Lobbying, Trade, and Misallocation*

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Abstract

This paper studies how lobbying affects welfare gains from trade in a second-best world. I develop an open economy model of heterogeneous firms that can lobby to influence firm-specific distortions, consisting of endogenous and exogenous components. As trade costs decline, exporters increase their lobbying efforts relative to non-exporters, due to the complementarity between market size and lobbying benefits. This divergence affects allocative efficiency, firm entry, and, consequently, welfare gains from trade. Whether lobbying amplifies or worsens gains from trade depends on which types of firms select into exporting in a second-best world. I estimate the model by reduced-form IV strategy and structurally using US firm-level data. Gains from trade exceed those without lobbying by 3%, driven by larger improvement in allocative efficiency due to increased lobbying by productive exporters that offset their initial distortions. However, when selection into exporting is driven by exogenous distortions, it is possible that trade leads to welfare losses and lobbying exacerbates these losses.

Keywords: lobbying, misallocation, gains from trade
JEL Codes: D24, D72, F14

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1 Introduction

The economic consequences of firms' political engagement have received much attention in both politics and academic research with the advent of large-sized firms brought on by globalization. There is abundant evidence showing that these large-sized firms are politically active and have spent sizable sums of money to influence the policy-making process.[1] However, the question of how firms' political influences affect welfare gains from trade remains an open question.

This paper studies the impact of lobbying on welfare gains from trade in a second-best world. I develop a two-country open-economy model featuring heterogeneous firms, where misallocation arises from firm-specific distortions consisting of both exogenous components and those endogenously determined by firms' lobbying decisions. Using this model, calibrated to US firm-level data, I quantitatively evaluate the gains from trade in the presence of lobbying. The key finding is that the gains from trade exceed those without lobbying by 3%, because more productive exporters increase their lobbying, offsetting their initially less favorable distortions. However, in an alternative scenario where selection into exporting is more driven by exogenous distortions, it is possible that trade brings welfare losses and lobbying exacerbates the losses. These results highlight that whether lobbying amplifies or mitigate gains from trade depends on which types of firms select into exporting in a second-best world.

In the model, lobbying results in an increase in firm-specific distortions, leading to firms becoming relatively more subsidized or less taxed, albeit at the expense of incurring both variable and fixed costs. Due to the presence of fixed costs, only select firms capable of overcoming these expenses engage in lobbying activities. Furthermore, larger-sized firms tend to allocate more resources to lobbying due to the complementary relationship between firm size and the benefits from lobbying.

Firms exhibit heterogeneity along three dimensions: productivity, exogenous distortions, and lobbying efficiency. Higher productivity allows firms to produce at lower costs, while those with higher exogenous distortions receive greater initial subsidies or face lower initial taxes. These exogenous distortions capture factors contributing to misallocation not directly influenced by lobbying. Firms with higher lobbying efficiency can achieve higher subsidies or lower taxes through lobbying while incurring lower variable lobbying costs. Conditional on lobbying efficiency, firms with higher productivity or exogenous distortions tend to be larger and invest more in lobbying due to the complementarity. Similarly, among firms with similar levels of productivity and exogenous distortions, those with higher lobbying efficiency allocate more resources to lobbying due to lower variable lobbying costs.

Openness to trade affects firm lobbying through the complementarity between firm size and benefits from lobbying. Lower trade costs induce exporters to expand their size through exporting in foreign markets and to increase spending on lobbying due to the complementarity. On the other

[1] For example, see Drutman (2015) and Zingales (2017). The debate over the influence of special interests on US politics has deep historical roots, as evidenced by President Theodore Roosevelt's 1910 speech decrying the control of government by business interests (Roosevelt, 1910). Recently, data collected under the Lobbying Disclosure Act (1995) reveals that firms spent a staggering $3.51 billion on lobbying alone in 2019.

hand, non-exporters' size shrinks due to heightened foreign competition and therefore, they decrease efforts on lobbying. This divergence of lobbying behaviors between the two groups impact allocative efficiency of an economy, firm entry, and therefore gains from trade. In the simplified setup of the model, I derive analytical formulas for welfare changes resulting from local iceberg trade cost shocks. Trade cost shocks affect firms' lobbying efforts and, consequently, their distortion levels, leading to deviations from the formulas developed by Arkolakis et al. (2012), Melitz and Redding (2015), and Bai et al. (2023) (henceforth referred to as ACR, MR, and BKL).

I construct the main dataset by combining Compustat balance sheet data with publicly disclosed firm lobbying expenditures since the enactment of the Lobbying Disclosure Act (1995). Using this dataset, I estimate the parameters of the model using both IV strategy and method of moments. To estimate the parameter governing the elasticity of lobbying on firm-specific distortions, I regress firm-specific distortions, derived from revenue-based total factor productivity (TFPR), on lobbying expenditures instrumented by the state-level time-varying appointment of a Congress member as chairperson of the House or Senate Appropriations Committee. The IV estimates suggest that a 1% increase in lobbying expenditures increases the distortions by 0.08%. I calibrate the remaining parameters by aligning the moments from the model with their counterparts in the data. The estimated parameters imply that productivity and exogenous distortions are negatively correlated, implying that more productive firms tend to be less subsidized or more taxed initially.

Using the calibrated model, I assess how openness to trade influences firm lobbying when moving from autarky to the current equilibrium with observed import shares. Compared to the autarky, exporters are more inclined to engage in lobbying and allocate more resources to it due to the expanded market size. Conversely, non-exporters are less likely to participate and spend fewer resources on it due to heightened foreign competition. Aggregating these heterogeneous responses across firms, I find that, at the extensive margin, the overall probability of participating in lobbying decreases by 0.5 percentage points due to decreased lobbying efforts by non-exporters. However, at the intensive margin, the average lobbying expenditures increase by 1.75% due to increased lobbying efforts by exports. These quantitative results align with the theoretical predictions.

Next, I compare the gains from trade in the presence and absence of lobbying. I find that the gains are larger by 3% with lobbying, primarily attributed to a more significant improvement in allocative efficiency. This occurs because, under the calibrated values, initially, more productive firms tend to face lower subsidies or higher taxes. As these firms increase lobbying efforts after opening to trade and overcome their initial distortions, there is a more substantial improvement in allocative efficiency. However, this is not always the case. In an alternative scenario, where firm selection into exporting is more driven by exogenous distortions, opening to trade brings a welfare loss, and lobbying exacerbates this loss. These results highlight that whether lobbying amplifies or worsens gains from trade depends on which types of firms select into exporting in a second-best world.

Moreover, the gains predicted by the ACR/MR and BKL formulas understate the true gains by

3.7% and 3.2%, respectively. These results underscore the importance of considering microstructure when evaluating gains from trade.

This paper contributes to the literature that studies gains from trade in distorted economies (see, among many others, Levchenko, 2007; Nunn, 2007; Khandelwal et al., 2013; Manova, 2013; Edmond et al., 2015; Święcki, 2017; Berthou et al., 2018; Costa-Scottini, 2018; Chung, 2019; Fajgelbaum et al., 2019; Choi et al., 2023). The most closely related paper is Bai et al. (2023), who investigate gains from trade in the presence of firm-specific exogenous distortions pioneered by Hsieh and Klenow (2009) and Restuccia and Rogerson (2008).[2] I extend their open-economy model to incorporate firm lobbying decisions and demonstrate that lobbying makes true gains from trade deviate from the sufficient statistics formulas developed by Arkolakis et al. (2012), Melitz and Redding (2015), and Bai et al. (2023). While Bombardini et al. (2021) and Cutinelli-Rendina (2021) examine the escape competition effects of lobbying in an open economy, this paper focuses on the complementarity between market size and lobbying.

This paper also contributes to the literature on corporate lobbying, as surveyed by Bombardini and Trebbi (2020) (see, among many others, Richter et al., 2009; Bombardini and Trebbi, 2011, 2012; Igan et al., 2012; Blanes i Vidal et al., 2012; Bertrand et al., 2014; Kerr et al., 2014; Kang, 2016; Kim, 2017; Bertrand et al., 2020; Blanga-Gubbay et al., 2020; Choi et al., 2021). My work is most closely related to Arayavechkit et al. (2017), García-Santana et al. (2020), and Huneeus and Kim (2018), who also model firm-specific distortions as endogenous outcomes of lobbying or political connections, and quantitatively assess the impact of firms' political activities on resource misallocation in a closed economy. I extend the model developed by García-Santana et al. (2020) and Huneeus and Kim (2018) to an open economy and study gains from trade in the presence of lobbying.

Finally, this paper is related to the literature on politics and trade (see, among many others, Grossman and Helpman, 1994; McLaren, 1997; Goldberg and Maggi, 1999; Gawande and Bandyopadhyay, 2000; Bombardini, 2008; Do and Levchenko, 2009; Bombardini and Trebbi, 2012; Gawande et al., 2012; Celik et al., 2013; Levchenko, 2013; Campante et al., 2023; Bombardini et al., 2020; Blanga-Gubbay et al., 2020; Hennicke and Blanga-Gubbay, 2022). See Rodrik (1995) and McLaren (2016) for surveys. I contribute to this literature by studying how the interaction between openness to trade and firm lobbying affects gains from trade. My quantitative results highlight the importance of understanding the underlying political system when evaluating gains from trade.

The remainder of this paper proceeds as follows. Section 2 outlines the quantitative model. Section 3 discusses the data and the calibration procedure. Section 4 presents the quantitative results. Section 5 concludes.

[2] On sources of misallocation, see, among many others, Lafontaine and Sivadasan (2009) and Petrin and Sivadasan (2013) on labor market frictions; Edmond et al. (2015) on imperfect competition; Midrigan and Xu (2014), Moll (2014), Gopinath et al. (2017), David and Venkateswaran (2019), and Choi and Levchenko (2023) on financial frictions; Hsieh and Moretti (2019), Tombe and Zhu (2019), and Choi (2023) on spatial misallocation; and Guner et al. (2008) and Garicano et al. (2016) on size dependent policies.

2 Theoretical Framework

I construct a general equilibrium heterogeneous firm model with lobbying. The model considers two potentially asymmetric countries, Home and Foreign, which may differ in labor endowment and distributions of firm primitives. Foreign variables are denoted by subscript f. Households supply labor inelastically and are immobile across countries.

Households Representative households in Home choose amounts of final goods C to maximize their utility subject to the budget constraint: $PC = wL + \Pi + T$, where P is the price of final goods, w is the wage, L is labor endowment, Π is dividend income, and T is lump-sum transfer from the government.

Final Goods Producers Final goods are produced by representative final goods producers under perfect competition. Final goods are non-tradable and used for consumption. Final goods producers combine intermediate varieties available in Home a CES aggregator:

$$Q = \left[\int_{\omega \in \Omega \cup \Omega^x} q(\omega)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where each variety is denoted as ω, σ is the elasticity of substitution, and q is the quantity demanded of each variety. Ω and Ω^x are the sets of domestic and foreign varieties available in Home, endogenously determined in the equilibrium. The ideal price index is given by

$$P = \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} + \int_{\omega \in \Omega^x} p^x(\omega)^{1-\sigma} \right]^{\frac{1}{1-\sigma}},$$

where p and p^x are prices charged by domestic and foreign intermediate goods producers.

Intermediate Goods Producers and Lobbying There is a mass of monopolistically competitive intermediate goods producers M, endogenous determined by their entry and production decisions. I refer to these intermediate goods producers as firms. Prior to entry, potential entrants are identical and face sunk costs of entry f_e in units of labor. The free entry condition is imposed, which ensures the aggregate profits are zero, $\Pi = 0$.

Labor is the only factor of input for production. The production function for each variety is linear in labor:

$$y(\omega) = \phi(\omega) l(\omega),$$

where y is output produced, ϕ is productivity, and l is labor input used for production. The production of each variety requires fixed production costs f in units of labor, so total labor used for production is $y/\phi + f$.

Firms can export after incurring fixed export costs f_x in units of labor (Melitz, 2003). They also incur iceberg costs $\tau_x > 1$ when exporting, so delivering one unit of an intermediate good to a foreign country requires τ_x units.

Firms are subject to domestic output distortions τ^y. If $\tau^y > 1$ (or < 1), firms are subsidized (or taxed). Output distortions increase with lobbying amounts. Thus, if firms increase their lobbying, they will be relatively more subsidized or taxed less. I assume that output distortions are composed of exogenous and endogenous components with the following functional form:

$$\tau^y(\omega) = \tau(\omega) \times \max\{\bar{\tau}, b(\omega)^\theta\}, \tag{2.1}$$

where b represents lobbying inputs chosen by firms, and τ denotes exogenous distortions drawn from a given distribution. Firms take τ as given and make lobbying decisions. $\bar{\tau}$ is a common distortion across firms, which can be interpreted as common subsidies or taxes applied to all firms in an economy.

The endogenous component, $\max\{\bar{\tau}, b^\theta\}$, is the result of lobbying. Once firms participate in lobbying, they endogenously choose their output distortions after incurring variable and fixed costs of lobbying, both of which are in units of domestic labor. The total labor used for lobbying amounts of b is

$$w\Big(\kappa\frac{b}{\eta} + f_b\Big),$$

where $\kappa b/\eta$ and f_b are variable and fixed costs of lobbying. κ is a parameter governing the overall level of the variable costs. η is stochastic firm-specific lobbying efficiency that rationalizes the pattern in the data that small-sized firms participate in lobbying within industry.[3] Firms with higher η incur lower variable costs to achieve the same endogenous output distortions compared to firms with lower η. The fixed lobbying cost rationalizes the pattern in the firm-level data that only a fraction of firms participate in lobbying (Kerr et al., 2014).

θ is one of the key parameters of the model that captures how effectively lobbying increases output distortions.[4] By taking the maximum, lobbying becomes effective only when it is sufficiently large enough to make the endogenous distortions larger than a level $\bar{\tau}$ that is common for all firms.[5] Therefore, lobbying firms receive lobbying-induced subsidies or are less taxed than to non-lobbying firms. With higher values of θ, the same amount of lobbying can increase the output distortions more. I impose restrictions on θ and σ as follows[6]:

[3] An alternative way of rationalizing small firms' lobbying is by allowing for heterogeneity in fixed lobbying costs. One difference with this approach is that, unlike heterogeneity in fixed lobbying costs that do not enter firm sales, variable lobbying efficiency enters firm sales directly and, therefore, allows for a more flexible fit of the firm size distribution.

[4] θ may reflect the quality of institutions or the political system. For example, θ can be higher in countries where corruption is prevalent.

[5] Under the functional form, $\bar{\tau}$ may affect the extensive margin of lobbying because only firms whose optimal lobbying inputs satisfy $b^\theta > \bar{\tau}$ participate in lobbying. However, with the calibrated values, I computationally find that no firms' optimal lobbying inputs are on the binding constraint. Therefore, setting $\bar{\tau}$ to one is innocuous as it does not quantitatively affect firm lobbying decisions, and the degree of misallocation does not depend on the common distortion level.

[6] These parametric restrictions guarantee that firms do not spend infinite amounts on lobbying. If $1 - \theta\sigma \geq 1$, the output distortions increase too quickly with b. Technically, this is the second-order condition of firms' maximization problems. These assumptions are also empirically supported by my estimate of θ in Section 3.2. With the estimate

Assumption 1. *θ and σ satisfy (i) $0 < 1 - \theta\sigma < 1$, and (ii) $\sigma > 1$.*

Firms are heterogeneous along three dimensions: productivity ϕ, exogenous distortions τ, and lobbying efficiency η. The firm-specific vector of primitives, $\boldsymbol{\psi} = (\phi, \tau, \eta)$, is drawn from a joint distribution $G(\boldsymbol{\psi})$ with an arbitrary correlation structure. They draw primitives after incurring the sunk entry costs. Each draw is independent across firms. Because firms with the same $\boldsymbol{\psi}$ behave identically, I index firms by $\boldsymbol{\psi}$.

Firms take the demand function in domestic and foreign markets as given and maximize their profits. They solve the following maximization problem:

$$\pi = \max_{\substack{\{b,p,p^x,\\ q,q^x,x\}}} \Big(\tau \times \max\{\bar{\tau}, b^\theta\}\Big)\Big\{pq - w\frac{q}{\phi} - wf + x\Big(p^x q^x - w\frac{\tau_x q^x}{\phi} - wf_x\Big)\Big\} - w\Big(\kappa\frac{b}{\eta} + f_b\Big)\mathbb{1}[b > 0],$$
$$\text{subject to} \quad q = p^{-\sigma}P^{\sigma-1}E, \quad q^x = (p^x)^{-\sigma}P_f^{\sigma-1}E_f, \quad x \in \{0,1\}, \quad (2.2)$$

where E and E_f are the total expenditures in Home and Foreign, x is a binary export decision, p^x is export price, and q^x is export quantity.

Firms charge a constant mark-up $\mu = \sigma/(\sigma - 1)$ over their marginal costs and choose to export if the profits in the foreign market are sufficiently high to cover the fixed export costs. Under monopolistic competition, conditional on lobbying amounts of b, the firm price is given by

$$p = \Big(\mu\frac{w}{\phi}\Big)\Big(\tau \times \max\{\bar{\tau}, b^\theta\}\Big)^{-1}.$$

Profits conditional on not lobbying are expressed as

$$\pi(0; \boldsymbol{\psi}) = \max_{x\in\{0,1\}} \Big\{\pi^d(0; \boldsymbol{\psi}) + x\pi^x(0; \boldsymbol{\psi})\Big\},$$

where $\pi^d(0; \boldsymbol{\psi})$ and $\pi^x(0; \boldsymbol{\psi})$ represent profits conditional on not lobbying in the domestic and foreign markets, respectively:

$$\pi^d(0; \boldsymbol{\psi}) = \underbrace{\frac{1}{\sigma}\Big(\mu\frac{w}{\phi}\Big)^{1-\sigma}\tau^\sigma P^{\sigma-1}E}_{=\tilde{\pi}^d(0;\boldsymbol{\psi})} - wf \quad \text{and} \quad \pi^x(0; \boldsymbol{\psi}) = \underbrace{\frac{1}{\sigma}\Big(\mu\frac{\tau_x w}{\phi}\Big)^{1-\sigma}\tau^\sigma P^{\sigma-1}E}_{=\tilde{\pi}^x(0;\boldsymbol{\psi})} - wf_x.$$

Here, $\tilde{\pi}^d(0; \boldsymbol{\psi})$ and $\tilde{\pi}^x(0; \boldsymbol{\psi})$ are the variable profits conditional on not lobbying in the domestic and foreign markets.

