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The Interrelation between Formal and Informal Institutions through International Trade

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March 22, 2021

Abstract

This paper theoretically examines how country-specific formal and informal institutions are interrelated through international trade within a two-country general-equilibrium framework. When formal and informal institutions collectively generate institutional quality, formal institutions endogenously arise based on exogenously given informal institutions. Institutional quality governs the productivity of an institutionally intensive sector that features increasing returns. I find that in open economies, formal institutions tend to improve with the quality of informal institutions. In contrast, under autarky, formal institutions deteriorate with informal institutional quality. These results reveal that trade opens up the opportunity for enhancing formal institutions of countries with rich informal institutions.

Keywords: Informal institutions, Formal institutions, Institutional comparative advantage, Scale economies

JEL Classification: F12, F17, D02

Data Availability Statement: The data that support the findings of this study are available from the author upon request.

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1 Introduction

Institutions govern human interaction by inducing cooperation between self-interested individuals. Formal institutions, such as legal systems, and informal institutions, such as local culture, constrain individual behavior and determine how efficiently a group-based end is achieved. In promoting the compliance of rules for a group, historical evidence shows that there is an interaction between formal and informal institutions, whether as complements or substitutes. North et al. (2000) argue that shared beliefs among U.S. citizens are complementary to the U.S. Constitution and encourage compliance with formal rules. Even where formal institutions are not well developed, informal counterparts can substitute for formal institutions by enforcing a customary rule. Greif (1993) shows that a reputation mechanism supported commercial relations among the Maghribi traders in the 11th century when there were few legal contracts.

From such evidence, it seems important to take account for the interaction between formal and informal institutions when examining institutional quality. Thus, in this paper, I assume that their interaction gives rise to institutional quality, which governs comparative advantage in an institutionally intensive good and trade cost incurred due to imperfect contract enforcement. Under this assumption, I theoretically examine how country-specific formal institutions are interrelated with informal counterparts through international trade.

In this paper, building on North (1990), I define formal institutions as formally-shaped fundamental constraints on individual behavior. They include different types of official rules, such as laws and the electoral system, whose forms can be clearly described. According to my definition, contracts are not a part of formal institutions since what fundamentally governs the behavior of parties tied to a contract is related laws and/or a political system. Similarly, I define informal institutions as informally-shaped fundamental constraints on individual behavior. Even though we are unable to accurately describe what informal institutions look like, deeply internalized informal rules lead individuals to behave in a certain way.

I consider institutional quality higher as institutions lead individuals to better cooperate with

one another toward a group-based goal. In the model, such a goal is specified as production and the trade of a good, and hence, better institutions enhance labor productivity and contract enforceability between traders in different countries. Specifically, informal institutions complement, or substitute for, formal institutions in generating institutional quality. Thus, formal and informal institutions collectively lead labor to cooperate in producing a good and enforcing a contract for internationally trading that good. By considering institutions as an aggregate of formal and informal institutions, this paper provides a theoretical framework, illustrating that international trade affects how domestic formal institutional quality is endogenously determined based on exogenously given local informal institutional quality. Particularly, the model offers a comprehensive framework in which different sets of formal and informal institutions can be applied in a situation where cooperation is needed to a group-based end, which is subject to opportunism.

To more carefully see how formal and informal institutions interact, let us go back to the example of the Maghribi traders in the Muslim Mediterranean. The Maghribi traders employed overseas agents who supplied trade-related services, which involved a high level of uncertainty in that the employed agent could embezzle the merchant's capital. To resolve the commitment problem, the 11th century Maghribi traders organized a coalition, a private-order institution, rather than relying on the ineffective legal system (Greif 1989, pp. 865-6; Greif 1993, p. 529). Within the coalition, a reputation mechanism was supported by an implicit contract, under which the member merchants would not hire an agent who cheated, encouraging them to maintain a trustworthy reputation, and they were supposed to provide trade-related information for other members, helping reveal who cheated (Greif, 1989, pp. 868, 880). This information was effectively transmitted because the coalition merchants, the descendants of Jewish traders, shared a social network through an emigration process that strengthened their bond (Greif 1989, p. 879; Greif 1993, pp. 535-6).

The reputation system also played a key role in lowering trade-related uncertainty in medieval Europe. However, growing trade made monitoring trading partners' behaviors more difficult, and the reputation mechanism itself was not sufficient to overcome opportunism. Milgrom et al. (1990, p. 4) explain that the need for a new institution that could better address this issue led to the evo-

lution of the Law Merchant: “the legal codes governing commercial transactions and administered by private judges drawn from the commercial ranks.” Providing a unified system of law governing trades across different regions, the Law Merchant gained a higher influence on commercial transaction in the 12th–13th centuries (Trakman, 1983, p.8). Despite the lack of state enforcement, the Law Merchant effectively mitigated opportunism because it was devised out of a trade custom, which reinforced business practice (Trakman, 1983, pp.7-21).

This story of Medieval trade implies that trade volume can grow as informal institutions substitute for formal ones in mitigating opportunism and facilitating cooperation. In response to trade growth, formal institutions can be developed in such a way that they complement informal rules.

To develop a theoretical model consistent with this implication, building on Markusen and Venables (1998), I endogenize formal institutions in a computable general equilibrium model comprising two goods, two factors, and two countries. Oligopoly offers the possibility of production concentration according to competitive advantage and allows consumers to enjoy pro-competitive gains from trade. This constitutes the fundamental setting in analyzing how differently formal institutions arise in open economies than under autarky. Thus, this paper does not consider relationship-specific transactions of differentiated products and the search of business partners in a monopolistic competition setting. Rather, by taking a general role of institutions as promoting cooperation toward a group-based goal, I directly link institutional quality to labor productivity, as well as contract enforcement for international trade. This allows for focusing on examining institutional impacts on production concentration in scale economies, without specifying a holdup problem.

Specifically, the model takes informal institutions as exogenously given and assumes that individuals behave based on deep-rooted informal rules. North (1990) explains that informal institutions habitually constrain our behavior since it is transmitted from our ancestors.¹ Thus, informal institutions have persistent characteristics and tend to change more slowly than formal institutions (Roland, 2004). The persistence of informal institutions is supported by empirical evidence, including Nunn and Wantchekon (2011), Alesina et al. (2013), and Guiso et al. (2016).

¹See chapter 5, Informal constraints (pp. 36-45) in North (1990), for his detailed explanation.

Considering potential substitutability and complementarity between formal and informal institutions, country-specific institutional quality is defined as a CES aggregate of the two types of institutions. Institutional quality determines the pattern of trade through institutional comparative advantage in scale economies and a trade cost incurred by the risk of the falling through of planned contracts. Thus, beyond Greif's work on the Maghribi traders (1989; 1993), this paper finds an additional source of trade growth: institutional comparative advantage strengthening scale effect. Although opportunism is not explicitly shown in production, it implicitly exists since promoting cooperation requires mitigating opportunism between self-interested workers. The government provides formal institutions by levying tax on labor income given exogenous informal institutions.

Institutions in the model are different from other factors that improve labor productivity. As an example, consider formal education. Conceptually, formal education is not an institution because it does not fundamentally lead individuals to cooperate with one another toward a group-based goal, even though it could be a channel through which rules are absorbed by individuals. Moreover, formal education is not a public good, whereas the aggregate of formal and informal institutions is treated as a public good in the model. Individuals access education service through a market, and an educational benefit is unable to be shared between all individuals.² Conversely, there is no market for an aggregate of laws and trust between citizens, and every economic agent that uses the aggregated institutions receives their full benefit in securing property rights.

The analysis using simulations is based on the estimates for the elasticity of substitution between formal and informal institutions. Using the production data for institutionally intensive industries and data on formal and informal institutions, the non-linear least squares (NLS) estimation yields the estimates of 1.8 and 3.5, as will be shown in Section 3. Each value is employed as a parameter for elasticity.

²However, when citizens are required to get a certain level of education, which is free of charge, this education is a public good. This public education could interact with exogenously given non-institutional, individual characteristics (e.g., an innate ability, which could be country-specific) in determining labor productivity. Thus, when setting aside the conceptual meaning of institutions, as long as productivity-enhancing factors are considered a public good, which requires high fixed costs, and interact with an exogenously given productivity determinant, the model could be used as a theoretical framework for the analysis of how such factors endogenously arise and how international trade affects these endogenous changes.

Comparative statics shows that the provision of formal institutions in open economies tends to increase with the quality of informal institutions, which is a stark comparison to its decreasing trend under autarky. This is explained by the balance between scale effect and the substitution of informal institutions for formal ones. Specifically, as informal institutions improve, the degree of comparative advantage in the institutionally intensive sector, featuring increasing returns, rises. Then, the scale effect is magnified, drastically raising the marginal product of formal institutions in producing the institutionally intensive good. Since this scale effect dominates the substitution effect, the provision of formal institutions rises with informal institutional quality. This impact is reinforced by the decreasing trade cost with improving institutions. The positive relationship between domestic formal and informal institutions is supported by previous research, including Tabellini (2008a). Notice that the substitutability between formal and informal institutions, as shown by the NLS estimates, is limited to generating institutional quality, and that they turn out to be in a positive relationship as a result of international trade. Under autarky, the absence of trade does not allow comparative advantage to work out. That is, the production of the institutionally intensive sector does not rise enough to make the scale effect outweigh the substitution effect. This causes the provision of formal institutions to fall with the quality of informal institutions.

This paper is related to the literature on formal institutions and trade. Levchenko (2007), Nunn (2007), and Feenstra et al. (2013) find that formal institutions are one of the determinants of trade patterns in the comparative advantage framework. Formal institutions also play a key role in analyzing sourcing modes within the framework of incomplete contracts, in that this framework typically relies on the implicit assumption of the absence of formal institutions (Grossman and Helpman, 2002, 2005; Antràs, 2003, 2005). In addition to affecting production process, formal institutions are shown to lower the uncertainty of trade of completed goods, thereby reducing trade costs (Anderson and Marcouiller, 2002; Berkowitz et al., 2006; Antràs and Foley, 2015).

Another related literature is on informal institutions and trade. Other than Greif's seminal work on the Maghribi traders (1989; 1993), the importance of a network in forming group ties and lowering trade costs has been studied theoretically (Kranton and Minehart, 2001; Casella and Rauch,

2002; Bowles and Gintis, 2004) and empirically (Gould, 1994; McMillan and Woodruff, 1999; Rauch, 1999; Rauch and Trindade, 2002). Additionally, as a determinant of trade patterns, Guiso et al. (2009) focus on trust between trading countries, while Tabellini (2008a, pp.279-83) examines local culture. Regarding endogenous culture in open economies, Bisin and Verdier (2014) provide a survey, including the cultural convergence topic (Olivier et al., 2008; Maystre et al., 2014).

This paper also complements the literature on the interaction between formal and informal institutions. Bidner and Francois (2011) find that a large population leads to a high trust level and functional institutions. Aghion et al. (2010) show that trust and government regulation are negatively associated, and Pinotti (2012) argues that this association mainly captures the causal impact of trust on regulation. Especially, trust and labor market institutions/regulations are focused on by Algan and Cahuc (2009) and Aghion et al. (2011). In buyer-seller relationships, Johnson et al. (2002) show that business ties can promote contract enforcements without effective courts, although firms can find new business partners more easily with effective courts. This substitutability of informal institutions for formal ones is also found in Guiso et al. (2004) and Allen et al. (2005), along with the studies listed regarding networks, which can be seen as an alternative to markets.

A growing number of studies have focused on the formal-informal interaction in the explicit setting of international trade (Dixit, 2003; Tabellini, 2008b; Yu et al., 2015; Araujo et al., 2016; Belloc and Bowles, 2017). Particularly, Araujo et al. (2016) find that formal institutions are important for export performance, but trade experience develops a reputation between existing traders, which, in turn, lowers the impact of formal institutions. This implies that informal institutions substitute for formal ones in securing international trade, which is consistent with Yu et al. (2015).

