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ABSTRACT

Leader Networks and Transaction Costs: A Chinese Experiment in Interjurisdictional Contracting*

Do leader networks promote efficient intergovernmental contracts? We examine a groundbreaking policy in China where subprovincial governments freely traded land conversion quotas, and investigate the role of leader networks on the boundary between jurisdictions that embrace trade versus autarky. Consistent with the presence of Williamsonian transaction costs featuring uncertainty, incomplete contracting, and asset specificity, we find that leader career networks facilitate trade, controlling for institutional similarity and prior trade relations. However, trade gains can be limited if leader networks offer selective coverage. Using data from the Chinese experiment, we find evidence consistent with trade match distortions induced by leader networks.

JEL Classification: H11, H77, P35, R52, D23

Keywords: transaction cost, government leader network, interjurisdictional contracting

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"But it is political markets in non-democratic polities that urgently need such transaction cost analysis. The far greater imperfections of such markets in communist and Third World countries are the root cause of their poor economic performance since it is polities which devise and enforce the property rights that are the incentive structure of economics. (Douglass North 1990, p.364)

1 Introduction

This study investigates the transaction cost determinants of interjurisdictional government contracts. We do so in an environment in which local leaders are appointed rather than elected, so that the concern for government responsiveness to resource misallocation is arguably the greatest (North 1990; Besley and Burgess 2002). The range of contracts relevant to the interjurisdictional context is diverse, and includes, for example, contracts that correct for environmental spillovers across jurisdictional boundaries, public good investments and infrastructure projects that transcend purely local costs and benefits concerns, as well as opportunities for mutually beneficial exchange and trade.[1]

In this study, we consider interjurisdictional trade contracts. The particular stage we consider is set in China's Zhejiang Province, where a system of centrally determined land use quotas and the resulting regional imbalance in demand and supply pave the way for potentially gainful trade in land allocation quotas between jurisdictions. In this experiment, effectively on transferable development rights between county-level local governments, we examine the extent to which transaction costs carve a boundary between jurisdictions that embrace the market and those that prefer autarky. We then investigate the determinants of these intergovernmental transaction costs, by bringing in key institutional and empirical features of the Chinese civil service that have so far received very little attention for our understanding of local economic performance in China.

Our study shares clear parallels with theories on the boundaries of the firm inspired by the seminal studies of Coase (1937), and Williamson (1975, 1981), as well as transaction cost politics (North 1990; Dixit 1996). To date these studies have emphasized the role of transaction costs that span firm-to-firm contracting (e.g., vertical/horizontal integration), firm-to-input contracting (e.g., employment and innovation), and government-to-firm contracting (e.g., government procurement of public goods). Studies related to the transaction costs incurred in intergovernmental contracts are rare with exceptions only in the public administration literature typically in a developed country settings (Ostrom 1990; Feiock 2013). The objective of this study is to provide a first look at this

[1]Specific examples of intergovernmental contracting abound (O'Brien and Li 1999). A short list includes contracts to improve environmental governance (Eaton and Kotska 2012), negotiate water governance under the threat of regular seasonal floods (Tilt 2015), and coordinate the enforcement and monitoring of transborder crime (Lo 2009).

issue in a developing country context with particular focus on land use governance.

Two sets of considerations are canonically featured in analyses of transaction costs (monitoring, enforcement and contracting costs) (Williamson 1981; Tadelis and Williamson 2012). The first relates to informational contractual hazards, due to uncertainty and contractual incompleteness. Uncertainty in any aspect of a contractual relationship or any participant of a contract can foster strategic and/or opportunistic behavior among contracting parties. Consequently, contracts may be strategically terminated without fair notice unless costs are incurred to invest in building monitoring capacity. Incomplete contracting arises when the full set of potential ex post shocks cannot be specified, which renders full contingency planning prohibitively costly. The second consideration often featured in transaction cost analyses relates to asset specificity, which arises when contracting parties must make investment upfront, leading to path dependencies that are costly to correct. In our context, the contractual parties are local governments, and thus, are themselves enforcers of laws and regulations. Furthermore, these local governments are accountable to the administrative umbrella of the same provincial government with arguably familiar institutions. Do informational contractual hazards and asset specificity nonetheless continue to shape the boundary between trade and autarky among jurisdictions?

We argue in the affirmative for both considerations. Our approach is two-fold. We begin by establishing a sorting theory of interjurisdictional trade in land conversion quotas. We derive the gains from trade between a matched buyer-and-seller pair from first principles, and use these to ascertain the likelihood of trade in two settings: (i) a pure competitive equilibrium in which transaction costs are uniform across all matched pairs and (ii) a setting in which select leaders with prior network linkages to other locations can enter into agreements with networked locations in the shadow of the market. We then test the implications of this model in a gravity-style estimation in which the determinants of trade, inclusive of the transaction cost determinants of trade, are considered in the data.

In a pure competitive equilibrium with a continuum of jurisdiction-specific willingness to import/export, we show that equilibrium assignment of buyers and sellers exhibits negative assortative matching among trading jurisdictions, while transaction costs dictate the boundary between trading and nontrading jurisdictions. This equilibrium is constrained efficient, following directly from Becker (1973), at given transaction costs. Lowering transaction cost, say through leader networks that mitigate against contractual hazards, unambiguously increases the incidence of trade. Nonetheless, transaction cost-saving leader networks can be a double-edged sword if networked trade in the shadow of the market gives rise to trade match distortion. This occurs when networked trade diverts trade from competitively assigned trade partners to networked trade partners. Indeed, our model shows that jurisdictions with the highest willingness to import (export) are more likely to refrain from networked trade if and only if the network matched seller (buyer) does not have as high a willingness to export (import) as the competitive equilibrium seller (buyer).

We empirically test these trade implications of the model in a gravity-style setting in which we investigate the determinants of the incidence of bilateral trading relationships. To control for jurisdiction-specific willingness to import/export, we assemble a county-level dataset that captures (i) standard demand- and supply-side determinants of the willingness to pay for land conversion quotas in importing and exporting jurisdictions, respectively, (ii) proxies for the extent of administrative decentralization in a county, which capture the authority to make large-scale investment decisions without the need for provincial level approval, and (iii) jurisdiction pair-specific proximity variables. In addition, we assemble a range of leader-specific variables that control for the effects of leader attributes, leader political cycles (year since appointment in current post), and, as has been emphasized, leader networks. We consider four types of networks: career networks, birthplace networks, education networks, and a combination of all three networks.

For identification, our baseline empirical model is a proportional hazards model (Cox 1972). This model ascertains the trade hazard rate among buyer-seller locations depending on the characteristics of the two parties. The model is semiparametric, and does not depend on particular assumptions on the distribution of time to trade. This baseline model is followed by a series of robustness checks, incorporating, for example, first trade event regressions, logit analysis on the proportion of matches, specifications that account for two-way causality, unobserved heterogeneity, and different types of network connections in the determinants of trade.

We make three broad sets of observations. First, of the four network variables, both overall network and career network contribute positively to the likelihood of a match, but the effect of the overall network variable is driven entirely by the career network variable. This result is consistently significant and robust in our estimations. Second, conditional on having a career network connection, higher willingness to import in a buyer jurisdiction *decreases* the likelihood of match. As implied in our model, this observation is consistent with leader networkers that are simultaneously cost-saving and match-distorting. Third, we control for institutional similarity (e.g., sharing the same prefecture city), and prior trade relations using our panel data. In all cases, both these factors are significant contributors to the likelihood of trade. Consistent with the presence of Williamsonian transaction costs, these results suggest that even for counties within the same province, transaction cost related to uncertainty, incomplete contracting, and asset specificity appear to play a role in determining the boundaries between counties that embrace trade, and those that do not.

This study contributes to three distinctive literature strands. First, this study extends the literature on the role of leader characteristics in determining policy outcomes (Jones and Olken 2005) by introducing government leader networks as an additional contributing factor. In this regard, a growing body of literature has demonstrated, for example, the importance of networks in determining the pattern of international trade (Grief 1993), the performance of venture capital funds (Hochberg et al. 2007), the quality of exports (Feenstra et al. 1999), and the cost of search particularly in differentiated product markets (Rauch 1999). Our knowledge base is extremely limited concerning the role of government leader networks in driving policy decisions on matters of interdependent concerns. This is particularly interesting in the case of China, where job rotation-driven career network building is a stated policy directive.[2]

Second, we contribute to the literature on tradeable permits, such as emissions permits (Chichilnisky and Heal 1995), development rights allowances (Mills 1980), or land conversion quotas (Tavares 2003; Thornes and Simon 1999), as in our case. We do so by introducing a sorting theory of matching (Becker 1973; Sattinger 1993) in which the price and volume of each transaction is negotiated individually and simultaneously. An important innovation in our sorting setup is that both the precise buyer and seller matches, and the pool of equilibrium buyers and sellers, are endogenously determined from the *same* pool of heterogeneous localities based on their relative willingness to pay for land conversion quotas.

Third, we contribute to the empirical literature on tradeable permits more generally. To the best of our knowledge, this paper presents the first evidence on the determinants of intergovernmental transactions in tradeable permits. Existing studies in this area are typically concerned with: the productivity/efficiency implications of the trading scheme (Tietenberg 1999); the ability of the program to fulfill preservation and/or environmental goals (Montero 1999), and the participation of firms and individuals (Machemer and Kaplowitz 2002). Furthermore, in all cases, the studies almost exclusively concern developed country programs (Johnston and Madison 1997; McConnell, Kopkits and Walls 2005; Talberg and Swoboda 2013). To date, developing country studies have been limited to case studies[3] and none has provided econometric evidence for the performance of tradeable development rights programs in a developing country.

[2]See Section 2 for an in depth discussion.

[3]See, for example, Coria and Sterner (2010) for the case of tradeable emissions permits in Chile.

The rest of this paper is organized as follows. In Section 2, we describe in greater detail the policy environment and specific features of the Chinese Civil Service, as well as the Zhejiang land conversion quota trading scheme. In Section 3, a sorting theory of land conversion quota trade is presented and the empirical implications of the determinants of trade are explained. Section 4 discusses our identification strategy, and Section 5 discusses the data. Section 6 discusses the main findings of our baseline estimations and robustness checks and Section 7 concludes.

2 Policy Environment

2.1 Chinese Civil Service System

The Chinese civil service is an organization covering 34 provincial level units, close to 3,000 county-level units, and more than 47,000 township-level units employing 10 million people.[4] A series of regulatory reforms aimed at improving management of the civil service system effectively began in 1993.[5] These reforms introduced performance-based rewards with explicit performance targets (Li and Zhou 2005; Guo 2009), and a well-enforced system of regular job rotation and training.[6]

One of the objectives of performance target management was to turn civil servants formerly vested in local interests into leaders incentivized by career concerns and political mobility. There is extensive evidence and research in this area (Maskin, Qian and Xu 2000, Li and Zhou 2005), focusing in particular on inter-jurisdictional competition for mobile resources in the presence of fiscal decentralization. By contrast, the implications of the civil servant job rotation and training system have rarely been studied.[7] The system is expected to prevent political capture, promote accountability, and facilitate information exchange (Wu 2010). Since 1993, a mandatory 5-year leader-rotation system (*ganbu jiaoliu zhidu*) was implemented. In China, the Communist Party of China county committee secretary (henceforth, party secretary (*shuji*)), is the highest political office in a county-level administrative unit, responsible for the formulation of local policies. The county governor (*xianzhang*) shares leadership responsibility of a jurisdiction and is charged with

[4]There are five levels of government in China. The central government, provincial-level units, prefecture-level units, counties, and townships. In addition, there are numerous villages below the township level (Lin, Tao, and Liu 2003).

