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 about a third of US tariff variation and that it causes large monetary transfers between US individuals, mostly driven by differences in welfare weights across sectors of employment. In terms of political economy mechanisms, the welfare weights that we estimate are consistent with lobbying being a significant driver of US trade protection. Perhaps surprisingly, swing states in US presidential elections 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 so 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 significant 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 in the country of interest ("Home") 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 requirement satisfied by leading political economy models, as we discuss further below. For any such political process, our general

[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).

tariff formula 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 policymaking 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. To measure $\partial[\omega(n) - \bar{\omega}]/\partial m_g$, we develop a 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 predictions are consistent with the differential changes in labor market outcomes across US regions and sectors observed during the US-China trade war, as we establish using the testing procedure of Adao et al. (2023a).

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 \$1.17, \$1.74, 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, Vehicles, and Metals, have a social marginal utility of income that is 138% higher than the US average. In contrast, the social marginal utility of income enjoyed by individuals in the three states with the highest welfare weights, Florida, Vermont, and Wyoming, is only 7.5% higher.

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, such as antidumping and countervailing duties; production subsidies, that may vary either across states or sectors; and income taxes, that are imposed both at the state and federal level. They are also highly correlated with estimates that account for exogenous constraints on US tariffs, such as those due to WTO membership; misspecification of terms-of-trade controls, perhaps due to negotiated trade taxes; and reverse causality between tariffs and imports.

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. In terms of magnitude, the redistributive motive accounts for a significant share of the cross-sectional variation in US tariffs: 32% in 2017, out of which 29% derives from sector-specific welfare weights and 3% from state-specific ones. Likewise, the monetary transfers associated with redistributive trade protection are large, with a long upper tail. Transitioning to a counterfactual US economy with welfare weights equalized across individuals—and hence with tariffs purged of their redistributive component—would reduce the real earnings of individuals at the 90th, 95th, and 99th percentiles of the gains from redistributive trade protection by $529, $1,700, and $2,814, respectively. In contrast, individuals at the 10th percentile lose $624.

In terms of political economy mechanisms, we use our estimates of welfare weights to discriminate between two leading explanations for the existence of tariffs: sectors' abilities to lobby, as formalized by Grossman and Helpman (1994), and states' abilities to swing presidential elections, as formalized by Ma and McLaren (2018). We show that the cross-sectional variation in our welfare weights is consistent with lobbying being a significant driver of US trade protection, with a lobbying dummy explaining about a fifth of the overall variation in welfare weights across sectors and regions. In contrast, we do not find that individuals from swing states receive significantly higher weights.

Related Literature

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

The literature on redistributive politics is rich and varied. Persson and Tabellini (2002) describe its focus to be on "how the interplay between democratic institutions and self-seeking individuals, lobby groups, and parties determines the degree of redistribution." Numerous theoretical models of the previous interactions have been developed and applied to the analysis of trade policy. Classic examples include Mayer (1984), Grossman and Helpman (1994), Dixit and Londregan (1996), and Grossman and Helpman (2005). This line of research has been complemented by detailed empirical studies highlighting different dimensions of these interactions, from lobbying expenditure on trade policy, as in Bombardini and Trebbi (2012) and Kim (2017), to the votes of elected officials on trade bills and trade agreements, as in Conconi et al. (2014) and Conconi et al. (2024).

To evaluate the importance of redistributive trade protection and identify the individuals who benefit from it, this paper leverages a key implication of the previous models: competition, whether between political candidates or lobbies, ensures that trade policies are constrained Pareto efficient. Our approach, which relies on this high-level property of the political process and abstracts from the specifics, has both costs and benefits. The main cost is in terms of scope. Since we do not specify a structural model of the political process, we cannot say anything about how changes in this process, for instance new limits on political contributions or changes in electoral competition, may endogenously affect welfare weights and, in turn, redistributive trade protection. We can only estimate the welfare weights associated with current political institutions. The main benefit of our approach is in terms of robustness. The upside of not relying on a specific structural model of the political process is, of course, that the validity of our empirical estimates does not rely on it either.[2]

Although our empirical strategy is agnostic about the political process through which tariffs come about, our estimates of welfare weights do have implications for what this underlying political process may or may not be. To take a well-known example, Grossman and Helpman's (1994) protection for sale model predicts that the welfare weights of different individuals only depend on whether they are employed in politically-organized sectors or not. In Ma and McLaren (2018), individuals instead only receive positive welfare weights if employed in a swing state. These are stark predictions that one can formally test using our empirical estimates, as we will do in Section 6. More generally, one can view the gaps in the social marginal utility of income of different individuals as the analog of the "wedges" in the misallocation literature (see e.g. Chari et al., 2007 and Hsieh and Klenow, 2009). In this sense, our estimates can be used to discriminate between existing political economy models in the same way that wedges can be used to discriminate between different sources of distortions.

From the public finance literature, our paper borrows 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).[3] Our general tariff formula also builds on the type of necessary first-order condition that is common in optimal commodity taxation, e.g. Diamond and Mirrlees (1971) and Greenwald and Stiglitz (1986). 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

[2]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 in the context of a partial-equilibrium model. In the same spirit, Helpman (1995) points out that the political support function pioneered by Hillman (1982) can be viewed as a reduced-form of the influence-driven contribution approach in Grossman and Helpman (1994), though the emphasis is on the limits of this equivalence and the distinct predictions of different political economy models.

[3]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.

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.

Within the trade literature, others have attempted to estimate the welfare weights that governments may assign to different sectors, including Gardner (1987), Tyers (1990), Francois and Nelson (2014), and Ossa (2014), and to a lesser extent different regions, as in Ma and McLaren (2018) and Gawande et al. (2024). Previous work typically focuses on environments that are partial equilibrium or feature a small number of tariffs. Ossa (2014), for instance, combines a multi-sector gravity model with data on the average tariffs for thirty-three industries in order to identify the thirty-three welfare weights that they each receive, up to normalization. Our paper offers a "shovel-ready" way to estimate welfare weights in general economic environments and without having to restrict the granularity of observed trade policy. This is critical to identify welfare weights that may simultaneously vary across sectors and regions of employment.

A striking feature of previous work on the political economy of trade policy is the limited extent to which it draws on advances in the empirical estimation of causal responses of labor market outcomes to trade policy, as reviewed in Goldberg and Pavcnik (2016). 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 model designed to harness the substantial heterogeneity in exposure to trade across the US population, and, importantly, we 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 $\mathrm{Y}(z; f)$. A production plan consists of a net output vector $y(f) \equiv \{y_g(f)\}$. It is feasible if

$$y(f) \in \mathrm{Y}(z; f).$$

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.[4] Tax revenues are rebated to domestic individuals through a uniform lump-sum transfer τ.

[4]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.

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 $\Upsilon(z; f)$, 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.

2.2 Competitive Equilibrium

Profit Maximization. Each firm f chooses $y(f)$ 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 $c(n)$ 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, with $\sum_{n \in \mathcal{N}} \phi(f, n) = 1$ for all $f \in \mathcal{F}$. 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. 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.

Examples. Trade taxes that satisfy Definition 2 may arise under various political systems. Mayer (1984) focuses on direct democracy. Under majority voting, he shows that tariffs in his model maximize the utility of the median voter.[5] The same median voter outcome would occur in a representative democracy in which two political parties compete for office by announcing (and committing) to a policy as in Downs (1957). If individuals themselves run for office (and lack the ability to commit to a policy), as in Besley and Coate (1997), then the median voter outcome may not arise, but the utility of whoever wins the election will continue to be maximized. More generally, electoral competition for votes between political parties with different ideologies may lead policy choices to maximize a weighted sum of individuals' utility, with higher weights given to "non-partisan" or "swing voters" whose votes are more likely to be swayed by changes in policy, as in Dixit and Londregan (1996). This is the approach followed by Ma and McLaren (2018) to analyze the role of "swing states" for US trade policy. Other potential determinants of utility weights across groups of individuals include turnout and knowledge, as discussed in Grossman and Helpman (2001). In each case, one can view the utility weights as the Lagrange multipliers associated with the utility constraints in Definition 2, with the different utility levels $\{\underline{u}(n)\}$ implicitly revealing the importance of these political forces.

The efficiency property embodied in Definition 2 may not only arise from political parties competing for votes, but also from special interests competing for influence. Grossman and Helpman's (1994) influential protection for sale model offers one such efficiency result for trade policy. In their model, a government that cares both about (utilitarian) welfare and political contributions ends up choosing trade taxes that maximize a weighted sum of individuals' utility, with higher weights being given to those in politically-organized sectors that are able to make such contributions.[6] Becker (1983) and Wittman (1989) offer early formalizations of the argument for efficiency.[7]

[5] Mayer (1984) focuses on the case of a small open economy. Dhingra (2014) extends Mayer's (1984) optimal tariff formula to the case of a large country.

[6] Since political contributions are real resources that are taken away from individuals in politically-organized sectors, constrained Pareto efficiency in Definition 2 should be interpreted as applying conditional on a given level of lobbying activities. In Grossman and Helpman (1994), the previous qualification has no bearing on the choice of trade taxes due to the assumption of quasi-linear preferences. It would more generally, as in Dixit et al. (1997).

[7] Left open is the question of why competition for office or influence would lead to trade taxes that are constrained Pareto-efficient rather than, even more radically, non-distortionary forms of redistribution like targeted lump-sum transfers. Although we remain mostly agnostic about this issue, two observations are worth making at this point. First, our approach need not be inconsistent with the existence of more efficient forms of redistribution. As we discuss in Section 2.4, if lump-sum transfers were indeed available, the tariff formula presented in Proposition 1 would continue to hold. Second, there are potential reasons why either lobbies or the government may want to commit to using inferior instruments for redistribution. Lobbies may prefer tariffs to lump-sum transfers because it allows them to extract a higher share of total surplus, as in Dixit et al. (1997). Benevolent governments, in turn, may prefer tariffs because lobbying activities, and in turn the overall level of

Finally, we note that Definition 2 is fully consistent with what Corden (1984) describes as a "conservative social welfare function" and views as "implicit in much policy-making." Such a function says that in response to market disturbances, e.g. a surge in Chinese imports, "one (or the) objective of policy is to prevent significant falls in real incomes of any significant sector of the economy." One can view market disturbances as shifts in the Pareto frontier and, whenever feasible, a conservative social welfare function simply calls for selecting allocations on the new frontier that Pareto dominate the original one. In this case, the utility levels $\{\underline{u}(n)\}$ entering the utility constraints in Definition 2 might simply be those associated with the pre-shock equilibrium.[8]

Counter-examples. If competition— whether for votes or for influence—is expected to lead to efficiency, what forces then may lead to departures from Definition 2? A key force may arise in dynamic environments if a lack of commitment by policy makers leads to inefficiencies. Acemoglu (2003) gives central stage to this consideration to explain the absence of a "Political Coase Theorem." In Acemoglu and Robinson (2001), the inability to commit to future policies is used to explain inefficient redistribution towards farmers. If future transfers depend on the number of farmers in the economy, they may favor trade taxes, which keep the agricultural sector large, to lump-sum transfers, which do not. In Coate and Morris (1995), it is also politicians' desire to influence future electoral outcomes that may lead them to choose inefficient, non-lump-sum transfers today in order to preserve their reputation and be in charge of policymaking tomorrow.

Despite these examples, it it important to note that for our purposes the key issue is not whether inferior forms of redistribution, like trade taxes, will be deployed instead of lump-sum transfers. We have already discussed in footnote 7 a number of reasons why they may be. The key issue is whether, conditional on trade taxes being used, they will be used in a way that violates Definition 2. In the case of reputational concerns, for instance, this would require not only that the choice of trade taxes versus lump-sum transfers has differential effects on voters' beliefs about the type of the politicians that they face. It would further require different trade policy choices to have differential effects on voters' beliefs, perhaps because some tariffs are more likely to reflect a legitimate second-best motive, say those targeting goods with high levels of carbon emissions.