This paper contributes to the broad literature on institutions by adding a new perspective on institutional quality as an outcome of the formal-informal interaction, while considering informal rules as different types of institutions, following North (1990). Based on this perspective, my paper further contributes to the literature on trade and institutions by shedding light on a new scope of gains from trade: trade provides the opportunity of improving formal institutions for the countries with rich informal institutions. Compared to Levchenko (2007), who also theoretically

finds institutions as a source of comparative advantage, this paper additionally considers increasing returns, a key feature of institutions, and the formal-informal interaction in generating institutional quality. Opening up to trade allows institutional comparative advantage to strengthen scale effect enough to dominate the decreasing force of formal institutions, arising from the substitution of informal institutions for formal counterparts. Therefore, this paper contributes to the literature on trade and institutions by providing a different mechanism through which trade shapes the formal-informal interaction.

The remainder of this paper is organized as follows. Section 2 develops a theory that provides a framework for understanding how formal and informal institutions are interrelated through trade. Section 3 estimates the elasticity of substitution between formal and informal institutions, and Section 4 performs simulations based on the estimated elasticity. Section 5 concludes.

2 The Theory

The theory in this Section builds on Markusen and Venables (1998).³

The model comprises two countries, 1 and 2, indexed by subscripts i and j , and two factors, labor, L , and capital, K . National firms in each country produce two homogeneous goods, X and Y . The good Y is chosen as the numeraire of the price system. Labor is perfectly mobile across sectors, whereas capital is only used for the production of Y . Both factors are immobile across countries.

There exist two types of institutions, formal and informal. As defined in the introduction, formal institutions refer to formally-shaped fundamental constraints on individual behavior, such as legal and electoral systems. Informal institutions refer to informally-shaped, deeply-internalized rules, such as social norms. The X sector uses the aggregate of formal and informal institutions as a public intermediate good.

The following section, 2.1, specifies how institutions are incorporated into production and how

³Markusen and Venables (1998) develop a general equilibrium model in which multinational firms endogenously arise in the presence of fixed costs and different factor endowments across countries.

formal institutions are provided by the government.

2.1 Production

The good Y in country i is produced according to the following Cobb-Douglas production function:

$$Y_i = L_{iy}^\nu K_i^{1-\nu}, \quad i = 1, 2, \quad (1)$$

where K_i is the capital endowment of country i , and L_{iy} is the labor used in the Y sector in country i . Then, the marginal products of L and K in country i are the wage rate, w_i^p , and the rental rate, r_i :

$$w_i^p = \nu \left(\frac{K_i}{L_{iy}} \right)^{1-\nu}, \quad r_i = (1 - \nu) \left(\frac{L_{iy}}{K_i} \right)^\nu, \quad i = 1, 2. \quad (2)$$

Note that with the endogenous tax rate t_i , which will be introduced later, w_i^p denotes the price of labor paid by a producer, $w_i(1 + t_i)$, where w_i is the price of labor received by a consumer.

As Markusen and Venables (1998, p.187) point out, this setting allows the wage rate to rise with the labor supply to the X sector. Specifically, due to the diminishing marginal product of labor in the Y sector, arising from the specific factor K , the wage rate increases as the X sector grows, absorbing more labor from the Y sector.

For the production of the good X , only labor is used:

$$X_i = \alpha_i L_{ix}, \quad i = 1, 2, \quad (3)$$

where L_{ix} is the labor used in the X sector in country i . Variable α_i is defined as follows:

$$\alpha_i \equiv 1 + E_i, \quad i = 1, 2, \quad (4)$$

where E_i indexes the institutional quality of country i .

Each country is endowed with a certain quality of informal institutions, I . The quality of formal institutions, F , is endogenous to the model. Allowing for potential substitutability and complementarity between F and I , the institutional quality of country i is defined as a CES aggregate of them:

$$E_i \equiv \left(F_i^\theta + I_i^\theta \right)^{\frac{1}{\theta}}, \quad i = 1, 2, \quad (5)$$

where $\theta(\leq 1)$ denotes the degree of substitutability between F and I .⁴

Each firm takes α as given while considering E as a public intermediate good.⁵ As equations (3) and (4) show, α captures the good X 's productivity that relies on institutional quality. By this structure, the X sector intensively uses institutions, which is stark in comparison with the Y sector for which institutions are not used. The X sector can be conceptualized as a sector that requires a high degree of cooperation between workers, rather than requiring just an automated system using capital. In such an environment, high-quality institutions can facilitate cooperation between self-interested workers by bringing them together, as well as by providing strong contract enforcement and property rights.

For example, as the government better secures property rights, as the legal system better verifies each worker's performance, and as labor laws better support labor contracts, workers will be more cooperative toward production. Similarly, as workers trust each other more and as domestic social ties are stronger, workers will be less subject to opportunism. Such informal institutions can substitute for, or complement, the formal institutions in mitigating opportunism and encouraging workers to cooperate toward the production of X .

The government levies a tax on the wage bill and spends the tax collected constructing formal institutions, meaning enhancing the quality of existing formal institutions as well as creating new institutions in such a way that they better encourage workers to cooperate. Given the assumption that one unit of labor produces one unit of formal institutions, the government budget constraint is given by

$$w_i L_i t_i = w_i^P F_i, \quad i = 1, 2, \quad (6)$$

where L_i is country i 's labor endowment. That is, tax collected is equal to the wage bill required for the provision of formal institutions. Note that the relationship between $w_i^P (= w_i(1 + t_i))$ and P_{F_i} ,

⁴This CES function only considers one parameter, θ , while dropping the other parameters shown in a general CES function. This allows for focusing on the main concern of the paper, the substitutability and complementarity between formal and informal institutions, and for minimizing the number of estimates for the simulations of the model. The estimation of $\sigma (= \frac{1}{1-\theta})$ is presented in Section 3.

⁵This setting is motivated by Markusen's unpublished material: Ch.6.5, Public intermediate (infrastructure) good with optimal provision. It is found at: <http://spot.colorado.edu/~markusen/teaching.html>.

which denotes the private valuation of one unit of formal institutions, will be listed and explained later in equation (13) with other pricing equations in Section 2.4.

The government's objective in the model is to support the firms that face opportunism in producing the good X by constructing formal institutions. When the firms face a new environment that favors more production of X , the government provides higher-quality formal institutions because the firms need better institutions that can support their opportunity to produce a greater volume of X . That is, as formal institutions become more important and valuable to the users of institutions, higher-quality formal institutions arise, which is in line with how the Law Merchant evolved in Medieval trade, described in the introduction. Note that there exists the oligopoly distortion in the market, and reducing the distortion is not the government's goal. If the government aimed to lower price by designating a target gap of average cost from marginal cost for a given quality of informal institutions, the quantity produced for the good X and the quality of formal institutions would be determined according to the target, not according to a comparative advantage force.⁶ Since the main concern of this paper is to examine how international trade affects the quality of formal institutions in scale economies, the model considers informal institutions as a source of institutional comparative advantage, which influences the degree of scale effect, and allows formal institutions to arise according to how valuable they are in producing X . What reduces the oligopoly distortion is international trade, as opposed to the government's intervention, and the resulting greater production of X encourages the government to enhance formal institutions.

Therefore, the government takes L_{ix} as given, while leaving the private market outcomes to be determined by the private firms for each given I_i . Then, the government chooses to provide formal institutions up to the point where the value of the marginal product of F_i in X_i is equal to its marginal cost, which is the (shadow) price of one unit of F_i in equilibrium when it is provided. The value of the marginal product of F_i in X_i is calculated by replacing L_{ix} in the marginal product of F_i in X_i with $\frac{X_i}{\alpha_i}$ and multiplying that marginal product by the price of X_i . The (shadow) price of

⁶Higher-quality formal institutions do not guarantee welfare improvement in the presence of the tax on labor income, as I will show Sections 4.1.2 and 4.2.3. Thus, even if the government aimed to reduce the distortion by enhancing formal institutions, welfare gain would not be guaranteed.

one unit of F_i , or the private valuation of one unit of F_i , is expressed as follows:

$$P_{F_i} = P_{ix} \frac{X_i (F_i^\theta + I_i^\theta)^{\frac{1}{\theta}-1}}{\alpha_i F_i^{1-\theta}}, \quad i = 1, 2, \quad (7)$$

where $F_i = L_i t_i / (1 + t_i)$ from the government budget constraint in equation (6). The tax rate is endogenously determined by this equation.

2.2 Consumption

A representative consumer in country i has the following Cobb-Douglas utility function:

$$u_i = X_{ic}^\beta Y_{ic}^{1-\beta}, \quad i = 1, 2, \quad (8)$$

where X_{ic} and Y_{ic} are the consumption level of X and Y goods. Utility-maximizing demands are

$$X_{ic} = \beta M_i \frac{1}{P_{ix}}, \quad Y_{ic} = M_i (1 - \beta), \quad i = 1, 2, \quad (9)$$

where M_i denotes the national income of country i . Consumption $X_{ic} = n_i X_{ii} + n_j X_{ji}$, where X_{ji} indexes the number of units of goods sold in country i , which are produced by a firm in country j ($j \neq i$). Variable n_i denotes the number of firms in the X sector in country i .

2.3 International Trade

Institutional quality determines contract enforceability between trading partners. For instance, when property rights are secured and when local culture encourages people to be honest, firms will be more likely to cooperate with other firms in a different country in order to be successful in trading goods.

Let the probability that country i 's firm follows the contract be $e^{-\frac{1}{E_i}}$.⁷ When $E_i = 0$, the probability converges to zero. When E_i goes to infinity, by contrast, the probability converges to one. For the contract to be enforced, both trading firms must follow the contract. Under the assumption

⁷I assume that exporter and importer have the same probability of following a contract, $e^{-\frac{1}{E_i}}$, in order to make the model simple. Costinot (2009) uses this probability to measure the risk of incomplete contract enforcement.

that firms in each country independently follow the contract, the probability that the contract for international trade is enforced by any two firms is given by $e^{-\left(\frac{1}{E_i} + \frac{1}{E_j}\right)}$. This setting allows the probability of reaching the planned trade to monotonically increase with the contract enforceability of one country, holding the other country's enforceability constant. Note that Appendix E considers contract enforcement between local traders, which is affected by domestic institutional quality.

In the presence of the risk that an originally-planned trade falls through, some of the products are considered melted during transaction. I define $\delta (> 0)$ as a trade cost incurred due to imperfect contract enforcement:

$$\delta \equiv e^{\left(\frac{1}{E_i} + \frac{1}{E_j}\right)} - 1, \quad i, j = 1, 2, i \neq j. \quad (10)$$

In addition to δ , international trade incurs transport cost, $\tau (> 0)$, by which some of the products are assumed to be melted during transportation. Then, to sell one unit of the good X abroad, firms need to produce $(1 + \delta)(1 + \tau)$ units of the good. No transport costs are assumed for the good Y .⁸ Recall that firms in the model are all national firms. Therefore, multinationals operating in the host country, which would not incur δ and τ , are not considered.

Beginning foreign sales requires firms to share a fixed cost, $f (> 0)$, measured in units of labor. Fixed cost f includes, for example, labor needed to set up a contract for international trade. For domestic sales, firms share a fixed cost, $h (> 0)$, measured in units of labor.⁹ The existence of these fixed costs leads to increasing returns, referring to the diminishing average cost with the output level of X . Notice that the fixed costs also capture the fixed costs for developing institutions because the government's provision of F completely relies on the productivity of the X sector. If h and f are too high to produce X , F cannot be provided. This makes formal institutions feature increasing returns, which is considered the main factor that determines the path of institutional transition (North, 1990).

