.2), we then obtain

$$du(n) = \mu(n)\{d\omega(n) + \sum_{f\in\mathcal{F}}\phi(f,n)[p\cdot dy(f)] - e_z(n)\cdot dz + \frac{1}{N}[t^*\cdot dm + m\cdot(dp - dp^w)]\}.$$

The same arguments as in the proof of Proposition 1 then implies (A.21). $\square$

B Online Data Appendix

This appendix provides details about data sources and measurement of the variables used throughout the paper.

B.1 Data for Model Calibration

We begin by describing the data sources and methodology that we adopt to measure the variables used to calibrate the model. All data is for the year 2017.

We define the set of domestic regions $\mathcal{R}_H$ as the 50 US states plus Washington, DC. The set of foreign countries $\mathcal{R}_F$ includes the top 100 US trade partners in 2017, plus the rest of the world treated as a single country. There are $|\mathcal{R}_H| = 51$ domestic regions and $|\mathcal{R}_F| = 101$ foreign countries.

Our sector classification contains 23 sectors. We consider 21 sectors in agriculture, oil, mining, and manufacturing that we define based on the intersection of NAICS industry codes in the 2017 BEA make-use tables and the 2017 Commodity Flow Survey (CFS): Agriculture (NAICS 11); Oil and gas (NAICS 211); Other mining (NAICS 212); Food and tobacco (NAICS 311); Textiles (NAICS 313); Apparel (NAICS 315); Wood products (NAICS 321); Paper and printing (NAICS 322-323); Oil and coal products (NAICS 324); Chemical products (NAICS 325); Plastic products (NAICS 326); Mineral products (NAICS 327); Primary metals (NAICS 331); Metal products (NAICS 332); Machinery (NAICS 333); Electronic products (NAICS 334); Electrical and appliances (NAICS 335); Motor vehicles (NAICS 3361); Other transportation equipment (NAICS 3364); Furniture (NAICS 337); and Miscellaneous manufacturing (NAICS 339). Given its importance for domestic trade, we also introduce one sector that combines Wholesale trade, Transportation and Warehousing (NAICS 42, 48 and 49), which accounts for 18% of domestic shipments in the 2017 CFS. Lastly, we have a single non-tradable, service sector containing all other NAICS sectors not listed above.

To define our product set $\mathcal{H} \equiv \cup_{s\in\mathcal{S}}\mathcal{H}_s$, we start from the 6-digit HS2017 classification, and drop products that the US did not export or import in 2017. We then use FGKK's crosswalk from 10-digit HS2017 products to 3-digit NAICS sectors to build our crosswalk from 6-digit HS2017 products to the sectors defined above. Specifically, for each 6-digit HS2017 product, we compute the share of trade (i.e., the sum of exports and imports) on each of our sectors using the trade flows of all 10-digit sub-products (of the given 6-digit HS) linked to the sector in FGKK's crosswalk. We then map the 6-digit HS2017 product to the sector in our classification with the highest trade share. This procedure implies that more than 90% of the 6-digit HS2017 products are mapped to a sector that accounts for at least 99% of the 10-digit sub-products' exports and imports. In 2017, there are 5,299 6-digit HS2017 products that have positive exports or imports and that are associated with one of our sectors.

We now describe how we build the variables used in calibration from various available datasets.

National Accounts. For each sector, we use the BEA's make-use tables (before redefinitions) to measure gross output Y_s^{NA}, intermediate spending flows I_{ks}^{NA}, final spending F_s^{NA}, exports Exp_s^{NA}, and imports Imp_s^{NA}. The make-use table contains information on production and purchases for 71 industries and 73 commodities. We first map output and spending from the commodity$\times$industry space to industry$\times$industry space by assuming that each industry supplies the same bundle of commodities to all buyers and demands the same bundle of commodities from all sellers. We then use the fact that the BEA industries are based on NAICS codes to map each of them to one of our sectors. Finally, we obtain each sector-level variable by summing across the BEA industries associated with that sector.

International Trade and Tariffs. We use USA TRADE ONLINE to download international trade data from the US Census. First, we use data by origin of movement and state of destination to obtain the value of FOB exports (origin of movement) and CIF imports (state of destination) for each region r and 6-digit HS2017 product $h \in \mathcal{H}$, which we denote as $Exp_{rih}^{\text{Census}}$ and $Imp_{irh}^{\text{Census}}$, respectively.[46] Second, for each 6-digit HS2017 $h \in \mathcal{H}$ and foreign country $i \in \mathcal{R}_F$, we use HS District-level Data to measure t_{ih}^{av} as the ratio between the calculated duty and the FOB import value (summed over all 10-digit HS2017 subproducts of the 6-digit HS2017, and all countries in the RoW). Third, we rescale imports and exports in each sector to be consistent with their values in the National Accounts:

$$X_{rih}^{M,F} = Exp_{rih}^{\text{Census}} \frac{Exp_s^{\text{NA}}}{\sum_{r \in \mathcal{R}_H, i \in \mathcal{R}_F, h \in \mathcal{H}_s} Exp_{rih}^{\text{Census}}}$$

and

$$X_{irh}^{F} = (1 + t_{ih}^{\text{av}}) Imp_{irh}^{\text{Census}} \frac{Imp_s^{\text{NA}}}{\sum_{r \in \mathcal{R}_H, i \in \mathcal{R}_F, h \in \mathcal{H}_s} (1 + t_{ih}^{\text{av}}) Imp_{irh}^{\text{Census}}}.$$

[46] A challenge with this data on international trade by domestic region is that exports are identified by the region in which their journey to port begins, which in some cases may differ from the region in which they were produced (and analogously for imports). However, the domestic shipments data described below should track the domestic flow between the region of production and the region of shipment for exports, so that we still (indirectly) attribute exports to their producing regions.

