Trade Liberalization and Firms' Corruption Engagement: Theory and Evidence from China*

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Abstract

This paper studies the role of trade liberalization in shaping domestic corruption. I develop a model of trade with heterogeneous firms that features endogenous corruption and export participation decisions. In the model, firms face a trade-off between engaging in corruption, thereby obtaining higher profits in the domestic market, or preserving their non-corrupt status in foreign markets to obtain higher export profits. In equilibrium, there is an inverted U-shaped relationship between firm productivity/size and corruption engagement. This prediction is confirmed in firm-level and aggregate data on international trade. I then calibrate the model to China and evaluate the extent to which trade policy is an effective tool for fighting domestic corruption. My findings suggest that (i) the share of firms that are "missing from trade" due to domestic corruption is 1%; (ii) conditional on the same reduction in the level of domestic corruption, trade liberalization is preferable to direct anti-corruption campaigns in terms of the associated gains in consumer welfare.

Keywords: Firm Heterogeneity, Domestic Corruption, Destination Corruption Aversion, Trade Liberalization

JEL Codes: F0, F1, F5, F6

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1 Introduction

Domestic corruption is prevalent in most developing and transition economies,[1] which constitutes a major impediment to economic development. For instance, corruption has been detrimental to economic development mainly through reducing international trade flows, distorting both the level and efficiency of investment, and lowering long-term economic growth potential.[2] Consequently, countries, especially those with emerging economies, are in need of solutions to domestic corruption. Conventional wisdom on the exact mechanisms behind domestic corruption, however, does not provide feasible tools for policymakers. Neither rigid institutional factors such as bureaucratic wages and the degree of press freedom, nor predetermined historical factors such as religious traditions and colonial heritages, make it easier for policymakers to devise immediate tools towards fighting domestic corruption.

Arguably, policymakers may address domestic corruption through conducting anti-corruption campaigns. Nevertheless, anti-corruption campaigns are hard to enact in reality due to institutional rigidity and the existence of large group of vested interest. In this paper, I come up with a convenient tool for policymakers to address domestic corruption. Specifically, I argue that trade liberalization plays a large role in shaping domestic corruption; I also propose a novel mechanism through which trade policies affect corruption.[3]

To shed light on the mechanism, I develop a model of trade with heterogeneous firms that features endogenous corruption and export participation decisions. My theory builds on a canonical model of trade *à* la Melitz (2003) with additional elements related to the cost and benefit sides of firms' engagement in domestic corruption. In my model, firms decide whether to engage in domestic corruption and/or whether to export by comparing the associated costs and benefits. The model produces the trade-off faced by firms between engaging in corruption, thereby obtaining higher profits in the domestic market, or preserving their non-corrupt status in foreign markets to obtain higher export profits. The model also shows how trade liberalization induces corrupt firms on the margin to stop engaging in domestic corruption and start to export instead. I argue that my findings broadly provide a novel channel of gains from trade liberalization through curbing

[1]See World Bank (2012) Enterprise Surveys on firm corruption. In particular, the Enterprise Survey for China documents that 42.2 percent of firms were expected to give gifts to secure government contracts. The number is much larger than the world average at 22.2%.

[2]For example, see Shleifer and Vishny, 1993; Mauro, 1995, 1998; Rose-Ackerman, 1997; Anderson and Marcouiller, 2002; Javorcik and Wei, 2009.

[3]Dutt (2009) shows that less restrictive trade policies reduce domestic corruption. Nevertheless, Dutt (2009) finds only a moderate effect and remains silent on the exact mechanism through which trade policies affect corruption.

domestic corruption; such a channel is missing in the previous canonical models of trade. This result also offers potentially important policy implications, especially for developing countries with prevalent domestic corruption.

My model suggests an inverted U-shaped relationship between firm productivity and corruption engagement. To empirically examine this testable prediction, I estimate firm productivity using data on firm-level production. I then identify corrupt firms by conforming the distribution of a proxy for firms' corruption expenses, i.e., the entertainment and traveling costs in firms' accounting books, to the share of corrupt firms; this proxy is suggested by Cai *et al.* (2011). Next, I explore the possible relationships between firm corruption engagement and productivity both parametrically and non-parametrically. Results show that the inverted U-shaped relationship exists and is robust to various empirical specifications.

I then calibrate the model using data from 43 countries and structurally estimate the model's parameters. The calibrated model suggests that destination countries with less domestically perceived corruption are relatively more corruption-averse towards goods from corrupt firms. Together with the inverted U-shaped relationship, these insights imply that a reduction in trade cost would increase the share of exporters and decrease the share of corrupt firms.

I use the calibrated model to conduct six policy-relevant counterfactual experiments, which are associated either with trade liberalization or with domestic anti-corruption campaigns. Under each of these policy scenarios, I explicitly demonstrate the changes in the share of corrupt firms, the share of exporters, and consumer welfare.

Experiments 1, 2 and 3 are designed to address the question of which policy tool is the most preferable for achieving the same level of domestic corruption reduction. To provide an answer, I leverage three policy tools, such as the fixed costs of corruption, iceberg trade costs and import tariffs, to the extent that each would reduce the share of corrupt firms by 10%. I subsequently examine the policy tools' welfare implications. My findings suggest that conditional on the same reduction in the level of domestic corruption, trade liberalization is preferable to direct anti-corruption campaigns in terms of the associated gains in consumer welfare.

A comparison between Experiments 4 and 5 reveals a novel channel of welfare gains from trade liberalization. To shed light on the channel, I leverage an identical reduction in iceberg trade costs in Experiments 4 and 5 and contrast the difference in welfare gains. The only distinction between Experiment 4 and Experiment 5 is that trade liberalization dampens domestic corruption in Experiment 4, while the mechanism is shut down in Experiment 5. My findings show that an identical reduction in iceberg trade costs yields higher welfare gains in Experiment 4 than those in Experiment 5. I argue that my findings provide a novel channel of gains from trade liberalization through curbing domestic corruption.

In addition, a comparison between Experiments 4 and 6 is helpful for understanding the difference in effectiveness between two trade liberalization-related policies in terms of curbing domestic corruption and increasing consumer welfare. To show the difference in effectiveness, I leverage an identical reduction in iceberg trade costs and import tariffs in Experiments 4 and 6 respectively and compare the changes in the share of corrupt firms and consumer welfare. My findings show that (i) tariff reduction reduces the share of corrupt firms by a larger extent than the same percentage decrease in iceberg trade costs; (ii) tariff reduction brings out greater gains in consumer welfare than the same percentage decrease in iceberg trade costs, even though tariff reduction is associated with an implementation cost, that is, the loss of tariff revenue. The greater impacts of tariff reduction on curbing domestic corruption and increasing consumer welfare are due to the fact that the elasticity of firms' export profits with respect to tariffs is larger than the elasticity of firms' export profits with respect to iceberg trade costs.

Last but not the least, domestic corruption has a trade-dampening effect, which constitutes a potential explanation of "Missing Trade". To quantify the share of firms that "miss from trade", I calibrate my model and the Melitz model to the benchmark data and compare the resulting share of exporters. I find that the share of exporters from my model is one percentage point less than that from the Melitz model. I then leverage trade liberalization as the tool to mitigate the issue of "Missing Trade". As it turns out, when iceberg trade costs are reduced by 18% relative to the benchmark, the issue of "Missing Trade" is eliminated.

In the next section, I discuss the contribution of this work relative to the existing literature. In Section 3, I present the model and illustrate the firm-level trade-off between engaging in corruption and preserving their non-corrupt status in foreign markets. In Section 4, I derive the inverted U-shaped relationship between firm productivity and corruption engagement. In Section 5, I describe my measurement of key variables, lay out econometric specifications, and provide theory-consistent evidence of the inverted U-shaped relationship. In Section 6, I describe the calibration procedure for model primitives, estimate the corruption-aversion parameters, and perform validity checks on the estimated corruption-aversion parameters with outside data sources. In Section 7, I conduct policy-relevant counterfactual experiments and provide welfare implications. Section 8 compares and discusses outcomes among the different counterfactual experiments. Section 9 concludes.

2 Related Literature

Recently, theoretical foundations on the association between international trade and other economic outcomes have emerged. For example, there have been discussions on trade and product quality (Hummels and Klenow, 2005; Hallak, 2006; Verhoogen, 2008; Khandelwal, 2010; Fan *et al.*, 2015, 2018), trade and misallocation (Khandelwal *et al.*, 2013; Lu and Yu, 2015; Hsu *et al.*, 2020), trade and financial development (Amiti and Weinstein, 2011; Chor and Manova, 2012; Chaney, 2016; Egger and Keuschnigg, 2017), and others. Nevertheless, much of the theoretical work of international trade remains silent on the relationship between engaging in trade and engaging in domestic corruption. This paper is one attempt to address the need of a theory that embeds a linkage between corruption and trade. Specifically, I contribute to the literature of the theoretical work of international trade by proposing a novel firm-level trade-off between engaging in corruption, thereby obtaining higher profits in the domestic market, or preserving their non-corrupt status in foreign markets to obtain higher export profits into a canonical model of trade with heterogeneous firms. The model is able to generate the corruption-dampening effect of trade liberalization.

Second, this paper is related to the bountiful empirical evidence that international trade does have an impact on domestic corruption (Brunetti and Weder, 1998; Fisman and Wei, 2004; Mishra *et al.*, 2008; Yang, 2008a, 2008b; Sequeira, 2016). In particular, Dutt (2009) examines whether protectionist trade policies lead to increased bureaucratic corruption. He finds strong evidence that corruption is significantly higher in countries with protectionist trade policies and argues that trade reforms may lead to improvements in governance. Yet, these reduced-form studies do not provide a clear mechanism through which trade exerts an impact on domestic corruption. I contribute to this strand of literature by developing a novel theory that highlights the mechanism explicitly. Testable predictions from the theory are in line with data evidence.

Third, there is a growing body of work that aims to obtain a cure for domestic corruption through thoroughly understanding its causes. To begin with, there is a strand of literature relating the prevalence of domestic corruption to various aspects of institutions (Ades and Di Tella, 1996; Brunetti and Weder, 1998, 2003; Evans and Rauch, 2000; Serra, 2006). Meanwhile, another strand of literature brings up the association between historical traditions and corruption. In particular, religious traditions and colonial heritages appear to be significant determinants of present corruption (La Porta *et al.*, 1997, 1999; Treisman, 2000; Swamy *et al.*, 2001; Serra, 2006). Lastly, the degree of economic development also exerts an influence on domestic corruption (Treisman, 2000). Though these findings on the causes of corruption are illuminating, they provide little comfort to policy makers due to the predetermined nature of historical traditions, time-to-build nature of the degree of economic development, and the rigidity of institutions. In contrast, this paper argues that trade liberalization is a handy instrument out of the tool kit of the policy makers to fight against domestic corruption. In the counterfactual experiments, it turns out that trade liberalization is almost as effective as a direct anti-corruption campaign in terms of reducing domestic corruption. In addition, trade liberalization brings out larger gains in consumer welfare than a direct domestic anti-corruption campaign.

Fourth, previous literature has numerous findings; some may even disagree with others, on the effect of corruption on economic development. On one hand, there is mounting evidence that corruption impedes economic development (Rose-Ackerman, 1978, 1997; Murphy *et al.*, 1991; Shleifer and Vishny, 1993; Hines, 1995; Mauro, 1995, 1997, 1998; Keefer and Knack, 1995; Tanzi and Davoodi, 1997; Kaufmann and Wei, 1999; Lambsdorff, 1999, 2003; Wei, 2000; Anderson and Marcouiller, 2002; François and Manchin, 2007; Dutt and Traca, 2010). On the other hand, economic development may benefit from domestic corruption (Leff, 1964; Huntington, 1968; Lui, 1985). In a recent study, Bai *et al.* (2020) points out that China's extraordinary economic growth partly comes from "special deals" made by local governments for favored private firms. I supplement existing findings by highlighting a novel channel through which corruption dampens trade, and thus impeding trade-induced efficiency gains from intra-industrial reallocation of resources when trade liberalizes.

Fifth, this paper is related to the literature on corruption and firms. On the one hand, studies have identified corrupt behaviors of firms either through auditing or experimental approaches (Fisman and Wei, 2004; Olken, 2006, 2007; Bertrand *et al.*, 2007; Cai *et al.*, 2011; Fisman and Wang, 2014; Fang *et al.*, 2019) or through indirect evidence from economic models (Duggan and Levitt, 2002; Di Tella and Schargrodsky, 2003; Khwaja and Mian, 2005; Hsieh and Moretti, 2006). In this paper, I follow Cai *et al.* (2011) and use the entertainment, travel and conference expenditures (ETC), a proxy for firm's investment in building "connections" with government officials, as a measure of corruption. On the other hand, the literature has documented various impacts of corruption on firms (Fisman and Svensson, 2007; Li *et al.*, 2008), with some studies mainly leveraging the quasi-experimental variation in policies following the anti-corruption investigation in China (Qian and Wen, 2015; Lin *et al.*, 2016; Ding *et al.*, 2020; Berkowitz *et al.*, 2021; Li *et al.*, 2022). In particular, Fang *et al.* (2020) summarizes four potential channels through which corruption exerts an impact on firms: the "grabbing hand" effect, the "grease of the wheel" effect, the demand effect, and the endogenous grits effect. In supplements to the aforementioned channels, I contribute to the literature by providing firm-level evidence that engaging in domestic corruption has a dampening effect on firms' exporting, and that exporters' corruption decisions are affected by the corruption-aversion parameter in each destination country.

Finally, this paper is related to two empirical studies on the trade-dampening effect of corruption, Parayno (1999) and Dutt and Traca (2010). Parayno (1999) conducts a country-specific case study using data from the Philippines, and finds evidence that businesses have to pay small amounts of bribes to clear customs. This type of extortion behavior (see Bardhan, 2006), where firms are requested to make bribes to facilitate even fully legitimate transactions, dampens bilateral trade. Dutt and Traca (2010) estimate a corruption-augmented gravity model using bilateral trade data at both the sectoral and aggregate (country) levels. Empirically, they find that corruption works as a deterrent to trade through importing country extorting bribes from exporting firms. In contrast to these two studies that emphasize the trade-dampening effect of corruption through extorting bribes from exporting firms, I propose a novel mechanism through which corruption impedes trade due to the destination country's aversion towards goods from corrupt exporters. I further provide a more structural approach via a general equilibrium model that incorporates heterogeneous firms, fixed costs of corruption, differential tax rates on domestic revenue, and a corruption-aversion parameter in each destination country that can be applied to multiple counterfactual scenarios. To the best of my knowledge, this is the first structural attempt to assess the trade-dampening effect of domestic corruption.

3 Model

This section establishes a theoretical framework that augments a canonical model of trade with heterogeneous firms by incorporating additional building blocks of fixed costs of corruption, differential tax rates on domestic revenue, and corruption-aversion parameters in destination countries. The framework lays out an environment to investigate the interplay between firms' engagement in domestic corruption and exporting to foreign destinations.

Suppose there are two countries in the world with a single sector of production. Each country i is endowed with L_i units of labor, which are inelastically supplied to a measure of heterogeneous firms.[4] Goods can be traded subject to iceberg trade costs and import

[4] I follow Alvarez and Lucas (2007) and assume that labor reflects equipped labor. In the quantitative analysis, I calibrate the labor endowments to the data.

tariffs from i to j, $\tau_{ij} \geq 1$ and $\kappa_{ij} \geq 1$, respectively.[5] Therefore, total variable trade costs satisfy $\zeta_{ij} = \tau_{ij}\kappa_{ij}$.

I introduce three additional building blocks associated with firms' engagement in domestic corruption into a canonical model of trade with heterogeneous firms $\grave{a}$ la Melitz (2003). On the cost side, I first assume a fixed cost of corruption, f_i^c, has to be incurred by corrupt firms in the domestic market. f_i^c can be thought of as one-shot bribery. Second, corrupt firms in origin country i are penalized by destination country j in the form of lower demand for their products. This penalty is formulated by incorporating a destination-origin specific corruption-aversion parameter, i.e., a_{ij}, in the preference of destination country j's representative consumer. On the benefit side, I assume that corrupt firms face a lower tax rate, i.e., t_i^l, on their domestic revenue while non-corrupt firms face a higher tax rate, i.e., t_i^h, on their domestic revenue. Therefore, the benefits of engaging in domestic corruption are captured by a reduction in revenue tax. This modeling choice is highly stylized in the sense that the difference in tax rates captures all benefits of firms' engaging in domestic corruption, such as profit gains from cheaper land prices, fewer red-tape barriers, and others.

The three additional building blocks together with firm productivity heterogeneity imply that there is an interplay between firms' engagement in domestic corruption and exporting to foreign destinations. An increase in firms' revenue in the foreign destination (e.g. due to trade liberalization) makes the destination country's penalty on corruption more harmful to firms' profits. Along the extensive margin, trade liberalization induces marginal corrupt firms to switch to export without corruption in the domestic market. Therefore, in the model, trade liberalization has a corruption-dampening effect.