Once firms engage in lobbying, the optimal lobbying inputs are characterized by the first-order conditions with respect to b. Because benefits from lobbying are larger with larger market size,

of θ around 0.08, the assumption is satisfied with the commonly used values for the elasticity of substitution in the literature.

exporters disproportionately lobby more than non-exporters. The optimal lobbying inputs for non-exporters and exporters can be written in terms of the variable profits conditional on not lobbying, aggregate variables, and model parameters. The optimal lobbying inputs for non-exporters and exporters are expressed as follows:

$$b^d = \Big(\frac{\theta\sigma\eta}{\kappa w}\tilde{\pi}^d(0;\boldsymbol{\psi})\Big)^{\frac{1}{1-\theta\sigma}} \quad \text{and} \quad b^x = \Big(\frac{\theta\sigma\eta}{\kappa w}\Big(\tilde{\pi}^d(0;\boldsymbol{\psi}) + \tilde{\pi}^x(0;\boldsymbol{\psi})\Big)\Big)^{\frac{1}{1-\theta\sigma}}. \tag{2.3}$$

Substituting Equation (2.3) into Equation (2.2), profits conditional on lobbying for non-exporters and exporters are expressed as follows:

$$\pi^d(b^d;\boldsymbol{\psi}) = (1-\theta\sigma)\Big(\frac{\theta\sigma\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{\pi}^d(0;\boldsymbol{\psi})^{\frac{1}{1-\theta\sigma}} - w(f+f_b)$$

and

$$\pi^x(b^x;\boldsymbol{\psi}) = (1-\theta\sigma)\Big(\frac{\theta\sigma\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\Big(\tilde{\pi}^d(0;\boldsymbol{\psi}) + \tilde{\pi}^x(0;\boldsymbol{\psi})\Big)^{\frac{1}{1-\theta\sigma}} - w(f+f_x+f_b).$$

The lobbying process exponentiates the variable profits conditional on not lobbying to the power of $1/(1-\theta\sigma)$, implying that firms with higher ϕ or τ gain larger benefits from lobbying. Additionally, firms with higher η have larger benefits from lobbying.

Lobbying and export decisions are jointly determined. Because lobbying increases output distortions for sales in both markets, firm export decisions are not separable across markets. For example, there can be a set of firms with low productivity but high lobbying efficiency that would not export to Foreign if lobbying technology were unavailable. With lobbying and export decisions, firms have four possible options and compare the total profits of each option. Their final profits are determined as the maximum of the four options:

$$\pi(\boldsymbol{\psi}) = \max\Big\{\pi^d(0;\boldsymbol{\psi}), \pi^d(0;\boldsymbol{\psi}) + \pi^x(0;\boldsymbol{\psi}), \pi^d(b^d;\boldsymbol{\psi}), \pi^x(b^x;\boldsymbol{\psi})\Big\},$$

where the terms inside the bracket represent non-lobbying non-exporters' profits, non-lobbying exporters' profits, lobbying non-exporters' profits, and lobbying exporters' profits, respectively.

Next, I characterize zero profit, lobbying, and export cutoffs, detailed in Online Appendix A.1. With the fixed production costs, firms start production only when their profits exceed zero. These production decisions are characterized by a zero profit cutoff productivity, $\bar{\phi}^e(\tau,\eta)$, determined by:

$$\pi(\bar{\phi}^e(\tau,\eta),\tau,\eta) = 0,$$

which decreases with both τ and η. Holding τ and η constant, only firms with productivity above this cutoff participate in production.

Similarly, with the fixed lobbying costs, lobbying decisions are characterized by a cutoff productivity. The unique cutoff productivity $\bar{\phi}^b(\tau,\eta)$ is determined by

$$\max\Big\{\pi^d(0;\bar{\phi}^b(\tau,\eta),\tau,\eta),\pi^d(0;\bar{\phi}^b(\tau,\eta),\tau,\eta)+\pi^x(0;\bar{\phi}^b(\tau,\eta),\tau,\eta)\Big\}$$
$$=\max\Big\{\pi^d(b^d;\bar{\phi}^b(\tau,\eta),\tau,\eta),\pi^x(b^x;\bar{\phi}^b(\tau,\eta),\tau,\eta)\Big\}, \quad (2.4)$$

where the left- and right-hand sides are the maximum profits conditional on not lobbying and lobbying, respectively. Holding τ and η constant, only firms with productivity above $\bar{\phi}^b(\tau,\eta)$ participate in lobbying: $b(\boldsymbol{\psi})>0$ if $\phi\geq\bar{\phi}^b(\tau,\eta)$ and $b(\boldsymbol{\psi})=0$ otherwise. The lobbying cutoffs decrease with τ and η.

Similarly, the fixed export costs characterize the export cutoff productivity, $\bar{\phi}^x(\tau,\eta)$:

$$\max\Big\{\pi^d(0;\bar{\phi}^x(\tau,\eta),\tau,\eta)+\pi^x(0;\bar{\phi}^x(\tau,\eta),\tau,\eta),\pi^x(b^x;\bar{\phi}^x(\tau,\eta),\tau,\eta)\Big\}$$
$$=\max\Big\{\pi^d(0;\bar{\phi}^x(\tau,\eta),\tau,\eta),\pi^d(b^d;\bar{\phi}^x(\tau,\eta),\tau,\eta)\Big\}, \quad (2.5)$$

where the left-and right-hand sides are the maximum profits conditional on exporting and not exporting, respectively. Holding τ and η constant, only firms with productivity above the export cutoffs participate in exporting: $x(\boldsymbol{\psi})=1$ if $\phi\geq\bar{\phi}^x(\tau,\eta)$ and $x(\boldsymbol{\psi})=0$ otherwise. The export cutoffs also decrease with τ and η.

Equilibrium In the equilibrium, there are a mass of entrants M_e, a mass of operating firms M, and ex-post distribution of productivity, exogenous distortions, and lobbying efficiency:

$$\hat{g}(\boldsymbol{\psi})=\begin{cases}\frac{g(\boldsymbol{\psi})}{\int_{\phi\geq\bar{\phi}^e(\tau,\eta)}g(\boldsymbol{\psi})d\boldsymbol{\psi}} & \text{if} \quad \phi\geq\bar{\phi}^e(\tau,\eta)\\ 0 & \text{otherwise.}\end{cases}$$

Let $\hat{G}(\boldsymbol{\psi})$ be the corresponding CDF of $\hat{g}(\boldsymbol{\psi})$. The probability of entry is $p_e=\int d\hat{G}(\boldsymbol{\psi})$. The mass of producers is $M=p_eM_e$.

The free entry condition implies that

$$p_e\bigg[\int\pi(\boldsymbol{\psi})d\hat{G}(\boldsymbol{\psi})\bigg]=wf_e.$$

The government budget is balanced, and the total tax revenues are transferred to consumers in lump-sum fashion:

$$T=M\bigg[\int\big(1-\tau^y(\boldsymbol{\psi})\big)\Big(p(\boldsymbol{\psi})q(\boldsymbol{\psi})+x(\boldsymbol{\psi})p^x(\boldsymbol{\psi})q^x(\boldsymbol{\psi})\Big)d\hat{G}(\boldsymbol{\psi})\bigg].$$

Goods market-clearing implies that $C = Q$. Labor market clearing implies that

$$L = M\left[\int \Big(l(\boldsymbol{\psi}) + b(\boldsymbol{\psi}) + f + x(\boldsymbol{\psi})f_x\Big)d\hat{G}(\boldsymbol{\psi})\right] + M_e f_e.$$

Trade is balanced:

$$M\left[\int p^x(\boldsymbol{\psi})q^x(\boldsymbol{\psi})d\hat{G}(\boldsymbol{\psi})\right] = M_f\left[\int p^x(\boldsymbol{\psi})q^x(\boldsymbol{\psi})d\hat{G}_f(\boldsymbol{\psi})\right],$$

where subscript f denotes Foreign. The price index is expressed as

$$P^{1-\sigma} = M\left[\int p(\boldsymbol{\psi})^{1-\sigma}d\hat{G}(\boldsymbol{\psi})\right] + M_f\left[\int x(\boldsymbol{\psi})p(\boldsymbol{\psi})^{1-\sigma}d\hat{G}_f(\boldsymbol{\psi})\right]$$

An equilibrium is formally defined as

Definition 1. *An equilibrium of the economy is defined as (a) a list of wages $\{w, w_f\}$, (b) functions of Home and Foreign $\{p(\omega), p^x(\omega), q(\omega), q^x(\omega), x(\omega), l(\omega), b(\omega), \tau^y(\omega)\}$, (c) aggregate price indices $\{P, P_f\}$, (d) lump-sum government transfers $\{T, T_f\}$, and (e) mass of entry and production firms $\{M, M_f, M_e, M_{e,f}\}$ such that (i) representative households maximize utility subject to their budget constraint; (ii) firms maximize profits; (iii) the labor and goods market clearing conditions are satisfied; (iv) the government budgets are balanced; (v) trade is balanced; and (vi) free entry condition is satisfied.*

Lobbying, Reallocation, and Gains from Trade Figure 1 illustrates that a decline in iceberg costs leads exporters to increase their lobbying expenditures while non-exporters decrease theirs, resulting in a divergence between the two groups.[7] When iceberg costs decrease from τ_x to τ_x', due to heightened foreign competition, the entry and lobbying cutoffs become higher: $\bar{\phi}^e(\tau,\eta) > \bar{\phi}'^e(\tau,\eta)$ and $\bar{\phi}^b(\tau,\eta) > \bar{\phi}'^b(\tau,\eta)$. However, the export cutoff becomes lower due to increased market size: $\bar{\phi}'^x(\tau,\eta) > \bar{\phi}^x(\tau,\eta)$.

The decrease in iceberg costs reallocates more resources to exporters through two channels. The first is the standard selection channel in which a larger market size increases production by exporters that self-select into exporting. In the second-best world, not only productivity but also exogenous distortions affect the selection. In the presence of lobbying, however, there is an additional reallocation channel: exporters come to have relatively higher distortions by increasing their lobbying efforts, as illustrated in Figure 1. This lobbying channel affects allocative efficiency, firm entry, and therefore, gains from trade.

[7] In this figure, I consider a special case where η is sufficiently high that the lobbying cutoff is lower than the export cutoff: $\bar{\phi}^b(\tau,\eta) < \bar{\phi}^x(\tau,\eta)$. In Online Appendix Figure A1, I graphically illustrate the case in which $\bar{\phi}^x(\tau,\eta) < \bar{\phi}^b(\tau,\eta)$ holds. Even in this case, lower iceberg costs induce divergence between the two groups.

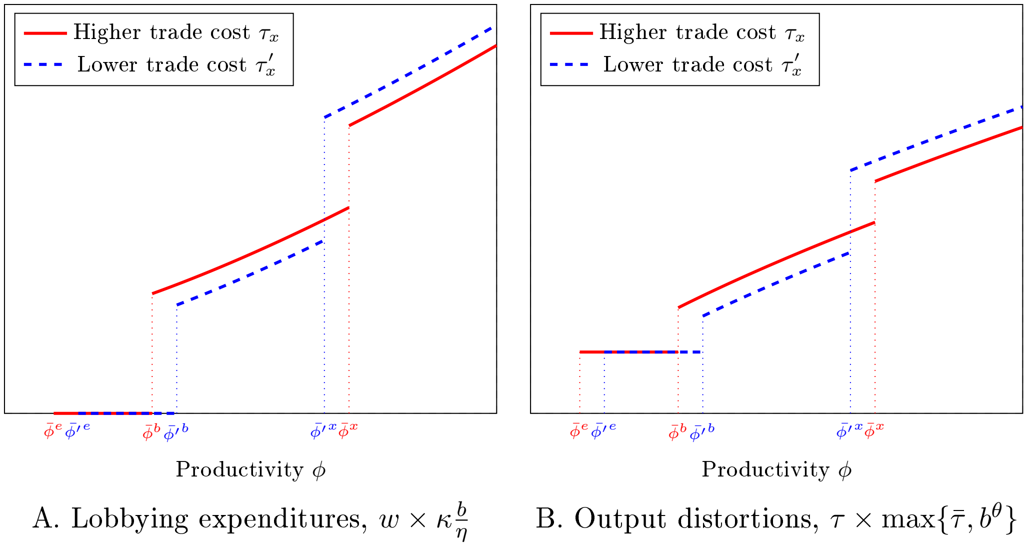


Figure 1. Lower trade costs induce exporters and non-exporters to increase and decrease their lobbying, respectively

Notes. This figure illustrates changes in the entry, export, and lobbying cutoffs and changes in firm lobbying expenditures and output distortions depending on their productivity levels when trade costs decline. The figure considers a special case in which the lobbying cutoff is lower than the export cutoff. Holding τ and η constant, Panels A and B plot firm lobbying expenditures and output distortions depending on their productivity ϕ. The x-axes represent productivity ϕ.

One way to view this is through the following decomposition which holds in both the presence and absence of lobbying. Changes in welfare due to local changes in iceberg costs $d\ln\mathbb{W}$ can be decomposed as

$$d\ln\mathbb{W} = \underbrace{\frac{1}{\sigma-1}d\ln M}_{=d\ln\mathbb{W}^{\mathrm{E}}\,:\,\text{Entry}} + \underbrace{d\ln\left[\int\left(\frac{1}{\phi}\frac{q(\boldsymbol{\psi})}{\tilde{q}}\right)d\hat{G}(\boldsymbol{\psi}) + \int\left(x(\boldsymbol{\psi})\frac{\tau_x}{\phi}\frac{q(\boldsymbol{\psi})}{\tilde{q}}\right)d\hat{G}(\boldsymbol{\psi})\right]^{-1}}_{=d\ln\mathbb{W}^{\mathrm{AE}}\,:\,\text{Allocative efficiency}}, \tag{2.6}$$

where $\tilde{q}$ is the harmonic average quantity produced by firms: $\tilde{q} = (\int q(\boldsymbol{\psi})^{\frac{\sigma-1}{\sigma}}d\hat{G}(\boldsymbol{\psi}))^{\frac{\sigma}{\sigma-1}}$.[8] The first term, $d\ln\mathbb{W}^{\mathrm{E}}$, pertains to changes in firm mass through entry. The second term, $d\ln\mathbb{W}^{\mathrm{AE}}$, is associated with allocative efficiency, akin to Hsieh and Klenow (2009). This term improves if iceberg cost changes lead more productive firms to produce a greater quantity relative to the average (higher weights $q(\psi)/\tilde{q}$ for higher ϕ firm), and vice versa.

Consider the second-best world without lobbying. Lower iceberg costs will decrease firm entry

[8]For example, Hsieh and Klenow (2009), Edmond et al. (2015), Huneeus and Kim (2018), and Choi and Shim (2023) use the similar decomposition. In the closed economy, this allocative efficiency term coincides with the formula for aggregate TFP derived in Hsieh and Klenow (2009), where dispersion in TFPR decreases this allocative efficiency. See Online Appendix A.1 for derivation in detail.

due to more intensified competition ($d\ln \mathbb{W}^{\mathrm{E}} < 0$). However, with exogenous distortions, the sign of $d\ln \mathbb{W}^{\mathrm{AE}}$ is ambiguous. Without exogenous distortions, selection based on productivity always improves $d\ln \mathbb{W}^{\mathrm{AE}}$ (Melitz, 2003). However, with exogenous distortions, it is possible that selection based on exogenous distortions deteriorates $d\ln \mathbb{W}^{\mathrm{AE}}$, as shown by Bai et al. (2023). With lobbying, as resources are more allocated to large-sized exporters due to lobbying, firm entry will be even lower compared to the no-lobbying case, worsening $d\ln \mathbb{W}^{\mathrm{E}}$ further. Lobbying interacts with distributions of the firm primitives and affect $d\ln \mathbb{W}^{\mathrm{AE}}$ with ambiguous signs.

2.1 Welfare Formula for Gains from Trade

In this subsection, I derive a formula for the gains from trade with lobbying and compare it to those developed by Arkolakis et al. (2012), Melitz and Redding (2015), and Bai et al. (2023) (ACR, MR, and BKL).

For analytical tractability, I consider a special case in which every firm engages in lobbying, and countries are symmetric. This symmetric setup, utilized also by Melitz and Redding (2015), ensures that the aggregate variables of both countries take identical values in equilibrium, simplifying the analysis. The case in which every firm engages in lobbying can be attained by setting $f_b = 0$ and $\bar{\tau} = 0$. Because firms cannot make positive profits without lobbying when $\bar{\tau} = 0$ and there are no fixed lobbying costs $f_b = 0$, every firm engages in lobbying, conditional on production. Without loss of generality, I normalize κ and w to 1.[9] These assumptions are formally stated as follows:

Assumption 2. *(i) $f_b = 0$ and $\bar{\tau} = 0$; and (ii) countries are symmetric.*

Under Assumptions 1 and 2, non-exporters and exporters' optimal lobbying inputs are

$$b^d = \eta^{\frac{1}{1-\theta\sigma}}(\theta\sigma)^{\frac{1}{1-\theta\sigma}}(\sigma^{-1}\mu\phi^{\sigma-1}\tau^{\sigma}P^{\sigma}Q)^{\frac{1}{1-\theta\sigma}} \quad \text{and} \quad b^x = (1+\tau_x^{1-\sigma})^{\frac{1}{1-\theta\sigma}} b^d.$$

The zero profit and the export cutoffs are $\bar{\phi}^e(\tau,\eta) = \hat{\phi}^e \tau^{\frac{-\sigma}{\sigma-1}}\eta^{\frac{-\theta\sigma}{\sigma-1}}$ and $\bar{\phi}^x(\tau,\eta) = \hat{\phi}^x \tau^{\frac{-\sigma}{\sigma-1}}\eta^{\frac{-\theta\sigma}{\sigma-1}}$, where

$$\hat{\phi}^e = \frac{cf^{\frac{1-\theta\sigma}{\sigma-1}}}{P^{\frac{\sigma}{\sigma-1}}Q^{\frac{1}{\sigma-1}}} \quad \text{and} \quad \hat{\phi}^x = \frac{cf_x^{\frac{1-\theta\sigma}{\sigma-1}}}{P^{\frac{\sigma}{\sigma-1}}Q^{\frac{1}{\sigma-1}}\left[(1+\tau_x^{1-\sigma})^{\frac{1}{1-\theta\sigma}}-1\right]^{\frac{1-\theta\sigma}{\sigma-1}}}.$$

for a constant c composed of the model parameters.