[5]Details are available in the Provisional Regulations on State Civil Servants (*Guojia gongwuyuan zhidu zanxing tiaoli*). The content of the regulation can be accessed at `http://cpc.people.com.cn/GB/64162/71380/71387/71591/4855083.html`, accessed December 15, 2015.

[6]The 1993 reform also introduced a competitive recruitment system that spells out education qualification requirements and a nationwide civil service exam. For example, the civil service exam in 2008 attracted 775,000 applicants for 13,500 places.

[7]The origin of civil service job rotation dates back to a central government policy directive since 1962 which required that all local government leaders at county level or above be rotated at regular intervals (Huang 2002).

leadership and administration of the local government. In what follows, we refer to both the party secretary and county governor as leaders of a county government.

The job rotation system gives rise to two interrelated sets of observations. Frequent job rotation gives rise to short political cycles, which in turn fosters career network building. In Table 1,[8] we summarize the mean age, mean political cycle, and mean number of career network links per year (the number of times the two leaders have worked in a county-level unit different from the current post in an average year) in the 96 county-level units in Zhejiang from 1999-2003. As shown, the mean age of the average leader is a little more than 43 years. The mean political cycle at 1.49 years is significantly less than the mandatory 5 years. This is consistent with a number of prior studies in this area in provinces other than Zhejiang (Guo 2007; Bo 2009). The mean number of network links ranges from a minimum of 0, to a maximum of 12.2, averaging 3.43.

2.2 Zhejiang Land Conversion Quota Trading Scheme

The 1986 Law of Land Administration is the inaugural piece of comprehensive land legislation enacted in China. An amendment in 1998 focused on agricultural land use, and by January 1999, a new system of land use planning quotas became effective. These planning quotas governed the permissible allocation of land to non-agricultural uses in all regions and jurisdictions in China.[9] Relevant particularly for local governments, Article 18 of the Regulations on the Implementation of the Land Administration Law gives a nationwide policy directive, aimed at encouraging local governments who wish to expand the allocation of construction land by engaging in raising the supply of cultivated land through land consolidation (Ministry of Agriculture of the People's Republic of China 2004; Wang, Tao, and Tong 2009).[10] Specifically, the Article states that

> "People's governments at all local levels should, pursuant to the comprehensive land use planning, take measures to press ahead with land consolidation. Sixty percent of the area of the newly-added cultivated land through land consolidation can be used as compensation quotas for cultivated land occupied for construction."

[8] The data are collected by assembling the published resumes of all county level leaders of the Zhejiang province from 1999 - 2003. In Section 5, we discuss the data in detail.

[9] National level planning quotas in effect between 1997 and 2010 for example, required at a minimum no less than 128 million hectares of reserved cultivated land in total, while conversion from cultivated to construction land could not exceed 1.97 million hectares (Chau and Zhang 2011).

[10] According to Article 41 of the Land Administration Law of the People's Republic of China, land consolidation refers to the consolidation of fields, ponds, roads, woods and villages to raise the quality and increase the supply of cultivated land (Zhang et al. 2014).

These decisions created powerful incentives for local governments to engage in land consolidation. Strikingly, the addition of new cultivated land in China during 1999-2006 reached a total of 3.5 million hectares. This is greater than the amount of land approved for use in construction projects (Chau and Zhang 2011).[11]

Against this background, the land conversion quota trading scheme in Zhejiang in September 1999 was created precisely to facilitate locations with excess demand for land conversion quotas to negotiate directly with locations with underutilized supply.[12] Both the price and the volume of these transactions were negotiated between buyers and sellers, subject to approval from the Zhejiang Provincial Department of Land and Resources (Wang et al. 2010; Zhang et al. 2014).

We collect a dataset based on internal statistics from the Zhejiang Provincial Department of Land and Resources on both the incidence and the buyer–seller pairs that participated in the trade in land conversion quotas. As noted, there are altogether 570 land quota trade activities across counties/districts in Zhejiang province during 1999 to 2003. For each trading activity, the dataset also records the names of the exporting and importing jurisdictions, and the year the trade took place. We illustrate in Figure 1 buyer localities, seller localities, localities that both bought and sold, and localities that neither bought nor sold in the 5-year period between 1999 and 2003.

A number of features are notable. Evidently, the program was well received.[13] Although the number of localities that never traded is small in most years, it is non-trivial. Seller locations and buyer locations were quite stable over time, indicating that location specific forces may be at play. Furthermore, there were multiple localities that both bought and sold during the same year, though not with the same partner. This is particularly interesting in view of the fact that the Zhejiang program does not put restrictions either on the buyer- or seller-origins of the land conversion quota traded. What are some of the reasons behind this contemporaneous two-way trade?

2.3 Leader Networks and Land Conversion Quota Trade

Juxtaposing the leader network and land conversion quota trade data, Figure 2 shows the kernel density plots of the average number of career network links between the two leaders at the time of trade by trade status (importer, exporter, two-way trader, and no trade). As shown, exporting

[11]Accounting for other sources of land loss such as natural hazards, and agricultural reorganization, there was an overall decline in the total amount of arable land (Chau and Zhang 2011).

[12]In fact, a 1998 Zhejiang province notice flexibly interprets Article 18, stipulating that 72% of the total areas of added effective cultivation could be used as rewarded quota for approved infrastructure, core village, small town and industrial district (Zhang et al. 2014).

[13]The land conversion quota trade began in 1999, with only 11 trading activities during that year. The number of trades increased significantly to 83 in 2000, further increased by 149 in 2001, peaked in 2002 at a recorded high of 247 events, and decreased to 80 trading activities in 2003.

jurisdictions and autarkic jurisdictions are similar, with both tending to have the least number of network links. Pure importers constitute the next group in terms of the number of network links. Finally, jurisdictions that seemingly paradoxically engaged in two-way trade during the same year tend to have the highest number of career network links.

These observations form the bases for the strategy of our theoretical model, in which we present a sorting model of trade between a continuum of heterogeneous jurisdictions, in which two types of trade are incorporated: trade based purely on market forces, and trade mediated by selective network connections.

3 A Model of Trade in Land Conversion Quotas

Consider an economy with a continuum of locations (i) of measure one, $i \in [0,1]$. A government policy mandates that all locations are subject to construction land use quotas. In any given location, additional construction land use quotas can be obtained either by (i) engaging in agricultural land consolidation efforts locally, so that a fraction of the newly added land area can be counted as permissible construction land use areas, or by (ii) importing unused construction land use quotas elsewhere. Thus, let construction land use in excess of the quota in location i be denoted as $x_i \geq 0$, where x_i gives the sum of construction quotas due to local land consolidation efforts $x_i^o \geq 0$, plus any net imports of additional land construction quotas from a different location, to be denoted as m_i. m_i can take on positive or negative values, depending on whether the location is a net importing or a net exporting location, where

$$x_i = x_i^o + m_i.$$

Let the preference of each location with respect to x_i be approximated by a strictly concave quadratic utility function:

$$U_i(x_i) = \alpha_i + \beta_i x_i - x_i^2/2, \;\; \alpha_i, \beta_i > 0.$$

We allow the baseline utility α_i, the marginal utility evaluated at $x_i = 0$, β_i, as well as any additional construction quota rewarded due to local land consolidation efforts x_i^o to vary across locations. The slope of the marginal utility schedule $\partial U_i(x_i)/\partial x_i$ with respect to x_i is normalized to minus unity for all locations.

Denote the location-specific marginal utility of construction land use quota imports as

$$\frac{\partial U_i(x_i)}{\partial x_i}|_{x_i = x_i^o} = \beta_i - x_i^o \equiv \omega_i.$$

ω_i measures the marginal utility of additional construction land use, β_i, accounting for local supply x_i^o rewarded due to land consolidation efforts. Henceforth, we refer to ω_i as the willingness to import, and $-\omega_i$ as the willingness to export. Since β_i as well as x_i^o are location specific, so is ω_i. Let the cumulative distribution function of ω_i be $F(\omega_i)$ on the interval $[\omega^-, \omega^+] \subset \mathbb{R}$.

Gains from Trade

Consider any arbitrary pair of buyer (b) and seller (s) with willingness to import ω_b and ω_s, respectively, from $[\omega^-, \omega^+]$ such that $\omega_b \geq \omega_s$. Denote $m(\omega_b, \omega_s) \geq 0$ as the match-specific land area traded, $p(\omega_s)$ the competitively determined gains from trade for the seller s, and T the transaction cost to be borne by the buyer, the seller, or both jointly.[14] The maximal gains from trade S are obtained by choosing a level of land area traded $m(\omega_b, \omega_s)$ between the buyer and seller in order to maximize the sum of the change in welfare in the two locations net of transaction cost:

$$S(\omega_b, \omega_s) = \max_m \quad [U_b(x_b^o + m) - U_b(x_b^o)] + [U_s(x_s^o - m) - U_s(x_s^o)] - T \tag{1}$$

Thus, gains from trade account for the net change in buyer utility $(U_b(x_b^o + m) - U_b(x_b^o))$, and in seller utility $(U_s(x_s^o - m) - U_s(x_s^o))$. Any transfers between the two jurisdictions necessary to effect trade are canceled out as gains from trade account for the welfare change of both the buyer and seller.[15] The solution to (1) is given by:

$$m(\omega_b, \omega_s) = \frac{1}{2}(\omega_b - \omega_s) \tag{2}$$

if and only if the difference in willingness to import is large enough to justify the transaction cost, or equivalently, if and only if $T < (\omega_b - \omega_s)^2/4$. Otherwise, $m(\omega_b, \omega_s) = 0$. Thus,

$$S(\omega_b, \omega_s) = \max\{\frac{1}{4}(\omega_b - \omega_s)^2 - T, 0\}. \tag{3}$$

$S(\omega_b, \omega_s)$ gives the maximal possible joint gains from trade given ω_b and ω_s. As shown, $S(\omega_b, \omega_s)$ is strictly positive for all ω_b and ω_s, such that $\omega_b - \omega_s > 2\sqrt{T}$, increasing in ω_b, decreasing in ω_s, and submodular in ω_b and ω_s.[16] It follows, therefore, that across two potential buyers $\omega_b > \omega_b'$, and two potential sellers $\omega_s > \omega_s'$, aggregate surplus is maximized by matching the buyer with the highest

[14]For now, we treat T as common across all possible pairs of locations. The case of pair specific heterogeneity in transaction cost will be discussed in the following section.

[15]It is straightforward to check that (1) above is a strictly concave problem with a unique solution for every ω_s, ω_b pair with $\omega_b \geq \omega_s$.

[16]To see this, note that for any $\omega_b > \omega_b'$, and $\omega_s > \omega_s'$, $S(\omega_b, \omega_s) + S(\omega_b', \omega_s') < S(\omega_b', \omega_s) + S(\omega_b, \omega_s')$. In standard sorting theories of match formation (Becker 1973; Shimer and Smith 2000), efficient allocation entails negative assortative matching in which higher ω_b are matched with low ω_s.

demand parameter with the seller with the lowest demand parameter, followed by the buyer with the next highest demand with the seller with the next lowest demand, for by submodularity,

$$S(\omega_b', \omega_s) + S(\omega_b, \omega_s') > S(\omega_b, \omega_s) + S(\omega_b', \omega_s').$$

In what follows, we check to establish if negative assortative matching is borne out in equilibrium.