3.1 Households

The economy is populated by representative consumers in country j who maximize utility by choosing their quantity demanded over a continuum of horizontally differentiated goods $\omega \in \Omega$, according to the following utility function:

$$U_j = \max_{\{q_{ij}(\omega)\}} \left[\sum_{i \in S} \int_{\omega \in \Omega_{ij}} a_{ij}(\omega)^{\frac{1}{\sigma}} q_{ij}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

such that $\sum_i \int_{\omega \in \Omega_{ij}} p_{ij}(\omega) q_{ij}(\omega) d\omega = I_j$, where $p_{ij}(\omega)$ is the price of good ω in destination

[5]The usual triangularity (no arbitrage) assumption applies. κ_{ij} is defined as one plus the *ad valorem* tariffs, $\tilde{\kappa_{ij}}$

country j that is shipped from origin country i, and $I_j = w_j L_j + TR_j + T_j$ is the total income of representative consumers in country j with labor endowment, L_j, tariff revenue, TR_j and government tax rebates, T_j. The parameter σ captures the elasticity of substitution across goods. Correspondingly, the elasticity of demand is a function of σ, which is specifically $\varepsilon = 1 - \sigma$.

The additional variable $a_{ij}(\omega)$ appearing in the households' preference reflects destination country j's corruption aversion to goods of corrupt firms shipped from origin country i. I assume this bilateral corruption-aversion parameter takes the form of a piecewise function:

$$a_{ij}(\omega) = \begin{cases} 0 < a_{ij} < 1, & \text{if good } \omega \text{ is exported by a corrupt firm in country } i \\ 1, & \text{o.w.} \end{cases} . \tag{2}$$

The parameter a_{ij} is restricted such that it is inside the unit interval, which reflects the destination country j's penalty on demands of goods of corrupt firms shipped from origin country i.

The utility function in (1) has one important property relative to the literature. Due to the presence of the bilateral corruption-aversion parameter, goods from corrupt firms in origin country i face lower foreign demand compared to goods from non-corrupt firms. This is precisely the link between firms' corruption engagement and export participation.

I next turn to characterizing representative consumers' demand in country i. By solving for the representative consumers' utility maximization problem, I derive country j's Marshallian demand function of good ω shipped from origin country i:

$$q_{ij}(\omega) = a_{ij}(\omega) p_{ij}(\omega)^{-\sigma} I_j P_j^{\sigma-1}, \tag{3}$$

where $P_j^{1-\sigma} = \sum_i \int_{\omega \in \Omega_{ij}} a_{ij}(\omega) p_{ij}(\omega)^{1-\sigma} d\omega$ is the aggregate C.E.S. price index.

Clearly, both I_j and P_j are endogenous outcomes in the economy. To pin down their equilibrium values, I next turn to describing the production structure of the economy.

3.2 Production

I model production in the spirit of Melitz (2003) because this allows me to explicitly pin down firms' domestic corruption engagement and firms' exporting status. Also, this heterogeneous firm trade framework, once calibrated to real data, allows me to conduct counterfactual experiments which provide clear and quantitative predictions at both the firm and aggregate levels; these predictions have straightforward interpretation relative to the benchmark data.

Each country hosts a measure of firms. A generic firm makes a draw of its productivity from a Pareto distribution such that the cumulative distribution function is as follows:

$$F_i(\varphi) = 1 - \left(\frac{b_i}{\varphi}\right)^{\theta}, \tag{4}$$

where φ denotes firm productivity, $F_i(\cdot)$ is the country-specific cumulative distribution function, b_i is the country-specific scale parameter, and θ is the dispersion parameter common to all countries. A larger θ implies a less dispersed distribution of firm productivity.

I assume the market structure is monopolistic competition. Therefore, each firm only produces a unique type of goods ω. In addition, I assume each firm employs labor as the single input in its production in the following way:

$$q_i(\omega) = (l_i(\omega) - f_{ii})\varphi, \tag{5}$$

where $l_i(\omega)$ is the total units of labor employed, f_{ii} is the units of labor used to pay the fixed costs of production in country i, and $q_i(\varphi)$ is the total production of good ω. Since each firm draws its own productivity, φ identifies a firm. Therefore, $q_i(\varphi)$ and $l_i(\varphi)$ also denotes firm production and firm labor employment, respectively.

Using φ as the firm index, I derive the firm's corresponding cost function as:

$$C_i(q_i(\varphi)) = w_i f_{ii} + \frac{w_i}{\varphi} q_i(\varphi). \tag{6}$$

Conditional on a firm's domestic corruption status, the firm decides its optimal pricing rule by maximizing its profits from serving market j:

$$\begin{aligned} &\max_{\{p_{ij}(\varphi)\}} \quad \{\frac{p_{ij}(\varphi)}{\kappa_{ij}} q_{ij}(\varphi) - \frac{w_i}{\varphi}\tau_{ij} q_{ij}(\varphi) - w_j f_{ij}\} \\ &\text{s.t.} \qquad q_{ij}(\varphi) = a_{ij}(\varphi) p_{ij}(\varphi)^{-\sigma} Y_j P_j^{\sigma-1}. \end{aligned} \tag{7}$$

From the first-order condition of profit optimization, the optimal price for each good is a constant markup over the marginal cost of production:

$$p_{ij}(\varphi) = \frac{\sigma}{\sigma - 1} \frac{w_i}{\varphi} \zeta_{ij}. \tag{8}$$

The constant markup pricing rule is an outcome when C.E.S. preference, monopolistic competition and constant marginal cost are combined. This pricing rule guarantees that higher firm productivity is fully passed on to consumers in terms of lower prices. This further implies that a firm's revenue and profits in market j, conditional on its corruption status, are as follows:

$$r_{ij}(\varphi|a_{ij}(\varphi)) = a_{ij}(\varphi)r_{ij}(\varphi); \tag{9}$$

$$\pi_{ij}(\varphi|a_{ij}(\varphi)) = \frac{r_{ij}(\varphi|a_{ij}(\varphi))}{\sigma} - w_j f_{ij}, \tag{10}$$

where $r_{ij}(\varphi) = \frac{p_{ij}(\varphi)q_{ij}(\varphi|a_{ij}(\varphi)=1)}{\kappa_{ij}}$ is the revenue of firm φ in market j if the firm does not engage in domestic corruption. It is clear that a corrupt firm obtains less revenue from market j due to market j's aversion on goods from corrupt firms.

Since demand is elastic, the lower price implies higher revenue for more productive firms. Also, the constant markup pricing rule implies that variable profits are a constant share of firm revenue.

3.3 Selection Into Domestic Corruption and Exporting

This subsection studies firms' decisions to engage in domestic corruption and/or to export based on their realization of productivity.

Suppose a generic firm pays a country-specific fixed cost of entry, f_i^e, before making a random draw of its productivity, φ, from a country-specific Pareto distribution, $F_i(\varphi)$. After realizing the level of its productivity, a surviving firm in country i, chooses to engage in domestic corruption, to export to the destination j, to do both, or to do neither, based on its comparison of payoffs from the following four cells:

Table 1: Firm's Payoffs Matrix

	Export	Not Export
Corrupt	$\pi_C^E(\varphi)$	$\pi_C^D(\varphi)$
Not Corrupt	$\pi_{NC}^E(\varphi)$	$\pi_{NC}^D(\varphi)$

Notes. Each cell documents a firm's payoffs under a specific scenario.

In Table 1, $\pi_C^E(\varphi)$ denotes profits of a corrupt exporter, which are equal to the sum of profits from domestic sales with a low revenue tax rate, t_i^l, and profits from foreign sales with lower demand due to foreign countries' corruption aversion:

$$\pi_C^E(\varphi) = \sum_{j \neq i} \left(\frac{a_{ij} r_{ij}(\varphi)}{\sigma} - w_j f_{ij} \right) + \left((1 - t_i^l) \frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} - w_i f_i^c \right), \tag{11}$$

where f_{ij} is the fixed costs of export and is paid by exporters using destination country j's labor. a_{ij} is the bilateral corruption-aversion parameter, which captures destination j's lower demand for goods from corrupt firms in country i. f_i^c is the fixed costs of corruption paid by corrupt firms in terms of origin labor.

$\pi_{NC}^E(\varphi)$ denotes profits of a non-corrupt exporter, which are equal to the sum of profits from domestic sales with a high revenue tax rate, t_i^h, and profits from foreign sales:

$$\pi_{NC}^E(\varphi) = \sum_{j \neq i} \left(\frac{r_{ij}(\varphi)}{\sigma} - w_j f_{ij} \right) + \left((1 - t_i^h) \frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} \right). \tag{12}$$

$\pi_C^D(\varphi)$ denotes profits of a corrupt firm that only sells in the domestic market, which are equal to profits from domestic sales with a low revenue tax rate, t_i^l:

$$\pi_C^D(\varphi) = (1 - t_i^l) \frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} - w_i f_i^c. \tag{13}$$

Lastly, $\pi_{NC}^D(\varphi)$ denotes profits of a non-corrupt firm that only sells in the domestic market, which are equal to profits from domestic sales with a high revenue tax rate, t_i^h:

$$\pi_{NC}^D(\varphi) = (1 - t_i^h) \frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii}. \tag{14}$$

In the following analysis, I assume that countries are identical in every aspect. I further assume the world that the economy lives in can be described by the following parametric restrictions from **R1** to **R3** (I provide evidence for these parametric restrictions in the calibration section):

R1: The fixed cost of corruption, f_i^c, is sufficiently large:

$$f_i^c > f_{ii} \frac{t_i^h - t_i^l}{1 - t_i^h},$$

R2: The bilateral corruption-aversion parameter, a_{ij}, normalized by trade cost is larger than the difference in tax rates between corrupt and non-corrupt firms:

$$(1 - a_{ij}) \tau_{ij}^{1-\sigma} \kappa_{ij}^{-\sigma} - (t_i^h - t_i^l) > 0,$$

R3: The fixed cost of export, f_{ij}, is sufficiently large compared with the fixed cost of corruption, f_i^c:

$$f_{ij} > f_i^c \frac{\tau_{ij}^{1-\sigma} \kappa_{ij}^{-\sigma}}{t_i^h - t_i^l}.$$

Under restrictions from **R1** to **R3**, I derive the following auxiliary proposition:

Proposition 1. *Conditional on exporting, firms do not engage in domestic corruption. Proof: see Appendix A.*

Proposition 1 shows that exporters do not engage in domestic corruption. Therefore, a generic firm that lives in an economy described by **R1** to **R3**, only compares payoffs among $\pi^D_{NC}(\varphi)$, $\pi^D_C(\varphi)$, and $\pi^E_{NC}(\varphi)$.

3.3.1 Entry and exit

After a generic firm's realization of productivity, the firm exits the market unless it has positive profits from selling in the origin country i:

$$\pi^D_{NC}(\varphi) = (1 - t^h_i)\frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} \geq 0. \tag{15}$$

This zero-profit condition pins down the productivity cutoff of firms that remain active in the origin country. The closed-form solution of the entry-exit cutoff is as follows:

$$\varphi^*_{ii,nc} = \left[\frac{w_i f_{ii}}{\frac{1-t^h_i}{\sigma}(w_i\frac{\sigma}{\sigma-1})^{1-\sigma} I_i P_i^{\sigma-1}}\right]^{\frac{1}{\sigma-1}}. \tag{16}$$

For a generic firm with productivity realization, φ, as $\varphi > \varphi^*_{ii,nc}$, the firm remains active in the origin country. Otherwise, the firm exits.

3.3.2 Selection into domestic corruption

An active firm in the origin country may only engage in domestic corruption when its profits from selling at home with corruption exceed those without corruption:

$$\begin{aligned}&\pi^D_C(\varphi) - \pi^D_{NC}(\varphi)\\ &= \underbrace{\left((1 - t^l_i)\frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} - w_i f^c_i\right)}_{\text{Profits of Corrupt Non-exporters}} - \underbrace{\left((1 - t^h_i)\frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii}\right)}_{\text{Profits of Non-corrupt Non-exporters}} \geq 0.\end{aligned} \tag{17}$$

The inequality above pins down the closed-form solution of the productivity cutoff of firms that engage in domestic corruption as:

$$\varphi^*_{ii,c} = \left[\frac{w_i f^c_i}{\frac{t^h_i - t^l_i}{\sigma}(w_i\frac{\sigma}{\sigma-1})^{1-\sigma} I_i P_i^{\sigma-1}}\right]^{\frac{1}{\sigma-1}}. \tag{18}$$

Among firms that only sell in the domestic market, a firm with realization of productivity, φ, as $\varphi > \varphi^*_{ii,c}$, engages in domestic corruption. Otherwise, the firm does not engage in domestic corruption as the increase in profits from domestic sales resulting from the low revenue tax rate, t_i^l, is not enough to compensate for the additional fixed cost of corruption.

I next turn to the firm selection into export.

3.3.3 Selection into exporting

An active firm with productivity, φ, starts to export to the foreign markets when its profits from being a non-corrupt exporter exceed its profits from being a corrupt non-exporter:

$$\pi_{NC}^{E}(\varphi) - \pi_{C}^{D}(\varphi) \\ = \underbrace{\sum_{j \neq i} \left(\frac{r_{ij}(\varphi)}{\sigma} - w_j f_{ij} \right) + \left((1 - t_i^h) \frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} \right)}_{\text{Profits of Non-corrupt Exporters}} - \underbrace{\left((1 - t_i^l) \frac{r_{ii}(\varphi)}{\sigma} - w_i f_{ii} - w_i f_i^c \right)}_{\text{Profits of Corrupt Non-exporters}} \geq 0. \tag{19}$$

This profit comparison pins down the closed-form solution of the productivity cutoff of firms that export to the foreign market as:

$$\varphi_{ij,nc}^{*} = \left[\frac{w_j f_{ij} - w_i f_i^c}{(w_i \frac{\sigma}{\sigma-1})^{1-\sigma} (\frac{\tau_{ij}^{1-\sigma} \kappa_{ij}^{-\sigma}}{\sigma} I_j P_j^{\sigma-1} - \frac{t_i^h - t_i^l}{\sigma} I_i P_i^{\sigma-1})} \right]^{\frac{1}{\sigma-1}}. \tag{20}$$

A generic firm with productivity, φ, as $\varphi > \varphi_{ij,nc}^{*}$, is an exporter that does not engage in domestic corruption. Otherwise, the firm does not export to any foreign destination.

3.4 International Trade

International trade occurs subject to barriers to trade, such as iceberg trade costs and import tariffs. In the origin country i, when the realization of a firm's productivity, φ, exceeds $\varphi_{ij,nc}^{*}$, the firm exports to destination country j with value of export prior to tariffs being levied as:

$$r_{ij}(\varphi) = \frac{p_{ij}(\varphi)}{\kappa_{ij}} q_{ij}(\varphi). \tag{21}$$

Total value of trade flows from i to j that is sent from i prior to tariffs being levied is calculated as the product of the number of firms exporting from i to j and the average value of export per exporter:

$$X_{ij} = N_{ij} \int_{\varphi^*_{ij,nc}} r_{ij}(\varphi) f(\varphi | \varphi > \varphi^*_{ij,nc}) d\varphi, \tag{22}$$

where $N_{ij} = N_i \Big(1 - F_i(\varphi^*_{ij,nc}) \Big)$ is the number of firms exporting from origin i to destination j, N_i is number of firms that have drawn their productivity, and $f(\varphi|\varphi > \varphi^*_{ij,nc})$ is the conditional $p.d.f.$ function of firm productivity.

Before solving for equilibrium wages , I need to pin down two variables, tariff revenue and tax rebates.

Total tariff revenue in country i is equal to the sum of import tariff revenue from each exporting country:

$$TR_i = \sum_j \tilde{\kappa_{ji}} X_{ji}, \tag{23}$$

where X_{ji} is the bilateral trade flows from exporting country j to importing country i prior to country i levies any import tariffs.

Tax rebates are equal to the total taxes collected by the government from imposing taxes on firms' domestic revenue:

$$T_i = \underbrace{\int_{\Omega_h} t_i^h r_{ii}(\varphi) d\varphi}_{\text{Taxes From Non-corrupt Firms}} + \underbrace{\int_{\Omega_l} t_i^l r_{ii}(\varphi) d\varphi}_{\text{Taxes From Corrupt Firms}}, \tag{24}$$

where Ω_h is composed of firms that do not engage in domestic corruption, including non-corrupt firms that only serve the domestic market as well as non-corrupt exporters, and Ω_l is composed of firms that engage in domestic corruption, which is the set of corrupt firms that only serve the domestic market.

3.5 Closing the Model

To solve for equilibrium wages, I need to further impose two conditions that total income equals total expenditure and that trade is multilaterally balanced as follows:

$$\sum_j (1 + \tilde{\kappa_{ji}}) X_{ji} = I_i; \tag{25}$$

$$\sum_j X_{ij} = \sum_j X_{ji}, \tag{26}$$

where $I_i = L_i w_i + T_i + TR_i$.

