DO SEARCH FRICTIONS COMPOUND PROBLEMS OF RELATIONAL CONTRACTING?*

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Abstract: We estimate the effect of search frictions on Kenyan farmers' decisions to supply French beans for export under contract. This paper has two main contributions. First, we build on the competitive wage models of Moen (1997) and Mortensen and Wright (2002) to include imperfect contract enforcement. Second, we employ two novel empirical methodologies to test our model using data from Kenya's French bean export industry. The first methodology measures search frictions based on the spatial density of firms and farmers in the market. The second uses preferences measured in a choice experiment to quantify the impact of search frictions on farmers entry and exit decisions under different contract enforcement scenarios. We find that search frictions are present in the market which primarily limits farmers' abilities to match with potential buyers but not vice versa. Examining the two component submarkets of the French bean export market, we find that search frictions are a potential barrier to entry for the fresh submarket and may be a factor in farmers' exit decision from the processed market. Lastly, we find search frictions are a potential barrier in areas where buyers are perceived as more reliable, suggesting a potential trade-off for policymakers depending on whether they design an intervention to target contract enforcement or search frictions. These findings are important for designing more effective programs to connect small-scale producers to French bean markets.

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1 Introduction

Two development interventions were conducted in Kirinyaga County, Kenya with the goal of increasing the number of small-scale producers supplying French beans for export. The interventions had mixed outcomes, and the causes of the programs' successes and failures were not clearly identified. In a recent working paper (Rosch and Ortega, 2014), we demonstrate that imperfect contract enforcement is one possible barrier to entering the market. In this paper, we investigate how search frictions interact with imperfect contract enforcement to deter small-scale farmers from participating in this market.

In markets with imperfect contract enforcement, theory predicts parties will use informal, relational contracts to generate incentives for both parties to adhere to contract terms within long-term relationships (e.g. (MacLeod, 2007; Levin, 2003; Baker et al., 2002)). In these models, the strength of incentives in relational contracting is constrained by two exogenous forces: agents' preferences over risk and time, and agents' reservation payments. In a world with search frictions and decentralized trading, however, finding new partners may be costly which will affect reservation payments. This is well established in the large literature on search theoretic models.[1] It is less well established how search frictions interact with other types of frictions that may impede relational contracting.

As search frictions increase, this drives up buyers' and sellers' reservation payouts and requires greater gains from trade to enter into contracting. This is the familiar hold-up problem for incomplete contracts (MacLeod and Malcomson, 1993). However, search frictions are essential to support relational contracting when autarky is not a credible punishment for reneging on contract terms. Search frictions increase the expected time it takes to form a new match, reducing the value of reneging on the contract terms for both parties in established relationships. This reduces the total surplus from trade necessary to maintain relational contracts. Thus the net impact from search frictions on trade with imperfect contract enforcement is non-obvious.

We examine three related questions about Kenya's French bean export market:

1. Does Kenya's French bean market export market show evidence of search frictions between farmers and export buyers?

2. Are search frictions a barrier to adopting French bean production in a world with perfect contract enforcement?

3. Are search frictions a barrier to adopting French bean production in a world with imperfect contract enforcement between farmers and export buyers?

[1] In labor search models, reservation payments are an endogenous outcome of the market. Search frictions that impede agents' abilities to locate and match with new trading partners drive a wedge between the reservation payment to an alternate buyer, the equivalent of the endogenous wage in a standard search model (e.g. Pissarides (1985)), and the reservation payout from an alternate activity (e.g. exogenous unemployment benefits).

To answer these and related questions, we build a simple directed search model featuring endogenous posted offers and imperfect contract enforcement. As a framework for our empirical analysis, we adapt Mortensen and Wrights's (2002) and Moen's (1997) models of directed search in a posted offer market and allow for heterogenous outside options across agents. We then examine the impact of imperfect contract enforcement on equilibrium market offers. To formalize this, we model imperfect contract enforcement in a similar manner as search models from monetary theory (e.g. Nosal and Rocheteau (2011)), which to our knowledge has not yet been integrated into labor search models.

Given the benchmark environment, we then develop empirical tests for whether search frictions pose a barrier to entry in this market.[2] We use a choice experiment to impute farmers' reservation payments under different contract enforcement scenarios. Then we use the local spatial density of buyers and sellers to estimate the effects of search frictions and imperfect contract enforcement on reservation payments and actual contract prices. Finally, we compare the reservation payments of paired farmers with and without contracts to determine whether search frictions could be impacting entry and/or exit decisions.

Although we are examining the dynamics of contracting between agents outside of employment relationships, it is a natural fit to study the dynamics of this market using labor search models. Firstly, these models describe behaviors that occur in many contexts. Figure (7) illustrates how terminology changes depending on whether the application is in labor markets, industrial supply chains, or agricultural markets. Secondly, the farmers we study have a relationship with their buyers that captures many of elements of the employer/employee relationship. Farmers are working at the direction of exporters even though they are not formally within the boundaries of the exporting firms. Likewise, both parties care only about performance for the contracted task, as opposed to a within-firm setting where total compensation may depend on multiple, interrelated tasks. Thus this market offers a relatively clean environment to empirically test labor search models' theoretical predictions.

Preliminary findings. We find that search frictions are present in the market and that they primarily limit farmers' abilities to match with potential buyers and not vice versa. Examining the two component submarkets of the French bean export market, search frictions are a potential barrier to entry for the fresh submarket and may be a factor in farmers' exit decision from the processed market. Lastly, search frictions are a potential barrier to entering the market in areas where buyers are more reliable on average, suggesting there may be a trade-off for policymakers depending on whether they design an intervention to target contract enforcement or search frictions. These findings are important for designing more effective programs to connect small-scale producers to

[2] Most search models predict some level of unemployment when search frictions are present. As an empirical matter, there is no established method to test that a given population of agents are unemployed *because* they experience different search frictions (see discussion in (Shimer, 2012)).

French bean markets.

Key contributions. This research is important for three main reasons. First, most labor contracts are incomplete in the sense that they either generate rents that can be bargained after the relationship is initiated, or do not specify all possible contingencies that could impact a continuing relationship, or can be renegotiated with the consent of all parties (Malcomson, 1997). Yet theorists have not incorporated this feature into models of equilibrium wage setting in markets with search frictions. Our model bridges this gap and provides empirically testable comparative static predictions for equilibrium outcomes. Second, few empirical studies of labor markets focus on frictions within a specific market (see (Petrongolo and Pissarides, 2001) for a survey), or examine whether search frictions act as a barrier to market for some types of agents. Our empirical approach introduces a new method of measuring the extent of search frictions using the local spatial densities of agents which makes it possible to study the effects of search frictions on market outcomes in settings where aggregate statistics are not available. Third, our results can help policy makers design interventions for Kenya's French bean market that better target the relevant barriers to market in this industry and have greater likelihood for improving farmer welfare.

Related literature. This paper contributes to two broad strands of literature. First, we contribute to the literature that seeks to estimate the effect of agent matching on relational contracts. Ackerberg and Botticini (2002) demonstrate it is important to control for endogenous matching of heterogeneous farmers and landlords when studying the structure of land rental contracts. They control for the effect of an unspecified matching technology that pairs farmers and landlords by using variation in land characteristics across their study area. We apply the same underlying logic to study French bean contracts, and improve on the method by providing a more explicit theoretical model of the matching process and using geographically-based proxy instruments that have a clear relationship to the theoretical model.

Second, we contribute to the broader theoretical literature on search frictions and relational contracting. Most search models assume wages are determined through ex-post Nash bargaining instead of through relational contracts. A few studies have looked at relational contracts in general equilibrium settings (Shapiro and Stiglitz, 1984; MacLeod and Malcomson, 1998; Board and Meyer-ter Vehn, 2011); however, these models do not incorporate search or matching frictions. Our model generates an equilibrium price for each submarket that is greater than the marginal cost of effort, just as in the Shapiro-Stiglitz efficiency wage model with frictionless matching and imperfect monitoring. In both models, transfers from buyers to sellers incentivize effort and allocate workers between matched and unmatched states. Unlike in the Shapiro-Stiglitz model, match dissolution in our model is not a punishment to sellers for shirking but rather an opportunity to switch between submarkets, thus forcing buyers to compensate sellers for contract default.

Our model also generates price dispersion, as in Board and Meyer-ter-Vehn's (2011) but for a different reason. In our model, price dispersion arises from heterogeneous buyer types separated into different submarkets. In Board and Meyer-ter-Vehn, price dispersion arises from on-the-job search in a frictionless market with imperfect contract enforcement. On-the-job search also generates dispersion of job quality, because the marginal cost of incentivizing effort decreases with increasing job tenure. Low wage jobs have lower expected returns to being matched, and provide lower-powered incentives to exert effort than higher paying jobs. In our model, however, the expected returns to being matched are equal in both submarkets, and so provide the same incentive to exert effort.

Acemoglu and Shimer (1999) show how wage posting and directed search generate efficient allocations when firms have to make ex-ante investments. In their case, workers (farmers) are the party making the investments of either high or low effort, while firms still retain all the bargaining power. In our model, firms are willing to invest in the cost of declaring themselves good type buyers for the same reason that firms are willing to invest in high levels of capital in Acemoglu and Shimer's (1999) model. Firms that make higher levels of ex-ante investment are able to post higher equilibrium offers and match more quickly than firms with lower offers. In our model, buyers that invest in declaring that they are good types are able to match more quickly than mixed type buyers because more sellers choose to search in the good type submarket than in the mixed submarket. Unlike in Acemoglu and Shimer, higher investment isn't associated with higher posted offers. Good type buyers are able to take advantage of their investment by offering lower posted prices than mixed type buyers. Sellers accept these lower posted prices because they yield the same expected gains as the imperfectly enforced prices of the mixed submarket.

The paper is organized as follows. Section 2 describes stylized facts about Kenya's French bean market. Section 3 presents our theoretical model. Section 4 describes the data, and section 5 displays the results of the empirical analyses. Section 6 discusses the implications of our findings for market design, and section 7 concludes.

2 Stylized Description of Kenya's French Bean Market

French beans, a variety of green beans, are one of Kenya's most important agricultural export crops by value. They are exported as either packaged fresh produce or as processed (frozen or canned) beans, and regulated by Kenya's Horticultural Crop Development Authority (HCDA). Aside from the export market, there is very limited domestic demand for French beans. Conversations with experts from the Ministry of Agriculture and HCDA suggest that outside of the capital, few households consume French beans, and that the majority of French beans available for sale in traditional markets and supermarkets were originally intended for the export market.

HCDA records show 84 different firms exported at least one shipment of beans in 2012. There is only one firm, Frigoken, which exports processed beans. Nonetheless, processed bean shipments make up a significant fraction of total exports, approximately 13% of total volume exported in 2012, and 12% in 2011. Although the fresh and processed markets are nominally one market, with farmers free to switch between them, the strong preference between varietals appropriate for canning and varietals appropriate for fresh exports effectively segments the market after farmers' make their planting decisions.

By Kenyan law, exporters are required to have a written contract with each farmer or group of farmers that they use to source horticultural produce. Contract terms must include price, quantity, and quality specifications, and typically include provisions for contract renewal, termination, and dispute resolution. According to HCDA records for Kirinyaga county, all contracts for the processing market are identical in terms of prices, production and quality requirements, and enforcement provisions. Contracts for the fresh market vary by exporting firm but do not vary substantially across the suppliers for any given firm. The most common difference within any given exporting firm's set of contracts is the delivery location. Across fresh market buyers, contracts differ in terms of required seed varietals, specifications for input levels and pre-approved suppliers, and availability of buyer-supplied credit. Phytosanitary and physical appearance conditions are largely identical for all fresh market contracts.

Although the HCDA has taken steps to improve contract enforcement after 2012, contracts are still imperfectly enforced. As a result, farmers often experience differences in realized revenues compared to contract specifications. Sometimes these differences are from explicit changes in prices paid. A Kenyan extension officer reports:

> "Prior to planting, an exporter and [a group of] farmers agree on a specific price and volume of beans. When the crop is in flower stage, it [the exporter] sends a verbal message through its truck loader to farmers that the price will be lower because the "market is bad." At harvest, the exporter sends another message with even lower price. At this time, the green beans must be picked and sold, hence farmers have no choice but to take the price. If they dispute the price offered, the exporter leaves the area and goes to buy in another region. I see this often during peak production season when there are plenty of beans." (Okello and Swinton, 2007, p. 279)

Price modifications also sometimes occur indirectly through "rejections". Because quality is not independently verified at time of delivery, exporters have discretion to adjust the share of a shipment which is deemed to be high quality so as to reduce the total payment to the farmers. This has been identified as a source of friction between exporters and small-scale suppliers of pineapples in Ghana (Suzuki et al., 2011). Other tactics used by exporters which reduce the farmers' realized total compensation from the contract included reporting shipments as underweight, and delaying or refusing to provide payments for delivered produce.