3.1 Competitive Equilibrium and Assortative Matching

Define a competitive equilibrium as (i) a set of buyers $\Omega_b \subset [\omega^-, \omega^+]$ and sellers $\Omega_s \subset [\omega^-, \omega^+]$, (ii) an assignment function $w_s(\omega_b)$ which gives the equilibrium assignment of the seller $\omega_s \in \Omega_s$ given buyer characteristic $\omega_b \in \Omega_b$, and (iii) a payment schedule $p(\omega_s)$ which gives the increase in seller utility beyond the no-trade baseline depending on seller characteristics.

A competitive equilibrium satisfies three sets of conditions. First, each potential buyer takes the payment schedule $(p(\omega_s))$ as given, and chooses a seller ω_s to maximize the buyer's share of the maximal gains from trade:[17]

$$\max_{\omega_s} S(\omega_b, \omega_s) - p(\omega_s). \tag{4}$$

Second, economy wide balance of trade requires that the measure of the range of locations that sell construction land quotas is equal to the measure of the range of locations that buy construction land quotas, or, $\int_{\omega \in \Omega_s} dF(\omega) = \int_{\omega \in \Omega_b} dF(\omega)$. Third, all locations are free to participate, and as such equilibrium joint gains from trade must be nonnegative for every matched pair with positive trade.

We relegate the details of the proof of the properties of the competitive equilibrium to the Appendix. In what follows, we provide an intuitive presentation of four key properties of the competitive equilibrium. To begin with, for all $\omega_s \in \Omega_s$ and $\omega_b \in \Omega_b$ such that gains from trade $S(\omega_b, \omega_s)$ are strictly positive, the solution to (4) yields an equilibrium assignment function $w_s(\omega_b)$ that takes the form:

$$w_s(\omega_b) = F^{-1}(1 - F(\omega_b)). \tag{5}$$

Thus, $w_s(\omega_b)$ is strictly decreasing in ω_b, which is consistent with negative assortative matching. For example, a buyer location with the highest willingness to import $\omega_b = \omega^+$ is matched with a seller location with the lowest willingness to import, $\omega_s = \omega^-$ or

$$w_s(\omega^+) = F^{-1}(1 - F(\omega^+)) = F^{-1}(0) = \omega^-.$$

[17] We assume for now that this maximization problem of a potential buyer is strictly concave. Later on, we show that this assumption is borne out in equilibrium.

The next highest demand buyer is in turn matched with the next lowest demand seller, and so on. A key implication of negative assortative matching is that the competitive equilibrium outcome is efficient given the gains from trade function $S(\omega_b, \omega_s)$, which follows directly from Becker (1973).

Second, for all $T > 0$, the nondegenerate range of inactive/nontrading locations in the mid-range $[\omega_s^{max}, \omega_b^{min}] \in [\omega^-, \omega^+]$ is given by the range of buyers and sellers for whom gains from trade accounting for transaction cost T is negative. Figure 3 displays both the downward sloping matching function $w_s(\omega_b)$ and the range of trade active locations as Ω_s and Ω_b.

Finally, with negative assortative matching, we confirm in the Appendix that seller compensation $p(\omega_s)$ rises with the willingness to export $-\omega_s$. Furthermore, buyers' gains $S(\omega_b, w_s(\omega_b)) - p(w_s(\omega_b))$ are strictly increasing in buyers' willingness to import. Intuitively, the higher the willingness to import ω_b, the larger the gains from trade, $S(\omega_b, w_s(\omega_b))$, by virtue of negative assortative matching in equilibrium. Analogously, $S(w_s^{-1}(\omega_s), \omega_s)$ rises with the seller's willingness to export $-\omega_s$. The competitive equilibrium must allow both the buyer and seller to partake in these gains as long as the trade match assignment is voluntarily selected by both the buyer and seller.

These observations take the cost of transaction as uniform among all possible buyer-seller matches. What if select buyer and seller pairs enjoy special prior connections, thus potentially mitigating against the transaction cost of trade? We turn to this question in the following Subsection 3.2.

3.2 Network Mediated Trade

Consider prior network linkages between buyers and sellers that enable information exchange. Arguably, through better knowledge of government personnel as well as local land market conditions, for example, a lower pair-specific transaction cost relative to the cost of trade between previously unknown parties $T^c < T$ may apply. Given this potential change in transaction cost, a connected buyer (ω_b)/seller (ω_s) has two choices: (i) accept the competitive assignment $(w_s(\omega_b)\ /\ w_s^{-1}(\omega_s))$, thereby forgoing the transaction cost savings, or (ii) strike an alternative contract with the connected location. If the latter is chosen, the competitive equilibrium outcome serves as the next best alternative, which in turn dictates the reservation utility of the buyer or seller in question. Denote the reservation utility of a buyer ω_b and seller ω_s beyond the no trade baseline $(U_b(x_b^o), U_s(x_s^o))$ as $\bar{U}(\omega_b)$ and $\bar{U}(\omega_s)$ respectively.

From Subsection 3.1, any two connected locations (ω_b, ω_s) can be of one of four types. First, the connected pair of buyer and seller may both be active in a competitive equilibrium, or equivalently $\omega_b \in \Omega_b$ and $\omega_s \in \Omega_s$ and trade with their competitively assigned partners $w_s(\omega_b)$ and $w_s^{-1}(\omega_s)$, respectively. It follows that $\bar{U}(\omega_b) = S(\omega_b, w_s(\omega_b)) - p(w_s(\omega_b))$ and $\bar{U}(\omega_s) = p(\omega_s)$, respectively.

By decreasing transaction cost, network mediated trade can enable the participation of locations that are previously deterred from trading due to high transaction cost. Thus, there are three other cases of interest:

- The buyer is active in competitive equilibrium, but the seller is not ($\omega_b \in \Omega_b$ and $\omega_s \notin \Omega_s$). Thus, $\bar{U}(\omega_b) = S(\omega_b, w_s(\omega_b)) - p(w_s(\omega_b))$ and $\bar{U}(\omega_s) = 0$.

- The buyer is inactive in competitive equilibrium, but the seller is active ($\omega_b \notin \Omega_b$ and $\omega_s \in \Omega_s$). Here, $\bar{U}(\omega_b) = 0$ and $\bar{U}(\omega_s) = p(\omega_s)$ for the seller.

- Both parties are inactive in competitive equilibrium, in which case $\bar{U}(\omega_b) = \bar{U}(\omega_s) = 0$.

Let $S^c(\omega_b, \omega_s)$ denote the expected surplus associated with trade in land conversion quotas between a pair of connected localities, with

$$S^c(\omega_b, \omega_s) = \max\{\frac{1}{4}(\omega_b - \omega_s)^2 - T^c, 0\}.$$

Network-mediated trade gives rise to higher joint surplus relative to the competitive outcome for ω_b and ω_s if and only if[18]

$$\Delta S(\omega_b, \omega_s) \equiv S^c(\omega_b, \omega_s) - \bar{U}(\omega_b) - \bar{U}(\omega_s) \geq 0$$

By hypothesis, network connection can facilitate trade by virtue of a lower transaction cost $T^c < T$. Nonetheless, a connected leader may forgo such cost savings if the willingness to trade of the connected party differs significantly from that of the competitive assignment. To assess how these network induced distortions in buyer/seller characteristics can impact trade, Table 2 summarizes the comparative statics responses of $\Delta S(\omega_b, \omega_s)$ with respect to ω_b and ω_s – respectively holding the connected seller type (ω_s) and connected buyer type ω_b constant – for each of the four distinctive cases elaborated above.

Evidently, the comparative statics of the determinants of trade among connected locations with respect to buyer and seller willingness to import is nuanced, depending on whether network-mediated trade (i) connects localities that are active or inactive in competitive equilibrium, and

[18] We do not put any restriction on how two connected parties divide the gains from trade. Our only assumption is that trade mediated by networks arises when the gains from trade between a connected pair of counties is greater than the sum of the individual gains from trade the two counties can expect if they trade with their respective competitively assigned trade partners.

(ii) introduces distortions in matches relative to the competitive assignment. Nonetheless, two observations are clear. An increase in the buyer's willingness to import only decreases the gains from trade via networks if (i) the buyer ω_b is an active trader in competitive equilibrium, and (ii) the networked seller has a willingness to export strictly lower than the competitive assignment ($-\omega_s < -\omega_s(\omega_b)$). Intuitively, this suggests that buyers with higher willingness to import tend not to trade via networks if doing so means a match distortion that decreases the buyers' gains from trade. Likewise, from Table 2, an increase in the sellers' willingness to export ($-\omega_s$) only decreases the gains from trade networks if (i) the seller ω_s is an active seller in competitive equilibrium, and (ii) the networked buyer has a willingness to import that is less than the market assignment ($\omega_b < \omega_s^{-1}(w_s)$).

Accordingly, we test whether an increase in buyers' willingness to import (sellers' willingness to export) increases the likelihood of trade via networks. A negative response is consistent with (i) networked location being an active trader in the absence of networks, and (ii) network linkages connecting leaders in locations with similar and relatively high willingness to import (export). As such, trade via network linkages give rise to trade match distortions that reduces the gains from networked trade particularly for those with the highest willingness to import (export).

4 Identification Strategy

We use a gravity-style model to investigate the possible factors leading to land conversion quota trade. We do so by means of a proportional hazards model (Cox 1972), in which we denote t_j as years elapsed since the policy of land conversion quota trade begin in 1999. For each exporter*importer pair j, let $h(t_j|x_{jt})$ measure the trade hazard rate – the probability of engaging in land conversion quota trade, conditional on not having done so before t_j, where

$$h(t_j|x_{jt}) = h_0(t_j)exp(\sum_i x_{ijt}a_i) \tag{6}$$

$h_0(t_j)$ is a baseline hazard function and no parametric assumptions are made on h_0. x_{ijt} represents factor i affecting the hazard function for jurisdiction pair j in year t. a_i are the coefficients to be estimated from the data.

The model is proportional in that the hazard jurisdiction pair j faces is multiplicatively proportional to the baseline hazard. Therefore, the hazard ratio for a unit change in x_{ijt} is $exp(a_i)$. If a_i is significantly positive, it indicates that a one-unit increase in x_{ijt} increases the hazard of land conversion quota trade by $exp(a_i) - 1$. If a_i is significantly negative, it indicates that a one-unit increase in x_{ijt} decreases the hazard of trade by $1 - exp(a_i)$.

The abovementioned proportional hazards model only utilizes the information for the first land conversion quota trade event for a specific jurisdiction pair j. While this is advantageous with respect to reverse causality concerns, this specification nonetheless suffers from loss of relevant information since it ignores multiple failures, namely additional land conversion quota trade events in our context. In the dataset, 108 of 349 trade events are multiple trades that have not been included in the previous setup of the proportional hazards model. Hence, we adopt the counting process approach by Andersen and Gill (1982) to include all the trade events for the proportional hazards model. The modification by Andersen and Gill (1982) of the Cox (1972) model involves a multivariate counting process allowing for recurrent events, which jointly evaluate the log likelihood of an n-component multivariate counting process (see Subsection 2.2 of Anderson and Gill, 1982).

5 Data

Zhejiang Jurisdictions, 1999-2003

We construct a dataset for all the possible jurisdiction pairs in Zhejiang province during 1999-2003. Specifically, there are 96 possible traders within the province, including 59 counties (or county level cities), 26 urban districts [19] and 11 urban jurisdictions (*shixiaqu*). Thus, there are 9,120 (96×95) possible trade pairs in each year. Since there are 5 years in our dataset, the total number of observations is 45,600 (9120*5).