Regional Accounts. For each region, we use the BEA's Regional Accounts to measure GDP and employment in each sector by summing across industries associated with that sector (using the same mapping from BEA industries to our sector classification discussed above). We define N_{rs} as the measured employment in each region and sector. Our measure of GDP, Π_{rs}, corresponds to the variable implied by the BEA's regional accounts, but re-scaled to match national GDP in each sector; that is, $\Pi_{rs} = \Pi_{rs}^{\text{RA}}(\Pi_s^{\text{NA}} / \sum_{r\in\mathcal{R}_H} \Pi_{rs}^{\text{RA}})$ where Π_{rs}^{RA} is the GDP reported in the Regional Accounts for sector s and region r, and $\Pi_s^{\text{NA}} = Y_s - \sum_{k\in\mathcal{S}} I_{ks}^{\text{NA}}$ is the value-added of sector s in the National Accounts. Reassuringly, for each sector, aggregate GDP from the Regional and National Accounts are very close; on average across sectors, the sum of regional GDP is 99.4% of the national GDP.

For each region-sector, we impute gross output as the maximum between its exports, $X_{rs}^{M,F} = \sum_{i\in\mathcal{R}_F} \sum_{h\in\mathcal{H}_s} X_{rih}^{M,F}$, and its GDP-implied revenue, $\Pi_{rs}/(1-\alpha_s)$:

$$Y_{rs} = \max\left\{\Pi_{rs}/(1-\alpha_s), X_{rs}^{M,F}\right\}.$$

We note that this procedure guarantees that the model matches observed GDP and employment reported in the BEA for almost all region-sector pairs in the United States.[47]

Domestic Shipments. We use the microdata of the 2017 CFS to measure region-to-region domestic shipments for each sector. We start by mapping the NAICS-based CFS classification to our sector classification. We then obtain sectoral bilateral shipments, X_{ors}^{CFS}, by summing the value of shipments in sector s from region o to region r, while adjusting for shipment sampling weights. For the subset of our sectors that are either equal to a CFS sector or the sum of multiple CFS sectors, we define bilateral domestic flows as

$$X_{ors}^{H} = x_{ors}^{\text{CFS}}(Y_{os} - X_{os}^{M,F}) \quad \text{with} \quad x_{ors}^{\text{CFS}} \equiv \frac{X_{ors}^{\text{CFS}}}{\sum_{d\in\mathcal{R}_H} X_{ods}^{\text{CFS}}}.$$

We now turn to the four tradable sectors without an analog in the CFS. Two sectors, Motor vehicles (NAICS 3361) and Other transportation equipment (NAICS 3364), are associated with the same sector in the CFS (Transportation Equipment Manufacturing, NAICS 336). For them, we compute bilateral domestic flows as $X_{ors}^{H} = x_{or336}^{\text{CFS}}(Y_{os} - X_{os}^{M,F})$, restricting the share of r in o's domestic shipments in each of the two sectors in our classification to be the same as that of their parent sector in the CFS. In addition, the CFS does not

[47] The only failure to match the GDP in the BEA Regional Accounts occurs when observed exports $X_{rs}^{M,F}$ exceed $\Pi_{rs}/(1-\alpha_s)$, in which case our model implies a region-sector GDP that is higher than the GDP reported in the BEA. Reassuringly, this happens for less than 3% of region-sector pairs, with a total excess amount that is less than 0.2% of US GDP.

report domestic shipments for two of our sectors: Agriculture (NAICS 11) and Oil and gas (NAICS 211). For them, we assume that the share of r in o's domestic shipments is the same as that of the average shipment in the CFS, $X_{ors}^{H} = x_{or}^{\text{CFS}}(Y_{os} - X_{os}^{M,F})$ with $x_{or}^{\text{CFS}} \equiv X_{or}^{\text{CFS}} / \sum_{d \in \mathcal{R}_H} X_{od}^{\text{CFS}}$ and X_{or}^{CFS} the value of all shipments from o to r in the CFS. Finally, given our assumption that all goods in the Service sector $(s = S)$ cannot be traded, we set $X_{rrS}^{H} = Y_{rS}$ and $X_{orS}^{H} = 0$ for $o \neq r$. By construction, our procedure guarantees that, for each region-sector pair, gross output is equal to the sum of observed trade flows to all foreign and domestic regions.

B.2 Additional Data for Estimation

Foreign Import Tariffs. The model validation presented in Section 3.5 relies on US import tariff changes implemented by the Trump administration in 2018-2019, as well as the retaliatory tariffs applied by US trading partners during the same period. Our measure of the US import tariff changes is the difference between 2019 and 2017 in the ad-valorem equivalent tariff applied by the US on each of the 6-digit HS2017 products and foreign countries that we described in Section 3.3 and Appendix B.1. FGKK's replication package is our source for data on the retaliatory tariff changes applied by US trading partners on different 6-digit HS2017 products during the US-China trade war.

Non-Tariff Measures. Our main data source regarding non-tariff measures (NTMs) is UNCTAD TRAINS. We use the bulk download tool to obtain data on the NTMs that the US imposed in 2017 on each 6-digit HS product and foreign country. The data set classifies US NTMs into five categories: (A) "sanitary and phytosanitary measures," (B) "technical barriers to trade," (C) "pre-shipment inspection and other formalities," (E) "non-automatic import licensing, quotas, prohibitions, quantity-control measures and other restrictions not including sanitary and phytosanitary measures or measures relating to technical barriers of trade", and (F) "price-control measures, including additional taxes and charges." We use this data to create a dummy variable for each category that is equal to one for an origin-product pair in our sample if and only if the associated 6-digit HS and foreign country were subject to at least one NTM in 2017.