These two equilibrium conditions, together with the given number of firms that have made their productivity draws, N_i, allow me to solve for $J \times 1$ equilibrium wages and the rest of the model as functions of the equilibrium wages:

$$w_i = \frac{\sum_j X_{ij} - T_i}{L_i}. \tag{27}$$

Following the standard approach in Metliz (2003), the number of firms that have made their productivity draws, N_i, is determined by combining the labor market clearing condition and the zero expected profit condition. Given that firms have to pay the fixed costs of corruption using labor in the origin country, firm corruption affects the number of firms in the economy. I provide details of the determination of N_i in Appendix B.

3.6 Characterization of the Equilibrium

Given the model primitives, $\{L_i, f_i^e, f_i^c, b_i, t_i^h, t_i^l, a_{ij}, \tau_{ij}, \kappa_{ij}, f_{ij}; \sigma, \theta\}$, a competitive equilibrium is defined by a set of prices, $\{w_i, P_i\}$, and a set of allocations, $\{T_i, TR_i, E_i, I_i, \varphi^*_{ij,nc}, \varphi^*_{ii,c}, N_i, X_{ij}\}$, such that

1. the representative consumer maximizes utility;
2. firms maximize profits;
3. the budget constraint holds;
4. trade is multilaterally balanced;
5. the labor market clears.

This provides a nonlinear system of equations that pins down n unknowns, $\mathbf{w} \equiv \{w_i\}$. By Walras's Law, one of the equations is redundant. Therefore, wages are only determined up to a constant. I follow Alvarez and Lucas (2007) to solve the vector of wages, $\mathbf{w} \equiv \{w_i\}$, using a contraction mapping algorithm. Once wages are determined, the rest of the endogenous variables of interest, such as the bilateral trade flows, $\mathbf{X} \equiv \{X_{ij}\}$, expenditure levels, $\mathbf{E} \equiv \{E_i\}$, total incomes, $\mathbf{I} \equiv \{I_i\}$, total tax rebates, $\mathbf{T} \equiv \{T_i\}$, and total tariff revenue, $\mathbf{TR} \equiv \{TR_i\}$, can be solved as a function of wages. This concludes the description of the theoretical model.

4 Testable Predictions

This section establishes a testable prediction out of my model in Section 3. Specifically, I derive a theoretical relationship between firm productivity and firm engagement in domestic corruption. This relationship guides my empirical investigation in Section 5.

With firms' productivity cutoffs of exiting, $\varphi^*_{ii,nc}$, engaging in domestic corruption, $\varphi^*_{ii,c}$, and exporting, $\varphi^*_{ij,nc}$, pinned down, firms' sorting behavior based on their productivity draws can be summarized by the following proposition:

Proposition 2. *Under restrictions from **R1** to **R3**, firms with productivity, φ, such that $\varphi^*_{ii,nc} < \varphi < \varphi^*_{ii,c}$, only sell in the domestic market and do not engage in domestic corruption; firms with productivity, φ, such that $\varphi^*_{ii,c} < \varphi < \varphi^*_{ij,nc}$, only sell in the domestic market and engage in domestic corruption; and firms with productivity, φ, such that $\varphi > \varphi^*_{ij,nc}$, sell in both domestic and foreign markets, and do not engage in domestic corruption.*
Proof: see Appendix A.

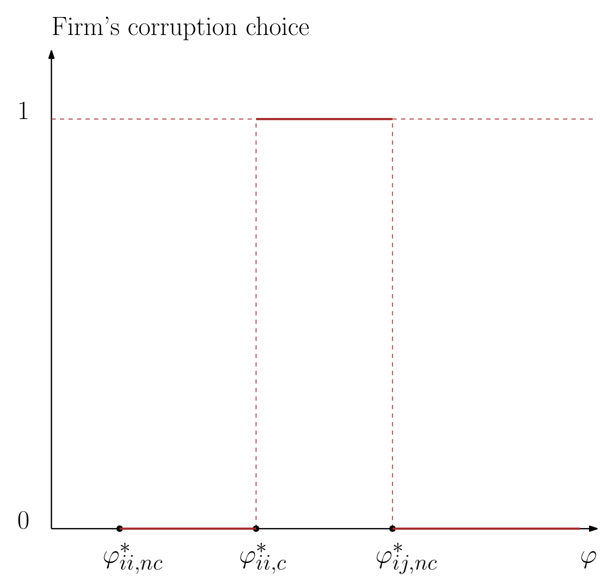


Figure 1: Inverted U-Shaped Relationship from Theory

I depict Proposition 2 graphically in Figure 1. As it is clear from the figure, among active firms, ones with low productivity do not engage in domestic corruption, ones with medium productivity do engage in domestic corruption, and ones with high productivity do not engage in domestic corruption. This theoretical relationship delivers a testable prediction as follows:

Testable Prediction *There exists an Inverted U-shaped relationship between a firm's productivity and its engagement in domestic corruption.* [6]

I next, turn to describing the measurement of key variables in Section 5. I also lay out my empirical strategy and report results.

5 Empirical Strategy and Results

This section tests the Inverted U-shaped relationship established in Section 4. I proceed by first describing the measurement of key variables and my econometric specifications that aim to verify whether the Inverted U-shaped relationship is supported by data evidence. Then, I report results.

5.1 Measurement of Key Variables

There are three categories of variables that show up in my empirical specification: firm-level corruption engagement, $\mathbb{1}_{\varphi}(\text{Corruption})$, firm productivity, φ, and other firm-level controls.

5.1.1 Firm-level corruption engagement

Corruption engagement is private knowledge to firms, and relevant data is seldom reported. Exceptions are survey data from public institutions, say, the Enterprise Survey from the World Bank. The World Bank Enterprise Survey is one of the most widely used datasets when studying topics that are related to firm corruption.The survey documents firms' responses to whether they have ever made abnormal payments to government officials and whether gifts to government officials are expected to "get things done." These responses are important information to identify whether the firm in question has ever engaged in domestic corruption. The dataset, however, is not without limitations. In particular, two of the limitations stand out for being restrictive in terms of my research purpose. First, on the international trade side, information is limited to (a) whether the firm is an exporter; and (b) what foreign sales as a share of total sales is. As a result, I do not observe the firm's sales broken down by destination. It turns out that firms' sales by destination are indispensable for me to estimate the bilateral corruption-aversion parameter, a_{ij}. Second, firms are only indexed by identification numbers in the World Bank Enterprise Survey. Other firm-level identifiers, such as firm names, addresses, telephone

[6]The Inverted U-shaped relationship remains robust to a multi-country setup of the model and a more general modeling of corruption costs. Details of these extensions are provided in Appendix F.

numbers, postal codes, legal persons, etc., are desensitized. The lack of concrete firm identifiers rules out the possibility of further merging the World Bank Enterprise Survey dataset with other firm-level data sources, which have a finer breakdown of firms' foreign sales by destination.

To combine information on firms' sales by destination and firm-level corruption engagement, I merge China's Manufacturing Enterprise Survey with the China Customs Database.[7] Both datasets are in 2004. The merged dataset documents information on firms' annual production, balance sheet and exports by destination. In particular, there is one accounting item in the merged dataset which documents the sum of a firm's expenses on entertainment, traveling and conference. I denote this accounting item by ETC, hereafter. In the literature, ETC is used to proxy a firm's corruption-related expenses. Especially in the pioneer work of Cai *et. al.* (2011), it is argued that due to sufficiently lax accounting practices in China, ETC is often used by firms to reimburse bribery to government officials in the name of entertainment, traveling and conference expenses.

Essentially, ETC includes a firm's regular expenses on entertainment, traveling and conference as well as irregular expenses pertaining to bribery of government officials. I assume the regular component of ETC is proportional to the firm's revenue while the irregular component of ETC, conceived as one-shot bribery to government officials, has the nature of a fixed cost such that

$$ETC_{\varphi} = \underbrace{\eta r_{\varphi}}_{\text{Regular Component}} + \underbrace{f^{c} \times \mathbb{1}_{\varphi}(\text{Corruption})}_{\text{Irregular Component}}, \tag{28}$$

where the r_{φ} is the firm's revenue and η is the ETC expenses per unit of the firm's revenue.

It is clear from (28) that ETC has a scaling problem such that firms with larger revenue have larger ETC expenses. To address the scaling problem, I construct the ratio of ETC to the revenue of the firm and denote this ratio as $ETCR$ such that

$$\begin{aligned} ETCR_{\varphi} &= \frac{\eta r_{\varphi} + f^{c} \times \mathbb{1}_{\varphi}(\text{Corruption})}{r_{\varphi}} \\ &= \eta + \frac{f^{c}}{r_{\varphi}} \times \mathbb{1}_{\varphi}(\text{Corruption}). \end{aligned} \tag{29}$$

Based on (29), it can be inferred that, on average, $ETCR$ of a corrupt firm is larger

[7] I follow Feenstra et al. (2014), Cai and Liu (2009), and the General Accepted Accounting Principles to clean the firm-level production data. I then merge the firm-level production data with the firm-product-destination-level custom data following Yu et al. (2005). Details of the dataset matching strategy are documented in Appendix D.

than $ETCR$ of a firm that does not engage in domestic corruption. This insight is shown as follows:

$$E\left[ETCR_{\varphi}|\mathbb{1}_{\varphi}(\text{Corruption}) = 1\right] - E\left[ETCR_{\varphi}|\mathbb{1}_{\varphi}(\text{Corruption}) = 0\right] = \frac{f^c}{r_{\varphi}} > 0. \quad (30)$$

I am now ready to identify corrupt firms by defining a threshold, h^*, in the distribution of $ETCR$ such that

$$\mathbb{1}_{\varphi}(\text{Corruption}) = \begin{cases} 1, & \text{if } ETCR_{\varphi} > h^* \\ 0, & \text{if } ETCR_{\varphi} < h^* \end{cases}. \quad (31)$$

Empirically, h^* is calibrated to match the share of corrupt firms in China using data from the World Bank Enterprise Survey in 2004 as follows:

$$1 - F_{ETCR}(h^*) = s_{China}^{Corrupt}, \quad (32)$$

where $F_{ETCR}(\cdot)$ is the cumulative distribution function of $ETCR$ across firms.

5.1.2 Firm-level productivity

I measure firm productivity using the Levinsohn and Petrin (2003) estimator. The Levinsohn and Petrin estimator is derived by exploiting the 7-year panel structure of information on firms' balance sheets and production documented in China's Manufacturing Enterprise Database from 2000 to 2006. Using the flexible nature of intermediate inputs, the LP (2003) approach addresses the problem of "lumpy investment" associated with the Olley and Pakes (1996) productivity estimator.

5.1.3 Other firm-level controls

For other firm-level controls, I follow the literature and include firm-level observables that potentially affect firms' corruption engagement, such as the log of firm wages, the log of firm employment and the log of firm capital intensity (i.e., capital to labor ratio).

5.2 Econometric Specifications

5.2.1 Main specifications

To test the Inverted U-shaped relationship between firm productivity and firm-level corruption engagement, my main empirical specification is as follows:

$$\mathbb{1}_{\varphi}(\text{Corruption}) = \delta_0 + \delta_1 \ln TFP_{\varphi} + \delta_2 (\ln TFP_{\varphi})^2 + X_{\varphi}\Upsilon + \epsilon_{\varphi}, \tag{33}$$

where X_{φ} takes care of firm-level controls such as the log of firm wages, the log of firm employment and the log of firm capital intensity.

For the Inverted U-shaped relationship to be in line with data evidence, the estimated coefficient on the log of firm productivity, δ_1, is expected to be positive, and the estimated coefficient on the quadratic term of the log of firm productivity, δ_2, is expected to be negative.

I estimate (33) using both the linear probability model (**LPM**) and the **Probit** model. Results should be robust to both estimators if the Inverted U-shaped relationship is strong in the data.

5.2.2 Alternative specifications

By controlling for other firm-level covariates, I have addressed the concern about omitted variable bias (**OVB**) driven by unobserved firm heterogeneity. Still there may remain concerns that the coefficients on the linear and quadratic terms of the log of firm productivity are biased due to confounding factors at various levels. If the bias is large enough, it may even change estimation results qualitatively by changing the signs of estimated coefficients. Say, firms' corruption engagement is industry-specific, and firm productivity is on average low in industries that witness prevalent firm corruption. This industry-level confounding factor biases the coefficient on the linear term of the log of firm productivity towards zero and biases the coefficient on the quadratic term of the log of firm productivity downward. Likewise, confounding factors at the province level, city level, etc., generate similar concerns.

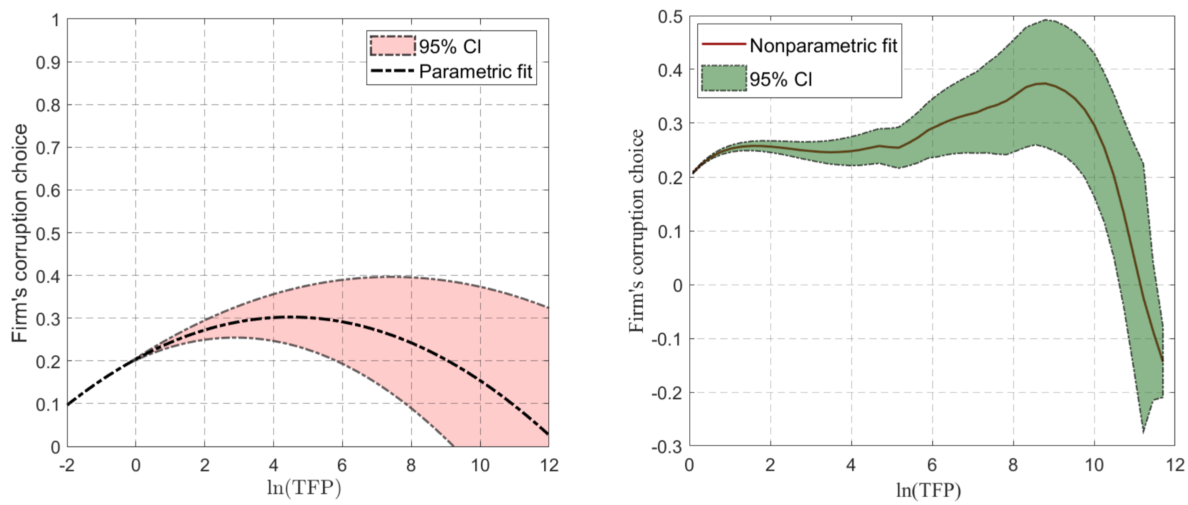
In the alternative specifications, I alleviate concerns specifically resulting from confounding factors at various levels by estimating the following empirical specification with fixed effect:

$$\mathbb{1}_{\varphi}(\text{Corruption}) = \alpha_0 + \alpha_1 \ln TFP_{\varphi} + \alpha_2 (\ln TFP_{\varphi})^2 + \nu_g + \xi_{\varphi}, \tag{34}$$

where ν_g is the fixed effect of group g, with $g =$ province, city, industry. Including the fixed effect dummy in the empirical specification allows me to verify whether estimates of α_1 and α_2 have the aforementioned signs without worrying about them being biased by confounding factors at various levels.

5.3 Results

In this section, I report regression results from my main empirical specifications and alternative specifications. Before discussions on regression results, I explore the relationship between firm productivity and firm-level corruption engagement figuratively by fitting the data both parametrically and nonparametrically.



(a) Parametric Fit

(b) Nonparametric Fit

Figure 2: Inverted U-Shaped Relationship from Data

Taking firm-level corruption engagement, $\mathbb{1}_{\varphi}$(Corruption), as the dependent variable and firm productivity, φ, as the predictor, I fit the data parametrically and nonparametrically in Figure 2. Panel (a) of Figure 2 assumes a quadratic relationship between $\mathbb{1}_{\varphi}$(Corruption) and φ and shows that the probability of a firm's engagement in domestic corruption initially rises with firm productivity and begins to drop after a certain productivity threshold. This pattern suggests that an Inverted U-shaped relationship appears in the data. There might however, exist a concern that the Inverted U-shaped relationship is driven by assuming a quadratic relationship between $\mathbb{1}_{\varphi}$(Corruption) and φ. Panel (b) of Figure 2 addresses this concern by adopting a nonparametric approach in which the relationship between $\mathbb{1}_{\varphi}$(Corruption) and φ is determined by data. As my theoretical model suggests, an Inverted U-shaped relationship is expected even without the explicit assumption of a quadratic relationship between $\mathbb{1}_{\varphi}$(Corruption) and φ. This is well demonstrated in Panel (b) of Figure 2, which shows an initial rise in the probability of firms' corruption engagement against firm productivity followed by a drop.