⁸Even with the transport costs for Y , the main results of this paper would not be changed. This is because the transport costs for Y would make the economy more focused on the good X as institutional quality improves, reinforcing the theoretical results.

⁹Comparative statics, which is discussed later, begins with autarky. In the analysis under autarky, h plays a role in determining the number of firms in the X sector.

2.4 Complementary-Slackness Conditions and Market Clearing

The following pricing equations are formulated as complementary-slackness conditions with respect to their complementary variables, output (actually consumed), in brackets:

$$P_{ix}(1 - \eta_{ii}) \leq c_i w_i^p, \quad [X_{ii}] \quad (11)$$

$$P_{jx}(1 - \eta_{ij}) \leq c_i w_i^p(1 + \delta)(1 + \tau), \quad [X_{ij}] \quad (12)$$

$$P_{Fi} \leq w_i^p, \quad [F_i] \quad (13)$$

$i, j = 1, 2, i \neq j$, where η_{ij} indexes the markup for country i 's firm in country j . Variable $c_i \equiv \frac{1}{\alpha_i}$ denotes country i 's unit labor requirement for the good X .

If, in equilibrium, marginal cost is greater than markup-adjusted price, there will be no output. Particularly, inequality (13) shows that, under the setting where the government provides formal institutions by taxing labor income, if marginal cost for constructing formal institutions is greater than its price, there will be no provision of formal institutions. A good is produced only when the strict equality holds in a pricing equation.

Assuming Cournot competition between the X sector firms, the markup is expressed by a firm's market share divided by the price elasticity of demand. Since the price elasticity of demand is one from equation (9), the markup of the firm is exactly its market share. It follows that $\eta_{ii} = \frac{X_{ii}}{X_{ic}}$ and $\eta_{ij} = \frac{X_{ij}}{X_{jc}}$. Combining these markup equations with equation (9),

$$\eta_{ii} = \frac{P_{ix}}{\beta M_i} X_{ii}, \quad \eta_{ij} = \frac{P_{jx}}{\beta M_j} X_{ij}, \quad i, j = 1, 2, i \neq j. \quad (14)$$

Substituting equation (14) into inequalities (11) and (12) yields

$$X_{ii} \geq \frac{\beta M_i}{P_{ix}^2} (P_{ix} - c_i w_i^p), \quad X_{ij} \geq \frac{\beta M_j}{P_{jx}^2} (P_{jx} - c_i w_i^p(1 + \delta)(1 + \tau)), \quad (15)$$

$i, j = 1, 2, i \neq j$.

Regarding formal institutions, plugging equation (7) into inequality (13) yields

$$\frac{(F_i^\theta + I_i^\theta)^{\frac{1}{\theta}-1}}{F_i^{1-\theta}} \leq \frac{\alpha_i}{X_i P_{ix}} w_i^p, \quad i = 1, 2. \quad (16)$$

The zero profit condition requires fixed costs to be greater than or equal to markup revenues.

This condition is also written as complementary-slackness condition with respect to the number of firms in the X sector, n_i :

$$P_{ix}\eta_{ii}X_{ii} + P_{jx}\eta_{ij}X_{ij} \leq w_i^p(f + h), \quad [n_i] \quad (17)$$

$i, j = 1, 2, i \neq j$. When the output level is greater than zero, by plugging equations (14) and (15) into inequality (17) and by converting the price of X into the consumption level for the X sector using equation (9), this zero profit condition can be written as follows:

$$\beta \left[M_i \left(1 - \frac{c_i w_i^p (n_i X_{ii} + n_j X_{ji})}{\beta M_i} \right)^2 + M_j \left(1 - \frac{c_i w_i^p (1 + \delta)(1 + \tau)(n_j X_{jj} + n_i X_{ij})}{\beta M_j} \right)^2 \right] \leq w_i^p(f + h), \quad i, j = 1, 2, i \neq j. \quad (18)$$

By income balance condition,

$$M_i = w_i L_i + r_i K_i, \quad i = 1, 2. \quad (19)$$

Labor market clearing condition requires

$$L_i = n_i \left[c_i X_{ii} + c_i (1 + \delta)(1 + \tau) X_{ij} + f + h \right] + F_i + L_{iy}, \quad i, j = 1, 2, i \neq j. \quad (20)$$

Goods market clearing conditions are given by

$$X_i = X_{ic} = n_i X_{ii} + n_j X_{ji}, \quad i, j = 1, 2, i \neq j, \quad (21)$$

$$Y_i + Y_j = Y_{ic} + Y_{jc}, \quad i, j = 1, 2, i \neq j. \quad (22)$$

Notice that if one country's market for the good Y clears, the other country's market for the good Y also clears by equation (22). Thus, by imposing equation (22), just one country's market clearing condition is required to ensure that both countries' markets clear. In fact, by Walras' Law, one country's market clears, confirming that the market for the Y good clears for each country. Market clearing for each good and each country ensures trade balance.¹⁰

¹⁰To see this, consider $n_i X_{ij}$, which is the same as $(X_i - n_i X_{ii})$, adjusted by trade costs. By equation (21), this value becomes $n_j X_{ji}$, adjusted by trade costs. Since price difference between countries captures trade costs, the values of imports and exports of X are the same. The same is true for the good Y .

2.5 Summary of the Model

The output of the good X is given by inequality (15), and the number of firms in the X sector is given by inequality (18). The price of the good X is shown in equation (9). The price of labor is associated with the labor market clearing condition in equation (20), where L_{iy} is shown in terms of factor prices in equation (2). The production of the Y sector is given by equation (1), and the national income is given by equation (19).

These equations are based on the rational behaviors of the private firms and the government. For each I , the firms maximize their profits, as expressed in equations (11) and (12), while taking the institutional quality as given. For each I , the government maximizes the net benefit of formal institutions, while taking the private market outcomes as given. Specifically, since formal institutions are financed by a tax on labor income, formal institutions are provided as long as their price equals the price of labor paid by a producer, as expressed in inequality (13). Meanwhile, by the government behavior maximizing the net benefit of formal institutions, the marginal cost for producing F (or the shadow price of F) is equalized to the value of the marginal product of formal institutions in producing X , as shown in equation (7). These two relationships derive the provision level of formal institutions, expressed in inequality (16).

The endogenous provision of formal institutions can be better understood by comparative statics. Intuitively, when the quality of informal institutions rises, the marginal product of formal institutions in X rises, as well, because both institutions together generate institutional quality that governs productivity. This is fueled by the increasing returns in the X sector, which constitutes a force of developing formal institutions. However, if formal and informal institutions substitute for one another in giving rise to institutional quality, there will be a force of lowering the quality of formal institutions as informal institutions improve. Conversely, if the two institutions are complementary to one another, there will be no decreasing force of formal institutional quality. The response of formal institutions also depends on whether the economies open up to trade. In open economies, a country with better informal institutions will have an institutional comparative

advantage, which, in turn, results in a greater degree of scale effect than the corresponding effect under autarky. Then, the marginal product of formal institutions in X soars as informal institutional quality rises, which could generate a great degree of increasing force of the provision of formal institutions, enough to dominate a decreasing force of it in cases where informal institutions substitute for formal counterparts. This process is reinforced by diminishing trade costs, δ , with improved contract enforceability.

Before conducting more thorough comparative statics using simulations in Section 4 in the absence of reduced-form solutions, the elasticity of substitution between formal and informal institutions is estimated in the following section.

3 Estimation of the Elasticity of Substitution between Formal and Informal Institutions

To estimate the elasticity of substitution between formal and informal institutions, $\sigma (= \frac{1}{1-\theta} \geq 0)$, I employ the non-linear least squares (NLS) estimation.¹¹ The estimation is based on the following constraint equation, constructed by combining equations (3)–(5), replacing θ with σ , and applying the logarithm:

$$\min_{\sigma} \sum_i \epsilon_i^2 \quad s.t. \quad \ln \frac{X_i}{L_i} = \ln \left[1 + \left(F_i^{\frac{\sigma-1}{\sigma}} + I_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \right] + \epsilon_i. \quad (23)$$

For the estimation of σ , I use the data on value added and the number of employees in the Trade, Production, and Protection Database (production database) organized by the 3-digit International Standard Industrial Classification (ISIC) revision 2. This dataset, developed by Nicita and Olarreaga (2006), covers up to 100 countries and 28 manufacturing industries from 1976 to 2004. I use 2000 as a base year. If the data are not available, I employ the data from 1998 or 1999.

In equation (23), X is the production level of the institutionally intensive good. To screen

¹¹ Another standard method to estimate the elasticity of substitution between inputs in a CES function is to use Kmenta's approximation. Kmenta (1967) presents an approximation of a CES function by taking a second-order Taylor expansion around $\theta = 0$ (i.e., a case of Cobb-Douglas function) to the logarithmed CES function. Therefore, this can be expressed by translog function with some restrictions on parameters. However, Kmenta's approximation involves some problems from using Taylor expansion around $\theta = 0$; Thursby and Lovell (1978) point out that when the linear approximation is truncated, there is omitted variable bias from its remainder terms. They additionally show that the approximation does not provide reliable estimates when an underlying function is not Cobb-Douglas.

which industries need institutions more, I rely on two measures of institutional intensity (d_z): Nunn (2007)'s measure and 1 minus the Herfindahl index, both of which are discussed in Appendix A.1.

Based on the 28 d_z s organized by the ISIC levels, I consider the ranking of d_z to screen the production of industries for which institutions are important. Specifically, I consider the industries that are in the top 20%, 30%, or 40% of d_z as institutionally intensive industries.

To estimate σ , the production data for the institutionally intensive industries are combined with the aggregate measures for formal and informal institutions. Formal institutions are measured using the Polity IV data from Marshall et al. (2014), the Database of Political Institutions (DPI) from Beck et al. (2001), and the data on judicial power from La Porta et al. (2004). Informal institutions (proxied by the aggregate of trust, control, and obedience) are measured using the European Values Study and World Values Survey (EVS and WVS, 2006). Note that the measures for formal and informal institutions are discussed in detail in Appendix A.2. I use the time span of 1995-2001 for the data on informal institutions and 1995-2000 for the data on formal institutions so that all data are around the base year of 2000. The aggregate dataset includes 30 countries. I additionally consider another set of formal institutions that only includes the Polity IV data, which increases observations up to 44. Table B.1 in Appendix B lists the 30 and 44 countries that are used for the estimation of σ .

The estimation results for σ are shown in Table 1. Column A presents the estimates of σ when using all three sets of data to measure formal institutions. Regardless of the criteria for institutionally intensive industry and the measure for d_z , the estimates are around the average of 1.8. Therefore, I use 1.8 as a parameter for the simulations in Section 4. Column B shows the estimated σ when the Polity IV data are used as a proxy for formal institutions. The estimates range from 2.7 to 4.2. I use 3.5, which is the average of the estimates in column B, as another parameter for σ in the simulations.

4 Comparative Statics

To explore how international trade plays a role in shaping the interaction between formal and informal institutions, comparative statics using simulations begins with autarky and is expanded to

open economies.¹²

Note that the parameters used in the simulations are listed in Table C.1 in Appendix C. The simulation results about the markup rates and the number of firms are discussed in Appendix D.

4.1 Autarky

The simulations for autarky are conducted by varying the quality of informal institutions, I , over the range of 0.001, 0.002,...,0.02. For simplicity, the subscript i is dropped in the following two sub-sections.

4.1.1 Formal Institutions

The economy produces F up to the point where the value of the marginal product of F in X equals its marginal cost $w^P(= w(1 + t))$, which is P_F . As this value rises, there exists a greater force to construct F . In this simulation, a higher I raises the marginal product of F in X because I and F collectively create the institutional quality that governs productivity. Since P_x falls with I , how much the marginal product of F in X increases with I determines the response of P_F , which in turn affects the provision of F .