We complement this dataset with information on the anti-dumping and countervailing measures that the US had in place in 2017. Our main source is the World Bank Temporary Trade Barriers Database (Bown et al., 2020), which reports the countries, products and years covered by each case that resulted in the US implementing anti-dumping and countervailing measures.[48] Since the data is based on the HS classification of the case's year, we use HS classification crosswalks to link 6-digit HS2017 products to the cases since 1996 that are still in place in 2017. We then create a dummy that is equal to one for an origin-product pair in our sample if and only if the associated 6-digit HS and foreign country were subject to at least one anti-dumping or countervailing measure in 2017. For each such origin-product pair, we also compute an estimate of the average tariff rate inclusive of anti-dumping and countervailing duties. We start by computing the average anti-dumping and countervailing duty rate applied to targeted firms across all cases associated with imports of that product from that origin that are still in force in 2017. We then add to this rate the baseline tariff rate that the United States applied to imports of that product from that origin in 2017.

Marginal Income Tax Rates. We download individual-level data from the 2017 ACS from IPUMS USA. We start by building a mapping from the ACS NAICS-based industry codes (INDNAICS) to our sector classification. We use this mapping to assign employed individuals to a region-sector pair based on their sector of employment and region of residence. We then compute each individual's marginal wage and salary income tax rate (federal plus state) by entering ACS variables into the NBER's Tax Sim 35 tax calculator, including information on wage and salary, business and farm, self-employment, investment, pension, social security, and welfare income, state of residence, age, marital status and spousal income, dependents, rent, and childcare expenses. Next, we average these marginal rates across individuals within each region-sector pair, weighting by ACS person weight and by wage and salary income.[49] This forms our measure of the average marginal tax on labor income generated by each region-sector pair. To obtain our measure of the average marginal tax on total income generated by each region-sector pair, we compute the weighted average of the pair's labor income tax and the capital income tax rate of 15%, weighting the former by the sector's labor share of value added. We obtain labor shares of value added from the 2017 BEA use table.

Unrestricted Tariffs. We classify the tariff on a product from a given origin as unrestricted if it satisfies one of the following two conditions: (i) it is associated with a country that is not a WTO member, or (ii) it is associated with a 6-digit HS product subject to tariff overhang and a country that is a WTO member and does not have a PTA with the United

[48]We thank Aksel Erbahar for his assistance in working with this dataset.

[49]For less than 2% of region-sector pairs, the 2017 ACS contains no observations. We impute marginal rates for these missing region-sector pairs as the predicted values of a regression of marginal rates on sector and region indicator variables.

States. We define a 6-digit HS product as subject to tariff overhang if all of its 8-digit sub-products satisfy two conditions: (i) all tariffs are ad-valorem, and (ii) the MFN applied tariff is below its WTO negotiated bound. We proceed as follows to build a dummy for whether the 8-digit HS product has a MFN applied tariff below its WTO negotiated bound. We first use the 2017 Annual Tariff Data from the USITC to measure the MFN ad-valorem import tariff of 8-digit HS2012 products. We then use the WTO Consolidated Tariff Schedules Database (available at WTO Tariff Analysis Online) to compute the negotiated bound on ad-valorem tariffs of 8-digit HS2007 products. We use the USITC crosswalk to convert both datasets to the 8-digit HS2017 classification. We only consider in our analysis the set of 6-digit HS2017 products for which all 8-digit HS2017 sub-products can be uniquely mapped to a tariff line in the USITC and WTO datasets.

Demographic Composition of Employment. We download individual-level data from the 2017 ACS from IPUMS USA. We start by building a mapping from the ACS NAICS-based industry codes (INDNAICS) to our sector classification. We use this mapping to assign employed individuals to a region-sector pair based on their sector of employment and region of residence. We also assign each employed individual to one out of eight demographic groups based on the combinations of sex (male or female), race (white or non-white), and education (at least 4 years of college or less than 4 years of college). Finally, for each region-sector pair, we use sampling weights to compute the distribution of employment across the eight demographic groups.

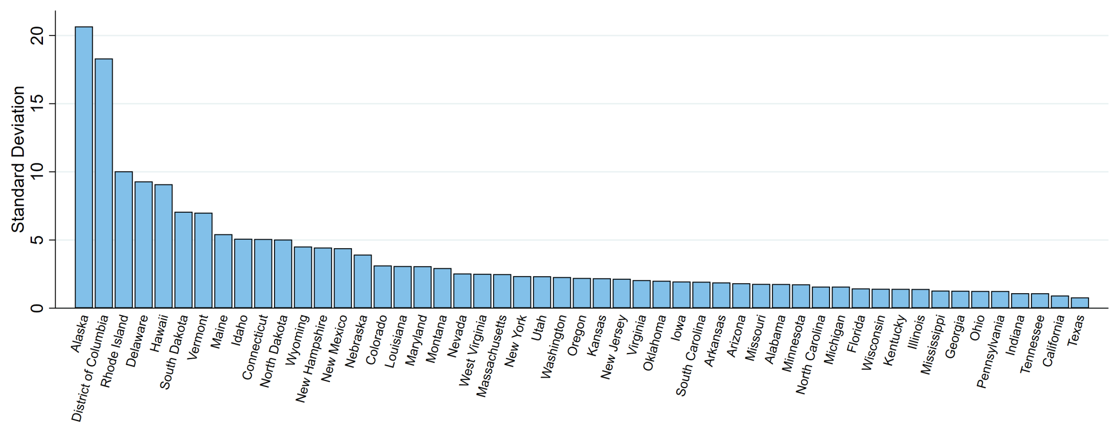
Swing States. Our source is the database of U.S. presidential elections from the MIT Election Data and Science Lab. For each state, we compute the average share of votes for the Republican and Democratic candidates in all presidential elections between 2000 and 2016. We define as swing states those with a voting margin below 5% such that $\text{vote margin}_r \equiv |\text{Republican avg. vote share}_r - \text{Democratic avg. vote share}_r|$. According to this definition, the swing states are: Colorado, Florida, Iowa, Ohio, Nevada, New Hampshire, Pennsylvania, Virginia, and Wisconsin.