I introduce the following two functions: for $\hat{\phi}^l < \hat{\phi}^x$,

$$\tilde{\lambda}(\hat{\phi}^l,\hat{\phi}^u) = \int\int\int_{\hat{\phi}^l\tau^{\frac{-\sigma}{\sigma-1}}\eta^{\frac{-\theta\sigma}{\sigma-1}}}^{\hat{\phi}^u\tau^{\frac{-\sigma}{\sigma-1}}\eta^{\frac{-\theta\sigma}{\sigma-1}}} \eta^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tau^{\frac{\sigma-1}{1-\theta\sigma}}\phi^{\frac{(\sigma-1)(1-\theta)}{1-\theta\sigma}} g(\phi,\tau,\eta)d\phi d\tau d\eta$$

$$\tilde{S}(\hat{\phi}^l,\hat{\phi}^u) = \int\int\int_{\hat{\phi}^l\tau^{\frac{-\sigma}{\sigma-1}}\eta^{\frac{-\theta\sigma}{\sigma-1}}}^{\hat{\phi}^u\tau^{\frac{-\sigma}{\sigma-1}}\eta^{\frac{-\theta\sigma}{\sigma-1}}} \eta^{\frac{\theta\sigma}{1-\theta\sigma}}\tau^{\frac{\sigma}{1-\theta\sigma}}\phi^{\frac{\sigma-1}{1-\theta\sigma}} g(\phi,\tau,\eta)d\phi d\tau d\eta.$$

[9] With every firm participating in lobbying, κ only proportionally influences equilibrium outcomes.

Using these functions, I define the share of the expenditure on domestic varieties as in ACR:

$$\lambda = \frac{\tilde{\lambda}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tilde{\lambda}(\hat{\phi}^x, \infty)}{\tilde{\lambda}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tilde{\lambda}(\hat{\phi}^x, \infty) + \tau_x^{1-\sigma}(1+\tau_x^{1-\sigma})^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tilde{\lambda}(\hat{\phi}^x, \infty)} \tag{2.7}$$

and the share of variable labor used for producing domestic varieties as in BKL:

$$S = \frac{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty)}{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty) + \tau_x^{1-\sigma}(1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty)}. \tag{2.8}$$

Unlike in ACR or BKL, trade costs show up in λ and S, because exporting and lobbying decisions are not separable due to lobbying.[10]

Additionally, I define the domestic share of expenditure on non-exporters' domestic varieties and the share of variable labor used by non-exporters:

$$\lambda_d = \frac{\tilde{\lambda}(\hat{\phi}^e, \hat{\phi}^x)}{\tilde{\lambda}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tilde{\lambda}(\hat{\phi}^x, \infty)} \quad \text{and} \quad S_d = \frac{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x)}{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty)}. \tag{2.9}$$

Finally, I define

$$\lambda_d^a = \frac{\tilde{\lambda}(\hat{\phi}^e, \hat{\phi}^x)}{\tilde{\lambda}(\hat{\phi}^e, \infty)} \qquad \text{and} \qquad S_d^a = \frac{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x)}{\tilde{S}(\hat{\phi}^e, \infty)}.$$

When τ_x goes to infinity (autarky), λ_d and S_d converge to λ_d^a and S_d^a, respectively, and λ_d^a and S_d^a converge to 1, while in the open economy, $\lambda_d > \lambda_d^a$ and $S_d > S_d^a$ hold. λ_d^a and S_d^a can be interpreted as non-exporters' domestic shares when exporters do not adjust their lobbying efforts while transitioning form the autarky to the open economy, holding the general equilibrium effects (P and Q) constant. Therefore, λ_d^a/λ_d and S_d^a/S_d capture changes in the non-exporters' domestic shares due to the divergence of lobbying efforts between non-exporters and exporters (Figure 1).

Following ACR and BKL, I define two elasticities related to the extensive margin:

$$\gamma_\lambda(\hat{\phi}^e) = -(1-\theta\sigma) \times \frac{d\ln\tilde{\lambda}(\hat{\phi}^e, \infty)}{d\ln\hat{\phi}^e} \qquad \text{and} \qquad \gamma_s(\hat{\phi}^e) = -(1-\theta\sigma) \times \frac{d\ln\tilde{S}(\hat{\phi}^e, \infty)}{d\ln\hat{\phi}^e},$$

which are scaled by the term $1-\theta\sigma$. Unlike in the cases of ACR and BKL, $\tilde{\lambda}(\hat{\phi}^e, \infty)$ and $\tilde{S}(\hat{\phi}^e, \infty)$ are not proportional to firms' cumulative domestic sales and variable labor used because of exporters' disproportionately larger lobbying expenditures. $\tilde{\lambda}(\hat{\phi}^e, \infty)$ and $\tilde{S}(\hat{\phi}^e, \infty)$ become proportional to firms' cumulative domestic sales and variable labor used only when $\theta = 0$ or $\tau_x \to \infty$.

[10]When $\theta = 0$, $\lambda = \frac{\tilde{\lambda}(\hat{\phi}^e,\infty)}{\tilde{\lambda}(\hat{\phi}^e,\infty)+\tau_x^{1-\sigma}\tilde{\lambda}(\hat{\phi}^x,\infty)}$ and $S = \frac{\tilde{S}(\hat{\phi}^e,\infty)}{\tilde{S}(\hat{\phi}^e,\infty)+\tau_x^{1-\sigma}\tilde{S}(\hat{\phi}^x,\infty)}$ as in BKL.

Proposition 1. *Under Assumptions 1 and 2, changes in welfare to local changes in iceberg costs are*

$$d\ln \mathbb{W} = \frac{1}{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)}\left\{-d\ln\lambda + d\ln M_e + d\ln\frac{\lambda_d^a}{\lambda_d}\right\} + \left(\frac{\frac{\gamma_\lambda(\hat{\phi}^e)}{\sigma-1} + \theta(\sigma-1)}{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)} + 1\right) d\ln PQ, \quad (2.10)$$

where

$$d\ln PQ = \left(\frac{1}{1-\theta\sigma} - \frac{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)}{\gamma_s(\hat{\phi}^e) + \sigma - 1}\right)\left\{-d\ln\lambda + d\ln\frac{\lambda_d^a}{\lambda_d} + d\ln M_e\right\}$$
$$\left(\frac{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)}{\gamma_s(\hat{\phi}^e) + \sigma - 1}\right)\left\{-d\ln\lambda + d\ln\frac{\lambda_d^a}{\lambda_d} + d\ln S - d\ln\frac{S_d^a}{S_d}\right\}.$$

Proof. See Online Appendix A.2. □

After normalizing w and L to 1, the welfare change can be expressed as $d\ln\mathbb{W} = d\ln\frac{wL+T}{P} = d\ln\frac{1+T}{P}$. The first and second terms of the right-hand side of Equation (2.10) are related to changes in price ($d\ln P$) and lump-sum transfers to households ($d\ln 1+T$). Changes in trade costs influence not only prices but also the fiscal externality through lump-sum transfers by affecting entry and export of firms with different distortion levels, and their lobbying decisions.

I summarize how the welfare formula in Proposition 1 can be connected to those studied in the previous papers.

- When lobbying is not allowed ($\theta = 0$), $S_d = S_d^a$ and $\lambda_d = \lambda_d^a$ hold, and Equation (2.10) collapses to the BKL formula

$$d\ln\mathbb{W} = \underbrace{\frac{1}{\gamma_\lambda(\hat{\phi}^e) + \sigma - 1}\{-d\ln\lambda + d\ln M_e\}}_{\text{ACR/MR}} + \underbrace{\left(\frac{\gamma_\lambda(\hat{\phi}^e)/(\sigma-1)}{\gamma_\lambda(\hat{\phi}^e) + \sigma - 1} + 1\right) d\ln PQ}_{\text{BKL: distortion}} \quad (2.11)$$

  where

$$d\ln PQ = \frac{\gamma_s(\hat{\phi}^e) - \gamma_\lambda(\hat{\phi}^e)}{\gamma_s(\hat{\phi}^e) + \sigma - 1}\{-d\ln\lambda + d\ln M_e\} + \left(\frac{\gamma_\lambda(\hat{\phi}^e) + \sigma - 1}{\gamma_s(\hat{\phi}^e) + \sigma - 1}\right)\{-d\ln\lambda + d\ln S\}$$

  The BKL formula deviates from the ACR and MR formulas due to the BKL distortion term that arises from exogenous distortions.

- (MR) When lobbying is not allowed ($\theta = 0$) and there are no exogenous distortions, $\gamma_s(\hat{\phi}^e) =$

$\gamma_\lambda(\hat{\phi}^e)$ and $S = \lambda$ hold. Equation (2.10) collapses to the MR formula:

$$d \ln \mathbb{W} = \frac{1}{\gamma_\lambda(\hat{\phi}^e) + \sigma - 1} \{-d \ln \lambda + d \ln M_e\}. \tag{2.12}$$

- (ACR) When lobbying is not allowed ($\theta = 0$) and firms are heterogeneous only along productivity that follows the Pareto distribution with the shape parameter κ, $\gamma_s(\hat{\phi}^e) = \kappa - (\sigma - 1)$ and $d \ln M_e = 0$. Equation (2.10) collapses to the ACR formula:

$$d \ln \mathbb{W} = \frac{1}{\kappa} \{-d \ln \lambda\}. \tag{2.13}$$

- (Lobbying and Pareto-distributed productivity) When lobbying is allowed ($\theta > 0$) and firms are heterogeneous only along productivity that follows the Pareto distribution with the shape parameter κ as in ACR, $\gamma_\lambda(\hat{\phi}^e) = (1 - \theta\sigma)\kappa - (\sigma - 1)(1 - \theta)$, $\gamma_s(\hat{\phi}^e) = (1 - \theta\sigma)\kappa - (\sigma - 1)$, and $\gamma_s(\hat{\phi}^e) > \gamma_\lambda(\hat{\phi}^e)$. Also, $S \neq \lambda$, $S_d \neq S_d^a$, and $\lambda_d \neq \lambda_d^a$, and $d \ln M_e \neq 0$. Combining the above expressions with Equation (A.23), the welfare formula becomes

$$d \ln \mathbb{W} = \frac{1}{(1 - \theta\sigma)\kappa + \theta(\sigma - 1)} \left\{ -d \ln \lambda + d \ln \frac{\lambda_d^a}{\lambda_d} + d \ln M_e \right\} + \left(\frac{\sigma}{\sigma - 1} - \frac{1}{\kappa} \right) d \ln PQ,$$

  where

$$d \ln PQ = \frac{\theta\sigma}{1 - \theta\sigma} \left\{ -d \ln \lambda + d \ln \frac{\lambda_d^a}{\lambda_d} + d \ln M_e \right\} + \left\{ -d \ln \lambda + d \ln \frac{\lambda_d^a}{\lambda_d} + d \ln S - d \ln \frac{S_d^a}{S_d} \right\},$$

  which deviates from the Pareto-version of the ACR formula.

A decline in iceberg costs reduces the prices of foreign varieties, consequently decreasing the price index, as indicated by the change in own import shares $-d \ln \lambda$ in the ACR formula. Without the Pareto distributional assumption, changes in iceberg costs impact firm entry, thereby influencing the price index, reflected by $d \ln M_e$ in the MR formula. With exogenous distortions, selection into entry and export affects lump-sum transfers, captured by the additional second term of the BKL formula. The difference between domestic sales and input shares ($d \ln S - d \ln \lambda$) provides insights into the fiscal externality. The necessary condition for welfare losses from trade is $d \ln S < d \ln \lambda$, which implies that the government subsidizes domestic firms' foreign sales relative more, leading to the negative fiscal externality ($d \ln PQ < 0$).

In the presence of lobbying, two new terms, λ_d^a / λ_d and S_d^a / S_d, emerge in Equation (2.10). These terms reflect changes in the non-exporters' domestic shares of expenditures on domestic varieties and variable labor due to the divergence of lobbying efforts by exporters and non-exporters when opening to trade. The divergence affects distortion levels of both exporters and non-exporters, and consequently, the price index. The impact on the price index is reflected by $d \ln \frac{\lambda_d^a}{\lambda_d}$ in the first term in

Equation (2.10). Additionally, the fiscal externality is affected by endogenous changes in distortions due to lobbying, captured by $d\ln\frac{\lambda_d^a}{\lambda_d} - d\ln\frac{S_d^a}{S_d}$ in the second term.

The BKL's necessary condition of welfare losses from trade is $d\ln S < d\ln\lambda$, which means that the government subsidizes exporters' sales more in the foreign market, worsening the fiscal externality. With lobbying, this necessary condition becomes $d\ln\frac{\lambda_d^a}{\lambda_d} + d\ln S - d\ln\frac{S_d^a}{S_d} < d\ln\lambda$. Conditioning on $d\ln\lambda$ and $d\ln S$, this condition is more likely to be satisfied, because exporters' shares within domestic sales are likely to increase more than their shares of labor due to lobbying and therefore, $d\ln\frac{\lambda_d^a}{\lambda_d} - d\ln\frac{S_d^a}{S_d} > 0$ is likely to hold.

In summary, endogenous changes in distortions due to lobbying cause deviations in gains from trade from the ACR, MR, and BKL formulas by influencing the price index and fiscal externality.

3 Taking the Model to the Data

This section outlines the data and the calibration procedure of the model presented in the previous section. Using an IV strategy based on the institutional features of the US political system, I structurally estimate θ, the elasticity of output distortions with respect to lobbying inputs. The remaining parameters are calibrated to the firm-level data using method of moments.

3.1 Data

I construct the main dataset by combining firm balance sheet information, lobbying data, and sector and state level databases. The sample period spans from 1998 to 2015.

Firm-Level Lobbying and Balance Sheet Data I merge the lobbying data obtained from Kim (2018) with Compustat, covering public firms listed on the North American stock markets. The lobbying data, publicly disclosed since 1998 following the Lobbying Disclosure Act, entail active registered lobbyists filing quarterly activity reports. Each report contains diverse information regarding firm lobbying practices, encompassing lobbying expenditures, issue areas, and descriptions of lobbying activities. The sample period spans from 1998 to 2015. I restrict the sample to firms operating within the manufacturing sectors and incorporated in the US, and exclude firm-year observations with missing or negative values for employment, capital, or sales.

Industry and State-Level Data Industry data come from the NBER-CES Manufacturing Industry Database, matched with the firm-level data based on SIC 4-digit codes. I obtain 3-digit SIC industry-state level wage rates from the US Census County Business Pattern data. I convert the 3-digit NAICS codes to the 3-digit SIC code, and match them with the firm data based on firms' headquarter states and industry affiliation.

State-level tax incentives, including include corporate income taxes, job creation tax credits, R&D tax credits, and property tax abatement, are obtained from the Panel Database on Incentives and Taxes (Bartik, 2018). Moreover, state-level transfers from the federal government are sourced from the US Census. These variables are utilized as controls during the estimation of θ.

Table 1: Descriptive Statistics

Sales (\$1M)	Lobbying expenditures (\$1K)	$1[\text{Lobby}_{it} > 0]$	$1[\text{Lobby}_{it} > 0] \neq 1[\text{Lobby}_{i,t-1} > 0]$
(1)	(2)	(3)	(4)
2130.93	196.71	0.18	0.17
(11646.85)	(1258.0)	(0.39)	(0.38)

Notes. This table provides the descriptive statistics. Nominal values are reported in 2009 USD. The dataset comprises $35,276$ firm-year level observations, representing $4,402$ unique firms. Standard deviations are reported in parentheses. The sample period spans from 1998 to 2015.

Descriptive Statistics The descriptive statistics of the final dataset are presented in Table 1. Columns 1 and 2 show the average sales and average lobbying expenditures, respectively. In column 3, 18% of firm-year level observations have positive lobbying expenditures, suggesting that lobbying is a prevalent activity among publicly traded firms. Column 4 indicates the percentage of extensive margin changes, with only about 17% of the total observations altering their lobbying status, underscoring the persistence of lobbying status.

3.2 Estimation of the Elasticity of Output Distortions to Lobbying

I estimate θ using regression models driven from the theoretical framework. I incorporate sectoral and time dimensions that are absent in the theoretical framework but I assume that θ is common across these dimensions. By including these additional dimensions, it becomes possible to control for sector-time and firm time-invariant fixed effects, which helps in accounting for sectoral differences in overall distortions and utilizing within-firm time-varying variation in lobbying expenditures to identify θ.

In the model, TFPR, measured as value-added divided by wage bills, is proportional to the inverse of output distortions[11]:

$$\text{TFPR}_{it} = \frac{\text{Value Added}_{it}}{w_{njt} L_{it}} \propto \left(\tau_{it} \times \max\{\bar{\tau}, b_{it}^{\theta}\} \right)^{-1}.$$

L_{it} is firm i's employment and w_{njt} is industry j wage in state n where firm i's headquarter is located. b_{it} represents the optimally chosen input for lobbying, while lobbying expenditures are reported in

[11] Value-added is calculated as sales multiplied with sectoral value-added shares and the wage bills are calculated as firm employment multiplied with state-industry specific wage. Sectoral value-added shares are calculated from the NBER-CES Manufacturing database. If labor markets are segmented, firms may face different wages depending on their industry affiliation and location. In such cases, variation in TFPR may reflect variation in wages rather than output distortions. Dividing value-added by wage bills helps mitigates this concern.

dollar terms in the data. I assume that lobbying expenditures are proportional to variable lobbying costs $w_t b_{it}/\eta_{it}$. I construct a variable $Lobby_{it}$ by dividing lobbying expenditures by wage, which is consistent with b_{it}/η_{it}, and use it as a proxy for b_{it}.

Using the mapping, first-differencing and taking the logarithm, I derive the following estimable regression model:

$$\Delta \ln 1/\text{TFPR}_{i,t+1} = \theta \Delta \ln Lobby_{it} + \mathbf{X}_{it}'\boldsymbol{\gamma} + \delta_{jt} + \underbrace{\Delta \ln \tau_{it} + \theta \Delta \ln \eta_{it}}_{=\Delta u_{it}}, \tag{3.1}$$

where Δ denotes the time-difference operator. Δu_{it} is a structural error term that is a function of firm primitives, where $\Delta \eta_{it}$ appears due to the fact that $Lobby_{it}$ $(= b_{it}/\eta_{it})$ is used as a proxy for b_{it}. Firm time-invariant factors are differenced out. To account for heterogeneous trends in TFPR that depend on unobservable and observable factors, I include sector-year fixed effects δ_{jt} and observable variables $\mathbf{X}_{it}$. These variables include detailed state-level tax incentives such as corporate income taxes, job creation tax credits, R&D tax credits, and property tax abatement, transfers from the federal government, changes in log state-industry level wages, and the initial lobbying status. The samples are averaged over 6 years to mitigate potential seasonality in lobbying expenditures due to political cycles and measurement errors of TFPR. Standard errors are clustered at the state level.

Alternatively, using the relationship between sales and lobbying inputs, I can also derive the following alternative estimable regression model:

$$\Delta \ln \text{Sale}_{i,t+1} = \theta\sigma \Delta \ln Lobby_{it} + \mathbf{X}_{it}'\boldsymbol{\gamma} + \delta_{jt} + \underbrace{(\sigma - 1)\Delta \ln \phi_{it} + \sigma \Delta \ln \tau_{it} + \theta\sigma \Delta \ln \eta_{it}}_{=\Delta u_{it}}, \tag{3.2}$$

which includes the same set of the observables, with standard errors clustered at the state-level.