The amount of discretion available to buyers and farmers to modify the terms of trade within a signed contract is impacted by difficulties in finding alternate trading partners at two stages in the production process. At harvest time, farmers report few alternate buyers available and low salvage values for unsold French beans. Farmers frequently prefer to leave crops unharvested rather than to harvest them for animal feed or home use. Prior to planting time, when contracts are being negotiated and signed, farmers also report difficulty in finding available buyers with which to partner. Some farmers report traveling as far as the capital in order to attend agricultural promotion fairs and connect with potential buyers.

3 The Model

In this section, we present a simple model to demonstrate the effect of imperfect contract enforcement on equilibrium market outcomes when search frictions are present. The model is based on the competitive search frameworks of Moen (1997) and Mortensen and Wright (2002). We first describe equilibrium under perfect enforcement and show how search frictions can act as a barrier to market in this context. We then extend the model to feature imperfect contract enforcement, highlighting how this added friction interacts with search frictions to deter sellers from participating in this market.

3.1 Environment

Time is continuous and goes on forever. There is a continuum of buyers and sellers who match in pairs in a decentralized market. Agents, referred to as buyers and sellers, are defined by their technologies and preferences: only sellers have the technology to produce, and only buyers wish to consume. The measure of sellers is normalized to one, while the measure of buyers is endogenous but not greater than 1. Let v and u be measures of the subsets of buyers and sellers, respectively, who are seeking a match. All buyers and sellers are risk neutral, infinitely lived, and share common discount rate, r. Sellers produce an indivisible good of quality $q \in [\underline{q}, \overline{q}]$ with strictly increasing convex cost function $C(q)$ where $C(\underline{q}) = C'(\underline{q}) = 0$. Buyers earn revenue $R(q)$ from each good traded which is strictly increasing and concave in q.

3.1.1 Matching Process

Buyers and sellers are matched pairwise according to a constant-returns-to-scale matching function. We adopt a Cobb Douglas specification:

$$M = m(u, v) = u^{\gamma} v^{1-\gamma} \tag{1}$$

where M is the total number of matched created, $m(u, v)$ is the technology used to produce matches, and γ is the elasticity of substitution for unmatched sellers and buyers. Let $\theta \equiv \frac{v}{u}$. θ represents the tightness of a market, or how difficult it is for buyers and sellers to find each other. $\theta \in [0, \infty)$ where $\theta \to 0$ indicates increasing difficulty for sellers to find buyers, and $\theta \to \infty$ indicates increasing difficulty for buyers to find sellers.

The probability of a buyer matching with a seller is:

$$Q(\theta) = m(\frac{u}{v}, \frac{v}{v}) = m(\frac{1}{\theta}, 1) = (\frac{1}{\theta})^{\gamma} 1^{1-\gamma} = (\theta)^{-\gamma} \tag{2}$$

Similarly, the probability of a seller matching with a buyer is:

$$P(\theta) = m(\frac{u}{u}, \frac{v}{u}) = m(1, \theta) = (1)^{\gamma} (\theta)^{1-\gamma} = (\theta)^{1-\gamma} = \theta Q(\theta) \tag{3}$$

As θ increases, $Q(\theta)$ decreases, and $P(\theta)$ increases. In other words, as the ratio of buyers to sellers in the market increases (higher relative share of buyers), it becomes more difficult for buyers to match and easier for sellers to match.

The matching function encapsulates two search frictions: a congestion externality and a thick market externality. The congestion externality says that as more sellers enter the market, it will be harder for any one seller to find a buyer to trade with. The same thing happens for buyers; more buyers in the market make it harder for any one buyer to match with a seller. This is a negative externality imposed by buyers on other buyers, and sellers on other sellers. The thick market externality, however, is a positive externality imposed by buyers on sellers and vice versa. As more sellers enter the market, it becomes easier for buyers to match with a seller. Likewise, more buyers improve the odds of sellers finding a match.

Buyers and sellers meet and trade in one of Θ submarkets, where submarkets are characterized by a specific market tightness θ_i and contract price $w_i(\theta_i)$. Buyers can pay a sunk cost $k > 0$ to announce an open contract in their preferred submarket. Buyers can post at most one open contract. Buyers post contracts and sellers search across submarkets for their preferred contract.

Once matched, pairs continue to trade with each other until the match breaks up, either exogenously with probability $s \in (0, 1)$ or endogenously when contracts are imperfectly enforced.

Unmatched sellers earn flow revenue $b \geq 0$ which accounts for the gain from their best alternative activity. Unmatched buyers have no alternate activities and therefore do not earn any benefits while unmatched.

3.1.2 Contracting Environment

Buyers post contracts and sellers search for their preferred contract. A contract is an incentive compatible menu of payments conditional on the quality of the traded good, $w(q, \theta_i)$, which is defined as:

$$w(q, \theta_i) = \begin{cases} pq & \text{if } q \geq \underline{q}(\theta_i) \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

where $pq > 0$ is the payment from buyer to seller.[3] $\underline{q}(\theta_i)$ is the minimum quality level that can be supported in equilibrium given the level of search frictions present in the market.

Quality is perfectly observable to both buyer and seller but not observable outside of the matched pair. We assume contracts are imperfectly enforced, that there is no record keeping technology, and that the history of play within a match is private information to the parties involved. Therefore a single defection on a contract cannot be punished outside of the match. Instead, buyers and sellers are punished by the threat of match termination and having to wait to be rematched.

We assume that sellers can never defect on a contract. Typically, imperfect contract enforcement is modeled to allow for bilateral action such that either buyer or seller can defect on the contract. For this problem, however, it is sufficient to consider a one-sided contract enforcement problem because we are not allowing for moral hazard. Quality is perfectly observable to both buyers and sellers, just not observable to a third party.

We also assume that the rate at which buyers defect on a contract is exogeneous. The most common models of bilateral trade with relational contracting endogenize the choice to default on contract terms under the threat of autarky (Levin, 2003; Halac, 2012). To generalize autarky to a setting with rematching, however, would require strong assumptions about sellers' ability to share information with each other as well as their willingness to commit to enforcing autarky. Since there is no device or entity in this market that publicizes contract defaults or renegotiations, we assume

[3] We assume contracts are stationary because agents are risk neutral, there is no adverse selection, and buyers only make contract offers to unmatched sellers. Burdett and Coles (2003) show that it is optimal for contract payments to increase in job tenure when sellers are risk averse and can search for new matches on-the-job.

that farmers respond to contract defaults by switching to the submarket with perfect contract enforcement.

The order of actions for a contract is summarized in Figure (7). First buyers post contract offers $w(q,\theta_i)$. Then sellers search for their preferred contract and matches form. Third, sellers produce quality q. Fourth, buyers provide payment $w'(q,\theta_i)$. If $w'(q,\theta_i) \neq w(q,\theta_i)$, the match endogenously terminates with probability 1. Even if buyers pay $w'(q,\theta_i) = w(q,\theta_i)$, the match may still exogenously terminate with probability s. Finally, if the match neither endogenously nor exogenously terminates, the buyer and seller repeat the entire process from step three with the same contract terms as before.

Under perfect contract enforcement, a 3rd party ensures buyers' ex post payments are identical to their originally posted offers, $w'(q,\theta_i) = w(q,\theta_i)$. With imperfect contract enforcement, buyers deliver $w'(q,\theta_i) = w(q,\theta_i)$ with exogenous probability α and $w'(q,\theta_i) = 0$ with complimentary probability $1-\alpha$.[4] Increasing values of α increase the likelihood that the buyer behaves as if contracts are perfectly enforced. We assume that matches will terminate endogenously after a single payment of $w'(q,\theta_i) = 0$.[5]

With imperfect contract enforcement, buyers keep a higher share of the ex post trade surplus on average, which we model as if buyers earn an exogenously higher average revenue. Under imperfect contract enforcement, buyers can choose their type. Buyers of type g can pay a one time cost of $\kappa > 0$ to announce to all sellers that they will always behave as if contracts are perfectly enforced. Buyers of type m incur no extra costs an defect on contract terms with exogenous probability α. Type g buyers earn $R_g(q)$ for each unit of q produced. Type m buyers earn $R_m(q)$ per unit of q, where $R_m(q)$ and $R_g(q)$ are strictly concave functions, and $R_m(q) > R_g(q)$ and $R'_m(q) > R'_g(q)$ for all $q \in [\underline{q}, \overline{q}]$.

3.1.3 How Search Frictions Interact with Contracting Frictions

Buyers post contracts that incentivize sellers to produce the optimal level of q^* that maximizes utility for buyers and sellers. With no search or contract frictions present, this optimal value can span the full set of possible quality levels. The optimal quality level generates the maximum possible surplus from trade by equating the buyers' marginal revenue with marginal cost to procure it from the seller, while providing a payment to the seller at least as good as his outside option.

[4]This method of modeling ex-post uncertainty over transfers between buyers and sellers is commonly used in the monetary search literature (Nosal and Rocheteau, 2011), but has not yet been introduced into labor search models.

[5]Contract theorists usually model the most restrictive strategy possible that still supports trade. Agents are assumed to employ a grim trigger strategy which says that no trade will occur after one defection. Assuming the match breaks up with probability = 1 after a single defection is conceptually equivalent to sellers employing a grim trigger.

Imperfect contract enforcement and search frictions impact the expected payment, $w(q, \theta_i)$, and the equilibrium value of q^*, but through two different mechanisms, as illustrated in Figure (7). Imperfect contract enforcement reduces the expected value of the payment to sellers, causing them to choose a lower equilibrium value of q^*. This results in lower costs incurred by sellers and lower revenues earned by buyers, and decreases the posted offer compared to the perfect contract enforcement case.

Search frictions effectively raise the cost of buyers' and sellers' reservation values and payments, respectively. Depending on how much surplus is available, these increased costs could potentially render some trades unprofitable at any value of q^*. As long as sufficient surplus exists for trade to occur at q^*, the increases to buyers' and sellers' outside options will be shared between buyers and sellers, resulting in higher equilibrium contract payments.

When combined, the impact on contract payments is indeterminate. When imperfect contract enforcement is an endogenous choice for buyers, search frictions would increase the cost to buyers' for deviating from the contracted payment, helping to drive the expected transfer back towards its value under perfect contract enforcement, and incentivizing sellers' to provide quality levels closer to first-best. With exogenous contract deviations, the parameters of the problem determine whether the effect from the search frictions or imperfect contract enforcement dominate.

3.2 Perfect Contract Enforcement

We begin by establishing the benchmark model with perfect contract enforcement.[6]

Steady-state relationship between unmatched buyers and sellers. In the base case with perfect contract enforcement, the populations of buyers and sellers are both homogeneous. Therefore there is only one active submarket in equilibrium. Assuming the submarket is in steady-state equilibrium, then the net difference between match creation and match destruction will be zero:

$$\dot{u} = (destruction) - (creation) \equiv 0 \tag{5}$$

Since all contracts are perfectly enforced, there is no endogenous match destruction. Matches are destroyed at the exogenous rate s and created at the rate $\theta Q(\theta)$. Therefore we can rewrite Equation (5) as:

$$\dot{u} = s(1-u) - \theta Q(\theta)u \equiv 0 \tag{6}$$

[6]This environment is equivalent to Moen's (1997) environment when submarkets are unordered, and Mortensen and Wright's (2002) environment when matched buyers and sellers can engage in repeat trading.

In words, Equation (6) says that the rate of change of unmatched sellers over time is equal to the mass of matched sellers whose matches are dissolved less the mass of unmatched sellers who become matched. Solving Equations (6) for u, we arrive at:

$$u = \frac{s}{s + \theta Q(\theta)} \tag{7}$$

In steady-state, the equilibrium level of unmatched sellers depends on the match separation rate and the degree of market tightness. Note that this model predicts there will always be some unmatched sellers in equilibrium. The presence of unmatched sellers in equilibrium implies that search frictions are necessarily a barrier to market, an issue that we will explore further in the next section.

Sellers' problem. We can write value functions for sellers in their unmatched and matched states:

$$rU = b + \theta Q(\theta)[E - U] \tag{8}$$

$$rE = w(q, \theta) - C(q) - s[E - U] \tag{9}$$

where U and E are the values that accrue to sellers in their unmatched and matched states, respectively. Equation (8) says that the value received by an unmatched seller is the expected gain from matching plus the value of their outside option. Equation (9) says that the value to sellers from being matched is the payment from the buyer less the costs incurred for producing quality q and the expected loss from match destruction. Solving Equation (9) for E and substituting back into Equation (8), we arrive at an equilibrium expression for U:

$$rU = \frac{(r + s)b + \theta Q(\theta)[w(q, \theta) - C(q)]}{r + s + \theta Q(\theta)} \tag{10}$$

Equation (10) shows that sellers' value when unmatched is function of the contract price and market tightness. In equilibrium, sellers will enter the market, causing prices and market tightness to adjust until sellers have maximized their value to being unmatched. Equation (10) implicitly assumes that sellers employ a reservation payment strategy. It must be the case that the gain from search for sellers must be at least as good as not searching at all, $E \geq U$. Therefore the minimum contract payment that a seller will need to enter the market is:

$$w_R \equiv rU \tag{11}$$

Sellers' reservation payments depend on their outside option, the cost of producing q, the probability of matching, the discount rate, and the exogenous match destruction rate. Reservation payments increase with higher outside options and increasing market tightness.