Given that the X sector features increasing returns, scale effect shapes the degree to which the marginal product of F in X rises with I and gives rise to a force to increase F . On the contrary, the substitutability of I for F generates a force to decrease F as I rises. Therefore, the decreasing trend of F over I , shown in sub-figure (a) in Figure 1, implies that, under autarky, scale effect is not great enough to offset the substitution effect. Specifically, for each level of I , F is lower when σ is 3.5 than when it is 1.8 because of the greater decreasing force of F .

The pattern of t responding to the increase in I is the same as the corresponding pattern of F because the construction of F is financed by a tax on labor income. More formally, from the government budget constraint in equation (6), the following equation is driven: $t/(1 + t) = F/L$. Since the left-hand side is increasing in t , F and t are positively related.

¹²The simulations are performed using GAMS solver Mixed Complementarity Problem (MCP).

Sub-figure (b) presents the production of Y rising with I . This happens even while the X production rises, implying that a rise in I does not lead to a great degree of production concentration, which makes scale effect dominated by the substitution effect. In fact, this is the opposite of the simulation result under open economies, where the Y production falls with I due to a great degree of scale effect, as I will show in Section 4.2.1. Sub-figure (b), specifically, shows that the Y production rises more with I when σ is 3.5 than it is 1.8. Given that K is a specific factor for the Y sector, this implies that labor employed in the Y sector increases more with I as σ is higher. The reason for this is that a smaller share of labor employed for constructing formal institutions, due to a greater substitutability of I for F , allows more labor to be employed in the private sectors. For each I , the X sector also produces a higher level of output as σ rises.

4.1.2 Welfare

Welfare is calculated by the aggregate income, $wL + rK$, divided by the price index, $P_x^\beta P_y^{(1-\beta)}$. As expressed in equation (2), the increasing labor in the Y sector, arising from the increase in I , causes r to rise and $w^p (= w(1 + t))$ to fall. Nonetheless, the wage rate received by consumers, w , rises with I , as presented in sub-figure (b) in Figure 2. That is, even when the firms pay a lower wage rate, households enjoy a higher wage rate because their tax rate, used for providing F , falls. With a higher σ , the impact of an increasing I on w is greater because t and F fall more by a higher degree of the substitution effect. Lastly, the price index falls with I , as the X production rises. This, along with the increased factor prices, causes both the real rental rate and real wage rate to rise, improving welfare, shown in sub-figure (a). For each I , a higher σ induces a lower price index and a higher w and r , leading to greater welfare.

4.2 Open Economies

The comparative statics under open economies is performed by changing I_i over the range of 0.001, 0.002,...,0.02, while fixing I_j at 0.01. Thus, the simulation results show how the equilibriums change when I_i relative to I_j , $\frac{I_i}{I_j}$, varies from 0.1 to 2. In addition, since Section 4.1 included

the explanation of how differently the main solutions to the model are determined according to the level of σ , which is also applicable to open economies, this section focuses on the overall responses of the main variables, shown regardless of the degree of σ , to the changes in $\frac{I_i}{I_j}$.

4.2.1 Formal Institutions

Sub-figure (a) in Figure 3 shows the endogenous provision of formal institutions under open economies. As in autarky, how F_i responds to a change in $\frac{I_i}{I_j}$ is determined by the tension between scale effect and the substitution effect. However, unlike autarky, there exist two factors that influence scale effect: institutional comparative advantage and the trade cost δ incurred due to imperfect contract enforcement, defined in equation (10). For now, institutional comparative advantage is focused on, and the trade cost δ , which depends on F_i and F_j , will be examined in Section 4.2.2.

Country i 's degree of institutional comparative advantage is directly measured by $\frac{\alpha_i}{\alpha_j}$ in that the unit labor requirement for the good X is $\frac{1}{\alpha_i}$. As shown in sub-figure (b), this measure rises with $\frac{I_i}{I_j}$, which magnifies the scale effect and causes the marginal product of F in X to soar. In other words, international trade allows a country with better informal institutions to have a greater degree of production concentration toward an institutionally intensive sector. Hence, the marginal product of F in X rises with I more greatly in this open economy than under autarky. This generates a great incentive to develop F enough to offset a decreasing force of F from the substitution effect.

Specifically, in the very first part of $\frac{I_i}{I_j}$, there are no country i 's exports of the good X due to a low level of comparative advantage in this good in the presence of transport costs. Thus, scale effect is dominated by the substitution effect, which leads to the fall in F_i with $\frac{I_i}{I_j}$, as shown in sub-figure (a). However, the further increase in $\frac{I_i}{I_j}$ allows country i to have a higher degree of comparative advantage in the good X , which in turn makes scale effect stronger. Thus, F_i tends to increase with $\frac{I_i}{I_j}$. This implies that countries with richer informal institutions are more likely to end up having higher-quality formal institutions when trade is opened up.¹³ The increasing rate

¹³When σ is below 1, the association between the qualities of formal and informal institutions is positive regardless of whether trade is opened up. However, formal institutions improve more by an increase of the quality of informal

of F_i diminishes as country i approaches a perfect specialization, which decreases the labor for producing F_i . Additionally, the rising substitution effect with $\frac{I_i}{I_j}$ decreases the increasing rate of F_i . Notice that when $\frac{I_i}{I_j}$ is 1.6, F_i with a σ of 3.5 starts falling. Regarding the response of t_i to the change in $\frac{I_i}{I_j}$, it shows the same pattern with F_i , as explained in Section 4.1.1.

Sub-figure (c) in Figure 3 shows that as $\frac{I_i}{I_j}$ rises, country i 's production of X relative to Y substantially grows. When σ is 1.8, $\frac{X_i}{Y_i}$ increases from about 0.6 to 56 over the entire range of $\frac{I_i}{I_j}$, which is a much greater increase compared to the corresponding change from about 1 to 4 under autarky. This growth of the X sector entails a considerable drop in the production of the good Y , as presented in sub-figure (d), implying labor employed in the Y sector drops, as well. This is opposite to the increasing pattern of the Y production over I under autarky. These results show that international trade leads to a great degree of scale effect and production concentration.

Turning to country j 's perspective, the increase in I_i leads country j to have a comparative advantage in the Y sector, which is captured by the increasing production of Y , shown in sub-figure (b) in Figure 4. Since the production of the good Y does not require institutions, the increasing level of the comparative advantage in Y does not encourage the government to provide F . In fact, the falls in the degree of comparative advantage in X and the price of the good X decrease the value of the marginal product of F in X . Therefore, the provision of F in country j tends to fall, as presented in sub-figure (a).

4.2.2 Trade Costs Incurred Due to Incomplete Contract Enforceability

The rise in F_i and the fall in F_j , resulting from the increase in I_i , affect the institutional quality of country i and j , E_i and E_j , respectively. Since the institutional quality is the aggregate CES form of F and I , holding I_j fixed, the rise in I_i increases E_i and decreases E_j .

These changes in E_i and E_j affect the trade cost incurred by imperfect contract enforcement, δ . Simulation results show that as $\frac{I_i}{I_j}$ rises, E_i increases by much more than E_j falls. This is because both I and F rise in country i , while only F falls in country j . The higher increase in E_i than the institutions under open economies than under autarky, unless σ is close to 0.

fall in E_j leads to a decrease in δ , as shown in Figure 5. This fall in δ reinforces the trade pattern and magnifies scale effect.

4.2.3 Welfare

Let us examine how the welfare in country i responds to the increases in I_i . While a fall in r_i , arising from the decline in labor employed in the Y sector, adds a decreasing force of welfare, a fall in the price index provides an increasing force for it. Since the real rental rate falls with $\frac{I_i}{I_j}$ (except with the very first part of it), as I will show in Section 4.2.4, a rise in w_i , along with the dropped price index, could improve the welfare, and a fall in w_i could deteriorate the welfare even with the dropped price index.

The wage rate w_i , presented in sub-figure (b) in Figure 6, shows an overall U-shape curve over $\frac{I_i}{I_j}$, even though the fall in labor employed in the Y sector raises $w_i^p (= w_i(1 + t_i))$. Specifically, after w_i passes the very first part, w_i decrease as $\frac{I_i}{I_j}$ moves up to approximately 1.2. In this range of $\frac{I_i}{I_j}$, in which w_i falls, t_i and F_i rise drastically. This implies that a higher t_i used for constructing F_i causes the wage rate households receive to fall. This, in turn, constrains welfare from improving. Notice that the welfare in sub-figure (a) shows a rather flat part when w_i falls and F_i rises considerably. The welfare with a σ of 1.8 falls even slightly when $\frac{I_i}{I_j}$ is between 0.8 and 1.2. Welfare starts rising again afterwards while w_i rises and the increasing rate of t_i diminishes with $\frac{I_i}{I_j}$.

Next, let us consider country j 's welfare. By having a comparative advantage in Y , labor moves toward the Y sector, raising r_j . This, along with the falling price index, adds an increasing force of welfare. Additionally, as sub-figure (d) in Figure 6 shows, w_j initially increases and shows a U-shape as $\frac{I_i}{I_j}$ further rises. This is because the falling t_j allows w_j to rise, even though the rise in labor in the Y sector lowers $w_j(1 + t_j)$. Hence, the welfare of country j tends to increase with $\frac{I_i}{I_j}$, shown in sub-figure (c). These results imply that countries, whose trading partners' informal institutions are greater than other countries, tend to have lower-quality formal institutions, while enjoying less tax burden and greater welfare. Notice that in the range from 0.3 to 0.7 of $\frac{I_i}{I_j}$, in which the welfare for country j is rather constant and even has a slightly decreasing part, w_j falls, and F_j stays high. This

shows that a high tax rate used for supporting high-quality formal institutions constrains welfare from improving, which is consistent with the result regarding country i 's welfare.

4.2.4 Income Distribution

To examine how income distribution is affected by having better informal institutions, consider the responses of real factor prices to the changes in $\frac{I_i}{I_j}$ when σ is 1.8, presented in Figure 7. First, the real wage in country i shows a relatively flat part, and the real wage in country j shows a slightly falling part. Each of these areas coincides with the area in which the wage rate households receive drops due to the high tax rate. Next, the real rental rate in country i tends to decrease, as shown in sub-figure (a). Although the price index falls as I_i rises, r_i significantly drops, as the economy focuses on the production of good X . Conversely, the real rental rate in country j tends to increase with $\frac{I_i}{I_j}$, shown in sub-figure (b). This happens while country j 's production concentration toward the good Y raises r_j .

Thus, who most benefits from improving a country's quality of informal institutions is its trading partner's owners of capital, the specific factor used for the production of non-institutionally-intensive sector. Who hurts most from improving a country's quality of informal institutions is that country's owners of capital, also the specific factor in the non-institutionally-intensive sector. Regardless of what country we look at, as F rises by levying a higher tax rate, the real rental rate prominently decreases.¹⁴ This implies that a higher tax rate, arising from improving informal institutions, is heavily burdened by the owners of a specific factor in a non-institutionally intensive sector as an economy structurally changes its production toward an institutionally-intensive sector.

4.3 Changes in Labor Endowment

So far, we have focused on the impact of informal institutional change on the quality of formal institutions. If labor endowment changes, instead of I , how would the government provision of formal institutions respond and how would international trade affect the formal-informal interac-

¹⁴Recall that for country j , F_j rises as $\frac{I_i}{I_j}$ falls.

tion? To explore this, I vary L_i over the range of 1, 1.05,...,2. Under autarky, I_i is fixed at 0.01. Under open economies, L_j is fixed at 1, and I_i and I_j are fixed at 0.01. There are no changes in the other parameters.

As shown in sub-figure (a) in Figure 8, F_i rises with L_i under autarky. With the increasing returns for the production of X , the rise in L_i boosts the marginal product of F_i in X_i . In open economies, this increasing tendency of F_i is rather strengthened, shown in sub-figure (b). That is, larger labor endowment leads the country i to have a comparative advantage in the labor intensive good X , which magnifies scale effect.