One issue arises from the presence of zeros in the lobbying data. These zeros pose a challenge for log transformations, and simply discarding them would result in the loss of informative variation across lobbying and non-lobbying firms. To address this, I handle observations with zero lobbying expenditures by assigning zero values for $\ln Lobby_{it}$ and conduct robustness checks.

Instrumental Variable Because $Lobby_{it}$ is a function of firm primitives, $Lobby_{it}$ is correlated with the error terms, making the OLS estimates suffer from the endogeneity problem. To address this concern, I employ an IV strategy, leveraging exogenous variation in firm lobbying efforts that appear to be seemingly uncorrelated with firm characteristics.

I instrument for $Lobby_{it}$ using the state-level time-varying appointment of a Congress member as chairperson of the House or Senate Appropriations Committee. This IV strategy is in the spirit of Bertrand et al. (2020), who leverage variation in committee seats to study the impact of firms' charitable giving on political influences. Data on congressional committee memberships, including the date of assignment and termination, as well as the states represented by members, are obtained from Stewart and Woon (2017), providing state-level time-varying information on chairpersonship of the Appropriations Committee.

A local Congress member's appointment as chairperson of the House or Senate Appropriations Committee works as an exogenous shifter for lobbying efforts.[12] Chairpersons of these committees wield considerable power over discretionary spending and federal contract opportunities, making them prime targets for lobbying efforts (Stewart and Groseclose, 1999; Blanes i Vidal et al., 2012; Berry and Fowler, 2018). The nomination of a chairperson of a congressional committee is typically determined by seniority and a complex political process, often following unexpected events such as loss of reelection, retirement, or death of the incumbent chairperson. This makes the appointment exogenous to the economic conditions of individual states or firms (Aghion et al., 2009; Cohen et al., 2011).

The IV is computed as the 6-year average of a dummy that equals 1 if a state Congress member serves as the chairperson of the House or Senate Appropriations Committee in a given year. The exclusion restriction is that firm primitives are uncorrelated with the IV. However, a potential concern arises from the possibility that the appointment of local politicians may influence state-level exogenous distortions common across firms, thereby introducing correlation between the IV and the error terms. To deal with this issue, I use two strategies. First, I include detailed state-level tax incentives and transfers from the federal government as controls to absorb these observable common factors contributing to exogenous distortions at the state level. Second, I show that results are robust when I demean dependent variables by the average of non-lobbying firms within each state and SIC 2-digit industry, excluding own firm.[13] Because the average is taken over non-lobbying firms, the demeaning process only removes exogenous components common within the categories, not related to lobbying. This approach is similar to Hsieh and Klenow (2009) who also demean firm specific distortions by the industry average to absorb out industry-common components.

Additionally, I conduct an event study to check whether the appointment of the chairperson has pre-trends in lobbying expenditures. Pre-trends, if present, could indicate the existence of spurious correlations arising from pre-existing confounding factors or reverse causality issues that would violate the exclusion restriction. I find no pre-trends (Online Appendix Figure B1), which provides support for the validity of the exclusion restriction.

Regression Results Table 2 reports the regression results. After addressing the endogeneity problem using the IV strategy, I observe significantly positive coefficients. The second-stage estimates indicate that a 1% increase in lobbying expenditures is associated with approximately a 0.09% increase in output distortions. In column 3, the dependent variable is demeaned by the state-industry

[12] Within the theoretical framework, the IV can be interpreted as a variable Z_{it} that shifts fixed costs of lobbying.

[13] I demean by $\frac{1}{N_{sjt}^{\text{No Lobby}}-1}\sum_{i'\in\mathcal{F}_{sjt}^{\text{No Lobby}}/\{i\}}\ln 1/TFPR_{i't}$, where $\mathcal{F}_{sjt}^{\text{No Lobby}}/\{i\}$ is a set of non-lobbying firms in state s in industry j in year t, excluding firm i, and $N_{sjt}^{\text{No Lobby}}$ is the number of non-lobbying firms in state s in industry j in year t.

average, which gives the similar estimate with that in column 2. Columns 4–6 report the OLS and IV estimates of the sales regression. The IV estimates in columns 5 and 6 are approximately 0.30 and 0.25. These values align with the IV estimates in columns 2 and 3. The estimates from the sales regression can be mapped to $\theta\sigma$. Under assumed σ values of 3 and 4, the corresponding implied values of θ are around 0.06 and 0.08, respectively, consistent with the estimated θ in columns 2 and 3. All specifications share the same first stage, which exhibits strength with the Kleibergen-Papp F-statistic around 12. The Anderson-Rubin test statistics (AR), providing weak-instrument-robust inference, also rejects the null hypothesis that the estimated coefficients are zero with statistical significance at the 1% level.

These estimated values are consistent with the prior findings of Huneeus and Kim (2018). They estimated the elasticity using a regression model akin to Equation (3.2). Their approach involves a firm time-varying shift-share IV based on firms' political connections and the weights each firm assigns to committees, inspired by Bombardini and Trebbi (2020). Despite using different sources of variation (state- vs. firm-level varying), their OLS and IV estimates of 0.048 and 0.21, respectively, are similar to my estimates, which stay within one standard deviation of the corresponding OLS and IV estimates in columns 4–6.

Direction of Bias The direction of bias of the OLS estimates can be interpreted through the lens of the model. The bias is affected by covariances and variances of firm primitives. For exposition purposes, I will consider the regression model in Equation (3.1) without any controls and a simplified closed economy setup in which every firm is operating and lobbying. These conditions are imposed to ensure that selection into production, exporting, and lobbying does not affect the bias, which allows me to derive the analytical expression for the bias, detailed in Online Appendix A.1.[14] In this setup, I can analytically characterize the bias of the OLS estimate $\hat{\beta}^{\text{OLS}}$:

$$\hat{\beta}^{\text{OLS}} \xrightarrow{p} \theta\sigma + \underbrace{\frac{\text{Cov}(\ln Lobby_{it}, \ln \tau_{it} + \theta \ln \eta_{it})}{\text{Var}(\ln Lobby_{it})}}_{=\mathcal{B}(\ln \boldsymbol{\psi}_{it})},$$

where $\mathcal{B}(\ln \boldsymbol{\psi}_{it})$ is the bias that is a function of covariances and variances of firm primitives:

$$\begin{aligned} \mathcal{B}(\ln \boldsymbol{\psi}_{it}) = \frac{1}{\text{Var}(\ln Lobby_{it})}\Big(&\frac{\theta^2\sigma}{1-\theta\sigma}\text{Var}(\ln \eta_{it}) + \frac{\sigma}{1-\theta\sigma}\text{Var}(\ln \tau_{it}) \\ &+ \frac{2\theta\sigma}{1-\theta\sigma}\text{Cov}(\ln \tau_{it}, \ln \eta_{it}) + \frac{\sigma-1}{1-\theta\sigma}\text{Cov}(\ln \phi_{it}, \ln \tau_{it}) + \frac{\theta(\sigma-1)}{1-\theta\sigma}\text{Cov}(\ln \phi_{it}, \ln \eta_{it})\Big), \end{aligned} \tag{3.3}$$

[14]This setup can be achieved by setting $\bar{\tau} = 0$, $f_b = 0$, $f = 0$, and $\tau_x \to \infty$. When these conditions are violated, the bias will be expressed as a more complicated function of firm primitives because selection into production, lobbying, and exporting will also affect the bias. In Online Appendix A.1, I also analytically characterize the bias of Equation (3.2).

Table 2: Estimation Results of θ

Dep.	$\ln 1/\text{TFPR}$			$\ln \text{Sale}$		
	OLS	IV		OLS	IV	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A. Second Stage					
$\Delta \ln Lobby_{it}$	-0.002	0.087^{***}	0.084^{**}	0.051^{***}	0.302^{***}	0.246^{***}
	(0.005)	(0.031)	(0.033)	(0.013)	(0.058)	(0.051)
	Panel B. First Stage					
IV		0.25^{***}	0.25^{***}		0.25^{***}	0.25^{***}
		(0.05)	(0.05)		(0.05)	(0.05)
KP-F		12.46	12.46		12.46	12.46
AR		13.21	15.61		14.17	8.33
AR p-val.		< 0.01	< 0.01		< 0.01	< 0.01
Dep. demeaned			✓			✓
Industry FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
N	1206	1206	1206	1206	1206	1206

Notes. Standard errors are clustered at the state level. * p<0.1; ** p<0.05; *** p<0.01. This table reports the OLS and IV estimates of Equations (3.1) and (3.2). The dependent variables are log inverse of TFPR and sales in columns 1–3 and 4–6, respectively. In columns 3 and 6, the dependent variables are adjusted by demeaning them by the state-industry average among non-lobbying firms, excluding the own firm. All specifications include corporate income tax, job creation tax credit, investment tax credit, R&D tax credit, property tax abatement, and transfers from the federal government, changes in state-industry wages, the initial lobbying status, and SIC 4-digit fixed effects. KP-F is the Kleibergen-Paap F-statistics. AR and AR p-val are the Anderson-Rubin test statistics and its p-value.

where

$$\begin{aligned}\text{Var}(\ln Lobby_{it}) = &\left(\frac{\theta\sigma}{1-\theta\sigma}\right)^2 \text{Var}(\ln \eta_{it}) + \left(\frac{\sigma}{1-\theta\sigma}\right)^2 \text{Var}(\ln \tau_{it}) + \left(\frac{\sigma-1}{1-\theta\sigma}\right)^2 \text{Var}(\ln \phi_{it}) \\ &+ \frac{2\sigma(\sigma-1)}{(1-\theta\sigma)^2}\text{Cov}(\ln \phi_{it}, \ln \tau_{it}) + \frac{2\theta\sigma(\sigma-1)}{(1-\theta\sigma)^2}\text{Cov}(\ln \phi_{it}, \ln \eta_{it}) + \frac{2\theta\sigma^2}{(1-\theta\sigma)^2}\text{Cov}(\ln \eta_{it}, \ln \tau_{it}).\end{aligned}$$

Depending on the signs of the covariances, the bias can take both positive and negative values. If the covariances are sufficiently negative, the OLS estimate will be downward biased, as in Table 2. In the later part of this section, I estimate these covariances using method of moments and find that the estimated covariances between $\ln \phi_{it}$ and $\ln \tau_{it}$ or $\ln \eta_{it}$ are negative. Based on the calibrated values and the estimates of the variances and covariances reported in Table 3 in the later section, the bias is -0.04, consistent with the downward bias.

Alternative Proxy for Firm-specific Distortions If the model is misspecified, it is problematic to infer TFPR as firm-specific distortions. To examine the robustness of the findings to model misspecification, I use the cash effective tax rate (ETR) developed by Dyreng et al. (2017) as an alternative proxy for firm-specific distortions. The ETR captures firms' long-run tax avoidance activities, such as tax and investment credits, and can be directly constructed from Compustat rather than from the model. It is defined as

$$\mathrm{ETR}_{it} = \frac{\sum_{h=1}^{6} \mathrm{TXPD}_{i,t-h}}{\sum_{h=1}^{6} \mathrm{PI}_{i,t-h}}, \tag{3.4}$$

where TXPD_{it} is cash tax paid (Item 317) and PI_{it} is pretax income (Item 122) from Compustat. Following Hanlon and Slemrod (2009), if ETR is larger than 0.5, they are reset to 0.5 to reduce the effect of outlier samples. Each variable is averaged over 6 years to calculate the long-run ETR, as suggested by Dyreng et al. (2017), who demonstrate that the long-run average is more reliable. Because ETR is interpreted as firm-specific taxes, I use $\ln(1-\mathrm{ETR}_{i,t+1})$ as the alternative dependent variable, which is consistent with output distortions measured by the inverse of TFPR. I find that lobbying decreases the ETR by a similar magnitude to the baseline TFPR estimates (columns 1 and 2 of Online Appendix Table B1).

Additional Robustness Checks I extend the model to include two production factors, labor and capital, and examine whether lobbying affects marginal revenue product of capital (MRPK).[15] I find that lobbying does not have a statistically significant relationships with MRPK (columns 3–4 of Online Appendix Table B1).

To examine whether the results are sensitive to the imposed functional forms, I use alternative forms, including inverse hyperbolic sine transformation of lobbying expenditures and a dummy variable for positive lobbying. Regardless of different functional forms, I obtain statistically significant and positive estimates with a strong first stage (columns 5–12 of Online Appendix Table B1).

[15] With the two factors of inputs with the Cobb-Douglas production function, capital distortions are proportional to $\frac{w_{njt}L_{it}}{K_{it}}$, where capital K_{it} is measured using PPEGT of Compustat. Similar to Equation (3.1), I can obtain the regression model for MRPK: $\Delta \ln \frac{w_{nj,t+1}L_{i,t+1}}{K_{i,t+1}} = \theta \Delta \ln Lobby_{it} + \Delta \mathbf{X}_{it}' \boldsymbol{\gamma} + \delta_{jt} + \Delta u_{it}$.

3.3 Method of Moments

Home and Foreign are calibrated to cross-sectional data corresponding to the US and China in 2007. I assume that $\ln \boldsymbol{\psi} = (\ln \phi, \ln \tau, \ln \eta)$ of the US follows a joint log-normal distribution:

$$\begin{pmatrix} \ln \phi \\ \ln \tau \\ \ln \eta \end{pmatrix} \sim \mathcal{N}\left(\begin{pmatrix} \mu_\phi^{\text{US}} \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_\phi^2 & & \\ \rho_{\phi\tau}\sigma_\phi\sigma_\tau & \sigma_\tau^2 & \\ \rho_{\phi\eta}\sigma_\phi\sigma_\eta & \rho_{\tau\eta}\sigma_\tau\sigma_\eta & \sigma_\eta^2 \end{pmatrix} \right).$$

I normalize the mean of $\ln \tau$ and $\ln \eta$ to zero because the model is invariant to the mean of exogenous distortions and the mean of lobbying efficiency is not separately identifiable from κ. The covariance matrix is characterized by three standard deviations, $\boldsymbol{\sigma}_{\boldsymbol{\psi}} = (\sigma_\phi, \sigma_\tau, \sigma_\eta)$, and three correlations, $\boldsymbol{\rho}_{\boldsymbol{\psi}} = (\rho_{\phi\tau}, \rho_{\phi\eta}, \rho_{\tau\eta})$. Given the absence of micro-level data on Foreign, I assume that $\boldsymbol{\psi}$ of Foreign follows a joint log-normal distribution with the same $\boldsymbol{\sigma}_{\boldsymbol{\psi}}$ and $\boldsymbol{\rho}_{\boldsymbol{\psi}}$ with the US but with different productivity level μ_ϕ^F.[16] I also take f_e, f, and f_x of Foreign to be the same as those of the US and assume that foreign firms cannot lobby. Because foreign firms cannot lobby, the foreign variables are invariant to μ_η^F. I indirectly infer these parameters related to the underlying distributions because of firm selection into production, exporting, and lobbying.

$\{\theta, \bar{\tau}, \mu_\phi^F, \sigma, f_e, L^{\text{US}}, L^F\}$ are calibrated externally. I set θ to 0.08, the estimated values in Table 2. I normalize L^{US} to be 10 and set the relative labor of Foreign to US L^F/L^{US} to 5.2 to match the relative labor force between China and the US. I set the elasticity of substitution to be 3 as in Hsieh and Klenow (2009). I normalize the mean productivity level of China μ_ϕ^F to zero. As standard in the literature, I normalize the entry cost f_e to one. I set the common distortion $\bar{\tau}$ to one.

The remaining 12 parameters $\boldsymbol{\Theta} = \{\mu_\phi^{\text{US}}, \sigma_\phi, \sigma_\tau, \sigma_\eta, \rho_{\phi\tau}, \rho_{\phi\eta}, \rho_{\tau\eta}, \kappa, f_b, \tau_x, f_x, f\}$ are jointly calibrated using method of moments to match the model moments with the 2007 data counterparts. The parameters minimize the following objective function:

$$\hat{\boldsymbol{\Theta}} = \arg\min_{\boldsymbol{\Theta}} \{(\mathbf{m} - \mathbf{m}(\boldsymbol{\Theta}))' \mathbf{W} (\mathbf{m} - \mathbf{m}(\boldsymbol{\Theta}))\},$$

where $\mathbf{m}$ and $\mathbf{m}(\boldsymbol{\Theta})$ are empirical and model moments and $\mathbf{W}$ is the weighting matrix. I set $\mathbf{W}$ to be the identity matrix. The moments are normalized to convert the difference between the model and the empirical moments into percentage deviation.

I choose the moments that are relevant and informative about the underlying parameters. In Online Appendix B.2, relationships between the parameters and the chosen moments are explained in detail. μ_ϕ^{US} is calibrated to match the relative real GDP of the two countries. In the model, I

[16] The estimate of $\rho_{\phi\tau}$ from Bai et al. (2023) based on the Chinese micro data is -0.83, which is similar to my estimate of -0.81 based on the US firms in Compustat.

Table 3: Model Parameters

Parameter	Description	Value	Identifying Moment
Panel A. Externally calibrated			
θ	Lobbying elasticity	0.08	Own estimate, col. 3 of Table 2
σ	Elasticity of substitution	3	Hsieh and Klenow (2009)
L^F/L^{US}	Foreign & US Labor	5.2	Relative labor of China to the US
μ_ϕ^F	China mean productivity	0	Normalization
μ_τ^{US}, μ_τ^F	US & China mean exo. distortion	0	Normalization
μ_η^{US}, μ_η^F	US & China mean lobbying effic.	0	Normalization
f_e	Entry cost	1	Normalization
$\bar{\tau}$	Common distortion	1	Normalization
Panel B. Internally calibrated			
μ_ϕ^{US}	US mean productivity	3.0	Relative real GDP of the US
σ_ϕ	Std. productivity	1.96	Std. TFPQ
σ_τ	Std. exo. distortion	0.90	Std. residual
σ_η	Std. lobbying effic.	2.80	Std. lobbying expenditures
$\rho_{\phi\tau}$	Corr. productivity & exo. distortion	-0.81	Corr. TFPQ & residual
$\rho_{\phi\eta}$	Corr. productivity & lobbying effic.	-0.57	Corr. TFPQ & lobbying expenditures
$\rho_{\tau\eta}$	Corr. exo. distortion & lobbying effic.	0.20	Corr. residual & lobbying expenditures
κ	Variable lobbying cost	0.01	Med. sales of lobbying & non-lobbying firms
f_b	Fixed lobbying cost	0.03	Lobbying expenditures & sales dist.
τ_x	Iceberg trade cost	4.12	US import share from China
f_x	Fixed export	0.033	Share of exporters, Bernard et al. (2007)
f	Fixed cost of production	0.005	Sales dist.

Notes. This table summarizes the calibrated values for the parameters of the model and their identifying moments.

define producer price index as $PPI = M(\int p(\psi)^{1-\sigma} d\hat{G}(\psi))^{1/(1-\sigma)}$ and real GDP as total domestic and export revenues generated by domestic firms divided by PPI. κ is calibrated to match the log difference between the medians of sales among lobbying and non-lobbying firms. Because κ only governs the overall level of lobbying firms' sales, this moment identifies κ.