Buyers' problem. We can also write analogous value functions for buyers in their unmatched and matched states:

$$rV = -k + Q(\theta)[J - V] \tag{12}$$

$$rJ = R(q) - w(q, \theta) - s[J - V] \tag{13}$$

where V and J are the flow Bellman equations for buyers in the unmatched and matched states, respectively. Equation (12) says that the value received by an unmatched buyer is the expected gain from matching less the cost of posting an available contract. Equation (13) says that the value of being matched for a buyer is equal to the gain from trade (revenue less payment to the seller) less the expected loss from match destruction. Assuming free entry of buyers into the market, in equilibrium buyers will have $V = 0$. Substituting this expression back into Equations (12) and (13), we arrive at the equilibrium contract creation condition:

$$J = \frac{k}{Q(\theta)} = \frac{R(q) - w(q, \theta)}{r + s} \tag{14}$$

Rewriting Equation (14) as $rk = Q(\theta)[R(q) - w(q, \theta)] - sk$ shows that in equilibrium, the expected gains from trade (right hand side of the expression) equals to the discounted cost of posting an open contract (left hand side of the expression). The choice of q and θ uniquely determines the equilibrium contract payment $w(q, \theta)$ for the submarket.

Equilibrium. In equilibrium, buyers post prices that optimize their expected gain from creating a contract opening subject to sellers' expected gain from searching in the market. Enough buyers enter the market and post contracts until buyers' expected gain from matching with a seller equals the cost of announcing an opening. To arrive at equilibrium, the market tightness adjusts until the correct proportion of buyers and sellers are in the market to optimize the balance between the congestion and thick market externalities.

Equilibrium is determined by the following set of equations:

$$w(q, \theta) = \arg \max_{w(q,\theta)} J \tag{15}$$

$$rU = \max_q \frac{(r+s)b + \theta Q(\theta)[w(q,\theta) - C(q)]}{r+s+\theta Q(\theta)} \tag{16}$$

$$J = \frac{k}{Q(\theta)} = \frac{R(q) - w(q,\theta)}{r+s} \tag{17}$$

$$u = \frac{s}{s+\theta Q(\theta)} \tag{18}$$

Buyers choose a contract payment $w(q, \theta)$ that optimizes their expected gain to being matched (Equation 15). Sellers choose a quality level q that optimizes their expected gain to being unmatched (Equation 16). Equilibrium is reached when enough buyers have entered the market such that all buyers earn no gains when unmatched (Equation 17) and the total number of unmatched sellers is stable over time (Equation 18).

This problem has a unique solution, and can be reformulated using the dual form:

$$\arg\max_{q,\theta} rU = \frac{(r+s)b + \theta Q(\theta)[w(q,\theta) - C(q)]}{r+s+\theta Q(\theta)} \tag{19}$$

$$\frac{k}{Q(\theta)} = \frac{R(q) - w(q,\theta)}{r+s} \tag{20}$$

$$u = \frac{s}{s+\theta Q(\theta)} \tag{21}$$

Substituting Equation (20) into Equation (19), the objective function can be simplified to:

$$\arg\max_{q,\theta} rU = \frac{(r+s)b + \theta Q(\theta)[R(q) - C(q) - \frac{k(r+s)}{Q(\theta)}]}{r+s+\theta Q(\theta)} \tag{22}$$

Applying the first order conditions with respect to θ, we see that:

$$\frac{[1-\eta(\theta^*)]}{r+s+\theta^* Q(\theta^*)}[R(q) - C(q) - b + k\theta^*] = \frac{k}{Q(\theta^*)} \tag{23}$$

where $\eta(\theta) = \frac{-\theta Q'(\theta)}{Q(\theta))}$ is the elasticity of the matching function.[7] Equation (23) says that the optimal market tightness, θ^*, equates the discounted expected gain from trade (left hand side) to

[7] From Equation (1), $\eta(\theta) = \gamma$ for a Cobb-Douglas matching function with constant returns to scale.

the discounted cost of opening a contract. Applying the first order conditions with respect to q, we see that:

$$\frac{\theta Q(\theta)[R'(q^*) - C'(q^*)]}{r + s + \theta Q(\theta)} = 0 \tag{24}$$

From Equation (24) optimal quality q^* satisfies $R'(q^*) = C'(q^*)$. Search frictions do not distort seller's effort and the quality traded is efficient. Moreover, this equilibrium outcome is socially efficient. Because of the posted offer mechanism, buyers can post contract offers that internalize the search externalities present in the market and incentivize first-best effort from sellers.

Trade is feasible provided there is enough surplus generated at q^* such that:

$$R(q^*) - C(q^*) \geq \arg\max_{q,\theta} rU \tag{25}$$

Substituting Equation (23) into the expression for the optimized value of rU:

$$R(q^*) - C(q^*) \geq b + [\frac{\eta(\theta^*)}{1 - \eta(\theta^*)}]k\theta^* \tag{26}$$

Equation (26) says that trade will occur provided that enough surplus is generated at first-best quality to cover the seller's outside option, b, and the expected cost of search. The optimal posted offer contract is therefore:

$$w(q,\theta) = \begin{cases} C(q^*) + b + [\frac{\eta(\theta^*)}{1-\eta(\theta^*)}]k\theta^* & \text{if } q \geq q^* \\ 0 & \text{otherwise} \end{cases} \tag{27}$$

3.3 Imperfect Contract Enforcement

Now we introduce imperfect contract into the search environment from the previous section. The novel contribution of this model is that we allow for two active submarkets, one with perfect contract enforcement and one with imperfect contract enforcement.

Steady-state relationship between unmatched buyers and sellers. To best illustrate the key effects of imperfect contract enforcement and search frictions on market outcomes, we begin with the case of homogenous sellers, $b_L = b_H = b$. Buyers, however, are no longer a homogeneous population. We will have two submarkets: one for buyers who pay a cost κ to announce they will always behave as if contracts are perfectly enforced, and one for all other buyers. Sellers will choose which type of submarket to enter and therefore which type of buyer to trade with.

Let $\theta_g = \frac{v_g}{u}$ be the market tightness in the submarket where buyers behave as if contracts are perfectly enforced, and $\theta_m = \frac{v_m}{u}$ be the market tightness for the submarket where contracts are imperfectly enforced. However, the adjustment process across submarkets is no longer independent, and changes in market tightness in one submarket impact the other submarket through the common factor u.

As before, we define a steady-state equilibrium where the net change in unmatched sellers over time is zero:

$$\dot{u} = se_g - \theta_g Q(\theta_g)u \equiv 0 \tag{28}$$

$$\dot{u} = (1 - \alpha + \alpha s)e_m - \theta_m Q(\theta_m)u \equiv 0 \tag{29}$$

where e_g and e_m are the number of matched sellers in the perfect enforcement and imperfect enforcement submarkets, respectively. Equation (28) is the same as Equation (6) with e_g replacing $(1-u)$. Equation (29) reflects the two sources of match termination. With probability $1-\alpha$, buyers do not provide any ex-post compensation and matches break up endogenously with probability 1. With probability α, buyers provide ex-post compensation as promised but matches still break up with exogenous probability s. We also need an additional equation to relate e_g, e_m, and u:

$$e_g + e_m + u = L \equiv 1 \tag{30}$$

Equation (30) says that the total population of sellers, L, is one of three possible states: unmatched, or matched in either submarket. Combining Equations (28), (29), and (30), we can write the equation for the measure of unmatched sellers as:

$$u = \frac{s(1 - \alpha + \alpha s)L}{s(1 - \alpha + \alpha s) + (1 - \alpha + \alpha s)\theta_g Q(\theta_g) + s\theta_m Q(\theta_m)} \tag{31}$$

Now the equilibrium level of unmatched sellers is determined by what happens in each submarket simultaneously. The total population of sellers does not impact how sellers trade-off between being unmatched and matched in either market; it only alters the levels for matched and unmatched sellers.

Sellers' problem. We can write value functions for sellers' in their unmatched and matched states as:

$$rU_i = b + \theta_i Q(\theta_i)[E_i - U_i] \qquad \forall \quad i \in \{g, m\} \tag{32}$$

$$rE_g = w(q,\theta_g) - C(q) - s[E_g - U_g] \tag{33}$$
$$rE_m = \alpha w(q,\theta_m) - C(q) - (1-\alpha+\alpha s)[E_m - U_m] \tag{34}$$

For the g submarket, value functions for the matched and unmatched states are unchanged from the previous section. For the m submarket, the only change is to the value function for the matched state. Imperfect contract enforcement impacts the expected payment, $\alpha w(q,\theta_m)$, and the probability of match destruction, $1-\alpha+\alpha s$. As in the previous sections, we substitute for E_i in each equation and arrive at expressions for the value of being unmatched in each submarket:

$$rU_g = \frac{(r+s)b + \theta_g Q(\theta_g)[w(q,\theta_g) - C(q)]}{r+s+\theta_g Q(\theta_g)} \tag{35}$$

$$rU_m = \frac{(r+1-\alpha+\alpha s)b + \theta_m Q(\theta_m)[\alpha w(q,\theta_m) - C(q)]}{r+1-\alpha+\alpha s+\theta_m Q(\theta_m)} \tag{36}$$

In equilibrium, sellers must be indifferent between being unmatched in either submarket. Therefore, $U_g = U_m = U$.

Buyers' problem. We write the analogous value functions for buyers in their unmatched and matched states in each submarket:

$$rV_i = -k + Q(\theta_i)[J_i - V_i] \qquad \forall \quad i \in \{g,m\} \tag{37}$$

$$rJ_g = R_g(q) - w(q,\theta_g) - s[J_g - V_g] \tag{38}$$
$$rJ_m = R_m(q) - \alpha w(q,\theta_m) - (1-\alpha+\alpha s)[J_m - V_m] \tag{39}$$

Just as in the sellers' problem, the value functions for buyers in the g submarket are unchanged from the equivalent value functions under perfect contract enforcement. In the m submarket, however, buyers' value to being matched differs for the expected revenue, expected payment to the agent, and probability of match termination. Combining all four equations, we can write expressions unmatched buyers in each submarket as:

$$rV_g = \frac{-(r+s)k + Q(\theta_g)[R_g(q) - w(q,\theta_g)]}{r+s+Q(\theta_g)} \tag{40}$$

$$rV_m = \frac{-(r+1-\alpha+\alpha s)k + Q(\theta_m)[R_m(q) - \alpha w(q,\theta_m)]}{r+1-\alpha+\alpha s + Q(\theta_m)} \tag{41}$$

Free entry will drive the equilibrium value of being unmatched in the m submarket to 0. Because of the fixed cost, however, the value of being unmatched in the g submarket is driven down to κ in equilibrium.

Equilibrium. In equilibrium, the subset of submarkets with active trading satisfy two conditions (Mortensen and Wright, 2002). First, each active submarket is open in the sense that it is the preferred submarket of at least one buyer-seller pair. Second, the set of active submarkets is complete in that no other potentially active submarket would be preferred by any matched pair.

To be a competitive equilibrium, the price function must be tangent to the utility functions for both buyers and sellers. So we can solve for the price function that equates the marginal rates of substitution for both buyers and sellers in each submarket.

Proposition 1. In equilibrium, sellers produce first best quality in each submarket. The relationship between market tightness in each submarket is:

$$\frac{(\theta_m^*)^2}{(\theta_g^*)^2} = \frac{\kappa}{k} + 1 \tag{42}$$

and the optimal posted offer contract for each submarket is:

$$w(q_g,\theta_g) = \begin{cases} C(q_g^*) + b + [\frac{\theta_g^* \eta(\theta_g^*)}{1-\eta(\theta_g^*)}](\kappa + k)\theta_g^* & \text{if } q_g \geq q^* \\ 0 & \text{otherwise} \end{cases} \tag{43}$$

$$w(q_m,\theta_m) = \begin{cases} \frac{1}{\alpha}\{C(q_m^*) + b + [\frac{\theta_m^* \eta(\theta_m^*)}{1-\eta(\theta_m^*)}]k\theta_m^*\} & \text{if } q_m \geq q^* \\ 0 & \text{otherwise} \end{cases} \tag{44}$$

Derivations for all equations in Proposition 1 are included in the Appendix.

Imperfect contract enforcement in this setting does not result in inefficient allocations along the intensive production margin. It only impacts the extensive margin of trade in a similar manner to Shapiro and Stiglitz's efficiency wage model (1984). Posted contract prices are higher in the m submarket than in the g submarket in order to incentivize sellers to search for buyers in the m submarket and produce higher quality $q_m^* > q_g^*$. Optimal quality is higher in the m submarket because buyers in this submarket have greater revenues from trade than in submarket g. However, the expected gains from search are the same in either market.