The general point is that trade taxes may fail to satisfy Definition 2 in dynamic environments where choices over today's trade policy may also affect the policy implemented tomorrow. In such situations, the "welfare weights" that we recover from our empirical analysis

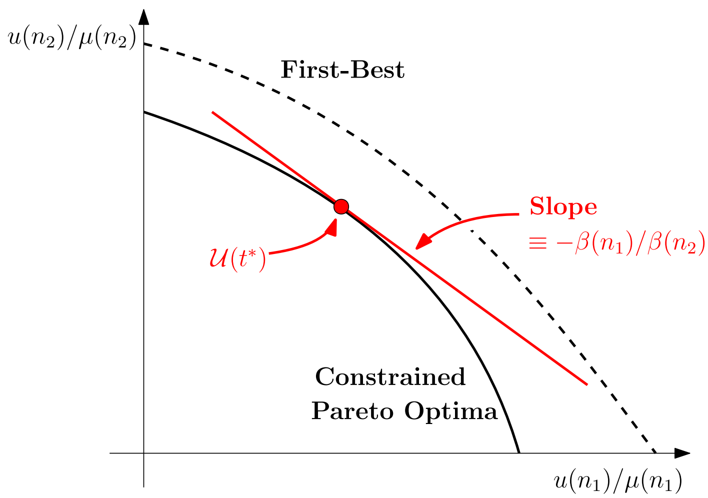
distortions, may be lower for inefficient instruments, as in Rodrik (1986).

[8] Deardorff (1987) formalizes the conservative social welfare function along these lines.

will reflect both the social marginal utility of income of a given group, in line with Definition 2, and the shadow values of manipulating future redistribution.[9]

Characterization. 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 $\beta(n) \equiv \lambda(n)/\bar{\lambda}$.[10] Figure 1 illustrates how the choice of Pareto-efficient trade taxes $t^* \in \mathcal{T}$ implicitly reveals those social marginal returns.

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.

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 $t \in \mathcal{T}$.[11] Under this convention, the vectors of partial derivatives $\partial p/\partial m_g$, $\partial p^w/\partial m_g$,

[9] Appendix A.3 presents a two-period example that illustrates the previous discussion.

[10] Since all tax revenues are assumed to be rebated via a uniform lump-sum transfer, the average social marginal utility of income $\bar{\lambda}$ is also equal to the social marginal value of fiscal revenues λ_{gov}. If one were to relax the assumption of uniform lump-sum transfers and allow for more general forms of government spending and social programs, then our characterization of tariffs would be unchanged, except for the definition of $\beta(n)$. Namely, the social marginal return of a hypothetical lump-sum transfer to individual n should be defined more generally as $\beta(n) \equiv \lambda(n)/\lambda_{gov}$.

[11] 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 $\partial z/\partial m_g$ 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*

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

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, $\beta \cdot d(\omega - \bar{\omega})$, terms-of-trade manipulation, $-m \cdot dp^w$, and correcting domestic distortions, $-\epsilon \cdot dz$. 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. Our general tariff formula highlights the 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 $\partial(\omega -$

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.

$\bar{\omega})/\partial m_g = 0$, 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).[12]

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.

[12]The terms-of-trade effect being equal to $m \cdot \partial p^w / \partial m_g$ does rely on our assumption that all domestic firms are owned by domestic individuals, i.e. $\sum_{n \in \mathcal{N}} \phi(f, n) = 1$ for all $f \in \mathcal{F}$. If there was foreign ownership of domestic firms, then the terms-of-trade effect in equation (9) would need to be adjusted to $m_{FDI} \cdot \partial p^w / \partial m_g$, with $m_{FDI} \equiv m + \sum_{f \in \mathcal{F}} \phi^w(f) y(f)$ and $\phi^w(f)$ the share of firm f held by foreigners. Domestic ownership of foreign firms could be dealt with in a similar manner, provided that the economic environment also explicitly describes foreign firms and their profits.

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. Beginning with other trade policy instruments, it is well-known that 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.[13] 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 Proposition A.1. Intuitively, (9) reflects the first-order conditions for the choice of t, holding all other policy choices constant. For the purposes of choosing t the only new consideration created by other policies is therefore the way that the fiscal revenue they generate is affected when t is adjusted.

The same observations apply to the case of domestic policy instruments. When these instruments do not generate fiscal externalities, as in the case of lump-sum transfers, even individual-specific ones, the first-order condition underlying Proposition 1 remains valid and our analysis goes through without qualification. The value of β observed in a competitive equilibrium may, of course, depend on whether these additional instruments exist or not, but their existence does not change the fact that β can be estimated using (9). In contrast, when the government uses distortionary taxes, such as producer subsidies, the fiscal externalities associated with these taxes should again be explicitly controlled for in our regressions, as shown in Proposition A.2.[14] In the presence of income taxes, one should further take into

[13]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.

[14]In theory, not controlling for such considerations may lead to severe omitted variable bias. Consider the case of a small open economy in which individuals have identical quasi-homothetic preferences and there are no distortions. Suppose that the domestic government has a linear social welfare function, so that $\beta > 0$ is exogenously given. If the domestic government can freely choose producer subsidies $\{s^y(f)\}$ in this environment, then it will set the fiscal externality associated with producer subsidies, $\sum_{f\in\mathcal{F}} s^y(f)\cdot\partial y(f)/\partial m_g$, to be exactly equal to the redistributive term, $\beta\cdot\partial(\omega-\bar{\omega})/\partial m_g$. According to Proposition A.2, one would therefore observe $t^* = 0$ and always infer from equation (9) (when failing to account for $\sum_{f\in\mathcal{F}} s^y(f)\cdot\partial y(f)/\partial m_g$) that

account how domestic taxes affect the ultimate incidence of transfers engineered by trade restrictions. Specifically, changes in real earnings should be adjusted by marginal income tax rates, as also established in Proposition A.2.

Constrained Trade Taxes. Our baseline analysis abstracts from WTO rules and trade agreements. Hence it treats a country's decision to abide by them as a choice that can be used to reveal social welfare weights. An alternative view is that these arrangements impose constraints on the choice of the government. 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 shown in Proposition A.3. 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 product from all WTO countries in the case of the most-favored-nation (MFN) clause, as also shown in Proposition A.3.

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 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

$\beta = 1$, regardless of whether or not this is true. We thank Bob Staiger for suggesting this example.

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 many 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) as well as on different individuals from these countries (perhaps due to political forces in i influencing its trade negotiations with Home, as in Grossman and Helpman, 1995), this can be allowed for by controlling more flexibly for $m(i,n) \cdot \partial p^w/\partial m_g$, with $m(i,n) \equiv c(i,n) - y(i,n)$ the net imports of individual n in country i, as shown in Proposition A.4.[15]

Other Distortions. We conclude by noting that Proposition 1 assumes that the only source of distortions is externalities in an otherwise perfectly competitive environment. This abstracts from firm-delocation effects, as in Venables (1987) and Ossa (2011), or profit-shifting effects, as in Brander and Spencer (1984) and Mrazova (2023). In Proposition A.5, 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. In the case where firms only produce a single good and the social marginal utility of income is equalized across individuals, this is 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 if 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 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 build a model of the US economy using a specific ver-

[15] In the case of a representative agent in each foreign country i, and hence no concern for foreign redistribution, the controls reduce to $m(i) \cdot \partial p^w/\partial m_g$, with $m(i)$ the net imports from country i.

sion of the general environment from Section 2. We then show that this model replicates the causal impact of observed tariff shocks on relative earnings, which raises confidence that it provides an accurate measure of $\partial(\omega - \bar{\omega})/\partial m_g$.

3.1 A Model of the US Economy

The specific environment that we rely on for the rest of our analysis is a variation 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 one services sector that is not internationally traded. To these 51×22 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.[16]

We let N_{rs} denote the fixed number of individuals living in region r and working in sector s.[17] Each individual is endowed with ϕ_{rs} units of equipped labor, which she sells to firms f in that region and sector at a wage w_{rs}.[18] 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 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

[16]We also assume that the residual individual's social marginal utility of income is equal to the US average. 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 in the data (e.g. between countries or states). This specific modeling choice has little effect on the welfare weights that we estimate, as discussed further in our working paper (Adao et al., 2023b).

[17]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.

[18]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.

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 $h \in \mathcal{H}$.[19] 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 ϕ_{rs} units 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

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

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, $\phi_{rs}(\partial w_{rs}/\partial m_{ih})$, 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 of real earnings to imports in (10), with further details about analytical derivations relegated to the Online Appendix.

[19] 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. This is because one can always go from an observed equilibrium with ad-valorem tariffs to an equivalent one with specific tariffs by letting the latter be equal to the ad-valorem ones times the price of US imports (pre-tariff) in the observed equilibrium, without any further consequences for our analysis.

3.2 Parametric Restrictions

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

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

$$Q_{rk}(f) = \left[\sum_{c=H,F} \sum_{o \in \mathcal{R}_c} \sum_{v \in \mathcal{H}_k} (\theta^c_{orkv})^{\frac{1}{\sigma}} [q_{orv}(f)]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{12}$$

where $\ell_{rs}(f)$ denotes labor from region r and sector s used by firm f, $q_{orv}(f)$ denotes its use of intermediate inputs of product v from origin o delivered to region r, and $\sigma \geq 0$ denotes the elasticity of substitution between different inputs.[20] Since we only observe product-level trade flows between domestic regions and foreign countries, but not between pairs of domestic regions, we impose $\theta^H_{orkv} = \bar{\theta}^H_{ork}$. Finally, we normalize input demand shifters so that $\alpha_s + \sum_{k \in \mathcal{K}} \alpha_{ks} = \sum_{c=H,F} \sum_{o \in \mathcal{R}_c} \sum_{v \in \mathcal{H}_k} \theta^c_{orkv} = 1$. Note that trade costs, of the standard iceberg form, are implicitly embedded in demand 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

$$U(n) = E(z, n) \prod_{s \in \mathcal{S}} [C_{rs}(n)]^{\gamma_s}, \tag{13}$$

$$C_{rs}(n) = \left[\sum_{c=H,F} \sum_{o \in \mathcal{R}_c} \sum_{h \in \mathcal{H}_s} (\theta^c_{orsh})^{\frac{1}{\sigma}} [c_{orh}(n)]^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{14}$$

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 equation (14) are the same as in equation (12). That is, both domestic firms and individuals demand the same "sector composite," a standard restriction in quantitative trade models that is driven by data availability (or lack thereof). 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.

[20] 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) and (12) hold. Note that there are no externalities in production in our model, a point we return to below.

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

$$p^{X,F}_{irh} = \theta^{X,F}_{irh} (q^{X,F}_{irh})^{\psi^{X,F}}, \tag{15}$$

$$p^{M,F}_{rih} = \theta^{M,F}_{rih} (q^{M,F}_{rih})^{-\psi^{M,F}}, \tag{16}$$

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 to minus domestic net imports, $q^{M,F}_{rih} = -m_{rih}$.[21] 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 $p^w \equiv \{p^{X,F}_{irh}, p^{M,F}_{rih}\}$.

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 (13). 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 model in 2017. These parameters comprise: the three elasticities, $\{\sigma, \psi^{X,F}, \psi^{M,F}\}$; the technology shifters, preference shifters, and labor endowments, $\{\alpha_s, \alpha_{ks}, \gamma_s, \xi_{rs}, \theta_{rds}, \theta^c_{orsh}, \theta^{X,F}_{irh}, \theta^{M,F}_{rih}, \phi_{rs}, N_{rs}\}$; and the US import tariffs, $\{t_{ih}\}$. We now describe how we calibrate each of them.