Lobbying Spending. Our source of lobby spending data is LobbyView (Kim, 2018). We use the report-level database to obtain all quarterly report fillings between 2000 and 2016. We match each report to one sector in our classification using the NAICS industry of the report's client (available in LobbyView's client-level database). Given the availability of information on the client's industry, we are able to assign 77% of all lobby spending to one of our sectors. We also obtain information on the lobbying issues of each report from the issue-level database. We define reports for trade-related issues as those associated with a report that was either about domestic/international trade ("TRD") or miscellaneous tariff bills ("TAR"). Finally, for each sector, we compute the average annual amount of lobbying spending between 2000 and 2016 for all issues as well as for the subset of trade-related issues.

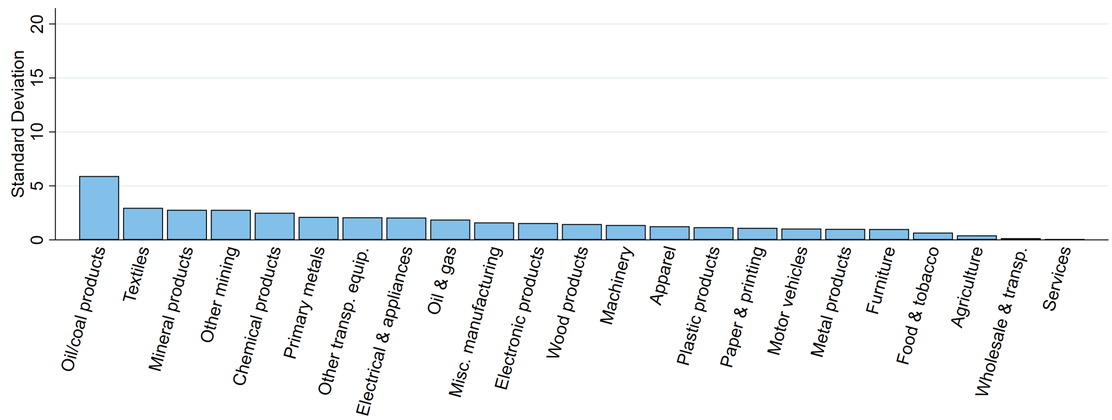
C Online Estimation Appendix

Figure C.1: Standard deviation of sensitivity of real earnings to different imports

(a) Region

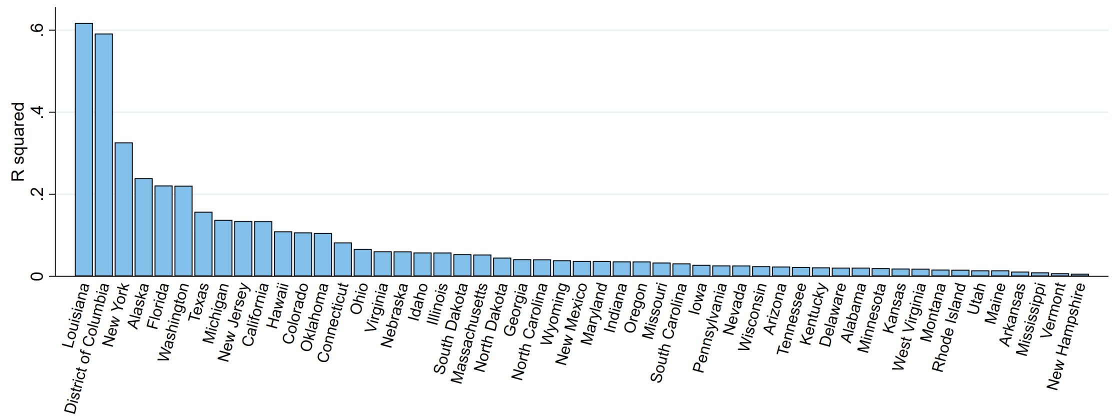


(b) Sector



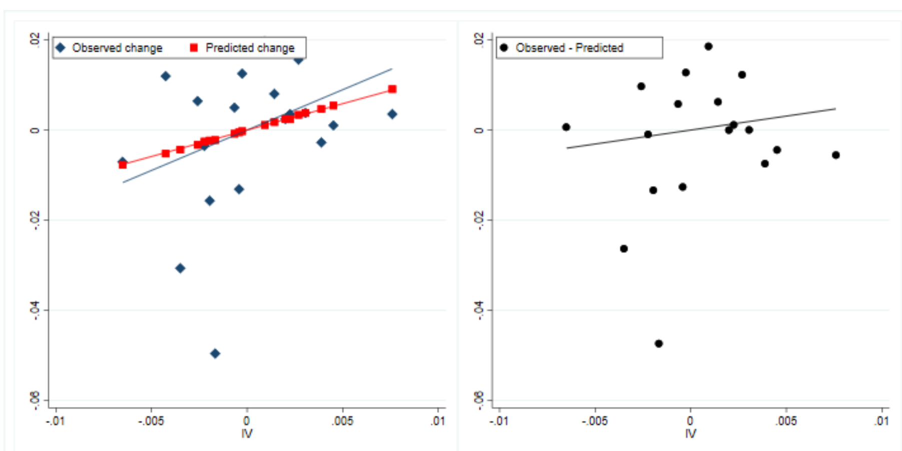
Notes: This figure reports the standard deviation of $\partial(\omega_s - \bar{\omega})/\partial m_{ih}$ and $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$, taken across all origin countries i and products h in our baseline sample, separately for each sector and region.