I next turn to report results on my main empirical specifications and alternative specifications. Results from both specifications support the existence of the Inverted U-shaped

Table 2: Firm's Corruption Engagement (Main Specifications)

	OLS		Probit	
	(1)	(2)	(3)	(4)
$\ln(TFP)$	0.044***	0.036***	0.152***	0.142***
	(0.004)	(0.004)	(0.013)	(0.014)
$(\ln(TFP))^2$	-0.005***	-0.004***	-0.018***	-0.016***
	(0.001)	(0.001)	(0.003)	(0.003)
$\ln(Wage)$		-0.056***		-0.240***
		(0.002)		(0.007)
$\ln(Labor)$		0.037***		0.127***
		(0.002)		(0.008)
$\ln(Capital/Labor)$		0.062***		0.238***
		(0.001)		(0.002)
Observations	176,402	173,662	176,402	173,662
R^2/Pseudo R^2	0.001	0.113	0.001	0.119

Notes. Standard errors are based on Eicker-White sandwich estimates and are robust to heteroskedasticity of an unknown form.

relationship between firm-level corruption engagement and firm productivity. As is shown in Table 2, estimates of coefficients on the linear and quadratic terms of the log of firm productivity are positive and negative, respectively, which are in line with the expected signs of δ_1 and δ_2 as in (33). Moreover, this result is qualitatively true across specifications that differ in either estimation methods or inclusion of firm-level controls. In sum, the Inverted U-shaped relationship between firm-level corruption engagement and firm productivity exists in the data and is not driven by confounding firm-level covariates.

In the alternative specifications, I further address the concern that the Inverted U-shaped relationship between firm-level corruption engagement and firm productivity might be driven by confounding factors at various levels. Specifically, I devise three specifications that target confounding factors at the province, city and industry levels, respectively. As is reported in Table 3, estimates of coefficients on the linear and quadratic terms of the log of firm productivity are positive and negative, respectively, which are in line with the expected signs of α_1 and α_2 as in (34). This result supports the existence of the Inverted U-shaped relationship in the data and remains robust to partialling out the fixed effect at various levels.

With the key mechanism of my model verified in the data, I next turn to calibrating the model and conducting counterfactual experiments.

Table 3: Firm's Corruption Engagement (Alternative Specifications)

	(1)	(2)	(3)
$\ln(TFP)$	0.046***	0.048***	0.036***
	(0.004)	(0.004)	(0.004)
$(\ln(TFP))^2$	-0.005***	-0.005***	-0.004***
	(0.001)	(0.001)	(0.001)
Province FE	Yes	No	No
City FE	No	Yes	No
Industry FE	No	No	Yes
Observations	176,402	176,402	176,402
R^2	0.003	0.008	0.024

Notes. Standard errors are based on Eicker-White sandwich estimates and are robust to heteroskedasticity of an unknown form.

6 Calibration

I calibrate the model to China and the rest of the world (RoW) for the reference year 2004. This exercise allows me to calibrate the parameters of the utility function and the production function. In particular, I estimate the corruption-aversion parameter, a_{ij}, for each destination country that does international trade with China. Subsequently, I conduct a validity check on my estimates of the corruption-aversion parameters with outside data sources and find that my estimates comply well with the outside data sources in terms of expected correlations. I next turn to the calibration details. A description of the data sources can be found in Appendix C.

6.1 Parameters of the Utility Function

The parameter of elasticity of substitution, σ, and the parameter of bilateral corruption aversion, a_{ij}, are calibrated for the demand side of the model. To start with, I evaluate σ for $\sigma = 2$, which falls in the range of sector-specific estimates of the elasticity of substitution by Broda and Weinstein (2006) for the 20 SITC-5 Sectors with the Largest Import Share by Period 1990 - 2001.

Next, I turn to the estimation of bilateral corruption aversion parameters, a_{ij}, for China and each of its trading partners. In general, a firm's sales in destination market j is such that

Table 4: Table of Parameters

	Definitions	Values	Sources
σ	Elasticity of Substitution	2	Taken from the Literature
τ_{ij}	Iceberg Trade Costs	2.85	Calibrated from $\frac{\zeta_{ij}}{\kappa_{ij}}$
κ_{ij}	Import Tariffs	1.1	Calibrated to MFN Tariffs
ζ_{ij}	Total Trade Costs	3.14	Estimated from Trade Flows
f_i^e	Fixed Costs of Entry	1	Normalized to 1
f_i^c	Fixed Costs of Corruption	0.27	Calibrated to the Share of Corrupt Firms
f_{ij}	Fixed Costs of Export	3.16	Calibrated to the Share of Exporters
t_i^h	High Tax Rate on Domestic Revenue	0.05	Taken from the Literature
t_i^l	Low Tax Rate on Domestic Revenue	0.02	Taken from the Literature
b_i	Scale Parameter of Productivity Distribution	0.79	Estimated from Productivity Distribution
θ	Shape Parameter of Productivity Distribution	2.88	Estimated from Productivity Distribution
a_{ij}	Corruption-Aversion Parameter	0.3	Estimated from Firm-level Trade Flows
L_i	Economic Size	27	Calibrated to Trade Shares and Wages

Notes. All numbers in this table are either estimated or calibrated to the benchmark data in 2004 for China and the rest of the world.

$$x_{ij}(\varphi) = \left(w_i \frac{\sigma}{\sigma - 1}\right)^{1-\sigma} \zeta_{ij}^{1-\sigma} I_j P_j^{\sigma-1} \varphi^{\sigma-1} a_{ij}(\varphi). \tag{35}$$

Taking $\sigma = 2$ from the literature (Broda and Weinstein, 2006), I normalize the firm-destination-level trade flows by an exponential function of firm productivity such that

$$\frac{x_{ij}(\varphi)}{\varphi^{\sigma-1}} = \left(w_i \frac{\sigma}{\sigma - 1}\right)^{1-\sigma} \zeta_{ij}^{1-\sigma} I_j P_j^{\sigma-1} a_{ij}(\varphi). \tag{36}$$

The dataset I use for estimation is a merged dataset of firms in China which combines information on firm-level production and firm-destination-level exports. Since the dataset is specifically about Chinese firms' exports, the origin country i is fixed to China. I therefore subsume the i index in the following regression analysis, and I use φ to index firm-level variation. As a result, (36) can be rewritten as

$$\frac{x_j(\varphi)}{\varphi^{\sigma-1}} = \left(\frac{\sigma}{\sigma - 1} w\right)^{1-\sigma} \zeta_j^{1-\sigma} I_j P_j^{\sigma-1} a_j(\varphi), \tag{37}$$

where the corruption aversion parameter, $a_j(\varphi)$, is rewritten in a similar fashion such that

$$a_j(\varphi) = \begin{cases} 0 < a_j < 1, & \text{if the firm, } \varphi\text{, engages in domestic corruption and exports to j} \\ 1, & \text{o.w.} \end{cases}. \tag{38}$$

Thus, destination country j's corruption-aversion parameter for firm φ, $a_j(\varphi)$, can be expressed as

$$a_j(\varphi) = (a_j - 1) \times \mathbb{1}_\varphi(\text{Corruption}) + 1, \tag{39}$$

where $\mathbb{1}_\varphi(\text{Corruption})$ is the indicator function of whether firm φ engages in domestic corruption.

I denote the algebraic expression, $\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} \zeta_j^{1-\sigma} I_j P_j^{\sigma-1}$, by β_j. Substituting (39) into (37), I derive

$$\begin{aligned} \frac{x_j(\varphi)}{\varphi^{\sigma-1}} &= \underbrace{\beta_j(a_j - 1)}_{\gamma_j} \mathbb{1}_\varphi(\text{Corruption}) + \beta_j \\ &= \gamma_j \mathbb{1}_\varphi(\text{Corruption}) + \beta_j. \end{aligned} \tag{40}$$

Then a stochastic counterpart to the equation in (40) can be estimated as:

$$\frac{x_j(\varphi)}{\varphi^{\sigma-1}} = \gamma_j \mathbb{1}_\varphi(\text{Corruption}) + \beta_j + error_{\varphi,j}. \tag{41}$$

I estimate (41) using the **OLS** estimator with a restriction that $a_j \in (0, 1)$. The identification assumption of γ_j and β_j is that the error terms have conditional zero means as

$$E(error_{\varphi,j} | \mathbb{1}_\varphi(\text{Corruption})) = 0. \tag{42}$$

Notice that in (41) the coefficients on destination dummies identify β_j, and the within-destination variation in $\mathbb{1}_\varphi(\text{Corruption})$ identifies γ_j. Estimates of γ_j and β_j allow me to calculate a_j as

$$\widehat{a}_j = \frac{\widehat{\gamma}_j}{\widehat{\beta}_j} + 1. \tag{43}$$

As a result of my estimation, on average, I obtain $a_j = 0.3$ as destination countries' corruption aversion parameter for corrupt firms in China.

6.2 Parameters of the Production Function

The production side parameters are calibrated using data from various sources. For the tax rates on firms' domestic revenue, I take numbers from Chen *et. al.* (2021), such that the high and low tax rates are 5% and 2%, respectively. The fixed costs of entry, f_i^e, are normalized to 1.

6.2.1 Productivity distribution

The scale parameter, b_i, and the shape parameter, θ, of the distribution of firm productivity, are estimated using the inverse distribution function such that

$$\varphi = b_i(1-\mu)^{\frac{-1}{\theta}}, \tag{44}$$

where φ is the productivity quantile that corresponds to μ such that $\mu = F(\varphi)$ and $F(\cdot)$ is the cumulative distribution function of firm productivity.

Taking logs on both sides of (44), I derive its log-level counterpart as

$$\ln\varphi = \ln b_i - \frac{1}{\theta}(1-\mu). \tag{45}$$

I obtain estimates of b_i and θ by first generating quantiles of φ and then running regressions as in (45). The scale parameter, b_i is identified by the constant term, and the coefficient on the functional term in μ identifies the scale parameter, θ. With the empirical distribution of firm productivity estimated by the LP (2003) method, the point estimates of b_i and θ are, respectively, 0.79 and 2.88.

6.2.2 Economic Sizes

To calibrate the economic sizes, L_i, for China and the rest of the world, I combine data on bilateral trade shares and cross-country wages with the goods market clearing condition such that

$$L_i = \frac{\sum_j \lambda_{ij} w_j L_j}{w_i}, \tag{46}$$

where λ_{ij} is destination country j's imports from origin country i as a share of destination country j's total expenditure, E_j, such that $\lambda_{ij} = \frac{X_{ij}}{E_j}$. The calibrated values of economic size for China and the rest of the world are 27 and 183, respectively.

6.2.3 Variable trade costs

To calculate parameters related to trade costs, I exploit the log-additive structure of β_j such that

$$\ln\beta_j = (1-\sigma)\left(\frac{\sigma}{\sigma-1}w\right) + (1-\sigma)\ln\tau_j + (1-\sigma)\ln\kappa_j + \ln\left(I_j P_j^{\sigma-1}\right), \tag{47}$$

where τ_j is the iceberg trade costs for shipping goods from China to country j, and κ_j is the import tariffs imposed on imports by country j. I denote $(1-\sigma)\left(\frac{\sigma}{\sigma-1}w\right)$ by α_0 and $\ln\left(I_j P_j^{\sigma-1}\right)$ by ε_j. Using an approach consistent with the literature, I proxy the components of iceberg trade costs, τ_j, using a measure of the bilateral distance, an adjacency dummy and a common language dummy:

$$(1-\sigma)\ln\tau_j = \rho_1 \ln(distance_j) + \rho_2\, adjacency_j + \rho_3\, common\_language_j. \tag{48}$$

Embedding (48) into (47) and rewriting it with new notations, I derive an estimable equation as

$$\ln\beta_j - (1-\sigma)\ln\kappa_j = \alpha_0 + \rho_1 \ln(distance_j) + \rho_2\, adjacency_j + \rho_3\, common\_language_j + \varepsilon_j. \tag{49}$$

I estimate (49) using the **OLS** estimator with data on β_j from estimation results of equation (41), $\widehat{\beta}_j$, data on *ad valorem* tariffs from TRAINS, and data on bilateral distance, adjacency dummy and common language dummy from CEPII. The identification assumption of ρ_i, $i = 1,2,3$, is that the error term ε_j has a conditional zero mean such that

$$E(\varepsilon_j | \ln(distance_j), adjacency_j, common\_language_j, \iota) = 0, \tag{50}$$

where ι is a vector of ones with length equal to the number of destination countries in the data.

With estimates of ρ_i, $i = 1,2,3$, I calculate the iceberg trade costs as

$$\widehat{\tau}_j = exp\left[\frac{1}{1-\sigma}\left(\widehat{\rho}_1 \ln(distance_j) + \widehat{\rho}_2\, adjacency_j + \widehat{\rho}_3\, common\_language_j\right)\right]. \tag{51}$$

As a result of my estimation, I obtain $\tau_j = 2.85$ on average as the iceberg trade cost to ship goods from China to its trading partners. The average MFN tariff from TRAINS for China's imports is 1.1. Therefore, I calibrate the average total trade cost to all trading partners of China as $\zeta_j = \tau_j\kappa_j = 3.14$.

6.2.4 Fixed costs of corruption and export

Lastly, I calibrate the values of the fixed cost of corruption, f_i^c, and the fixed cost of export, f_{ij}. To briefly illustrate the calibration process, I first normalize f_{ii} to 1 and draw the fixed costs of corruption, f_i^c, from a grid of possible values such that $f_i^c \in [\underline{f}_i^c, \overline{f}_i^c]$. I make draws of the fixed costs of exporting, f_{ij}, when $i \neq j$, in the same fashion such that $f_{ij} \in [\underline{f}_{ij}, \overline{f}_{ij}]$. Given my draws of f_i^c and f_{ij}, I then calculate a prediction for the share of corrupt firms, $m_i^{Corrupt}$, and the share of exporters, m_i^{Export}, from my model described in Section 3. Next, I construct a criterion function, Q_0, and compute its value as follows:

$$Q_0(f_i^c, f_{ij}) = \begin{bmatrix} m_i^{Corrupt} - s_i^{Corrupt} \\ m_i^{Export} - s_i^{Export} \end{bmatrix}' W \begin{bmatrix} m_i^{Corrupt} - s_i^{Corrupt} \\ m_i^{Export} - s_i^{Export} \end{bmatrix}. \tag{52}$$

W is a weighting matrix that puts weights on the squared deviation of the share of corrupt firms and on that of the share of exporters between the data and the model. $s_i^{Corrupt}$ and s_i^{Export} are data on the shares of corrupt firms and exporters from the corruption section of the World Bank Enterprise Survey in 2004.

I obtain the calibrated f_i^c and f_{ij} by repeating this exercise for different values of f_i^c and f_{ij} until the difference from the model prediction and the data on the shares of corrupt firms and exporters is minimized. Formally, f_i^c and f_{ij} are calibrated as follows:

$$(\widehat{f_i^c}, \widehat{f_{ij}}) = \underset{f_i^c, f_{ij}}{\arg\min}\, Q_0(f_i^c, f_{ij}). \tag{53}$$

Due to the "curse of dimensionality," it is a computational burden to exhaustively evaluate the criterion function for a large number of grids on f_i^c and f_{ij}. To reduce the computational burden, I adopt an adaptive grid search algorithm that solves for f_i^c and f_{ij} with good performance in matching the model predicted shares of corrupt firms and exporters to those in the real data. In the process of evaluating the criterion function, the algorithm does not exhaust all possible pairs of f_i^c and f_{ij}, but instead starts to evaluate the criterion function for relatively coarse grids on f_i^c and f_{ij}. Once the first-round values, $f_i^c(1)$ and $f_{ij}(1)$, that minimize the criterion function are found, the algorithm adaptively lessens the searching radius and builds neighborhood of finer grids around $f_i^c(1)$ and $f_{ij}(1)$. Possible values of f_i^c and f_{ij} outside of the neighborhood developed during the first round of searching are therefore never evaluated in subsequent rounds. This reduction in the to-be-searched parameter space yields a large improvement in computational efficiency. As a result, I obtain f_i^c to be 0.27 and f_{ij} to be 3.16. The calibrated values imply that the fixed costs of export are much larger in magnitude than the fixed costs of corruption.

6.3 Validity Checks

Assessing the validity of the corruption aversion estimates, $\widehat{a}_j$, I investigate the correlation between a_j and the Corruption Perceptions Index (CPI) across destination countries. Intuitively, destination countries with more domestic corruption are expected to be less corruption-averse to goods from corrupt firms. Therefore, the expectation is that the correlation between a_j and CPI_j is negative.

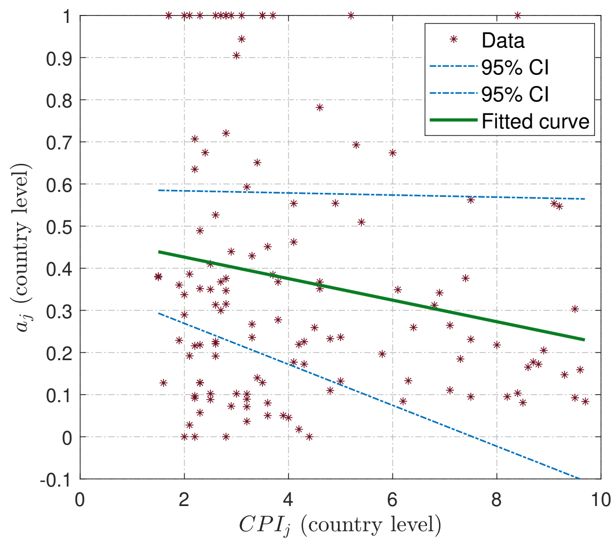


Figure 3: Correlation Between CPI_j and a_j

To shed light on the correlation between a_j and CPI_j, I first plot the corruption aversion parameter against the Corruption Perceptions Index across destination countries. The negative correlation is well demonstrated in Figure 3 in which the fitted curve is downward-sloping. In other words, destination countries with more domestic corruption (indicated by smaller values of CPI_j), are less corruption-averse to goods from corrupt firms (indicated by larger values of a_j).