The tax rate t_i moves in the same direction as F_i . To see what this implies, consider the following relationship between F_i and t_i , derived from the government budget constraint in equation (6): $F_i = L_i t_i / (1 + t_i)$. Rearranging this equation and applying the assumption that one unit of labor produces one unit of F , we can see the tax rate in terms of labor allocation as follows: $t_i = L_{F_i} / (L_{ix} + L_{iy})$, where L_{F_i} denotes labor employed for the provision of F_i , and $L_{ix} + L_{iy} = L_i - L_{F_i}$. Based on this relationship, the increasing t_i implies that when labor endowment rises, the labor used for the provision of F increases more than the labor employed in the private sectors.

Returning to Figure 8, large population induces high-quality formal institutions, regardless of whether trade is opened up. By contrast, a country with rich informal institutions has low-quality formal institutions under autarky, and trade enables the country to have high-quality formal institutions. The first reason for these different trade impacts is that informal institutions substitute for formal institutions, whereas labor does not. Without the substitution effect, F_i increases with L_i in both closed and open economies. Secondly, an increase in L_i does not have a direct impact on boosting productivity and reducing trade costs. Since I_i is constant, α_i and δ are only indirectly affected by the rise in F_i through scale effect. Conversely, an increase in I_i directly influences α_i and δ , causing a great degree of scale effect enough to offset the increasing substitution effect.

5 Concluding Remarks

This paper theoretically examines how formal and informal institutions are interrelated through international trade in a static, general-equilibrium model. The interrelation is uncovered by considering informally-formed constraints on individuals, such as trust, social networks, and values, as different types of institutions, following North (1990), and by assuming that both formal and informal institutions collectively generate domestic institutional quality.

The comparative statics provides important implications for trade and institutions. International trade induces countries with rich informal institutions to develop their formal institutions. By allowing institutional comparative advantage to strengthen scale effect, which is reinforced by institutions' role in lowering trade cost incurred by imperfect contract enforcement, international trade makes formal institutions more useful in producing institutionally intensive goods. What matters for having better formal institutions is how intensively institutions are used in a sector in which a country has a comparative advantage. When a country has a comparative advantage in a good that does not require institutions, opening up to trade would not give the country an opportunity to improve its formal institutions. Only when a country has a comparative advantage in an institutionally intensive good can scale effect become great enough to overcome the substitution effect of informal institutions that generates a force of deteriorating formal institutions, ultimately enabling that country to enjoy the opportunity of having high-quality formal institutions.

These results are based on the new view this paper offers regarding institutional quality as an outcome of the interaction between formal and informal institutions. With this view, while adding a specific mechanism on how international trade grows and formal institutions arise beyond what the story of Medieval trade shows, this paper sheds light on a new role of international trade as a catalyst in developing formal institutions in a country with rich informal institutions.

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Tables

Table 1: NLS estimation results for σ

Criteria for institutionally intensive industry	A. Formal institutions: Polity IV + DPI + La Porta et al.				B. Formal institutions: Polity IV			
	$\hat{\sigma}$	se	obs	R-sq	$\hat{\sigma}$	se	obs	R-sq
1. d_z: Nunn's measure								
Top 40% of d_z	1.80***	(0.14)	29	0.96	3.34**	(1.32)	43	0.90
Top 30% of d_z	1.77***	(0.13)	29	0.96	3.13***	(1.09)	43	0.90
Top 20% of d_z	1.86***	(0.17)	29	0.95	4.24	(2.66)	43	0.89
2. d_z: 1-HI								
Top 40% of d_z	1.73***	(0.11)	30	0.96	2.70***	(0.67)	44	0.91
Top 30% of d_z	1.87***	(0.17)	30	0.95	3.55**	(1.56)	43	0.90
Top 20% of d_z	1.89***	(0.18)	29	0.95	3.77**	(1.86)	42	0.90
Average	1.82	0.15	29.33	0.95	3.45	1.53	43	0.90

Notes: Table B.1 in Appendix B lists the countries that are employed for the estimation of σ . Robust standard errors are in parentheses. *** and ** indicate the statistical significance of estimates at the levels of 1% and 5%, respectively.