Elasticities. We set the values of the three elasticities $\{\sigma, \psi^{X,F}, \psi^{M,F}\}$ equal to FGKK's estimates, since their estimating equations for each of these parameters are consistent with the parametric assumptions imposed in Section 3.2. FGKK's empirical strategy uses the US-China trade war in 2018-2019 as an exogenous source of variation that allows identification

[21] The vector of net imports $m = \{q^{X,F}_{irh}, -q^{M,F}_{rih}\}$ is feasible, $m \in \Omega(p^w, z)$, if equations (15) and (16) hold.

of: the elasticity of US import demand σ, by using the changes in US tariffs as a shifter of the prices paid by US importers; the elasticity of foreign export supply $\psi^{X,F}$, by using the change in US tariffs as a shifter of the prices received by foreign exporters; and the elasticity of foreign import demand $\psi^{M,F}$, by using the foreign retaliatory tariffs as a shifter of the prices paid by foreign importers. The point estimates are $\sigma = 2.53$, $\psi^{X,F} = 0.00$, and $\psi^{M,F} = 0.96$.

Technology Shifters, Preference Shifters, and Labor Endowments. We set the values of $\{\alpha_s, \alpha_{ks}, \gamma_s, \xi_{rs}, \theta_{rds}, \theta^c_{orsh}, \theta^{X,F}_{irh}, \theta^{M,F}_{rih}, \phi_{rs}, N_{rs}\}$ to match US data from 2017 on: value added and employment by US region and sector; domestic trade flows by US region and sector; and international trade flows by US region, foreign country, and product. In our baseline calibration, we further normalize all prices and wages to one. This amounts to a choice of units of account for goods and factors that ultimately pins down the levels of $\{\theta_{rds}, \theta^c_{orsh}, \theta^{X,F}_{irh}, \theta^{M,F}_{rih}, \phi_{rs}\}$, without further implications for the rest of our analysis. We briefly describe the various data sources used in this procedure below and offer further details about data construction and calibration in the Online Appendix.

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 at the (equivalent of) 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.[22] 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 the services sector has 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

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

each producing region and sector. We then use Commodity Flow Survey data 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.

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.[23] Under our price normalization, specific and ad-valorem tariffs coincide: $t_{ih} = t_{ih}^{\mathrm{av}}$. 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 $51 \times 22 = 1,122$ 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 some of the variation that will allow us to identify welfare weights in Section 4, we report in Figure 2 the average impact of import restrictions from different tradable sectors k on the real earnings of workers from different sectors s or different regions r relative to the US average, which we denote $\partial(\omega_s - \bar{\omega})/\partial m_k$ and $\partial(\omega_r - \bar{\omega})/\partial m_k$, respectively. Changes in imports are measured in millions of dollars, whereas changes in real earnings per worker are measured in dollars.

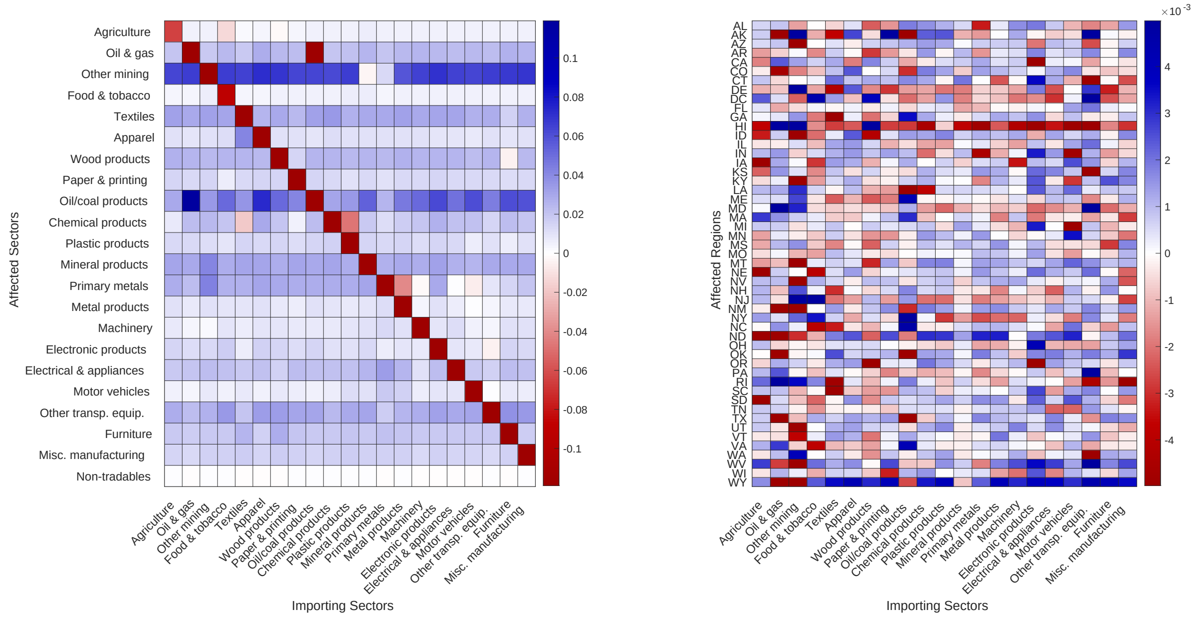
Figure 2a focuses on sectors. For each cell (s, k), it displays $\partial(\omega_s - \bar{\omega})/\partial m_k$, further demeaned by the average impact $\partial(\omega_s - \bar{\omega})/\partial m$ across import restrictions from all sectors k to reflect the fact that our regressions will include a constant.[24] Red colors, which indicate

[23] In practice, US tariffs may vary at the HS-10 level. As mentioned above, the US Census, however, only records state-level exports and imports at the 6-digit level, hence our choice to aggregate tariffs at the same level. Allowing tariffs to vary at the 6-digit level still makes our analysis much more granular than previous ones (e.g. Goldberg and Maggi (1999) and Ossa (2014) consider 107 and 57 sectors, respectively).

[24] When averaging across imported products from any given sector k, 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

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. All values reported are de-meaned within each row.

negative entries, are primarily on display when $s = k$. Blue colors, which indicate that individuals gain from imports, can be seen when $s \neq k$. The red diagonal 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. For individuals employed in the non-tradable sector (in the bottom row), we see little difference across imports from different sectors.

Figure 2b turns to analogous effects across states. Each cell (r, k) now reports $\partial(\omega_r - \bar{\omega})/\partial m_k$, again de-meaned by $\partial(\omega_r - \bar{\omega})/\partial m$. The range of entries is an order of magnitude smaller than that for sectors in Figure 2a, indicating that as we vary import restrictions from different sectors k, there is typically less dispersion in the changes in real earnings experienced by workers from a given region r than by workers from a given sector s. This reflects the fact that most workers in all regions are employed in the non-tradable sector as well as the fact that diversification of employment across tradable sectors within each region partly smoothens the heterogeneity documented in Figure 2a.

country-product pairs across all sectors. These are the same country-product pairs that we use in the empirical analysis of Section 4.

The previous observations notwithstanding, it is important to note that Figure 2 abstracts from substantial heterogeneity in the responses to the changes in the imports of different origin-product pairs (i, h) that belong to the same sector k, as can be seen from Appendix Figure D.1. This heterogeneity implies, in turn, that the cross-regional variation in $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$ captures more than differences in sectoral composition because, for example, different regions import different products from different foreign origins.[25] We will also leverage this variation to identify separately welfare weights across sectors and regions below.

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 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 return to the tariff changes implemented in 2018 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. (2023a) (ACD) we put our 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 model's predictions are correct, the two projections should be the same.[26]

[25] This general pattern is illustrated in Appendix Figure D.2. For each region r, it reports the R^2 of a regression 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, consistent with our region- and sector-level measures of real earnings sensitivity to imports capturing different sources of variation across origin-product pairs (i, h).

[26] Since the estimates of elasticities $\{\sigma, \psi^{X,F}, \psi^{M,F}\}$ already leverage the same tariff changes, one may wonder whether additional testing can be conducted. As discussed in ACD, the answer is yes. The reason is that our model relies on a large number of untested assumptions, from the structure of domestic input-output linkages to a lack of factor mobility. 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 are not used in estimation; namely, earnings per worker across regions and sectors.

Formally, we estimate the following two linear regressions:

$$\Delta \log w_{rs}^{\text{obs.}} = \alpha_0^{\text{obs.}} + \alpha_1^{\text{obs.}} z_{rs} + \varepsilon_{rs}^{\text{obs.}}, \tag{17}$$

$$\Delta \log w_{rs}^{\text{pred.}} = \alpha_0^{\text{pred.}} + \alpha_1^{\text{pred.}} z_{rs} + \varepsilon_{rs}^{\text{pred.}}, \tag{18}$$

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.[27] 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 value added 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 0.52 for the test that the estimated coefficient in column (3) is zero.[28] Column (4) also shows that there is no pre-trend, consistent with the assumption that changes in tariffs are orthogonal to other changes in the US economy. These results strengthen the credibility of our model's predictions about the causal impact of tariffs on value added per workers across US sectors and regions.

Finally, we note that, according to our model, value added per worker should vary be-

[27] Proposition 1 only relies on the impact of infinitesimal changes in tariffs, as summarized by the Jacobian matrix $\{\partial \omega_{rs}/\partial m_{ih}\}$. Accordingly, 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 $\Delta \log(1+t_{ih}^{F,\text{av}}) - \mu^F$, with μ and μ^F the simple averages of US and foreign tariffs changes, each computed across all i and h. Note that although we have not introduced foreign tariffs explicitly in our model, equation (16) 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 $o \in \mathcal{R}_H$. Like 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.

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

Table 1: Changes in labor market outcomes during the US-China trade war: a test

	Dependent variable: log of change in				
	Value-added per worker				Employment
	Observed 2017-2019 (1)	Predicted 2017-2019 (2)	Obs. - Pred. 2017-2019 (3)	Observed 2015-2017 (4)	Observed 2017-2019 (5)
Estimate	1.007	1.300	-0.289	-0.117	-0.072
Std. error	(0.446)	(0.061)	(0.448)	(0.243)	(0.275)
p-value	0.024	0.000	0.519	0.629	0.792

Notes: Sample of 987 region-sector pairs with positive employment and value-added in 2015, 2017 and 2019. All specifications include a constant, as described in equations (17) and (18). Predicted outcomes in columns (2) and (3) correspond to our model's predictions for the impact of US and foreign 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.

cause of changes in total value added, not changes in the number of workers, which is assumed to be fixed. Column (5) investigates this issue by returning to (17), 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.[29]

4 Revealing Welfare Weights

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

$$\beta(n) = \sum_{j \in \mathcal{J}} \text{Dummy}_j(n) \times \beta_j, \tag{19}$$

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

[29]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.

that since $\frac{1}{N}\sum_{n\in\mathcal{N}}\beta(n)=1$, as established in Section 2, we must also have $\frac{1}{N}\sum_{j\in\mathcal{J}}N_j\beta_j=1$, with $N_j\equiv\sum_{n\in\mathcal{N}}\text{Dummy}_j(n)$ the number of individuals in group j.

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.[30] Thus, using the notation from Section 3, we can write our general tariff formula (9) as

$$t_{ih}=-\sum_{s\in\mathcal{S}}\beta_s N_s\frac{\partial(\omega_s-\bar{\omega})}{\partial m_{ih}}-\sum_{r\in\mathcal{R}_H}\beta_r N_r\frac{\partial(\omega_r-\bar{\omega})}{\partial m_{ih}}+\text{Controls}_{ih}+\varepsilon_{ih}, \tag{20}$$

where t_{ih} denotes the tariff on the 6-digit HS product h from foreign country i applied by the US in 2017, as described in Section 3.3. We restrict our sample to the 71,689 country-product pairs with US imports in 2017 above \$100,000.[31]

According to (20), the tariff t_{ih} is a function of four terms. The first two terms are our objects of primary interest. They capture redistribution across individuals according to 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 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.[32] The third term in (20) refers to ad-

[30] This interest is motivated, in part, by the contrasting predictions of models emphasizing sectoral mechanisms, such as Grossman and Helpman (1994), and regional mechanisms, such as Ma and McLaren (2018). We thus pursue a version with sector- and region-specific effects for reasons of parsimony, i.e. $|\mathcal{R}_H|+|\mathcal{S}|$ parameters to estimate rather than $|\mathcal{R}_H|\times|\mathcal{S}|$, even though separate values of β_j for each region-sector combination are formally identified. For the interested reader, Appendix Figure D.6 reports results from an augmented specification that also includes eight socioeconomic groups formed from the interactions between three binary categories associated with education (college-educated and not), gender, and race (white or non-white) available in region-sector ACS data. This version yields values of β_s and β_r that are extremely similar to those in our baseline, as further discussed in our working paper (Adao et al., 2023b).