For a Cobb-Douglas matching technology, the ratio of the ratio of θ_m^* to θ_g^* depends only on κ and k. For positive values of κ, we see that equilibrium requires $\theta_m^* > \theta_g^*$. The submarket where buyers behave as if contracts are perfectly enforced is less tight than the submarket where buyers can default on their posted contract offers. Intuitively, sellers prefer the g submarket, leaving fewer available to search in the m submarket.

Comparative Statics. Table (1) summarizes the comparative static predictions. From Equation (44), it is readily apparent that $\frac{dw_m}{d\alpha} < 0$. As buyers in the m submarket deviate from posted prices more frequently, they must offer higher contract prices to induce sellers to contract in that market. Equation (44) also shows that $\frac{dw_m}{d\theta_m^*} > 0$. So as contract enforcement gets worse in the m market, posted prices increase and market tightness both increase in that submarket. Sellers then have a better likelihood of matching with buyers in the m submarket, although buyers are less likely to honor their contract commitments.

From Equation (42), we know that the ratio of $\frac{\theta_m^*}{\theta_g^*}$ is fixed by k and κ, and therefore invariant to changes in α. Any changes in θ_m^* are exactly offset by changes in θ_g^*. From Equation (43), we know that $\frac{dw_g}{d\theta_g^*} > 0$. Therefore, a decrease in α increases market tightness and posted contract prices in the g submarket too. Worsening contract enforcement in the m submarket makes buyers in submarket m raise their posted offers, making the g submarket less attractive to sellers, and forcing buyers in g submarket to also raise their prices.

3.4 Comparison of Perfect and Imperfect Contract Enforcement Models

Table (2) summarizes how the equilibrium predictions differ between the perfect and imperfect contract enforcement settings. Both settings predict that the equilibrium quality, q, should be the first best outcome. With risk neutral buyers and sellers, there are no effects of imperfect contract enforcement on the intensive margin, and payments and match probabilities absorb all the impacts on the extensive margin of trade.

The probability that a seller will match with a good type buyer, θ_g^*, is strictly lower under imperfect enforcement then under perfect enforcement. If we fix the total number of unmatched sellers to be at the same level under perfect and imperfect contract enforcement and set Equations (7) and (31) equal to each other, we can see that θ^*, θ_g^*, and θ_m^* have a simple relationship:

$$\theta^* Q(\theta^*) = \theta_g^* Q(\theta_g^*) + (\frac{s}{1-\alpha+\alpha s})\theta_m^* Q(\theta_m^*) \tag{45}$$

For $0 < \alpha < 1$, the fraction $\frac{s}{1-\alpha+\alpha s}$ falls strictly between s and 1. Therefore $\theta_g^* < \theta^*$. However, the relationship between θ_m^* and θ^* depends model parameters.

We know from Equation (67) that $\theta_g^* < \theta_m^*$. κ is the critical factor that generates different market tightness in each submarket. If both markets had free entry, the ratio of $\frac{\theta_m^*}{\theta_g^*}$ would be 1 and agents would have the same probability of matching in either submarket. In this environment, imperfect contract enforcement by itself does not alter the probability of making a match in either submarket. Instead, imperfect contract enforcement creates the possibility for buyers and sellers to value perfect contract enforcement, which manifests as different match probabilities and contract prices across the two submarkets.

Posted offers from the mixed type are always greater than posted offers for the good type for $0 < \alpha < 1$. Because the relationship between θ_m^* and θ^* depends model parameters is indeterminant, however, we also cannot say whether posted offers from the good type buyer will be higher or lower under imperfect enforcement compared to under perfect contract enforcement. With imperfect contract enforcement, posted offers internalize the cost of declaring buyer type, κ, which is not paid by buyers or sellers when contracts are perfectly enforced. Higher values of κ increase the wedge between θ_g^* and θ_m^*, which acts to offset the increase in posted offers relative to the perfect enforcement case.

4 Data

4.1 Survey design

We surveyed two hundred and forty households in Kirinyaga County, Kenya between September-October 2013. Households were sampled as matched pairs in a case-control design. Each pair consists of one randomly selected farmer who was currently contracted to produce French beans (case), and a matching farmer without a contract (control) who was purposefully selected as the geographically closest neighboring farmer without a contract. Details about the sampling design and matching procedures are provided in Rosch and Ortega (2014).

The survey collected data on household characteristics, food security, social capital, farm assets, production and marketing decisions, French bean market characteristics, and contracting experience. As part of the survey, we administered a choice experiment to each farmer to measure their preferences over different contract enforcement regimes. The choice experiment measured farmers' preferences for producing low or high quality French beans, which captures information about the production cost functions, and their preferences for contracting with more and less reliable buyers, which measures their willingness to contract under different exogenous contract enforcement scenarios.

Our sampling design was based on farmers with contracts on register with the Kenyan French bean regulatory authorities. As such, we observed some sampling variation between contract status and actual production of French beans at the time of the survey. Table (3) shows the current production status for farmers with and without contracts. Three of the contracted farmers were no longer producing French beans at the time of the survey. The rest were all actively producing beans. Seven of the non-contracted farmers were producing French beans, either in expectation of signing a contract or to supply the local market. Of the remaining farmers in the non-contracted group, approximately one-third had never grown French beans and the remaining two-thirds had exited the market. 1/3 of the contracted farmers surveyed supplied the processed export market; the remaining 2/3 of surveyed farmers supplied the fresh export market.

We also observed some sampling variation between contract status and receipt of contract offers. All currently contract farmers received at least one offer, and 17 farmers received multiple contract offers. Of the 118 farmers without contracts, 18 farmers (15% of the sample) received at an offer to contract from at least one buyer and 2 received multiple contract offers. 17 of the 18 farmers had previously grown French beans.

4.2 Data structure and key variables

Because we sample pairs of farmers, we have both information unique to each farmer, and information that is unique to each pair of farmers. At the level of individual farmers, the key variables of interest are distance to market, a dummy variable if they received a contract offer, price offered, reservation payment, outside option, and perception of probability of buyer default (α). At the level of individual pairs, the key variables of interest are the local densities of buyers, sellers, and filled contracts; local average prices; and local average perception of buyer default ($\overline{\alpha}$).

Data from individual farmers. Distance to market is measured as the average distance to market for all plots farmed. We include three measurements of price offered: contracted price offered, and minimum and maximum bids received from alternative buyers. We impute measures for the reservation payment, outside option, and α using the choice experiment results.

The choice experiment presented each farmer with a series of decisions between hypothetical contracts. Every farmer was presented with a series of choice scenarios, each involving two hypothetical contracts and a third, no-choice option. We calibrated the hypothetical contracts to mimic the full set of contracts used in the market. This allowed us to isolate the effect of differences in preferences on contract status separately from the effect of actual contracts offered. Contracts in the experiment included three attributes: contract price, required quality, and type of buyer proposing the contract.

We used the panel of choices made by each farmer to estimate individual specific willingness to supply or accept a contract (WTA).[8] The willingness to supply metric represents the minimal payment that the farmer requires in order to supply French beans under contract, w_R, given different contract attributes. We can also impute a value for the farmer's outside option to contracting, b, because each choice set included the possibility of picking no contract.

To calculate a farmer's specific reservation payment for the bundle of attributes embodied by a contract, we aggregate the individual specific WTAs for quality and partner type.[9] The bundle then captures the production costs of growing French beans as well as the marketing risks associated with a given buyer type. Then we compare these measures across matched pairs of farmers with and without contracts. Differences in reservation payments across pairs will then reflect differences in how they perceive the market, including differences in search frictions.

To form an individual-specific index of buyer reliability to proxy for α, we construct ratios of WTA for different buyer types. The choice experiment included four categories of buyers: a complete stranger, a perfect trading partner, the farmers' current trading partner, and the most reliable partner a farmer had ever traded with. A perfect partner type was defined to be a buyer who would never renegotiate or defect on the specified contract. This type corresponded to a state of exogenous perfect contract enforcement. The complete stranger was defined to be a buyer with no personal connection to the farmer and no additional information about the buyer's expected default rate. This type corresponded to exogenous imperfect contract enforcement with no relationship history to allow for relational contracting.

The current trading partner was defined as the buyer with whom the farmer was currently trading.[10] This type corresponded to a state of exogenous imperfect contract enforcement with some history that could allow for relational contracting. The most reliable partner type was defined as most reliable of all the buyers that the farmer has personally traded with at any point in time. This type corresponded to exogenous imperfect contract enforcement with relational contracting with a buyer who employs the most cooperative trading strategy available. These last two types capture regimes were relational contracting could be taking place, with potentially stronger levels of endogenous contract enforcement under the most reliable partner type than the current trading partner type.

We calculate WTA using complete stranger as the base case. Therefore WTA for a perfect partner represents how much lower a payment a farmer requires to contract with a perfect partner then they would charge for a complete stranger. Therefore the ratio of WTA for current partner to perfect

[8] A complete description of the estimation procedures is available in Rosch and Ortega (2014).

[9] WTA for a bundle of attributes is the sum of the individual effects for each attribute plus any interaction effects between attributes. Our choice experiment design allowed for interaction effects, but these interactions were not statistically significant. Results are available from the authors upon request.

[10] For contracted farmers, this was the buyer with whom they have a current contract. For non-contracted farmers, this was a buyer to whom they regularly sold their farm output.

partner measures how much the farmer values their current partner on the scale from complete stranger to perfect partner. A current partner that behaves exactly like a perfect partner would have a ratio of 1. A current partner that behaves exactly like a completely stranger would have a ratio of 0. These ratios for the current partner and most reliable partner form an index of buyer reliability, δ, which we then use to proxy for α.

Data from individual pairs of farmers. We recorded GPS coordinates for each farmer surveyed. Figure (7) shows the locations of all sampled farmers with contracts and the corresponding buyer with whom they transact. The maps shows that farmers tend to be clustered, which reflects the underlying dispersion of irrigation projects within the county. The map also shows that some clusters have a greater variety of buyers actively contracting in their local area. We exploit this variation in cluster and buyer densities across Kirinyaga County in order to identify the relationship between available contracts and farmers seeking contracts.

For each contracted farmer in our sample, we count the number of sampled pairs and unique buyers active within the surrounding 5km radius. We use the number of sampled pairs to proxy for the total number of contracted pairs in the market. As our survey was designed to be representative of all contracted farmers in Kirinyaga, this measure should provide an unbiased estimate of the total number of local matches in each part of the county. We use the number of unique buyers to proxy the number of contracts available in the local neighborhood of each farmer.

We use the distance between the paired contracted and nearest non-contracted farmers as a proxy for the total number of farmers seeking contracts. Greater distances between pairs should correspond to a larger number of available farmers in the local area.[11] Figure (4) shows the distribution of distances between surveyed pairs. Distances were calculated based on the GPS coordinates where each farmer was interviewed.[12] The median distance between pairs was 1.09 km.

Figure (7) plots the measure of buyer versus seller density for each contracted farmer sampled, along with a polynomial fit line. The figure shows the expected downward sloping relationship, analogous to the Beveridge Curve relationship between job vacancies and unemployment rates for labor markets.

We calculate the local average price and $\overline{\delta}$ using the individual prices and δ reported by the contracted farmers within the surrounding 5km radius. Again, because we are only using results from the randomly selected member of each pair and not both members, the spatial averages should provide unbiased estimates of the true values for the population of contracted farmers.

[11] We have no information available for the amount or spatial distribution of uncultivated land in Kiringaya County. During the course of the survey, however, we did not observe any uncultivated land bordering the households or plots of the surveyed farmers.

[12] The majority of farmers were interviewed in their homes or in fields closely adjacent to their homes. Some farmers were not available for interviews at home, but were willing to be interviewed in more remote locations (market centers, fields located far from their home, etc). This accounts for the observations with pair differences over 10km apart.

4.3 Characteristics of farmers with and without contracts

Table (4) shows how farmers with and without contracts differ in terms of their household and farm characteristics, while Table (5) summarizes how they differ in their French bean marketing experiences and Table (6) summarizes how they differ in their search for buyers. We report statistics separately for the farmers without contracts who received no contract offers and the farmers without contracts who received at least one offer.

Household and farm characteristics. Farmers who received at least one offer have household and farm characteristics that are very similar to the farmers with contracts. These two groups significantly differ only in terms of French bean experience, French bean trainings, and French bean acreage. In contrast, the population of farmers who do not receive any contract offers differ from the population of contracted farmers in many dimensions. On average, farmers who receive no contract offers are more likely to be female, less educated, have less training and experience growing French beans, have fewer members in their household, earn less income, farm fewer acres, plant fewer acres of French beans, produce fewer types of crops, and are less likely to have irrigation than farmers with contracts. In Rosch and Ortega (2014), we show that these factors do not to influence farmers' preferences over contracting. While they may not influence farmers' *ability* to supply under contract, they may be influencing farmers' *opportunity* to contract.