Figures

Figure 1: Formal institutions and the production of Y under autarky

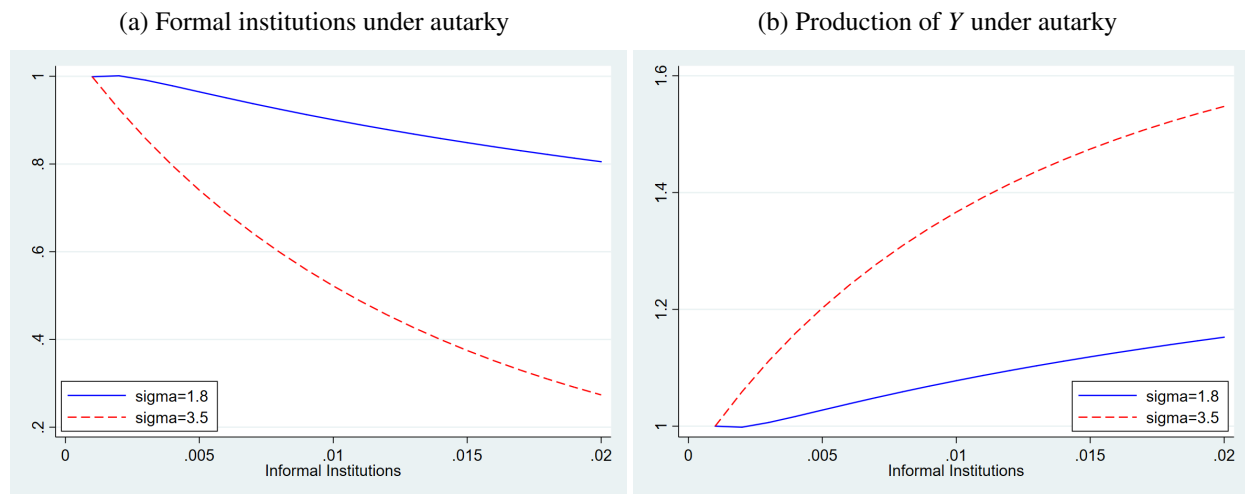


Figure 2: Welfare and the wage rate under autarky

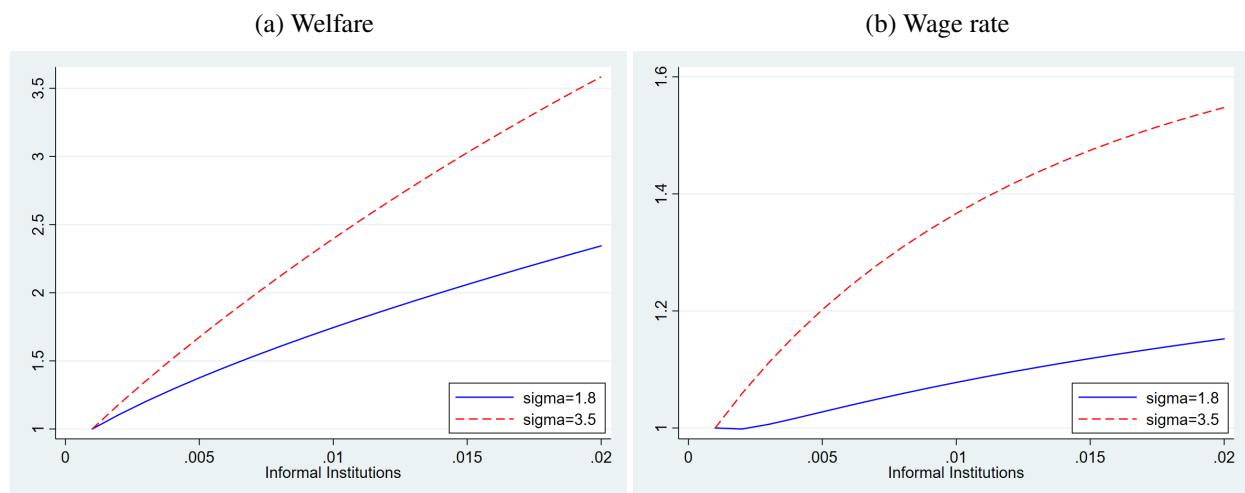


Figure 3: Country i 's responses under open economies

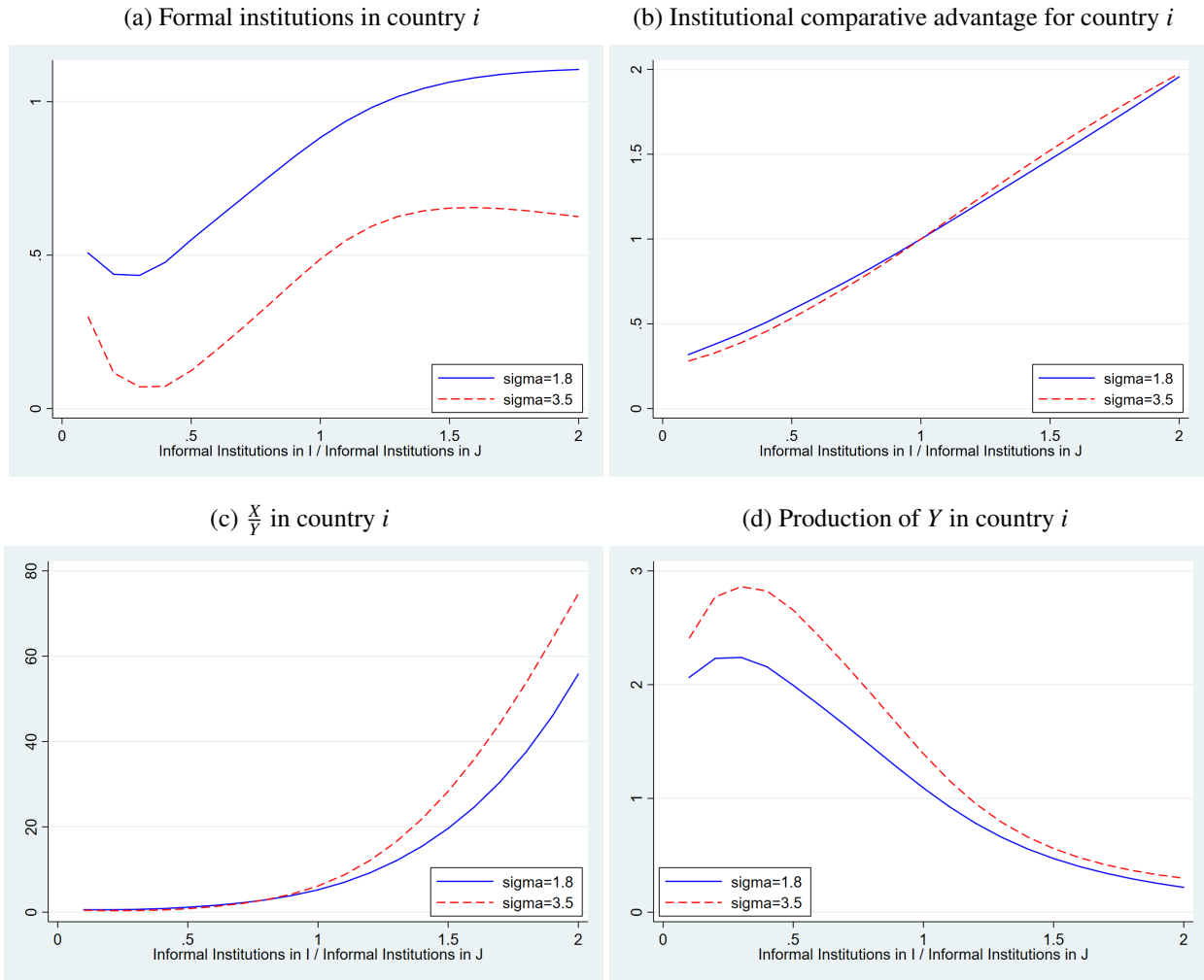


Figure 4: Country j 's responses under open economies

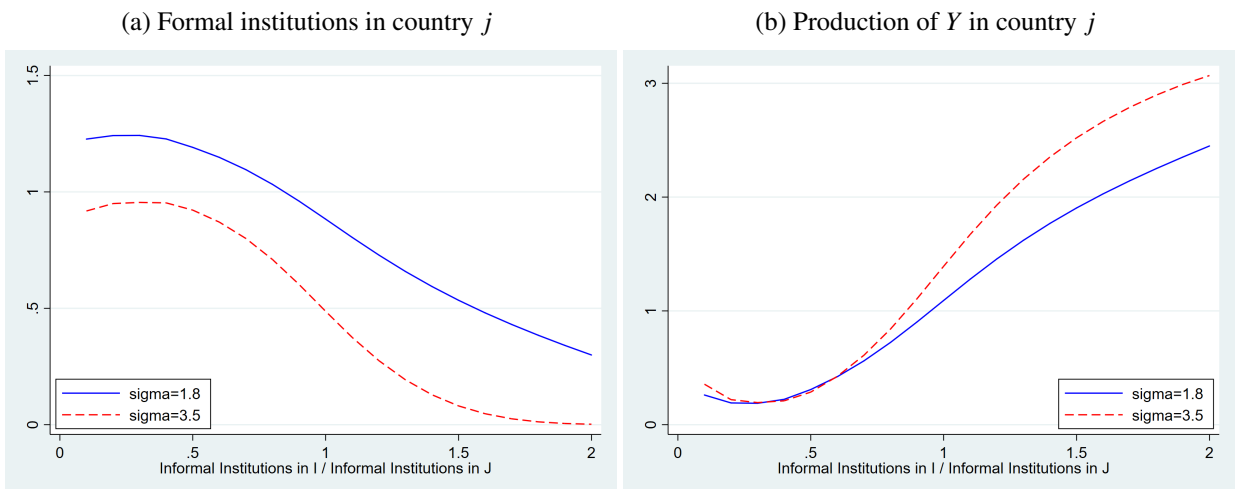


Figure 5: Trade cost incurred by imperfect contract enforcement

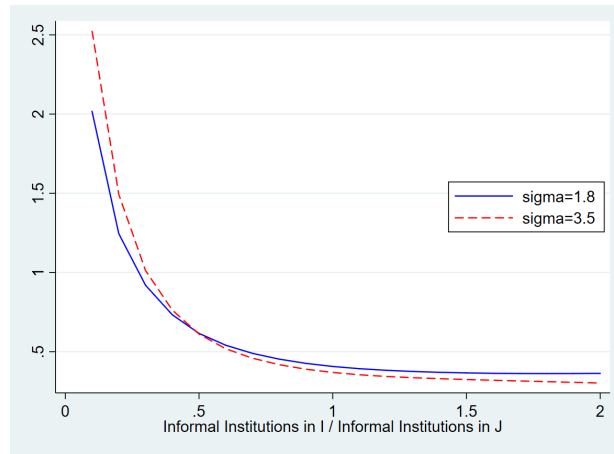
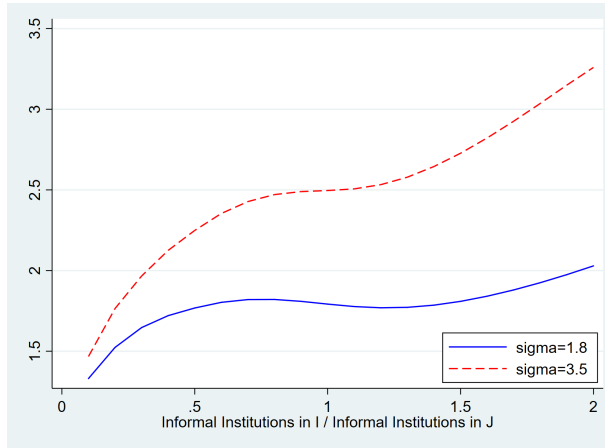
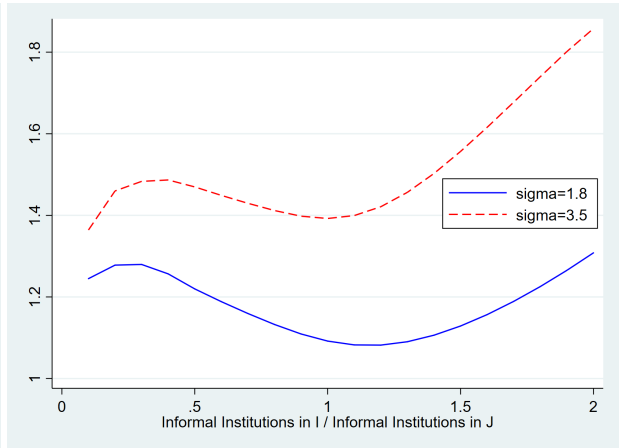


Figure 6: Welfare and the wage rate under open economies

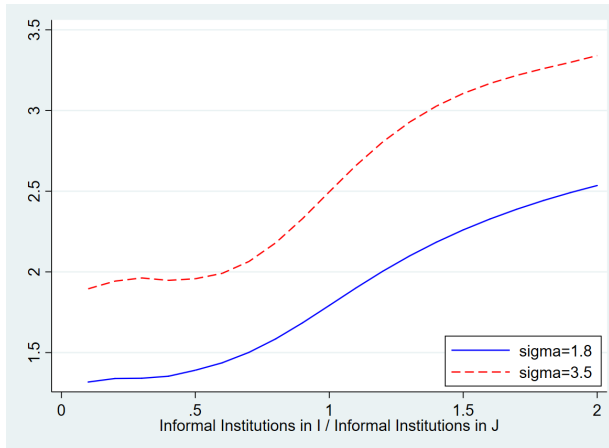
(a) Welfare of country i



(b) Wage rate in country i



(c) Welfare of country j



(d) Wage rate in country j

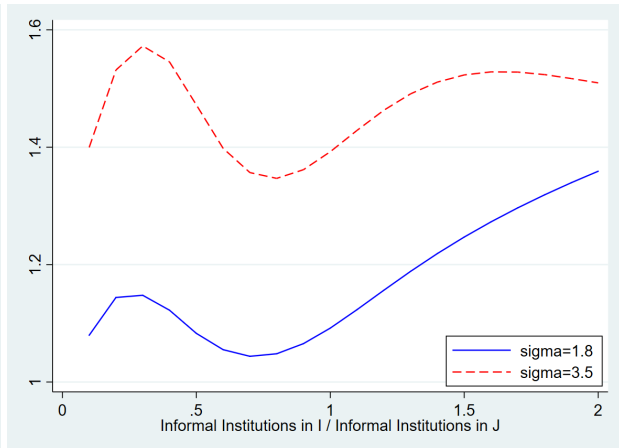


Figure 7: Real factor prices under open economies

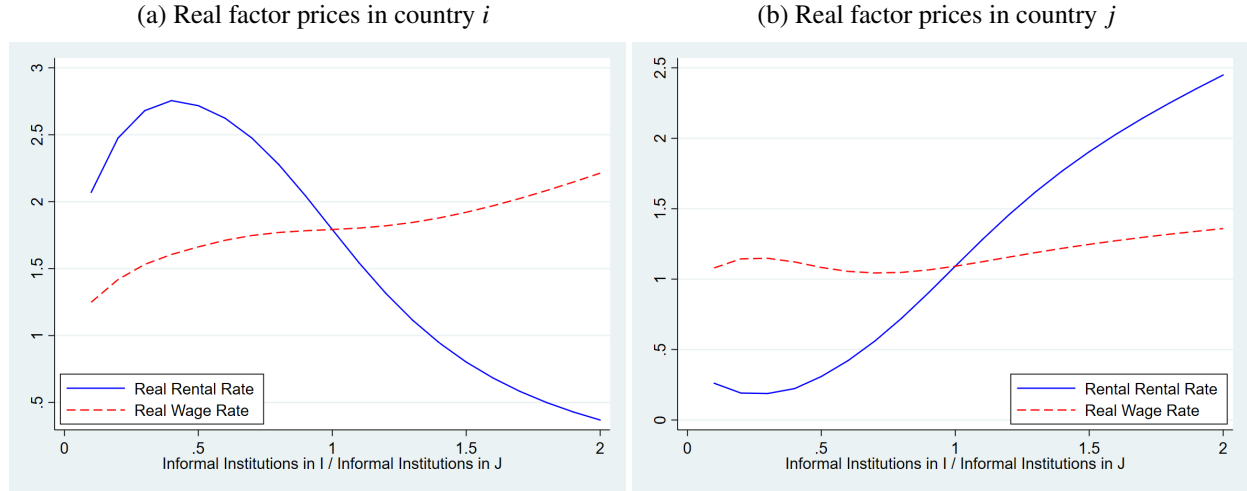
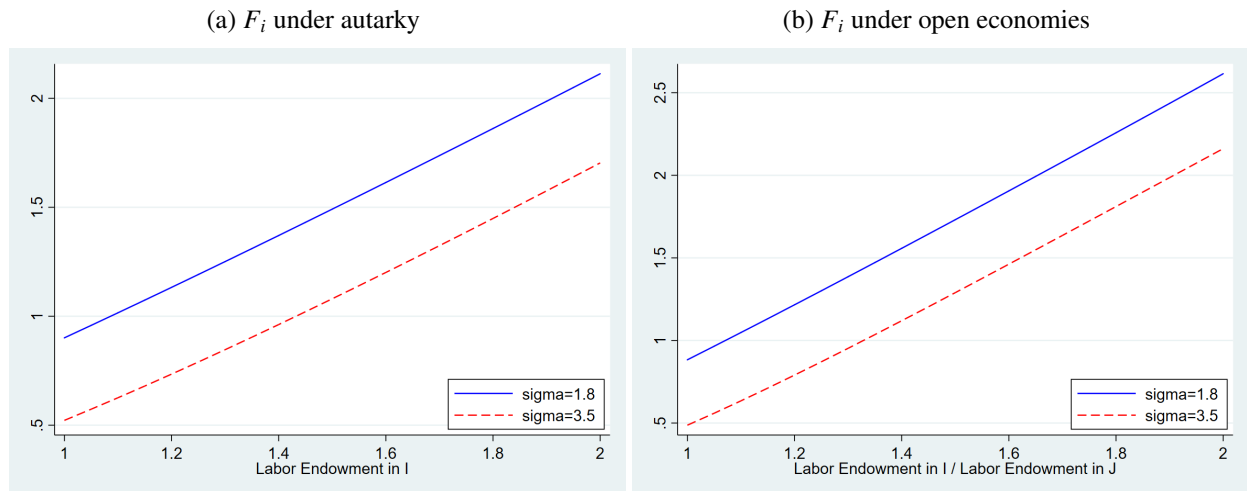


Figure 8: Responses of F_i to the changes in L_i



Appendix A Measures and Data

A.1 Institutional Intensity

As a measure of institutional intensity, d_z , I use the contract intensity in Nunn (2007). To determine whether an input transaction intensively uses institutions, he uses two indicators following Rauch (1999): whether an input transaction occurs in an organized exchange and whether an input has a reference price in trade publications. In Nunn's data that I use, the contract intensity is measured by the weighted average of the input shares that are traded in neither case. As another measure of d_z , I rely on the Herfindahl index (HI). Institutional quality is expected to be important for the production of a complex good to overcome potential holdup problems (Cowan and Neut, 2007; Levchenko, 2007). I calculate the HI using the 1997 U.S. I-O Use Table given by the Bureau of Economic Analysis (BEA). Since the HI falls with the complexity of a good, following Blanchard and Kremer (1997), I use 1 minus the HI as a measure of d_z .