This negative correlation is also statistically significant. I next turn to showing the robustness of the statistical significance at both the country level and the firm level using a regression as follows:

$$a_v = \varsigma CPI_v + \varrho_v, \tag{54}$$

where $v = j, \varphi$. j is the index of destination countries and φ is the index of firms. Specifically, I construct firm-level measures of the corruption aversion parameter and CPI as follows:

$$a_{\varphi} = \frac{\sum_{j \in S_{\varphi}} a_j}{|S_{\varphi}|}; \tag{55}$$

$$CPI_{\varphi} = \frac{\sum_{j \in S_{\varphi}} CPI_j}{|S_{\varphi}|}, \tag{56}$$

where S_{φ} is the set of destination countries that firm φ exports to. In expectation, the negative correlation between the corruption aversion parameter and the Corruption Perceptions Index implies a negative sign of ς.

The interpretation of ς is straightforward in the country-level regression as in (54), where ς reveals the correlation between corruption aversion parameters and the Corruption Perceptions Index across destination countries. The interpretation of ς however, is different in the firm-level regression as in (54), which is due to the notion of destination countries being firm-specific. To be more detailed, each firm, φ, exports to a unique set of destination countries, S_{φ}. This set of destination countries can be averaged to a single composite destination country which is specific to firm φ with the corruption-aversion parameter being a_{φ} and the Corruption Perceptions Index being CPI_{φ}. Then, ς reveals the correlation between the corruption-aversion parameter and the Corruption Perceptions Index across firm-specific destination countries as constructed above.

Table 5: Correlation Between Corruption Aversion and CPI

	a_j	a_{φ}	$a_{\varphi}^{Weighted}$
	Country level	Firm level	
	(1)	(2)	(3)
CPI_j	-0.026**		
	(0.010)		
CPI_{φ}		-0.010***	
		(0.001)	
$CPI_{\varphi}^{Weighted}$			-0.002***
			(0.001)
Observations	129	30,715	30,715
R^2	0.036	0.023	0.001

Notes. Standard errors are based on Eicker-White sandwich estimates and are robust to heteroskedasticity of an unknown form.

In the data, firm φ's exports to destination country j as a share of the firm's total exports is different across destination countries. This difference in trade share reflects the difference in importance among firm φ's trading partners. To account for this in constructing the single composite destination country specific to firm φ, I come up with two additional firm-level measures of the corruption aversion parameter and the Corruption Perceptions Index as follows:

$$a_{\varphi}^{Weighted} = \sum_{j \in S_{\varphi}} \lambda_{\varphi,j} a_j; \tag{57}$$

$$CPI_{\varphi}^{Weighted} = \sum_{j \in S_{\varphi}} \lambda_{\varphi,j} CPI_j, \tag{58}$$

where $\lambda_{\varphi,j}$ is firm φ's exports to destination j as a share of the firm's total exports such that $\lambda_{\varphi,j} = \frac{X_j(\varphi)}{\sum_j X_j(\varphi)}$ and $X_j(\varphi)$ is firm φ's exports to destination j.

I report the regression results in Table 5. As is clearly shown in Table 5, the estimated coefficients on CPI are negative, which is in line with expectations of ς as in (54). Moreover, the coefficient estimates are statistically significant at the level of 5%. The negative correlation and statistical significance are robust to constructing the corruption aversion parameter and the Corruption Perceptions Index at either the country level or the firm level. Also, these results remain true when I adopt the trade-share-weighted firm-level measures, $a_{\varphi}^{Weighted}$ and $CPI_{\varphi}^{Weighted}$.

7 Counterfactual Experiments

In the counterfactual experiments, computational works are required to evaluate the model for each set of primitives. I assume the primitives of the model do not respond to indirect shocks such that $\widehat{\tau}_{ij} = 1$ and $\widehat{\kappa}_{ij} = 1$ (unless otherwise noted in the counterfactual experiments).

In this section, I ask the question: which policy tool is the most preferable when used to achieve a given outcome in terms of domestic corruption reduction? To provide an answer, I conduct three counterfactual experiments that each would reduce the share of corrupt firms by 10%. I subsequently examine the welfare implications of each of the experiments. Specifically, in the first experiment, I globally reduce fixed costs of corruption by 17%. In the second experiment, I globally reduce iceberg trade costs by 15% and assume that this reduction is costless. In the third experiment, I globally reduce import tariffs by 8% while taking into account the fact that consumers are hurt by the loss of tariff revenue.

Welfare gains (losses) are gauged using the concept of equivalent variation, ev_j. In terms of the model here, this metric of welfare changes is equivalent to the percentage change of real income from the actual to the counterfactual world. I document details of the derivation of equivalent variation, ev_j, in Appendix E.

I next turn to the quantification of welfare gains (losses) in China from each of the counterfactual changes of interest.

7.1 Increasing the Fixed Cost of Corruption

In the first counterfactual experiment, I increase the fixed cost of engaging in domestic corruption globally by 17% such that the share of corrupt firms is reduced by 10%. The counterfactual change in the fixed cost of corruption is therefore specified as:

$$\widehat{f_i^c} = 1.17, \tag{59}$$

where $\widehat{f_i^c}$ is the "exact hat" algebra in the spirit of Dekle *et al.* (2007), which is defined as the ratio of the counterfactual value of the fixed cost of corruption, $f_i^{c\prime}$, to the actual value of the fixed cost of corruption, f_i^c. Since I have calibrated the actual value of the fixed cost of corruption, f_i^c, to match one of the data moments, i.e., the share of corrupt firms in country i, I derive the counterfactual value of the fixed cost of corruption, $f_i^{c\prime}$, as $f_i^{c\prime} = f_i^c \widehat{f_i^c}$. This allows me to solve the model for each set of primitive values. Combining the actual and counterfactual values of real income allows me to construct the measure of equivalent variation, ev_i, and thus, the measure of welfare gains (losses) in percent, $\Delta_i = 100 \times ev_j$.

I calculate the welfare gains (losses), Δ_i, for a continuum of changes in the fixed cost of corruption. Specifically, I equally space the closed interval of $\widehat{f_i^c}$ into 100 grids, with the minimum being $\widehat{f_i^c}_{min} = 1$ and the maximum being $\widehat{f_i^c}_{max} = 1.17$. For simplicity, I assume a costless reduction in the fixed cost of corruption. This quantification exercise allows me to obtain a clear trajectory of the welfare changes, Δ_i, for a potential domestic anti-corruption campaign, which may combat the tough domestic corruption only through a gradual adjustment process. Also, this exercise is of particular interest to policymakers. After considering the implementation cost of increasing the fixed cost of corruption, policymakers may exhaustively explore the policy space and rationally choose a specific point along the trajectory of welfare changes that maximizes welfare gains. I plot the welfare gains, Δ_i, along a continuum of changes in the fixed cost of corruption in Figure 4.

The results indicate that the representative consumer in all countries would gain from a domestic anti-corruption campaign which increases the fixed cost of corruption. Also, with the productivity cutoffs for engaging in domestic corruption, $\varphi^*_{ii,c}$, and for exporting, $\varphi^*_{ij,nc}$, I calculate the share of corrupt firms, $m_i^{Corrupt}$, and the share of exporters to

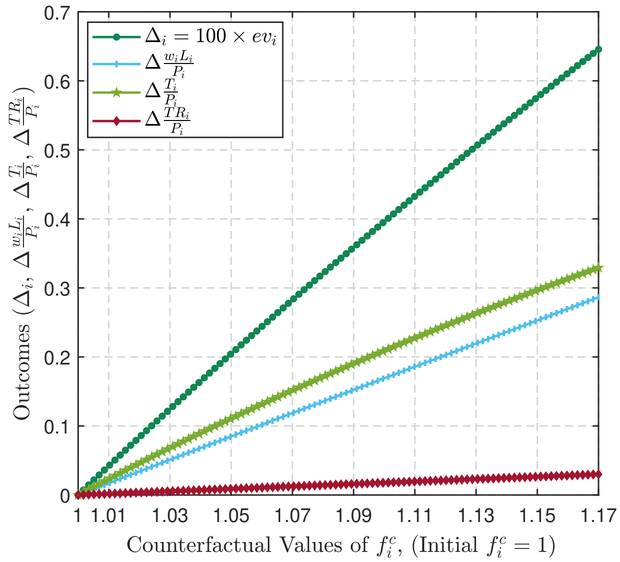


Figure 4: Results of Experiment 1

destination j, m_{ij}, along the trajectory of counterfactual changes:

$$m_i^{Corrupt} = F(\varphi^*_{ij,nc}) - F(\varphi^*_{ii,c}); \tag{60}$$

$$m_{ij} = 1 - F(\varphi^*_{ij,nc}). \tag{61}$$

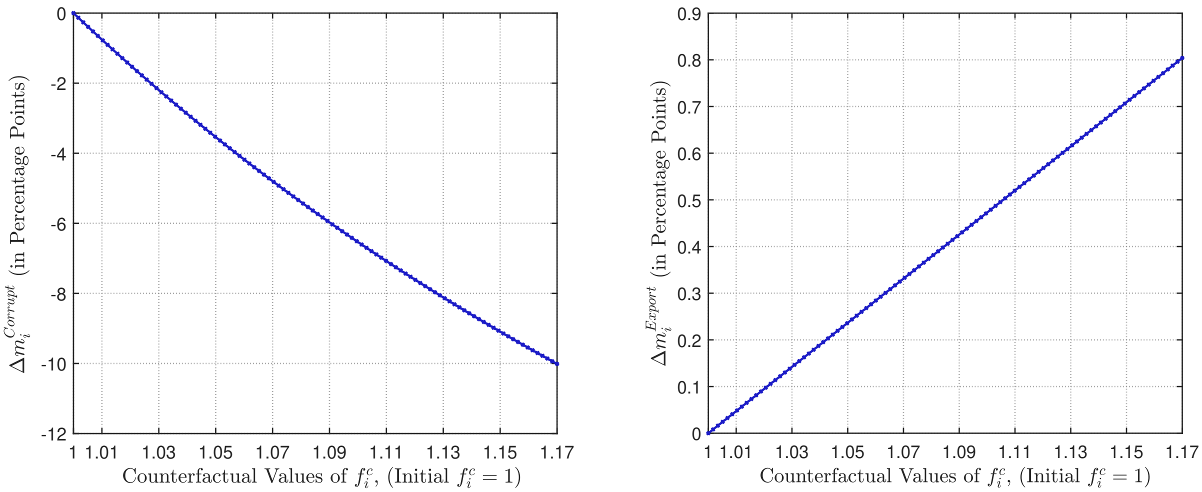
In Figure 5, I plot the share of corrupt firms and the share of exporters to destination j against the counterfactual changes in the fixed cost of corruption. It is clear that an increase in the fixed cost of corruption gives rise to a decrease in the share of corrupt firms and an increase in the share of exporters.

In sum, a domestic anti-corruption campaign that increases the fixed cost of corruption not only achieves its policy target of decreasing the share of corrupt firms, but also encourages export. Welfare increases along the trajectory, though its magnitude is mild.

To understand the sources of welfare gains, I decompose the welfare in origin country i as:

$$Welfare_i = \frac{I_i}{P_i} = \underbrace{\frac{w_i L_i}{P_i}}_{\text{Real Wages}} + \underbrace{\frac{T_i}{P_i}}_{\text{Real Tax Rebates}} + \underbrace{\frac{TR_i}{P_i}}_{\text{Real Tariff Revenue}}, \tag{62}$$

where the real wages, real tax rebates, and real tariff revenue are measured in units of total output.



(a) Share of Corrupt Firms

(b) Share of Exporting Firms

Figure 5: Results of Experiment 1

In Figure 4, I plot the real wages, real tax rebates and real tariff revenue against the counterfactual changes of the fixed cost of corruption. Clear as it is from the figure, a domestic anti-corruption campaign increases welfare from all sources. A detailed argument for each source of the overall welfare change is as follows.

First, the increase in real wages is mainly driven by the decrease in aggregate price index, P_i. When the fixed cost of corruption increases globally, the productivity cutoff for exporting from country j to country i, $\varphi^*_{ji,nc}$, decreases. As a result, there are more highly productive exporters serving country i from country j. Through the lens of the model, changes in firm productivity are fully passed on to changes in goods prices. Therefore, that relatively more productive exporters in country j start to serve market i, drives down the prices of goods, thus driving down the aggregate price index. Second, besides the decrease in the aggregate price index, the increase in real tax rebates is partially due to the decrease in the share of corrupt firms. This is because a decrease in the share of corrupt firms that are charged a lower tax rate results in an increase in the share of non-corrupt firms that are charged a higher tax rate, meaning an increase in nominal tax rebates. Third, besides the decrease in the aggregate price index, the increase in real tariff revenue is also due to the increase in the share of exporters. An increase in the share of exporters increases the total bilateral trade flows, thus, given unchanged *ad valorem* tariffs, increasing the nominal tariff revenue.

Lastly, instead of focusing on the trajectory of welfare changes along a series of counterfactual changes, I focus on the welfare quantification from a specific counterfactual experiment, in which I increase the fixed cost of corruption by 17%. I further decompose the total welfare gains into welfare gains from each of the sources.

Table 6: Welfare Quantification and Decomposition

	Δ_i (Welfare)	$\Delta\ \frac{w_i L_i}{P_i}$	$\Delta\ \frac{T_i}{P_i}$	$\Delta\ \frac{TR_i}{P_i}$
Experiment 1: 17% increase in f_i^c	0.65	0.29	0.33	0.03

Notes. All numbers in this table are measured in percent of benchmark welfare. The decomposition of welfare gains is as in (62). $\Delta\ \frac{w_i L_i}{P_i}$, $\Delta\ \frac{T_i}{P_i}$, $\Delta\ \frac{TR_i}{P_i}$, are changes in real wages, real tax rebates, and real tariff revenue, respectively.

As is summarized in Table 6, a 17% increase in the fixed cost of corruption improves consumer welfare by 0.65%, an admittedly modest increase that mainly derives from the increase in real wages and the increase in real tax rebates, by 0.29% and 0.33%, respectively.

7.2 Global Reduction in Trade Costs

In the second counterfactual experiment, I reduce all iceberg trade costs by 15% such that the share of corrupt firms is reduced by 10%. The counterfactual changes in the iceberg trade costs are therefore specified as:

$$\widehat{\tau}_{ij} = \begin{cases} 0.85 & \text{if } i \neq j \\ 1 & \text{if } i = j \end{cases}, \tag{63}$$

where $\widehat{\tau}_{ij}$ is the "exact hat" algebra in the spirit of Dekle *et al.* (2007), which is defined as the ratio of the counterfactual value of the iceberg trade cost, ${\tau_{ij}}'$, to the actual value of the iceberg trade cost, τ_{ij}. I derive the counterfactual value of the iceberg trade cost, ${\tau_{ij}}'$, as ${\tau_{ij}}' = \tau_{ij}\widehat{\tau}_{ij}$. This allows me to solve the model for each set of primitive values. Combining the actual and counterfactual values of real income allows me to construct the measure of equivalent variation, ev_i, and thus, the measure of welfare gains (losses) in percent, Δ_i.

I calculate the welfare gains (losses), Δ_i, for a continuum of changes in the iceberg trade costs. Specifically, when $i \neq j$, I equally space the closed interval of $\widehat{\tau}_{ij}$ into 100 grids, with the maximum being $\widehat{\tau}_{ijmax} = 1$ and the minimum being $\widehat{\tau}_{ijmin} = 0.85$. This experiment is clean in the sense that the implementation of the iceberg trade cost reduction is costless. This quantification exercise allows me to obtain a clear trajectory of the welfare changes, Δ_i, for multiple rounds of global trade liberalization, which may reduce the iceberg trade costs through a gradual adjustment process. Also, this exercise has a broad audience among policymakers. Through the lens of the model, trade cost reduction exerts

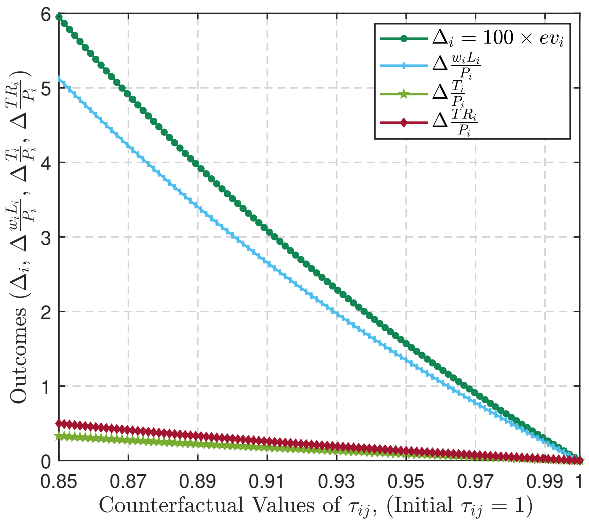


Figure 6: Results of Experiment 2

impacts on both international trade and domestic corruption engagement. Policymakers, who are either intending to encourage international trade or to combat domestic corruption, share interest in leveraging trade cost reduction as one of their policy tools. I plot the welfare gains, Δ_i, along a continuum of changes in the iceberg trade cost in Figure 6.