French bean marketing. Looking at the results in Table (5), we see that farmers who received no contract offers also perceive the French bean market differently from the population of farmers with contracts. On average, these farmers know of fewer French bean buyers, receive fewer offers, and consequently receive significantly lower market prices than farmers with current contracts. Even though these groups are located equidistant from their closest local market, and the farmers without contracts are located 0.4 km closer to roads, these groups perceive the French bean market very differently.

Farmers without contracts who received at least one contract offer, however, are very similar to the farmers with current contracts. On average, the farmers with current contracts sell to slightly more buyers than the farmers who rejected all offers. Interestingly, farmers with contracts also receive maximum price offers of 12 Kenyan shillings (Ksh) per kg more than the farmers who rejected all offers. 12 Ksh/kg represents a 40% premium over the floor price contract offered for in processed bean market. It is possible that these rejections were solely for processing market contracts and that we did not observe rejections of any fresh market contracts, however this conjecture cannot be explored with our existing dataset.

On average, the farmers who receive contract offers (regardless of their current contract status) know more French bean buyers and receive more offers than farmers who do not receive any offers. They receive offers from roughly half of their known buyers and half of those offers were for written contracts. The farmers who receive no offers know two fewer French bean buyers on average and perceive market prices close to 0 Ksh/kg, even though most of these farmers have previously produced French beans.

Farmers with current contracts sell to a larger set of buyers on average than just the set of buyers who proposed written contracts. This indicates that there is some side-selling behavior occurring in the market. Farmers without contracts who receive no contract offers also sell to slightly more buyers than offer them contracts. This suggests that there is some production occurring outside of contracts, but this appears to be a small share of the market.

The average minimum price for the with contract group is 33.7 Ksh/kg, which is just above the standard price offered for contracts for processed beans (30 Ksh/kg). The average maximum price for the with contract group is 56.8 Ksh/kg, which is just slightly more than the average contract price listed for all contracts in our sampling frame.

Search behavior. Looking at the results in Table (6), we see that relatively few farmers actively search for new buyers. 40% of farmers with contracts searched for a buyer in 2013, compared to roughly 10-15% of farmers without contracts. On average, farmers without contracts also devote 6 hours less and spend half as much on buyer search than farmers with contracts, although their unit costs of search seem to be roughly equivalent.

Overall, these facts suggest that how buyers select the farmers to whom they offer contracts is a key factor for farmers' observed contract status. Buyers seem to be targeting male farmers, with more education, larger size farms, and with access to irrigation. Most non-contracted farmers are aware of multiple buyers, but still receive no contract offers or bids of any kind. Few farmers end up rejecting all contract offers, and few farmers report side-selling outside of their contract. Farmers who receive offers, whether accepted or rejected, devote significantly more time and money to searching for French bean buyers. This evidence is consistent with a story of search frictions complicating the buyer-farmer matching dynamic and potentially acting as a barrier to market in this setting.

4.4 Choice experiment variables for farmers with and without contracts

Table (7) shows the average willingness to accept (WTA) values from the choice experiment. Quality has a negative effect on willingness to contract, which is consistent with our expectations that it measures farmer's costs of producing French beans. Partner attributes all have positive coefficients, that increase from current trading partner, to most reliable partner, to perfect partner.[13] A negative outside option indicates that farmers' best alternatives to contracting as not as profitable as the

[13] Base case is a perfect stranger.

contracts in the choice experiment, on average.

As shown in column (1) - (2), there are no significant differences for any WTA between farmers with contracts and farmers who received at least one contract offer. Farmers who received no offers, however, have significantly higher WTAs for current partner and perfect partner than farmers with contracts. This means that the farmers who received no offers would need higher contract prices to compensate for partner risk than farmers currently under contract, even if the contracts were perfectly enforced.

Buyer reliability, α, as measured using the ratio of CTP to PP, is at roughly 60%, with no significant differences between farmers with and without contracts. α measured using the most reliable partner, however, is somewhere between 70% - 100%. Additionally, farmers with current contracts perceive buyer reliability to be roughly 25-30% higher than farmers without contracts. Because the bulk of our surveyed farmers without contracts had some prior experience with French bean contracting, these estimates are consistent with the idea that farmers who end up exiting the market tend to encounter less reliable buyers on average.

5 Results

5.1 Are search frictions present in this market?

Matching function. We estimate a matching function:

$$M_i(v_i^*, u_i^*) = f(v_i^*, u_i^*) + \overline{\delta}_i + \epsilon_i \tag{46}$$

where i is the sampled farmer, v^* is the equilibrium number of contract vacancies, u^* is the number of farmers seeking a contract, $M(v^*, u^*)$ is the total number of contracted farmers or filled vacancies, $f(v, u)$ is a production function that transforms farmers and vacancies into filled contracts, and $\overline{\delta}_i$ is the average value of the buyer reliability index δ for all contracted farmers within a 5 kilometer radius around farmer i.[14] Following the literature, we estimate Cobb-Douglas and translog functional forms for the matching function. Results are shown in Table (8).

Both the Cobb-Douglas and translog specifications show positive effects for buyer density and pair distance on the number of local contracts created. Buyer density is statistically significant in both specifications. Pair distance is not statistically significant in either model, but as shown in Table (8) regression 5, this is due to the opposing first and second order effects of farmer density on the

[14] Equation (46) takes a "black box" approach to the matching function (Petrongolo and Pissarides, 2001), meaning that we do not model the effect of each type of friction individually but only look for aggregate relationships between available buyers, sellers, and the total number of contracts in the market.

likelihood of forming contracts. Both proxies for α are statistically significant individually, have consistent magnitudes across model specifications, and show positive effects on match formation which agree with model predictions.

Without accounting for α, both Cobb-Douglas and translog specifications show diminishing returns to scale overall. After accounting for partner reliability, the Cobb-Douglas specification still displays diminishing returns to scale although they are much less severe. The translog specification shows increasing returns to scale for the proxy based on the MTRP, and constant returns to scale for the proxy based on CTP. The existence and uniqueness of equilibrium in our search model is predicated on having a CRS matching technology. Diminishing returns to scale would suggest that the negative affects of the congestion externality outweigh the positive thick market externality at increasing levels of buyers and sellers in the market. Increasing returns to scale would suggest the opposite case, and generally leads to multiple possible equilibrium (Diamond, 1982).

Overall, these results suggest that search frictions are present in the market, that the frictions are more limiting for farmers searching for available buyers than vice versa, and that match formation is impacted by buyer reliability. Increasing the number of available farmers is likely to have a negligible effect on the aggregate number of contracted farmers in the market. In areas where buyers behave as though contracts are better enforced (values of δ closer to 1), we see increased match formation which is consistent with the predictions of the theoretical model.

Given that we are treating the degree of buyer reliability as an exogenous force, we cannot speak definitively about what is causing the variation in buyer reliability that we observe across the county. Although all farmers in the area have the same *de jure* access to legal institutions, property rights, credits sources, etc., their *de facto* access may be different across the population. Furthermore, our survey only included farmers and not buyers. Variations in buyers' access to legal institutions will impact their contracting behavior, which could be perceived by sellers as better exogenous contract enforcement.

All estimates of the matching function show no effect on match probability from increasing seller density in the market. Assuming that this is a true feature of this market and not an artifact of low sample size or measurement error, then search frictions are independent of the level of sellers available in the market. This implies that there is no thick market externality for buyers from inducing more sellers to enter the market, and thus no need to split the gains from trade with sellers. Our model assumes that sellers are a scare resource and therefore that buyers must compensate sellers for search costs in equilibrium. The empirical findings suggest that buyers should be treated as the scare resource, which would have very different implications for model closure and division of gains from trade in equilibrium.

Market Prices. We estimate the effect of search frictions on local market prices:

$$\overline{w_i}(v_i^*, u_i^*, \overline{\delta_i}) = f(v_i^*, u_i^*) + \overline{\delta_i} + \epsilon_i \tag{47}$$

where $\overline{w_i}$ is the average contracted price of all contracted farmers within a 5km radius, $\overline{\delta_i}$ is the average of the proxy value for all contracted farmers within a 5km radius, and v_i^* and u_i^* are measured as before. We also examine the effects of search frictions on the average minimum and maximum bids received in the 12 month period prior to the survey. The results are shown in Table (9).

The densities of buyers and sellers both have positive and significant correlations with the average contract prices offered. Our theoretical model predicts positive effects on prices from increased numbers of buyers, but negative effects from increased sellers in the market. Average buyer reliability as measured by the CTP metric is not correlated with average contract prices, while reliability measured by the MRTP metric is strongly negatively correlated with average contract price.

Pair distance has a significant and negative effect on the local average minimum bid. As more sellers enter the market, the minimum prices offered decrease, which is consistent with the predictions of our theoretical model. Buyer density and reliability are not correlated with minimum prices, which is consistent with the notion that the overall floor to the market is determined by the prices in the submarket with perfect contract enforcement (processing submarket). Because the processing submarket in Kenya is composed of only one firm that offers the same price to all contracted farmers, we would not expect buyer density to have an effect on minimum prices in this particular setting.

These effects are reversed for average maximum bid in the market. Now pair distance is not significant, while buyer density and reliability both have significant negative effects on the maximum prices. This is inconsistent with the predictions of our theoretical model, which predicts that increasing the number of buyers available should increase equilibrium prices. However, increasing the reliability of buyers reduces the maximum prices that need to be offered by making the two submarkets more similar.

The effect we estimate of search frictions on aggregate contract prices is inconsistent with that predicted by our model. Contract prices are positively correlated with higher buyer density but also higher seller density. If seller density does impact match formation, then the positive correlation between contract prices and seller density would suggest that the thick market externality is dominating the congestion externality. In this case, we would expect to see sellers investing more in search since more matches would drive up the average prices offered. However, we observe very few instances of sellers outside of the market investing any time or money in searching for buyers.

On the other hand, if seller density does not impact match formation, then it would also not impact contract prices offered. In that case, the seller density metric could be simply capturing how sellers respond to market prices. Where buyers choose to offer higher contract prices, we would observe that more sellers accept the contracts on average. Likewise, when minimum offers are lower, fewer farmers opt to contract. This conjecture is more consistent with the empirical results, and reinforces the idea that our theoretical model should only incorporate one-sided search frictions.

Reservation payments. To proxy for the reservation payment, we use preferences measured through a choice experiment to calculate a reservation payment for which the farmer is indifferent between contracting and not contracting. Figure (7) shows the distribution of payments for our sampled farmers for different degrees of exogenous buyer reliability. These payments are measured relative to the reservation payment needed to accept a contract from a complete stranger. Of the farmers we sampled, the median farmer requires a 5 Ksh/kg higher reservation payment from his current trading partner, 2 Ksh/kg lower payment from his most reliable partner, and 11 Ksh/kg lower payment from a perfect partner than the minimum payment required to contract with a complete stranger. To put these figures in context, the minimum contract price we observed for the fresh submarket was 40 Ksh/kg. Given that all processed submarket contracts pay 30 Ksh/kg, 11 Ksh/kg represents 110% of the minimum price difference between the fresh and processed submarkets.

Using only information from farmers with contracts, we estimate the effect of search frictions on farmers' reservation payments:

$$w_{R,i}(q^*, v_i^*, u_i^*) = f(v_i^*, u_i^*) + b_i + k_i + \delta_i + \epsilon_i \tag{48}$$

We run these regressions using reservation payments computed assuming contracts were offered by their current buyer, their historically most reliable buyer, and a buyer who acts as though contracts were perfectly enforced. We use distance to market to proxy for search costs, k_i, and the value of the outside option as calculated in the choice experiment to account for b_i. The results are shown in Table (10).

Buyer reliability has a weakly negative effect on reservation payment in half of the regressions. As buyers become more reliable on average, farmers are willing to contract for lower promised payments. Outside options are positive and significant for the reservation payments from a perfect partner, but negative for payments from their current trading partner. When ex-post payments can differ from ex-ante promises, farmers with better alternatives to contracting are willing to contract at lower prices than farmers with less lucrative alternatives to contracting. This is a puzzling result which does not match with our theoretical predictions.

Individual prices. Using only information from farmers with contracts, we estimate the effect of search frictions on the actual prices offered to farmers:

$$w_i(q^*, v_i^*, u_i^*) = f(v_i^*, u_i^*) + b_i + k_i + \delta_i + \epsilon_i \tag{49}$$

We use three outcomes: contract prices offered, and minimum and maximum bids received. We assume that all farmers have the same bargaining power and expected productivity. The results are shown in Table (11). The outside option has a statistically significant and positive effect on all three measures of market prices. As farmers have more profitable alternative crops to pursue, buyers have to offer higher payments to induce the farmers to supply French beans. The magnitude of this effect is negligible, however. All coefficient estimates show an effect on contract prices that represent less than 1% of the price offered in the processed submarket in all regressions.