I set σ_ϕ to match the standard deviation of quantity-based total factor productivity (TFPQ) defined as $\text{TFPQ} = (\text{Value Added}^{\frac{\sigma}{\sigma-1}})/wL$ that is proportional to ϕ in the model. I set σ_τ to match the standard deviation of the residuals from Equation (3.1) that can be mapped to $\ln\tau$ in the model. I set σ_η to match the standard deviation of lobbying expenditures corresponding to wb/η in the model. I fit $\rho_{\phi\tau}$, $\rho_{\phi\eta}$, and $\rho_{\tau\eta}$ to the correlations between TFPQ and the residuals, TFPQ and log of lobbying expenditures, and log of lobbying expenditures and the residuals from Equation (3.1), respectively. I normalize TFPQ and the residuals by the weighted average within each industry, where the weights are given by value-added. Additionally, I fit three additional moments: the standard deviation of

Table 4: Data and Model Moments

Moments	Data (2007)	Model
Panel A. Targeted Moments		
Relative real GDP	1.36	1.31
Corr. TFPQ & residual	−0.77	−0.90
Corr. TFPQ & lobbying expenditures	0.39	0.59
Corr. residual & lobbying expenditures	−0.42	−0.29
Std. TFPQ	1.83	1.74
Std. residuals	0.88	0.94
Std. lobbying expenditures	1.67	1.54
Std. TFPR	0.74	0.89
Share of lobbying firms	0.19	0.20
Log diff. med. sales of lobbying & non-lobbying firms	2.59	2.51
Share of exporters	0.18	0.20
US import shares from China	0.05	0.05
Log diff. sales of the 50p and 10p	3.38	3.10
Log diff. sales of the 70p and 50p	1.83	1.49
Log diff. sales of the 50p and 25p	1.76	1.68
Panel B. Non-Targeted Moments		
Shares of lobbying firms (Sales > 75p)	0.44	0.45
Shares of lobbying firms (75p ≥ Sales > 50p)	0.14	0.25
Shares of lobbying firms (50p ≥ Sales > 25p)	0.11	0.08
Shares of lobbying firms (25p ≥ Sales)	0.08	0.01
Std. log sales	2.50	2.25
Corr. TFPQ & TFPR	0.79	0.82
Corr. sales & lobbying expenditures	0.56	0.88
Corr. sales & residual	−0.60	−0.62
Corr. sales & TFPR	0.50	0.48
Corr. sales & TFPQ	0.83	0.89

Notes. Panels A and B report the targeted and non-targeted moments of the model and the data counterparts, respectively. Except for the relative GDP, the share of exporters and the US import shares from China, all the moments are calculated from Compustat and the lobbying database of 2007. The relative GDP between the US and China is obtained from the Penn World Table. The share of exporters comes from Bernard et al. (2007), and the US import shares from China are calculated from the WIOD in 2007.

TFPR, the log difference between sales of the 75th and 50th percentiles (75p and 50p), and the log difference between sales of the 50th and 25th percentiles (50p and 25p). Because the distribution of TFPR and sales are a function of the primitives, these three moments are informative on the standard deviations and the correlations of the primitives.

I set f_b to match the shares of lobbying firms. I fit f using the difference between log sales of the 50th and the 10th percentiles (50p and 10p). Because f affects production decisions of small-sized firms at the bottom of the sales distribution, this moment can pin down the parameter. I fit f_x to match the shares of exporters to be 0.18, the reported value in Bernard et al. (2007). I set τ_x to match the import shares from China in the US in 2007. The estimated τ_x is 4.12, higher than the estimate of 1.7 in Anderson and Van Wincoop (2004), and 1.83 in Melitz and Redding (2015). This estimate of 4.15 may reflect high trade costs between the US and China.

Estimation Results Table 3 reports the calibrated parameters and describes their identifying moments. Table 4 reports the model fit. The data moments are well-approximated in the model. Also, Panel B reports non-targeted moments in the data. Matching these non-targeted moments is important because these non-targeted moments also have information on the primitives similar to that of the targeted moments. The model reproduces similar patterns for these non-targeted moments both qualitatively and quantitatively.

I find that the standard deviation of lobbying efficiency is larger than that of productivity or exogenous distortions. A negative correlation between productivity and exogenous distortions ($\rho_{\phi\tau} < 0$) reflects that more productive firms are less subsidized (or more taxed). A negative correlation between productivity and lobbying efficiency ($\rho_{\phi\eta} < 0$) implies that more productive firms have lower lobbying efficiency, and a positive correlation between exogenous distortions and lobbying efficiency ($\rho_{\tau\eta} > 0$) implies that firms with higher exogenous distortions have higher lobbying efficiency.

4 Quantitative Results

4.1 Lobbying and Opening to Trade

I begin by examining how firm lobbying would change when the US economy transitions from autarky to the current equilibrium with the observed import share, reported in Table 5. Upon opening to trade, the average lobbying expenditures increase by 1.75%, but fewer firms engage in lobbying: the probability of lobbying decreases by 0.50 percentage point.[17] However, these results vary depending on the export status in the current equilibrium. Exporters increase lobbying at both the intensive and extensive margins, whereas non-exporters decrease at both margins. Therefore, the aggregate increases at the intensive margins are driven by exporters, whereas the aggregate decreases at the extensive margins are driven by non-exporters. These findings corroborate the theoretical predictions

[17] More precisely, in column 1, I compare the average lobbying expenditures, $\int_{\bar{\phi}^e}(w\kappa b(\psi)/\eta)d\hat{G}(\psi)$, of the autarky and the current equilibrium. In column 2, I compare the average lobbying expenditures in the autarky and the current equilibrium among exporters: $\int_{\bar{\phi}^x}(w\kappa b^a(\psi)/\eta)d\hat{G}(\psi)$ and $\int_{\bar{\phi}^x}(w\kappa b^t(\psi)/\eta)d\hat{G}(\psi)$, where b^a and b^t are their optimal lobbying inputs in the autarky and the current equilibrium. I restrict the comparison to this set of firms because there is no notion of exporting in the autarky. Similarly, in column 3, I compare the average lobbying expenditures in the autarky and the current equilibrium among non-exporters operating in the current equilibrium: $\int_{\bar{\phi}^e}^{\bar{\phi}^x}(w\kappa b^a(\psi)/\eta)d\hat{G}(\psi)$ and $\int_{\bar{\phi}^e}^{\bar{\phi}^x}(w\kappa b^t(\psi)/\eta)d\hat{G}(\psi)$. I compute the extensive margin results analogously.

Table 5: Lobbying and Opening to Trade

	Overall	Exporters	Non-exporters
	(1)	(2)	(3)
Δ Avg. lobbying expenditures (%)	1.75	1.27	-18.39
Δ Probability of lobbying (p.p)	-0.50	0.19	-0.71

Notes. This table reports the changes in US firm lobbying expenditures at intensive and extensive margins, when moving from the autarky to the current equilibrium with the observed import shares. Column 1 reports the average changes of all firms. Columns 2 and 3 report the average changes among exporters and non-exporters in the current equilibrium, respectively.

outlined in Figure 1.

4.2 Lobbying and Gains from Trade

Next, I compare welfare gains from trade of the baseline with lobbying to those of the counterfactual without lobbying. Table 6 reports the results. Gains from trade in the baseline are 3% (0.06 percentage points) higher than those in the counterfactual economy (2.19% vs. 2.13%). Own import shares are lower in the baseline by a 0.3 percentage point as lobbying decreases overall TFP of the economy. In both economies, the welfare gains come from the improved allocative efficiency terms $d\ln\mathbb{W}^{\mathrm{AE}}$, whereas the entry terms $d\ln\mathbb{W}^{\mathrm{E}}$ deteriorate due to less entry and more exit by domestic firms (Equation (2.6)). The magnitude of the improvement of $d\ln\mathbb{W}^{\mathrm{AE}}$ is larger in the baseline by 6% (2.75% vs. 2.59%), but this larger magnitude is partially offset by more deteriorated $d\ln\mathbb{W}^{\mathrm{E}}$ (-0.56% vs. -0.45%).

The results depend on how lobbying interacts with underlying firm primitives in the second-best world. Recall that ϕ and τ are negatively correlated, meaning that more productive firms face lower subsidies or higher taxes initially, and the standard deviation of $\ln\phi$ is larger than that of $\ln\tau$. Given these conditions, more productive but more taxed or less subsidized firms select into exporting. Due to the market size effects, they increase lobbying efforts which partially offset their initial exogenous distortions. This leads to a larger improvement in allocative efficiency when opening to trade in the baseline, compared to the counterfactual. However, with these increased lobbying efforts by exporters, more resources are allocated to them, leading to a more pronounced decrease in firm entry in the baseline.

Table 6: Gains from Trade in the Presence and Absence of Lobbying

	Baseline (Lobbying)	Counterfactual (No Lobbying)	Diff. (col. 1 - col. 2)
	(1)	(2)	(3)
	Panel A. Actual Gains from Trade		
Gains from trade, $d \ln \mathbb{W}$ (%)	2.19	2.13	0.06
Entry, $d \ln \mathbb{W}^{\mathrm{E}}$	-0.56	-0.46	-0.10
Allocative efficiency, $d \ln \mathbb{W}^{\mathrm{AE}}$	2.75	2.59	0.16
Own import shares, λ (%)	95.28	95.58	-0.30
	Panel B. Predicted Gains from Trade		
ACR/MR	2.13	2.0	0.13
BKL	2.14	2.13	0.01

Notes. Panel A reports the welfare gains from trade and own import shares upon opening to trade in the baseline with lobbying and the counterfactual without lobbying. Panel B reports gains from trade predicted by the formulas of Arkolakis et al. (2012) and Melitz and Redding (2015), and Bai et al. (2023).

Between the gains from trade in both economies, the following relationship holds

$$\underbrace{\ln \frac{\mathbb{W}_T^B}{\mathbb{W}_A^B}}_{\substack{\text{Gains from trade:}\\ \text{Baseline}\\ \text{(Lobbying)}\\ = 2.19\%}} = \underbrace{\ln \frac{\mathbb{W}_T^C}{\mathbb{W}_A^C}}_{\substack{\text{Gains from trade:}\\ \text{Counterfactual}\\ \text{(No lobbying)}\\ = 2.13\%}} + \underbrace{\left(\underbrace{\ln \frac{\mathbb{W}_T^B}{\mathbb{W}_T^C}}_{\substack{\text{Welfare effects of lobbying:}\\ \text{opening to trade = -15.87\%}}} - \underbrace{\ln \frac{\mathbb{W}_A^B}{\mathbb{W}_A^C}}_{\substack{\text{Welfare effects of lobbying:}\\ \text{autarky = -15.93\%}}} \right)}_{\text{Changes in welfare effects of lobbying = 0.06\%}}, \tag{4.1}$$

where subscripts T and A denote opening to trade and autarky, and superscripts B and C the baseline and the counterfactual economies, respectively. The difference between the gains from trade of the baseline and the counterfactual economies reflects changes in the welfare effects of lobbying in the open economy and the autarky. The welfare loss due to lobbying in the autarky is -15.93%, which is 0.06 percentage points lower than -15.87% observed in the open economy. This implies that when opening to trade, the adverse welfare effects of lobbying become less severe, which is related to the larger improvement in the allocative efficiency in the baseline.

The Case of Welfare Losses from Trade With the calibrated values, the gains from trade are positive (Table 6). I explore the effects of lobbying in a scenario where opening to trade leads to welfare losses, as studied by Bai et al. (2023), by setting alternative parameter values ($\sigma_\phi = 1.2$, $\sigma_\tau = 1.1$, and $\rho_{\phi\tau} = -0.90$).

Table 7 reports the results for this scenario. Both economies experience welfare losses when

Table 7: The Case of Welfare Losses from Trade

	Baseline (Lobbying)	Counterfactual (No Lobbying)	Diff. (col. 1 - col. 2)
	(1)	(2)	(3)
	Panel A. Actual Gains from Trade		
Gains from trade, $d\ln\mathbb{W}$ (%)	-1.00	-0.29	-0.71
Entry, $d\ln\mathbb{W}^{\mathrm{E}}$	-0.61	-0.50	-0.11
Allocative efficiency, $d\ln\mathbb{W}^{\mathrm{AE}}$	-0.39	0.21	-0.60
Own import shares, λ (%)	96.33	97.08	0.75
	Panel B. Predicted Gains from Trade		
ACR/MR	1.30	0.99	0.31
BKL	-0.60	-0.29	-0.67

Notes. This table reports the results on gains from trade in a scenario with welfare losses from trade. The scenario is based on alternative parameter values: $\sigma_\phi = 1.2$, $\sigma_\tau = 1.1$, and $\rho_{\phi\tau} = -0.90$. Panel A reports the welfare gains from trade and own import shares upon opening to trade in the baseline with lobbying and the counterfactual without lobbying. Panel B reports gains from trade predicted by the formulas of Arkolakis et al. (2012) and Melitz and Redding (2015), and Bai et al. (2023).

opening to trade, but the baseline experiences larger welfare losses. In particular, deterioration of $d\ln\mathbb{W}^{\mathrm{AE}}$ is more severe. This occurs because, unlike the case of positive gains, where productivity plays a significant role in selection into exporting, higher and lower values for σ_τ and σ_ϕ lead to selection into exporting being driven more by exogenous distortions. Consequently, exporters that are initially more subsidized (or less taxed) become to have even higher distortions through increased lobbying, worsening $d\ln\mathbb{W}^{\mathrm{AE}}$.

The results in Tables 6 and 7 imply that whether lobbying amplifies or worsens gains from trade depends on which types of firms self-select into exporting in a second-best world. If selection into exporting is driven by firms with higher productivity, gains from trade are likely to be amplified with lobbying as productive exporters partially undo initially imposed exogenous distortions, thereby improving allocative efficiency. However, when selection into exporting is driven by firms with higher exogenous distortions, more distorted exporters lobby to have even higher distortions, worsening allocative efficiency.

Actual vs. Predicted Welfare Gains Next, I examine the deviation of gains from trade under lobbying from those predicted by the BKL and ACR/MR formulas (Equations 2.12 and 2.11), reported in Panel B of Table 6. In column 1, with lobbying, the ACR/MR and BKL formulas underestimate the true gains from trade by 2.8% and 2.4% (0.06 percentage points and 0.05 percentage points), respectively. On the other hand, in column 2 without lobbying, which is the setup studied by BKL, the actual gains are well-approximated by the BKL formula. Panel B of Table 7 reports the deviations in the scenario with welfare losses. In this scenario, the difference between the true gains and the ACR/MR gains is more stark, as the ACR/MR formulas always predict positive gains from trade. Also, the loss predicted by the BKL formula is 40% lower. These deviations between the actual and predictions gains in the presence of lobbying confirm the analytical results on the welfare formula in Section 2.1 and highlight the importance of considering the microstructure when evaluating gains from trade.

Sensitivity Analysis To further examine the interaction between lobbying and firm primitives, I evaluate gains from trade while varying one parameter related to the distributions of firm primitives, holding other parameters constant. Figure 2 reports the results. The differences in the gains from trade in the baseline and the counterfactual economies are most sensitive to changes in the correlations of Home ($\rho_{\phi\tau}$, $\rho_{\phi\eta}$, and $\rho_{\tau\eta}$). The quantitative result on the difference based on the calibrated values, reported in Panel B of Table 6, is at the lower range among different values for the correlations.

A relationship between $\rho_{\phi\tau}$ and the difference is nonlinear (Panel A). The gap initially increases and reaches the maximum around 0.3. More productive exporters can overcome the initial tax more easily as $\rho_{\phi\tau}$ starts to increase, but beyond the value of 0.3, exporters increase lobbying efforts too excessively and the gains from trade of the baseline start to diminish. $\rho_{\phi\eta}$ and $\rho_{\tau\eta}$ exhibit more monotonic relationships (Panels B and C). In the baseline, the gains from trade increase with values of $\rho_{\phi\eta}$ and $\rho_{\tau\eta}$. As $\rho_{\phi\eta}$ increases, more productive firms become more efficient in lobbying, making them overcome initially low distortions more easily, which in turn leads to the increasing relationship. Higher $\rho_{\tau\eta}$ implies that firms with higher exogenous distortions become more efficient in lobbying. Therefore, with higher $\rho_{\tau\eta}$, they engage more in lobbying in the autarky. When opening to trade, lobbying by unproductive non-exporters decrease, leading to the larger gains.

I also conduct the sensitivity analysis while varying one parameter by 1% of the magnitude of the calibrated values and holding other parameters constant. I also consider an alternative value of 0.06 for θ, taken from the estimate of Huneeus and Kim (2018). For the case of $\theta = 0.06$, the remaining parameters are re-calibrated using method of moments. Table 8 reports these results. The main findings that the gains from trade are larger in the baseline than the counterfactual and that the ACR/MR and BKL formulas underestimate the actual gains remain robust to the alternative parameter values.