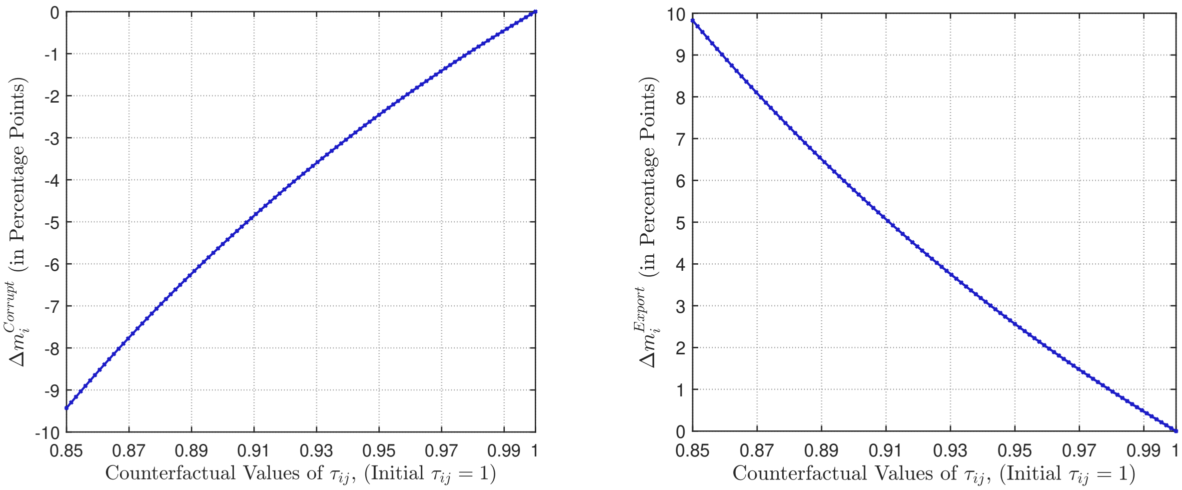
The results indicate that the representative consumer in all countries would gain from a global trade liberalization which decreases the iceberg trade cost. Also, I calculate and plot the share of corrupt firms, $m_i^{Corrupt}$, and the share of exporters to destination j, m_{ij}, against the series of counterfactual changes in trade cost in Figure 7. It is clear that a decrease in the trade cost gives rise to a decrease in the share of corrupt firms and an increase in the share of exporters.

In sum, a global trade liberalization that decreases the iceberg trade costs not only achieves its policy target of encouraging international trade, but also it manages to combat domestic corruption as the share of corrupt firms decreases. Welfare increases along the trajectory, with a nontrivial magnitude.

To understand the sources of welfare gains, I decompose the welfare in origin country i as in (62).

In Figure 6, I plot the real wages, real tax rebates and real tariff revenue against the counterfactual changes of the iceberg trade cost. Clear as it is from the figure, a reduction in iceberg trade cost increases welfare from all sources. A detailed argument for each source of the overall welfare change is as follows.

First, the increase in real wages is mainly driven by the decrease in aggregate price



(a) Share of Corrupt Firms

(b) Share of Exporting Firms

Figure 7: Results of Experiment 2

index, P_i. On the extensive margin, when the iceberg trade cost decreases globally, the productivity cutoff for exporting from country j to country i, $\varphi^*_{ji,nc}$, decreases. As a result, there are more highly productive exporters serving country i from country j. Through the lens of the model, changes in firm productivity are fully passed on to changes in goods prices. Therefore, that relatively more productive exporters in country j start to serve market i, drives down the prices of goods. On the intensive margin, when the iceberg trade cost decreases globally, those exporters in country j who serve market i even before trade liberalization happens, now still export to market i but with a lower destination price. Combining adjustments of prices of goods along the intensive and extensive margins, the aggregate price index, P_i, decreases when there is a reduction in iceberg trade cost. Second, besides the decrease in the aggregate price index, the increase in real tax rebates is partially due to the decrease in the share of corrupt firms. This is because a decrease in the share of corrupt firms that are charged a lower tax rate results in an increase in the share of non-corrupt firms that are charged a higher tax rate, meaning an increase in nominal tax rebates. Third, besides the decrease in the aggregate price index, the increase in real tariff revenue is also due to the increase in the share of exporters. An increase in the share of exporters increases the total bilateral trade flows, thus, given unchanged *ad valorem* tariffs, increasing the nominal tariff revenue.

Lastly, instead of focusing on the trajectory of welfare changes along a series of counterfactual changes, I focus on the welfare quantification from a specific counterfactual experiment, in which I decrease the iceberg trade cost by 15%. I further decompose the

Table 7: Welfare Quantification and Decomposition

	Δ_i (Welfare)	$\Delta\ \frac{w_i L_i}{P_i}$	$\Delta\ \frac{T_i}{P_i}$	$\Delta\ \frac{TR_i}{P_i}$
Experiment 2: 15% reduction in τ_{ij}	5.95	5.12	0.33	0.50

Notes. All numbers in this table are measured in percent of benchmark welfare. The decomposition of welfare gains is as in (62). $\Delta\ \frac{w_i L_i}{P_i}$, $\Delta\ \frac{T_i}{P_i}$, $\Delta\ \frac{TR_i}{P_i}$, are changes in real wages, real tax rebates, and real tariff revenue, respectively.

total welfare gains into welfare gains from each of the sources.

As is summarized in Table 7, a 15% decrease in the iceberg trade cost improves consumer welfare by 5.95%. This improvement in consumer welfare is mostly due to the increase in real wages, which accounts for 86% of the gains.

7.3 Global Reduction in Tariffs

In the third counterfactual experiment, I globally reduce the import tariffs by 8% such that the share of corrupt firms is reduced by 10%. The counterfactual change in tariffs is therefore specified as:

$$\widehat{\kappa}_{ij} = \begin{cases} 0.92 & \text{if } i \neq j \\ 1 & \text{if } i = j \end{cases}, \tag{64}$$

where $\widehat{\kappa}_{ij}$ is the "exact hat" algebra in the spirit of Dekle *et al.* (2007), which is defined as the ratio of the counterfactual value of the import tariffs, ${\kappa_{ij}}'$, to the actual value of the import tariffs, κ_{ij}. The average applied import tariff for all products in China is approximately 10%. I assume the tariff revenue, TR_i, are lump-sum transfers to the representative consumer. TR_i is calculated as in (23).

This experiment differs from Experiment 2 in that trade liberalization becomes costly. In Experiment 2, I assume there is zero policy cost associated with reducing the iceberg trade cost. In this experiment, however, when import tariffs are reduced globally, I have to take into account the fact that consumers are losing their tariff revenue. Therefore, I consider the loss of tariff revenue as the implementation costs of import tariff reduction.

I calculate the welfare gains (losses), Δ_i, for a continuum of changes in the import tariffs. Specifically, when $i \neq j$, I equally space the closed interval of $\widehat{\kappa}_{ij}$ into 100 grids, with the maximum being $(\widehat{\kappa}_{ij})_{max} = 1$ and the minimum being $(\widehat{\kappa}_{ij})_{min} = 0.92$. This experiment is costly in the sense that the implementation of the import tariff reduction is associated with losses of tariff revenue. This quantification exercise allows me to obtain a clear trajectory of the welfare changes, Δ_i, for multiple rounds of global trade liberalization, which may reduce the import tariffs through a gradual adjustment process. Also, this exercise has a broad audience among policymakers. Through the lens of the model, import tariff reduction exerts impacts on both international trade and domestic corruption engagement. Policymakers, who are either intending to encourage international trade or to combat domestic corruption, share interest in leveraging import tariff reduction as one of their policy tools. Moreover, compared with factors impacting the iceberg trade costs, say, bilateral distance, common languages and common former colonies, import tariffs are more feasible for policymakers to leverage. I plot the welfare gains, Δ_i, along a continuum of changes in the import tariffs in Figure 8.

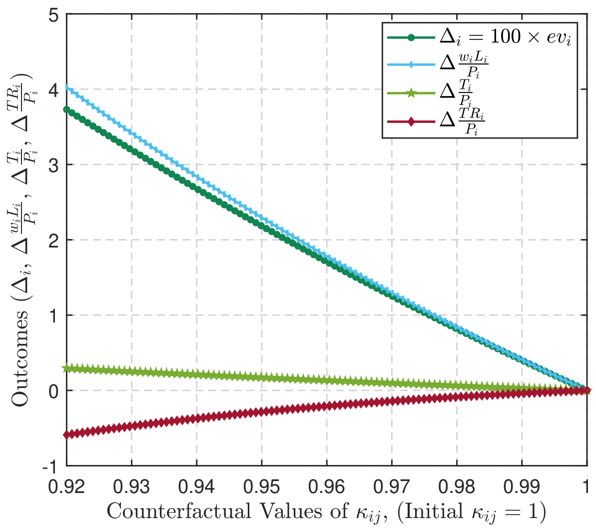


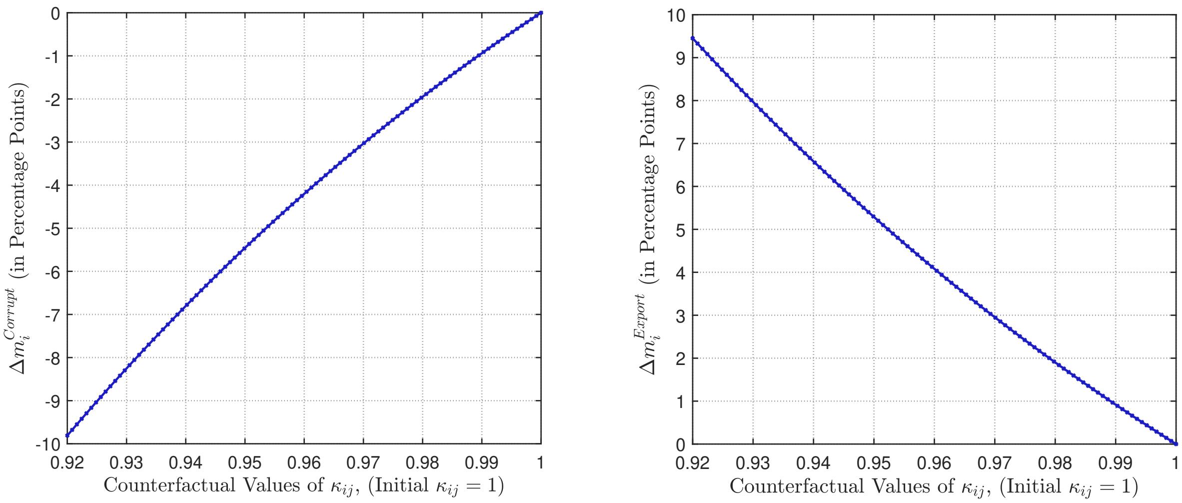
Figure 8: Results of Experiment 3

The results indicate that the representative consumer in all countries would gain from a hypothetical global trade liberalization which reduces import tariffs. Also, I calculate and plot the share of corrupt firms, $m_i^{Corrupt}$, and the share of exporters to destination j, m_{ij}, against the series of counterfactual changes in import tariffs in Figure 9. It is clear that a decrease in the import tariffs gives rise to a decrease in the share of corrupt firms and an increase in the share of exporters.

In sum, a global reduction in import tariffs not only achieves its policy target of encouraging international trade, but also it manages to combat domestic corruption as the share of corrupt firms decreases. Welfare increases along the trajectory, with a nontrivial magnitude.

To understand the sources of welfare gains, I decompose the welfare in origin country i as in (62).

In Figure 8, I plot the real wages, real tax rebates and real tariff revenue against the



(a) Share of Corrupt Firms

(b) Share of Exporting Firms

Figure 9: Results of Experiment 3

counterfactual changes of the import tariffs. Clear as it is from the figure, a reduction in import tariffs increases total consumer welfare by increasing real wages and real tax rebates, though the reduction in import tariffs decreases real tariff revenue. A detailed argument for each source of the overall welfare change is as follows.

First, the increase in real wages is mainly driven by the decrease in aggregate price index, P_i. On the extensive margin, when the import tariffs decrease globally, the productivity cutoff for exporting from country j to country i, $\varphi^*_{ji,nc}$, decreases. As a result, there are more highly productive exporters serving country i from country j. Through the lens of the model, changes in firm productivity are fully passed on to changes in goods prices. Therefore, that relatively more productive exporters in country j start to serve market i, drives down the prices of goods. On the intensive margin, when the import tariffs decrease globally, those exporters in country j who serve market i even before trade liberalization happens, now still export to market i but with a lower destination price. Combining adjustments of prices of goods along the intensive and extensive margins, the aggregate price index, P_i, decreases when there is a reduction in import tariffs. Second, besides the decrease in the aggregate price index, the increase in real tax rebates is partially due to the decrease in the share of corrupt firms. This is because a decrease in the share of corrupt firms that are charged a lower tax rate results in an increase in the share of non-corrupt firms that are charged a higher tax rate, meaning an increase in nominal tax rebates. Third, though there is the decrease in the aggregate price index, the decrease in nominal tariff revenue is dominant, making the real tariff revenue decrease.

This decrease in nominal tariff revenue is intuitive in the sense that when import tariffs are reduce, consumers suffer from losses of their tariff revenue.

Table 8: Welfare Quantification and Decomposition

	Δ_i (Welfare)	$\Delta\ \frac{w_i L_i}{P_i}$	$\Delta\ \frac{T_i}{P_i}$	$\Delta\ \frac{TR_i}{P_i}$
Experiment 3: 8% reduction in κ_{ij}	3.73	4.03	0.29	-0.59

Notes. All numbers in this table are measured in percent of benchmark welfare. The decomposition of welfare gains is as in (62). $\Delta\ \frac{w_i L_i}{P_i}$, $\Delta\ \frac{T_i}{P_i}$, $\Delta\ \frac{TR_i}{P_i}$, are changes in real wages, real tax rebates, and real tariff revenue, respectively.

Lastly, instead of focusing on the trajectory of welfare changes along a series of counterfactual changes, I focus on the welfare quantification from a specific counterfactual experiment, in which I globally reduce import tariffs by 8%. I further decompose the total welfare gains into welfare gains from each of the sources.

As is summarized in Table 8, a global reduction in import tariffs by 8% improves consumer welfare by 3.73%. The increases in real wages and real tax rebates contribute positively to the gains in consumer welfare, by 4.03 and 0.29 percentage points, respectively. Real tariff revenue decreases; this decrease contributes negatively to the gains in consumer welfare by 0.59 percentage points.

8 Discussions

This section compares outcomes among different counterfactual experiments, with a particular interest in (i) evaluating the preferability of anti-corruption-related policies in terms of their welfare implications; (ii) quantifying the share of firms that "miss from trade" due to domestic corruption; (iii) shedding light on a novel channel of welfare gains from trade liberalization; (iv) understanding the difference in effectiveness between iceberg trade cost reduction and tariff reduction in terms of curbing domestic corruption.

8.1 Policy Preferability

To assess policy preferability in combating domestic corruption, I make pairwise comparisons among Experiments 1, 2 and 3 in terms of their associated gains in consumer welfare. In Experiment 1, a domestic anti-corruption campaign is performed by a 17% increase in the fixed cost of corruption such that the share of corrupt firms is reduced by 10%. Though to some extent the domestic anti-corruption campaign has effects on increasing the share of exporters (as in Table 10) and improving consumer welfare (as in Table 9), both magnitudes are only moderate, increasing by 1% and 0.65%, respectively.

Table 9: Welfare Quantification and Decomposition

	Δ_i (Welfare)	$\Delta\ \frac{w_i L_i}{P_i}$	$\Delta\ \frac{T_i}{P_i}$	$\Delta\ \frac{TR_i}{P_i}$
Experiment 1: 17% increase in f_i^c	0.65	0.29	0.33	0.03
Experiment 2: 15% reduction in τ_{ij}	5.95	5.12	0.33	0.50
Experiment 3: 8% reduction in κ_{ij}	3.73	4.03	0.29	-0.59

Notes. All numbers in this table are measured in percent of benchmark welfare. The decomposition of welfare gains is as in (62). $\Delta\ \frac{w_i L_i}{P_i}$, $\Delta\ \frac{T_i}{P_i}$, $\Delta\ \frac{TR_i}{P_i}$, are changes in real wages, real tax rebates, and real tariff revenue, respectively.

In Experiment 2, one approach to trade liberalization is performed by a 15% reduction in iceberg trade costs such that the share of corrupt firms is reduced by 10%. In terms of effects on international trade, this reduction in iceberg trade costs increases the share of exporters by 10%, which is clearly larger than the effect from the domestic anti-corruption campaign in Experiment 1. Also, compared to Experiment 1, this policy is associated with a significantly larger welfare effect.

