Interdependent Development: Market Access and Institutions in the Global Economy*

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Abstract

This paper develops a theory of interdependent development in which international trade and institutional quality reinforce each other. In the first step, we embed the incomplete-contract model of Acemoglu et al. (2007) into a Krugman-style general-equilibrium trade framework. The key result in this step is that per capita real income depends multiplicatively on real market access and institutional quality. In the second step, national planners choose institutional quality while weighing its costs. Larger real market access—through trade liberalization or neighboring reforms—raises the marginal benefit of institutional improvement, leading to higher institutional quality. Higher institutional quality, in turn, enlarges the country's real market access and creates cross-country institutional externalities that generate a flying-geese pattern of reforms. Due to the externalities, Nash and competitive equilibria underprovide institutional quality relative to the global optimum.

JEL codes: E02, O11, F12

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1 Introduction

The long-standing debate on the sources of economic development often contrasts geographic fundamentals with the quality of institutions: Diamond (1997) stresses geography's role, while Acemoglu et al. (2012) argue that institutions are decisive. Yet geography can shape institutions themselves. In this paper, we highlight one key geographic channel—market access[1]—and develop a theory of how it fosters institutional reform and, in turn, economic development. In particular, the conducive impacts of market access and trade on economic development have been widely documented empirically (Frankel and Romer, 1999; Ades and Glaeser, 1999; Alesina et al., 2000; Alcalá and Ciccone, 2004; Redding and Venables, 2004), and we are interested in understanding the role of institutions in this relationship. Our theory is motivated by the following two historical anecdotes.

The first is the post-war phenomenal growth of South Korea and Taiwan, both of which have been politically very close to the US and Japan since the Cold War era. The close political ties imply low trade barriers and large market access among these countries. After World War II and before the rise of Mainland China, the US had been the largest export destination for Japan, South Korea, and Taiwan. In other words, the market access to the US (and Europe in general) has substantially contributed to the growth of these three East Asian economies. One can dissect these growth phenomena further as Japan's post-war rapid growth started earlier than South Korea's and Taiwan's, which, in turn, started earlier than Mainland China's and Southeast Asian countries (except Singapore's). The market access to Japan may have also substantially contributed to the growth of South Korea and Taiwan. Clearly, these countries improve their economic institutions (not necessarily in terms of political institutions) along the way (Acemoglu and Robinson, 2012). Hence, there is a flying geese pattern (a.k.a., a positive domino effect) of institutional improvement and economic development.[2]

The second motivating anecdote is the Atlantic trade, as shown by Acemoglu et al. (2005). Even though they emphasize the role of the differential medieval institutions among Atlantic traders (England and the Netherlands vs. France, Portugal, and Spain) in their subsequent institutional reforms, the rise of Atlantic trade due to the breakthrough in navigation is the precondi-

[1]By market access, we mean a country's firms' accessibility to the global market, as typically defined in the trade literature.

[2]For a "flying geese pattern of development", see Akamatsu (1962) who coined and popularized this term. Note, however, that the theoretical underpinnings of Akamatsu (1962) are more similar to the product-cycle theory *á la* Antràs (2005), rather than the theory we propose here.

tion for these institutional reforms. Namely, when the economic benefits of institutional reforms were higher for Atlantic traders than for the rest of Europe, the reforms were more likely to occur there. The fact that non-Atlantic-trader European nations also made their reforms much earlier than the rest of the world may also be due to the growing neighboring markets, in addition to competition and the spread of knowledge. In a longer historical perspective, the first anecdote can be understood as the continuation of the second anecdote.

Motivated by these anecdotes, we propose a theory of interdependent development among countries by explaining (1) how a larger market access may induce institutional reforms and hence further economic development; and (2) how this process can become a domino effect. Using both cross-country data and Vietnamese cross-province data, Jiao and Wei (2022) shows that positive foreign demand shocks tend to induce institutional reforms. This provides empirical support for our first proposition that a larger market access leads to higher institutional quality. Even though they also provide a theory to explain the link between trade and institutional quality, their small-open-economy approach could not explain the flying geese pattern. Our work contributes to the literature by building a general-equilibrium trade model to explain the interdependent development of institutions and economic performance.

Our theory consists of two steps. The first step is to incorporate an incomplete contract model following Acemoglu et al. (2007) into an international trade environment *á la* Krugman (1980).[3] The production process is modeled as two layers of production, the first being differentiated-product firms and the second being the input suppliers to these firms. The inputs for each differentiated product are specialized, and thus there is a relationship specificity between each firm and each supplier. If various contingencies are not well specified in the contract between a firm and its suppliers and if the contracting institutional quality is inadequate, then a hold-up problem arises (Grossman and Hart, 1986). The hold-up problem makes suppliers under-invest in non-contractible activities relative to the efficient levels and thus depress their supply to the firms, resulting in a lower overall productive efficiency. Improvement in institutional quality leads to improvement in overall productive efficiency.

The key result in this step is that the per capita real income depends on two multiplicative terms: real market access and institutional quality. This result parallels the regression specification in Alcalá and Ciccone (2004), who show that trade (as measured by real openness), domestic

[3] Relative to Acemoglu et al. (2007), our model simplifies as we are not concerned with technology adoption, but it adds the market access dimension because their incomplete-contract model is now embedded in a full-fledged general-equilibrium trade framework. In this step, institutional quality is taken as given.

population, and institutional quality each positively affect the per capita real income. Our real market access corresponds to their real openness and domestic population combined, and thus our model serves as a microfoundation for their empirical findings.

The second step is to model a national planner's choice of institutional quality. For simplicity, we assume that national planners are benevolent and seek to maximize their national welfare net of institution building and maintenance costs. Institutional reforms are a complex process in the political economy (Acemoglu and Robinson, 2001). Our benevolent planner approach effectively incorporates the attrition of political economy as part of the institutional cost in a reduced-form manner, while highlighting the role of market access through careful modeling of trade and general equilibrium.

We analyze three types of solutions. First, we examine a competitive equilibrium in which the government takes aggregate variables such as the price index and market access as given. We show that real market access leads to higher institutional quality when population size is fixed. Note that this result holds for general asymmetric countries. Competitive equilibrium is applicable when the number of countries is large or when the country of concern is small.

The second solution that we examine is the Nash equilibrium, which is suitable for the case where the countries of concern are large and therefore their governments consider the impact of institutional quality on their own real market access. The analysis becomes considerably more difficult, but we are able to provide a definite statement, for the case of symmetric countries, on how trade openness improves real market access, which, in turn, leads to higher institutional quality. We conduct extensive numerical analyses that verify that the main prediction holds when countries are asymmetric.

Third, we study the welfare properties of the above-mentioned two types of equilibria by comparing them with a global planner's solution. We highlight the *institutional externality effect*. Such an effect exists because *a country's improvement in institutional quality leads to an increase in the size of its home market, which is a component of other countries' real market access.* This is the key intuition behind the flying geese pattern. We find that institutional quality is the highest in the global planner's solution, followed by the Nash equilibrium and then the competitive equilibrium. The Nash equilibrium's institutional quality and welfare are higher because national planners take the effects on their own real market access into account, thus creating an amplifying effect that is absent in the competitive equilibrium.

To verify that our results hold more generally for the Nash equilibrium case, we use numerical methods and deviate from symmetric countries in the following ways when studying the impact of trade liberalization on institutional quality. First, we allow country size to differ, while keeping the cross-country trade costs symmetric when they are lowered. We find that the scale effect of population size depends on the relative strength of the marginal benefits through real market access and the marginal cost through institutional costs. Second, we allow the bilateral trade costs to change asymmetrically, but keep the country size the same. We find a *trade diversion effect* on institutional quality. When some but not all countries liberalize their trade relations, those whose bilateral trade costs are reduced increase their institutional qualities. In contrast, those whose trade costs remain unchanged choose lower institutional qualities. This is primarily due to trade diversion, which reduces the real market access for non-trade-liberalized countries.

To demonstrate *flying geese pattern of institutional improvement*, we conduct a simulation in which transport costs steadily decline over time in a world geography featuring central and peripheral locations. When transport costs decline over time, the first country to implement institutional reform is the central one that enjoys the largest real market access, followed by the slightly less central ones and eventually the peripheral countries. In this exercise, we demonstrate clearly why the later reformers' real market access is enlarged not only because of the declining transport costs but also because of the earlier reformers' improved institutional qualities, which increase all countries' real market access.

The literature on the relations between institutions and economic development is extensive. A substantial portion of the literature focuses on the effect of institutions on economic development, e.g., Acemoglu et al. (2007), Levchenko (2007), Dutt and Traca (2010), Beverelli et al. (2018), and Chor and Ma (2021). Several studies have examined the reverse relationship, including Acemoglu et al. (2005), Levchenko (2012), Puga and Trefler (2014), Mukoyama and Popov (2015), and Jiao and Wei (2022). What sets us apart from these studies is the simultaneous determination of institutional quality and economic development.

Regarding the relationship between trade and institutions, we further discuss Puga and Trefler (2014) and Levchenko (2012), in addition to Jiao and Wei (2022). Puga and Trefler (2014) document the relationship between long-distance trade and the modern innovations in contracting institutions in medieval Venice, as well as the later retreat from an open and inclusive regime toward political closure and social stratification. Their paper is similar to Acemoglu et al. (2005) in terms of the role of trade as a precondition for institutional reforms, but it has a dynamic theory that explains why the concentration of trade and wealth leads to a retreat in institutional quality. Levchenko (2012) presents a theory in which trade promotes institutional quality, and his mechanism relies on the competition among countries in the sector subject to the hold-up problem, which reduces the rents available. Thus, interest groups are incentivized to lobby the government to improve institutions, thereby enhancing their comparative advantages in this sector. Obviously, the focus and mechanisms of these studies differ from ours; by incorporating the simultaneous determination of institutions and economic development into a general equilibrium trade framework, we demonstrate how institutional externalities generate interdependent development.

Also closely related is the study by Desmet et al. (2020) who explain the Great Divergence by showing how spatial competition may matter for technology adoption, in addition to market size. Both their work and ours explain economic development via a spatial angle; whereas they focus on technology adoption, we focus on institutional quality.

The rest of the paper is organized as follows. Section 2 presents a model illustrating the interconnection between institutions and trade. Section 3 investigates the national planner's problems that endogenize institutional qualities. Section 4 concludes.

2 Institutions and Global Economy

We propose a theory to explain the link between real market access and contracting institutions. First, Section 2 incorporates an incomplete-contract model following Acemoglu et al. (2007) into an international trade context *à la* Krugman (1980) to establish the links between contracting institutions and market access in a global economy, taking institutional qualities as given. Then, Section 3 endogenizes the choices of institutional qualities by solving national planners' problems and studies how real market access affects these choices. Note that we choose Krugman (1980) for our general equilibrium trade model for its tractability. The theory generally works in other general equilibrium trade models.

2.1 Model Setup

2.1.1 Consumption

There are J countries with each having population L_j, $j \in \{1, 2, ..., J\}$. Consumer preferences are the same and given by the CES utility function over a continuum of goods

$$U_j = \left(\int_{\omega} q_j(\omega)^{\beta} \, d\omega \right)^{\frac{1}{\beta}}, \tag{1}$$

where $\beta \in (0, 1)$ and $q_j(\omega)$ is the quantity consumed for the good ω. The elasticity of substitution is given by $\sigma \equiv 1/(1-\beta) > 1$. Each individual is endowed with one unit of labor, which is inelastically supplied. The wage rate is denoted as w_j, and each individual pays a lump-sum tax t_j to the government. Each country's representative consumer chooses the utility-maximizing consumption bundle subject to the budget constraint $\int_{\omega} p_j(\omega) \, q_j(\omega) \, d\omega \leq L_j \left(w_j - t_j \right)$, where $p_j(\omega)$ is the price of differentiated good ω facing country j's consumers. As is standard, country j's price index is given by $P_j = \left(\int_{\omega} p_j(\omega)^{1-\sigma} \, d\omega \right)^{\frac{1}{1-\sigma}}$.

The government of each country j levies taxes to build and maintain institutional quality. These institutional costs are in terms of the final goods, that is, using the CES aggregator as in (1). How these costs depend on institutional quality will be specified in Section 3.

2.1.2 Production

Labor is the only fundamental input of this economy. There are two layers of production: differentiated goods and specialized inputs. The market for differentiated goods is monopolistically competitive. The production of each differentiated good requires specialized inputs procured from various suppliers. As will be described shortly, contract incompleteness (i.e., the inverse of institutional quality) between a firm and its suppliers results in a hold-up problem and causes underinvestment and inefficiency.