5 Conclusion

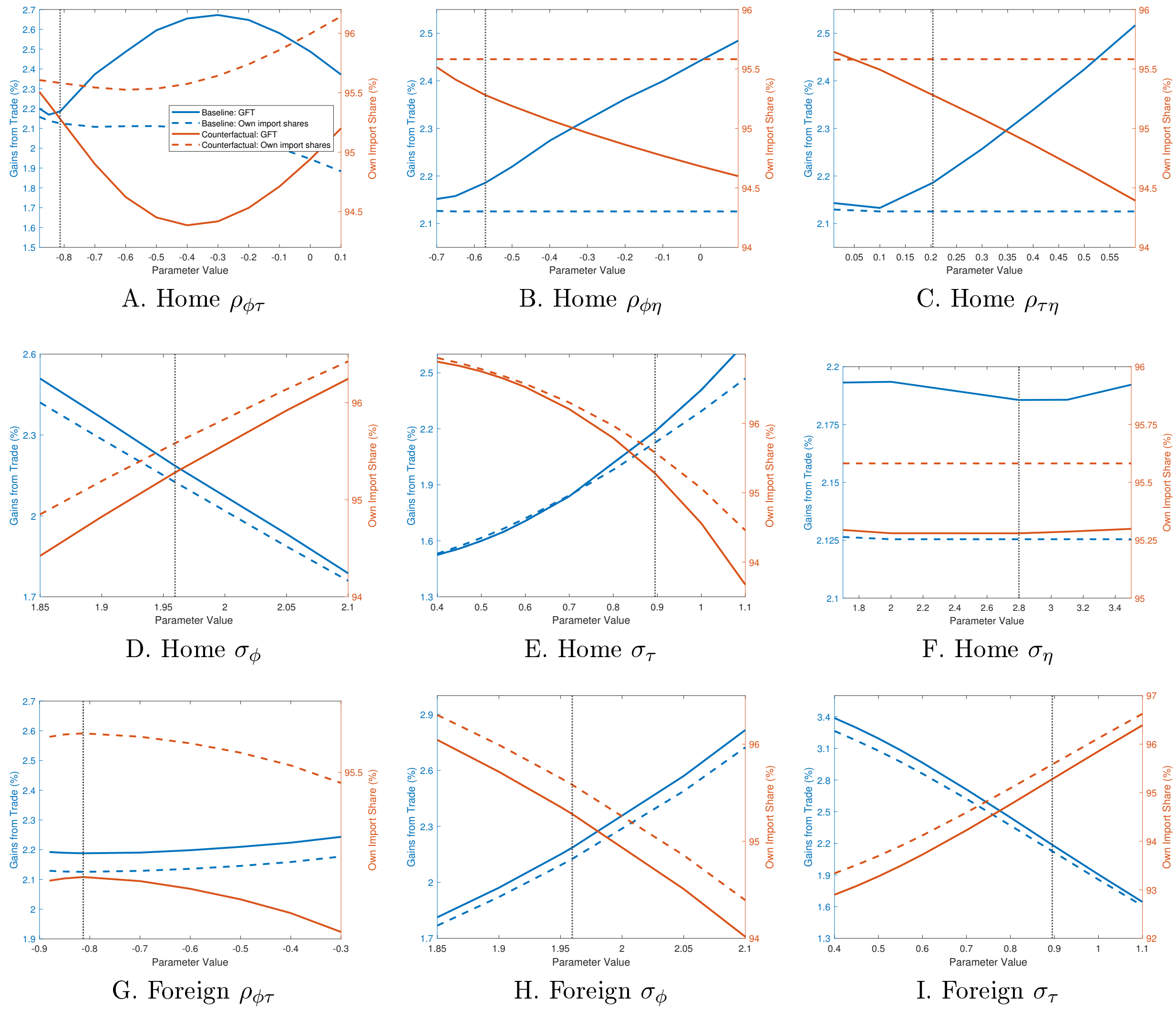
This paper studies welfare gains from trade in a second-best world with lobbying. As trade costs decline, exporters increase lobbying efforts relative to non-exporters due to the complementarity

Table 8: Sensitivity Analysis

Parameters	Home $\rho_{\phi\tau}$		Home $\rho_{\phi\eta}$		Home $\rho_{\tau\eta}$		Home σ_{ϕ}		Home σ_{τ}		Home σ_{η}		Foreign $\rho_{\phi\eta}$		Foreign σ_{ϕ}		Foreign σ_{ϕ}		$\theta = 0.06$
	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	$\downarrow$ 1%	$\uparrow$ 1%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
	Panel A. Actual Gains from Trade																		
Gains from trade (%)																			
Baseline (Lobbying)	2.20	2.19	2.19	2.19	2.20	2.18	2.25	2.14	2.15	2.21	2.18	2.19	2.19	2.19	2.11	2.26	2.21	2.16	2.16
Counterfactual (No Lobbying)	2.12	2.13	2.13	2.13	2.13	2.13	2.18	2.07	2.11	2.14	2.13	2.13	2.13	2.13	2.06	2.20	2.15	2.10	2.11
	Panel B. Predicted Gains from Trade																		
BKL	2.15	2.14	2.14	2.15	2.14	2.13	2.20	2.09	2.10	2.16	2.12	2.14	2.13	2.13	2.06	2.21	2.16	2.11	2.13
ACR/MR	2.15	2.10	2.13	2.12	2.12	2.12	2.19	2.07	2.09	2.15	2.11	2.13	2.12	2.12	2.05	2.20	2.15	2.10	2.12

Notes. This table reports the results of the sensitivity analysis of the home and Foreign parameters related to the distribution of firm primitives and θ. Panel A reports the actual gains from trade in the baseline economy with lobbying and the counterfactual economy without lobbying. Panel B reports the gains from trade predicted by the formulas of Arkolakis et al. (2012), Melitz and Redding (2015), and Bai et al. (2023). In columns 1–18, I vary the values of the parameters by 1% from their baseline calibrated values. In column 19, I consider $\theta = 0.06$ based on the estimate from Huneeus and Kim (2018), in which all the remaining parameters are re-calibrated.

Figure 2. Lobbying and Distributions of Home and Foreign Firm Primitives



A. Home $\rho_{\phi\tau}$ B. Home $\rho_{\phi\eta}$ C. Home $\rho_{\tau\eta}$

D. Home σ_{ϕ} E. Home σ_{τ} F. Home σ_{η}

G. Foreign $\rho_{\phi\tau}$ H. Foreign σ_{ϕ} I. Foreign σ_{τ}

Notes. This figure reports gains from trade and own import shares for different values of parameters related to the distributions of Home and Foreign firm primitives. The blue solid and dashed lines represent gains from trade of the baseline and the counterfactual economies. The red solid and dashed lines represent own import shares of the baseline and the counterfactual economies.

between benefits from lobbying and market size. This divergence between the two groups impacts allocative efficiency, firm entry, and therefore, gains from trade. The study finds that in the US, gains from trade are amplified in the presence of lobbying. This is because, when opening to trade, more productive firms select into exporting and increase lobbying, mitigating their initially unfavorable distortions and leading to a larger improvement in allocative efficiency. However, in a case where trade leads to welfare losses, in which selection into exporting is more driven by exogenous distortions, lobbying exacerbates these losses. These results highlight the importance of understanding the interplay between lobbying and which types of firms select into exporting in a second-best world.

However, the use of Compustat data, limited to publicly traded firms, restricts the representativeness of the findings to the entire US economy. Additionally, the model overlooks strategic behaviors among firms, barriers to entry, and competition dynamics. Future research should enrich both data and theory to explore the interaction between lobbying and trade openness further. Moreover, extending this framework to study other forms of rent-seeking behaviors, such as tax evasion and corporate bribery, presents promising avenues for research.

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ONLINE APPENDIX

(NOT FOR PUBLICATION)

Appendix A Theory

A.1 Model Derivation

Derivation of Optimal Lobbying Inputs and Profits I derive expressions for firms' optimal lobbying and profits conditional on lobbying. I first characterize non-exporters' optimal lobbying inputs and profits. Conditional on lobbying amounts of b, non-exporters' profits are

$$\pi^d(b;\boldsymbol{\psi}) = \frac{1}{\sigma}\Big(\mu\frac{w}{\phi}\Big)^{1-\sigma}\tau^\sigma b^{\theta\sigma}P^{\sigma-1}E - w\Big(\kappa\frac{b}{\eta} + f_b + f\Big) = \tilde{\pi}^d(0;\boldsymbol{\psi})b^{\theta\sigma} - w\Big(\kappa\frac{b}{\eta} + f_b + f\Big) \quad \text{(A.1)}$$

where $\tilde{\pi}^d(0;\boldsymbol{\psi})$ are non-exporters' variable profits conditional on not lobbying.

Firms choose their optimal lobbying inputs that maximize profits, characterized by the first-order conditions (FOC). Taking the derivative with respect to b, I obtain the following FOC:

$$\kappa\frac{w}{\eta} = \theta\sigma\tilde{\pi}^d(0;\boldsymbol{\psi})b^{(\theta\sigma-1)}.$$

After arranging the above equation, the optimal lobbying inputs can be expressed as follows:

$$b = \Big(\theta\sigma\frac{\eta}{\kappa w}\tilde{\pi}^d(0;\boldsymbol{\psi})\Big)^{\frac{1}{1-\theta\sigma}}.$$

After substituting the optimal lobbying inputs into Equation (A.1), I obtain that

$$\pi^d(b;\boldsymbol{\psi}) = \Big((\theta\sigma)^{\frac{\theta\sigma}{1-\theta\sigma}} - (\theta\sigma)^{\frac{1}{1-\theta\sigma}}\Big)\Big(\frac{\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{\pi}^d(0;\boldsymbol{\psi})^{\frac{1}{1-\theta\sigma}} - w(f + f_b).$$

Exporters' optimal lobbying inputs and profits can be derived similarly. Conditional on spending lobbying amounts of b, exporters' profits are

$$\begin{aligned}\pi^x(b;\boldsymbol{\psi}) &= \Big[\frac{1}{\sigma}\Big(\mu\frac{w}{\phi}\Big)^{1-\sigma}\tau^\sigma P^{\sigma-1}E + \frac{1}{\sigma}\Big(\frac{\tau_x w}{\phi}\Big)^{1-\sigma}\tau^\sigma P_f^{\sigma-1}E_f\Big]b^{\theta\sigma} - w\Big(\kappa\frac{b}{\eta} + f_b + f + f_x\Big)\\ &= \tilde{\pi}^x(0;\boldsymbol{\psi})b^{\theta\sigma} - w\Big(\kappa\frac{b}{\eta} + f_b + f + f_x\Big).\end{aligned}$$

where $\tilde{\pi}^x(0;\boldsymbol{\psi})$ are non-exporters' variable profits conditional on not lobbying. From the FOC with respect to b, the optimal lobbying inputs are expressed as

$$b = \Big(\theta\sigma\frac{\eta}{\kappa w}\tilde{\pi}^x(0;\boldsymbol{\psi})\Big)^{\frac{1}{1-\theta\sigma}}.$$

After substituting the optimal lobbying inputs, I obtain that

$$\pi^x(b;\boldsymbol{\psi}) = \Big((\theta\sigma)^{\frac{\theta\sigma}{1-\theta\sigma}} - (\theta\sigma)^{\frac{1}{1-\theta\sigma}}\Big)\Big(\frac{\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{\pi}^x(0;\boldsymbol{\psi})^{\frac{1}{1-\theta\sigma}} - w(f + f_b + f_x).$$

Zero Profit Cutoff The zero profit cutoff productivity satisfies that $\pi(\bar{\phi}^e(\tau,\eta),\tau,\eta) = 0$. Using this condition, I can derive the zero profit cutoff as follows:

$$\bar{\phi}^e(\tau,\eta) = \left[\frac{\sigma f}{\frac{1}{\sigma}(\mu w)^{1-\sigma}P^{\sigma-1}E}\right]^{\frac{1}{\sigma-1}}. \tag{A.2}$$

Lobbying Cutoff When η is sufficiently high, non-exporters may participate in lobbying, that is, $\bar{\phi}^b(\tau,\eta) < \bar{\phi}^x(\tau,\eta)$. In such a case, the lobbying cutoff is implicitly defined by the following condition:

$$c\Big(\frac{\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\Big(\frac{1}{\sigma}\Big(\mu\frac{w}{\bar{\phi}^b(\tau,\eta)}\Big)^{1-\sigma}P^{\sigma-1}E\Big)^{\frac{1}{1-\theta\sigma}} - wf_b = \frac{1}{\sigma}\Big(\mu\frac{w}{\bar{\phi}^b(\tau,\eta)}\Big)^{1-\sigma}\tau^{\sigma}P^{\sigma-1}E, \tag{A.3}$$

where c is a constant defined as $c = (\theta\sigma)^{\frac{\theta\sigma}{1-\theta\sigma}} - (\theta\sigma)^{\frac{1}{1-\theta\sigma}}$. In the case in which $\bar{\phi}^b(\tau,\eta) \geq \bar{\phi}^x(\tau,\eta)$ holds, the lobbying cutoff is implicitly defined by the following condition:

$$\begin{aligned} c\Big(\frac{\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\Big(\frac{1}{\sigma}\Big(\mu\frac{w}{\bar{\phi}^b(\tau,\eta)}\Big)^{1-\sigma}(P^{\sigma-1}E + \tau_x^{1-\sigma}P_f^{\sigma-1}E_f)\Big)^{\frac{1}{1-\theta\sigma}} - wf_b \\ = \frac{1}{\sigma}\Big(\mu\frac{w}{\bar{\phi}^b(\tau,\eta)}\Big)^{1-\sigma}\tau^{\sigma}(P^{\sigma-1}E + \tau_x^{1-\sigma}P_f^{\sigma-1}E_f). \end{aligned} \tag{A.4}$$

Also note that after setting the common distortion $\bar{\tau}$ to one, only firms that satisfy the condition $b \geq 1$ participate in lobbying because of the maximum of the functional form of the output distortions (Equation (2.1)).

Export Cutoff In the case in which $\bar{\phi}^b(\tau,\eta) \geq \bar{\phi}^x(\tau,\eta)$ holds, the export cutoff satisfies that

$$\frac{1}{\sigma}\Big(\mu\frac{\tau_x w}{\bar{\phi}^x(\tau,\eta)}\Big)^{1-\sigma}\tau^{\sigma}P_f^{\sigma-1}E_f = wf_x.$$

From this condition, the export cutoff can be expressed as follows:

$$\bar{\phi}^x(\tau,\eta) = \left(\frac{wf_x}{\frac{1}{\sigma}(\mu\tau_x w)^{1-\sigma}P_f^{\sigma-1}E_f}\right)^{\frac{1}{\sigma-1}}. \tag{A.5}$$

In the case where $\bar{\phi}^b(\tau,\eta) < \bar{\phi}^x(\tau,\eta)$, the export cutoff satisfies

$$\begin{aligned} c\Big(\frac{\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\Big(\frac{1}{\sigma}\Big(\mu\frac{w}{\bar{\phi}^x(\tau,\eta)}\Big)^{1-\sigma}(P^{\sigma-1}E + \tau_x^{1-\sigma}P_f^{\sigma-1}E_f)\Big)^{\frac{1}{1-\theta\sigma}} - wf_x \\ = c\Big(\frac{\eta}{\kappa w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}\Big(\frac{1}{\sigma}\Big(\mu\frac{w}{\bar{\phi}^x(\tau,\eta)}\Big)^{1-\sigma}P^{\sigma-1}E\Big)^{\frac{1}{1-\theta\sigma}}. \end{aligned}$$

From this condition, the export cutoff can be expressed as follows:

$$\bar{\phi}^x(\tau,\eta) = \left(\frac{wf_x}{c(\frac{\eta}{\kappa w})^{\frac{\theta\sigma}{1-\theta\sigma}} (\frac{1}{\sigma})^{\frac{1}{1-\theta\sigma}} (\mu w)^{\frac{1-\sigma}{1-\theta\sigma}} \left((P^{\sigma-1}E + \tau_x^{1-\sigma} P_f^{\sigma-1} E)^{\frac{1}{1-\theta\sigma}} - (P^{\sigma-1}E)^{\frac{1}{1-\theta\sigma}} \right)} \right)^{\frac{1-\theta\sigma}{\sigma-1}}. \tag{A.6}$$

Derivation of Equation (2.6) The total labor used for production can be written as follows:

$$L^p = M\Big[\int \frac{q(\boldsymbol{\psi})}{\phi} d\hat{G}(\boldsymbol{\psi}) + \int x(\boldsymbol{\psi}) \frac{q(\boldsymbol{\psi})}{\phi} d\hat{G}(\boldsymbol{\psi}) \Big].$$

Dividing both sides by Q, I can obtain that

$$\frac{L^p}{Q} = M\Big[\int \frac{1}{\phi} \frac{q(\boldsymbol{\psi})}{Q} d\hat{G}(\boldsymbol{\psi}) + \int x(\boldsymbol{\psi}) \frac{1}{\phi} \frac{q(\boldsymbol{\psi})}{Q} d\hat{G}(\boldsymbol{\psi}) \Big].$$

Using that $Q = M^{\frac{\sigma}{\sigma-1}} \Big[\int q(\boldsymbol{\psi})^{\frac{\sigma-1}{\sigma}} \Big]^{\frac{\sigma}{\sigma-1}}$,

$$\frac{L^p}{Q} = M^{-\frac{1}{\sigma-1}} \Big[\int \frac{1}{\phi} \frac{q(\boldsymbol{\psi})}{\tilde{q}} d\hat{G}(\boldsymbol{\psi}) + \int x(\boldsymbol{\psi}) \frac{1}{\phi} \frac{q(\boldsymbol{\psi})}{\tilde{q}} d\hat{G}(\boldsymbol{\psi}) \Big],$$

where $\tilde{q}$ is defined as follows:

$$\tilde{q} = \Big[\int q(\boldsymbol{\psi})^{\frac{\sigma-1}{\sigma}} d\hat{G}(\boldsymbol{\psi}) \Big]^{\frac{\sigma}{\sigma-1}}.$$

Rearranging the terms, I can rewrite Q as follows:

$$Q = AL, \quad \text{where} \quad A = M^{\frac{1}{\sigma-1}} \times \Big[\int \frac{1}{\phi} \frac{q(\boldsymbol{\psi})}{\tilde{q}} d\hat{G}(\boldsymbol{\psi}) + \int x(\boldsymbol{\psi}) \frac{1}{\phi} \frac{q(\boldsymbol{\psi})}{\tilde{q}} d\hat{G}(\boldsymbol{\psi}) \Big]^{-1} \times \frac{L^p}{L}.$$

I further show that $\frac{L^p}{L}$ is always constant regardless of values of θ. Then, $d\ln \mathbb{W} = \frac{1}{\sigma-1} d\ln M + d\ln bigg[\int \frac{1}{\phi} \frac{q(\psi)}{\tilde{q}} d\hat{G}(\boldsymbol{\psi}) + \int x(\boldsymbol{\psi}) \frac{1}{\phi} \frac{q(\psi)}{\tilde{q}} d\hat{G}(\boldsymbol{\psi}) \Big]^{-1}$ holds. For non-exporters and exporters, the following relationship holds between their lobbying inputs and operating profits:

$$\frac{b^d}{\eta} = \frac{1}{\kappa w} \frac{\theta\sigma}{1-\theta\sigma} \tilde{\pi}^d(b^d;\boldsymbol{\psi}) \qquad \text{and} \qquad \frac{b^x}{\eta} = \frac{1}{\kappa w} \frac{\theta\sigma}{1-\theta\sigma} \tilde{\pi}^x(b^x;\boldsymbol{\psi}).$$

For their production workers,

$$l_d = \frac{q_d}{\phi} = \frac{\sigma-1}{w} \frac{1}{1-\theta\sigma} \tilde{\pi}^d(b^d;\boldsymbol{\psi}) \qquad \text{and} \qquad l_x = \frac{q_d + \tau_x q_x}{\phi} = \frac{\sigma-1}{w} \frac{1}{1-\theta\sigma} \tilde{\pi}^x(b^x;\boldsymbol{\psi}).$$

Therefore, total sum of variable lobbying and production labor is proportional to operating profits: $\frac{b^d}{\eta} + l_d = c_1 \tilde{\pi}^d(b^d;\boldsymbol{\psi})$ and $\frac{b^x}{\eta} + l_d = c_1 \tilde{\pi}^x(b^x;\boldsymbol{\psi})$ holds for both non-exporters and exporters, for some constant c_1. For non-lobbying firms, regardless of their export status, variable labor used for lobbying is zero. Their variable labor used for production is also proportional to their operating profits: $l_d = c_2\tilde{\pi}^d(0;\boldsymbol{\psi})$ and $l_x = c_2\tilde{\pi}^x(0;\boldsymbol{\psi})$.