[31] For computational reasons, when implementing (20), we only consider variations of the tariffs for the 71,689 country-product pairs in our sample, while keeping all other tariffs fixed. Thus the regressors $\{\partial(\omega_s-\bar{\omega})/\partial m_{ih}\}$ and $\{\partial(\omega_r-\bar{\omega})/\partial m_{ih}\}$ formally correspond to the changes in real earnings caused by a marginal change in tariffs such that dm_{ih} is non-zero, all other changes in imports are zero within our sample, and all changes in tariffs are zero outside our sample.

[32] Since the value of these regressors depend on the estimates of the elasticities $\{\sigma,\psi^{X,F},\psi^{M,F}\}$, the confidence intervals for the estimates of β_s and β_r that we report below take into account the sampling uncertainty in these three elasticities. To do so, we first augment FGKK's replication code to write their estimation problem as a just-identified GMM model (so as to obtain the variance-covariance matrix for $\{\sigma,\psi^{X,F},\psi^{M,F}\}$). We then treat the regressors $\partial(\omega_s-\bar{\omega})/\partial m_{ih}$ and $\partial(\omega_r-\bar{\omega})/\partial m_{ih}$ as generated regressors whose standard errors are augmented using the delta method.

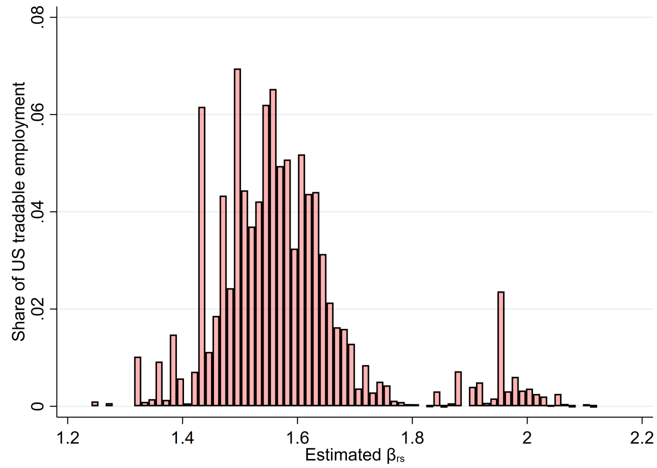
ditional factors that we control for, beyond sector- and region-based redistributive motives. Our baseline analysis populates this set with an intercept, the terms-of-trade motive for trade protection $m \cdot (\partial p^w / \partial m_{ih})$, and, for computational reasons, the fiscal externalities associated with country-product pairs outside our sample.[33] Finally, 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 in our regression.

We begin by estimating equation (20) 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} given our control set. Potential violations from such an orthogonality requirement may arise from the existence of other trade policy instruments, production subsidies, income taxes, exogenous constraints on US tariffs, misspecification of terms-of-trade controls due to negotiated trade taxes, and reverse causality between tariffs and imports. 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

[33] Like in FGKK's original model, foreign export supply curves are (almost) perfectly elastic in our analysis. It does not follow, however, that the terms-of-trade motive, $m \cdot (\partial p^w / \partial m_{ih})$, is zero. While the prices of US imports do not respond to import restrictions, the prices of US exports do, as US tariffs tend to increase the demand for US products and raise US wages. In turn, from the point of view of manipulating the US terms of trade, the optimal US tariff is uniform, but non-zero. Due to the computational considerations referred to in footnote 31, $m \cdot (\partial p^w / \partial m_{ih})$ differs slightly from the optimal tariff on ih, which would have to be computed holding fixed the imports of all goods, not just those in our sample. For this reason, $m \cdot (\partial p^w / \partial m_{ih})$ exhibits a small amount of variance so we control for it. For the same reason, we also include in Controls_{ih} the sum of the fiscal externalities associated with goods outside our sample, consistent with Proposition A.3. In our baseline specification, we require the coefficient on these fiscal externalities to be minus one, also consistent with theory. Since the value of US imports on goods outside our sample is small, relaxing this restriction, or ignoring this adjustment altogether, has very little impact on our results.

Figure 3: Distribution of estimated welfare weights



Notes: This figure displays the histogram of estimates of welfare weights across regions and tradable 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 (20). We omit 51 values, all corresponding to the Apparel sector in different regions, with $\hat{\beta}_{rs} \geq 2.5$.

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. In this case, our estimates of welfare weights would recover the total impact of a transfer to an individual, both direct and indirect via its effects on other individuals' welfare.

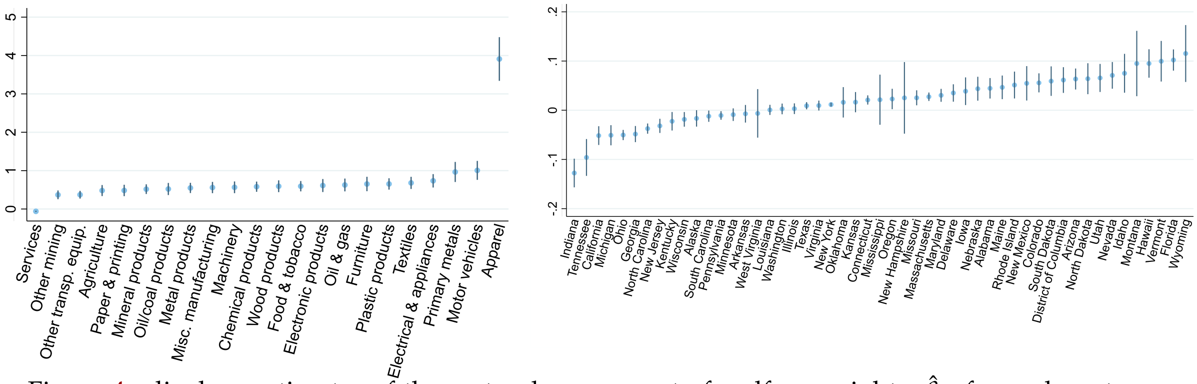
4.2 Baseline Estimates

Using the OLS estimates of β_s and β_r in equation (20), 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 US individuals employed in tradable sectors. Three features are immediately apparent.

First, the fact that all welfare weights are above one implies that individuals in tradable sectors, who directly receive trade protection, tend to have higher social marginal utilities of income than individuals outside these sectors. Second, there is substantial dispersion in welfare weights among individuals employed in tradable sectors, 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 20%, 37%, and 239% 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 estimated welfare weights $\hat{\beta}_{rs}$ are statistically larger than

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 (20) and normalized such that the mean of $\hat{\beta}_s$ across s is zero. Figure 4b does the same but for the regional component of welfare weight, $\hat{\beta}_r$, for each region r, 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 and adjusted for sampling uncertainty in the estimates of the elasticities $\{\sigma, \psi^{X,F}, \psi^{M,F}\}$ that enter our regressors.

zero at standard significance levels. This lends credence to the constrained Pareto 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.[34] 95% confidence intervals for these estimates are also shown. Across sectors, estimates of $\hat{\beta}_s$ range from -0.06 for Services to 3.91 for Apparel, and while Apparel is a clear outlier, which was omitted from Figure 3, even the second- and third-largest values, 1.01 for Motor vehicles and 0.97 for Metals, are considerably higher than, and statistically different from, that of the Other mining sector, the tradable sector with lowest welfare weight.[35] 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 -0.13 for Indiana to 0.12 for Wyoming.

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 D.5. By construction, these welfare

[34]Our theory requires $\frac{1}{N}\sum_{r,s}\beta_{rs}N_{rs} = 1$. This restriction implies that $\{\beta_{rs}\}$ are identified. In contrast, $\{\beta_r\}$ and $\{\beta_s\}$, are only identified up to a constant: starting from $\beta_{rs} = \beta_r + \beta_s$, one can always construct $\beta'_r = \beta_r + c$ and $\beta'_s = \beta_s - c$ that satisfy $\beta_{rs} = \beta'_r + \beta'_s$, hence the need for a normalization in Figure 4.

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

weights adjust for compositional differences in how individuals employed in different 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 Apparel, Motor Vehicles, and Metals, which combine to comprise 0.7% of total employment and 8.0% of tradable sector employment, enjoy an average social marginal utility of income that is 138% 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 $2.38 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 $1.20 given to someone in the bottom state. This asymmetry between sectors and states 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 of $\hat{\beta}_s$ and $\hat{\beta}_r$ reported in Section 4.2 were obtained under a number of assumptions that we now probe further. Table 2 describes results from 12 different approaches to estimating these parameters under a range of alternative specifications, each displayed in a separate row. For each of them, column 1 reports how alternative estimates of $\hat{\beta}_s$ and $\hat{\beta}_r$ correlate with the baseline values described in Section 4.2 and columns 2 and 3 report the dispersion of the estimates of welfare weights across sectors and regions. We summarize each of these 12 alternative procedures here, and provide further details about methods and auxiliary data sources in the Online Appendix.

- **Other trade policy instruments:** To deal with non-tariff measures (NTMs), we implement the tariff formula from Proposition A.1. First, in row 2 we add controls for the fiscal externality associated with the revenue potentially generated by the six types of NTMs available from the TRAINS and Temporary Trade Barriers (Bown et al., 2020) databases. Second, in row 3 we restrict ourselves to the subsample of 26% of observations in which there is no NTM in place at all, and the new and old formula coincide. Finally, in row 4 we add to our measure of tariffs t_{ih} an estimate of antidumping and countervailing duties.

- **Production subsidies:** To deal with production subsidies, we implement the tariff formula from Proposition A.2. It highlights an extra fiscal externality equal to $\sum_{f \in \mathcal{F}} s^y(f) \cdot \partial y(f)/\partial m_{ih}$. We account for it by measuring (following Ferrari and Ossa, 2023) state and local subsidies $s^y(f)$ and either subtracting $\sum_{f \in \mathcal{F}} s^y(f) \cdot \partial y(f)/\partial m_{ih}$ from the dependent variable in row 5 or controlling for this effect (which relaxes the assumption

Table 2: **Sensitivity analysis**

	Specification	Correl-ation of $\widehat{\beta}_{rs}$ with baseline (1)	Standard deviation of $\widehat{\beta}_{rs}$ across	
			sectors (2)	states (3)
1	Baseline	–	0.74	0.05
2	Control for fiscal externality of NTMs	1.00	0.74	0.05
3	Drop observations with NTMs	0.81	1.08	0.08
4	Add AD and CV rates to dependent variable	1.00	0.74	0.05
5	Add fiscal externality of subsidies to dep. var.	1.00	0.75	0.05
6	Control for fiscal externality of subsidies	1.00	0.77	0.05
7	Control flexibly for fiscal externality of subsidies	0.98	1.41	0.11
8	Measure income post-income taxes	1.00	0.98	0.06
9	Drop constrained tariff lines	0.95	1.05	0.17
10	Add MFN clause constraint	1.00	0.79	0.07
11	Control for country terms-of-trade (ToT) effects	0.99	0.90	0.06
12	Control for country-sector ToT effects	0.95	1.05	0.07
13	Use alternative model as IV	0.88	0.33	0.05

Notes: Rows 2-13 of this table report results from specifications that introduce alternative modeling assumptions to those in the baseline (row 1). See text for details. "AD" and "CV" refer to antidumping and countervailing duties, respectively.

that its coefficient is one) in row 6. Alternatively, in row 7 we control for the interaction of $\partial y(f)/\partial m_{ih}$ with sector and region fixed-effects, which dispenses with the need to measure $s^y(f)$ (under the assumption that subsidies take the form $s^y(f) = s^y_s + s^y_r$).