Distance to market has a significant positive relationship on the minimum and maximum bids received by farmers. This is consistent with Equation (27). The farther farmers have to travel to get to market, the greater the cost of searching for (or advertising) a vacancy, and the higher equilibrium payments needed to compensate for these costs. However, distance has no impact on contract prices offered. This result is inconsistent with Equation (27), but matches well with HCDA records showing that exporters consistently offer uniform contract prices across all their subcontracted farmers, regardless of where they are located within the county.

For farmer and buyer densities, we find significant effects only on the maximum bid received and the signs are opposite of those predicted in Equation (27). This parallels the findings for the average market prices. Again we see that decreasing market tightness, either through increasing the number of buyers or decreasing the number of sellers, decreases the maximum bids on average. Moreover, buyer reliability is only weakly significant for one of the regressions. This is a surprising result, since our model predicts buyer competition to drive up prices.

Our theoretical model is based on a highly simplified environment with homogeneous sellers and buyers within each submarket. However, we observe in the data that farmers are heterogeneous with regards to their outside options and search costs. We also observe price dispersion across buyers in the market. This dispersion of prices, outside options, and search costs may be impacting our estimates of the effect of search frictions on market and individual prices. Although we do not include heterogenous types of buyers or sellers in our model, price dispersion is one of the key aspects of Mortensen and Wright's framework, which our theoretical model is based on. In their framework, price dispersion stems directly from heterogeneous reservation values for buyers and sellers. Assuming these types of heterogeneities are perfectly observable to buyers and sellers[15],

[15] Guerrieri et al. (2010) offer a model of adverse selection in a frictional search model with perfect contract enforcement.

they could be easily incorporated into the existing theoretical model, and possibly improve our ability to predict the behaviors observed in the data.

5.2 Are search frictions a barrier to market?

To test if search frictions are a possible barrier to market, we analyze the differences in reservation payments between farmers with and without contracts. From Equations (11) and (10), a farmer's reservation payment should be determined by his outside option, his costs for producing French bean quality, and the effect from search frictions. If search frictions are a barrier to market, then matched pairs of farmers should have different values of w_R on average. We test:

$$H_0 : E[w_{R,i,C=1} - w_{R,i,C=0}] = 0 \tag{50}$$

$$H_A : E[w_{R,i,C=1} - w_{R,i,C=0}] \neq 0 \tag{51}$$

where i is the set of all sampled pairs, $C = 1$ is the contracted farmer in pair i, and $C = 0$ is the non-contracted farmer in pair i. The results are shown in Table (12).

On average, farmers with and without contracts do not have different reservation payments except when trading with their most reliable trading partner (column 1). When contracts are perfectly enforced and when trading with their current partners, farmers in and out of the market require the same minimum payments on average. Farmers with contracts require 10.6 Ksh/kg less on average than farmers without contracts to contract with their best ever partners, suggesting that the group with contracts has encountered a more cooperative set of buyers over time than the group without contracts. We see similar results if look at just the pairs where the matching farmer received no contract offers (column 3). If we consider only the pairs where the matching farmer also received at least one contract offer (column 2), we see no significant differences in reservation payments for any buyer type. These results suggest that if search frictions are acting as a barrier to market, it is not due to systematic differences in reservation payments.

Looking at the differences between the fresh and processed submarkets, however, we see systematic differences in preferences for farmers in and out of the market in both submarkets. When contracts are perfectly enforced in the fresh submarket, there are no average differences between farmers with contracts and farmers who have never entered the market (columns 4). When contracts are imperfectly enforced, however, farmers with contracts have significantly lower reservation payments than farmers who have never entered the market. We see the same pattern when comparing contracted farmers with those who have exited the market (column 6). When contracts are perfectly enforced, farmers in the market have higher reservation payments on average then those who exit the market, but lower average payments under both imperfect enforcement scenarios. These results suggest that if search frictions are a barrier to market, it is only a problem because of poor contract enforcement.

For the processed submarket, we see no average differences in reservation payments between contracted farmers and those who have never entered the market (column 5), and either no difference or lower average payments compared to farmers who have exited the market. This suggests that search frictions are not a barrier to entry for the processed submarket, but could potentially be a factor in farmers' exit decisions.

To isolate the effect of search frictions on market entry and exit decisions, we subtract individuals outside option from their reservation payment as in Equation (52). This allows us to factor out differences in outside options and measure the impact of search frictions on reservation payments.

$$Y_i \equiv w(R)_i - b_i = f(v_i, u_i) + \epsilon_i \tag{52}$$

If search frictions are a barrier to market, then matched pairs of farmers should have different values of Y on average. Recall that matches were selected as the nearest geographic neighbors of the opposite status. As nearest neighbors, we expect that they should experience the same degree of market tightness. Table (13) summarizes the results.

Although the aggregate results show no sign of search frictions (column 1), this is because the effects of search frictions are different for the fresh and processed markets. For the fresh market, we see that contracted farmers have significantly smaller premiums for search frictions than farmers who have never entered the market (column 4), but no difference for farmers who have exited the market (column 6). The size of the premiums increases as contract enforcement moves further away from perfect enforcement. These results reinforce the idea that search frictions are a potential barrier to entry for the fresh market, and that their effect is augmented by imperfect contract enforcement.

In the processed market, there are no differences in search frictions for the farmers in the market and the farmers who have never entered the market (column 5). However, farmers who have remained in the processed market have much higher search premiums than farmers who have exited the market (column 7). Search frictions do not seem to be a barrier to entering the processed market, but farmers who choose to remain in the processed market experience tighter markets than farmers who exit the market. These findings are consistent with a notion that the farmers who exit the processed market do so because their contracts are not renewed and are unable to locate alternate buyers to form new contracts.

To provide additional evidence that that these results are due to search frictions, we regress the average differences in Y across pairs against our proxies for average buyer reliability in the market. The correlation coefficients for the $\overline{\delta}$ terms are summarized in Table (14). Both measures of average buyer reliability are strongly correlated with Y under all contract enforcement regimes (column 1). Positive coefficients indicate that the difference between paired farmers is larger in areas where buyers are more reliable on average. A 1% increase in average buyer reliability is associated with a 7-8 Ksh/kg difference using the CTP metric, and a 3-4 Ksh/kg difference using the MRTP metric. We see systematic differences when the pair both receive contract offers (column 2), when only one farmer receives any contract offers (column 3), the pairs compare fresh market farmers with farmers who have never entered the market (column 4), and fresh market farmers compared with farmers who have exited the market (column 6).

These findings support the idea that search frictions are a barrier to market in the fresh submarket. For the processed submarket, however, we see no evidence of a systematic relationship between average buyer reliability and paired differences in Y (columns 5 and 7). This suggests that the average differences between processed market farmers and exited farmers are due to factors other than search frictions.

6 Policy Implications

Our results show that farmers who do not receive contract offers have the same average reservation payments under perfect contract enforcement as farmers with contracts (Table 12), suggesting that the two groups do not differ in their abilities to produce French beans. Our results also show that the farmers who do not receive contract offers have markedly different observable characteristics from contracted farmers, including less education, smaller size farms, and less access to irrigation (Table 4). This suggests that buyers are avoiding farmers that they perceive are unable to supply French beans, even when these perceptions do not reflect farmers' actual capabilities. Thus there may be an opportunity for policy to help farmers' overcome these misperceptions.

We also observe that farmers with and without contract offers do not differ in how they experience search frictions on average (Table 13) even though the farmers without offers know significantly fewer buyers (Table 5) and invest less time and money in search (Table 6). However, differences in search frictions across pairs are more pronounced in areas where buyers are more reliable on average (Table 14), indicating that search frictions are more likely to be a barrier to market in areas where contract enforcement is less of a barrier to market.

This suggests that there may be a trade-off for policymakers depending on whether they design an intervention to target contract enforcement or search frictions. Reducing search frictions by helping farmers connect with more buyers, may also bring them into contact with less reliable buyers on average, which presents its own barrier to market (Table 12). Improving contract enforcement, however, may not correct for problems of search frictions as we observe that average differences in search frictions persist for the fresh submarket even with our measure of perfect contract enforcement (Table 13). To effectively increase farmer participation in this market, development interventions may need to tackle both issues simultaneously.

The farmers with contracts invest more in search, know more buyers, and have encountered more reliable buyers on average. While we cannot tell from this analysis whether or not this additional search caused the farmers with contracts to have encountered more reliable buyers, a development intervention that makes it easier for farmers to find more reliable buyers will improve the incentives for farmers to enter and remain in this market over time. However, the intervention would also need to address buyers' misperceptions about farmer capabilities in order to maximize participation for disadvantaged producers.

7 Conclusions

We estimate the effect of search frictions on Kenyan farmers' decisions to supply French beans for export under contract. This paper has two main contributions. First, we build on the competitive wage models of Moen (1997) and Mortensen and Wright (2002) to include imperfect contract enforcement. Second, we employ two novel empirical methodologies to test our model using data from Kenya's French bean export industry. The first methodology measures search frictions based on the spatial density of firms and farmers in the market. The second uses preferences measured in a choice experiment to quantify the impact of search frictions on farmers entry and exit decisions under different contract enforcement scenarios. We find that search frictions are present in the market which primarily limits farmers' abilities to match with potential buyers but not vice versa. Examining the two component submarkets of the French bean export market, we find that search frictions are a potential barrier to entry for the fresh submarket and may be a factor in farmers' exit decision from the processed market. Lastly, we find search frictions are a potential barrier in areas where buyers are perceived as more reliable, suggesting a potential trade-off for policymakers depending on whether they design an intervention to target contract enforcement or search frictions. These findings are important for designing more effective programs to connect small-scale producers to French bean markets.

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Appendix

We derive the results for Proposition 1.

Submarket g

In the g submarket, the marginal rates of substitution for sellers and buyers are:

$$\frac{dw(q,\theta_g)}{d\theta_g} = \frac{\frac{\partial U_g}{\partial \theta_g}}{\frac{\partial U_g}{\partial w(q,\theta_g)}} = \frac{(r+s)[1-\eta(\theta_g)][w(q,\theta_g)-C(q)-b]}{\theta_g[r+s+\theta_g Q(\theta_g)]} \tag{53}$$

$$\frac{dw(q,\theta_g)}{d\theta_g} = \frac{\frac{\partial V_g}{\partial \theta_g}}{\frac{\partial V_g}{\partial w(q,\theta_g)}} = \frac{(r+s)\eta(\theta_g)[R_g(q)-w(q,\theta_g)+k]}{r+s+Q(\theta_g)} \tag{54}$$

Setting Equations (53) and (54) equal to each other and solving for $w(q,\theta_g)$, yields:

$$w(q,\theta_g) = \frac{[r+s+\theta_g Q(\theta_g)]\theta_g \eta(\theta_g)[R_g(q)+k] + [r+s+Q(\theta_g)][1-\eta(\theta_g)][C(q)+b]}{[r+s+\theta_g Q(\theta_g)]\theta_g \eta(\theta_g) + [r+s+Q(\theta_g)][1-\eta(\theta_g)]} \tag{55}$$

The payment function is a weighted average of the gain from trade for the buyer, $R_g(q)-(-k)$, and the seller, $C(q)+b$. Substituting Equation (55) into Equation (40) and imposing $rV_g = \kappa$, we find that equilibrium market tightness must satisfy:

$$\frac{(Z_g+Y_g)}{Q(\theta_g^*)}\{[r+s+Q(\theta_g^*)]\kappa + (r+s)k\} = Y_g[R_g(q)-C(q)-b] - Z_g k \tag{56}$$

where $Z_g = [r+s+\theta_g^* Q(\theta_g^*)]\theta_g^* \eta(\theta_g^*)$ and $Y_g = [r+s+Q(\theta_g^*)][1-\eta(\theta_g^*)]$. Equation (56) is analogous to the equation that defines θ^* under perfect contract enforcement, Equation (23). As before, the optimal market tightness equates the expected cost of posting a contract with the expected gain from trade.

To find the optimal q^*, we calculate $\frac{\partial U_g}{\partial q}$ and $\frac{\partial V_g}{\partial q}$ for sellers and buyers respectively:

$$\frac{\partial U_g}{\partial q} = \frac{\theta_g Q(\theta_g)[\frac{\partial w(q,\theta_g)}{\partial q} - C'(q)]}{[r+s+\theta_g Q(\theta_g)]} \tag{57}$$

$$\frac{\partial V_g}{\partial q} = \frac{Q(\theta_g)[R_g'(q) - \frac{\partial w(q,\theta_g)}{\partial q}]}{[r+s+Q(\theta_g)]} \tag{58}$$

For a competitive equilibrium where buyers and sellers are both optimizing utility, U_g and V_g must be as large as possible. Therefore Equations (57) and (58) must both equal zero. This occurs when $\frac{\partial w(q,\theta_g)}{\partial q} = C'(q)$ and $R'_g(q) = \frac{\partial w(q,\theta_g)}{\partial q}$. Therefore the equilibrium quality requires $R'_g(q^*) = C'(q^*)$. There are no distortions to contracting for first-best quality in the submarket where buyers behave as though contracts are perfectly enforced.