The free entry condition implies that

$$p_e\bigg(p_l(1-p_{x|l})\Big(\mathbb{E}[\tilde{\pi}^d(b^d;\boldsymbol{\psi})] - w(f+f_b)\Big) + p_l p_{x|l}\Big(\mathbb{E}[\tilde{\pi}^x(b^x;\boldsymbol{\psi})] - w(f+f_x+f_b)\Big)$$
$$+ (1-p_l)(1-p_{x|nl})\Big(\mathbb{E}[\tilde{\pi}^d(0;\boldsymbol{\psi})] - wf\Big) + (1-p_l)p_{x|nl}\Big(\mathbb{E}[\tilde{\pi}^x(0;\boldsymbol{\psi})] - w(f+f_x)\Big)\bigg) = wf_e,$$

where p_l is a probability of engaging in lobbying, $p_{x|l}$ is a probability of exporting conditional on lobbying, and $p_{x|nl}$ is a probability of exporting conditional on not-lobbying. Substituting these proportional relationships between operating profits and variable labor used for production and lobbying into the free entry condition, I obtain that $\frac{L_p}{L} = C$ for some constant C consistent of the model parameters.

Comparison between the Allocative Efficiency Terms in Equation (2.6) and Hsieh and Klenow (2009) I show that the allocative efficiency term coincides with the allocative efficiency term derived in Hsieh and Klenow (2009) in the closed economy without lobbying. Under the monopolistic competition with the CES demand, the second term can be rewritten as follows:

$$M^{-\frac{\sigma}{\sigma-1}}\bigg[\int \frac{1}{\phi}\Big(\frac{p(\boldsymbol{\psi})}{P}\Big)^{-\sigma} d\hat{G}(\boldsymbol{\psi})\bigg]^{-1}.$$

Using the ideal price index, this can be rewritten as follows:

$$A = \frac{\bigg[\int(\phi\tau)^{\sigma-1}d\hat{G}(\boldsymbol{\psi})\bigg]^{\frac{1}{\sigma-1}}}{\bigg[\int \tau \times \underbrace{\frac{(\mu w)^{1-\sigma}(\phi\tau)^{\sigma-1}P^{\sigma-1}E}{E}}_{=\omega(\boldsymbol{\psi})} d\hat{G}(\boldsymbol{\psi})\bigg]},$$

where $\omega(\boldsymbol{\psi})$ is the share of firms sales' to total expenditures. The denominator is the weighted average of τ where the weights are given by value-added shares of firms. Define $\overline{\text{TFPR}}$ as the denominator of the above expression. Because $\tau \propto \text{TFPR}$, I can obtain the TFP formula of Hsieh and Klenow (2009):

$$A \propto \bigg[\int \Big(\phi\frac{\text{TFPR}}{\overline{\text{TFPR}}}\Big)^{\sigma-1} d\hat{G}(\boldsymbol{\psi})\bigg]^{\frac{1}{\sigma-1}}.$$

A.2 Proof of Proposition 1

This section presents the proof of Proposition 1. Without loss of generality, I normalize wage w to one. The price index can be expressed as follows:

$$P^{1-\sigma} = \left(\frac{\sigma}{\sigma-1}w\right)^{\frac{(1-\sigma)(1-\theta)}{1-\theta\sigma}} \left(\frac{\theta\sigma}{\kappa w}\right)^{\frac{\theta(\sigma-1)}{1-\theta\sigma}} \left(\frac{1}{\sigma}\right)^{\frac{\theta(\sigma-1)}{1-\theta\sigma}} (P^{\sigma}Q)^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}$$
$$\times M_e\Big[\tilde{\lambda}(\hat{\phi}^e,\hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tilde{\lambda}(\hat{\phi}^x,\infty) + \tau_x^{1-\sigma}(1+\tau_x^{1-\sigma})^{\frac{\theta(\sigma-1)}{1-\theta\sigma}}\tilde{\lambda}(\hat{\phi}^x,\infty)\Big], \quad \text{(A.7)}$$

where λ is a share of expenditures on domestic varieties and λ_d is a share of domestic expenditures on non-exporters' varieties (Equations (2.7) and (2.9)). Equation (A.7) can be re-expressed as follows:

$$P^{1-\sigma} = cons \times M_e(P^{\sigma}Q)^{\frac{\theta(\sigma-1)}{1-\theta\sigma}} \frac{1}{\lambda}\frac{\lambda_d^a}{\lambda_d}\tilde{\lambda}(\hat{\phi}^e,\infty), \quad \text{(A.8)}$$

where $cons$ is a collection of parameters, and $cons$ and w are invariant to iceberg cost changes. Equation (A.8) is one of the two key equations for the proof.

The free entry condition implies that

$$p_e\Big((1-p_x)\mathbb{E}[\tilde{\pi}^d(b^d)] + p_x(\mathbb{E}[\tilde{\pi}^x(b^x)] - wf_x) - wf\Big) = wf_e,$$

where p_e is the probability of entry and p_x is the probability of exporting conditioning on entry. $\mathbb{E}[\tilde{\pi}^d(b^d)]$ and $\mathbb{E}[\tilde{\pi}^x(b^x)]$ are the expected operating profits of non-exporters and exporters conditional on the optimal amounts of lobbying. Rearranging, I can derive that

$$(1-p_x)\mathbb{E}[\tilde{\pi}^d] + p_x\mathbb{E}[\tilde{\pi}^x] = w\Big(\frac{f_e}{p_e} + f + p_x f_x\Big). \quad \text{(A.9)}$$

Labor used for production for non-exporters and exporters is

$$l_d = \frac{q_d}{\phi} = \frac{\sigma-1}{w}\Big(\frac{\eta}{w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}(\theta\sigma)^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{\pi}^d(0)^{\frac{1}{1-\theta\sigma}} = \frac{\sigma-1}{w}\frac{1}{1-\theta\sigma}\tilde{\pi}^d(b^d) \quad \text{(A.10)}$$

and

$$l^x = \frac{q_d}{\phi} + \frac{\tau_x q_x}{\phi} = \frac{\sigma-1}{w}\Big(\frac{\eta}{w}\Big)^{\frac{\theta\sigma}{1-\theta\sigma}}(\theta\sigma)^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{\pi}^x(0)^{\frac{1}{1-\theta\sigma}} = \frac{\sigma-1}{w}\frac{1}{1-\theta\sigma}\tilde{\pi}^x(b^x), \quad \text{(A.11)}$$

where $\tilde{\pi}^d(0)$ and $\tilde{\pi}^x(0)$ are operating profits conditional on not lobbying:

$$\tilde{\pi}^d(0) = \frac{1}{\sigma}\Big(\frac{w}{\phi}\Big)^{1-\sigma}\tau^{\sigma}P^{\sigma}Q \qquad \text{and} \qquad \tilde{\pi}^x(0) = \frac{1}{\sigma}\Big(\frac{w}{\phi}\Big)^{1-\sigma}\tau^{\sigma}((1+\tau_x^{1-\sigma})P^{\sigma}Q.$$

Labor used for lobbying for non-exporters and exporters is

$$\frac{b^d}{\eta} = \eta^{\frac{\theta\sigma}{1-\theta\sigma}} \left(\frac{\theta\sigma}{w}\right)^{\frac{1}{1-\theta\sigma}} \tilde{\pi}^d(0)^{\frac{1}{1-\theta\sigma}} = \frac{1}{w}\frac{\theta\sigma}{1-\theta\sigma}\tilde{\pi}^d(b^d) \tag{A.12}$$

and

$$\frac{b^x}{\eta} = \eta^{\frac{\theta\sigma}{1-\theta\sigma}} \left(\frac{\theta\sigma}{w}\right)^{\frac{1}{1-\theta\sigma}} \tilde{\pi}^x(0)^{\frac{1}{1-\theta\sigma}} = \frac{1}{w}\frac{\theta\sigma}{1-\theta\sigma}\tilde{\pi}^x(b^x). \tag{A.13}$$

Labor market clearing condition implies that

$$M\Big((1-p_x)\mathbb{E}[l^d + \frac{b^d}{\eta}] + p_x\mathbb{E}[l^x + \frac{b^x}{\eta}] + f + p_x f_x\Big) + M_e f_e = L \tag{A.14}$$

Using Equations (A.10), (A.11), (A.12), and (A.13), I can obtain that

$$\left[\frac{\sigma-1}{w}\frac{1}{1-\theta\sigma} + \frac{1}{w}\frac{\theta\sigma}{1-\theta\sigma}\right]\Big((1-p_x)\mathbb{E}[\tilde{\pi}^d(b^d)] + p_x\mathbb{E}[\tilde{\pi}^x(b^x)]\Big) = (1-p_x)\mathbb{E}[l^d + \frac{b^d}{\eta}] + p_x\mathbb{E}[l^x + \frac{b^x}{\eta}]. \tag{A.15}$$

Combining the free entry and the labor market clearing conditions (Equations (A.9) and (A.15)), I can obtain the following expression for firm mass:

$$M = \frac{1-\theta\sigma}{\sigma}\frac{L}{(f + p_x f_x + \frac{f_e}{p_e})}. \tag{A.16}$$

Substituting Equations (A.16) and (A.15) into Equation (A.14), I can derive the following expression:

$$M\Big((1-p_x)\mathbb{E}[\tilde{\pi}^d(b^d)] + p_x\mathbb{E}[\tilde{\pi}^x(b^x)]\Big) = \frac{\sigma-1+\theta\sigma}{\sigma}L.$$

This can be rewritten as

$$\begin{aligned}
&\frac{\sigma-1}{w} w^{-\frac{\theta\sigma}{1-\theta\sigma}} (\theta\sigma)^{\frac{\theta\sigma}{1-\theta\sigma}} \left(\frac{1}{\sigma}\mu\right)^{\frac{1}{1-\theta\sigma}} \\
&\qquad \times \left[\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty) + \tau_x^{1-\sigma}(1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty)\right] \\
&\qquad\qquad \times M_e P^{\frac{\sigma}{1-\theta\sigma}} Q^{\frac{1}{1-\theta\sigma}} = \frac{\sigma-1+\theta\sigma}{\sigma}L
\end{aligned} \tag{A.17}$$

Define S and S_d as follows:

$$S = \frac{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty)}{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty) + \tau_x^{1-\sigma}(1+\tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}}\tilde{S}(\hat{\phi}^x, \infty)}$$

and

$$S_d = \frac{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x)}{\tilde{S}(\hat{\phi}^e, \hat{\phi}^x) + (1 + \tau_x^{1-\sigma})^{\frac{\theta\sigma}{1-\theta\sigma}} \tilde{S}(\hat{\phi}^x, \infty)}.$$

Also, let $S_d^a = \lim_{\tau_x \to \infty} \tilde{S}_d$. Then, Equation (A.17) can be rewritten as follows:

$$\frac{1}{S} \frac{S_d^a}{S_d} \tilde{S}(\hat{\phi}^e, \infty) M_e P^{\frac{\sigma}{1-\theta\sigma}} Q^{\frac{1}{1-\theta\sigma}} = cons, \tag{A.18}$$

where the right-hand side is a collection of parameters, L, and w that are invariant to iceberg costs. Equation (A.18) is the second key equation for the proof.

I totally differentiate Equations (A.8) and (A.18). Totally differentiating Equation (A.8) related to the price index, I can obtain the following expression:

$$(1-\sigma) d \ln P = \frac{\sigma\theta(\sigma-1)}{1-\theta\sigma} d \ln P + \frac{\theta(\sigma-1)}{1-\theta\sigma} d \ln Q + d \ln M_e - d \ln \lambda + d \ln \frac{\lambda_d^a}{\lambda_d} - \frac{1}{1-\theta\sigma} \gamma_\lambda(\hat{\phi}^e) d \ln \hat{\phi}^e. \tag{A.19}$$

Similarly, totally differentiating Equation (A.18) related to the labor market clearing and the free entry conditions, I can obtain the following expression:

$$d \ln M_e + \frac{\sigma}{1-\theta\sigma} d \ln P + \frac{1}{1-\theta\sigma} d \ln Q - d \ln S + d \ln \frac{S_d^a}{S_d} - \frac{1}{1-\theta\sigma} \gamma_s(\hat{\phi}^e) d \ln \hat{\phi}^e = 0. \tag{A.20}$$

Totally differentiating the entry cutoff,

$$d \ln \hat{\phi}^e = -d \ln P - \frac{1}{\sigma - 1} d \ln PQ. \tag{A.21}$$

Combining Equations (A.19) and (A.21), I can derive that

$$-d \ln P = \frac{1}{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)} \left\{ -d \ln \lambda + d \ln M_e + d \ln \frac{\lambda_d^a}{\lambda_d} \right\} + \frac{\frac{\gamma_\lambda(\hat{\phi}^e)}{\sigma-1} + \theta(\sigma-1)}{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)} d \ln PQ. \tag{A.22}$$

Substituting the above equation into $d \ln Q = -d \ln P + d \ln PQ$, because changes in welfare are equivalent to changes in the aggregate quantities produced, $d \ln W = d \ln Q$, I can obtain that

$$\begin{aligned} d \ln W = & \frac{1}{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)} \left\{ -d \ln \lambda + d \ln M_e + d \ln \frac{\lambda_d^a}{\lambda_d} \right\} \\ & + \left(\frac{\frac{\gamma_\lambda(\hat{\phi}^e)}{\sigma-1} + \theta(\sigma-1)}{\gamma_\lambda(\hat{\phi}^e) + (\sigma-1)(1-\theta)} + 1 \right) d \ln PQ. \end{aligned} \tag{A.23}$$

Combining Equations (A.20) and (A.21),

$$-d\ln P = \frac{1}{\sigma-1} d\ln PQ + \frac{1-\theta\sigma}{\gamma_s(\hat{\phi}^e)+\sigma-1}\left\{-d\ln S + d\ln\frac{S_d^a}{S_d} + d\ln M_e\right\}.$$

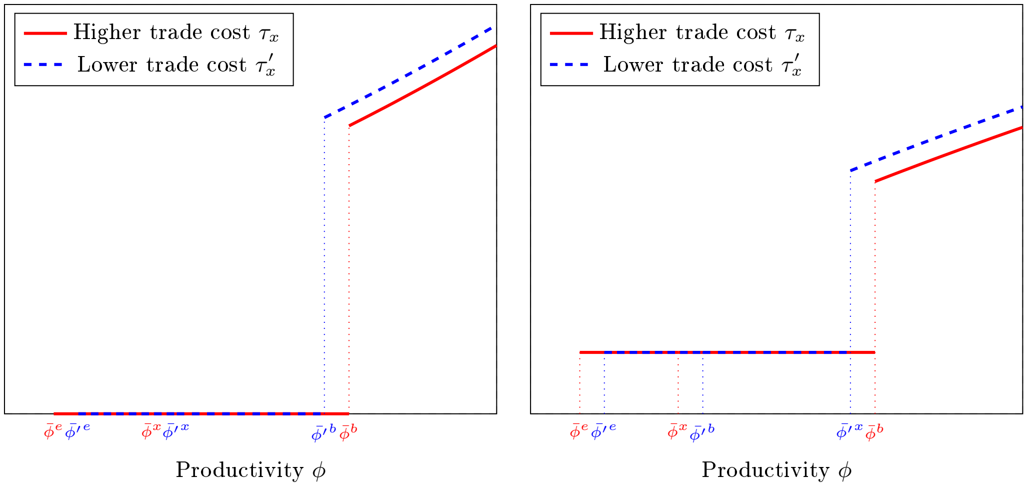
Substituting Equation (A.22) into the above equation, I can obtain that

$$\begin{aligned} d\ln PQ = {} & \frac{1}{1-\theta\sigma}\left\{-d\ln\lambda + d\ln\frac{\lambda_d^a}{\lambda_d} + d\ln M_e\right\} \\ & - \frac{\gamma_\lambda + (\sigma-1)(1-\theta)}{\gamma_s+\sigma-1}\left\{-d\ln S + d\ln\frac{S_d^a}{S_d} + d\ln M_e\right\}. \end{aligned}$$

Rearranging the equation,

$$\begin{aligned} d\ln PQ = {} & \left(\frac{1}{1-\theta\sigma} - \frac{\gamma_\lambda(\hat{\phi}^e)+(\sigma-1)(1-\theta)}{\gamma_s(\hat{\phi}^e)+\sigma-1}\right)\left\{-d\ln\lambda + d\ln\frac{\lambda_d^a}{\lambda_d} + d\ln M_e\right\} \\ & \left(\frac{\gamma_\lambda(\hat{\phi}^e)+(\sigma-1)(1-\theta)}{\gamma_s(\hat{\phi}^e)+\sigma-1}\right)\left\{-d\ln\lambda + d\ln\frac{\lambda_d^a}{\lambda_d} + d\ln S - d\ln\frac{S_d^a}{S_d}\right\}. \end{aligned}$$

□



A. Lobbying expenditures, $w \times \kappa \frac{b}{\eta}$ B. Output distortions, $\tau \times \max\{\bar{\tau}, b^{\theta}\}$

Figure A1. When $\bar{\phi}^x(\tau,\eta) < \bar{\phi}^b(\tau,\eta)$, lower trade costs induce a subset of exporters to increase their lobbying more

Notes. This figure illustrates changes in firm lobbying and output distortions depending on their productivity level and changes in the entry, export, and lobbying cutoffs when trade costs become lower. This figure considers a special case in which the lobbying cutoff is higher than the export cutoff. Holding τ and η constant, Panels A and B plot firm lobbying expenditures and output distortions depending on their productivity ϕ. The x-axes are productivity ϕ.

Appendix B Quantification

B.1 Estimation of the Elasticity of Output Distortions to Lobbying

B.1.1 Derivation of the Bias

I derive the bias of the OLS estimates in Equation (3.3). I consider a simplified closed economy setup in which every firm is lobbying and operating. This setup can be achieved by letting $\tau_x \to \infty$, $\bar{\tau} = 0$, $f = 0$, and $f_b = 0$. These conditions are imposed to ensure that selection into production, exporting, and lobbying does not affect the bias. Because of the condition $\bar{\tau} = 0$, firms make positive profits only after lobbying, and because of the condition $f_b = 0$, every firm participating in lobbying, which ensures that there is no selection in lobbying conditional on production. Also, the condition $f = 0$ makes every firm participate in production once they pay the entry costs, which implies that there is no selection into production. Because of the closed economy condition, there is no selection into exporting conditional on production.