- **Income taxes:** We again use Proposition A.2. Our baseline analysis omits income taxation. More generally, one needs to distinguish between pre-tax and post-tax real incomes. In row 8 we do so by using data on state and federal income tax schedules from TaxSim and microdata from the American Community Survey (ACS), which allows us to compute an income-weighted average of marginal tax rates faced by individuals within each state-sector pair.

- **Constrained trade taxes:** To deal with constraints on a country's ability to choose its trade taxes, we use the tariff formula from Proposition A.3. In row 9 we confine attention to the 3.6% of observations that appear to be unconstrained (that is, where no trade agreement applies and the MFN rate exhibits "overhang") and add controls for the fiscal externalities associated with potentially constrained trade taxes (that is, those in the complementary 96.4% of observations). As a second exercise, row 10 focuses on the constraint imposed by MFN itself. This calls for using as regressors the marginal changes with respect to $M_{\text{WTO}h} \equiv \sum_{i\in\text{WTO}} m_{ih}$ rather than m_{ih}, since $M_{\text{WTO}h}$ is what the government controls.[36]

- **Negotiated trade taxes:** 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 all foreign individuals, including zero weight, as is commonly assumed. However, preferential trade agreements may lead US policy to internalize foreign countries' welfare in heterogeneous ways. To allow for this possibility, we implement the tariff formula from Proposition A.4. Row 11 first includes controls for 101 separate terms-of-trade motives, one for each foreign country. Going further, row 12 controls for 303 separate terms-of-trade effects within each combination of country and 3 broad sectors, which allows for sector-level political economy considerations within foreign countries to affect trade negotiations with the US.[37]

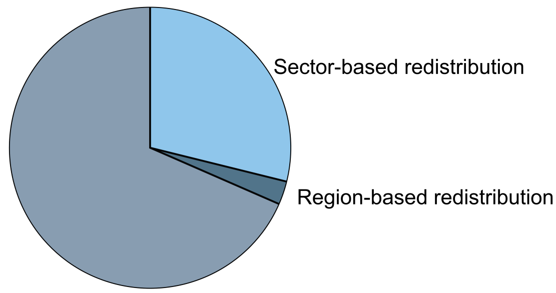
- **Instrumental variable specification:** Our baseline analysis measures the sensitivity of imports to real earnings via a model in which tariff revenue is redistributed uniformly across all agents. One way to assess the potential for misspecification due to this assumption is to use an instrumental variable (IV) that measures sensitivity in an alternative model that does not redistribute tariff revenue. Further, if this alternative model is calibrated to the case of a counterfactual economy with zero tariffs (as in row 13) then this IV also probes concerns about simultaneity bias, as in prior work (Trefler, 1993; Goldberg and Maggi, 1999).

As Table 2 makes clear, the resulting estimates of $\hat{\beta}_s$ and $\hat{\beta}_r$ that we obtain across these 12 specifications remain similar to those of our baseline analysis. In particular, the correlation between baseline and alternatives (column 1) is never lower than 0.81. And the core finding of Section 4.2—that the variance of welfare weights across sectors (column 2) is considerably larger than that across states (column 3)—remains true in all specifications.

[36] An additional potential constraint on trade taxes is that they are non-negative—import subsidies are not used by the US. 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. The resulting estimates of welfare weights are extremely similar in such an analysis, as discussed in Adao et al. (2023b).

[37] Within each foreign country, this specification assumes the existence of three groups of individuals, with different vectors of net imports depending on whether they are employed in agriculture, manufacturing, or services. Specifically, the gross exports of individuals employed in a sector are equal to country i's total exports in that sector and zero otherwise, whereas all individuals have the same gross imports. By construction, the sum of net imports across all three groups is equal to the net imports in country i.

Figure 5: 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 (20), 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.

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.

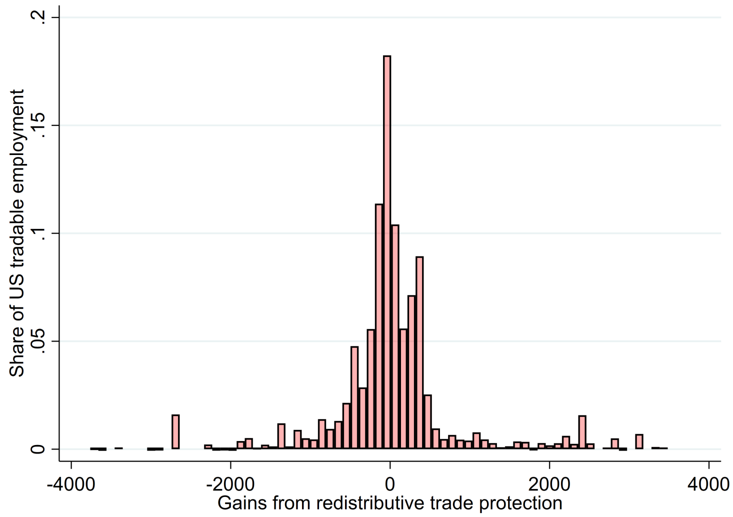
To answer this question, we carry out an Owen-Shapley regression decomposition that returns the share of the variance explained by the first two sets of regressors in (20). The results of this decomposition are displayed in Figure 5. Two findings are evident. First, although we aim to explain the variation in 71,689 tariff lines using changes in real earnings across only 51 regions and 22 sectors, the redistributive motives, either due to sector- or region-based considerations, account for about one third (31.6%) of the total variation in US trade policy. Second, sector-based motives for redistribution explain the lion's share of total redistributive motives (28.9%), implying that region-based considerations are indeed relatively minor (2.7%).

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 model from Section 3 to construct a counterfactual US economy with trade taxes purged of the redistributive component that we have estimated in

Figure 6: Distribution of gains from redistributive trade protection



Notes: This figure reports the histogram of the gains from redistributive trade protection across regions and tradable sectors, weighted by employment N_{rs}. Gains are defined as minus the 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 (21). We omit 26 region-sector pairs with either gains above or losses below $4,000.

Section 4. Formally, we set counterfactual trade taxes t'_{ih} equal to

$$t'_{ih} = t_{ih} - (t_{R,ih} - t_R) \tag{21}$$

with t_{ih} the observed US tariff, $t_{R,ih} \equiv -\sum_{s\in\mathcal{S}} \hat{\beta}_s N_s \frac{\partial(\omega_s - \bar{\omega})}{\partial m_{ih}} - \sum_{r\in\mathcal{R}_H} \hat{\beta}_r N_r \frac{\partial(\omega_r - \bar{\omega})}{\partial m_{ih}}$ the redistributive component associated with our baseline estimates of welfare weights, and t_R the average value of $t_{R,ih}$. This is equivalent to considering a counterfactual US economy in which social marginal returns to different individuals have been equalized, holding fixed the average level of trade protection. 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 6 displays the distribution of the gains from redistributive trade protection across individuals employed in tradable sectors. 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 the 90th, 95th, and 99th percentiles of the distribution, the changes in real income caused by the redistributive component of the US tariffs is $529, $1,700, and $2,814, respectively. In contrast, those at the 10th percentile lose $624.

6 Political Economy Mechanisms

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 illustrate how to use our estimates in order to discriminate between two leading explanations for the existence of tariffs in the previous political economy literature: sectors' abilities to lobby, as formalized by Grossman and Helpman (1994), and states' abilities to swing presidential elections, as formalized by Ma and McLaren (2018).

6.1 Structurally Interpreting Welfare Weights

In Grossman and Helpman (1994), lobbying is modeled as a menu auction à la Bernheim and Whinston (1986). A subset of sectors, those that are politically organized, can make political contributions that are contingent on the government's choice of trade policy, whereas other sectors cannot. The government's objective function is assumed to be a weighted sum of total political contributions and the welfare of the economy's representative agent. For our purposes, the key implication of Grossman and Helpman's (1994) protection for sale model is that welfare weights take the form:

$$\beta_{GH}(n) = \begin{cases} \frac{a+1}{a+\alpha_L} & \text{if individual } n \text{ is employed in a politically organized sector,} \\ \frac{a}{a+\alpha_L} & \text{otherwise,} \end{cases} \tag{22}$$

where $a \geq 0$ denotes the weight that the government assigns to aggregate welfare relative to political contributions and α_L denotes the share of the population employed in politically organized sectors. Hence welfare weights only depend on whether individuals are employed in a politically organized sector, in which case they receive higher weights.

In contrast, Ma and McLaren (2018) focus on a political environment in which two national parties compete à la Lindbeck and Weibull (1993). Citizens are located in different states, with different ideological biases. Swing states correspond to neutral states. National parties choose trade policies to maximize the number of states in which they receive a majority of votes. The key implication of Ma and McLaren (2018) is that welfare weights take the form:

$$\beta_{MM}(n) = \begin{cases} \beta_r & \text{if individual } n \text{ is employed in a region } r \text{ that is a swing state,} \\ 0 & \text{otherwise,} \end{cases} \tag{23}$$

where $\beta_r \geq 0$ denotes the weight that the government assigns to any voter in region r. Hence welfare weights only depend on whether individuals are located in a swing state, in which case they receive higher weights.

6.2 Testing Existing Political Economy Models

In both models, welfare weights, as described in equations (22) and (23), are sufficient statistics for the impact of the political process on the structure of trade policy. To test these models' core political economy predictions—while abstracting from their simplifying assumptions about the economic environment—we can therefore check whether our estimates of welfare weights are systematically higher for politically organized sectors and/or for swing states.[38]

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 politically organized 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.[39] 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 politically organized group are: Apparel, Chemical products, Electronic products, Oil and coal products, and Primary metals.

Likewise, we divide US regions into swing states and non-swing states based on margins of victory in past elections. 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 earlier work of Ma and McLaren (2018) and Bown et al. (2023), 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, Nevada, New Hampshire, Ohio, Pennsylvania, Virginia, and Wisconsin.

[38]Such a test implicitly relies on the assumption that the government, in the case of Grossman and Helpman (1994), or political parties, in the case of Ma and McLaren (2018), have the same beliefs as households and firms about the economic environment, as described in Section 3. This symmetric treatment of policymakers, households, and firms is standard in the existing literature, including the numerous empirical tests of Grossman and Helpman's (1994) protection for sale model. It should be clear, however, that if policymakers have different beliefs about the economic environment, then identifying their preferences would also require taking a stand on what these beliefs are. While we do not attempt to contribute to the literature along this dimension, recent empirical work by Bombardini et al. (2023) suggests a potential way forward.

[39]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 3: Political economy mechanisms: a test

	Dependent variable: welfare weight ($\widehat{\beta}_{rs}$)		
	(1)	(2)	(3)
Politically organized sector	0.903		0.904
	(0.087)		(0.087)
Swing state		0.030	0.032
		(0.034)	(0.031)
Constant	0.988	0.993	0.981
	(0.015)	(0.019)	(0.017)
R^2	0.209	0.003	0.212

Notes: Sample of 1,033 region-sector pairs with positive employment in 2017. All specifications are weighted by employment in 2017. The dependent variable is the estimated welfare weight of each region-sector, $\hat{\hat{\beta}}_{rs} = \hat{\beta}_s + \hat{\beta}_r$ with $\hat{\beta}_s$ and $\hat{\beta}_r$ the OLS estimates of β_s and β_r in (20). Robust standard errors in parentheses.

Table 3 reports the results of OLS regressions that project the welfare weights (estimated in Section 4.2) 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. Column (1) focuses on the lobbying dummy. We see that those in high trade-lobbying sectors have statistically significantly higher welfare weights, with the lobbying dummy explaining about a fifth of the overall variation in welfare weights across sectors and regions. The ratio of the slope (0.903) to the intercept (0.988) identifies $1/\hat{a} = 0.91$. This implies that workers employed in high trade-lobbying sectors enjoy an average social marginal utility that is about twice as large as that for workers employed in other sectors. Column (2) turns to the swing state dummy. 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. The same pattern holds when both lobbying and swing states dummies are included, as can be seen from Column (3).