Submarket m

In the m submarket, the marginal rates of substitution for sellers and buyers are:

$$\frac{dw(q,\theta_m)}{d\theta_m} = \frac{\frac{\partial U_m}{\partial \theta_m}}{\frac{\partial U_m}{\partial w(q,\theta_m)}} = \frac{(r+1-\alpha+\alpha s)[1-\eta(\theta_m)][\alpha w(q,\theta_m) - C(q) - b]}{\alpha\theta_m[r+1-\alpha+\alpha s+\theta_m Q(\theta_m)]} \tag{59}$$

$$\frac{dw(q,\theta_m)}{d\theta_m} = \frac{\frac{\partial V_m}{\partial \theta_m}}{\frac{\partial V_g}{\partial w(q,\theta_m)}} = \frac{(r+1-\alpha+\alpha s)\eta(\theta_m)[R_m(q) - \alpha w(q,\theta_m) + k]}{\alpha[r+1-\alpha+\alpha s+Q(\theta_m)]} \tag{60}$$

Setting Equations (59) and (60) equal to each other and solving for $w(q,\theta_m)$, yields:

$$\alpha w(q,\theta_m) = \frac{[r+1-\alpha+\alpha s+\theta_m Q(\theta_m)]\theta_m\eta(\theta_m)[R_m(q)+k] + [r+1-\alpha+\alpha s+Q(\theta_m)][1-\eta(\theta_m)][C(q)+b]}{[r+1-\alpha+\alpha s+\theta_m Q(\theta_m)]\theta_m\eta(\theta_m) + [r+1-\alpha+\alpha s+Q(\theta_m)][1-\eta(\theta_m)]} \tag{61}$$

The payment equation for the m submarket differs from the payment equation for the g submarket only by replacing $R_m(q)$ for $R_g(q)$, and $1-\alpha+\alpha s$ for s. Substituting Equation (61) into Equation (41) and imposing $rV_m = 0$, we find that equilibrium market tightness must satisfy:

$$\frac{(r+1-\alpha+\alpha s)k}{Q(\theta_m^*)} + \frac{Z_m k}{Y_m} = \frac{Y_m}{Z_m+Y_m}[R_m(q) - C(q) - b] \tag{62}$$

where $Z_m = [r+1-\alpha+\alpha s+\theta_m^* Q(\theta_m^*)]\theta_m^*\eta(\theta_m^*)$ and $Y_m = [r+1-\alpha+\alpha s+Q(\theta_m^*)][1-\eta(\theta_m^*)]$.

To find the optimal q^*, we calculate $\frac{\partial U_m}{\partial q}$ and $\frac{\partial V_m}{\partial q}$ for sellers and buyers respectively:

$$\frac{\partial U_m}{\partial q} = \frac{\theta_m Q(\theta_m)[\alpha\frac{\partial w(q,\theta_m)}{\partial q} - C'(q)]}{[r+1-\alpha+\alpha s+\theta_m Q(\theta_m)]} \tag{63}$$

$$\frac{\partial V_m}{\partial q} = \frac{Q(\theta_m)[R'_m(q) - \alpha\frac{\partial w(q,\theta_m)}{\partial q}]}{[r+1-\alpha+\alpha s+Q(\theta_m)]} \tag{64}$$

Setting Equations (63) and (64) equal zero, we see that $\alpha\frac{\partial w(q,\theta_g)}{\partial q} = C'(q)$ and $R'_m(q) = \alpha\frac{\partial w(q,\theta_g)}{\partial q}$. Optimal quality in the m submarket also satisfies $R'_m(q^*) = C'(q^*)$. However, first-best quality levels are higher in submarket m than submarket g because $R'_m > R'_g$ for all q.

Linking the Submarkets

Substituting Equations (55) and (56) into Equation (35), and Equations (61) and (62) into Equation (36), we find expressions for rU_g and rU_m:

$$rU_g^* = b + \frac{\theta_g^* \eta(\theta_g^*)}{1-\eta(\theta_g^*)}(\kappa + k)\theta_g^* \tag{65}$$

$$rU_m^* = b + \frac{\theta_m^* \eta(\theta_m^*)}{1-\eta(\theta_m^*)}k\theta_m^* \tag{66}$$

Because $rU_g = rU_m = rU$ in equilibrium, we can set Equations (65) and (66) equal to each other and find a relationship between κ and k:

$$\kappa = k[\frac{(\theta_m^*)^2}{(\theta_g^*)^2} - 1] \tag{67}$$

Feasibility in each submarket requires:

$$R_g(q^*) - C(q^*) \geq b + [\frac{\theta_g^* \eta(\theta_g^*)}{1-\eta(\theta_g^*)}](\kappa + k)\theta_g^* \tag{68}$$

$$R_m(q^*) - C(q^*) \geq b + [\frac{\theta_m^* \eta(\theta_m^*)}{1-\eta(\theta_m^*)}]k\theta_m^* \tag{69}$$

In the g submarket, the gains from trade must cover the fixed costs of announcing seller type as well as the cost for posting a open contract. $\underline{q}$ for each submarket is therefore the value that makes Equations (68) and (69) bind with equality. If $q^* < \underline{q}$, the gains from trade are not sufficient to meet the sellers' reservation payment after accounting for search frictions. The optimal payment in each submarket follows directly from Equations (68) and (69).

Tables

Table 1: Comparative Static Predictions for Equilibrium Payments

	Submarket g	Submarket m
α	$\frac{dw_g}{d\alpha} < 0$	$\frac{dw_m}{d\alpha} < 0$
θ_g^*	$\frac{dw_g}{d\theta_g^*} > 0$	$\frac{dw_m}{d\theta_g^*} > 0$
θ_m^*	$\frac{dw_g}{d\theta_m^*} > 0$	$\frac{dw_m}{d\theta_m^*} > 0$

Table 2: Comparison of Equilibrium Predictions of Theoretical Model

	Perfect Enforcement	Imperfect Enforcement
Quality	1st best	1st best $q_g^* < q_m^*$
Seller matching	$\theta^* Q(\theta^*)$	$\theta_g^* Q(\theta_g^*) < \theta^* Q(\theta^*)$ $\theta_g^* Q(\theta_g^*) < \theta_m^* Q(\theta_m^*)$
Payments	$w(q,\theta) = C(q^*) + b + [\frac{\eta(\theta^*)}{1-\eta(\theta^*)}]k\theta^*$	$w(q_g,\theta_g) = C(q_g^*) + b + [\frac{\theta_g^*\eta(\theta_g^*)}{1-\eta(\theta_g^*)}](\kappa + k)\theta_g^*$ $w(q_m,\theta_m) = \frac{1}{\alpha}\{C(q_m^*) + b + [\frac{\theta_m^*\eta(\theta_m^*)}{1-\eta(\theta_m^*)}]k\theta_m^*\}$

Table 3: Production Status for With-Contract and No-Contract Groups

		Contract Status	
		With-Contract	No-Contract
Production Status	Never Produced	0	37
	Currently Producing	115	7
	No Longer Producing	3	74
Total		118	118

Table 4: Household and Farm Characteristics for With-Contract and No-Contract Groups

	With Contract (1)	No Contract		Mean of Paired Differences (1) - (2)	Mean of Paired Differences (1) - (3)
		With Offers (2)	No Offers (3)		
Respondent Characteristics					
Male (%)	57.63	66.67	39.00	-0.11 (0.17)	0.19*** (0.07)
Age	45.35	48.17	46.13	-4.67 (5.15)	-0.45 (1.82)
Education	3.19	2.50	2.58	0.39 (0.36)	0.66*** (0.21)
Farming Experience (Years)	20.97	25.94	20.40	-6.28 (5.33)	0.80 (1.68)
French Bean Experience (Years)	12.24	5.56	4.14	5.28* (2.53)	8.35*** (1.04)
French Bean Trainings	1.99	0.89	0.66	1.33*** (0.34)	1.29*** (0.16)
Household Characteristics					
Male Head of Household (%)	88.98	88.89	82.00	0.00 (0.11)	0.07 (0.05)
Household Size	4.20	4.33	3.85	-0.66 (0.62)	0.45** (0.21)
Total Household Income (1000 Ksh)	453.01	219.33	168.58	-13.21 (89.69)	328.87*** (103.88)
Value of Outstanding Loans (1000 Ksh)	45.08	14.39	20.15	97.93 (62.05)	12.83 (9.53)
Production Characteristics					
Acreage Owned	2.43	2.66	1.99	-0.53 (0.54)	0.50 (0.34)
Acreage Farmed	3.90	2.76	2.25	0.56 (0.97)	1.74*** (0.54)
French Bean Acres Farmed	2.90	0.36	0.11	2.47*** (0.83)	2.81*** (0.50)
Number of Different Crops Grown	3.47	3.44	2.85	0.00 (0.57)	0.63*** (0.18)
Farm-Fixed Assets Owned (1000 Ksh)	5520.17	2430.84	2165.73	184.06 (860.54)	3877.39 (2556.37)
Irrigation	1.00	1.00	0.70	0.00 (0.00)	.30*** (0.05)
Obs	118	18	100	18	100

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The mean of paired differences tests are calculated as $H_0 : \overline{Var_{with} - Var_{without}} = 0; H_A : \overline{Var_{with} - Var_{without}} \neq 0$

Table 5: Marketing Characteristics for With-Contract and No-Contract Groups

	With Contract (1)	No Contract		Mean of Paired Differences (1) - (2)	Mean of Paired Differences (1) - (3)
		With Offers (2)	No Offers (3)		
Known French bean buyers	4.94	3.61	3.09	-0.28 (0.47)	2.02*** (0.55)
Buyers offering to purchase beans in past year	2.08	1.72	0.21	0.06 (0.33)	1.92*** (0.21)
Buyers offering a contract in past year	1.05	1.11	0.00	-0.06 (0.15)	1.05*** (0.05)
Buyers sold to in past year	1.34	0.83	0.10	0.33** (0.14)	1.27*** (0.20)
Lowest price offered per Kg in past year	33.72	32.39	3.38	3.83 (5.02)	29.89*** (1.72)
Highest price offered per Kg in past year	56.81	44.72	5.96	12.06* (5.74)	50.86*** (3.76)
Distance to Year-Round Road (km)	1.26	1.12	0.90	-0.11 (0.51)	0.41* (0.24)
Distance to Market (km)	4.35	5.20	4.50	-0.28 (1.19)	-0.28 (0.44)
Obs	118	18	100	18	100

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The mean of paired differences tests are calculated as $H_0 : \overline{Var_{with} - Var_{without}} = 0; H_A : \overline{Var_{with} - Var_{without}} \neq 0$.

Table 6: Search Characteristics for Farmers With-Contract and No-Contract Groups

	With Contract (1)	No Contract	
		With Offers (2)	No Offers (3)
Time spent searching for French bean buyers (hours)	15.83	1.67	9.45
Total cost of French bean buyer search (Ksh)	1526.17	166.67	727.27
Per unit cost of buyer search (Ksh)	164.40	55.56	185.61
Obs (Engaged in any buyer search)	46	3	11
Obs (Total)	118	18	100
Share of farmers who search (%)	40.0	16.7	11.0

Table 7: Average WTA and δ, Across Populations

	With Contract (1)	No Contract		Mean of Paired Differences (1) - (2)	Mean of Paired Differences (1) - (3)
		With Offers (2)	No Offers (3)		
Quality	-15.25***	-11.17***	-12.55***	-6.54	-2.27
	(1.59)	(1.53)	(1.39)	(3.81)	(2.10)
Current Trading Partner	22.35***	26.46***	30.10***	-4.69	-7.65***
	(0.93)	(2.27)	(0.96)	(2.83)	(1.32)
Most Reliable Trading Partner	38.36***	29.58***	40.90***	9.16	-2.61
	(2.10)	(3.49)	(1.71)	(5.84)	(2.84)
Perfect Partner	44.70***	46.89***	54.29***	2.83	-10.49***
	(2.77)	(2.08)	(1.66)	(7.91)	(3.16)
No Contract	-29.51***	-18.80	-27.10	-22.07	-0.36
	(9.55)	(17.78)	(17.04)	(28.74)	(19.58)
δ (CTP)	0.63***	0.58***	0.58***	-0.04	0.07
	(0.04)	(0.06)	(0.02)	(0.06)	(0.05)
δ (MRTP)	1.02***	0.68***	0.77***	0.29*	0.25***
	(0.08)	(0.08)	(0.03)	(0.15)	(0.10)
Obs	118	18	100	18	100

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The mean of paired differences tests are calculated as $H_0 : \overline{Var_{with} - Var_{without}} = 0; H_A : \overline{Var_{with} - Var_{without}} \neq 0$.