Table 10: Impacts on Domestic Corruption and International Trade

	$\Delta\ m_i^{Corrupt}$	$\Delta\ m_i^{Export}$
Experiment 1: 17% increase in f_i^c	-10	1
Experiment 2: 15% reduction in τ_{ij}	-10	10
Experiment 3: 8% reduction in κ_{ij}	-10	10

Notes. All numbers in this table are measured in percentage points. $\Delta\ m_i^{Corrupt}$ and $\Delta\ m_i^{Export}$ are changes in the share of corrupt firms and the share of exporters in China, respectively.

Another approach to trade liberalization is shown in Experiment 3, in which import tariffs are reduced by 8% such that the share of corrupt firms is reduced by 10%. In terms of effects on international trade, the reduction of import tariffs by 8% increases the share of exporters by 10%, which is a much larger effect than that in Experiment 1. Also, the reduction of import tariffs by 8% increases consumer welfare by 3.73%, which is significantly larger than the consumer welfare changes in Experiment 1.

In sum, the quantification of multiple counterfactual experiments provides a takeaway that, conditional on the same reduction in the level of domestic corruption, trade liberalization is preferable to direct anti-corruption campaigns in terms of the associated gains in consumer welfare. Therefore, trade liberalization policies ought to be taken seriously by policymakers when combating domestic corruption.

8.2 "Missing Trade" Resulting from Domestic Corruption

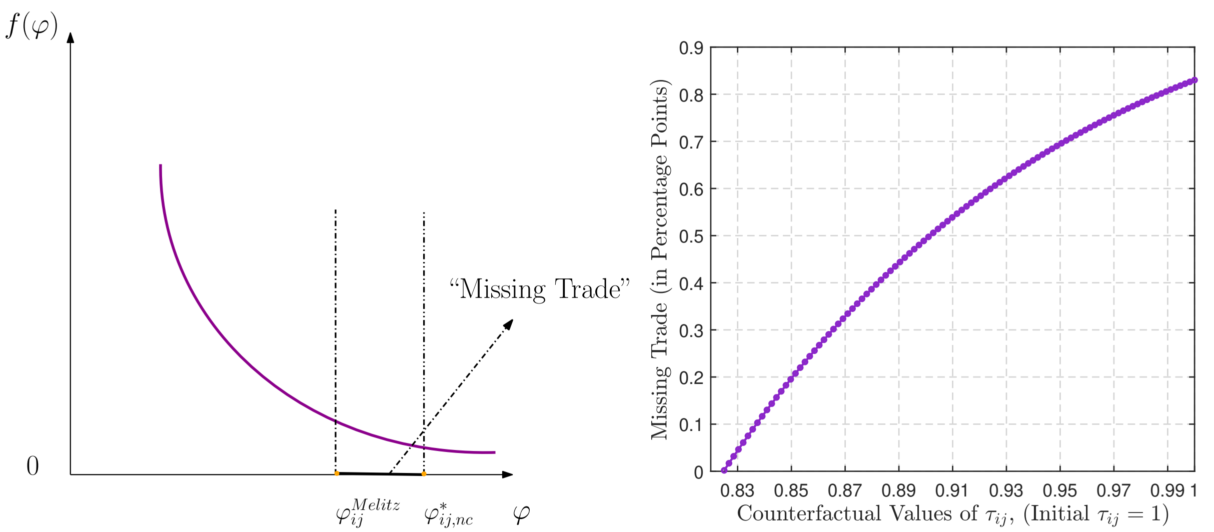
Domestic corruption has a trade-dampening effect, which constitutes a potential explanation of "Missing Trade".

As is shown in Panel (a) of Figure 10, the productivity cutoff for exporting from my model exceeds that from the Melitz model. I quantify the share of firms that "miss from trade" as follows:

$$\Delta m_{ij}^{Missing} = F(\varphi_{ij,nc}^{*}) - F(\varphi_{ij}^{Melitz}). \tag{65}$$

In the baseline simulation, domestic corruption generates "Missing Trade" such that the share of exporters from my model is one percentage point less than that from the Melitz model.

I then leverage trade liberalization as the tool to mitigate the issue of "Missing Trade". Specifically, I ask the question: how much reduction in iceberg trade costs would eliminate "Missing Trade" resulting from firms' engagement in domestic corruption?



(a) "Missing Trade" Resulting from Corruption (b) "Missing Trade" Versus Trade Liberalization

Figure 10: Quantification of "Missing Trade"

In Panel (b) of Figure 10, I simulate the share of firms that "miss from trade" when iceberg trade costs are reduced gradually. As is shown by the figure, trade liberalization is effective in mitigating the issue of "Missing Trade". In particular, when iceberg trade costs are reduced by 18% relative to the benchmark, the issue of "Missing Trade" is completely eliminated.

8.3 Gains From Trade Liberalization

To shed light on a novel channel of gains from trade liberalization, I conduct three new counterfactual experiments and contrast the difference in numbers on welfare gains between Experiments 4 and 5 as shown in Table 11. Calibrated to the identical benchmark data, Table 11 shows that the total welfare gains in Experiment 4 are higher than those in Experiment 5 by 0.47 percentage points. Perusing the decomposition of welfare gains indicates that the larger welfare gains in Experiment 4 mainly come from the larger increase in real wages and real tax rebates. This decomposition is illuminating in the sense that it reveals an additional channel, besides those embedded in the Melitz (2003) model, through which trade cost reduction increases welfare. In a trade model with firm heterogeneity in productivity and domestic corruption engagement, trade cost reduction decreases the share of corrupt firms, on one hand, alleviating the distortions created by the differential tax wedges, and on the other hand, decreasing the units of labor wasted in paying the fixed cost of corruption. Since this channel through which trade cost reduction decreases the share of corrupt firms is shut down in the Melitz (2003) model in Experiment 5, both changes of real wages and real tax rebates appear smaller.

Table 11: Welfare Quantification and Decomposition

	Δ_i (Welfare)	$\Delta\ \frac{w_i L_i}{P_i}$	$\Delta\ \frac{T_i}{P_i}$	$\Delta\ \frac{TR_i}{P_i}$
Experiment 4: 10% reduction in τ_{ij}	3.51	3.02	0.20	0.29
Experiment 5: 10% reduction in τ_{ij} (Melitz)	3.04	2.78	0	0.26
Experiment 6: 10% reduction in κ_{ij}	4.34	4.73	0.34	-0.73

Notes. All numbers in this table are measured in percent of benchmark welfare. The decomposition of welfare gains is as in (62). $\Delta\ \frac{w_i L_i}{P_i}$, $\Delta\ \frac{T_i}{P_i}$, $\Delta\ \frac{TR_i}{P_i}$, are changes in real wages, real tax rebates, and real tariff revenue, respectively.

In sum, I argue that my findings broadly provide a novel channel of gains from trade liberalization through curbing domestic corruption; such a channel is missing in the previous canonical models of trade. Because the results show that policies related to trade liberalization reduce domestic corruption, my work also has potentially important implications, especially to policymakers in developing countries with prevalent domestic corruption.

8.4 Difference in Policy Effectiveness

In this section, I compare the effectiveness of iceberg trade cost reduction with tariff reduction in terms of curbing domestic corruption. Subsequently, I discuss their welfare implications. The takeaways from this section are that (i) a 10 percent reduction in import tariffs yields a larger reduction in the share of corrupt firms than does the same reduction in iceberg trade costs; and (ii) a 10 percent reduction in import tariffs yields greater gains in consumer welfare than does the same reduction in iceberg trade costs. This latter is true even given the associated loss of tariff revenue.

Table 12: Impacts on Domestic Corruption and International Trade

	$\Delta\ m_i^{Corrupt}$	$\Delta\ m_i^{Export}$
Experiment 4: 10% reduction in τ_{ij}	-6	6
Experiment 5: 10% reduction in τ_{ij} (Melitz)	--	5
Experiment 6: 10% reduction in κ_{ij}	-11	11

Notes. All numbers in this table are measured in percentage points. $\Delta\ m_i^{Corrupt}$ and $\Delta\ m_i^{Export}$ are changes in the share of corrupt firms and the share of exporters in China, respectively.

To shed light on the difference in effectiveness between iceberg trade cost reduction and import tariff reduction in terms of curbing domestic corruption, I compare results from Experiments 4 and 6. As is shown in Table 12, a 10% reduction in import tariffs brings down the share of corrupt firms by 11%, which is much larger than the 6% decrease in the share of corrupt firms that results from a 10% reduction in iceberg trade costs. The larger impact is because firms' export profits are more elastic with respect to import tariffs than they are with respect to iceberg trade costs. This argument is described by the following two equations:

$$\frac{\partial \ln \pi_{ij}(\varphi)}{\partial \ln \tau_{ij}} = 1 - \sigma; \tag{66}$$

$$\frac{\partial \ln \pi_{ij}(\varphi)}{\partial \ln \kappa_{ij}} = -\sigma. \tag{67}$$

To intuitively understand the difference between the two elasticities above, assume a scenario in which both iceberg trade costs and import tariffs experience the same percentage increase. In the case of iceberg trade costs, firms' profit maximization leads to the complete pass-through of iceberg trade costs into destination prices. This ability to adjust prices makes firms' profits less vulnerable to exogenous shocks. In contrast, firms cannot adjust prices when import tariffs change. This inability to adjust prices makes firms' profits more vulnerable to exogenous shocks.

I then show that tariff reduction brings greater gains in consumer welfare than does an iceberg trade cost reduction, by comparing welfare implications of Experiments 4 and 6. As is shown in Table 11, a 10% reduction in import tariffs increases consumer welfare by 4.34%, which is much larger than the 3.51% increase in consumer welfare resulting from a 10% reduction in iceberg trade costs. This finding is striking in that there are implementation costs associated with tariff reduction while there are zero implementation costs associated with iceberg trade cost reduction. When there is reduction in import tariffs, consumers are losing part of their income in the form of tariff revenue, which means losses in one source of consumer welfare. However, the elasticity of firms' export profits with respect to tariffs is larger than the elasticity of firms' export profits with respect to iceberg trade costs. Therefore, tariff reduction is more capable of encouraging both the intensive and the extensive margins of trade. As a result, gains in consumer welfare associated with trade liberalization are larger in the tariff reduction scenario even though tariff revenue is reduced.

9 Conclusion

I develop a model of trade with heterogeneous firms that features endogenous corruption and export participation decisions. In the model, firms face the trade-off between engaging in corruption, thereby obtaining higher profits in the domestic market, or preserving their non-corrupt status in foreign markets to obtain higher export profits. Hence, under trade liberalization, the share of corrupt firms decreases while the share of exporters increases. As it turns out, the corruption-dampening effect of trade liberalization has not yet been carefully assessed in canonical models of trade.

More importantly, although trade liberalization is an indirect policy tool in terms of fighting the prevalence of domestic corruption, it is as effective as a direct policy of anti-corruption campaign that targets domestic corruption specifically. In addition, the counterfactual experiments point out that trade liberalization, when used as a tool to curb domestic corruption, dominates a direct anti-corruption policy (i.e., an increase in the fixed costs of corruption), in terms of bring about associated gains in consumer welfare. These results have important implications that (i) high importance ought to be attached to trade liberalization when combating domestic corruption; and (ii) policymakers who ignore the corruption-dampening effect of trade liberalization fail to facilitate trade cost reduction to the best extent.

The lack of data on firm-level corruption expenses for a large set of countries, restricts my setup of a theoretical framework in a multi-country environment. However, my calibrated two-country model that provides quantitative predictions on the share of exporters, the share of corrupt firms, and the welfare gains under multiple policy scenarios, should be a good first-order approximation of a multi-country model with identical features, especially when the magnitude of the policy changes are not too large. I leave the exploration of a multi-country framework for future research.

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Appendix A. Proof of Propositions

Here, I provide details on the proofs of proposition 1 and proposition 2 appearing in the main text under three parametric restrictions from **R1** to **R3**. Proposition 2 characterizes a key feature of my model, which is supported by data evidence. Also, once calibrating my model to the real data, the model primitives satisfy the three parametric restrictions depicted by **R1**-**R3**. I next turn to describing other propositions that hold true with different parametric assumptions as well as their proofs. At the end of the day, my theoretical analysis of firms' exporting and corruption engagement exhausts the whole parametric space. For the following analysis, I assume the world is composed of two identical countries. I therefore, subsume country indices for expositional convenience.

A.1. Proof of Proposition 1

Proposition 1 states that under **R2** and conditional on exporting, firms do not engage in domestic corruption.

To show the validity of proposition 1 under **R2**, it suffices to show that the total profits from being a non-corrupt exporter always exceed those from being a corrupt exporter, i.e.,

$$\pi_{NC}^{E}(\varphi) - \pi_{C}^{E}(\varphi) > 0. \tag{A.1}$$

Substituting expressions of $\pi_{NC}^{E}(\varphi)$ as in (16) and $\pi_{C}^{E}(\varphi)$ as in (15) into (A.1), I derive

$$\pi_{NC}^{E}(\varphi) - \pi_{C}^{E}(\varphi) = \frac{(1-a)\tau^{1-\sigma}\kappa^{-\sigma} - (t^h - t^l)}{\sigma}\left(\frac{\sigma}{\sigma-1}\frac{w}{\varphi}\right)^{1-\sigma} IP^{\sigma-1} + wf^c. \tag{A.2}$$

For (A.1) to hold true, it suffices to require that $(1-a)\tau^{1-\sigma}\kappa^{-\sigma} - (t^h - t^l) > 0$, which is guaranteed by **R2**.

A.2. Proof of Proposition 2

Proposition 2 states that under restrictions from **R1** to **R3**, firms with productivity, φ, such that $\varphi_{ii,nc}^{*} < \varphi < \varphi_{ii,c}^{*}$, only sell in the domestic market and do not engage in domestic corruption; firms with productivity, φ, such that $\varphi_{ii,c}^{*} < \varphi < \varphi_{ij,nc}^{*}$, only sell in the domestic market and engage in domestic corruption; and firms with productivity, φ, such that $\varphi > \varphi_{ij,nc}^{*}$, both sell in domestic and foreign markets, and do not engage in domestic corruption.

To show the validity of proposition 2 under parametric restrictions from **R1** to **R3**, it suffices to show that firms' productivity cutoffs of exiting, $\varphi_{ii,nc}^{*}$, engaging in domestic corruption, $\varphi_{ii,c}^{*}$, and exporting, $\varphi_{ij,nc}^{*}$, rank as follows:

$$\varphi_{ii,nc}^{*} < \varphi_{ii,c}^{*} < \varphi_{ij,nc}^{*}. \tag{A.3}$$

First, I show the productivity cutoff of exiting, $\varphi_{ii,nc}^{*}$, is less than that of engaging in domestic corruption, $\varphi_{ii,c}^{*}$. Substituting the expressions of $\varphi_{ii,nc}^{*}$ as in (20) and $\varphi_{ii,c}^{*}$ as in (22) into (A.3), I derive

$$\frac{wf}{\frac{1-t^h}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} IP^{\sigma-1}} < \frac{wf^c}{\frac{t^h-t^l}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} IP^{\sigma-1}}. \tag{A.4}$$

Simplifying (A.4) derives

$$f^c > \frac{t^h - t^l}{1 - t^h} f, \tag{A.5}$$

which is equivalent to **R1**.

Second, showing the productivity cutoff of engaging in domestic corruption, $\varphi_{ii,c}^{*}$, is less than that of exporting, $\varphi_{ij,nc}^{*}$, I substitute the expressions of $\varphi_{ii,c}^{*}$ as in (22) and $\varphi_{ij,nc}^{*}$ as in (24) into (A.3) and derive

$$\frac{wf^c}{\frac{t^h-t^l}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} IP^{\sigma-1}} < \frac{w(f^x-f^c)}{\frac{\tau^{1-\sigma}\kappa^{-\sigma}-(t^h-t^l)}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} IP^{\sigma-1}}, \tag{A.6}$$

where f^x is the symmetric fixed cost of exporting. Simplifying (A.6) derives

$$f^x > \frac{\tau^{1-\sigma}\kappa^{-\sigma}}{t^h-t^l} f^c, \tag{A.7}$$

which is equivalent to **R3**.

A point worth of mentioning is that when **R2** holds, it is true that $\frac{\tau^{1-\sigma}\kappa^{-\sigma}}{t^h-t^l} > 1$. Therefore, the fixed cost of exporting exceeds that of engaging in domestic corruption, i.e., $f^x > f^c$. This completes my proof of the two propositions appearing in the main text.

Appendix B. Solving for the Number of Firms, N_i

In this appendix, I pin down the number of firms that have ever paid the fixed cost of entry in the origin country, through combining the labor market clearing condition and the zero expected profit condition.

B.1. Labor Market Clearing Condition

The labor market is cleared when total labor supply is equal to the sum of various sources of labor demand. On the supply side, the representative household is equipped with L_i amount of labor endowment, which is supplied inelastically to a measure of heterogeneous firms. On the demand side, there are several sources that require labor for, respectively, producing goods, $l_{ij}(\varphi)$, paying the fixed cost of accessing market j, f_{ij}, paying the fixed cost of corruption, f_i^c, and paying the fixed cost of entry, f_i^e.

To find out the total demand of labor, I next turn to finding out the labor demand from each of the sources.