The mapping between the World Bank's production data in the ISIC rev. 2 level and the HI in the I-O level is constructed as follows. In the concordance between 10-digit Harmonized System (HS10) and Standard International Trade Classification (SITC) revision 2 by Feenstra (1996), I truncate the 5-digit SITC codes to the 4-digit SITC codes. This truncated SITC is linked to the I-O classification based on BEA's concordance between HS10 and I-O classification. With additional concordance of 4-digit SITC and 3-digit ISIC given by Muendler (2009), each HS10 code is mapped to an I-O and ISIC level. Based on this, I calculate the number of HS10, which is classified by I-O level, out of the total number of HS10 within an ISIC code. Then, the industries organized by I-O levels under an ISIC code have the matching shares based on the number of HS10. Next, I add up the d_z s weighted by these shares for each ISIC code.

A.2 Institutions

For a proxy for country-specific informal institutions, I focus on culture. A measure of culture comprises three components: trust, control, and obedience. These are also used as the components

of culture by Tabellini (2010) and Williamson and Kerekes (2011). Each cultural component is constructed by using the European Values Study and World Values Survey (EVS and WVS, 2006). I use the time span of 1995-2001.

Trust can reduce transaction costs, deriving more efficient outcomes (Zak and Knack, 2001). To measure trust, the following question is employed: “Generally speaking, would you say that most people can be trusted or that you can’t be too careful in dealing with people?” Regarding this question, there are two options: “most people can be trusted” and “can’t be too careful.” The measure of trust is constructed by the number of respondents who answered “most people can be trusted” divided by the sum of the respondents who answered either option, multiplied by 10.

Regarding the measure of control, as people feel more that they are the ones who can control their lives, they would better cooperate with others toward economic profits. To measure control, the following question is used: “Some people feel they have completely free choice and control over their lives, while other people feel that what we do has no real effect on what happens to them. Please use this scale where 1 means ‘none at all’ and 10 means ‘a great deal’ to indicate how much freedom of choice and control you feel you have over the way your life turns out.” The measure of control for each country is calculated by averaging the answers of the respondents.

Obedience, mainly emphasized in a coercive society, discourages individuals from pursuing innovation and cooperating with others toward economic profits (Tabellini, 2010, p. 685). To measure obedience, I employ the following question: “Here is a list of qualities that children can be encouraged to learn at home. Which, if any, do you consider to be especially important?” The measure of obedience is constructed by the number of the respondents who chose “obedience” as an important quality divided by the total number of the respondents, multiplied by 10.

To construct an aggregate index for informal institutions, first, I obtain the average value of each measure for each country. I secondly adjust the original measure of obedience by 10 minus that measure for each country, since a higher level of obedience is expected to lower cooperation. Lastly, I add the measures of trust, control, and adjusted obedience, the sum of which is then scaled so that the maximum value for the index reaches 10.

To measure formal institutions, I rely on constraints on executives using three datasets. The first dataset I employ is the Database of Political Institutions (DPI) constructed by Beck et al. (2001). Following Glaeser et al. (2004), two measures in the dataset are used: plurality and proportional representation. The two electoral rules promote competition between legislators and help to legislate for public interest (Williamson and Kerekes, 2011, p.545). To make the range of the measure consistent with the range from 0 to 10 of informal institutions, I multiply the dummies for the two electoral rules by 10. Then, each year's measure is the average of the two values, which could be 0, 5, or 10. I finally average the DPI measures over 1995-2000.

The second dataset comes from La Porta et al. (2004). Following Glaeser et al. (2004), two variables of judicial independence and constitutional review are employed. Judicial independence prevents executives from affecting the judgment of the court. The measure was constructed by normalizing the variables of the tenure of Supreme Court judges, the tenure of the highest ranked judges, and the existence of case law from 0 to 1. Constitutional review imposes restrictions for carrying out policies and establishing laws that benefit the executive and the legislature or allied groups (La Porta et al., 2004, p.447). This is measured by normalizing the degree of the judges' power to review the constitutionality of laws and the degree of difficulty to change the constitution from 0 to 1. I multiply each normalized measure by 10 and average them, ranging from 0 to 10.

The third dataset is the Polity IV dataset of Marshall et al. (2014). The variable I use is executive constraints, which refers to "the extent of institutionalized constraints on the decision making powers of chief executives, whether individuals or collectivities." Ranging from 1 to 7, the variable is constructed based on the evidence about institutional restrictions on executives. Each country's measure is averaged over 1995-2000, scaled in such a way that the maximum value reaches 10.

A comprehensive index for formal institutions is constructed by averaging the above three measures, scaled so that the highest score is 10.

Table A.1 shows the institutional qualities of the 41 countries whose data on formal and informal institutions are available.

Table A.1: Country-specific informal and formal institutions

Country	Informal				Formal							
					Polity IV		DPI		Pl.	Prop. rep.	La Porta	
		T	C	O							Const. review	Judicial indep.
Denmark	10.0	6.7	7.3	1.4	8.3	10.0	5.0	0.0	10.0	9.2	8.3	10.0
Sweden	9.9	6.3	7.3	1.4	7.6	10.0	5.0	0.0	10.0	7.1	4.2	10.0
Norway	9.4	6.5	7.2	2.6	8.3	10.0	5.0	0.0	10.0	9.2	8.3	10.0
New Zealand	9.1	4.9	7.8	2.2	8.6	10.0	10.0	10.0	10.0	5.0	0.0	10.0
Netherlands	9.0	6.0	6.7	2.5	7.1	10.0	5.0	0.0	10.0	5.8	5.0	6.7
Finland	8.9	5.3	7.6	2.9	7.1	10.0	5.0	0.0	10.0	5.8	1.7	10.0
Japan	8.7	4.3	5.9	0.5	9.7	10.0	10.0	10.0	10.0	8.3	10.0	6.7
Germany	8.6	3.5	7.1	1.3	10.0	10.0	10.0	10.0	10.0	9.2	8.3	10.0
Austria	8.4	3.3	7.5	1.8	7.4	10.0	5.0	0.0	10.0	6.7	6.7	6.7
Australia	8.3	4.0	7.6	2.9	10.0	10.0	10.0	10.0	10.0	9.2	8.3	10.0
Korea Rep.	8.3	2.9	7.1	1.4	8.9	8.6	10.0	10.0	10.0	7.5	8.3	6.7
Greece	8.1	2.4	7.0	1.1	9.1	10.0	10.0	10.0	10.0	6.7	6.7	6.7
Canada	8.1	3.7	7.7	3.1	7.9	10.0	5.0	10.0	0.0	7.9	5.8	10.0
Switzerland	8.1	3.7	7.2	2.6	8.3	10.0	10.0	10.0	10.0	4.2	1.7	6.7
Indonesia	7.6	5.2	7.2	5.3	5.4	5.0	5.0	5.0	5.0	5.8	1.7	10.0
Italy	7.4	3.3	6.3	2.8	9.1	10.0	10.0	10.0	10.0	6.7	6.7	6.7
Bangladesh	7.3	2.1	6.3	1.9	7.0	7.1	5.0	10.0	0.0	8.3	6.7	10.0
USA	7.2	2.6	8.0	4.3	8.3	10.0	5.0	10.0	0.0	9.2	8.3	10.0
Ireland	7.1	3.6	7.3	4.8	8.3	10.0	5.0	0.0	10.0	9.2	8.3	10.0
Belgium-Lux	7.0	2.7	6.7	3.6	7.3	10.0	5.0	0.0	10.0	6.3	5.8	6.7
Argentina	6.9	1.7	7.3	3.5	7.2	7.6	5.0	0.0	10.0	8.3	6.7	10.0
UK	6.8	3.3	7.3	5.2	6.9	10.0	5.0	10.0	0.0	5.0	0.0	10.0
Spain	6.8	3.4	6.6	4.7	9.0	10.0	10.0	10.0	10.0	6.3	5.8	6.7
Jordan	6.8	2.8	7.2	4.7	5.9	4.3	5.0	10.0	0.0	7.9	5.8	10.0
Mexico	6.7	2.7	7.8	5.3	7.9	7.1	10.0	10.0	10.0	5.8	8.3	3.3
France	6.6	2.1	6.5	3.6	6.2	8.6	5.0	10.0	0.0	4.6	5.8	3.3
Venezuela	6.5	1.5	8.1	5.1	6.2	8.1	5.0	0.0	10.0	5.0	6.7	3.3
Portugal	6.4	1.2	6.9	3.7	7.4	10.0	5.0	0.0	10.0	6.7	6.7	6.7
Chile	6.3	2.2	7.2	5.1	7.3	10.0	5.0	10.0	0.0	6.3	5.8	6.7
Colombia	6.2	1.1	7.9	5.0	6.4	8.6	5.0	0.0	10.0	5.0	6.7	3.3
Egypt	6.2	3.8	5.5	5.3	5.8	4.3	5.0	10.0	0.0	7.5	8.3	6.7
India	6.1	3.9	6.1	6.3	10.0	10.0	10.0	10.0	10.0	9.2	8.3	10.0
Pakistan	5.9	2.7	4.7	4.1	7.0	6.7	5.0	10.0	0.0	8.8	7.5	10.0
Philippines	5.9	0.7	6.9	4.4	8.4	8.6	7.5	10.0	5.0	8.3	6.7	10.0
South Africa	5.7	1.4	6.7	5.3	7.1	7.5	5.0	5.0	5.0	8.3	6.7	10.0
Turkey	5.7	1.3	5.3	3.8	7.6	10.0	5.0	0.0	10.0	7.1	4.2	10.0
Peru	5.4	0.8	7.1	5.6	6.0	4.3	5.0	0.0	10.0	8.3	6.7	10.0
Nigeria	5.3	2.2	7.0	7.2	6.4	3.7	5.0	10.0	0.0	10.0	10.0	10.0
Brazil	5.2	0.3	7.4	5.9	8.7	8.6	10.0	10.0	10.0	6.7	6.7	6.7
Uganda	4.7	0.8	6.8	6.9	6.0	4.3	5.0	10.0	0.0	8.3	6.7	10.0
Zimbabwe	4.5	1.1	5.8	6.7	5.9	4.3	5.0	10.0	0.0	7.9	5.8	10.0

Notes: Countries are listed in the order of the measure of informal institutions. T, C, and O denote trust, control, and obedience, respectively. Pl. and Prop. rep. denote plurality and proportional representation.

Appendix B List of the Countries

Table B.1: List of the countries used for the estimation of σ

30 countries							
Argentina	Australia	Austria	Belgium-Lux	Canada	Chile	Colombia	Egypt
Finland	France	Germany	Greece	India	Indonesia	Ireland	Italy
Japan	Jordan	Korea Rep.	Mexico	Netherlands	Norway	Portugal	S. Africa
Spain	Sweden	Turkey	UK	USA	Venezuela		
Additional 14 countries							
Bulgaria	Czech Rep	El Salvador	Hungary	Iran	Latvia	Morocco	Poland
Romania	Russian Fed	Slovakia	Slovenia	Tanzania	Uruguay		

Appendix C Parameters

Table C.1: List of the parameters used in the simulations

Parameter	Parameter description	Autarky	Open economy
β	Share of X in utility	0.5	0.5
ν	Labor share in production	0.8	0.8
σ	Elasticity of substitution between F and I	1.8, 3.5	1.8, 3.5
h	Fixed cost for domestic sales	4	8
f	Fixed cost for international sales	n/a	8
τ	Transport costs	n/a	1.7
L	Labor endowment	1	1
K	Capital endowment	1	1
I_i	Informal institutions	0.001–0.02	0.001–0.02
I_j	Informal institutions in the other country	n/a	0.01

The parameters and initial values for the variables are chosen in such a way that proportional changes can be easily seen during a counterfactual analysis. For example, labor endowment in the model is given by 180, but the parameter for the labor endowment is given for 1 by choosing the functional form for labor supply as labor endowment multiplied by 180. It is easier to see proportional change when we change the parameter for labor endowment from 1, 1.05,...,2 than changing it from 180, 189,...,360.