Each differentiated-good firm ω in country i demands specialized inputs $X_i(s)$ from domestic suppliers $s \in [0, 1]$. For tractability, firm heterogeneity is abstracted away from the model. For notational convenience, the use of a specialized input is simply denoted as $X_i(s)$ even though each specialized input is specific to each differentiated good ω. The production function for every good ω is given by

$$y_i(\omega) = \left(\int_0^1 X_i(s)^{\alpha} \, ds \right)^{\frac{1}{\alpha}}, \tag{2}$$

where $\alpha \in (0,1)$. To produce specialized input $X_i(s)$, a continuum of specific investments $x_i(m,s)$, where $m \in [0,1]$, by supplier s are required; the production function of the specialized input is given by the Cobb-Douglas form:

$$X_i(s) = \exp\left[\int_0^1 \ln\left[x_i(m,s)\right] dm\right]. \quad (3)$$

Any specific investment $x_i(m,s)$ is made of labor using a one-to-one mapping: $x = l$ with labor l. The cost of investment x in country i is thus the wage w_i.

Assume that the offer from the monopolist firm to any supplier is take-it-or-leave-it. As the input $X_i(s)$ is specialized, its outside option is 0. The firm needs to sign a contract with each of its suppliers s, designating the investment level $x_i(m,s)$ for each $m \in [0,1]$. If the contract is complete and specifies fully the terms and conditions about the amounts of the investment $x_i(m,s)$ that supplier s should make for each m, then supplier s will abide by the contract and make corresponding investments. Otherwise, if part of the investments is not contractible (i.e., cannot be covered/specified/enforced by the contract), then the supplier will only follow the contract to make the designated investments for the contractible part and determine the remaining investments at its discretion. Let $\mu_i \in [0,1]$ reflect the degree of the contracting institution in country i such that μ_i fraction of the types of investment is contractible, whereas the remaining $1-\mu_i$ fraction is not. Without loss of generality, we can denote that $m \in [0,\mu_i]$ is contractible and $[\mu_i, 1]$ is not.

The timeline of the model is that each country's government chooses its contracting institutional quality in an environment that will be detailed in Section 3. There is a large pool of potential entrants in each country, and given institutional qualities $\{\mu_i\}_{i=1}^J$, the potential entrants decide whether or not to enter, and if yes, an entry cost f denominated in terms of labor units must be paid. Upon entry, each entrant obtains a distinct product and becomes a monopolist for it. For each monopolistic firm, there is a unit continuum of input suppliers.[4] The four stages of the game between each firm and its suppliers are given as follows:

1. The firm ω in country i offers a contract $\left[\{x_{i,c}(m,s)\}_{m=0}^{\mu_i}, \kappa_s\right]$ to every supplier s. Here $x_{i,c}(m,s)$ is the contractible investment level and κ_s is an upfront payment to each supplier s, which could be either positive or negative;

[4]In Acemoglu et al. (2007), the firm also chooses the number of suppliers, but this choice is shut down here. We normalize the number of suppliers for each firm to create unity and abstract away technology adoption, which is not our focus.

2. For m in $[0, \mu_i]$, the suppliers invest $x_i(m, s) = x_{i,c}(m, s)$ as specified in the contract. For m in $(\mu_i, 1]$, the suppliers determine investments in anticipation of the ex-post distribution of the total revenue between the firm and the suppliers;

3. The firm and suppliers bargain over the division of the revenue, and at this stage, suppliers could withhold their specific services in non-contractible activities;

4. Output is produced and sold, and the revenue is distributed according to the bargaining agreement made in Stage 3.

2.2 Equilibrium given Institutional Quality

This subsection derives the equilibrium given institutional qualities $\{\mu_i\}_{i=1}^{J}$. For the above-described game between a firm and its suppliers, we focus on the symmetric sub-game perfect equilibrium (SSPE), following Acemoglu et al. (2007). Since the suppliers are not the full residual claimants, they tend to underinvest in non-contractible activities. The overall production efficiency and welfare can be shown to increase with institutional quality.

2.2.1 Firm's Sales

Let the factory-gate price be denoted by p_i (for cleaner exposition, index ω is suppressed). Selling differentiated goods from country i to country j incurs iceberg trade costs such that to deliver one unit of a good to j, $\tau_{ij} \geq 1$ units need to be shipped from country i. In this model with monopolistic competition and the CES preference, the price facing consumers at country j for a good originated from country i is $p_j(\omega) \equiv p_{ij} = p_i \tau_{ij}$. The revenue for any firm in i is $r_{ij} = \left(\frac{p_{ij}}{P_j}\right)^{1-\sigma} E_j$, where P_j and E_j are the price index and the expenditure in country j, respectively. Let the number of firms in country i be denoted by n_i. The trade flow $R_{ij} \equiv n_i r_{ij}$ between exporting country i and importing country j can be rewritten as

$$R_{ij} = s_i \tau_{ij}^{1-\sigma} d_j, \tag{4}$$

where $s_i = n_i p_i^{1-\sigma}$ is the supply capacity of country i and $d_j = E_j P_j^{\sigma-1}$ the demand capacity of country j.

Total revenue of a firm in country i is $r_i \equiv \sum_{j=1}^{J} r_{ij} = p_i^{1-\sigma} M_i$, where the market access M_i for firms in country i is

$$M_i \equiv \sum_j \tau_{ij}^{1-\sigma} d_j = \sum_j \tau_{ij}^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}} = \tau_{ii}^{1-\sigma} \frac{E_i}{P_i^{1-\sigma}} + \sum_{j \neq i} \tau_{ij}^{1-\sigma} \frac{E_j}{P_j^{1-\sigma}}. \tag{5}$$

The larger the market access M_i, the more revenue for firms in country i. The last equality of (5) indicate that the market access can be divided into home market access (the first term) and foreign market access (the second term). This distinction is important for understanding institutional externality, which we shall discuss in the next section.

Combining the definition of revenue, $r_i \equiv p_i y_i$, with $r_i = p_i^{1-\sigma} M_i$ entails

$$r_i = y_i^{\beta} M_i^{1-\beta}. \tag{6}$$

The total revenue in country i is $R_i = \sum_j R_{ij} = n_i p_i^{1-\sigma} M_i$. The price index P_j satisfies

$$P_j^{1-\sigma} = \sum_i n_i p_{ij}^{1-\sigma} = \sum_i \frac{R_i}{M_i} \tau_{ij}^{1-\sigma}. \tag{7}$$

Moreover, the total revenue R_i equals the workers' total (pre-tax) income:

$$R_i = w_i L_i. \tag{8}$$

Assume trade is balanced, and thus the total expenditure equals the total revenue, i.e.,

$$E_i = R_i. \tag{9}$$

Note that the total expenditure E_i includes both consumers' and the government's expenditures.

2.2.2 Incomplete Contracts

For the SSPE in the incomplete-contract case, first consider the bargaining stage. As in Acemoglu et al. (2007), the Shapley value is used as the bargaining solution for the firm and its suppliers. For any supplier s, she follows the contract and makes investment level $x_c(m, s)$ for $m \in [0, \mu_i]$ and determines at her discretion the non-contractible investment level $x_n(m, s)$ for $m \in (\mu_i, 1]$. Meanwhile, the firm's other suppliers make investment level $x_c(m, -s)$ for $m \in [0, \mu_i]$ and the non-contractible investment level $x_n(m, -s)$ for $m \in (\mu_i, 1]$.

To compute the Shapley value for supplier s, we begin by noting that the firm is an essential player in this bargaining game. By definition, the Shapley value of supplier s is the average of her marginal contributions that consist of all players below her in all feasible orderings. If a coalition does not include the firm, its output is zero, regardless of the coalition's size. Consequently, the marginal contribution of supplier s is zero when a coalition excludes the firm. When a coalition includes the firm and a measure $\iota \in (0,1]$ of suppliers, the marginal contribution of supplier s when there are ι players below her is given by

$$m(s,\iota) = \frac{\partial \overline{r}^{\iota}}{\partial \iota},$$

where the coalition's revenue $\overline{r}^{\iota}$ is expressed as

$$\overline{r}_{\iota} = M_i^{1-\beta}\left(\int_0^{\iota}\left(\exp\left[\int_0^1 \ln x(m,k)\,dm\right]\right)^{\alpha} dk\right)^{\frac{\beta}{\alpha}}.$$

In the setting of symmetric equilibrium, let $x_c(m,s) = x_c(m,-s) = x_c$, $x_n(m,s) = x_n(s)$, and $x_n(m,-s) = x_n(-s)$. Consequently, the marginal contribution of supplier s is derived as

$$\begin{aligned} m(s,\iota) &= \frac{\partial \overline{r}_{\iota}}{\partial \iota} = M_i^{1-\beta}\frac{\beta}{\alpha}\left(\iota\left(x_c^{\mu_i}x_n^{1-\mu_i}(-s)\right)^{\alpha}\right)^{\frac{\beta}{\alpha}-1}\left(x_c^{\mu_i}x_n^{1-\mu_i}(s)\right)^{\alpha} \\ &= M_i^{1-\beta}\frac{\beta}{\alpha}\left[\frac{x_n(s)}{x_n(-s)}\right]^{\alpha(1-\mu_i)} x_c^{\beta\mu_i}x_n^{\beta(1-\mu_i)}(-s)\,\iota^{\frac{\beta}{\alpha}-1} \end{aligned}$$

Given any $\iota \in (0,1]$, the firm is included in the production coalition with probability $\iota/1$. Taking the average of the marginal contributions of supplier s when there are ι players below her over all feasible orderings, we obtain the Shapley value of supplier s:

$$\begin{aligned} SV_s &= \int_0^1 \frac{\iota}{1} m(s,\iota)\,d\iota \\ &= (1-\gamma)\left[x_c^{\mu_i}x_n(-s)^{1-\mu_i}\right]^{\beta} M_i^{1-\beta}\left(\frac{x_n(s)}{x_n(-s)}\right)^{(1-\mu_i)\alpha} \\ &= (1-\gamma)\,r_i, \end{aligned}$$

where $\gamma \equiv \frac{\alpha}{\alpha+\beta}$, and the third equality uses (2), (3), (6), and $x_n(s) = x_n(-s)$ in the SSPE equilibrium.

That is, suppliers share a $1-\gamma$ fraction of the firm's revenue, and the firm keeps a γ fraction of its revenue. Thus, γr_i is the Shapley value of the firm; γ increases in α but decreases in β. This is intuitive since a larger α means a greater elasticity of substitution among specialized inputs and, hence, smaller bargaining power for the suppliers. A higher β corresponds to a larger elasticity of substitution among differentiated goods, which reduces the firm's marginal contribution to the production relationship and thus lowers the firm's bargaining power.

Taking the upfront payment κ_s, the contractible investment x_c, and others' non-contractible investments $x_n(-s)$ as given, each supplier decides the optimal non-contractible investment by solving

$$x_n = \arg\max_{x_n(s)} (1-\gamma)\left[x_c^{\mu_i} x_n(-s)^{1-\mu_i}\right]^{\beta} M_i^{1-\beta}\left(\frac{x_n(s)}{x_n(-s)}\right)^{(1-\mu_i)\alpha} + \kappa_s - \mu_i x_c w_i - (1-\mu_i)\, x_n(s)\, w_i.$$

Therefore, this incentive compatibility constraint, together with the symmetry requirement, entails

$$x_n = \left[\frac{\alpha(1-\gamma)\, x_c^{\mu_i\beta} M_i^{1-\beta}}{w_i}\right]^{\frac{1}{1-\beta(1-\mu_i)}}. \tag{10}$$

The firm determines the level of contractible investment by solving the following problem:

$$\pi = \max_{x_c} \gamma\left(x_c^{\mu_i} x_n{}^{1-\mu_i}\right)^{\beta} M_i^{1-\beta} - \kappa_s,$$

subject to the participation constraint of suppliers:

$$(1-\gamma)\left[x_c^{\mu_i} x_n{}^{1-\mu_i}\right]^{\beta} M_i^{1-\beta} + \kappa_s \geq \left(\mu_i x_c + (1-\mu_i)\, x_n\right) w_i.$$

The firm can extract all the surplus from its suppliers so that the participation constraint holds with equality. Therefore, the firm's problem can be written as

$$\pi = \max_{x_c}\left(x_c^{\mu_i} x_n^{1-\mu_i}\right)^{\beta} M_i^{1-\beta} - \left[\mu_i x_c + (1-\mu_i)\, x_n\right] w_i,$$

and the solution is

$$x_c = \left[\alpha(1-\gamma)\right]^{\frac{\beta(1-\mu_i)}{1-\beta}} B(\mu_i)^{1-\beta(1-\mu_i)}\, w_i^{-\frac{1}{1-\beta}} M_i, \tag{11}$$

where $B(\mu_i) \equiv \left[\left(\frac{1-\gamma}{1-\beta(1-\mu_i)} + \gamma\right)\beta\right]^{\frac{1}{1-\beta}}$ is a decreasing function in μ_i. Plugging (11) into (10) entails

$$x_n = \left[\alpha(1-\gamma)\right]^{\frac{1-\beta\mu_i}{1-\beta}} B(\mu_i)^{\beta\mu_i}\, w_i^{-\frac{1}{1-\beta}} M_i. \tag{12}$$

When $\mu_i = 1$ (complete contract), the middle two stages of the game are removed, and the resulting investment is efficient and denoted as x^*. It is easy to show that $x^* = \beta^{\frac{1}{1-\beta}} w_i^{-\frac{1}{1-\beta}} M_i$. When $\mu_i < 1$, the above formulation applies, and $x_n < x_c$, i.e., the suppliers always under-invest for the non-contractible portion. However, the ratio, x_n/x_c, increases in μ_i, indicating that higher institutional quality leads to smaller distortion. From (11) and (12), $x_n \longrightarrow \gamma x_c < x_c \longrightarrow x^*$ when $\mu_i \longrightarrow 1$. That is, the distortion does not fully disappear even in the limit, highlighting the role of the middle two stages of the game in creating it.