Figure C.2: R^2 **of regression for each region** r **of** $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ **on** $\{\partial(\omega_s - \bar{\omega})/\partial m_{ih}\}_{s \in \mathcal{S}}$



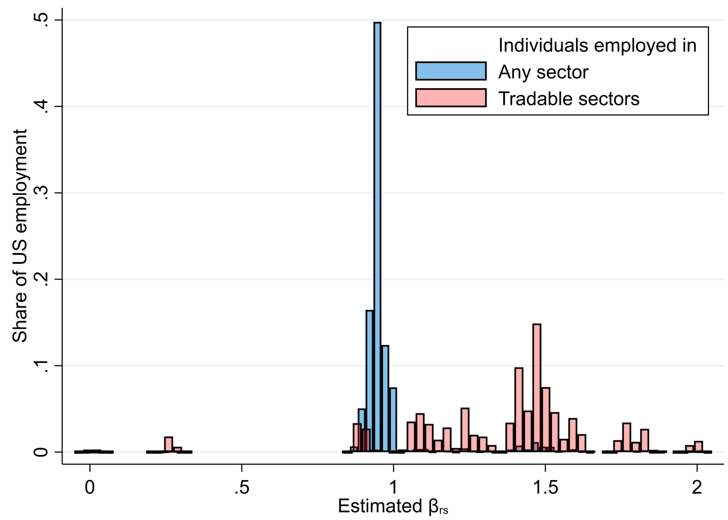
Notes: This figure reports the R^2 from a regression, estimated separately for each region r, of $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ on the set of 23 sectoral variables $\{\partial(\omega_s - \bar{\omega})/\partial m_{ih}\}_{s \in \mathcal{S}}$ and a constant in our baseline sample of origin countries i and products h.

Figure C.3: Changes in earnings per worker during the US-China trade war: a test



Notes: The left figure plots observed and predicted changes in earnings per worker against our IV and the right figure plots the difference between observed and predicted changes against our IV. Each figure displays a binned scatter plot in which the underlying region-sector observations are grouped into 20 bins in terms of the IV, weighted by initial employment.

Figure C.4: Distribution of estimated welfare weights

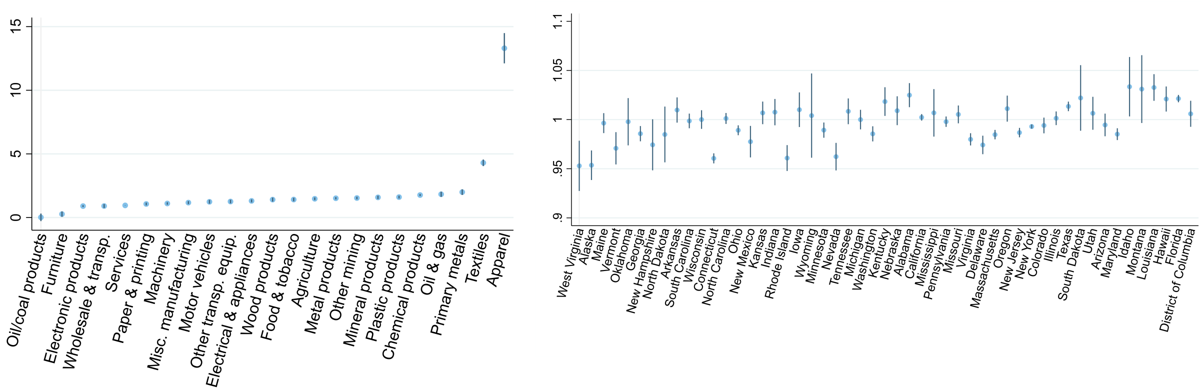


Notes: This figure displays the histogram of estimates of welfare weights across regions and sectors, $\hat{\beta}_{rs} = \hat{\beta}_s + \hat{\beta}_r$, as in Figure 3, but for $\hat{\beta}_{rs} \leq 2.1$. The blue bars correspond to all US individuals, and the red bars correspond to the 8.9% of US individuals employed in tradable sectors.

Figure C.5: Estimates of average welfare weights across sectors and regions

(a) $\bar{\beta}_s$ estimates

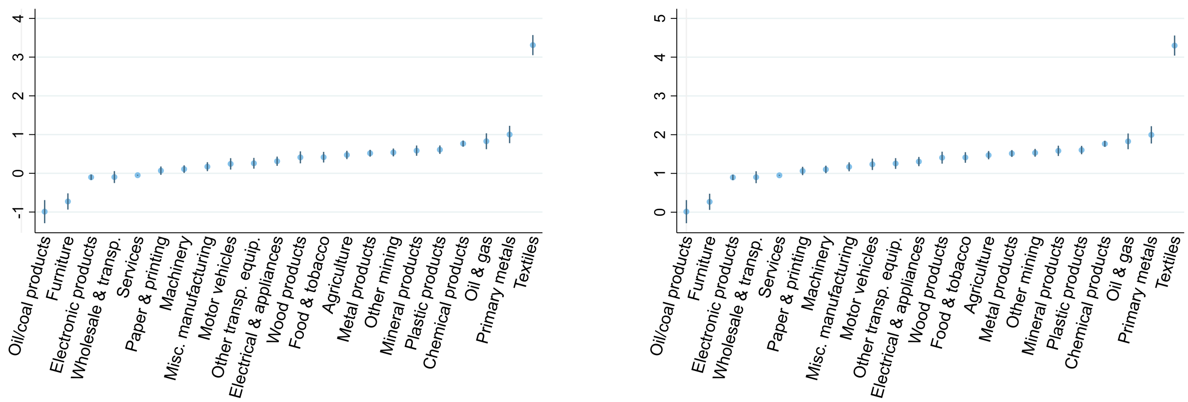
(b) $\bar{\beta}_r$ estimates



Notes: Panels (a) and (b) display average welfare weights within each sector and region, computed as $\bar{\beta}_s \equiv \sum_r \left(\frac{N_{sr}}{N_s}\right) \hat{\beta}_{rs}$ and $\bar{\beta}_r \equiv \sum_s \left(\frac{N_{sr}}{N_r}\right) \hat{\beta}_{rs}$, respectively. Blue dots correspond to point estimates and bars denote 95% confidence intervals. Standard errors are clustered at the product-level.