7 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 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 22 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 equal to $1,153 per worker annually. The previous conclusions are mainly driven by differences in welfare weights across sectors, with differences across states only playing a minor role. In line with this observation, the welfare weights that we estimate are consistent with lobbying being a significant driver of US trade protection. Perhaps surprisingly, swing states in US presidential elections play a much smaller 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.

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A 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. □

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.[40] 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 A.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. □

[40] 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 and Subsidies. Consider a generalized version of the environment of Section 2.1 in which, in addition to trade taxes, the government may now impose producer subsidies $s^y(f) \equiv \{s_g^y(f)\} \in \mathcal{S}^y(f)$, as well as income tax schedules $T(\cdot;n) \in \mathcal{T}(n)$. Note that production subsidies may vary across firms, perhaps because they operate in different sectors or regions, and 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 $q(f)$ the vector of prices faced by firm f. The non-arbitrage condition (2) now generalizes to

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

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

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

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

with $\pi(q(f), z; f)$ 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,

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

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 A.2 (Domestic Taxes)**.** *Suppose that Home's government has access to producer subsidies $s^y(f) \in \mathcal{S}^y(f)$ and income tax schedules $T(\cdot;n) \in \mathcal{T}(n)$. Then Pareto efficient trade taxes* *satisfy*

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

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 subsidies $s^y(f) \in \mathcal{S}^y(f)$ 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

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

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

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

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 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 A.3 (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, each with many individuals indexed by n. Individuals choose their vector of net imports $m(i,n)$ in order to solve

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

Foreign's offer curve is such that Home's net imports $m \in \Omega(p^w, z)$ if and only if $m = -\sum_{i,n} m(i,n)$ with $m(i,n)$ that solves (A.15).[41] Because of trade negotiations, we assume

[41]The maximand $u(m(i,n); i, n)$ is what Dixit and Norman (1980) refer to as the "Meade utility function."

that Pareto efficient trade taxes at Home now solve

$$\max_{t \in \mathcal{T}} \max_{\{u(n), u(i,n)\}} u(n_0) \tag{A.16}$$
$$\text{subject to: } u(n) \geq \underline{u}(n) \text{ for } n \neq n_0,$$
$$u(i,n) \geq \underline{u}(i,n) \text{ for all } i \text{and } n,$$
$$\{u(n), u(i,n)\} \in \tilde{\mathcal{U}}(t),$$

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 A.4 (Negotiated Trade Taxes)**.** *Suppose that there are foreign individuals whose utility the Home government cares about, as summarized by equations (A.15) and (A.16). Then Pareto efficient trade taxes satisfy*

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

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

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

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

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

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

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

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

with $\mu(i,n) \geq 0$ the Lagrange multiplier associated with the foreign individual'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 $\lambda(i,n) \equiv \mu(i,n)\nu(i,n) \geq 0$ the social marginal utility of of individual n in country i (from Home's perspective). □

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 A.5 (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). □

A.3 An Example of Pareto Inefficient Trade Taxes

In Section 2.3, we have argued that Pareto inefficient trade taxes may arise in dynamic environments where choices over today's trade policy may also affect the policy implemented tomorrow. We now formalize this idea in the context of a two-period example.

There are two periods, indexed by $T = 1$ or 2. Within each period, the environment is as described in Section 2.1 and the competitive equilibrium is as described in Section 2.2. Across periods, the overall utility of an individual n with utility flow $u_1(n)$ in period 1 and utility flow $u_2(n)$ in period 2 is $u_1(n) + u_2(n)$. Technology and preferences are fixed over time, but trade taxes may vary. We let $t_T \equiv \{t_{g,T}\}$ denote the vector of trade taxes in period T and $\mathcal{U}(t_T)$ denote the set of utility profiles attainable in a competitive equilibrium with trade taxes t_T.

In period 1, the government chooses trade taxes t_1, but cannot commit to the future trade taxes t_2. Specifically, conditional on a vector of trade taxes t_1 from period 1, we assume that the government sets trade taxes in period 2 in order to solve

$$\begin{aligned}
&\max_{t_2 \in \mathcal{T}} \max_{\{u_2(n)\}} u_2(n_0) \\
&\text{subject to: } u_2(n) \geq \underline{u}(n, t_1) \text{ for } n \neq n_0, \\
&\qquad\qquad \{u_2(n)\} \in \mathcal{U}(t_2),
\end{aligned}$$

Critically, t_1 may affect the reservation utility $\underline{u}(n, t_1)$ of different individuals in the period 2 problem. This captures in a reduced-form way the impact of period 1's policies on political forces and hence the government's incentives in period 2. For instance, t_1 may affect the size of different sectors and their political power, as in Acemoglu and Robinson (2001), or t_1 may affect voters' beliefs about a politician's type in period 1 and, in turn, the probability that a politician with different preferences may be elected and select policy in period 2, as in Coate and Morris (1995). For any given vector of trade taxes in period 1, we let $\mathcal{T}_2^*(t_1)$ denote the set of optimal trade taxes in period 2.

We are now ready to describe the choice of the government in period 1. We solve for a Subgame Perfect Nash Equilibrium (SPNE) in which the government in period 1 anticipates the government in period 2 to pick $t_2 \in \mathcal{T}_2^*(t_1)$. Hence the vector of trade taxes t_1^* chosen in period 1 solves

$$\begin{aligned} \max_{\{t_T\}\in\mathcal{T}} \max_{\{u_T(n)\}} & \sum_{T=1,2} u_T(n_0) \\ \text{subject to: } & \sum_{T=1,2} u_T(n) \geq \underline{u}(n) \text{ for } n \neq n_0, \\ & \{u_T(n)\} \in \mathcal{U}(t_T), \\ & t_2 \in \mathcal{T}_2^*(t_1). \end{aligned}$$

To facilitate the description of trade taxes in a SPNE, suppose that (i) for any vector of trade taxes t_T, there is a unique utility profile $\{u(n, t_T)\}$ attainable in a competitive equilibrium (i.e. $\mathcal{U}(t_T)$ is a singleton) and (ii) for any vector of trade taxes t_1 imposed in period 1, there is a unique vector of trade taxes $t_2^*(t_1)$ that solves the government's problem in period 2 (i.e. $\mathcal{T}_2^*(t_1)$ is a singleton). We can therefore directly express the necessary first-order conditions associated with the vector of trade taxes t_1^* chosen in period 1 as

$$\sum_{n\in\mathcal{N}} \nu(n) \left\{D_{t_1}[u(n, t_1^*)] + D_{t_1}[t_2^*(t_1^*)]D_{t_2}[u(n, t_2^*(t_1^*))]\right\} = 0.$$

The condition for Pareto efficiency of trade taxes in period 1 instead requires

$$\sum_{n\in\mathcal{N}} \nu(n) D_{t_1}[u(n, t_1^*)] = 0.$$

It follows that trade taxes chosen in period 1 are Pareto-inefficient if the two vectors, $D_{t_1}[u(n, t_1^*)]$ and $D_{t_1}[t_2^*(t_1^*)]D_{t_2}[u(n, t_2^*(t_1^*))]$, are not collinear.

B 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 22 sectors. We consider 21 sectors in agriculture, oil, mining, and manufacturing that we define based on the intersection of NAICS-based 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). In addition, 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.

We now describe how we build the variables used in calibration.

National Accounts. For each sector, we use the BEA's make-use tables (before redefinitions) to measure gross output Y_s^{NA}, intermediate spending 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×industry space to the industry×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 associated BEA industries.

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.[42] 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 re-scale imports and exports in each sector to be consistent with their values in the National Accounts. For every $h \in \mathcal{H}_s$ within sector $s \in \mathcal{S}$, we construct

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

and

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

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

[42] 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.

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.[43]

For each region-sector, we impute gross output as the maximum between its exports, $X_{rs}^{M,F} = \sum_{i \in \mathcal{R}_F} \sum_{h \in \mathcal{H}_s} X_{rish}^{M,F}$, 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.[44]

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 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 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. 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.

[43]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.

[44]The only failure 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.

Regional spending. Given international and domestic shipments, each region r's total spending on goods of sector s is equal to $X_{rs} = \sum_{h \in \mathcal{H}_s} \sum_{i \in \mathcal{R}_F} X^F_{irsh} + \sum_{o \in \mathcal{R}_H} X^H_{ors}$.

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.[45] 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

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

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.

Domestic Production Subsidies. Our approach to obtaining data on production subsidies draws on that used by Ferrari and Ossa (2023). We primarily use data from the Upjohn Institute's Panel Database on Business Incentives (Bartik, 2017), which is available for 32 states, comprising a collective 91% of US GDP in 2017. Following Ferrari and Ossa (2023), we supplement this source with the *New York Times*' Business Incentive Database (Story et al., 2016) for the remaining 18 states. In addition, we use the Environmental Working Group's Farm Subsidy Database (Environmental Working Group, 2025) for the Agriculture sector, since this is omitted from the two previous databases.

The Upjohn database aims to calculate the (annualized value of the) "standard deal" of state and local government incentive payments that would be available to a representative firm establishing a new location in a given state and sector in the year 2015.[46] This value is expressed relative to the (annualized value of the) value-added produced by such a firm. We use each state-sector's gross output to value-added ratio (based on the production data described above) in order to convert the incentives reported by Upjohn as a share of gross output. Following again Ferrari and Ossa (2023), we treat these as the ad-valorem equivalent of s^y in our model. Because the Upjohn database does not cover the Real Estate, Oil & Gas, and Other Mining sectors, we assign each state's average reported subsidy rate to these three sectors.

The *New York Times* database differs from the Upjohn database in several respects.[47] First, it reports the total amount of incentives paid out to firms (by state and local governments) in any given state in a given year, rather than an estimate of the annualized value of incentives for a firm starting out in 2015. Second, the latest available year in the *New York Times* database is 2012. For these reasons, like Ferrari and Ossa (2023), we re-scale all values in the *New York Times* database by the ratio of total annualized implied payouts in the Upjohn database to total subsidy payouts (among the 32 Upjohn states) in the *New York Times* database.[48] We then apply these adjusted *New York Times* values to the 18 states not available in Upjohn (and apply them to all sectors other than Agriculture within these states), converting them into implied subsidy rates by dividing by total state gross output (among all sectors but

[46]Specifically, we use the "firm age weighting" in Upjohn to construct annualized values.

[47]We thank Ferrari and Ossa (2023) for sharing their web-scraped version of the *New York Times* database.

[48]This involves first converting the Upjohn subsidy rates, which are in terms of annual payouts per unit value-added, into total annual payouts by multiplying by the total value-added within each state-sector.

Agriculture), as above.

Finally, the Environmental Working Group (EWG) database reports total subsidies paid to the Agriculture sector within each state in 2017. In contrast to the Upjohn and *New York Times* databases, this source tracks subsidies provided by the federal government (rather than state and local ones), but this is appropriate given the nature of agricultural subsidy programs which are primarily set at the federal level. We divide the EWG subsidy payments by the state's agricultural gross output in 2017 to obtain state-specific ad-valorem subsidies for this sector.

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 is our measure of the average marginal tax on labor income for 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 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

[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.

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). 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 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.

C Model Appendix

Section C.1 characterizes the competitive equilibrium of the parametric model introduced in Section 3, and Section C.2 describes our calibration procedure for the model's parameters.