The output for each differentiated good $y(\omega)$, which is equal to the output for each supplier $X(s)$, is given by

$$y_i = X_i = x_{c,i}^{\mu_i} x_{n,i}^{1-\mu_i} = I(\mu_i)\, w_i^{-\frac{1}{1-\beta}} M_i, \tag{13}$$

where $I(\mu) = [\alpha(1-\gamma)]^{\frac{1-\mu}{1-\beta}} B(\mu)^{\mu}$. For any firm in country i, the price charged for a differentiated good, the revenue, and the profit are

$$p_i = y_i^{-\frac{1}{\sigma}} M_i^{\frac{1}{\sigma}} = I(\mu_i)^{\beta-1} w_i, \qquad r_i = I(\mu_i)^{\beta}\, w_i^{-\frac{\beta}{1-\beta}} M_i, \qquad \pi_i = D(\mu_i)\, w_i^{-\frac{\beta}{1-\beta}} M_i, \tag{14}$$

where

$$D(\mu) = \left[1 - (1-\gamma)\left(\frac{\beta\mu}{1-\beta+\beta\mu} + \alpha\right)\right] I(\mu)^{\beta}.$$

Lemma 1. $I(\mu)$ and $D(\mu)$ are both strictly increasing in μ.

The proof is relegated to Appendix A.1. Lemma 1 and (13) imply that conditioned on wages w_i and market access M_i, *the higher the institutional quality, the higher the overall production efficiency*, which is captured by $I(\mu_i)$ term. Lemma 1 and (14) imply that, conditional on wages and market access, *firm profits increase in institutional quality.*

Combining with (14), the free entry condition, $\pi_i = w_i f$, becomes

$$M_i = \frac{w_i^{\sigma} f}{D(\mu_i)}. \tag{15}$$

The real market access is formally defined as M_i/P_i^{σ}; the deflation is by P_i^{σ} rather than P_i because the market access M_i is a cross-country sum of the trade-cost-discounted products of real income and price indices raised to a power σ (see [5]). With this definition, (15) can be written as $\frac{M_i}{P_i^{\sigma}} =$

$\left(\frac{w_i}{P_i}\right)^{\sigma}\frac{f}{D(\mu_i)}$. Thus, the real income in country i is

$$\frac{w_i L_i}{P_i} = \left(\frac{M_i}{P_i^{\sigma}}\frac{D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} L_i. \tag{16}$$

That is, *the real income of a country increases in both its institutional quality and its real market access, and the two are complementary to each other.* As in Acemoglu et al. (2007), the term $D(\mu_i)^{1/\sigma}$ can be called the *derived efficiency* because the larger the derived efficiency, the higher the real income, conditioned on real market access.

Dividing both sides of (16) by population L_i and taking logarithms, we find that this equation parallels the regression specification in Alcalá and Ciccone (2004) (see their Eq. [8]), who show that trade (as measured by real openness), domestic population, and institutional quality each positively affect the per capita real income. Our real market access corresponds to their real openness and domestic population combined, and thus our model serves as a microfoundation for their empirical findings.

In a closed economy, it is readily verified that real market access and real income are the same (see Appendix A.6); thus, real income is solely determined by the derived efficiency, and real market access does not play a separate role. In an open economy, however, real market access and real income of a country are generally different.

Note that total labor supply L_i equals total labor demand, which comprises the entry cost f in terms of labor units, the employment $\mu_i x_c$ for contractible investments, and the employment $(1-\mu_i)x_n$ for non-contractible investments. Under the labor market clearing condition, the number of firms in country i is

$$n_i \quad = \quad \frac{L_i}{f}\left[1-\beta\left(\frac{(1-\gamma)\,\mu_i}{1-\beta+\beta\mu_i}+\gamma\right)\right]. \tag{17}$$

Intuitively, the number of firms is proportional to the population size and inversely proportional to entry cost. Moreover, *the number of firms decreases (and hence the firm size increases) in institutional quality.* This is because worse institutional quality results in more severe hold-up problems and smaller firm size; given the fixed population size, there must be more firms. This relationship resonates with the findings by Hsieh and Olken (2014) that developing countries like Indonesia and India have relatively more small firms compared with the US, and this model serves as a microfoundation for explaining this phenomenon by the distortions arising from contract incompleteness.

The following definition defines an equilibrium given institutional qualities $\{\mu_i\}$. The following proposition summarizes the results of this section.

Definition 1. An equilibrium given a vector of institutional quality $\{\mu_i\}_{i=1}^J$ is a market access vector $\{M_i\}_{i=1}^J$, a price index vector $\{P_i\}_{i=1}^J$, an expenditure vector $\{E_i\}_{i=1}^J$, an income vector $\{R_i\}_{i=1}^J$ and a wage vector $\{w_i\}_{i=1}^J$ that satisfy equilibrium conditions (5), (7), (8), (9) and (15) for each country i.

Proposition 1. In an equilibrium given a vector of institutional quality $\{\mu_i\}_{i=1}^J$, the real income of a country is given by (16); it increases in both institutional quality and real market access, and the two are complementary to each other. Moreover, the following holds:

1. The number of firms decreases (and hence the firm size increases) in institutional quality.
2. Conditional on wages and market access, overall production efficiency and firm profits increase in institutional quality.
3. In a closed economy, real market access and real income are the same, and thus, real market access does not play a separate role. In an open economy, these two are generally different.

3 National Planners and Institutional Qualities

This section studies how institutional qualities are determined and how real market access matters. For tractability, we focus on benevolent governments that choose institutional qualities subject to the costs of building and/or maintaining the institutions.

For each country i, the cost of building and maintaining the contracting institutional quality μ_i is in terms of the final goods and takes the form $C_i(\mu_i, L_i) = A_i\mu_i^\rho L_i^\eta$, where $\rho > 1$ and $\eta \geq 1$. The institutional cost is therefore $P_iC_i(\mu_i, L_i) = P_iA_i\mu_i^\rho L_i^\eta$. Examples of building/maintenance costs include communication costs and investments in legislative procedure, public and compulsory education, law enforcement, and the legal system. Naturally, these costs increase in institutional quality and population size. The convexity in institutional quality reflects the decreasing returns in institutional building when the institution gets closer to the frontier. The convexity in population size is assumed to reflect that a larger population is likely to be associated with a more heterogeneous or geographically dispersed population, resulting in more-than-proportional communication and implementation costs. The parameter A_i captures country-specific factors in institution building/maintenance, such as the country's geography, demography, and history.

The model consists of two stages. In the first stage, each country's government chooses its institutional quality. The second stage is the model described in Section 2.

3.1 National Planners' Problems

For tractability, assume that these costs are raised by levying lump-sum taxes t_i from each individual and that the government runs a balanced budget. For each country i, the total government revenue is given by $T_i = t_i L_i$, and balanced budget implies that $T_i = P_i C_i(\mu_i, L_i)$. Welfare is defined as consumers' utility, i.e., their after-tax real income: $W_i \equiv (w_i L_i - T_i)/P_i$. By choosing institutional quality, the benevolent government solves

$$\max_{\mu_i} W_i = \frac{w_i L_i}{P_i} - C_i(\mu_i, L_i). \tag{18}$$

Using (16), (18) becomes

$$\mu_i^* = \arg\max_{\mu_i} W_i = \left(\frac{M_i}{P_i^\sigma}\frac{D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} L_i - A_i \mu_i^\rho L_i^\eta. \tag{19}$$

3.1.1 Competitive Equilibrium

We first consider a simpler equilibrium concept in which each national planner takes all of the market access and price indices as given. This can be justified if there are numerous countries, and each country is small. Under this concept, an equilibrium is referred to as a *competitive equilibrium*, which is formally defined as follows.

Definition 2. Given institutional qualities $\{\mu_i\}$, an equilibrium is given by Definition 1. A competitive equilibrium of institutional qualities $\{\mu_i^c\}$ is such that each national planner's choice of $\mu_i = \mu_i^c$ is the solution to (19), given the equilibrium $\{M_i\}$ and $\{P_i\}$.

Under a competitive equilibrium, real market access M_i/P_i^σ is taken as given by national planners. To ensure that (19) entails a unique solution, a sufficient condition is that the derived efficiency, $D(\mu_i)^{1/\sigma}$, is strictly concave in μ_i such that W_i is also strictly concave in μ_i. The following lemma provides such a sufficient condition.

Lemma 2. Given any $\beta \in (0,1)$, for any x such that $x \in \left[\beta, \frac{\beta}{1-\beta}\right]$, let $\alpha_0(x)$ denote the unique solution to $\left(\sqrt{x}+1\right)\frac{x}{\alpha_0+x} - \ln\left(1+\frac{x}{\alpha_0}\right) = 0$ with the constraint that $0 \le \alpha_0 \le 1$. Define

$$\bar{\alpha}_0(\beta) \equiv \max_{x \in \left[\beta, \frac{\beta}{1-\beta}\right]} \alpha_0(x).$$

Let $\alpha \in (\bar{\alpha}_0(\beta),1)$. Then $D(\mu)^{\frac{1}{\sigma-1}}$ is strictly concave, which, in turn, implies that the derived efficiency $D(\mu)^{\frac{1}{\sigma}}$ is also strictly concave.

The proof of Lemma 2 is relegated to Appendix A.2. This lemma can be understood as a parameter constraint to ensure that the marginal benefit in institutional quality is strictly decreasing. Essentially, Lemma 2 asks that, for any given β, the substitutability among different specialized inputs, α, be sufficiently large. To see the intuition, first note that contract incompleteness results in larger distortions when different inputs are more complementary. This is because if the inputs are more complementary, weaker competition among input suppliers induces these suppliers to offer lower investments for non-contractible activities in the bargaining stage, resulting in larger distortions. If the complementarity is too strong (α too low), it could be possible that improving institutional quality exhibits increasing returns in improving the derived efficiency for some parts of the domain $\mu \in [0,1]$. Lemma 2 indicates that such potential increasing returns can be suppressed if there exists sufficient substitutability among specialized inputs to induce sufficient competition among input suppliers.

Because real market access is complementary to institutional quality, which is embodied in the derived efficiency $D(\mu_i)^{1/\sigma}$, larger real market access increases the marginal benefit of improving institutional quality. When the population size L_i is held fixed, real market access does not affect the marginal cost. Denote $\text{RMA}_i \equiv M_i/P_i^{\sigma}$, and we reach the following proposition:

Proposition 2. Suppose that the regularity condition in Lemma 2 holds. There exists a unique competitive equilibrium in which $\{\mu_i = \mu_i^c\}_{i=1}^J$ satisfies

$$\frac{1}{\sigma}\left(\frac{\text{RMA}_i}{f}\right)^{\frac{1}{\sigma}} D(\mu_i)^{\frac{1-\sigma}{\sigma}} D'(\mu_i) L_i = \rho A_i \mu_i^{\rho-1} L_i^{\eta}. \tag{20}$$

Moreover, a country's institutional quality increases when its real market access increases with its population size held fixed.

The formal proof of Proposition 2 is relegated to Appendix A.3. Proposition 2 establishes that a larger real market access leads to higher institutional quality, holding population size fixed. Changes in a country's real market access when its population size is held fixed can be due to changes in trade costs and the population size of other countries.