Figure C.6: Estimates of sector-based welfare weights (omitting Apparel sector)

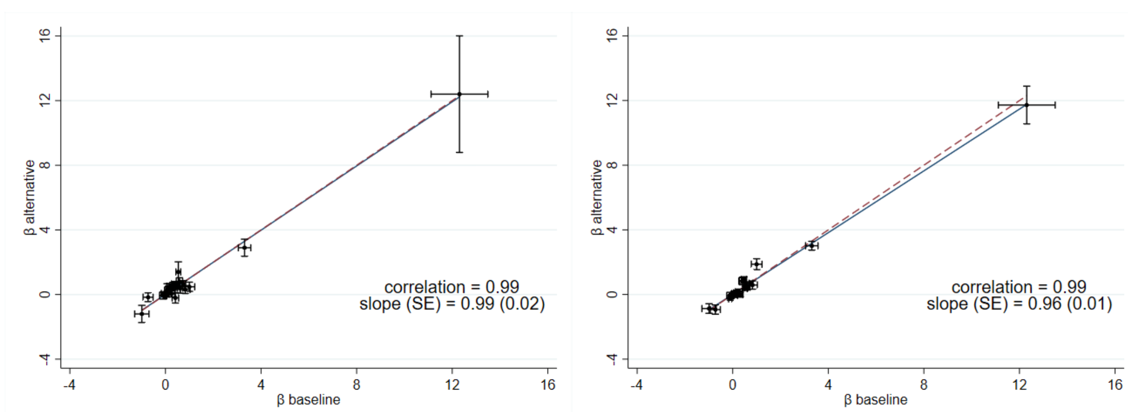
(a) $\hat{\beta}_s$ estimates **(b)** $\bar{\beta}_s$ estimates



Notes: Panel (a) displays estimates of the marginal social return, β_s, for each sector s, as obtained from equation (24) and normalized such that the mean of $\hat{\beta}_s$ across s is zero. Panel (b) displays estimates of average welfare weights computed as $\bar{\beta}_s \equiv \sum_r \left(\frac{N_{sr}}{N_s}\right) \hat{\beta}_{rs}$. Blue dots correspond to point estimates and bars denote 95% confidence intervals. In both cases, the Apparel sector is omitted for clarity. Standard errors are clustered at the product-level.

Figure C.7: Additional sensitivity analysis with respect to NTMs

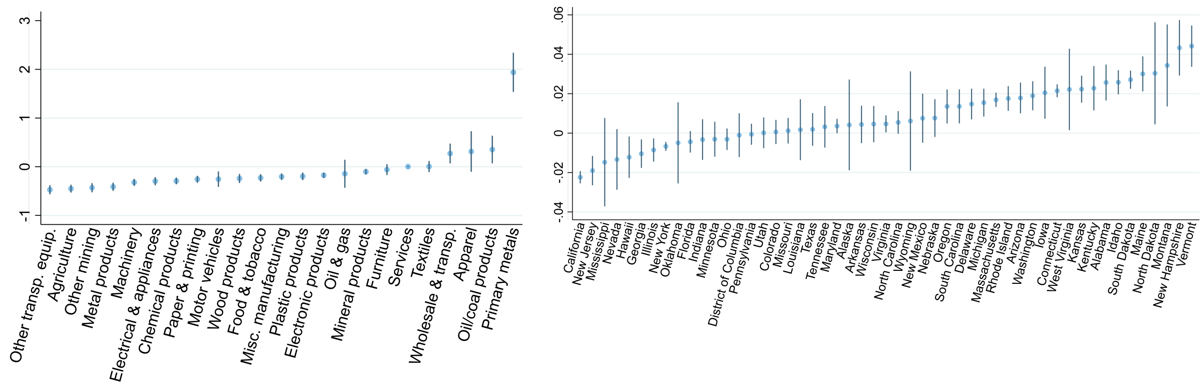
(a) Subsample without NTMs **(b)** Include AD and CV duties



Notes: Each figure displays the relationship between baseline estimates (of $\hat{\beta}_r$ and $\hat{\beta}_s$ across all regions r and regions s) on the x-axis and estimated values obtained under alternative assumptions on the y-axis. Panel (a) focuses on the subsample of 26.2% observations with no NTM in place, whereas Panel (b) adds to our measure of tariffs an estimate of antidumping (AD) and countervailing (CV) duties in 2017. The solid blue line illustrates the line of best fit (whose slope and standard error are reported) and the dashed red line indicates the 45-degree line. Bars indicate 95% confidence intervals on each estimate.