In this setup, firms' optimal lobbying inputs are expressed as

$$b_{it} \propto \eta_{it}^{\frac{1}{1-\theta\sigma}} \phi_{it}^{\frac{\sigma-1}{1-\theta\sigma}} \tau_{it}^{\frac{\sigma}{1-\theta\sigma}}.$$

Because $Lobby_{it} = b_{it}/\eta_{it}$,

$$Lobby_{it} \propto \eta_{it}^{\frac{\theta\sigma}{1-\theta\sigma}} \phi_{it}^{\frac{\sigma-1}{1-\theta\sigma}} \tau_{it}^{\frac{\sigma}{1-\theta\sigma}}.$$

Using the above equation, $\mathrm{Cov}(\ln Lobby_{it}, \ln \tau_{it} + \theta \ln \eta_{it})$ can be expressed as

$$\mathrm{Cov}(\ln Lobby_{it}, \ln \tau_{it} + \theta \ln \eta_{it}) = \mathrm{Cov}(\frac{\theta\sigma}{1-\theta\sigma} \ln \eta_{it} + \frac{\sigma-1}{1-\theta\sigma} \ln \phi_{it} + \frac{\sigma}{1-\theta\sigma} \ln \tau_{it}, \ln \tau_{it} + \theta \ln \eta_{it})$$

which can be rearranged to

$$\begin{aligned}\mathrm{Cov}(\ln Lobby_{it}, \ln \tau_{it} + \theta \ln \eta_{it}) = {} & \frac{\theta^2\sigma}{1-\theta\sigma}\mathrm{Var}(\ln \eta_{it}) + \frac{\sigma}{1-\theta\sigma}\mathrm{Var}(\ln \tau_{it}) \\ & + \frac{2\theta\sigma}{1-\theta\sigma}\mathrm{Cov}(\ln \tau_{it}, \ln \eta_{it}) + \frac{\sigma-1}{1-\theta\sigma}\mathrm{Cov}(\ln \phi_{it}, \ln \tau_{it}) + \frac{\theta(\sigma-1)}{1-\theta\sigma}\mathrm{Cov}(\ln \phi_{it}, \ln \eta_{it}).\end{aligned}$$

$\mathrm{Var}(\ln Lobby_{it})$ can be expressed as

$$\begin{aligned}\mathrm{Var}(\ln Lobby_{it}) = {} & \left(\frac{\theta\sigma}{1-\theta\sigma}\right)^2 \mathrm{Var}(\ln \eta_{it}) + \left(\frac{\sigma}{1-\theta\sigma}\right)^2 \mathrm{Var}(\ln \tau_{it}) + \left(\frac{\sigma-1}{1-\theta\sigma}\right)^2 \mathrm{Var}(\ln \phi_{it}) \\ & + \frac{2\sigma(\sigma-1)}{(1-\theta\sigma)^2}\mathrm{Cov}(\ln \phi_{it}, \ln \tau_{it}) + \frac{2\theta\sigma(\sigma-1)}{(1-\theta\sigma)^2}\mathrm{Cov}(\ln \phi_{it}, \ln \eta_{it}) + \frac{2\theta\sigma^2}{(1-\theta\sigma)^2}\mathrm{Cov}(\ln \eta_{it}, \ln \tau_{it})\end{aligned}$$

Similarly, the bias of the sales regression model in Equation (3.2) can be expressed as follows:

$$\mathcal{B}^s(\boldsymbol{\psi}_{it}) = \frac{1}{\mathrm{Var}(\ln \mathit{Lobby}_{it})} \times \mathrm{Cov}\left(\frac{\sigma-1}{1-\theta\sigma}\ln\phi_{it} + \frac{\sigma}{1-\theta\sigma}\ln\tau_{it} + \frac{\theta\sigma}{1-\theta\sigma}\ln\eta_{it}, (\sigma-1)\ln\phi_{it} + \sigma\ln\tau_{it} + \theta\sigma\ln\eta_{it}\right),$$

where

$$\begin{aligned}
&\mathrm{Cov}\left(\frac{\sigma-1}{1-\theta\sigma}\ln\phi_{it} + \frac{\sigma}{1-\theta\sigma}\ln\tau_{it} + \frac{\theta\sigma}{1-\theta\sigma}\ln\eta_{it}, (\sigma-1)\ln\phi_{it} + \sigma\ln\tau_{it} + \theta\sigma\ln\eta_{it}\right)\\
&\quad = \frac{(\sigma-1)^2}{1-\theta\sigma}\mathrm{Var}(\ln\phi_{it}) + \frac{\sigma^2}{1-\theta\sigma}\mathrm{Var}(\ln\tau_{it}) + \frac{(\theta\sigma)^2}{1-\theta\sigma}\mathrm{Var}(\ln\eta_{it})\\
&\quad + \frac{2\sigma(\sigma-1)}{1-\theta\sigma}\mathrm{Cov}(\ln\phi_{it},\ln\tau_{it}) + \frac{2\theta\sigma(\sigma-1)}{1-\theta\sigma}\mathrm{Cov}(\ln\phi_{it},\ln\eta_{it}) + \frac{2\theta\sigma^2}{1-\theta\sigma}\mathrm{Cov}(\ln\tau_{it},\ln\eta_{it}).
\end{aligned}$$

B.1.2 Event Study

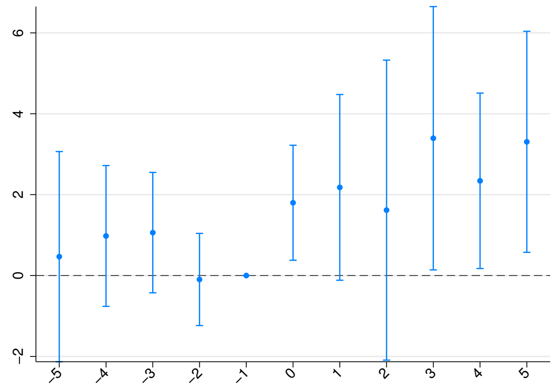
Suppose the chairperson IV satisfies the relevance condition, so the IV is significantly correlated with the lobbying expenditures in the first stage. A natural concern is that the first-stage results may reflect spurious correlations rather than causality. Although the exclusion restriction is fundamentally untestable, an event study can detect spurious correlations caused by reverse causality problems or preexisting confounding factors by checking pre-trends. For example, a reverse causality problem can arise if a firm lobbies to make a local Congress member be appointed as the chairperson.

I conduct an event study to examine whether there are preexisting trends in lobbying expenditures before a local Congress member's appointment as the chairperson of the House or Senate Appropriations Committee. If there were reverse causality problems or preexisting confounding factors, it would violate the parallel trend assumption. The reverse causality problem can be detected if an increase in lobbying expenditures leads to the appointment. Also, if there were preexisting confounding factors, they may show up as differential pre-trends.

I estimate the following event study regression:

$$100 \times \mathbb{1}[\mathit{Lobby}_{it} > 0] = \sum_{\tau=-5}^{5} \beta_\tau \mathrm{Chair}_{i\tau} + \mathbf{X}'_{it_0}\boldsymbol{\gamma} + \delta_i + \delta_{jt} + \epsilon_{it}. \tag{B.1}$$

The dependent variables is a dummy of positive lobbying multiplied by 100. $\mathrm{Chair}_{i,t-\tau}$ are the event study variables that are defined as $\mathrm{Chair}_{i,\tau} = \mathbb{1}[t = t_i^{\mathrm{Chair}} - \tau]$ where t_i^{Chair} is the year when a local Congress member of the state in which firm i is headquartered is appointed as the chairperson. $\mathrm{Chair}_{i,-1}$ is normalized to be zero, so β_τ is interpreted as the changes of lobbying expenditures relative to the one year before the appointment. The samples include both treated and non-treated firms. Firm fixed effects δ_i and sector-time fixed effects δ_{jt} are controlled to absorb time-invariant unobservables and sectoral shocks. $\mathbf{X}_{it}$ are observables that include interaction between the initial lobbying status and year fixed effects. Standard errors are clustered at the state-level.



Dep. $100 \times \mathbb{1}[Lobby_{it} > 0]$

Figure B1. Event Study. Lobbying and Appointment as the Chairperson of the House or Senate Appropriations Committee

Notes. This figure illustrates event study coefficients β_τ in Equation (B.1). The dependent variable is a dummy of positive lobbying. The coefficient in $t-1$ is normalized to be zero. The specification includes firm fixed effects, sector-year fixed effects, and the initial lobbying status interacted with year fixed effects. Standard errors are clustered at the state level. The vertical lines show the 90% confidence intervals.

Figure B1 illustrates estimated coefficients β_τ in Equation (B.1). Before the appointment, there are no pre-trends in lobbying expenditures, but once a local Congress member becomes the chairperson, firms start increasing their lobbying expenditures. The evidence of no pre-trends in lobbying expenditures indicates that the first-stage correlation is not driven by reverse causality problems or preexisting omitted confounding factors, which bolsters the support of the identifying assumption of the IV. After the appointment, the probability of lobbying increases by around 2% relative to one year before the appointment.

Table B1: Robustness. Estimation Results of θ

Robustness	ETR		MRPK		Alternative Functional Form							
Dep.	$\ln 1-\text{ETR}_{i,t+1}$		$\ln \frac{w_{nj,t+1}L_{i,t+1}}{K_{i,t+1}}$		$\ln 1/\text{TFPR}_{it}$		$\ln \text{Sale}_{it}$		$\ln 1/\text{TFPR}_{it}$		$\ln \text{Sale}_{it}$	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta \ln Lobby_{it}$	-0.003	0.059^{**}	0.002	-0.065								
	(0.003)	(0.028)	(0.003)	(0.054)								
$\Delta \mathbb{1}[Lobby_{it}>0]$					-0.025	1.052^{***}	0.528^{***}	3.651^{***}				
					(0.060)	(0.370)	(0.147)	(0.723)				
$\Delta\text{asinh}(Lobby_{it})$									-0.002	0.082^{***}	0.048^{***}	0.286^{***}
									(0.005)	(0.030)	(0.012)	(0.055)
KP-F		12.46		12.46		14.86		14.86		12.59		12.59
AR		7.37		1.04		13.21		14.17		13.21		14.17
AR p-val		<0.01		0.30		<0.01		<0.01		<0.01		<0.01
N	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206	1206

Notes. Standard errors are clustered at the state level. * p<0.1; ** p<0.05; *** p<0.01. This table reports the OLS and IV estimates of Equations (3.1) and (3.2). The dependent variables are the cash effective tax rates in columns 1–2, log wage bill divided by capital in columns 3–4, log inverse of TFPR in columns 5–6 and 9–10, and sales in columns 7–8 and 11–12, respectively. All specifications include corporate income tax, job creation tax credit, investment tax credit, R&D tax credit, property tax abatement, and transfers from the federal government, changes in state-industry wages, the initial lobbying status, and SIC 4-digit fixed effects. KP-F is the Kleibergen-Paap F-statistics. AR and AR p-val are the Anderson-Rubin test statistics and its p-value.

B.2 Identifying Moments

This section describes how the identifying moment in the data can be mapped to the counterparts of the model. In the calibration procedure, the internally calibrated parameters are all jointly determined, but I describe the identifying moment that is most relevant for each parameter.

- Mean productivity of the US relative to that of Foreign, $\mu_\phi^{\mathrm{US}}/\mu_\phi^F$
  - I normalize the mean productivity of Foreign to be one $\mu_\phi^F = 1$. I define the real GDP as:

$$\text{Real GDP} = \frac{M\Big(\int_{\phi\geq\bar{\phi}^e(\tau,\eta)} r(\boldsymbol{\psi})d\hat{G}(\boldsymbol{\psi}) + \int_{\phi\geq\bar{\phi}^x(\tau,\eta)} r_x(\boldsymbol{\psi})d\hat{G}(\boldsymbol{\psi})\Big)}{M\Big(\int_{\phi\geq\bar{\phi}^e(\tau,\eta)} p(\boldsymbol{\psi})^{1-\sigma}d\hat{G}(\boldsymbol{\psi})\Big)^{\frac{1}{1-\sigma}}},$$

    where r and r_x are domestic and export revenues, and the denominator is the defined PPI. Holding other parameters constant, the mean productivity of the US increases the US real GDP; therefore, this moment can pin down μ_ϕ^{US}.

- Standard deviation of log productivity, σ_ϕ
  - ϕ can be mapped to TFPQ in the data:

$$\phi \propto \text{TFPQ} = \frac{(\text{Value-Added})^{\frac{\sigma}{\sigma-1}}}{wL}.$$

    Therefore, the variance of the log TFPQ can pin down σ_ϕ.

- Standard deviation of log exogenous distortions, σ_τ
  - The residuals from Equation (3.1) can be mapped to $\theta\ln\eta + \ln\tau$. Therefore the variance of this residual can be mapped to

$$\theta^2\sigma_\eta^2 + \theta\rho_{\tau\eta}\sigma_\eta\sigma_\tau + \sigma_\tau^2.$$

    The above relationship shows that conditional on θ, σ_η, and $\rho_{\tau\eta}$, the variance of the residuals is informative on σ_τ.

- Standard deviation of log lobbying efficiency, σ_η
  - The log of firm lobbying expenditures in dollar terms ($B_{it} = \frac{\kappa w b}{\eta}$) is proportional to

$$B_{it} \propto \frac{1}{1-\theta\sigma}((\sigma-1)\ln\phi + \sigma\ln\tau + \theta\sigma\ln\eta).$$

Therefore, the variance of the log of firm lobbying expenditures can be mapped to

$$\frac{1}{(1-\theta\sigma)^2}\Big((\sigma-1)^2\sigma_\phi^2+\sigma^2\sigma_\tau^2+(\theta\sigma)^2\sigma_\eta^2 \\ +2(\sigma-1)\sigma\rho_{\phi\tau}\sigma_\phi\sigma_\tau+2(\sigma-1)\theta\sigma\rho_{\phi\eta}\sigma_\phi\sigma_\eta+2\sigma(\theta\sigma)\rho_{\tau\eta}\sigma_\tau\sigma_\eta\Big),$$

which is informative on σ_η conditioning on the other parameters.

- Correlation between log productivity and exogenous distortions, $\rho_{\phi\tau}$
  - The correlation between the log of TFPQ and the residuals from Equation (3.1) can be mapped to $\theta\rho_{\phi\eta}+\rho_{\phi\tau}$.
- Correlation between log productivity and lobbying efficiency, $\rho_{\phi\eta}$
  - The correlation between TFPQ and firm lobbying expenditures in dollar terms ($B_{it}=\frac{\kappa wb}{\eta}$) can be mapped to
$$\frac{\sigma-1}{1-\theta\sigma}\sigma_\phi^2+\frac{\sigma}{1-\theta\sigma}\rho_{\phi\tau}+\frac{\theta\sigma}{1-\theta\sigma}\rho_{\phi\eta}.$$
- Correlation between log exogenous distortions and lobbying efficiency, $\rho_{\tau\eta}$
  - The correlation between the residuals from Equation (3.1) and lobbying expenditures can be mapped to the numerator of the bias expressed (Equation (3.3)):
$$\frac{\theta^2\sigma}{1-\theta\sigma}\sigma_\eta^2+\frac{\sigma}{1-\theta\sigma}\sigma_\tau^2+\frac{\theta(\sigma-1)}{1-\theta\sigma}\sigma_\phi\sigma_\eta\rho_{\phi\eta}+\frac{2\theta\sigma}{1-\theta\sigma}\sigma_\tau\sigma_\eta\rho_{\tau\eta}+\frac{\sigma-1}{1-\theta\sigma}\sigma_\phi\sigma_\tau\rho_{\phi\tau}.$$
- Parameter related to the level of variable lobbying cost, κ
  - To identify this parameter, I target the fraction of the median sales of lobbying firms to the median sales of non-lobbying firms:
$$\frac{\text{Med}_{\{\boldsymbol{\psi}|\phi\geq\bar{\phi}^b(\tau,\eta)\}}\{r(b;\boldsymbol{\psi})\}}{\text{Med}_{\{\boldsymbol{\psi}|\phi<\bar{\phi}^b(\tau,\eta)\}}\{r(0;\boldsymbol{\psi})\}},$$
    where $r(b;\boldsymbol{\psi})$ and $r(0;\boldsymbol{\psi})$ are lobbying and non-lobbying firms' sales, respectively. Because κ only appears in lobbying firms' sales (Equation (2.3)), this moment can pin down κ.
- Fixed lobbying costs, f_b
  - f_b affects extensive margin of lobbying (Equations (A.3) and (A.4)). By targeting the probability of participating in lobbying, I can pin down f_b.
- Fixed export costs, f_x
  - f_x affects extensive margin of exporting (Equations (A.5) and (A.6)). By targeting the probability of participating in exporting, I can pin down f_x.

- Fixed production costs, f
  - f affects production decisions of firms. Because only small-sized firms are affected by f, the difference between the median and 10p of log sales can pin down this parameter.

- Iceberg costs, τ_x
  - The aggregate US import shares can be expressed as follows:

$$\frac{M_f\Big[\int x(\boldsymbol{\psi})\Big(\mu\frac{\tau_x w_f}{\phi}\Big)^{1-\sigma}\tau^{\sigma}\hat{G}_f(\boldsymbol{\psi})\Big]P^{\sigma-1}E}{E},$$

  where subscript f denotes Foreign (China). Holding other variables constant, higher τ_x decreases the US import shares. Therefore, the US import shares pin down τ_x.

B.3 Algorithm

Solving for Equilibrium I normalize the wage of Home to 100. For given parameters, the solution of the model is characterized by the five unknowns $\{P, E, w^f, P^f, E^f\}$ that satisfies the following five nonlinear equations: the price indices for both Home and Foreign

$$P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} + \int_{\omega\in\Omega^x} p^x(\omega)^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

the goods market clearing conditions for both Home and Foreign

$$E = wL + T,$$

and the balanced trade condition

$$M\left[\int p^x(\boldsymbol{\psi})q^x(\boldsymbol{\psi})d\hat{G}(\boldsymbol{\psi})\right] = M_f\left[\int p^x(\boldsymbol{\psi})q^x(\boldsymbol{\psi})d\hat{G}_f(\boldsymbol{\psi})\right].$$

Method of Moments The objective function

$$\hat{\boldsymbol{\Theta}} = \arg\min_{\boldsymbol{\Theta}}\{(\mathbf{m} - \mathbf{m}(\boldsymbol{\Theta}))'\mathbf{W}(\mathbf{m} - \mathbf{m}(\boldsymbol{\Theta}))\},$$

minimizes the normalized distances between the model moments and the data counterparts. I solve for $\hat{\boldsymbol{\Theta}}$ using the following steps:

- Step 1 Guess a set of parameters.
- Step 2 Based on the guess, solve for the equilibrium.
- Step 3 Evaluate the moments computed from the model and compare these moments to the data counterparts.

- Step 4 I first look for a range of plausible values of parameters using grid search. I repeat steps 1-3 for a given grid.
- Step 5 Once I find a range of plausible values of parameters, I find the parameter that minimizes the objective function subject to this range using the constrained nonlinear optimization algorithm.