C.1 Competitive equilibrium

Prices. For each domestic origin $r \in \mathcal{R}_H$, destination $d \in \mathcal{R}$, and product $h \in \mathcal{H}_s$ from sector $s \in \mathcal{S}$, equations (11)-(12) imply that the domestic price p_{rdh} is equal to

$$p_{rdh} = (\theta_{rds})^{-1} p_{rs}, \tag{C.1}$$

$$p_{rs} = [\alpha_s]^{-\alpha_s} [w_{rs}]^{\alpha_s} \prod_{k \in S} [\alpha_{ks}]^{-\alpha_{ks}} [P_{rk}]^{\alpha_{ks}}, \tag{C.2}$$

$$P_{rk} = \left[\sum_{c=H,F} \sum_{v \in \mathcal{H}_k} \sum_{o \in \mathcal{R}_c} \theta^c_{orkv} [p_{orv}]^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{C.3}$$

Since there are no export taxes at Home, non-arbitrage further implies that if $d \in \mathcal{R}_F$, then

$$p_{rdh} = p^{M,F}_{rdh}. \tag{C.4}$$

Finally, for each foreign origin $i \in \mathcal{R}_F$, domestic destination $d \in \mathcal{R}_H$, and product $h \in \mathcal{H}_s$ from sector $s \in \mathcal{S}$, non-arbitrage implies

$$p_{idh} = t_{ih} + p^{X,F}_{irh}. \tag{C.5}$$

Bilateral Trade Flows. The expressions for prices in (C.1)-(C.3) and the expressions for technology and preferences in (11)-(12) and (13)-(14) imply that the (tariff-inclusive) spending in domestic region $r \in \mathcal{R}_H$ on product $h \in \mathcal{H}_s$ from foreign country $i \in \mathcal{R}_F$ is

$$X^F_{irsh} = \frac{\theta^F_{irsh} [p_{irh}]^{1-\sigma}}{[P_{rs}]^{1-\sigma}} X_{rs}, \tag{C.6}$$

where X_{rs} is total expenditure in region r on sector s. Similarly, spending in region r on all products of sector $s \in \mathcal{S}$ from domestic region $o \in \mathcal{R}_H$ is

$$X^H_{ors} = \frac{\sum_{h \in \mathcal{H}_s} \theta^H_{orsh} [p_{os}]^{1-\sigma}}{[P_{rs}]^{1-\sigma}} X_{rs}. \tag{C.7}$$

Input Demand. The problem of the representative producer f that produces $h \in \mathcal{H}_s$ in $r \in \mathcal{R}_H$ to sell in $d \in \mathcal{R}$ is

$$\max_{\ell_{rs}(f),\, Q_{rk}(f)} p_{rdh}\theta_{rds}(\ell_{rs}(f))^{\alpha_s} \prod_k (Q_{rk}(f))^{\alpha_{ks}} - w_{rs}\ell_{rs}(f) - \sum_k P_{rk}Q_{rk}(f).$$

This implies $w_{rs}\ell_{rs}(f) = \alpha_s Y_{rdh}$ and $P_{rk}Q_{rk}(f) = \alpha_{ks}Y_{rdh}$, where $Y_{rdh} = p_{rdh}q(f)$ is the firm's total revenue. Aggregating across all firms within the same region $r \in \mathcal{R}_H$ and sector $s \in \mathcal{S}$ and applying the labor market clearing condition then implies

$$W_{rs} = \alpha_s Y_{rs} \quad \text{and} \quad I_{rks} = \alpha_{ks} Y_{rs}, \tag{C.8}$$

where $W_{rs} \equiv w_{rs}N_{rs}$ and $Y_{rs} \equiv \sum_{d\in\mathcal{R}, h\in\mathcal{H}_s} Y_{rdh}$ are the value added and revenue of all firms in domestic region r and sector s, and I_{rks} is the expenditure of all such firms on intermediate inputs from sector k.

Substituting in for $Q_{rk}(f)$ in each firm's production function, we obtain the revenue in each region-sector:

$$Y_{rs} = \phi_{rs}N_{rs}(p_{rs})^{1/\alpha_s} \prod_{k\in\mathcal{S}} [\alpha_{ks}/P_{rk}]^{\alpha_{ks}/\alpha_s}. \tag{C.9}$$

Final Demand. Equation (13) implies that final expenditure in region r on sector s is

$$F_{rs} = P_{rs}C_{rs} = \gamma_s F_r, \tag{C.10}$$

where F_r denotes aggregate final spending in r, which is equal to r's aggregate income,

$$F_r = \sum_{s\in\mathcal{S}} W_{rs} + \sum_{s\in\mathcal{S}} N_{rs}\tau \quad \text{with} \quad \tau = \frac{1}{N} \sum_{i\in\mathcal{R}_F} \sum_{r\in\mathcal{R}_H} \sum_{s\in\mathcal{S}} \sum_{h\in\mathcal{H}_s} \frac{t_{ih}}{p_{irh}} X^F_{irsh}. \tag{C.11}$$

The consumption price index is given by

$$P^C_r = \prod_{k\in\mathcal{S}} (P_{rk})^{\gamma_k}. \tag{C.12}$$

Market Clearing. Total spending of each region r on sector s is

$$X_{rs} = \xi_{rs} + \gamma_s \left(\sum_{k\in\mathcal{S}} \alpha_k Y_{rk} + N_r\tau \right) + \sum_{k\in\mathcal{S}} \alpha_{sk} Y_{rk}, \tag{C.13}$$

where $N_r \equiv \sum_s N_{rs}$. Domestic demand for goods of sector s produced by region $r \in \mathcal{R}_H$ is

$$D_{rs}^H = \sum_{d \in \mathcal{R}_H} X_{rds}^H. \tag{C.14}$$

Using equations (16), (C.1), and (C.4), foreign country i's expenditure $X_{ris}^{M,F} = \sum_{h \in \mathcal{H}_s} p_{rih}^{M,F} q_{rih}^{M,F}$ on goods produced by domestic region r in sector s is

$$X_{ris}^{M,F} = (p_{rs})^{1-1/\psi^{M,F}} (\theta_{ris})^{-(1-1/\psi^{M,F})} \sum_{h \in \mathcal{H}_s} (\theta_{rih}^{M,F})^{1/\psi^{M,F}}.$$

Thus total foreign demand faced by region r in sector s, $D_{rs}^F \equiv \sum_{i \in \mathcal{R}_F} X_{ris}^{M,F}$, is given by

$$D_{rs}^F = \delta_{rs} (p_{rs})^{1-1/\psi^{M,F}} \quad \text{where} \quad \delta_{rs} \equiv \sum_{i \in \mathcal{R}_F} (\theta_{ris})^{-(1-1/\psi^{M,F})} \sum_{h \in \mathcal{H}_s} (\theta_{rih}^{M,F})^{1/\psi^{M,F}}. \tag{C.15}$$

Domestic good market clearing then requires, for each region r and sector s,

$$Y_{rs} = D_{rs}^F + D_{rs}^H. \tag{C.16}$$

By equations (15) and (C.5), market clearing for imports requires that for all $i \in \mathcal{R}_F$, $r \in \mathcal{R}_H$, and $h \in \mathcal{H}$,

$$(p_{irh})^{1+\psi^{X,F}} = t_{ih} (p_{irh})^{\psi^{X,F}} + \theta_{irh}^{X,F} (X_{irsh}^F)^{\psi^{X,F}} \tag{C.17}$$

with X_{irsh}^F given by equation (C.6).

C.2 Calibration

We now show how we calibrate $\{\alpha_s, \alpha_{ks}, \gamma_s, \xi_{rs}, \theta_{rds}, \theta_{orsh}^c, \theta_{irh}^{X,F}, \theta_{rih}^{M,F}, \phi_{rs}, N_{rs}\}$. As a first step, we normalize all foreign export prices to one, $p_{irh}^{X,F} = 1$, which implies that $t_{ih} = p_{irh}^{X,F} t_{ih}^{\text{av}} = t_{ih}^{\text{av}}$. We also normalize wages and the prices of domestically produced goods to one: $w_{rs} = 1$ and $p_{rdh} = (\theta_{rds})^{-1} p_{rs} = 1$. From (C.1)-(C.3), this implies that

$$P_{rk} = \left[\sum_{v \in \mathcal{H}_k} \sum_{o \in \mathcal{R}_H} \theta_{orkv}^H + \sum_{v \in \mathcal{H}_k} \sum_{o \in \mathcal{R}_F} \theta_{orkv}^F [1 + t_{ov}^{\text{av}}]^{1-\sigma} \right]^{\frac{1}{1-\sigma}}. \tag{C.18}$$

Lower-nest Technology and Preference Parameters: $\{\theta_{orsh}^c\}$. Under our price normalization, (C.6) implies

$$\theta_{irsh}^F = \frac{X_{irsh}^F}{X_{rs}} \left[\frac{P_{rs}}{1 + t_{ih}^{\text{av}}} \right]^{1-\sigma},$$

where X^F_{irsh} is the (tariff-inclusive) value of imports of product $h \in \mathcal{H}_s$ from country i by region r, X_{rs} is the aggregate spending on sector s in region r , and P_{rk} is given by (C.18).

Similarly, (C.7) implies that $\sum_{v \in \mathcal{H}_k} \theta^H_{orkv} = (X^H_{ors}/X_{rs})[P_{rs}]^{1-\sigma}$. Given that $\theta^H_{orkv} = \bar{\theta}^H_{ork}$ for all $v \in \mathcal{H}_k$,

$$\theta^H_{orkv} = \bar{\theta}^H_{ork} = \frac{X^H_{ors}}{X_{rs}}[P_{rs}]^{1-\sigma} \Big/ |\mathcal{H}_k|.$$

Upper-nest Technology Parameters: $\{\alpha_{ks}, \alpha_s, \theta_{rds}\}$**.** Since (C.8) holds for all domestic regions, we set α_{ks} equal to sector s's national spending share on inputs from sector k:

$$\alpha_{ks} = \frac{I^{\text{NA}}_{ks}}{Y^{\text{NA}}_s}.$$

Using (C.8), we then set the value-added share α_s equal to:

$$\alpha_s = 1 - \sum_{k \in \mathcal{S}} \alpha_{ks}.$$

Finally, under our price normalization, (C.1) and (C.2) imply

$$\theta_{rds} = [\alpha_s]^{-\alpha_s} \prod_{k \in S} [\alpha_{ks}]^{-\alpha_{ks}} [P_{rk}]^{\alpha_{ks}}.$$

Upper-nest Preference Parameters: $\{\gamma_s\}$**.** Since (C.10) holds for all domestic regions, we set γ_s equal to the share of s in national final spending:

$$\gamma_s = \frac{F^{\text{NA}}_s}{\sum_k F^{\text{NA}}_k}.$$

Foreign Supply and Demand Shifters: $\{\theta^{X,F}_{irh}, \theta^{M,F}_{rih}\}$**.** Under our price normalization, (15) and (16) imply

$$\theta^{X,F}_{irh} = (1 + t^{\text{av}}_{ih})^{\psi^{X,F}} (X^F_{irsh})^{-\psi^{X,F}},$$
$$\theta^{M,F}_{rih} = (X^{M,F}_{rish})^{\psi^{M,F}},$$

with $X^{M,F}_{rish}$ the value of exports of product h of sector s from region r to country i.