Figure C.8: Changes in welfare weights across sectors and regions, 2017-2019

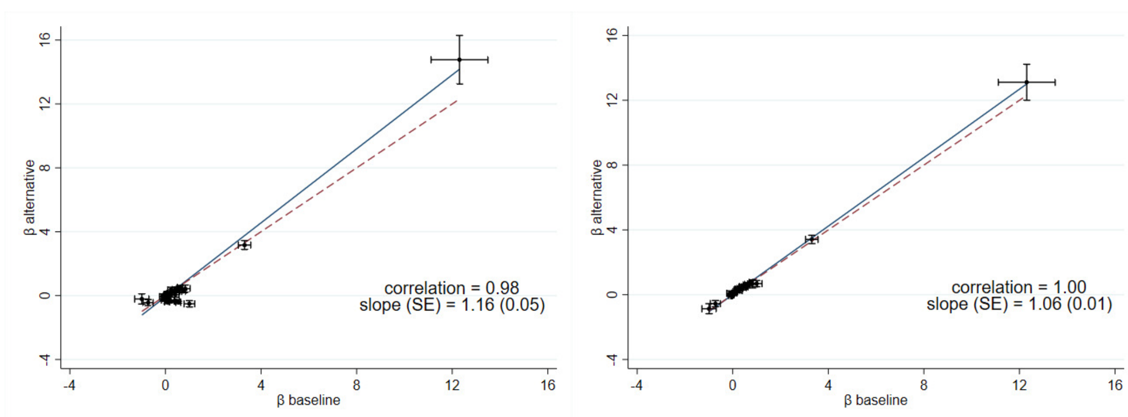
(a) $\hat{\beta}_s^{2019} - \hat{\beta}_s^{2017}$ estimates **(b)** $\hat{\beta}_r^{2019} - \hat{\beta}_r^{2017}$ estimates



Notes: The left panel displays the difference in the sectoral component of welfare weights between 2017 and 2019, $\hat{\beta}_s^{2019} - \hat{\beta}_s^{2017}$, for each sector s, as obtained from the estimation of equation (24) separately for 2017 and 2019. The right panel displays the analog for the regional component of welfare weight, $\hat{\beta}_r^{2019} - \hat{\beta}_r^{2017}$, for each US region r. Blue dots correspond to point estimates and bars denote 95% confidence intervals. Standard errors are clustered at the product-level.

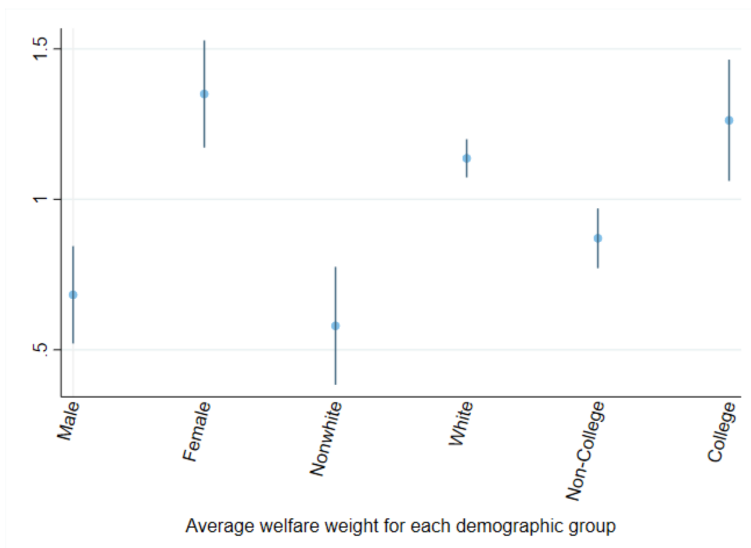
Figure C.9: Additional sensitivity analysis with respect to controls

(a) Drop constant **(b)** Drop terms-of-trade control



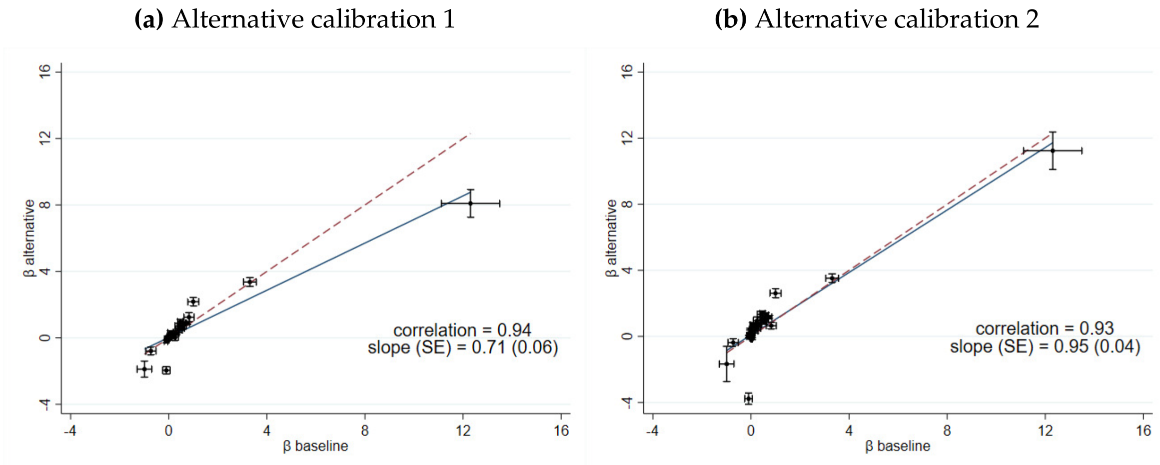
Notes: Each figure displays the relationship between baseline estimates (of $\hat{\beta}_r$ and $\hat{\beta}_s$ across all regions r and sectors s) on the x-axis and estimated values obtained under alternative assumptions on the y-axis. Panel (a) drops the constant from the baseline control set, whereas Panel (b) drops the control for terms-of-trade motives. The solid blue line illustrates the line of best fit (whose slope and standard error are reported) and the dashed red line indicates the 45-degree line. Bars indicate 95% confidence intervals on each estimate.

Figure C.10: Estimates of average welfare weights across other demographic groups



Notes: The figure displays the estimated values of the average welfare weight of each demographic group d, computed as $\bar{\beta}_d \equiv \sum_{r,s} \left(\frac{N_{rsd}}{N_d}\right) \hat{\beta}_{rsd}$.