Trade Incidence

The key variable of interest in this study is the land conversion quota trading activities between local governments. This is defined at the "exporter*importer*year" level. The data is collected based on internal statistics from the Zhejiang Provincial Department of Land and Resources. The information contains both the incidence and buyer-seller pairs that participated. There are altogether 570 land quota trade activities across counties/districts in the 5-year period between 1999 and 2003. Since multiple trade activities can occur between the same pair of exporter and importer in the same year, we collapse multiple trade activities in the same year into one event for each "exporter*importer*year" cell. As a result, there are 349 trading events at the "exporter*importer*year" level during 1999-2003.

[19] *Qu xian* was revoked and upgraded to *Qujiang* district in 2001, and therefore, was not included in our sample.

Determinants of Trade

As our model indicates, the pattern of land conversion quota trade depends critically on the transaction cost associated with the trade, and the difference in willingness to import between any pair of buyer and seller, $\omega_b - \omega_s$. We take T to depend on possible linkages between local government leaders with a potential trading partner. For willingness to import and export, we take ω_i to depend both on market forces, as well as the extent to which a government is at liberty to make local development decisions. The stronger the market demand for land, the higher we expect ω_i to be. Furthermore, the greater the administrative autonomy a local government possesses in making local investment and infrastructure reforms, the higher is the incentive to import construction land use rights. Specifically, the list of determinants of trade includes the following:

1. Connected Leaders

   The literature on the role of political connections on economic performance and policy effectiveness in China is a very nascent area of research. Qin (2013), for example, tests whether firms with political connections receive preferential treatment through centrally funded capital investment and subsidies based on the working experience of top leaders of the State Council and a panel of manufacturing firms. Qian (2008) provides evidence on the relationship between government enforcement effort to weed out counterfeit products and company relationships with the government.

   Contrary to these studies, in this study connectedness features prominently in the determination of transaction cost T^c via its ability to facilitate information exchange. Thus, network connections can potentially mitigate against contract uncertainty (Tadelis and Williamson 2012), and thereby lower the cost of monitoring between jurisdictions. Furthermore, network connections may foster institutional familiarity and accordingly decrease the cost of writing complete contracts. Naturally, there are various ways in which such information exchange can occur for decision-making leaders. To capture these, we collect the published resumes for each county/district governor and county/district party secretary from 1999 to 2003. The network between county/district A (exporter) and B (importer) is defined in three ways: 1) career network due to work experience; 2) birthplace network, and 3) education network. We consider that county/district A (exporter) and B (importer) have network connections in year t if: 1) at least one of the two officials in A (B) has worked in B (A);[20] 2) at least one of the two officials in A (B) was born in B (A); or 3) at least one of the two officials in A (B)

[20]Career-experience network is defined based on work history in nonbirthplace counties/districts.

graduated from the same university/college as any of the two officials in B (A).

2. Other Connectedness Variables

   In addition to leader networks, we furnish other controls and possible determinants of the extent of informational hazards (e.g., geographical and institutional distance) in intergovernmental contracting, and furthermore, we control for the role of asset specificity to establish if the full history of land conversion quota trade in a county matters (Tadelis and Williamson 2012). Specifically, we include: 1) a dummy variable indicating common border between each possible pair, which measures the geographical closeness of potential trading partners; 2) a dummy variable indicating the same prefecture city for each jurisdiction pair, which measures the institutional closeness; and (3) a dummy variable indicating whether prior trade in land conversion quotas has taken place between jurisdiction pairs.

3. Market Forces

   We capture market forces in each location in two ways, including demand and supply considerations. We use gross domestic product (GDP) per capita of the subprovincial district to which the locality belongs for contributing to demand ω_i, in the model. For 1999-2003, these data are collected from the Statistical Yearbooks of the Zhejiang province (2000-2004). We draw motivation for doing so from the empirical land conversion literature particularly in China. For example, Seto and Kaufmann (2003) present evidence of a feedback loop that links income growth, consumer demand, and urban expansion in a study of agricultural land conversion in the Pearl River Delta of China. Off-farm wage income is likewise found to be positively associated with agricultural land conversion.[21] Lichtenberg and Ding (2009) present evidence from Shanghai and neighboring provinces that urban land rent is strongly correlated with economic growth. Furthermore, fiscal decentralization reforms since 1994 mean that local governments are increasingly reliant on locally collected revenue to finance public goods (Qian and Roland 1998). Thus, a high GDP per capita indicates a unit that can arguably afford to pay for additional land quotas for development purposes. Our use of per capita income to capture the import demand perspective (the parameter β) is motivated by these observations.

   To capture export supply side conditions, one would ideally use data on the level of land use

[21] Seto and Kaufmann (2003) also suggest clearly that foreign direct investment, as well as the relative productivity of agricultural and industrial land are important determinants of the rate of agricultural land conversion in the Pearl River Delta.

quota at the county level. Since this information is not available, we introduce the share of cultivated land for each county, collected from the Statistical Yearbooks, to capture supply side considerations. Furthermore, since land conversion quota exports are feasible only when a county has excess land quota gained through land consolidation to sell (Section 2), another way of capturing supply side conditions would be to control for the cost of land consolidation. We do so by controlling for the topographical characteristics of a county, specifically, by measuring the share of land with slope less than 5 degrees from the 1km*1km pixel China land-cover data.[22]

4. Administrative Autonomy

   Since the counties included in this study are subprovincial units under the umbrella of a single provincial government, we address the possibility of incomplete autonomy in making/effecting local policy decisions by controlling for the administrative autonomy of each county we study. Schneider (2003) discusses various ways to measure local administrative autonomy, including, for example, the percentage of local revenue from taxes, and percentage of total grants and revenues not accounted for by central transfers. Unfortunately, data on these measures at the county level is not available. Instead, we refer to a policy notice in 1992 by the Zhejiang Provincial Government that directly gives 13 select administrative units additional authority over socio-economic affairs:

   > "... if it is a nonproduction infrastructure proejct with a total investment of less than 15 million yuan, or if it is a basic production construction project with a total investment of less than 30 million yuan, or if it is a technical upgrading project with a total investment of less than 10 million yuan, it could be examined and approved by the county (or county-level city) governments". (Yu and Gao 2013; Zhejiang Provincial Government 1992)

   The list of administrative units included four urban districts (namely *Xiaoshan*, *Yuhang*, *Huangyan* and *Jiaojiang*) and nine counties (namely *Yinxian*, *Cixi*, *Yuyao*, *Haining*, *Tongxiang*, *Shaoxing*, *Jiashan*, *Pinghu*, and *Haiyan*). As a measure of administrative autonomy, we create a dummy variable with a value of 1 for the 13 administrative decentralized jurisdictions, and 0 otherwise.

[22] We thank Dr. Zhe Guo from IFPRI for kindly helping us compile the slope data.

5. Other Variables

   Finally, we include additional variables to capture: 1) scale effects: as total land area collected from the Zhejiang Statistical Yearbooks; 2) urban area effects: a dummy variable indicating whether the potential exporter and importer are urban areas, since the decision-making process is likely to differ in urban areas (districts/urban jurisdictions) and surrounding counties; and 3) leader-specific effects. Arguably, the number of network connections grows with seniority in the presence of a civil service job rotation system. Thus, we control for the average age of the county leaders collected from individual leader resumes in order to determine whether it is the experience of the leader that reduces transaction cost, or the actual bilateral connections. Furthermore, we control for political cycle effects in order to account for any leader-specific change in incentives to improve performance, depending on time until the next job rotation. Due to data limitations, we have only limited observations on leader age, and political cycles, and regressions inclusive of these effects are included later on in our robustness discussion.

5.1 Data Summary

Table 3 summarizes the key variables used in the estimation. Among all "exporter*importer*year" cells, around 0.7 percent experienced at least one land conversion quota trade. The average GDP per capita during 1999-2003 in the counties/districts is 14,620 yuan (around 2,360 US dollars). In terms of network connections, around 12.4 percent of the cells have at least one out of the three types of connections: 2.2 percent of the leaders among all the cells have birthplace connections; 3.5 percent have working experience connections; and 8.2 percent share the same university/college networks.

Table 4 shows the variables by trade status. In particular, importers on average enjoy higher GDP per capita, while nontraders have on average the lowest. Evidently, two-way traders have the highest number of network connections in all four categories, followed by exporters, importers and then non-traders with the exception of education networks, with exporters in fact having a higher number of education network links than importers on average.

Table 5 provides the descriptive statistics for the 13 decentralized jurisdictions depending on whether the jurisdiction in question is an urban district, or a county/county-level city. Compared to the nondecentralized urban districts, the four decentralized urban districts have higher GDP per capita, larger population and more land (Panel A). Compared to the non-decentralized counties/county-level cities, the 9 decentralized county level jurisdictions have higher GDP per capita, larger population, but smaller land areas (Panel B). Import activity is highest in decentralized urban districts, followed by decentralized counties/county-level cities, nondecentralized urban districts and nondecentralized counties / county level cities. Export activity is highest in nondecentralized counties/county-level cities, followed by decentralized counties / county level cities, nondecentralized urban districts, and decentralized urban districts.

Next, we report the findings of our econometric estimations, which simultaneously account for the effects of leader networks, market forces, administrative autonomy, and the other variables discussed above on the determination of the incidence of land conversion quota trade.

6 Specifications and Main Findings

Table 6 presents the results based on proportional hazards model estimations. Column 1 reports the results using the information of the first trade event between jurisdiction pairs, while column 2 reports the results allowing for multiple trade events in different years between the same jurisdiction pairs, following the approach by Andersen and Gill (1982). In both columns, we examine the role of leader networks on the incidence of trade, controlling for market forces, administrative autonomy, among other variables discussed in Section 5. Before we discuss the findings, we first examine the econometric issues that may arise, and a corresponding estimation strategy.

Two-Way Causality

Since trade in land conversion quota trade may have an impact on some of the control variables, such as GDP per capita and network variables in subsequent years, one concern is possible bias due to two-way causality. To address this concern, we report the findings from a set of regressions that only uses explanatory variables in the year 1999 – the starting year of the land conversion quota trade project – as controls. By doing so, we ascertain the variations of time to trade solely based on the initial conditions of each jurisdiction pair. Columns 3 and 4 in Table 6 present the results.

Proportions instead of Hazards

While the proportional hazards model ascertains the trade hazard rate, one may be interested instead in the proportion of eligible exporter*importer pairs that ultimately trade with one another. Thus we present a series of logit regressions to confirm whether a switch in emphasis from hazard rates to proportions makes a difference to our analysis. All time-variant explanatory variables are lagged 1 year in order to avoid two-way causality. These results are reported in Table 7.

Rare Event

While many counties/districts in Zhejiang participated in land conversion quota trading, there are many zero entries among all the exporter*importer pairs, as shown in Table 3. The relatively few number of trade matches leads to potential concern for biased estimates in maximum likelihood estimations with rare events (King and Zeng 2001). Hence, we estimate a Firth logit regression (Firth 1993; Heinze and Schemper 2001), which applies penalized maximum likelihood regression to reduce bias introduced by rare events in maximum likelihood estimates in generalized linear models (similar to accommodations to rare events in logistic regressions in King and Zeng 2001). These results are also reported in Table 7.

Unobserved Heterogeneity

While we attempt to account for the various determinants of the likelihood of trade by capturing leader-level, market-level, and institutional-level characteristics, it is nonetheless possible that the baseline likelihood of trade at the buyer-seller pair level may be governed by unobserved variables for which we have not been able to collect information. These include personal connections not captured in the network variables, other existing relationships, whether in rivalry or cooperation, between counties that have not yet been accounted for. Therefore, we estimate a random effect logit regression that allows a random coefficient for each jurisdiction pair j. The results are also reported in Table 7. [23]

Unpacking the Effects of Networks

The main specification employs the most inclusive definition of leader networks, combining career, birthplace and education networks. In Table 8, as well as in Appendix Table 1, we separately report the role of career, birthplace, and education networks on the incidence of trade.