Residual Spending: $\{\xi_{rs}\}$**.** We first compute lump-sum transfers using (C.11):

$$\tau = \frac{1}{N} \sum_{i \in \mathcal{R}_F} \sum_{r \in \mathcal{R}_H} \sum_{s \in \mathcal{S}} \sum_{h \in \mathcal{H}_s} \frac{t_{ih}^{\text{av}}}{1 + t_{ih}^{\text{av}}} X_{irsh}^F.$$

Finally, given X_{rs}, Y_{rs}, and $N_r \tau$, we use (C.13) to solve for ξ_{rs} as:

$$\xi_{rs} = X_{rs} - \gamma_s \left(\sum_{k \in \mathcal{S}} \alpha_k Y_{rk} + N_r \tau \right) - \sum_{k \in \mathcal{S}} \alpha_{sk} Y_{rk}.$$

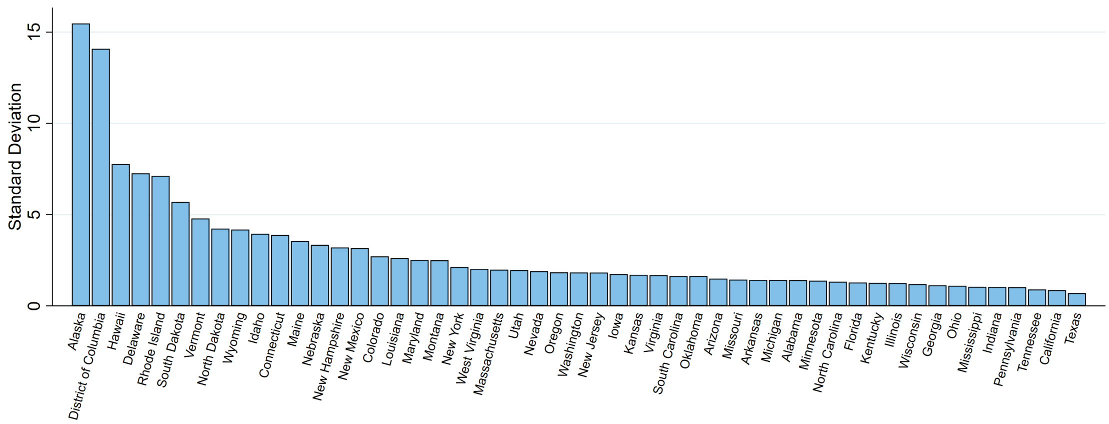
Employment and labor endowments: $\{\phi_{rs}, N_{rs}\}$ We set region-sector employment to the values in the BEA's regional accounts, $N_{rs} = N_{rs}^{\text{RA}}$. We then set region-sector labor endowments per worker, ϕ_{rs}, to match value-added in each region-sector. Given our wage normalization and equation (C.8), this is equivalent to setting ϕ_{rs} such that

$$\phi_{rs} N_{rs} = \alpha_s Y_{rs}.$$

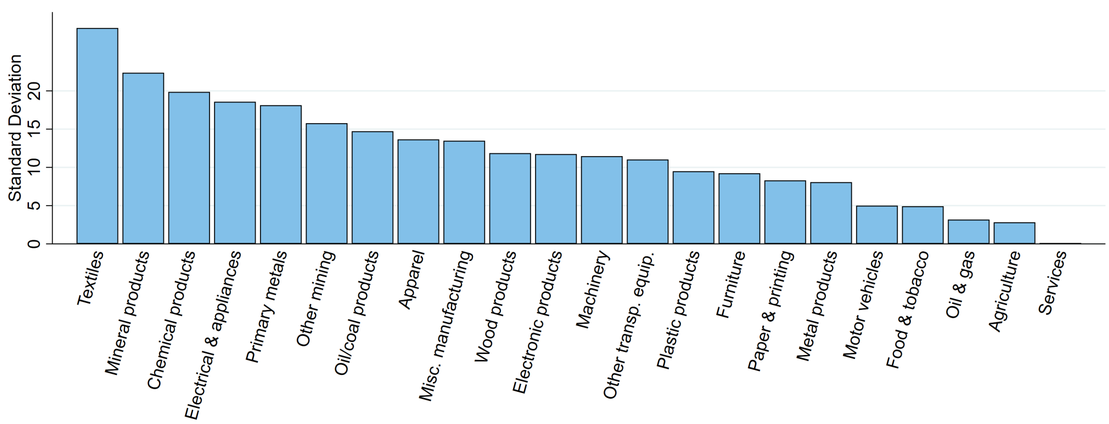
D Estimation Appendix

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

(a) Region

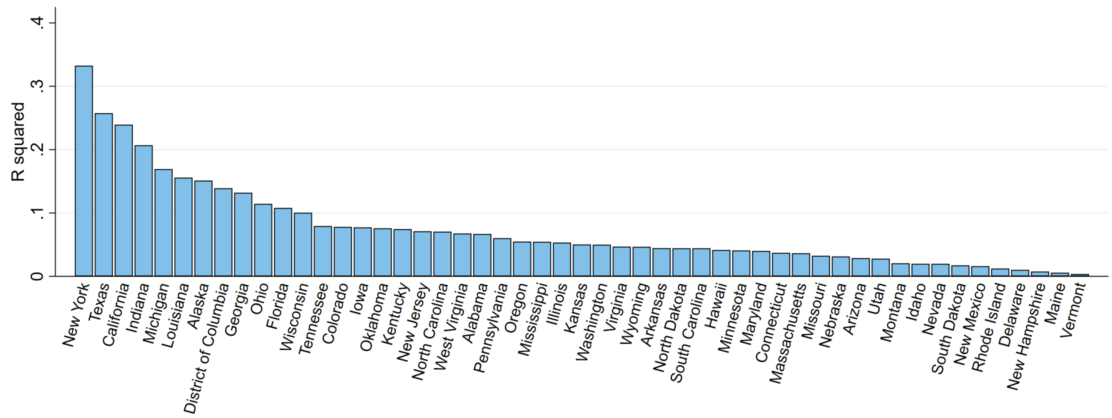


(b) Sector



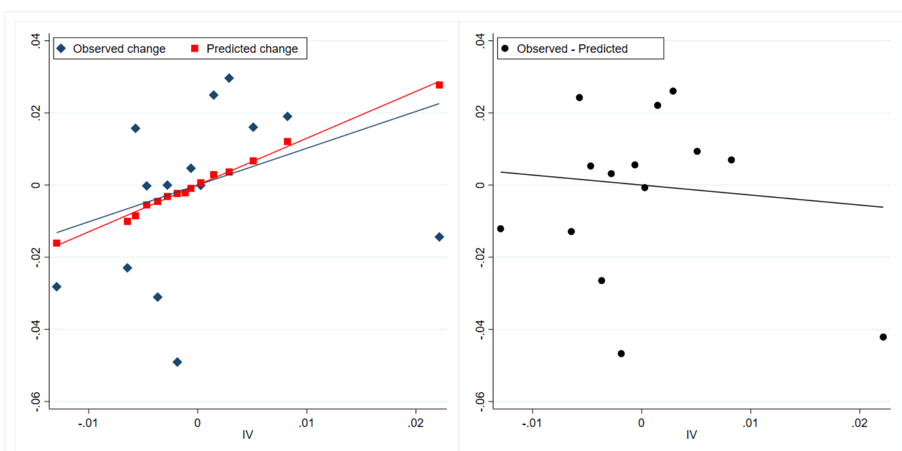
Notes: This figure reports the standard deviation of $\partial(\omega_s - \bar{\omega})/\partial m_{ih}$ and $\partial(\omega_r - \bar{\omega})/\partial m_{ih}$, taken across all origin countries i and products h in our baseline sample, separately for each sector and region.

Figure D.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 22 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 D.3: Changes in earnings per worker during the US-China trade war: a test

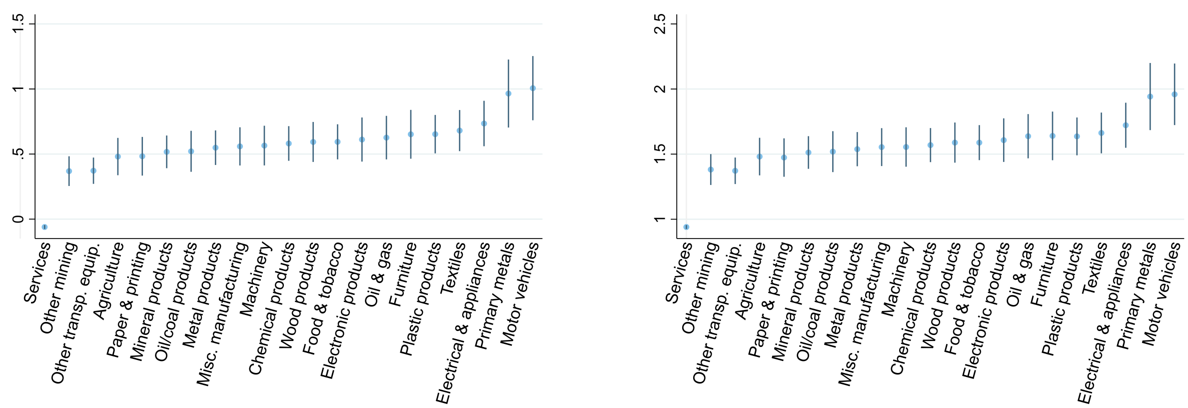


Notes: The left figure plots observed and predicted changes in earnings per worker against our IV and the right figure plots the difference between observed and predicted changes against our IV. Each figure displays a binned scatter plot in which the underlying region-sector observations are grouped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

Figure D.4: Estimates of sector-based welfare weights (omitting Apparel sector)

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

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

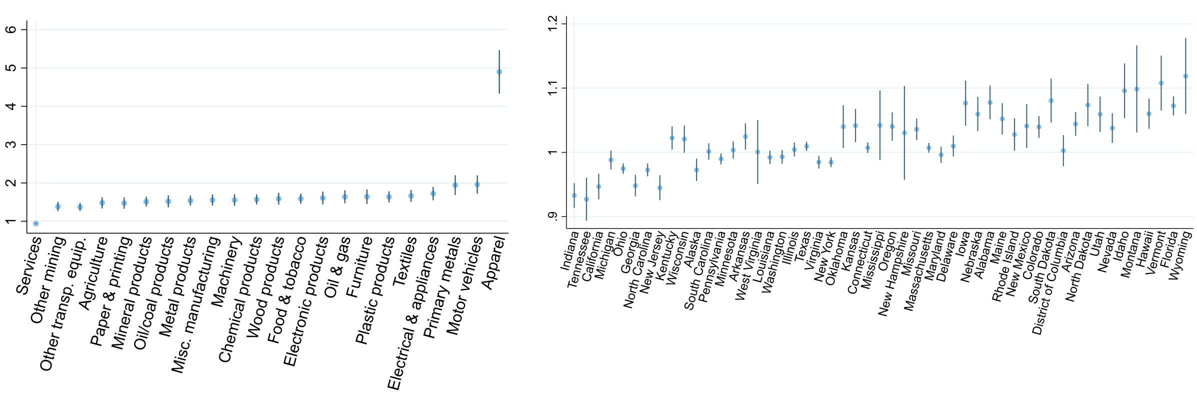


Notes: Panel (a) displays estimates of the marginal social return, β_s, for each sector s, as obtained from equation (20) and normalized such that the mean of $\hat{\beta}_s$ across s is zero. Panel (b) displays estimates of average welfare weights computed as $\bar{\beta}_s \equiv \sum_r \left(\frac{N_{sr}}{N_s}\right) \hat{\beta}_{rs}$. 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 D.5: Estimates of average welfare weights across sectors and regions

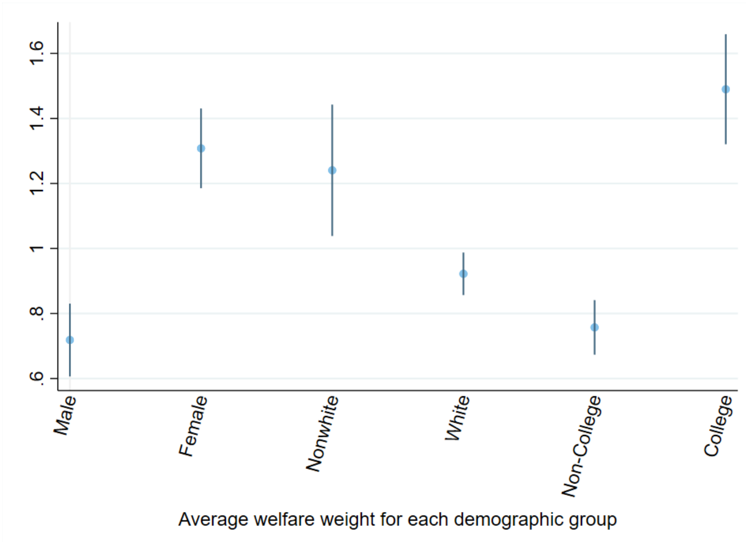
(a) $\bar{\beta}_s$ estimates

(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 D.6: Estimates of average welfare weights across other demographic groups



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