Figure C.11: Sensitivity analysis with respect to treatment of imbalances



Notes: This figure displays the relationship between baseline estimates (of $\hat{\beta}_r$ and $\hat{\beta}_s$ across all regions r and sectors s) on the x-axis and estimated values obtained under alternative treatments of imbalances on the y-axis. Panel (a) accounts for regional imbalances following Caliendo et al. (2019). It removes the residual agent, setting $\xi_{rs} = 0$ for all r and s, and introduces additional region-specific lump-sum transfers d_r set so that each region's total spending equals its total income. Since these transfers only vary across regions, they are not sufficient to guarantee market clearing in every region-sector pair. The procedure resolves this issue by computing market clearing prices and measuring the sensitivity of real earnings to imports around the associated counterfactual equilibrium. Panel (b) follows Rodríguez-Clare et al. (2022). The procedure also starts by setting $\xi_{rs} = 0$ for all r and s and sets d_r so that each region's total spending equals its total income, but it recalibrates final spending shares, allowing them to vary by region in order to match the composition of spending, subject to the constraint that spending shares are positive. Since this constraint means that the resulting shares are not guaranteed to satisfy market clearing, the final step of this procedure again computes market clearing prices and measures the sensitivity of real earnings to imports around the associated counterfactual equilibrium. In each panel, the solid blue line illustrates the line of best fit (whose slope and standard error are reported) and the dashed red line indicates the 45-degree line. Bars indicate 95% confidence intervals on each estimate.

Table C.1: Sensitivity analysis for estimates of β_r and β_s

	All (1)	Drop apparel (2)	Employment-weighted (3)
Panel (a): Non-tariff measures			
Slope	0.95	0.96	0.99
(SE)	(0.00)	(0.04)	(0.04)
Correlation	1.00	0.97	0.98
Panel (b): Domestic taxes			
Slope	1.30	1.21	1.29
(SE)	(0.01)	(0.04)	(0.02)
Correlation	1.00	1.00	1.00
Panel (c): Unconstrained tariffs			
Slope	1.30	1.28	1.34
(SE)	(0.03)	(0.23)	(0.07)
Correlation	0.97	0.75	0.87
Panel (d): MFN clause			
Slope	0.92	0.77	0.86
(SE)	(0.02)	(0.13)	(0.07)
Correlation	0.99	0.92	0.95
Panel (e): Negotiated trade taxes			
Slope	1.03	0.75	1.12
(SE)	(0.04)	(0.16)	(0.09)
Correlation	0.98	0.80	0.90
Panel (f): Reverse causality from tariffs to imports			
Slope	0.68	0.42	0.55
(SE)	(0.03)	(0.15)	(0.13)
Correlation	0.95	0.54	0.58
Panel (g): Censoring of tariffs at zero			
Slope	1.01	0.88	1.08
(SE)	(0.02)	(0.07)	(0.11)
Correlation	0.98	0.82	0.84
Panel (h): Controlling for education, gender, and race			
Slope	1.01	1.03	1.03
(SE)	(0.00)	(0.02)	(0.02)
Correlation	1.00	0.98	0.98

Notes: Each panel reports the results of a regression of alternative estimates of β_r and β_s on baseline estimates of β_r and β_s, where the alternative estimates are obtained under the specifications described in Section 4.3. The regressions reported in column (1) include all regions r and sectors s, whereas those in column (2) drop the apparel sector, and those in column (3) conduct regressions that are weighted by employment.

Table C.2: Winners and losers from redistributive trade protection - sensitivity

	(1)	(2)	(3)	(4)	(5)	(6)
Panel (a): Estimated welfare weight						
Sectoral lobbying intensity:						
High trade-lobbying dummy	0.675				0.675	0.675
	(0.104)				(0.104)	(0.104)
High all-lobbying dummy		0.366				
		(0.027)				
Log trade-lobbying per worker			0.233	0.213		
			(0.040)	(0.070)		
Swing state:						
< 5% margin, 2000-2016	0.000	0.001	0.002	0.003		
	(0.014)	(0.015)	(0.020)	(0.022)		
< 3% margin, 2000-2016					0.008	
					(0.016)	
< 5% margin, 1988-2000						0.007
						(0.014)
Log employment				-0.010		
				(0.017)		
R^2	0.091	0.032	0.135	0.136	0.091	0.091
Panel (b): Estimated protection gain						
Sectoral lobbying intensity:						
High trade-lobbying dummy	0.018				0.018	0.018
	(0.002)				(0.002)	(0.002)
High all-lobbying dummy		0.020				
		(0.002)				
Log trade-lobbying per worker			0.008	0.007		
			(0.001)	(0.002)		
Swing state:						
< 5% margin, 2000-2016	0.001	0.001	0.001	0.001		
	(0.002)	(0.002)	(0.002)	(0.002)		
< 3% margin, 2000-2016					0.001	
					(0.002)	
< 5% margin, 1988-2000						0.000
						(0.002)
Log employment				-0.001		
				(0.001)		
R^2	0.095	0.140	0.264	0.267	0.096	0.095

Notes: Sample of 1,080 region-sector pairs with positive employment in 2017. All specifications include a constant and are weighted by employment in 2017. The dependent variable in panel (a) is the estimated welfare weight and that in panel (b) is the estimated gain from redistributive trade protection. Column (1) is the baseline specification in Table 2. In columns (2)-(4), we consider alternative definitions of sectoral lobbying intensity based on lobbying contracts for all issues and the log of trade-lobbying expenditure per worker. In columns (5)-(6), we consider alternative definitions of swing states that vary the vote margin cutoff and the set of presidential elections used to compute the vote margin. Robust standard errors in parentheses.