[23]The random effects logit regression is specified as follows:[24]

$$P(Y_t = 1|x_{ji,t-1}) = F(a_0 + \sum_i x_{ji,t-1}a_i + \eta_j) \tag{7}$$

where η_j is the random intercept for jurisdiction pair j which follows a normal distribution with mean zero and standard deviation of φ. $x_{ji,t-1}$ represents the same covariates being used in the proportional hazards model, but with 1-year lag to avoid two-way causality.

Based on Tables 6-8 and Appendix Table 1, we report four broad sets of findings. First, network connections in general significantly increase the likelihood of land conversion quota trade between the two parties (row 1 Tables 6, 7, and 8; and Appendix Table 1). That said, career network connection appears to play the most prominent role, while birthplace and education networks are in fact insignificant when considered separately (Appendix Table 1). If we interpret the magnitude of the effect based only on general network effect in Table 6, the estimated coefficient indicates that being connected with at least one type of the networks enhances the hazard of trade by around 213 percent ($exp(1.142) - 1$) to 1,085 percent ($exp(2.473) - 1$).

To ascertain the presence of trade match distortion as suggested in Section 3, we include first a term that interacts exporter per capita GDP (a proxy for willingness to export) with our leader network variable. The results are weak in almost all of our specifications, suggesting the absence of seller network trade match distortion. However, the same cannot be said of the possibility of importer trade match distortion. In particular, in Tables 6, 7, and 8, this interaction term is negative throughout, and statistically significant particularly when leader career network is taken into account. From our discussion in Section 3, these findings are consistent with leader career network connections that (i) impact buyers with sufficiently high GDP per capita to be active in competitive equilibrium despite transaction costs, and (ii) connect buyers with similarly and relatively high willingness to import land conversion quota. The existence of match distortion suggests the possibility that locations that would have otherwise acted as buyers in competitive equilibrium become sellers of land conversion quotas to locations with even higher demand for land. Notably, this is consistent with the picture illustrated in Figure 1, in which some counties simultaneously bought and sold land conversion quotas to different peer counties/ districts in the same year.

The other connectedness variables are also highly significant and exhibit the expected signs. In particular, jurisdictions from the same prefecture city are more likely to trade land conversion quotas with each other, although geographic closeness alone is not significantly associated with a higher likelihood of trade. Altogether, we interpret this evidence as supporting the importance of information collected through a leader's political career as well as institutional closeness as key determinants of the transaction cost of trade between two jurisdictions. Interestingly, in Table 7, we find that having prior trade relations significantly increases the likelihood of future trade. This path dependence supports asset specificity as a determinant of the transaction costs of trade in this Chinese experiment.

Turning to the role of market forces, lower (higher) GDP per capita counties/districts are associated with higher likelihood of selling (buying) land conversion quotas (rows 5-6, Table 6). The coefficients on exporter GDP per capita range from -2.102 to -3.47, translating into hazards ratios ranging from 0.88 $(1 - exp(-2.102))$ to 0.97 $(1 - exp(-3.47))$. This indicates that if an exporter's GDP per capita increases by 10 percent, the associated trade hazard decreases by between 18.2 percent $(1 - exp(ln(1 + 0.1) * -2. - 102)$ and 28.2 percent $(1 - exp(ln(1 + 0.1) * -3.47)$. By contrast, the coefficients on importer GDP per capita range from 1.709 to 2.123, which indicates that if importer's GDP per capita increases by 10 percent, the associated trade hazard increases by between 17.7 percent $(exp(ln(1+0.1)*1.709)-1)$ and 22.4 percent $(exp(ln(1+0.1)*2.123)-1)$. In addition to these import demand side considerations, we find that a larger share of cultivated land indeed increases the likelihood of selling land conversion quotas, while geological conditions characterized by a predominance of steep terrains strictly decreases the likelihood of selling land conversion quotas.

In addition to market forces, we are also interested in how the administrative autonomy of a jurisdiction affects the incidence of trade. In all of our specifications, administrative decentralized counties/districts are associated with lower likelihood of selling land conversion quotas, and higher likelihood of buying such quotas. The coefficients on the decentralization status of exporters is around -1, which suggests that if a land conversion quota seller is from any of the 13 decentralized jurisdictions, it decreases the hazard of trade significantly by around 63 percent $(1 - exp(-1))$. Similarly, the coefficients on the decentralization status of importers suggest that being located in the 13 decentralized jurisdictions increases the hazard of trade by between 41.9 percent $(exp(0.35)-1)$ and 73 percent $(exp(0.548)-1)$. These findings are consistent with a positive relationship between administrative autonomy and ω_i. Thus, administrative autonomy improves the likelihood of trade among importers, and decreases the likelihood of trade among exporters.

In addition to the three main findings, Tables 6 and 7 offer two additional observations. First, a scale effect is indeed present, with larger total area enjoying higher likelihood of being both an exporter and importer in land conversion quota trade. Second, an urban district effect is evident, in which counties are more likely exporters of land conversion quotas while urban districts are more likely importers.

6.1 Other Leader-Specific Considerations

In this subsection, we question whether our conclusions regarding the impact of leader networks on the transaction cost of intergovernmental contracts may have been driven by other leader-specific characteristics. In particular, we consider the leader's age as a proxy for the individual's experience in the political hierarchy. As discussed, we do so to allay concerns regarding the conflation of years of experience with the number of network connections as a determinant of transaction cost. Furthermore, we introduce political cycle effects, which have been shown in the context of other countries to feature importantly in the decision-making of local leaders in some cases (e.g., Alesina, Roubini, and Cohen 1997) but not others (e.g., Iyer and Mani 2012).

These results are reported in Table 9 (Panels A and B). In Panel A, we introduce the average age and average age squared of the leaders of the county in question, separately for exporting counties and importing counties. In Panel B, we introduce the average number of years and average number of years squared that the leaders of the county in question have been in office. Interestingly, we find that the importance of leader networks remains robust upon introducing these leader-specific characteristics. In addition, the age and political cycle effects are in fact insignificant in most of our specifications. The only two exceptions occur in the logit specifications that address importer leader-age effects, where the age of the leader in the importer county is shown to have an inverted U shaped relationship with the incidence of trade, with the maximum effect at around 40 years ($\approx 0.716/0.018$ or $0.957/0.024$).

As a final check, we unpack the impacts of career connections of the two county level leaders, namely, the party secretary and county governor. To do so, we generate two career network variables for each county and each year, one pertaining to the party secretary's career history, and the other to that of the county governor. The results are summarized in Table 10. Notably, between the network connections of the two leaders, only the career network connection of the county governor – responsible for the day-to-day operations of the local government – features significantly in the incidence of trade in land conversion quota. Specifically from Table 10, career networks of county governors reduce transaction costs in general. However, possible trade match distortions among networked importers are also evident through the negative and significant interaction term between the importer's GDP per capita and the presence of county governor career network connections.

7 Conclusion

Do leader networks facilitate efficient intergovernmental contracts? From the Zhejiang experiment in land conversion quota trading, we draw three main lessons. First, we find that the prior career experience of a leader in a different locality is shown to be of paramount importance in determining trade outcomes, consistent with the transaction cost view that network connections confer informational advantages. Interestingly, while we find that leader networks increase the incidence of contracts, they may not increase the incidence of efficient contracts. In particular, we find that trade mediated by network connections can give rise to match distortions. This may explain some of the observations involving simultaneous two-way trade in select counties/districts in our data. In addition, while we find that leader decisions depend on market forces, the impact of market forces is mediated by the level of autonomy a county enjoys in making administrative decisions.

The career history of leaders in China is subject to the rules of the civil service system. The main contribution of this study is the finding that these rules have impacts that extend well beyond typical career advancement concerns of civil servants. Indeed, we show that leaders' experience and network linkages are key determinants of the transaction costs incurred in interjurisdictional contracts. This said, another contribution of this study is in observing that a price of transaction cost saving leader networks may well exist in the form of distortions in the trade matches that are ultimately formed.

Many future research questions remain. For example, there is as yet no study on the quality aspect of land consolidation efforts in China, and likewise, there is no study to date on the agricultural productivity impact of China's land administration reforms. What roles do leader characteristics play? Furthermore, there are many policy programs in China that transcend county-level and/or provincial-level boundaries, such as infrastructure projects and cross-border environmental programs. What roles do leader networks play in these interactions?

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Figure 1: Land Conversion Quota Trade: 1999-2003

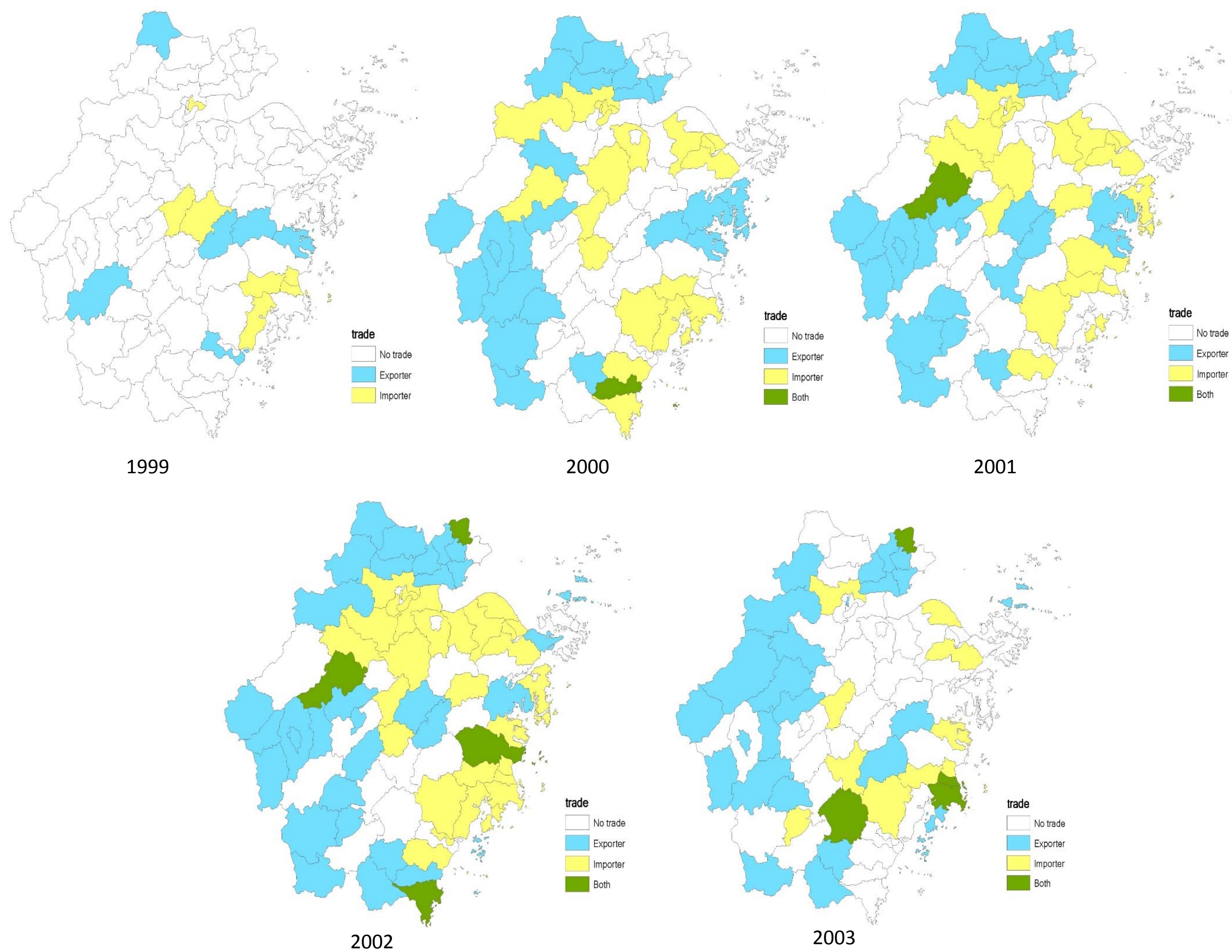

Figure 2: Average No. of Leader Network Links and Land Conversion Quota Trade: 1999-2003