3.1.2 Nash Equilibrium

We now consider a more complex scenario in which countries do not take their market access and price indices as given. This is relevant when a country is large in terms of population because the effects of its choice of institutional quality on its and others' market access and prices, through the mechanism illustrated in Section 2.2.2, are no longer negligible. We consider a Nash equilibrium in which each national planner chooses its institutional quality given other national planners' choices.

Definition 3. Given institutional qualities $\{\mu_i\}$, an equilibrium is given by Definition 1. A Nash equilibrium of institutional qualities $\{\mu_i^n\}$ is such that each national planner's choice $\mu_i = \mu_i^n$ is the solution to (19) given other national planners' choices $\{\mu_j^n\}_{j\neq i}$.

Analyzing problem (19) under a Nash equilibrium is much more difficult than under competitive equilibrium because the choices of $\{\mu_i\}$ affect the general equilibrium objects $\{M_i, P_i\}$, of which the interactions are highly nonlinear, in addition to the complex nature of a Nash equilibrium. Nevertheless, we can provide a definite statement for symmetric countries. Under symmetric countries, $\tau_{ij} = \tau$, and let $\phi \equiv \tau^{1-\sigma}$ be the trade openness with $\phi \in [0, 1]$. We have the following proposition.

Proposition 3. Suppose that the regularity condition in Lemma 2 holds. Also, suppose that there are J symmetric countries; i.e., $L_j = L$ and $A_j = A$ for all j, and that the trade costs for any pair of countries is $\tau \geq 1$. Then, there exists a unique symmetric Nash equilibrium in which $\{\mu_i = \mu^n\}_{i=1}^J$ satisfies

$$\varsigma(\phi, J)\, D(\mu_i)^{\frac{2-\sigma}{\sigma-1}}\, D'(\mu_i)\, L^{\frac{\sigma}{\sigma-1}} = \rho A \mu_i^{\rho-1} L^{\eta}, \tag{21}$$

where $\varsigma(\phi, J)$ increases in ϕ and J and is given by

$$\varsigma(\phi, J) \equiv \frac{1}{\sigma}\left(\frac{1}{\sigma-1}\cdot\frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma}+1\right)\left(\frac{1+(J-1)\phi}{f}\right)^{\frac{1}{\sigma-1}}.$$

Moreover, larger real market access, either induced by a decrease in trade cost τ or an increase in the number of trading partners $J-1$, leads to a higher institutional quality.

The detailed proof of Proposition 3 is relegated to Appendix A.4. The proof mainly involves deriving the first-order equation (21) by the Nash equilibrium conditions and symmetry. The left-hand and right-hand sides of (21) are the marginal benefit and marginal cost of increasing μ_i, respectively. Obviously, the marginal cost strictly increases in μ_i, and by Lemma 2, the marginal benefit strictly decreases in μ_i. Thus, the solution μ^n is unique, as the domain is a closed interval $[0, 1]$. As $\varsigma(\phi, J)$ increases in ϕ and J, it captures how trade openness positively affects real market access. Therefore, the last statement of the proposition holds because when ϕ or J increases, the marginal benefit and hence μ^n increase.

Holding population size fixed, Proposition 3 captures the same spirit as Proposition 2 that when the real market access increases (due to positive exogenous shocks), the institutional quality increases. Indeed, real market access is the only channel through which trade openness affects institutional qualities in our model. Next, we study the effect of population size.

Proposition 4. Suppose that the regularity condition in Lemma 2 holds. Under the Nash equilibrium in the symmetric world, the equilibrium institutional quality increases (decreases) in the population size when $\eta < \frac{\sigma}{\sigma-1}$ ($\eta > \frac{\sigma}{\sigma-1}$). Institutional quality is independent of population size when $\eta = \frac{\sigma}{\sigma-1}$.

The proof of Proposition 4 is relegated to Appendix A.5, which shows that the marginal benefit of institutional quality is proportional to $L^{\frac{\sigma}{\sigma-1}}$ while the marginal cost is proportional to L^{η}. Thus, when $\eta < \frac{\sigma}{\sigma-1}$, the increase in marginal benefit outweighs the increase in marginal cost, leading to higher institutional quality. We have the following corollary.

Corollary 1. Suppose that the regularity condition in Lemma 2 holds. Under autarky, the equilibrium institutional quality increases (decreases) in the population size when $\eta < \frac{\sigma}{\sigma-1}$ ($\eta > \frac{\sigma}{\sigma-1}$). Institutional quality is independent of population size when $\eta = \frac{\sigma}{\sigma-1}$.

The proof of Corollary 1 is relegated to Appendix A.6. In the case of autarky, trade plays no role, and the scale effect of real market access on institutional quality is reduced to the scale effect due to population size. This corollary states that the scale effect exists but is ambiguous. While larger countries have larger market access, the institutional quality is not necessarily higher.

3.1.3 Welfare Properties

In both competitive and Nash equilibria, national planners' choices of institutional qualities are not optimal in a global sense because they do not account for institutional externality effects. To see why there is an externality, first consider the fully integrated world ($\tau_{ij} = 1$ for all ij pairs), in which each country's price index is the same and can be normalized to 1. Hence, the real market access is

$$M \equiv M_i = \sum_j \tau_{ij}^{1-\sigma} E_j P_j^{\sigma-1} = \sum_j w_j L_j.$$

The equation above and the free entry condition entail

$$M^{\frac{\sigma-1}{\sigma}} = \sum_j \left(\frac{D\left(\mu_j\right)}{f} \right)^{\frac{1}{\sigma}} L_j. \tag{22}$$

Equation (22) reveals an *institutional externality effect*, which we explain as follows. From (22), the (real) market access increases in each country's population size L_j with the term $D(\mu_j)^{1/\sigma}$ acting as the weight of the influence of each country's population size. In other words, *a country's investment to improve its own institutional quality is indeed a public good for global welfare* because it increases the real market access for all countries.

Recall that the larger the country's size, the larger its own marginal benefit of improving its institutional quality; it is clear by inspecting (19) and noting $M_i/P_i^{\sigma} = 1$ in this fully integrated world. When the parameter η is small, the effect of population size on the marginal cost will be smaller than that on the marginal benefit of improving institutional quality. Thus, the larger countries have higher institutional qualities in spite of the equalized real market access across countries. This corresponds to the free-rider problem, as there is no global government, and each country decides its own institutional quality. From a global viewpoint, there is insufficient provision for institutional qualities. The fact that each country's institutional quality is a public good is most transparent in this case of zero trade frictions, but its logic generally applies to situations where trade is costly.

The global optimal solution of institutional qualities is obtained by solving $\max_{\{\mu_i\}} \sum_i W_i$. We have the following proposition.

Proposition 5. Suppose that the regularity condition in Lemma 2 holds. Also suppose that there are J symmetric countries; i.e., $L_j = L$ and $A_j = A$ for all j, and that the trade costs for any pair of countries is $\tau \geq 1$. Then, there exists a unique global planner's solution, denoted as $\mu_i = \mu^g$, which satisfies

$$\frac{1}{\sigma-1}\left(\frac{1+(J-1)\,\phi}{f}\right)^{\frac{1}{\sigma-1}} D\left(\mu_i\right)^{\frac{2-\sigma}{\sigma-1}} D'\left(\mu_i\right) L^{\frac{\sigma}{\sigma-1}} = \rho A \mu_i^{\rho-1} L^{\eta}. \tag{23}$$

Denote the individual country's welfare as W^g, W^n, W^c under the global optimal solution, Nash equilibrium, and competitive equilibrium, respectively. We have

1. $\mu^g > \mu^n > \mu^c$, and $W^g > W^n > W^c$.
2. $\mu^n \longrightarrow \mu^c$ and $W^n \longrightarrow W^c$ as $J \longrightarrow \infty$, whereas the gap between μ^g and μ^n and hence that between W^g and W^n remain.

The detailed proof is relegated to Appendix A.7. The proof mainly involves deriving (23) and then comparing the first-order conditions (20), (21), and (23) under the symmetric world. We show in Appendix A.7 that the competitive equilibrium $\mu_i = \mu^c$ in a symmetric world satisfies

$$\frac{1}{\sigma}\left(\frac{1+(J-1)\,\phi}{f}\right)^{\frac{1}{\sigma-1}} D\left(\mu_i\right)^{\frac{2-\sigma}{\sigma-1}} D'\left(\mu_i\right) L^{\frac{\sigma}{\sigma-1}} = \rho A \mu_i^{\rho-1} L^{\eta}. \tag{24}$$

Then, a direct comparison among the multiplicative constants before $D\left(\mu_i\right)^{\frac{2-\sigma}{\sigma-1}}$ on the left-hand side of (21), (23), and (24) reveals that $\mu^g > \mu^n > \mu^c$. This comparison also implies that the marginal benefit curve is the highest under the global planner's problem, followed by the curves under Nash equilibrium and competitive equilibrium sequentially. Then, the result $W^g > W^n > W^c$ follows from the fact that the marginal cost curves are the same across the three solution concepts.

To see the intuition, first observe (19) and recall the key difference between a competitive equilibrium and a Nash equilibrium. In a competitive equilibrium, a national planner takes the real market access (M_i/P_i^{σ}) as given when choosing institutional qualities. In contrast, the incentives for a national planner to improve institutional quality in a Nash equilibrium are larger because there is now an additional channel for improving the national welfare through real market access (recall [16]), as higher institutional quality leads to higher productive efficiency and, hence, higher home market access. As a result, $\mu^n > \mu^c$ and hence $W^n > W^c$. As explained, institutional externality effects exist in both competitive equilibrium and Nash equilibrium, and thus $\mu^g > \mu^n$ and hence $W^g > W^n$.

The fact that the Nash equilibrium outcomes are between the global optimal solution and the competitive equilibrium can be comprehended by varying the number of countries J for $J \geq 2$.

When $J \longrightarrow \infty$, every country is minuscule and has little influence over its real market access; thus, Nash equilibrium outcomes become the same as the competitive equilibrium outcomes. However, increasing the number of countries does not eliminate the institutional externality effects, and hence, the outcomes under the two types of equilibria remain suboptimal. When J becomes small, the difference between Nash and competitive equilibria becomes large, but as argued before, the Nash equilibrium is a better solution concept in this case.

3.2 Asymmetric Countries

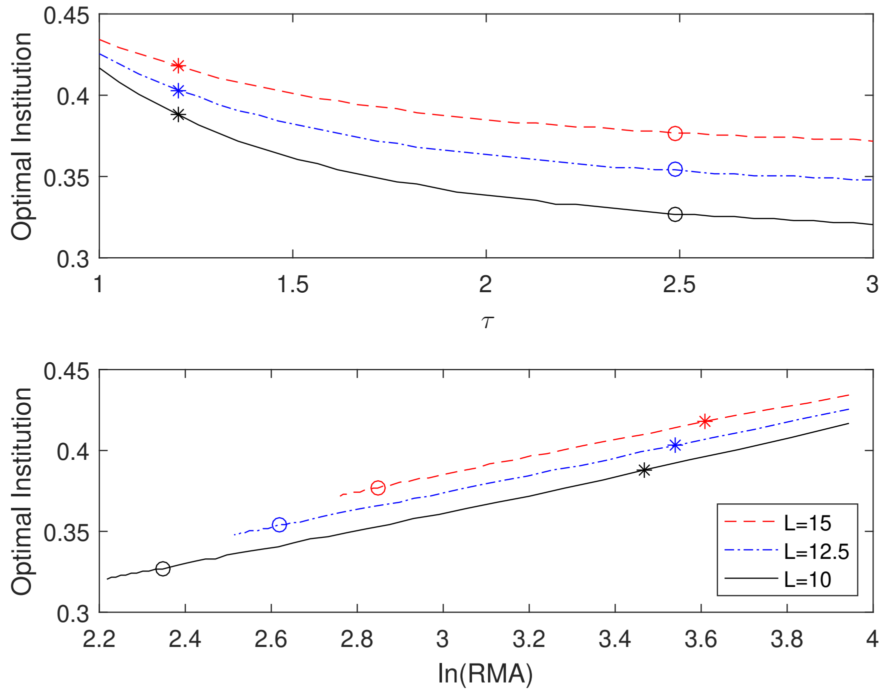
Whereas Proposition 2 holds for general asymmetric countries, the results in Propositions 3 to 5 are under symmetric countries. To investigate the robustness of the results under Nash equilibrium in the case of asymmetric countries, we resort to numerical simulations. We first study the cases where population sizes differ, and then study the case of differential trade costs.