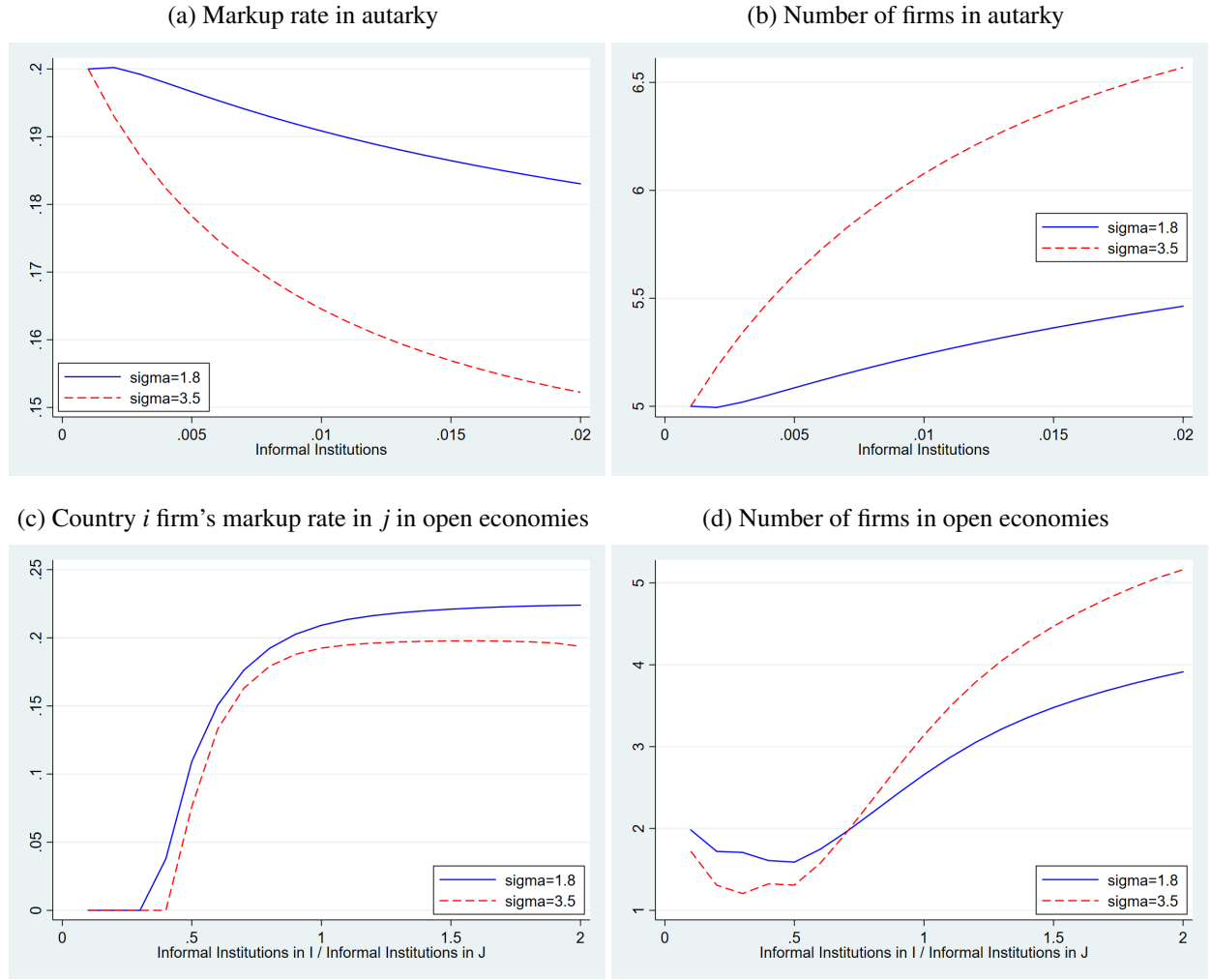
Appendix D Markup Rate and the Number of Firms

Under autarky, the equilibrium markup rate of a firm, η , decreases with I , as presented in sub-figure (a) in Figure D.1. When the equality holds in pricing equation (11), it can be written as follows: $(1-\eta) = \frac{w^p}{\alpha P_x}$, which implies that $d \ln(1-\eta) = d \ln w^p - d \ln \alpha - d \ln P_x$. Since α increases with I , and w^p decreases with I , the sign of $d \ln w^p - d \ln \alpha$ is negative. Thus, the decreasing η , i.e., increasing $(1-\eta)$, means that P_x drops more than the absolute value of $d \ln w^p - d \ln \alpha$. The decreasing markup implies an increasing number of firms, as shown in sub-figure (b). This comes from the fact that the markup rate is exactly market share in the Cournot competition; under autarky, the market share is 1 over the number of firms for the X sector.

In open economies, the equilibrium markup rate of country i 's firm for domestic sales follows an overall U-shape curve over $\frac{I_i}{I_j}$. Specifically, the markup rate tends to fall until $\frac{I_i}{I_j}$ reaches 1 and increases afterwards. That is, as the firms are more engaged in foreign sales while their country has a comparative advantage in X , the domestic markup rises. To see this formally, consider pricing equation (11) regarding domestic sales, implying that $d \ln(1-\eta_{ii}) = d \ln w_i^p - d \ln P_{ix} - d \ln \alpha_i$. Given that $d \ln w_i^p$ and $d \ln \alpha_i$ are positive, and that $d \ln P_{ix}$ is negative, the balance of the first two terms and the last term determine the sign of $d \ln(1-\eta_{ii})$. In fact, w_i^p and α_i increase at a fairly constant rate. However, P_{ix} abruptly falls until $\frac{I_i}{I_j}$ reaches 1 and tends to be rather constant afterwards. That is, as country i has an institutional comparative advantage and satisfies foreign consumers' demand for the good X , P_{ix} becomes much less responsive to the rise in $\frac{I_i}{I_j}$. Therefore, in the first part, the drastically falling price leads to a positive $d \ln(1-\eta_{ii})$, i.e., decreasing η_{ii} . However, as $\frac{I_i}{I_j}$ further increases, the price effect is weakened, resulting in a negative $d \ln(1-\eta_{ii})$, i.e., increasing η_{ii} .

The equilibrium markup rate for a country i 's firm in j , η_{ij} , is overall increasing with $\frac{I_i}{I_j}$ and is concave-down, as shown in sub-figure (c) in Figure D.1. Specifically, it considerably increases until $\frac{I_i}{I_j}$ reaches 1 and tends to stay constant afterwards. That is, as country i has an institutional comparative advantage and as the foreign market for X becomes more competitive between country i 's firms, η_{ij} tends to be constant. A higher competition can be seen with sub-figure (d), which

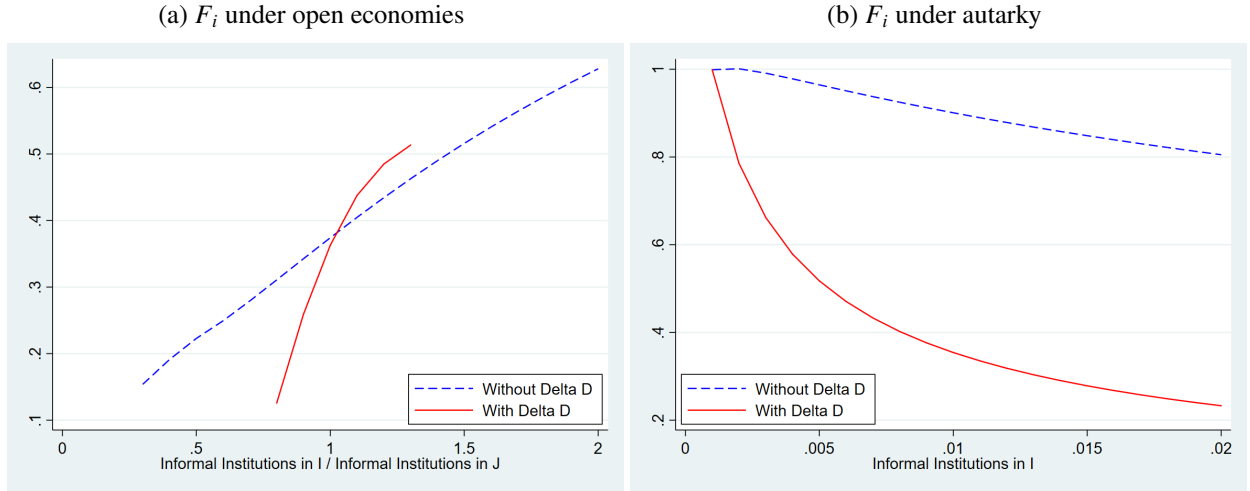
Figure D.1: Markup rate and the number of firms



shows that the number of firms in the X sector in country i tends to increase with $\frac{L_i}{L_j}$. To formally examine the response of η_{ij} , consider pricing equation (12), implying that $d \ln(1 - \eta_{ij}) = d \ln w_i^p - d \ln P_{jx} + d \ln(\frac{1}{\alpha_i}(1 + \delta))$, holding τ fixed. Since P_{jx} tends to fall with $\frac{L_i}{L_j}$, the first two terms in the right-hand side are positive. Additionally, since both $\frac{1}{\alpha_i}$ and δ decrease with $\frac{L_i}{L_j}$, $d \ln(\frac{1}{\alpha_i}(1 + \delta))$ is negative. Thus, the increasing η_{ij} , i.e., decreasing $(1 - \eta_{ij})$, implies that the fall in $\frac{1}{\alpha_i}(1 + \delta)$ dominates the other two forces that increase $(1 - \eta_{ij})$. As P_{jx} and δ become rather constant while $\frac{L_i}{L_j}$ passes 1, η_{ij} does not show a noticeable change.

Appendix E The Model with Trade Cost for Domestic Sales

Figure E.1: Formal institutions with and without δ^D



In this Appendix, I assume that once the good X is produced, firms trade their products for domestic sales. I define $\delta_i^D(> 0)$ as an iceberg trade cost incurred due to imperfect contract enforcement in the domestic sales of X : $\delta_i^D \equiv e^{\frac{2}{E_i}} - 1$, $i = 1, 2$. Then, for one unit of domestic sales, firms need to produce $(1 + \delta_i^D)$ units of the good.

Note that, for simulations, parameter σ is given by 1.8, and transport cost τ is given by 0.05 to ensure that trade occurs. The other parameters are given by the same values used in Sections 4.1 and 4.2. Also note that simulation results are obtained by including δ_i^D in pricing equation (11) and the labor market clearing condition in equation (20).

Sub-figure (a) in Figure E.1 shows how the introduction of δ_i^D affects the interaction between F_i and $\frac{I_i}{I_j}$ in open economies. With δ_i^D , the effect of a rise in I_i on the marginal product of F_i in X_i is greater than the corresponding effect without δ_i^D , as the economy has an extra benefit of reducing trade cost for domestic sales. Hence, production becomes more sensitive to the change in I_i . This reduces the range of $\frac{I_i}{I_j}$, in which Y , the numeraire, is produced. For example, when I_i is low, the country j does not produce the good Y while the country i specializes in that good.

When δ_i^D exists, since the economy has a higher marginal productivity of F_i in X_i with an

additional rise in I_i , each level of I_i can substitute for a higher F_i in order to have the same degree of productivity gain. Thus, under autarky, as I_i rises, formal institutions falls more with δ_i^D than without it, presented in sub-figure (b). These results, depicted in sub-figures (a)-(b), show that when domestic trade cost is considered, an economy with rich informal institutions can even further improve its formal institutions by engaging in international trade.