The labor demand for a generic firm with productivity, φ, serving the market in destination country j is equal to units of output shipped to destination j divided by firm productivity:

$$l_{ij}(\varphi) = \frac{q_{ij}(\varphi)\tau_{ij}}{\varphi}. \tag{B.1}$$

Therefore, the labor demand in origin i that is used in goods production is:

$$L_i^{Production} = \sum_j N_i \int_{\varphi_{ij}} l_{ij}(\varphi) f(\varphi) d\varphi, \tag{B.2}$$

where $\varphi_{ij} = \varphi^*_{ij,nc}$, and $f(\varphi)$ is the p.d.f. of the distribution of firm productivity, φ.

A firm in country j with productivity, φ, such that $\varphi > \varphi^*_{ji,nc}$, is an exporter to country i after paying the fixed cost of exporting, f_{ji}, in terms of labor in country i. Therefore, the demand of labor in country i for paying the fixed cost of export is the sum of fixed costs of export paid by all exporters to country i:

$$L_i^{Export} = \sum_j N_j \int_{\varphi_{ji}} f_{ji} f(\varphi) d\varphi. \tag{B.3}$$

A firm in country i with productivity, φ, such that $\varphi^*_{ii,c} < \varphi < \varphi^*_{ij,nc}$, engages in domestic corruption and pays the fixed cost of corruption, f_i^c. Therefore , the demand of labor in country i used to pay for the fixed cost of domestic corruption is the sum of the fixed cost of corruption paid by all corrupt firms:

$$L_i^{Corruption} = N_i \int_{\varphi^*_{ii,c}}^{\varphi^*_{ij,nc}} f_i^c f(\varphi) d\varphi. \tag{B.4}$$

Since N_i is the number of firms in country i that have ever paid for the fixed cost of entry, and the fixed cost of entry, f_i^e, is paid in terms of origin labor, the labor demand in country i that is used to compensate for the fixed cost of entry is simply:

$$L_i^{Entry} = N_i f_i^e. \tag{B.5}$$

As it turns out, the total labor demand is constituted as the sum of labor demand from all sources as follows:

$$L_i^D = L_i^{Production} + L_i^{Export} + L_i^{Corruption} + L_i^{Entry}. \tag{B.6}$$

Total labor supply is simply set to be exogenously equal to total labor endowment, L_i:

$$L_i^S = L_i. \tag{B.7}$$

Hence, the labor market clearing condition is described by the equality between total labor demand and total labor supply:

$$L_i^D = L_i^S. \tag{B.8}$$

Now I am ready to impose the free entry condition, with which firms are expected to earn zero profit upon entry.

B.2. Free Entry Condition

Before entry, a firm has knowledge of magnitude of the fixed cost of entry, f_i^e. The fixed cost of entry has a sunk cost nature in the sense that after entering the market, f_i^e no longer affects the firm's choices among exiting, engaging in domestic corruption, and/or exporting. Also, although the firm knows nothing about its productivity level when deciding to enter the market, it does have knowledge of the distribution of its productivity, specifically, knowledge of the distribution type and parameter values.

The combination of knowledge of productivity distribution and the fixed cost of entry allows the firm to form its expectation on profits, and to compare the expected profits to the fixed cost of entry. In the equilibrium the expected profits must equal the fixed cost of entry such that the number of firms that have ever paid the fixed cost of entry is stable. Hence, the following equation must hold true in the equilibrium:

$$E_\varphi(\sum_j \pi_{ij}(\varphi)) = w_i f_i^e. \tag{B.9}$$

B.3. Number of Firms in the Equilibrium

Combining the labor market clearing condition as in (B.8) and the free entry condition as in

(B.9), I am able to pin down the number of firms that have ever paid their fixed cost of entry, N_i, as follows:

$$A_i = \sum_j (\sigma - 1)(\varphi_{ij}^{Melitz})^{1-\sigma} f_{ij} \frac{\theta}{\theta - (\sigma - 1)} b_i^{\theta} (\varphi_{ij})^{(\sigma-1)-\theta}; \tag{B.10}$$

$$B_i = \sum_j f_{ji} b_j^{\theta} (\varphi_{ji})^{-\theta}; \tag{B.11}$$

$$C_i = f_i^c b_i^{\theta} ((\varphi_{ii,c}^*)^{-\theta} - (\varphi_{ij})^{-\theta}); \tag{B.12}$$

$$D_i = f_i^e; \tag{B.13}$$

$$N_i = \frac{L_i}{A_i + B_i + C_i + D_i}, \tag{B.14}$$

where A_i, B_i, C_i and D_i are auxiliary variables deployed for expositional convenience of N_i. φ_{ij}^{Melitz} is the productivity cutoff of exporting in the Melitz (2003) model such that

$$\varphi_{ij}^{Melitz} = \left[\frac{w_j f_{ij}}{\frac{\tau_{ij}^{1-\sigma} \kappa_{ij}^{-\sigma}}{\sigma} (\frac{\sigma}{\sigma-1} w_i)^{1-\sigma} I_j P_j^{\sigma-1}} \right]^{\frac{1}{\sigma-1}}. \tag{B.15}$$

Appendix C. Data

The reference year for all data is 2004. Trade data are from the custom dataset collected by China General Administration of Customs. Each observation is reported at the firm-product-destination level. I aggregate firm-product-destination-level trade flows into firm-destination-level trade flows. Following the literature as in Cai *et. al.* (2011), firm-level corruption expenses are proxied for using the sum of entertainment, traveling and conference expenses (ETC). ETC appears as an additional accounting item in the firm-level production dataset collected by China's National Bureau of Statistics (NBS) in 2004 but not in other years. This specialty is due to the fact that the firm-level production data in 2004 happens to include additional variables documented from the firm census dataset in 2004. Due to changing scopes of variable documentation, ETC is no longer documented in subsequent years of firm census. To identify corrupt firms, I construct the ratio of ETC to firm revenue (ETCR) and generate data on firms' corruption engagement using the distribution of ETCR and data on the share of corrupt firms from World Bank Enterprise Survey (2004). Specifically, I define a threshold h^* in the distribution of ETCR and identify a corrupt firm if its ETCR exceeds h^*, otherwise the firm is taken as one who does not engage in corruption. At the end of the day, h* is calibrated to real data on the share of corrupt firms. The data on firm-level productivity is estimated as the Levinsohn-Petrin (2003) TFP using information from the firm-level production dataset. Given the flexible nature of intermediate inputs, the Levinsohn-Petrin (2003) approach addresses the problem of "lumpy investment" associated with the Olley-Pakes (1996) TFP estimator. I therefore, take the Levinsohn-Petrin (2003) estimates as my measure of firm TFP. The data on import tariffs are from UNCTAD Trade Analysis Information System (TRAINS) which provides tariff data at HS6 product level. I calculate simple averages of tariffs across all available product categories at HS6 classification for each bilateral pair. Data on bilateral distance, adjacency dummies and common language dummies are from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII, 2015). Differential tax rates on domestic revenue are taken from the literature as in Chen *et. al.* (2021). The data on cross-country wages are obtained from the Socio-Economic Accounts released by Groningen Growth and Development Centre (GGDC, 2016).

Appendix D. Dataset Matching

Estimating the corruption aversion parameter, a_{ij}, necessitates a dataset, in which the firm-level productivity and firm-product-destination-level trade flows are observed. To meet the data requirement, I merge the firm-destination-level trade flows collected by China General Administration of Customs with the firm-level production data collected by China's National Bureau of Statistics in 2004. The merged dataset reports observations at the firm-product-destination level. I first proceed to talk about specifics in the data sources, and then turn to describing my matching strategy.

D.1. Data Sources

The first component of the merged dataset is the firm-level production data, which is annually collected by China's National Bureau of Statistics for all state-owned enterprises (hereafter, SOEs) and all scale-up[8] enterprises of other ownership types. The firm-level production data is available from 1998 to 2013. The specific year used in this paper is 2004. This dataset documents information on firm identifiers (name, zip code, phone, address, ...), annual production, income statement and balance sheet.

The second component of the merged dataset is the firm-product-destination-level trade data, which is collected by the General Administration of Customs. The available time periods range from 2000 to 2016. The specific year used in this paper is 2004. This trade dataset reports information on firm identifiers (name, zip code, phone, address ...), export values, export quantities, product categories at HS8 classification, destination countries, ports, etc....

D.2. Matching Strategy

Before merging the firm-level production data with the firm-product-destination-level trade data, I first clean the firm-level production data following Feenstra et al. (2014), Cai and Liu (2009), and the General Accepted Accounting Principles to discard outliers, observations with key identification or financial information missing, and observations that violate basic accounting rules. I next turn to merging the firm-level production data with the firm-product-destination-level data in two steps following Yu et al. (2005). In the first step, I simply merge the two datasets in the same year by firm name. Approximately, 90% of the observations in the matched dataset are results of the first step. In the second step, I further merge the "unsuccessful observations" by postal code and last 7-digit phone number.

I report the matched statistics in Table 13. With the filtered sample, the two-step matching strategy successfully matches 38,433 observations, which account for about 20% of firms in the filtered firm-level production dataset.

[8]Before 2011, a firm is defined as scale-up when its revenue from main activity exceeds 5 millions Chinese Yuan. After 2011, a firm is defined as a scale-up one only when its revenue from main activity exceeds 20 millions Chinese Yuan.

Table 13: Matched Statistics - Number of Firms

	Trade Data		Production Data		Matched Data			
Year	Transactions (1)	Firms (2)	Raw firms (3)	Filtered firms (4)	w/Raw firms (5)	w/Filtered firms (6)	w/Raw firms (7)	w/Filtered firms (8)
2004	19,703,008	153,779	271,086	199,847	42,791	35,626	45,830	38,433

Notes. Column (1) reports number of observations of HS eight-digit monthly transaction-level trade data from China's General Administration of Custom by year. Column (2) reports number of firms covered in the transaction-level trade data by year. Column (3) reports number of firms covered in the firm-level production data set compiled by China's National Bureau of Statistics without any filtering and cleaning. By constrast, column (4) presents number of firms covered in the firm-level production data set with careful filtering according to GAAP requirements. Accordingly, column (5) reports number of matched firms using exactly identical company names in both the trade data set and the raw production data set. By contrast, column (6) reports number of matched firms using exactly identical company names in both the trade data set and the filtered production data set. Column (7) reports number of matched firms using exactly identical company names and exactly identical postal codes and phone numbers in both the trade data set and the raw production data set. By constrast, column (8) reports number of matched firms using exactly identical company names and exactly identical postal codes and phone numbers in both the trade data set and the filtered production data set.

Appendix E. Indirect Utility and Welfare Changes

Given the aggregate price index, $\{P_j\}$, in country j, I derive the indirect utility function using the Marshallian demand in (3):

$$V(P_j, I_j) = \frac{I_j}{P_j}. \tag{E.1}$$

Under hypothetical trade liberalization, the representative consumers in country j will face a different total income, I_j', and a new aggregate price index, P_j' . To measure changes in welfare, I employ the concept of equivalent variation, ev_j, defined as the additional income (normalized by the initial income) at prices ex ante trade liberalization, P_j, necessary to make representative consumers in country j indifferent to ex ante and ex post trade liberalization equilibria:

$$V(P_j, I_j(1 + ev_j)) = V(P_j', I_j'). \tag{E.2}$$

Given the functional form of $V(\cdot)$, ev_j has a closed-form solution as:

$$ev_j = \left(\frac{I_j'}{P_j'} \Big/ \frac{I_j}{P_j}\right) - 1. \tag{E.3}$$

Appendix F. Extensions

Here, I provide some extensions of the model by relaxing several model assumptions such that the key mechanisms and conclusions of the model mentioned in the main text remain robust.

F.1. Firm-level Trade-off in a Multi-Country Setup

In Section 3, I set up a two-country framework where firms face a trade-off between engaging in corruption, thereby obtaining higher profits in the domestic market, or preserving their non-corruption status in foreign markets to obtain higher export profits. I argue that the assumption of a two-country framework is not central to generate the trade-off. Here, I solve a version of the multi-country framework and show that the trade-off faced by firms is insensitive to such an extension.

For simplicity, I assume there are $S + 1$ countries in the world. I denote the set of countries as Ω such that $\Omega = i, k_1, k_2, ..., k_s$. Suppose all countries are identical except the fixed costs of export.

Without loss of generality, I consider firms in origin country i that decide whether to engage in domestic corruption by trading off domestic profits against export profits. Assume the fixed costs of export can be sorted such that $f_{ii} < f_{ik_1} < f_{ik_2} < ... < f_{ik_s}$. Therefore, a generic firm decides to engage in domestic corruption if its profits from being an exporter with corruption is larger than those from being an exporter without corruption as follows:

$$\left(\pi_{ii}^C(\varphi) + \sum_{j=k_1}^{k^C} \pi_{ij}^C(\varphi)\right) - \left(\pi_{ii}^{NC}(\varphi) + \sum_{j=k_1}^{k^{NC}} \pi_{ij}^{NC}(\varphi)\right) \geq 0. \tag{F.1}$$

By rearranging the left-hand side of (F.1), I derive the firm-level trade-off between profit losses in the export markets and profit gains in the domestic market as follows:

$$\left(\pi_{ii}^{C}(\varphi)+\sum_{j=k_1}^{k^C}\pi_{ij}^{C}(\varphi)\right)-\left(\pi_{ii}^{NC}(\varphi)+\sum_{j=k_1}^{k^{NC}}\pi_{ij}^{NC}(\varphi)\right)$$
$$=\underbrace{\left[\pi_{ii}^{C}(\varphi)-\pi_{ii}^{NC}(\varphi)\right]}_{\text{Profit gains from domestic market}}+\underbrace{\left[\sum_{j=k_1}^{k^C}\pi_{ij}^{C}(\varphi)-\sum_{j=k_1}^{k^{NC}}\pi_{ij}^{NC}(\varphi)\right]}_{\text{Profit losses from export markets}}\geq 0, \tag{F.2}$$

where k^{NC} and k^C are determined by the total number of destination countries that satisfy $\pi_{ij}^{NC}(\varphi) \geq 0$ and $\pi_{ij}^{C}(\varphi) \geq 0$, respectively. The two conditions imply that $k^{NC} > k^C$.

F.2. Adding a Variable Component to the Costs of Corruption

In Section 3, I model the costs of engaging in domestic corruption as fixed costs. In reality, it is reasonable to imagine situations where firms' costs of engaging in domestic corruption vary with firm sizes. I am agnostic about these mechanisms. However, I argue that, as long as the costs of engaging in domestic corruption grow less than proportionally to firm sizes, the selection effects that firms with medium productivity are non-exporters with domestic corruption and that firms with high productivity are exporters without domestic corruption, are insensitive to such an extension. Therefore, assuming the costs of engaging in domestic corruption exhibit a nature of fixed costs is just a reduced-form way of modeling to generate the selection effects. Here, I solve a version of the framework in which costs of corruption are composed of both a variable component related to firm sizes and a fixed component irrespective of firm sizes.

In the model, a firm's size grows at a rate of $\sigma - 1$ with respect to firm productivity, φ. To make the costs of corruption grow less proportionally to firm sizes, I specify the costs of engaging in domestic corruption as follows:

$$f^c(\varphi) = \underbrace{m * \varphi^b}_{\text{Variable Component}} + \underbrace{f^c}_{\text{Fixed Component}}, \tag{F.3}$$

where b is the rate of growth of the costs of corruption engagement with respect to firm productivity such that $0 < b < \sigma - 1$.

To examine the selection into domestic corruption, I compare profits from the following two modes:

$$\pi_{C}^{D}(\varphi) - \pi_{NC}^{D}(\varphi)$$
$$= \underbrace{\frac{t^h - t^l}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} IP^{\sigma-1}\varphi^{\sigma-1}}_{\text{Rate of Growth at } \sigma-1} - \underbrace{wm\varphi^b}_{\text{Rate of Growth at b}} - wf^c, \tag{F.4}$$

Therefore, there exists a productivity cutoff, φ_c^*, such that $\forall\varphi > \varphi_c^*$, $\pi_C^D(\varphi) \geq \pi_C^D(\varphi)$.

To examine the selection into exporting , I compare profits from the following two modes:

$$\begin{aligned}
&\pi^E_{NC}(\varphi) - \pi^D_C(\varphi) \\
&= \underbrace{\frac{(\tau^{1-\sigma}\kappa^{-\sigma}) - (t^h - t^l)}{\sigma}\left(\frac{\sigma}{\sigma-1}w\right)^{1-\sigma} IP^{\sigma-1}\varphi^{\sigma-1}}_{\text{Rate of Growth at } \sigma-1} \\
&+ \underbrace{wm\varphi^b}_{\text{Rate of Growth at b}} -(wf_x - wf^c),
\end{aligned} \tag{F.5}$$

It is clear from (F.5) that there exists a productivity cutoff, φ^*_x, such that $\forall\varphi > \varphi^*_x$, $\pi^E_{NC}(\varphi) \geq \pi^D_C(\varphi)$. Therefore, adding a variable component to the costs of engaging in domestic corruption does not change the selection effect that firms with high productivity are exporters without domestic corruption.