3.2.1 Effects of asymmetric population sizes

Figure 1 plots the case where the three countries are identical except that they differ in population size. Countries 1, 2, and 3 have $L = 15, 12.5$, and 10, respectively. Trade costs between any pair of countries are symmetric and denoted by τ. We choose $\beta = 0.7$ and $\eta = 1.01$ so that $\eta < \frac{\sigma}{\sigma-1}$.[5] The upper panel depicts the equilibrium relationship between institutional quality and trade cost for each country; here, it is clear that the lower the trade cost, the higher the institutional quality. The lower panel depicts the equilibrium relationship between real market access and institutional quality for each country. In both panels, we highlight the equilibrium values for the three countries within the same equilibrium. In particular, the circles and the asterisks denote the two equilibria where the trade costs $\tau = 2.5$ and $\tau = 1.2$, respectively. The lower panel shows clearly that when real market access becomes higher due to a lower trade cost, institutional quality improves. Taken together, Figure 1 shows that Proposition 3 holds even when countries differ in population size; that is, the lower the trade cost, the higher the real market access and institutional qualities, holding each country's population size fixed. Moreover, for each given τ, a country with a larger population size has better institutional quality. As $\eta < \frac{\sigma}{\sigma-1}$, this verifies Proposition 4 in an asymmetric-country setting. This result will change if $\eta < \frac{\sigma}{\sigma-1}$ fails to hold, as we shall see shortly.

[5] Recall that $\sigma = 1/(1-\beta)$. The remaining parameters are $\alpha = 0.3$ and $f = 1$.

Figure 1: Effects of Population Size on Institutional Quality



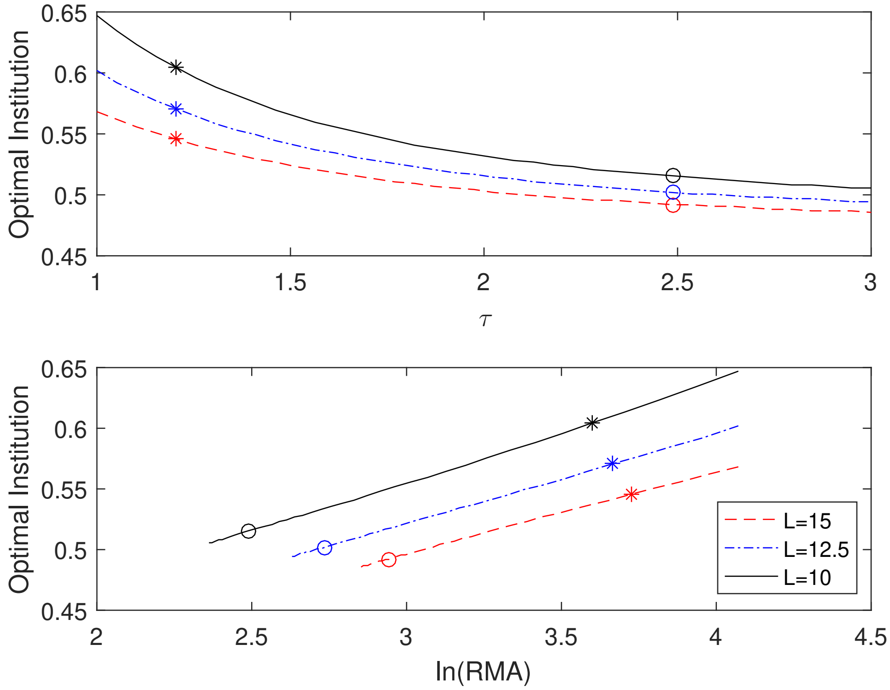
Notes: Three countries differ in their population sizes. The price index in country 1 is normalized to be 1. η is set to be 1.01 so that $\eta < \frac{\sigma}{\sigma-1}$.

Observe that in the fully integrated world where $\tau = 1$, larger countries enjoy higher institutional qualities even though all countries have the same market access and price index and, hence, the same real market access. This is, indeed, the reflection of the institutional externality effects as explained in Section 3.1.3. Again, the smaller countries here free-ride on the higher institutional qualities provided by the larger countries, who have incentives to provide higher qualities because it improves their home market access.

Figure 2 plots the case where all parameters are the same as Figure 1 except that η is increased from 1.01 to 1.5 such that $\eta > \frac{\sigma}{\sigma-1}$. Again, this figure shows that Proposition 3 holds under this asymmetric-country setting with a higher value of η. In contrast with Figure 1, Figure 2 shows that the larger the population size, the lower the institutional quality, and this again verifies Proposition 4 in an asymmetric-country setting. In this case, the marginal cost of institutional quality sharply increases with population size and hence outpaces the increase in the marginal benefit through real market access.

Figure 3 plots the case where η takes an intermediate value at 1.3 with all of the other pa-

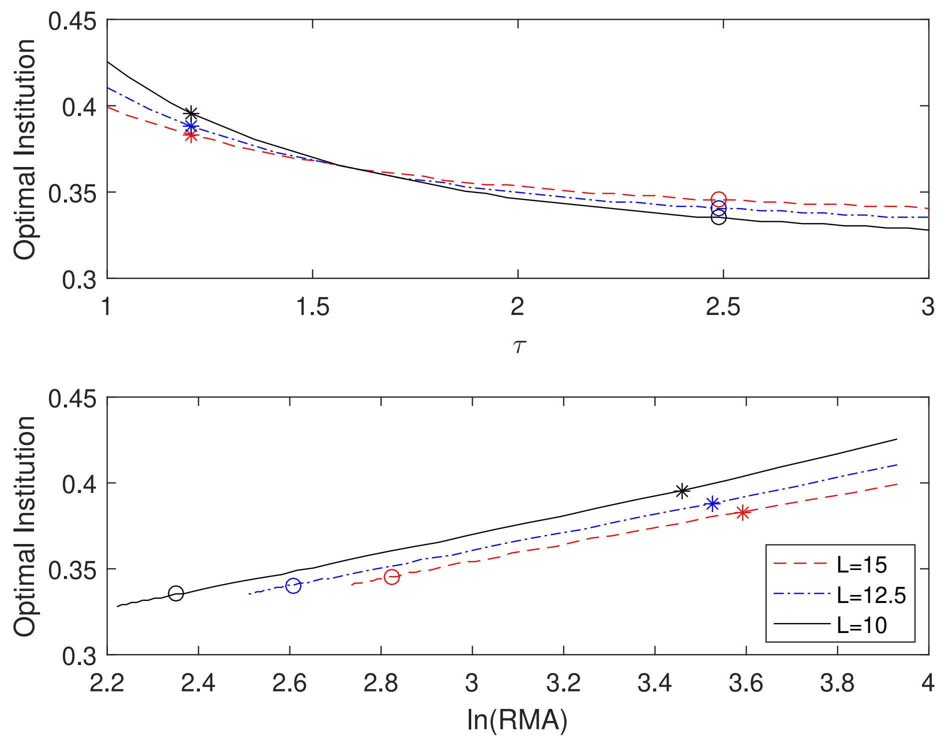
Figure 2: Effects of Population Size on Institutional Quality



Notes: Three countries differ in their population sizes. The price index in country 1 is normalized to be 1. η is set to be 1.5 such that $\eta > \frac{\sigma}{\sigma-1}$.

rameters being the same as the previous two figures. Again, Proposition 3 also holds under this asymmetric-country setting with an intermediate value of η. Observe that when $\tau > 1.5$, the larger the population size, the higher the institutional quality, which is the pattern seen in Figure 1. When $\tau < 1.5$, the larger the population size, the lower the institutional quality, which is the pattern seen in Figure 2. To understand this flip, it is easier to consider the two extreme cases. First, when the trade cost approaches infinity, so that each country becomes an autarky, a country's real market access is tied solely to its own population size. Therefore, the determination of institutional quality is simply a tug-of-war between the rates at which the marginal benefit and the marginal cost change with population size. At $\eta = 1.3$, $\eta < \frac{\sigma}{\sigma-1}$ holds, and thus the result verifies Corollary 1 and is similar to that seen in Figure 1. Second, when there is no trade cost ($\tau = 1$), a country's population size contributes only a portion to the real market access, as indicated by (22). Therefore, the contribution of a country's population size to real market access is diluted compared with the autarkic case just discussed, thus diluting the rate at which the marginal benefit of improving institutional quality changes with population size and entailing the pattern seen

Figure 3: Effects of Population Size on Institutional Quality



Notes: Three countries differ in their population sizes. The price index in country 1 is normalized to be 1. η is set to be 1.3.

in Figure 2.[6]

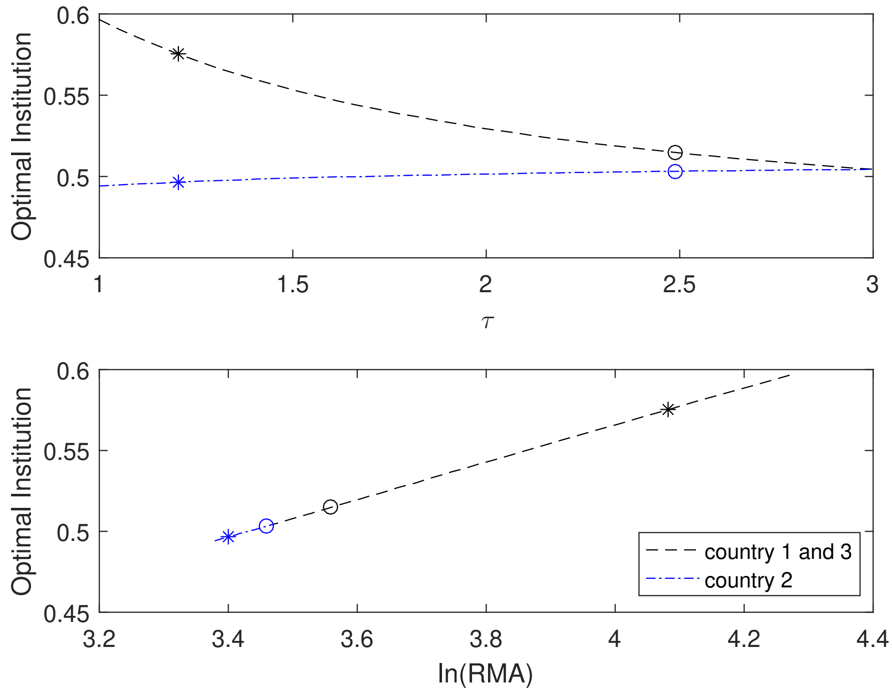
3.2.2 Effects of differential trade costs

Next, we investigate the effects of differential trade costs. In particular, we would like to see how trade liberalization between two countries may affect the institutional qualities of other countries. For our numerical analysis, we consider the case where three countries have the same population size with the same bilateral trade costs $\tau = 3$ initially.[7] The upper panel of Figure 4 plots the changes in equilibrium institutional qualities against the level of the bilateral trade cost between countries 1 and 3, while the trade cost of either country with country 2 remains unchanged at $\tau = 3$. The lower panel plots the corresponding real market access and institutional quality.

[6] Observe that in the integrated world case, the larger the population size, the smaller the institutional quality. This does not mean that the institutional externality effect does not exist. Instead, it indicates that this effect is dominated by the larger effect of population size on the marginal cost.

[7] The other parameters are $L = 10$, $f = 1$, $\eta = 1.3$, $\alpha = 0.25$, $\beta = 0.6$, which implies $\sigma = 2.5$.

Figure 4: Trade Liberalization between Country 1 and Country 3



Notes: The three countries have equal population sizes; countries 1 and 3 reduce their bilateral trade costs from $\tau = 3$, whereas country 2's trade cost with the other two countries remains at $\tau = 3$. The price indices of countries 1 and 3 are normalized to 1.

From Figure 4, countries 1 and 3 experience better institutional quality as they mutually decrease their trade costs, whereas country 2's institutional quality deteriorates even though its trade costs are unchanged. We choose two equilibrium points to further elaborate on the effects of asymmetric trade liberalization. In particular, the circles and the asterisks denote the two equilibria where the trade costs between countries 1 and 3 are $\tau = 2.5$ and $\tau = 1.2$, respectively. Because real market access is the only channel through which trade costs affect institutional quality, the results in the upper panel suggest that country 2's real market access deteriorates while that of countries 1 and 3 improves, which is indeed what we see in the lower panel.

Why does country 2's real market access and institutional quality deteriorate when its trade costs with the other two countries are unchanged? We dissect the reasoning into three parts. First, suppose that institutions are exogenous. The direct effect of the mutual trade liberalization between countries 1 and 3 lowers the price indices of these two countries, implying fiercer competition for country 2's firms in the other two countries' markets, thereby decreasing these firms' real market access. Because it becomes more difficult for country 2's firms to export and easier for countries 1 and 2 to trade, this is indeed the *trade diversion effect* commonly seen in the literature. Second, when institutional qualities are endogenous, increased real market access for countries 1 and 3 induces increases in their institutional qualities, which further reduces the price indices of these two countries. This, in turn, further reduces country 2's real market access due to the even fiercer competition. We call this an *endogenous-institution effect.* Third, the above-discussed institutional externality effect also works here because country 2 strategically free rides on increased institutional qualities of the other two countries and hence further reduces its own institutional quality.