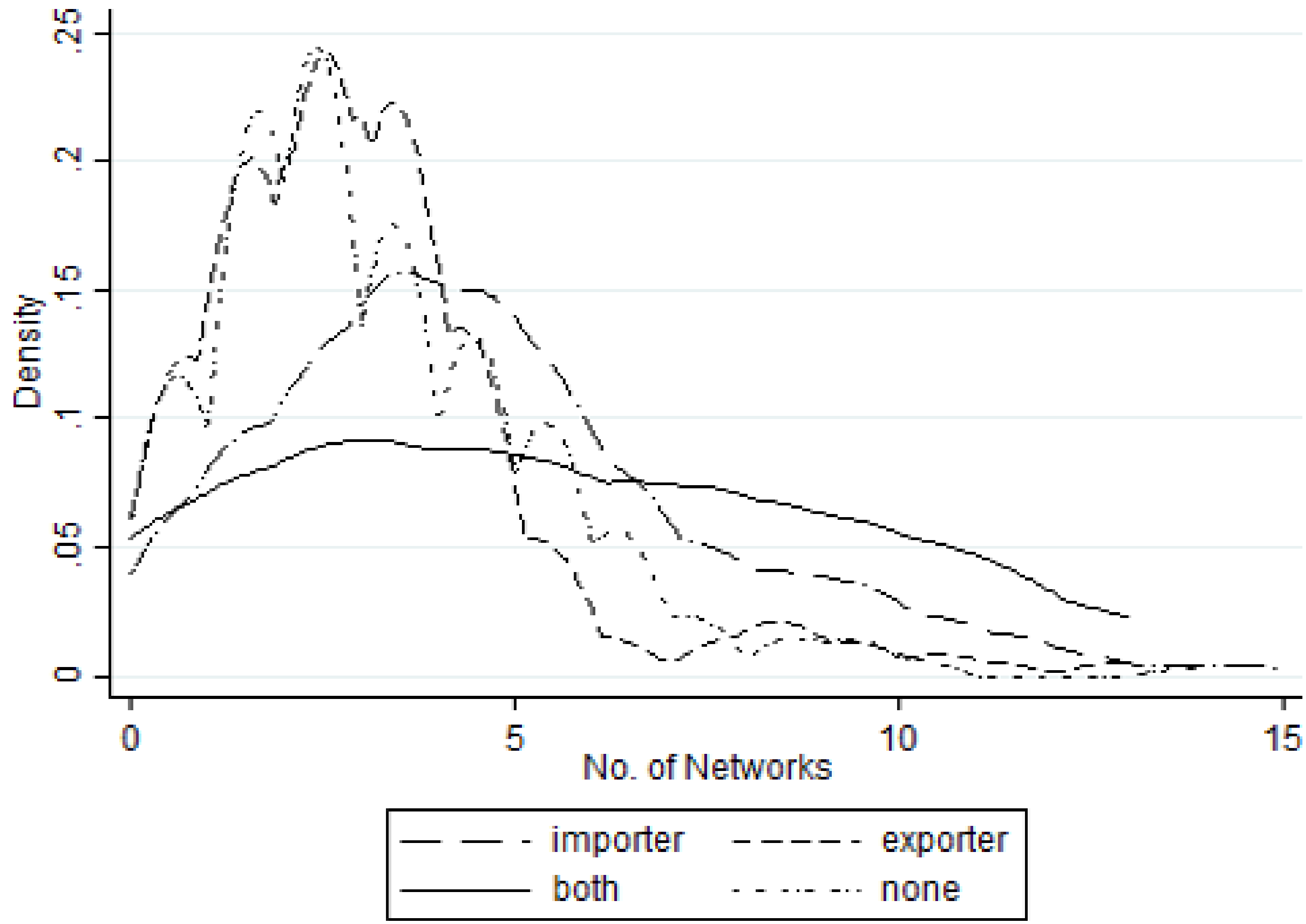

Figure 3: Negative Assortative Matching and The Boundary of Trade and Autarky

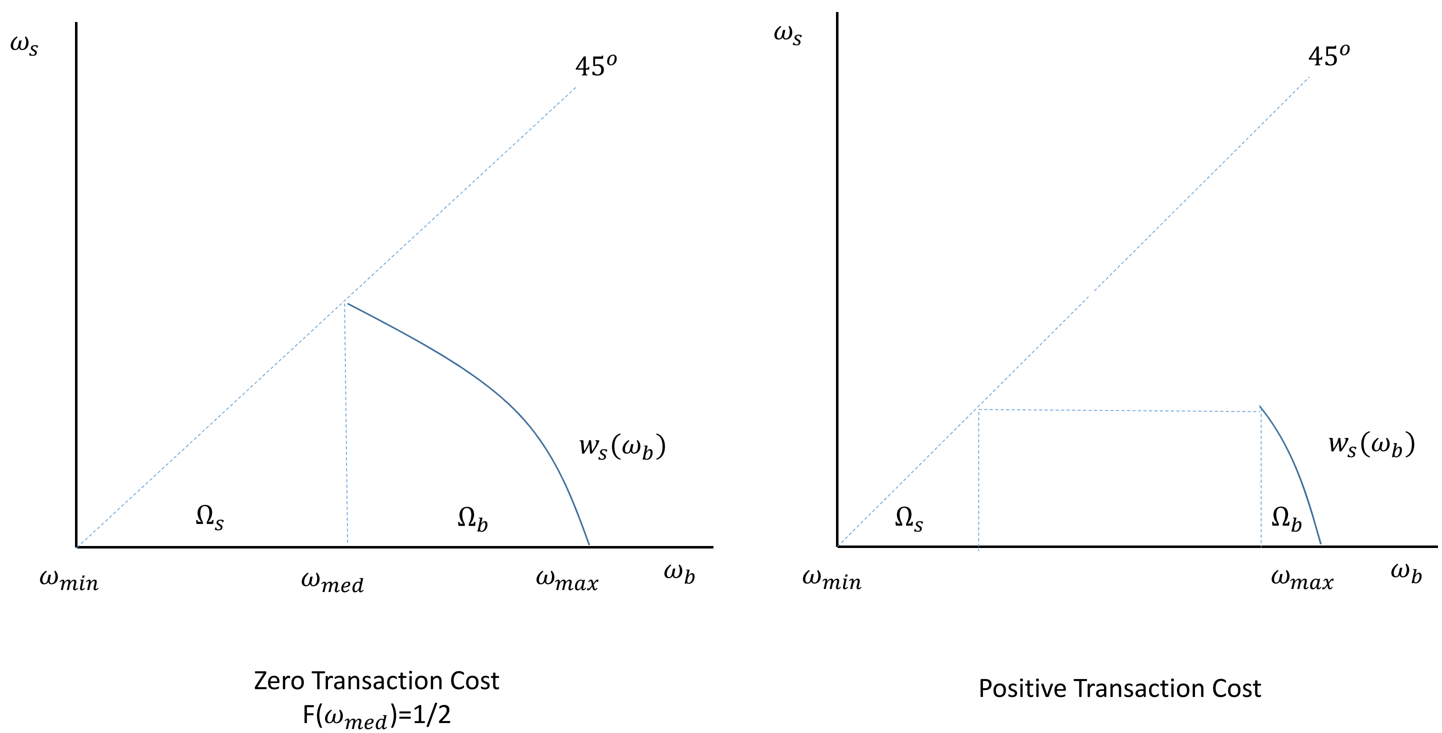

Table 1: County-Level Leader Attributes in Zhejiang 1999 - 2003

Leader Characteristics (1993 - 2003, 96 jurisdictions of Zhejiang Province) Party Secretary (*shuji*) and County Governor (*xianzhang*)					
Variables	Obs	Mean	Std Dev.	Min	Max
Mean Age	83	43.07	3.02	34.89	51.2
Mean Political Cycle	69	1.49	0.99	0	4.4
(years since appt. in current post)					
Mean # of Career Network Links per year	96	3.43	2.20	0	12.2

Table 2. Comparative Statics of $\Delta S(\omega_b, \omega_s)$ with respect to ω_b and ω_s:

	Both Trade $\omega_b \in \Omega_b, \omega_s \in \Omega_s$	Only Buyer Trades $\omega_b \in \Omega_b, \omega_s \notin \Omega_s$	Only Seller Trades $\omega_b \notin \Omega_b, \omega_s \in \Omega_s$	Neither Trades $\omega_b \notin \Omega_b, \omega_s \notin \Omega_s$
ω_b	$\text{sgn}(w_s(\omega_b) - \omega_s)$	$\text{sgn}(w_s(\omega_b) - \omega_s)$	$+$	$+$
ω_s	$\text{sgn}(w_s^{-1}(\omega_s) - \omega_b)$	-	$\text{sgn}(w_s^{-1}(\omega_s) - \omega_b)$	-

Table 3: Summary of Statistics
(Year: 1999-2003; Total number of jurisdictions: 96)

Variables	Obs	Mean	Std Dev.	Min	Max
Trade activity dummy	45,570	0.008	0.087	0	1
GDP per capita (in 10,000 yuan)	40,535	1.468	0.873	0.295	5.507
Adjacency (dummy)	45,570	0.052	0.221	0	1
Belonging to the same city (dummy)	45,570	0.094	0.291	0	1
Decentralization (dummy)	45,570	0.135	0.342	0	1
Share of cultivated land	40,725	0.196	0.144	0.025	0.839
Share of slope less than 5 degree	45,570	0.809	0.162	0.379	1
Total Area (in sq. kilometer)	45,570	1235.761	828.82	18.1	4452
Urban district (dummy)	45,570	0.437	0.496	0	1
Birthplace networks (dummy)	45,560	0.023	0.151	0	1
Career networks (dummy)	45,560	0.036	0.187	0	1
Education networks (dummy)	43,880	0.079	0.269	0	1
Either of the three networks (dummy)	45,560	0.122	0.327	0	1

Note: Please refer to Section 4 for the data sources of each variable in this table.

Table 4: Variables by Trade Status

Variables	Importer	Exporter	Two-way Trader	Non-trader
Total Number	52	55	24	13
GDP Per Capita (10,000 yuan)	1.76	1.33	1.64	1.23
Decentralized Share	17.31%	7.27%	4.17%	7.69%
Network Links_All	12.74	12.77	14.66	7.58
Network Links_Career	4.06	3.55	4.53	2.42
Network Links_Birthplace	2.69	2.28	3.05	1.55
Network Links_Education	7.57	8.34	9.18	4.52

Notes: 1. This table summarizes the total number of counties by trade status, as well as the average GDP per capita, the share of decentralized jurisdictions, the average number of links per year for each type of connections by trade status; 2. A county that ever imported is defined an importer in this table, a county that ever exported is defined an exporter. Two-way traders are thus counted twice, once as importer and once as exporter. No trade denotes counties that never traded. The total number of counties can be retrieved by summing the number of importers, the number of exporters, the number of non-traders, minus the number of two-way traders.