We have verified that all of the above results shown in Figures 1 to 4 are robust to a wide range of parameter values. The details of these robustness checks are provided in Appendix A.8.

3.3 Flying Geese Pattern of Institutions

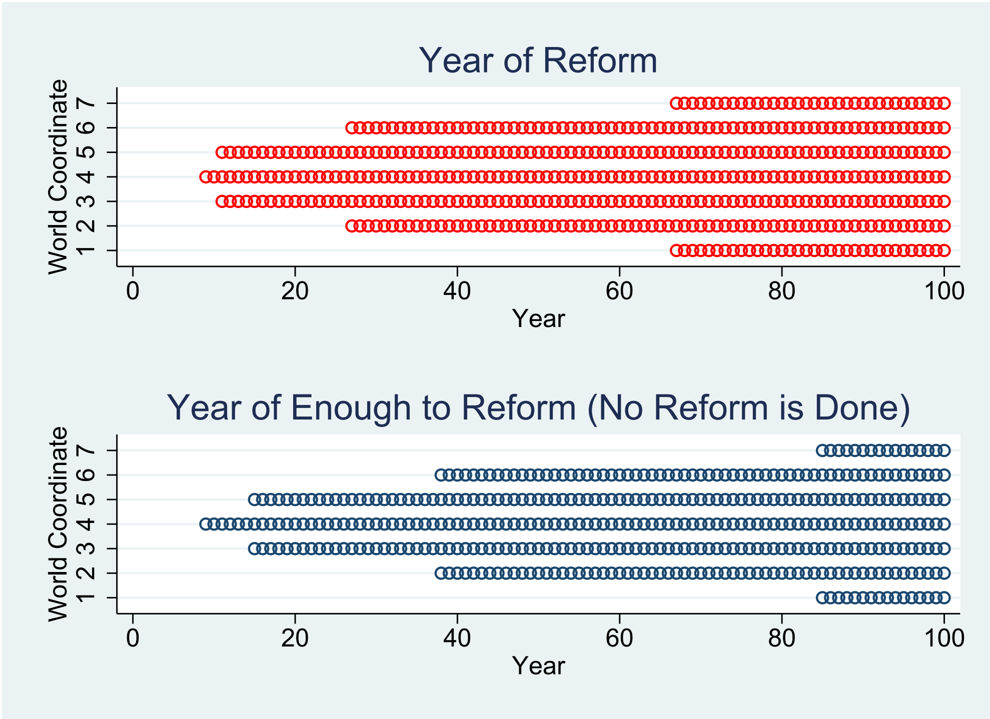
In this subsection, we take advantage of our model to demonstrate a flying geese pattern of institutions driven by improving transport technology and thus enlarging the real market access. The same argument can be applied to other factors (such as the political factors mentioned in the introduction) that drive the increases in real market access. Suppose that there are J same-sized countries, and the geography of the world is a line segment with the countries being spaced evenly. Under this geography, the one(s) in the middle naturally enjoy the largest real market access, and they are referred to as the "world center".[8] Label the countries from left to right by 1 to J in order. Starting from some point in time ($t = 0$), the trade cost between countries i and j at year t is given by $\tau_{ijt} = 1 + \exp(-\nu t)(\tau_0^{|i-j|} - 1)$, where ν is the tuning parameter governing the extent to which trade costs decline over time due to the advancement of transport technology, and τ_0 is the trade cost parameter at $t = 0$. The world center is $\frac{J+1}{2}$ if J is odd, and are $\frac{J}{2}$ and $\frac{J}{2} + 1$ if J is even. In our simulation, we choose $J = 7$.

To highlight the core idea and simplify the simulation, we assume that each country can choose either a high or low institutional quality, μ_H or μ_L.[9] Every country starts with μ_L, and to obtain and maintain μ_H, a fixed improving cost F is required for every period that this country wants the institutional quality μ_H. The model is solved using the Nash equilibrium. Figure 5 shows how institutional qualities evolve over time. Focus on the upper panel of the figure first,

[8]These countries can also be evenly spaced on a circumference or a sphere, as long as the structure of trade costs among countries exhibits the pattern that the average trade cost is the lowest at the "world center" and increases for countries that are further away from this center.

[9]The parameters are $\mu_H = 1$, $\mu_L = 0.2$, $f = 1$, $\alpha = 0.25$, $\beta = 0.4$, $\tau_0 = 2$, $\nu = 0.02$, $F = 68$, and $L = 10$.

Figure 5: Flying Geese Pattern of Institutional Quality



Notes: There are 7 countries in the world; each chooses between a high or low institutional quality, given other countries' choices. The trade cost between country i and country j at year t takes the form $\tau_{ijt} = 1 + \exp(-\nu t)(\tau_0^{|i-j|} - 1)$, where ν is the tuning parameter governing the extent to which trade costs decline over time, and τ_0 is the trade cost parameter at $t = 0$. A colored circle indicates that the country has reformed and obtained the high institutional quality μ_H in that period.

and note that a colored circle indicates that the country has reformed and obtained the high institutional quality μ_H in that period. During the first few periods, even though real market access increases due to the decline in trade costs, no country makes any institutional improvement because the benefit of improving institutional quality is not enough to overcome the fixed improvement cost. As trade costs continue to decline, country 4 (the world center) takes the initiative to reform and obtain high institutional quality in period 9. This is followed by countries 3 and 5 in period 11, countries 2 and 6 in period 27, and finally, countries 1 and 7 from period 67 onward. Indeed, the timing and locations of reforms display a flying-geese pattern.

By flying geese, one implicitly means that what a country does triggers the same for another. In the model setup here, every country would eventually have enough to reform, i.e., the benefit of switching from μ_L to μ_H outweighs the fixed improvement cost, simply because of the ever-declining trade cost. To show how one country's reform may affect others, the colored circles in the lower panel of Figure 5 indicate the periods when the country has enough to reform but no reform is done. In contrast to the upper panel, the first periods when the countries have enough to reform are 9, 15, 38, and 85 from the world center to the peripheral countries; the timing for a country to have enough to reform is all delayed except for the world center. The lower panel captures the pure effect of increasing real market access due to declining trade costs, while the contrast between the two panels indicates that one country's reform, which leads to greater production efficiency in that country, also increases real market access for all countries and thereby speeds up the reform process. So, this is a *bona fide* flying geese pattern.

4 Conclusion

This paper develops a theory of interdependent development, showing how international trade and institutional quality mutually reinforce each other. We embed the incomplete-contract framework of Acemoglu et al. (2007) in a Krugman-style general-equilibrium trade model, and we show that a country's per capita real income depends multiplicatively on its real market access and institutional quality. We illustrate national planners' choices of institutional quality in this global economic environment. Larger real market access raises the marginal return to institutional improvement and leads to higher institutional quality. An increase in institutional quality leads to enhanced productive efficiency, resulting in larger purchasing power, i.e., larger home market access. Because *one country's home market access is other countries' foreign market access*, this cross-country institutional externality is what underlies both the trade-diversion effects and the flying geese pattern. In summary, our analysis provides a unified framework in which market access and institutional quality co-evolve, helping to explain historical waves of institutional reform and providing a perspective for understanding the policy challenges facing today's developing countries.

Appendix

A.1 Proof of Lemma 1

We want to show that $I(\mu)$ and $D(\mu)$ are both strictly increasing in μ.

A.1.1 The properties of $I(\mu)$

Recall $I(\mu) = [\alpha(1-\gamma)]^{\frac{1-\mu}{1-\beta}}\left[\left(\frac{1-\gamma}{1-\beta(1-\mu)}+\gamma\right)\beta\right]^{\frac{\mu}{1-\beta}}$. Define $\bar{I}(\mu) \equiv (1-\beta)\ln I(\mu)$, and it suffices to show that $\frac{d\bar{I}}{d\mu} > 0$. Note that

$$\frac{d}{d\mu}\left(\frac{d\bar{I}}{d\mu}\right) = \beta^2\frac{\left[2\alpha(\beta-1)\beta-\beta^2\right]\mu - 2\left[\alpha(1-\beta)^2+\beta(1-\beta)\right]}{(\beta(\mu-1)+1)^2\left\{\beta+\alpha[\beta(\mu-1)+1]\right\}^2}.$$

Since $2\alpha(\beta-1)\beta-\beta^2 < 0$ and $\alpha(1-\beta)^2+\beta(1-\beta) > 0$, we have $\frac{d}{d\mu}\left(\frac{d\bar{I}}{d\mu}\right) < 0$ on the interval $(0,1)$. As $\frac{d\bar{I}}{d\mu}$ is decreasing in $(0,1)$, $\frac{d\bar{I}}{d\mu}$ achieves its minimum at $\mu = 1$. Hence, $\frac{d\bar{I}}{d\mu}|_{\mu=1} = -\ln\left(\frac{\alpha}{\alpha+\beta}\right) - \frac{\beta^2}{\alpha+\beta}$, which is decreasing in α. When $\alpha = 1$, $\frac{d\bar{I}}{d\mu}|_{\mu=1} = \ln(1+\beta) - \frac{\beta^2}{1+\beta} > 0$ for any β in $(0,1)$. Hence $\frac{d\bar{I}}{d\mu}|_{\mu=1} > 0$ for any α and β in $(0,1)$. Therefore, $\frac{d\bar{I}}{d\mu}$ is always positive in $(0,1)$ and $I(\mu)$ is thus strictly increasing in μ.

A.1.2 The properties of $D(\mu)$

Recall $D(\mu) = \left[1-\left(\beta\mu\frac{1-\gamma}{1-\beta+\beta\mu}+\alpha-\alpha\gamma\right)\right]I(\mu)^{\beta}$. Note that $\frac{d}{d\mu}\left(\frac{1-\beta}{\beta}\frac{d\ln D}{d\mu}\right) = \frac{-\beta^3}{(\beta(\mu-1)+1)(\beta+\alpha(\beta(\mu-1)+1))^2} < 0$. To show D is strictly increasing in μ, it suffices to show $\frac{d\ln D}{d\mu}|_{\mu=1} > 0$, as $\frac{d\ln D}{d\mu}$ is strictly decreasing in μ. Note that $\frac{1-\beta}{\beta}\frac{d\ln D}{d\mu}|_{\mu=1} = -\ln\left(\frac{\alpha}{\alpha+\beta}\right) - \frac{\beta}{\alpha+\beta}$, which is always positive for any positive α and β in $(0,1)$. Hence, $\frac{1-\beta}{\beta}\frac{d\ln D}{d\mu}|_{\mu=1} > 0$, and hence $D(\mu)$ is strictly increasing in μ.

A.2 Proof of Lemma 2

Let $G = D^{\frac{1}{\sigma-1}}$, and denote $G_1 = \frac{d\ln G}{d\mu}$ and $G_2 = \frac{d}{d\mu}\left(\frac{d\ln G}{d\mu}\right)$. Then, we have $G'' = \left(G_1^2+G_2\right)G$. Note both $G(\mu)$ and $G'(\mu) > 0$ from Section A.1.2. To show that the function $G(\mu)$ is strictly concave is equivalent to show that $G_1^2 < -G_2$, or

$$\ln\left(1+\frac{\beta}{\alpha\beta(\mu-1)+\alpha}\right) < \left[\left(\frac{\beta}{(\beta(\mu-1)+1)}\right)^{\frac{1}{2}}+1\right]\frac{\beta}{-\alpha\beta+\alpha+\beta+\alpha\beta\mu}.$$

Let $x = \frac{\beta}{\beta(\mu-1)+1}$. Then, we have $\beta \le x \le \frac{\beta}{1-\beta}$ as $0 \le \mu \le 1$. Let $H(\alpha,x) \equiv \left(\sqrt{x}+1\right)\frac{x}{\alpha+x} - \ln\left(1+\frac{x}{\alpha}\right)$. To prove that $G(\mu)$ is strictly concave, it suffices to show $H(\alpha,x) \ge 0$ for any α and x. Note $H(\alpha,x)$ is increasing in α when $\alpha < \sqrt{x}$, and decreasing in α when $\alpha > \sqrt{x}$. Both $H\left(\sqrt{x},x\right)$ and $H(1,x)$ are positive for $\beta \le x \le \frac{\beta}{1-\beta}$. Therefore, for any value $x \in [\beta, \frac{\beta}{1-\beta}]$, we can always locate a unique $\alpha_0(x)$ such that $H(\alpha_0,x) = 0$ and $0 < \alpha_0 < \sqrt{x}$. A sufficient condition for the function

$G(\mu)$ to be concave is that $\alpha > \max \alpha_0(x)$, where $\beta \leq x \leq \frac{\beta}{1-\beta}$.

To see why $G = D^{\frac{1}{\sigma-1}}$ being strictly concave in μ implies that $D^{\frac{1}{\sigma}}$ is also strictly concave, note that we can write $D^{\frac{1}{\sigma}} = F(G)$, where $F = G^{\frac{\sigma-1}{\sigma}}$. Because F is strictly increasing and strictly concave, and G is strictly concave, it is readily verified that $F(G(\mu))$ is strictly concave.

A.3 Proof of Proposition 2

Recall (19) from Section 3.1 that

$$\mu_i^{c*} = \arg\max_{\mu_i} W_i = \left(\text{RMA}_i \frac{D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} L_i - A_i \mu_i^{\rho} L_i^{\eta}, \tag{A.1}$$

where $\text{RMA}_i \equiv M_i / P_i^{\sigma}$, which each national planner takes as given under a competitive equilibrium. The facts that $D(\mu)^{\frac{1}{\sigma}}$ is strictly concave (Lemma 2) and $\rho > 1$ imply that the problem (A.1) entails a unique solution for each country i. Hence, there exists a unique competitive equilibrium. If the solution to (A.1) is interior, then it satisfies the first-order condition, which can be written as

$$\frac{1}{\sigma}\left(\frac{\text{RMA}_i}{f}\right)^{\frac{1}{\sigma}} D(\mu_i)^{\frac{1-\sigma}{\sigma}} D'(\mu_i) L_i = \rho A_i \mu_i^{\rho-1} L_i^{\eta}, \tag{A.2}$$

where the left-hand side is the marginal benefit of increasing μ_i, while the right-hand side is the marginal cost. Obviously, the marginal cost strictly increases in μ_i, and the marginal benefit strictly decreases in μ_i as $D(\mu)$ is strictly increasing and concave in μ and $\sigma > 1$. Because the marginal benefit strictly increases in RMA_i, a larger real market access leads to better institutional quality, holding population size fixed.

A.4 Proof of Proposition 3

In a world of J symmetric countries, we focus on the symmetric Nash equilibrium where every country i finds it optimal to set $\mu_i = \mu^{n*}$, given other countries' choices being $\mu_{-i} = \mu^{n*}$, for some $\mu^{n*} \in [0, 1]$. When μ_i changes, all of the other countries than i will have the same changes in the market access and price index, denoted by $d \ln M_{-i}$ and $d \ln P_{-i}$, respectively.

By total differentiating the market access equation (5) for country i and combining other equilibrium conditions (8), (9), and (15), we obtain

$$\left(1-\frac{\lambda_{i,i}}{\sigma}\right) d\ln M_i - \frac{1-\lambda_{i,i}}{\sigma} d\ln M_{-i} = \frac{\lambda_{i,i}}{\sigma} d\ln D(\mu_i) + (\sigma-1)\,(1-\lambda_{i,i})\, d\ln P_{-i}, \tag{A.3}$$

where $\lambda_{i,j} \equiv \frac{X_{ij}}{E_i} = \frac{\tau_{ij}^{1-\sigma} E_j P_j^{\sigma-1}}{\sum_j \tau_{ij}^{1-\sigma} E_j P_j^{\sigma-1}}$ is the export share (the share of exports to country j in the total production of country i, R_i, which equals E_i). Similarly, total differentiating the market access equation (5) for country $-i$ and combining other equilibrium conditions (8), (9), and (15), we obtain

$$\left(1-\frac{1-\lambda_{-i,i}}{\sigma}\right) d\ln M_{-i} - \frac{\lambda_{-i,i}}{\sigma} d\ln M_i = \frac{\lambda_{-i,i}}{\sigma} d\ln D(\mu_i) + (\sigma-1)\,(1-\lambda_{-i,i})\, d\ln P_{-i}. \tag{A.4}$$

By total differentiating (7) and setting $P_i = 1$ (by choosing numeraire) so that $d\ln P_i = 0$ for this particular country i, we have

$$\left(1-\frac{1}{\sigma}\right)\xi_{ii} d\ln M_i + \left(1-\frac{1}{\sigma}\right)(1-\xi_{ii}) d\ln M_{-i} = \frac{\xi_{ii}}{\sigma} d\ln D(\mu_i), \tag{A.5}$$

where $\xi_{i,j} \equiv \frac{X_{ij}}{E_j} = \frac{\tau_{ij}^{1-\sigma} E_i M_i^{-1}}{\sum\limits_i \tau_{ij}^{1-\sigma} E_i M_i^{-1}}$ is the import share (the share of imports from country i in the total expenditure of country j). Note that $\xi_{i,i} = \lambda_{i,i}$ since both equal the ratio of the domestic trade to the total expenditure.

The three equations above are linear in $d\ln D(\mu_i)$, and they are rewritten as

$$\begin{aligned} d\ln M_i &= \left[\frac{\lambda_{i,i}}{\sigma-1} + \frac{(1-\lambda_{i,i})(\lambda_{i,i}-\lambda_{-i,i})}{\sigma+(\sigma-1)(\lambda_{i,i}-\lambda_{-i,i})}\right] d\ln D(\mu_i), \\ d\ln M_{-i} &= \left[\frac{\lambda_{i,i}}{\sigma-1} - \frac{\lambda_{i,i}(\lambda_{i,i}-\lambda_{-i,i})}{\sigma+(\sigma-1)(\lambda_{i,i}-\lambda_{-i,i})}\right] d\ln D(\mu_i), \\ d\ln P_{-i} &= \frac{\lambda_{i,i}-\lambda_{-i,i}}{(\sigma-1)\left[\sigma+(\sigma-1)(\lambda_{i,i}-\lambda_{-i,i})\right]} d\ln D(\mu_i). \end{aligned}$$

At a symmetric Nash equilibrium, the optimal institutional quality for country i is such that $\mu_i = \mu^{n*}$, given other countries' choices being $\mu_{-i} = \mu^{n*}$. In this case, we have $\lambda_{i,i} = \frac{1}{1+(J-1)\phi}$ and $\lambda_{-i,i} = \frac{\phi}{1+(J-1)\phi}$, where $\phi = \tau^{1-\sigma}$ is the trade openness with $\phi \in [0,1]$. Therefore, the log change in real market access of country i is (recall that $d\ln P_i = 0$)

$$d\ln M_i = \left(\frac{1}{\sigma-1}\cdot\frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma}\right) d\ln D(\mu_i), \tag{A.6}$$

and the log change in real market access for any other country $-i$ is

$$d\ln M_{-i} - \sigma\, d\ln P_{-i} = \frac{1}{\sigma-1}\left(\frac{\sigma\phi}{\sigma(J-1)\phi + (\sigma-1)(1-\phi)+\sigma}\right) d\ln D(\mu_i). \tag{A.7}$$

We want to prove the following three statements. First, a unique symmetric Nash equilibrium exists. Second, a decrease in trade cost τ or an increase in the number of trading partners $J-1$ leads to a larger real market access, conditional on institutional qualities. Third, a decrease in τ or an increase in $J-1$ leads to better institutional quality. Then, the statement of this proposition follows from the fact that real market access is the only channel through which institutional qualities are affected by τ and $J-1$.

To prove the first statement, we shall show that $\mu_i = \mu^{n*}$ satisfies the first-order condition of choosing μ_i, and that this solution is unique. Each national planner solves the problem (A.1) by choosing institutional quality μ_i, given other countries' institutional qualities. The first-order condition is

$$\left(\frac{M_i D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} d\ln\left(\frac{M_i D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} L_i = \rho A_i \mu_i^{\rho-1} L_i^{\eta} d\mu_i, \tag{A.8}$$

in which we have used $P_i = 1$ for this particular country i by choosing numeraire. We want to evaluate the first-order condition at $\mu_i = \mu^{n*}$. For this purpose, first observe that when every country's institutional quality equals μ^{n*}, all countries' price indices are equal ($P_i = P_{-i} = 1$). Combining the definition of market access (5) with the free-entry condition (15) and $P_i = P_{-i} = 1$ entails

$$M_i = f\left(\frac{\left[1+(J-1)\tau^{1-\sigma}\right] L_i}{f}\right)^{\frac{\sigma}{\sigma-1}} D(\mu_i)^{\frac{1}{\sigma-1}}. \tag{A.9}$$

Plugging (A.6) and (A.9) into (A.8), the first-order condition becomes

$$\varsigma(\phi, J)\, D(\mu_i)^{\frac{2-\sigma}{\sigma-1}} D'(\mu_i)\, L^{\frac{\sigma}{\sigma-1}} = \rho A \mu_i^{\rho-1} L^{\eta}, \tag{A.10}$$

where

$$\varsigma(\phi, J) \equiv \frac{1}{\sigma}\left(\frac{1}{\sigma-1}\cdot\frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma} + 1\right)\left(\frac{1+(J-1)\phi}{f}\right)^{\frac{1}{\sigma-1}}.$$

The term $D(\mu_i)^{\frac{2-\sigma}{\sigma-1}} D'(\mu_i)$ on the left-hand side of (A.10) is the derivative of $D(\mu_i)^{\frac{1}{\sigma-1}}$. By Lemma 2,

$D(\mu_i)^{\frac{1}{\sigma-1}}$ is strictly concave, and hence $D(\mu_i)^{\frac{2-\sigma}{\sigma-1}} D'(\mu_i)$ strictly decreases in μ_i. Thus, the marginal benefit of μ_i (the left-hand side) strictly decreases in μ_i, while the marginal cost (the right-hand side) strictly increases in μ_i. As the marginal benefit and cost are defined on the closed interval $\mu_i \in [0,1]$, there must exist a unique solution, and this solution is μ^*. The solution is a corner one if the marginal cost is at least as large as the marginal benefit at $\mu_i = 0$ or if the marginal benefit is at least as large as the marginal cost at $\mu_i = 1$. Whenever there is an interior solution, it satisfies (A.10).

To see the second statement, first note that in the symmetric Nash equilibrium, as we normalize the price index $P_i = 1$ for country i, $\mathrm{RMA}_i = M_i$. Thus, by (A.9), a decrease in trade cost τ or an increase in the number of trading partners $J-1$ will lead to larger real market access and higher wage rates, conditioned on μ_i. This proves the second statement.

To prove the third statement, it suffices to show that $\varsigma(\phi, J)$ increases in J and ϕ. This is because J and ϕ affect the decisions of institutional qualities only through the marginal benefits side of (A.10), i.e., only through real market access. Thus, when the marginal benefits increase due to an increase in J or ϕ, institutional qualities increase. Observe that

$$\begin{aligned}
\frac{\partial \ln \varsigma(\phi, J)}{\partial J} &= \frac{1}{\sigma-1} \cdot \frac{\phi}{1+(J-1)\phi} - \frac{\frac{1}{\sigma-1} \cdot \frac{(\sigma-1)(1-\phi)+\sigma}{[\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma]^2} \cdot \sigma\phi}{\frac{1}{\sigma-1} \cdot \frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma} + 1} \\
&> \frac{1}{\sigma-1} \cdot \frac{\phi}{1+(J-1)\phi} - \frac{\frac{1}{\sigma-1} \cdot \frac{(\sigma-1)(1-\phi)+\sigma}{[\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma]^2} \cdot \sigma\phi}{\frac{1}{\sigma-1} \cdot \frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma} + \frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma}} \\
&= \frac{1}{\sigma-1} \cdot \frac{\phi}{1+(J-1)\phi} - \frac{\phi}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma} \\
&> \frac{\phi}{(\sigma-1)[1+(J-1)\phi]} - \frac{\phi}{\sigma[(J-1)\phi+1]+(\sigma-1)(1-\phi)} \\
&> \frac{\phi}{(\sigma-1)[1+(J-1)\phi]} - \frac{\phi}{\sigma[(J-1)\phi+1]} > 0
\end{aligned}$$

Similarly, it is readily shown that $\frac{\partial \ln \varsigma(\phi, J)}{\partial \phi} > 0$.

A.5 Proof of Proposition 4

According to (A.10), the left-hand side (marginal benefit of improving institutional quality) is proportional to $L^{\frac{\sigma}{\sigma-1}}$, whereas the right-hand side (marginal cost of improving institutional quality) is proportional to L^{η}. It follows that a country will experience worse institutional quality if its population size increases when $\eta > \frac{\sigma}{\sigma-1}$; a country will experience better institutional quality if its population size increases when $\eta < \frac{\sigma}{\sigma-1}$. Institutional quality is independent of population size when $\eta = \frac{\sigma}{\sigma-1}$.