Table 5: Descriptive Statistics of Decentralized Jurisdictions (1999 - 2003)

	Panel A: Urban Districts					
	Decentralized Jurisdictions (4)			Non-Decentralized Jurisdictions (23)		
	mean	min	max	mean	min	max
GDP per capita (year 2003, 10,000 yuan)	2.74	1.9	3.56	2.1	0.55	5.51
Population (year 2003, 10,000 persons)	75.05	47.15	115.74	36.48	12.5	65.14
Land area (sq. kilometers)	980.25	274	1262	405.07	18.1	1502.1
Average number of land trade events as importer per jurisdiction	21.25	1	62	4.22	0	32
Average number of land trade events as exporter per jurisdiction	0	0	0	1.3	0	18
	Panel B: Decentralized Counties/County Level Cities					
	Decentralized Jurisdictions (9)			Non-Decentralized Jurisdictions (49)		
	mean	min	max	mean	min	max
GDP per capita (year 2003, 10,000 yuan)	2.88	2.44	3.88	1.4	0.47	2.95
Population (year 2003, 10,000 persons)	64.67	36.45	100.71	53.6	10.93	122.56
Land area (sq. kilometers)	925.78	507	1527	1608.33	100	4452
Average number of land trade events as importer per jurisdiction	7.44	0	38	2.86	0	26
Average number of land trade events as exporter per jurisdiction	5.56	0	18	8.24	0	54

Notes: 1. Among urban districts, 4 (Yuhang; Xiaoshan; Huangyan; Jiaojiang) out of 27 of them were decentralized in 1992. Among counties and county level cities, 9 (Cixi; Haining; Haiyan; Jiashan; Pinghu; Shaoxing; Tongxiang; Yuyao; Yinxian) out of 58 were decentralized in 1992; 2. The 11 urban jurisdictions (*shixiaqu*) are excluded from the comparison since they are not comparable to an independent county or district.

Table 6: Factors Affecting Land Conversion Quota Trade Between Jurisdiction Pairs

	Proportional Hazards Model		(Using 1999 Values)	
	(First Trade)	**(All Trades)**	**(First Trade)**	**(All Trades)**
Explanatory Variables	[1]	[2]	[3]	[4]
Connected (three types) in year t	1.33	1.142	1.973	2.473
	(0.594)**	(0.622)*	(0.640)***	(0.639)***
Ln (GDP per capita) of exporter	-0.441	-0.3	-1.632	-1.954
* Connected (three types) in year t	(0.673)	(0.713)	(0.910)*	(0.912)**
Ln (GDP per capita) of importer	-0.684	-0.612	-0.576	-0.677
* Connected (three types) in year t	(0.401)*	(0.423)	(0.495)	(0.559)
Adjacent or not	-0.134	0.096	-0.044	0.173
	(0.261)	(0.295)	(0.256)	(0.287)
Belonging to the same prefecture city	1.828	1.686	1.687	1.433
	(0.189)***	(0.207)***	(0.202)***	(0.219)***
Ln (GDP per capita) of exporter in year t	-3.383	-3.47	-2.361	-2.102
	(0.442)***	(0.453)***	(0.437)***	(0.431)***
Ln (GDP per capita) of importer in year t	2.123	1.919	1.871	1.709
	(0.291)***	(0.300)***	(0.252)***	(0.254)***
Decentralization dummy for exporter	-1.025	-0.945	-1.007	-0.914
	(0.276)***	(0.286)***	(0.264)***	(0.279)***
Decentralization dummy for importer	0.35	0.403	0.519	0.548
	(0.218)	(0.233)*	(0.221)**	(0.235)**
Share of cultivated land of exporter in year t	2.364	3.333	0.511	1.07
	(0.586)***	(0.679)***	(0.465)	(0.507)**
Share of cultivated land of importer in year t	-0.238	-0.441	-0.226	-0.307
	(0.778)	(0.939)	(0.662)	(0.761)
Share of cultivated land of exporter	8.327	7.896	8.000	7.717
with slope < 5 degree	(1.169)***	(1.191)***	(1.184)***	(1.247)***
Share of cultivated land of importer	-0.596	-0.231	-0.176	0.23
with slope < 5 degree	(0.798)	(0.917)	(0.741)	(0.829)
Ln (Total area) of exporter in year t	1.067	1.107	0.958	0.982
	(0.148)***	(0.157)***	(0.146)***	(0.155)***
Ln (Total area) of importer in year t	0.454	0.494	0.579	0.617
	(0.104)***	(0.109)***	(0.105)***	(0.114)***
District dummy for exporter	-1.1	-1.2	-1.207	-1.359
	(0.221)***	(0.229)***	(0.231)***	(0.242)***
District dummy for importer	0.894	1.11	0.957	1.168
	(0.197)***	(0.200)***	(0.196)***	(0.197)***
N	32,712	33,052	33,848	34,190
Log likelihood	-1,517.96	-2,181.22	-1,538.15	-2,206.85
Wald chi-square	495.1	572.44	488.11	538.43
Number of failures	197	286	197	286

Notes: 1. The coefficients (instead of hazard ratios) are provided for the results of proportional hazards models; 2. Robust clustered standard errors at jurisdiction pair level are provided in parentheses; 3. *** p<0.01; ** p<0.05; * p<0.1.

Table 7: Robustness Checks Using Logit Models

	Logit Models	
	Firth	**Random Effect**
Explanatory Variables	[1]	[2]
Connected (three types) in year t-1	1.12	1.009
	(0.601)*	(0.688)
Ln (GDP per capita) of exporter	0.027	-0.001
* Connected (three types) in year t-1	(0.548)	(0.635)
Ln (GDP per capita) of importer	-0.696	-0.494
* Connected (three types) in year t-1	(0.461)	(0.540)
Adjacent or not	0.178	0.101
	(0.231)	(0.282)
Belonging to the same prefecture city	1.319	1.614
	(0.210)***	(0.272)***
Prior trade dummy	2.956	2.199
	(0.183)***	(0.373)***
Ln (GDP per capita) of exporter in year t-1	-2.564	-3.15
	(0.449)***	(0.561)***
Ln (GDP per capita) of importer in year t-1	1.721	1.961
	(0.351)***	(0.411)***
Decentralization dummy for exporter	-0.562	-0.706
	(0.252)**	(0.304)**
Decentralization dummy for importer	0.313	0.35
	(0.164)*	(0.199)*
Share of cultivated land of exporter in year t-1	1.406	1.365
	(0.499)***	(0.603)**
Share of cultivated land of importer in year t-1	0.601	0.598
	(0.396)	(0.443)
Share of cultivated land of exporter	6.912	8.592
with slope $<$ 5 degree in year t-1	(0.801)***	(1.107)***
Share of cultivated land of importer	-0.855	-0.956
with slope $<$ 5 degree in year t-1	(0.713)	(0.810)
Ln (Total area) of exporter in year t-1	0.926	1.119
	(0.147)***	(0.181)***
Ln (Total area) of importer in year t-1	0.325	0.359
	(0.103)***	(0.120)***
District dummy for exporter	-1.066	-1.275
	(0.201)***	(0.242)***
District dummy for importer	1.096	1.176
	(0.163)***	(0.192)***
N	25,718	25,718
Log likelihood	-1,047.10	-1,073.10
Wald chi-square	780.03	515.56

Notes: 1. The coefficients (instead of odds ratios) are provided for Firth Logit and Random Effect Logit models; 2. Covariates in year $t-1$ are used; 3. Standard errors are provided; 4. Year fixed effects are included in all the columns; 5. *** p<0.01; ** p<0.05; * p<0.1.

Table 8: Robustness Checks Using Career Networks

	Proportional Hazards Model				Logit Models	
			(Using 1999 Values)			
	(First Trade)	(All Trades)	(First Trade)	(All Trades)	Firth	Random Effect
	Career Network					
Explanatory Variables	[1]	[2]	[3]	[4]	[5]	[6]
Connected (Career)	2.032	1.921	2.797	3.104	2.34	2.422
	(0.689)***	(0.716)***	(0.763)***	(0.770)***	(0.676)***	(0.803)***
Ln (GDP per capita) of exporter	0.059	0.013	-1.14	-0.889	-0.021	-0.032
* Connected (Career)	(0.853)	(0.981)	(1.098)	(1.039)	(0.632)	(0.755)
Ln (GDP per capita) of importer	-0.933	-0.751	-1.304	-1.849	-1.372	-1.212
* Connected (Career)	(0.499)*	(0.569)	(0.585)**	(0.620)***	(0.550)**	(0.666)*
Adjacent or not	-0.264	-0.012	-0.074	0.133	0.148	0.04
	(0.269)	(0.299)	(0.264)	(0.295)	(0.234)	(0.289)
Belonging to the same Prefecture city	1.436	1.213	1.472	1.318	1.084	1.313
	(0.235)***	(0.262)***	(0.237)***	(0.288)***	(0.239)***	(0.293)***
Prior trade dummy	—	—	—	—	2.916	2.121
	—	—	—	—	(0.184)***	(0.378)***
N	32,712	33,052	33,848	34,190	25,718	25,718
N	32,712	33,052	33,848	34,190	25,718	25,718
Log likelihood	-1,509.63	-2,169.39	-1,533.88	-2,204.17	-1,040.98	-1,066.15
Wald chi-square	528.52	646.92	510.65	584.25	784.88	518.84
Number of failures	197	286	197	286		

Notes: 1. The coefficients (instead of hazard ratios) are provided for the results of proportional hazards models (Column 1-2); 2. The coefficients (instead of odds ratios) are provided for Firth Logit and Random Effect Logit models; 3. Covariates in year t are used in column 1-2; Covariates in year $t-1$ are used in column 3-4; 4. Robust clustered standard errors are provided in parentheses for columns 1-2, and standard errors are provided in columns 5-6; 5. Year fixed effects are included in columns 5-6; 6. *** p<0.01; ** p<0.05; * p<0.1.

Table 9: Robustness Checks With Leader-Specific Attributes

	Proportional Hazards Model (First Trade)	Proportional Hazards Model (All Trades)	Logit Models Firth	Logit Models Random Effect
		Panel A: Age effect		
Explanatory Variables	[1]	[2]	[3]	[4]
Connected (Career)	1.128	1.235	0.764	1.064
	(0.289)***	(0.288)***	(0.289)***	(0.355)***
Exporter Average Age	0.25	0.248	0.048	0.154
	(0.186)	(0.174)	(0.153)	(0.177)
Exporter Average Age Squared	-0.005	-0.005	-0.002	-0.004
	(0.002)*	(0.002)**	(0.002)	(0.002)
N	25,893	26,183	20,464	20,464
Log likelihood	-1,200.98	-1,762.70	-779.16	-810.05
Wald chi-square	454.83	527.72	622.04	400.11
Number of failures	164	243		
Explanatory Variables	[5]	[6]	[7]	[8]
Connected (Career)	0.789	0.701	0.793	0.877
	(0.367)**	(0.376)*	(0.397)**	(0.437)**
Importer Average Age	1.337	0.974	0.716	0.957
	(0.871)	(0.700)	(0.395)*	(0.533)*
Importer Average Age Squared	-0.015	-0.011	-0.009	-0.012
	(0.010)	(0.008)	(0.005)*	(0.006)*
N	25,977	26,185	20,466	20,466
Log likelihood	-973.59	-1,271.63	-687.04	-720.00
Wald chi-square	279.93	305.18	452.5	347.16
Number of failures	129	171		
		Panel B: Political Cycle Effect		
Explanatory Variables	[1]	[2]	[3]	[4]
Connected (Career)	1.053	1.181	0.981	1.349
	(0.323)***	(0.335)***	(0.323)***	(0.412)***
Exporter Cycle	0.059	-0.007	0.326	0.385
	(0.208)	(0.175)	(0.200)	(0.216)*
Exporter Cycle Squared	-0.021	-0.015	-0.049	-0.055
	(0.050)	(0.043)	(0.046)	(0.051)
N	18,547	18,763	14,483	14,483
Log likelihood	-966.27	-1,392.35	-685.11	-709.92
Wald chi-square	316.81	365.69	517.61	312.56
Number of failures	137	198		
Explanatory Variables	[5]	[6]	[7]	[8]
Connected (Career)	0.623	0.494	0.974	1.064
	(0.416)	(0.438)	(0.461)**	(0.493)**
Importer Cycle	-0.185	-0.166	0.122	0.153
	(0.223)	(0.196)	(0.238)	(0.245)
Importer Cycle Squared	0.014	-0.001	-0.076	-0.085
	(0.055)	(0.051)	(0.063)	(0.064)
N	18,588	18,764	14,484	14,484
Log likelihood	-754.81	-1,001.89	-523.41	-551.63
Wald chi-square	230.01	262.13	361.37	301.22
Number of failures	105	142		

Notes: 1. The coefficients (instead of hazard ratios) are provided for the results of proportional hazards models (columns 1, 2, 5, and 6); 2. The coefficients (instead of odds ratios) are provided for Firth Logit and Random Effect Logit models (columns 3, 4, 7 and 8); 3. Covariates in year t are used in columns 1, 2, 5, and 6; Covariates in year $t-1$ are used in columns 3, 4, 7 and 8; 4. Robust clustered standard errors are provided in parentheses for columns 1, 2, 5, and 6; Standard errors are provided for columns 3, 4, 7 and 8; 5. Year fixed effects are included in columns 3, 4, 7 and 8; 6. *** p<0.01; ** p<0.05; * p<0.1.

Table 10: Robustness Checks Unbundling Party Secretary and County Governor Effects

	Proportional Hazards Model		**(1999 Values)**		**Logit Models**	
	(First Trade)	**(All Trades)**	**(First Trade)**	**(All Trades)**	**Firth**	**Random Eff.**
Explanatory Variables	[1]	[2]	[3]	[4]	[5]	[6]
Connected (county governor)	0.24	0.871	2.917	3.18	2.174	2.242
	(0.928)	(0.982)	(0.950)***	(1.029)***	(0.767)***	(0.900)**
Ln (GDP per capita) of exporter	0.836	0.78	-0.251	-0.137	0.771	0.583
* Connected (county governor)	(1.009)	(0.944)	(1.086)	(1.098)	(0.740)	(0.872)
Ln (GDP per capita) of importer	-0.333	-1.057	-2.494	-3.006	-2.167	-1.941
* Connected (county governor)	(0.670)	(0.567)*	(0.682)***	(0.665)***	(0.739)***	(0.867)**
N	32,712	33,052	33,848	34,190	25,718	25,718
Log likelihood	-1,517.57	-2,180.77	-1,536.13	-2,208.00	-1,044.30	-1,069.82
Wald chi-square	499.76	563.65	472.59	526.75	786.72	529.48
Number of failures	197	286	197	286		
Connected (party secretary)	1.271	1.186	1.37	1.303	1.634	1.559
	(0.831)	(0.759)	(0.951)	(0.939)	(0.770)**	(0.927)*
Ln (GDP per capita) of exporter	0.482	0.55	-1.367	-1.422	-0.019	0.043
* Connected (party secretary)	(0.876)	(0.928)	(1.319)	(1.345)	(0.705)	(0.851)
Ln (GDP per capita) of importer	-0.692	-0.568	0.2	0.144	-0.93	-0.801
* Connected (party secretary)	(0.538)	(0.574)	(0.794)	(0.876)	(0.689)	(0.821)
N	32,712	33,052	33,848	34,190	25,718	25,718
Log likelihood	-1,512.95	-2,171.47	-1,540.10	-2,217.54	-1,047.06	-1,072.21
Wald chi-square	528.49	576.8	514.53	525.85	791.55	510.18
Number of failures	197	286	197	286		

Notes: 1. The coefficients (instead of hazard ratios) are provided for the results of proportional hazards models (columns 1 - 4); 2. The coefficients (instead of odds ratios) are provided for Firth Logit and Random Effect Logit models. 3. Covariates in year t are used in columns 1-4; Covariates in year $t-1$ are used in column 5-6; 4. Robust clustered standard errors are provided in parentheses for columns 1-4; Standard errors are provided for columns 5-6; 5. Year fixed effects are included in columns 5-6; 6. *** p<0.01; ** p<0.05; * p<0.1.

Appendix

Properties of the Competitive Equilibrium

I. Negative Assortative Matching: The first order condition of the maximization problem in (4) evaluated at the equilibrium assignment $w_s(\omega_b)$ is:

$$-(\omega_b - w_s(\omega_b)) = p'(w_s(\omega_b)). \tag{8}$$

Totally differentiating the first order condition in (11) with respect to ω_b, the equilibrium assignment $w_s(\omega_b)$ is negatively assortative, or

$$w_s'(\omega_b) = \frac{1}{1 - p''(w_s(\omega_b))} < 0. \tag{9}$$

where it can be confirmed that $1-p''(w_s(\omega_b)) < 0$ if the second order condition of the maximization problem is to be satisfied.

The negative assortative matching in (9) above implies that in a competitive equilibrium, the highest $\omega_b = \omega^+$ would match with the lowest $\omega_s = \omega^-$. As for the rest of the assignment schedule, ω_s is matched in equilibrium to ω_b if and only if the mass of $\omega \geq \omega_b$ is equal to the mass of $\omega \leq \omega_s$. Thus,

$$F(\omega_b) = 1 - F(w_s(\omega_b)) \quad \Leftrightarrow w_s(\omega_b) = F^{-1}(1 - F(\omega_b))$$

as displayed in (5).

II. Equilibrium Locational Division into Buyer/Seller/Inactive Regions: As stated in Section 3, with transaction costs T, the largest ω_s that exports is given by $\omega_s^{max} = \max\{\omega_s | S(w_s^{-1}(\omega_s), \omega_s) - T \geq 0\}$, while the smallest ω_b that import is given by $\omega_b^{min} = \min\{\omega_b | S(\omega_b, w_s(\omega_b)) - T \geq 0\}$.

III. Equilibrium Allocation of Gains from Trade. Let the equilibrium gains from trade for the marginal seller $p(\omega_s^{max})$ be equal to zero. For all other infra-marginal sellers:

$$p(\omega_s) - p(\omega_s^{max}) = \int_{\omega_s^{max}}^{\omega_s} p'(\omega) d\omega = \int_{\omega_s^{max}}^{\omega_s} -(w_s^{-1}(\omega) - \omega)) d\omega.$$

for $\omega_s < \omega_s^{max}$, and zero otherwise. By inspection, $p(\omega_s)$ is increasing with respect to the seller's willingness to export $-\omega_s$ is $p'(\omega) < 0$ from (8). Now by the envelope theorem, (1) and (3),

$$\frac{\partial S(\omega_b, w_s(\omega_b)) - p(w_s(\omega_b))}{\partial \omega_b} = (\omega_b - w_s(\omega_b))/2 > 0$$

whenever there is strictly positive trade. Thus, $S(\omega_b, w_s(\omega_b)) - p(w_s(\omega_b))$ is increasing with respect to the buyer's willingness to import.

Appendix Table 1. Robustness Checks Using Birthplace and Education Networks

	Proportional Hazards Model				**Logit Models**	
			(1999 Values)			
	(First Trade)	**(All Trades)**	**(First Trade)**	**(All Trades)**	**Firth**	**Random Eff.**
			Panel A: Birthplace Network			
Explanatory Variables	[1]	[2]	[3]	[4]	[5]	[6]
Connected (Birthplace)	-0.123	-0.497	1.074	0.819	-0.083	-0.199
	(1.165)	(1.236)	(1.301)	(1.274)	(1.078)	(1.251)
Ln (GDP per capita) of exporter	-0.397	-1.205	-1.543	-2.215	-0.729	-0.989
* Connected (Birthplace) in year t	(1.180)	(1.426)	(1.616)	(1.881)	(0.883)	(1.107)
Ln (GDP per capita) of importer	0.633	1.436	0.084	0.925	1.105	1.497
* Connected (Birthplace) in year t	(0.710)	(0.928)	(0.983)	(1.199)	(0.850)	(1.032)
Adjacent or not	-0.127	0.157	-0.04	0.194	0.256	0.169
	(0.264)	(0.303)	(0.258)	(0.294)	(0.231)	(0.285)
Belonging to the same Prefecture city	1.914	1.761	1.84	1.671	1.428	1.785
	(0.197)***	(0.213)***	(0.201)***	(0.216)***	(0.196)***	(0.269)***
Prior trade dummy	–	–	–	–	2.969	2.151
	–	–	–	–	(0.183)***	(0.396)***
N	32,712	33,052	33,848	34,190	25,718	25,718
Log likelihood	-1,519.57	-2,180.74	-1,542.73	-2,217.67	-1,049.41	-1,073.75
Wald chi-square	479.35	537.93	485.21	506.7	791.39	505.86
Number of failures	197	286	197	286		
			Panel B: Education Network			
Connected (Education)	-0.902	-0.517	-0.355	0.368	0.359	0.083
	(0.775)	(0.651)	(0.941)	(0.872)	(0.830)	(0.957)
Ln (GDP per capita) of exporter	0.914	0.761	0.572	-0.341	-0.252	-0.286
* Connected (Education) in year t	(0.855)	(0.708)	(1.325)	(1.224)	(0.670)	(0.766)
Ln (GDP per capita) of importer	0.127	0.09	0.156	0.184	0.037	0.292
* Connected (Education) in year t	(0.544)	(0.485)	(0.636)	(0.652)	(0.624)	(0.731)
Adjacent or not	-0.161	0.114	-0.084	0.15	0.226	0.142
	(0.265)	(0.297)	(0.264)	(0.299)	(0.232)	(0.283)
Belonging to the same Prefecture city	1.975	1.797	1.854	1.709	1.51	1.854
	(0.190)***	(0.211)***	(0.191)***	(0.216)***	(0.183)***	(0.256)***
Prior trade dummy	—	–	–	–	2.97	2.22
	–	—	–	–	(0.183)***	(0.384)***
N	31,598	31,934	32,880	33,218	24,774	24,774
Log likelihood	-1,499.48	-2,153.81	-1,523.79	-2,192.24	-1,034.37	-1,059.98
Wald chi-square	462.18	535.26	474.73	510.92	764.25	501.77
Number of failures	195	283	195	283		

Notes: 1. The coefficients (instead of hazard ratios) are provided for the results of proportional hazards models (Column 1-2); 2. The coefficients (instead of odds ratios) are provided for Firth Logit and Random Effect Logit models; 3. Covariates in year t are used in column 1-2; Covariates in year $t-1$ are used in column 3-4; 4. Robust clustered standard errors are provided in parentheses for columns 1-2, and standard errors are provided in columns 5-6; 5. Year fixed effects are included in columns 5-6; 6. *** p<0.01; ** p<0.05; * p<0.1.