A.6 Proof of Corollary 1

Under autarky, $M_i = E_i P_i^{\sigma-1}$, and thus

$$\frac{M_i}{P_i^\sigma} = \frac{w_i L_i}{P_i}.$$

That is, the real market access equals the real income in a closed economy. Combining this fact with (16) entails

$$\frac{w_i L_i}{P_i} = \left(\frac{D(\mu_i)}{f}\right)^{\frac{1}{\sigma-1}} L_i^{\frac{\sigma}{\sigma-1}}. \tag{A.11}$$

Plugging (A.11) into (18) and taking the first-order condition yield

$$\frac{1}{\sigma-1}\left(\frac{1}{f}\right)^{\frac{1}{\sigma-1}} L_i^{\frac{\sigma}{\sigma-1}} D(\mu_i)^{\frac{2-\sigma}{\sigma-1}} D'(\mu_i) = \rho A_i \mu_i^{\rho-1} L_i^\eta,$$

which is, indeed, (A.10) with $J = 1$ and $\phi = 0$. Similar to the proof in Appendix A.5, a country experiences worse (better) institutional quality when its population size increases if $\eta > \frac{\sigma}{\sigma-1}$ ($\eta < \frac{\sigma}{\sigma-1}$). Institutional quality is independent of population size when $\eta = \frac{\sigma}{\sigma-1}$.

A.7 Proof of Proposition 5

We first solve the global planner's problem, where the planner takes into account all aggregate variables and attaches equal weight to each country's welfare:

$$\max_{\{\mu_k\}} \sum_k \left(\frac{M_k}{P_k^\sigma}\frac{D(\mu_k)}{f}\right)^{\frac{1}{\sigma}} L_k - \sum_k A_k \mu_k^\rho L_k^\eta.$$

The first-order condition for μ_i is

$$\left(\frac{M_i D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} L_i d\ln\left(\frac{M_i D(\mu_i)}{f}\right)^{\frac{1}{\sigma}} + \sum_{k\neq i}\left(\frac{M_k}{P_k^\sigma}\frac{D(\mu_k)}{f}\right)^{\frac{1}{\sigma}} L_i d\ln\left(\frac{M_k}{P_k^\sigma}\right)^{\frac{1}{\sigma}} = \rho A_i \mu_i^{\rho-1} L_i^\eta d\mu_i. \tag{A.12}$$

Combining (A.6) and (A.7), we have

$$d \ln M_i + (J-1)(d \ln M_{-i} - \sigma \, d \ln P_{-i}) = \frac{1}{\sigma-1} d \ln D(\mu_i). \tag{A.13}$$

Using the symmetry that $M_i D(\mu_i) = M_j D\left(\mu_j\right)$ and plugging (A.9) and (A.13) into (A.12), the first-order condition is simplified to

$$\frac{1}{\sigma-1}\left(\frac{1+(J-1)\phi}{f}\right)^{\frac{1}{\sigma-1}} D(\mu_i)^{\frac{2-\sigma}{\sigma-1}} D'(\mu_i) L_i^{\frac{\sigma}{\sigma-1}} = \rho A_i \mu_i^{\rho-1} L_i^{\eta}. \tag{A.14}$$

Similar to the proof for Proposition 3, the left-hand side is the marginal benefit of improving μ_i, which strictly decreases in μ_i, while the right-hand side is the marginal cost, which strictly increases in μ_i. As the marginal benefit and cost are defined over a closed interval $\mu_i \in [0,1]$, there exists a unique solution. When the solution is interior, it satisfies (A.14).

Next, we consider the symmetric competitive equilibrium where each national planner i takes the market access M_i and price index P_i as given. Under symmetry, P_i is normalized to 1 for all countries. Using $\text{RMA}_i \equiv M_i/P_i^{\sigma}$ and plugging (A.9) into (A.2), the first-order condition that determines μ^c is given as follows:

$$\frac{1}{\sigma}\left(\frac{1+(J-1)\phi}{f}\right)^{\frac{1}{\sigma-1}} D(\mu_i)^{\frac{2-\sigma}{\sigma-1}} D'(\mu_i) L^{\frac{\sigma}{\sigma-1}} = \rho A \mu_i^{\rho-1} L^{\eta}. \tag{A.15}$$

The first-order conditions for determining μ_i^g, μ_i^n, and μ_i^c are given by (A.14), (A.10), and (A.15), respectively; they are different only in terms of the multiplicative constant before the term $D(\mu_i)^{\frac{2-\sigma}{\sigma-1}}$. It is readily verified that

$$\frac{1}{\sigma-1} > \frac{1}{\sigma}\left(\frac{1}{\sigma-1} \cdot \frac{(\sigma-1)(1-\phi)+\sigma}{\sigma(J-1)\phi+(\sigma-1)(1-\phi)+\sigma} + 1\right) > \frac{1}{\sigma}, \tag{A.16}$$

and thus $\mu_i^g > \mu_i^n > \mu_i^c$. Because the marginal benefit of improving institutional quality is larger in the global planner's problem, followed by the Nash equilibrium and the competitive equilibrium, and the marginal costs are the same under the three solutions, we have $W_i^g > W_i^n > W_i^c$.

Observe that when $J \longrightarrow \infty$, the second inequality in (A.16) becomes equality, while the first inequality remains. This means that $\mu_i^n \longrightarrow \mu_i^c$ and $W_i^n \longrightarrow W_i^c$ as $J \longrightarrow \infty$, whereas the gap between μ_i^g and μ_i^n and hence that between W_i^g and W_i^n remain.

A.8 Robustness Checks on Simulation Results for Asymmetric Countries

The numerical simulations in Section 3.2 show that the statements in Proposition 3 hold even when countries are asymmetric. Section 3.2 also demonstrates a trade diversion effect. In this appendix, we show that these results are robust across wide ranges of parameters.

The first robustness check is about Figures 1 to 3, which show that the Nash equilibrium institutional qualities and real market access are both higher when trade costs are lower. The three figures differ in terms of the scale effect of population size due to varying marginal cost parameters (η), which change the order of institutional qualities among countries of different sizes. However, the values of η do not alter the fact that the changes in trade costs drive a positive correlation between real market access and institutional quality.

To gauge the robustness of this result, we first simulate the Nash equilibrium institutional qualities and real market access for each specific set of parameters listed in Table A1 and for τ ranging from 1 to 3. We then regress the simulated institutional qualities on the log of simulated real market access and the log of population size. The regression coefficients on the log of real market access are reported in Table A1. Note that we use a 40-point grid in $\tau \in [1, 3]$, and since there are three countries, the sample size for each regression is 120. Recall that in the baseline simulations in Section 3.2, the vector of population size is (10, 12.5, 15). In Table A1, we adjust the population sizes with a common scale factor L_{scale} but keep their relative sizes fixed. We consider alternative values of α (0.25, 0.50, and 0.80), β (0.55, 0.67, and 0.80), L_{scale} (0.5, 0.8, and 1.1), and η (1.01, 1.3 and 1.5). The η's correspond to the first three figures in Section 3.2, and we allow large variations in the rest of the parameters.[10]

All of the regression coefficients are positive and significant at the 1% significance level. This demonstrates the robustness of the simulation results in Figures 1 to 3.

[10]The choices of β map to the values of σ that range from 2.2 to 5. For these values of β, $\bar{\alpha}_0(\beta)$ as defined in Lemma 2 ranges from 0.25 to 0.27. Thus, we allow α to vary from 0.25 to 0.8.

Table A1: Robustness of Figures 1 to 3

α	β	L_{scale}	η = 1.01	η = 1.3	η = 1.5
0.25	0.55	0.50	0.1077	0.1264	0.1962
		0.80	0.1512	0.1566	0.2134
		1.10	0.1864	0.1799	0.2302
	0.67	0.50	0.0537	0.0641	0.1082
		0.80	0.0670	0.0696	0.1078
		1.10	0.0777	0.0741	0.1077
	0.80	0.50	0.0279	0.0334	0.0583
		0.80	0.0313	0.0328	0.0523
		1.10	0.0338	0.0322	0.0484
0.50	0.55	0.50	0.0637	0.0726	0.1054
		0.80	0.0832	0.0857	0.1157
		1.10	0.0989	0.0956	0.1231
	0.67	0.50	0.0354	0.0405	0.0596
		0.80	0.0419	0.0432	0.0594
		1.10	0.0467	0.0450	0.0594
	0.80	0.50	0.0197	0.0225	0.0325
		0.80	0.0212	0.0221	0.0303
		1.10	0.0226	0.0218	0.0287
0.80	0.55	0.50	0.0436	0.0495	0.0718
		0.80	0.0568	0.0585	0.0785
		1.10	0.0673	0.0651	0.0832
	0.67	0.50	0.0259	0.0294	0.0420
		0.80	0.0305	0.0311	0.0420
		1.10	0.0336	0.0325	0.0419
	0.80	0.50	0.0152	0.0170	0.0235
		0.80	0.0161	0.0167	0.0220
		1.10	0.0170	0.0167	0.0212

The second robustness check is about Figure 4, which illustrates the trade diversion effect on institutional quality. The figure shows that under the Nash equilibrium and when some but not all countries (countries 1 and 3) liberalize their trade relations, those whose bilateral trade costs are reduced increase their institutional qualities, while those whose trade costs remain unchanged (country 2) choose lower institutional qualities.

In Table A2, we report the simulated institutional qualities for every country under two scenarios, dubbed as old and new. The old scenario is when the bilateral trade costs are $\tau_{ij} = 3$ for all ij pairs; the new scenario is when countries 1 and 3's bilateral trade costs drop to $\tau_{13} = \tau_{31} = 1$ while country 2's trade costs remain at $\tau_{2i} = \tau_{i2} = 3$ for all $i \neq 2$. As in Figure 4, the baseline population size for each country is set at 10. We simulate for the same set of parameter values as in Table A1.[11] As shown in Table A2, $\mu_1^{\text{new}} = \mu_3^{\text{new}}$ are higher than $\mu_1^{\text{old}} = \mu_3^{\text{old}}$ and that μ_2^{new} is lower than μ_2^{old}, demonstrating the robustness of the message of Figure 4.[12]

[11] For the ease of presentation, Table A2 reports only the results for $\eta = 1.3$, but the results for the other two values of η remain robust and are available upon request.

[12] When β is large, the difference between μ_2^{new} and μ_2^{old} become invisible with four decimal places.

Table A2: Robustness of Trade Diversion Effects

α	β	L_{scale}	$\mu_1^{new} = \mu_3^{new}$	$\mu_1^{old} = \mu_3^{old}$	μ_2^{new}	μ_2^{old}
0.25	0.55	0.50	0.4781	0.3992	0.3905	0.3992
		0.80	0.6083	0.5081	0.4969	0.5081
		1.10	0.7134	0.5970	0.5845	0.5970
	0.67	0.50	0.3667	0.3217	0.3191	0.3217
		0.80	0.4018	0.3529	0.3492	0.3529
		1.10	0.4280	0.3755	0.3717	0.3755
	0.80	0.50	0.3492	0.3254	0.3254	0.3254
		0.80	0.3404	0.3179	0.3179	0.3179
		1.10	0.3342	0.3129	0.3129	0.3129
0.50	0.55	0.50	0.3066	0.2616	0.2566	0.2616
		0.80	0.3767	0.3229	0.3154	0.3229
		1.10	0.4305	0.3705	0.3630	0.3705
	0.67	0.50	0.2691	0.2416	0.2390	0.2416
		0.80	0.2904	0.2603	0.2578	0.2603
		1.10	0.3054	0.2741	0.2716	0.2741
	0.80	0.50	0.2829	0.2678	0.2678	0.2678
		0.80	0.2778	0.2628	0.2628	0.2628
		1.10	0.2741	0.2591	0.2591	0.2591
0.80	0.55	0.50	0.2115	0.1815	0.1777	0.1815
		0.80	0.2591	0.2228	0.2178	0.2228
		1.10	0.2954	0.2541	0.2491	0.2541
	0.67	0.50	0.2028	0.1827	0.1815	0.1827
		0.80	0.2178	0.1965	0.1952	0.1965
		1.10	0.2290	0.2065	0.2053	0.2065
	0.80	0.50	0.2303	0.2190	0.2190	0.2190
		0.80	0.2265	0.2153	0.2153	0.2153
		1.10	0.2240	0.2128	0.2128	0.2128

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