Table 8: Matching Function Estimates

	Cobb-Douglas				Translog			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Buyer Density	0.661***	0.892***	0.916***	0.909***	1.512**	2.099***	1.408***	1.323**
	(0.0981)	(0.0865)	(0.0780)	(0.0788)	(0.454)	(0.394)	(0.362)	(0.427)
Pair Distance	0.0326	0.0184	0.0199	0.0208	0.133*	0.0954	0.0256	0.0195
	(0.0275)	(0.0227)	(0.0206)	(0.0207)	(0.0653)	(0.0556)	(0.0538)	(0.0564)
Buyer x Distance					-0.0788	-0.0578	0.00180	0.00733
					(0.0541)	(0.0459)	(0.0443)	(0.0468)
$(BuyerDensity)^2$					-0.825*	-1.072**	-0.469	-0.401
					(0.382)	(0.325)	(0.308)	(0.356)
$(PairDistance)^2$					-0.123***	-0.0301	-0.0276	-0.0297
					(0.0333)	(0.0314)	(0.0291)	(0.0297)
δ (CTP)		4.421***		-0.854		4.270***		-0.540
		(0.593)		(1.190)		(0.634)		(1.418)
δ (MRTP)			2.214***	2.540***			2.063***	2.273***
			(0.231)	(0.511)			(0.256)	(0.607)
Constant	2.006***	-1.079*	-0.555	-0.338	1.836***	-1.506**	-0.562	-0.383
	(0.128)	(0.427)	(0.284)	(0.416)	(0.265)	(0.544)	(0.365)	(0.596)
Obs	118	118	118	118	118	118	118	118
Adjusted R^2	0.271	0.506	0.593	0.591	0.366	0.546	0.596	0.593
Returns to Scale	DRTS	DRTS	DRTS	DRTS	DRTS	CRTS	IRTS	IRTS

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

OLS estimates of the aggregate matching function for the French bean industry in Kirinyaga County, Kenya.

Dependent variable is the natural log of the number of contracted farmers within a 5km radius.

Table 9: Effect of Search Frictions on Average Market Prices

	Average Contract Price			Average Minimum Bid			Average Maximum Bid		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Buyer Density	1.387*	1.295*	0.522	0.189	0.393	0.523	-14.63***	-20.09***	-22.41***
	(0.702)	(0.755)	(0.711)	(0.855)	(0.918)	(0.909)	(3.511)	(3.496)	(3.079)
Pair Distance	0.428**	0.434**	0.471**	-0.645***	-0.657***	-0.662***	-1.144	-0.808	-0.756
	(0.197)	(0.198)	(0.188)	(0.240)	(0.241)	(0.240)	(0.984)	(0.918)	(0.813)
Avg δ (CTP)		-1.769			3.904			-104.5***	
		(5.172)			(6.289)			(23.94)	
Avg δ (MRTP)			-7.525***			2.905			-67.69***
			(2.107)			(2.691)			(9.118)
Constant	42.96***	44.19***	51.67***	33.61***	30.88***	30.24***	74.13***	147.1***	152.5***
	(0.915)	(3.725)	(2.589)	(1.115)	(4.529)	(3.307)	(4.577)	(17.24)	(11.21)
Observations	118	118	118	118	118	118	118	118	118
Adjusted R^2	0.041	0.034	0.130	0.049	0.043	0.050	0.116	0.236	0.399

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Effect of Search Frictions on Reservation Payments

	CTP		MRTP		PP	
	(1)	(2)	(3)	(4)	(5)	(6)
Buyer Density	-2.880	-1.992	-2.371	-2.069	-2.094	-1.620
	(6.614)	(6.583)	(6.907)	(6.851)	(3.564)	(3.548)
Pair Distance	-1.019	-1.088	-1.829	-1.904	-0.934	-0.978
	(1.732)	(1.738)	(1.809)	(1.809)	(0.933)	(0.937)
Outside Option	-0.0584**	-0.0598*	0.0158	0.0103	0.0406**	0.0392**
	(0.0292)	(0.0305)	(0.0305)	(0.0317)	(0.0157)	(0.0164)
Distance to Market	-0.385	-0.323	-0.956	-0.902	-0.547	-0.509
	(0.720)	(0.720)	(0.752)	(0.749)	(0.388)	(0.388)
Avg δ (CTP)	-74.42		-83.85*		-47.68*	
	(47.49)		(49.59)		(25.59)	
Avg δ (MRTP)		-27.04		-37.06*		-18.22
		(21.20)		(22.07)		(11.43)
Constant	57.72*	36.64	51.72	35.47	21.08	8.592
	(34.35)	(25.84)	(35.87)	(26.89)	(18.51)	(13.93)
Observations	118	118	118	118	118	118
Adjusted R^2	0.004	-0.004	0.015	0.015	0.099	0.092

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Effect of Search Frictions on Individual Prices

	Contract Price		Minimum Bid		Maximum Bid	
	(1)	(2)	(3)	(4)	(5)	(6)
Buyer Density	0.547	0.152	0.917	1.758	-14.95**	-16.68**
	(1.966)	(1.957)	(2.582)	(2.536)	(7.074)	(6.938)
Pair Distance	0.832	0.847	-0.459	-0.453	3.713**	3.669**
	(0.515)	(0.517)	(0.676)	(0.669)	(1.853)	(1.832)
Outside Option	0.0588***	0.0580***	0.0229**	0.0286**	0.111***	0.0964***
	(0.00867)	(0.00906)	(0.0114)	(0.0117)	(0.0312)	(0.0321)
Distance to Market	-0.208	-0.226	0.546*	0.558**	1.333*	1.327*
	(0.214)	(0.214)	(0.281)	(0.277)	(0.770)	(0.758)
Avg δ (CTP)	15.83		10.95		-57.61	
	(14.11)		(18.54)		(50.79)	
Avg δ (MRTP)		3.811		13.15		-43.74*
		(6.304)		(8.168)		(22.35)
Constant	36.55***	43.25***	23.95*	16.61*	109.2***	118.8***
	(10.21)	(7.682)	(13.41)	(9.953)	(36.74)	(27.23)
Observations	118	118	118	118	118	118
Adjusted R^2	0.272	0.266	0.043	0.061	0.176	0.194

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Average Differences in Reservation Payments Across Matched Pairs

	Mean Difference						
	All (1)	Contract - Offer (2)	Contract - No Offer (3)	Fresh - Never (4)	Processed - Never (5)	Fresh - Exit (6)	Processed - Exit (7)
Current Trading Partner	-4.18	0.98	-5.11	-12.58**	-0.57	-5.34***	7.09
	(3.18)	(8.25)	(3.45)	(5.42)	(14.35)	(1.88)	(13.91)
Most Reliable Trading Partner	-10.56***	-12.86	-10.15***	-4.07	-26.11	-5.56***	-23.23*
	(3.51)	(10.48)	(3.71)	(6.68)	(18.99)	(1.66)	(13.56)
Perfect Partner	-2.92	-6.54	-2.27	4.96	-11.64	1.71*	-20.80***
	(1.87)	(3.81)	(2.10)	(4.34)	(9.05)	(0.88)	(5.64)
Number of obs	118	18	100	24	13	61	20

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis.

Dependent variable is differences in reservation payment for accepting a contract bundle as measured by a choice experiment. T-test compares $H_0 : \overline{Var_{with} - Var_{without}} = 0; H_A : \overline{Var_{with} - Var_{without}} \neq 0$

Table 13: Average Differences in Search Frictions Across Matched Pairs

	Mean Difference						
	All	Contract - Offer	Contract - No Offer	Fresh - Never	Processed - Never	Fresh - Exit	Processed - Exit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Current Trading Partner	-0.51	23.05	-4.75	-130.57**	81.49	-8.17	123.63***
	(17.18)	(26.27)	(19.72)	(53.21)	(70.14)	(11.12)	(35.40)
Most Reliable Trading Partner	-6.89	9.20	-9.79	-122.07**	55.96	-8.48	95.31**
	(16.72)	(24.85)	(19.24)	(53.56)	(71.57)	(11.18)	(34.09)
Perfect Partner	0.75	15.53	-1.91	-113.04**	70.43	-1.13	97.75***
	(16.60)	(27.12)	(19.00)	(53.35)	(70.02)	(11.45)	(33.52)
Number of obs	118	18	100	24	13	61	20

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable is differences in reservation payment less outside option values. $H_0 : \overline{Var_{with} - Var_{without}} = 0; H_A : \overline{Var_{with} - Var_{without}} \neq 0$

Table 14: Effect of δ on Average Differences in Search Frictions Across Matched Pairs

	Mean Difference						
	All (1)	Contract - Offer (2)	Contract - No Offer (3)	Fresh - Never (4)	Processed - Never (5)	Fresh - Exit (6)	Processed - Exit (7)
$\bar{\delta}$ (CTP)							
Current Trading Partner	830.35***	971.64***	788.48***	1513.82*	918.23	274.99	384.05
	(241.09)	(252.61)	(290.89)	(819.33)	(870.10)	(240.43)	(376.03)
Most Reliable Trading Partner	752.00***	803.22***	738.40**	1554.83*	861.58	287.92	287.57
	(236.29)	(263.70)	(284.66)	(822.10)	(894.82)	(221.41)	(366.26)
Perfect Partner	794.43***	1008.85***	742.40**	1400.12	811.88	294.74	503.93
	(233.22)	(259.38)	(280.74)	(830.94)	(878.09)	(226.67)	(346.43)
$\bar{\delta}$ (MRTP)							
Current Trading Partner	420.79***	415.87***	420.56***	964.20**	329.53	178.45**	127.38
	(102.63)	(106.46)	(124.85)	(348.19)	(413.25)	(86.40)	(183.40)
Most Reliable Trading Partner	378.21***	334.18***	390.70***	998.21***	298.86	170.95*	85.71
	(100.95)	(113.26)	(122.21)	(347.58)	(424.25)	(87.17)	(177.83)
Perfect Partner	398.68***	413.45***	396.75***	925.11**	285.71	183.07**	192.31
	(99.44)	(113.64)	(120.32)	(354.82)	(415.48)	(88.97)	(170.03)
Number of obs	118	18	100	24	13	61	20

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable is differences in farmers' reservation payments less outside option values. Positive values mean increasing differences in reservation payments between farmers with and without contracts. Negative values mean decreasing differences in reservation payments between farmers with and without contracts.

Figures

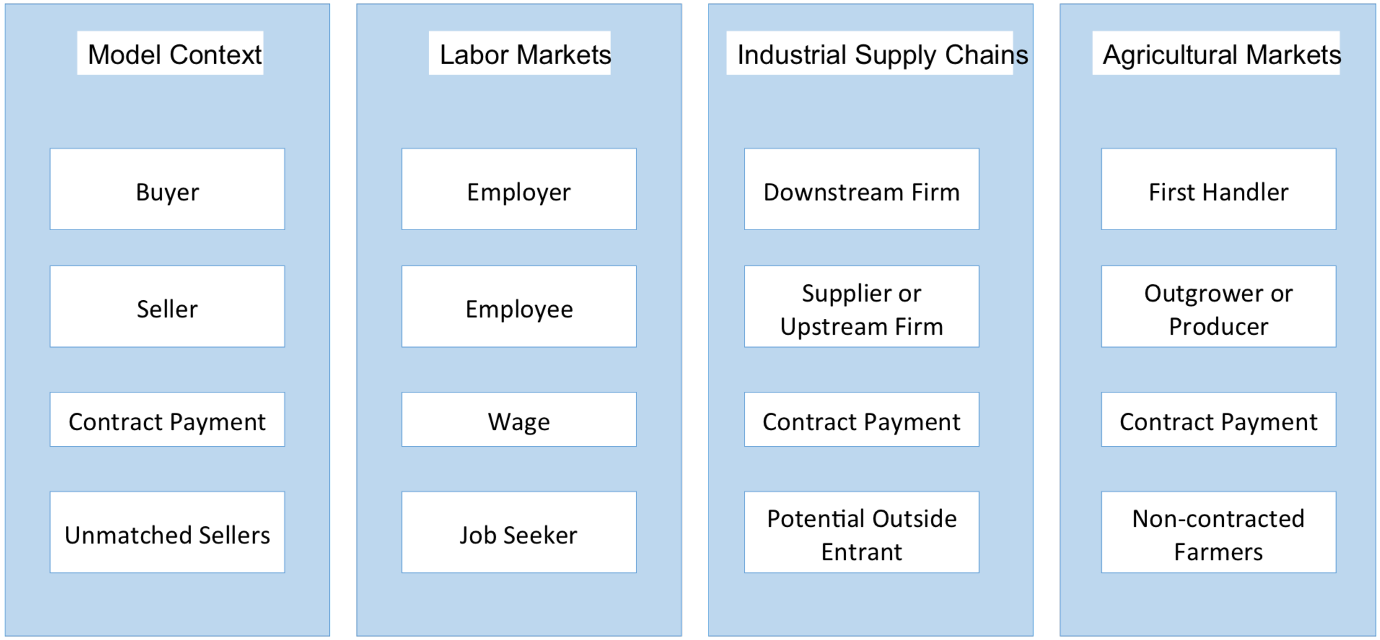


Figure 1: Glossary of Terms for Different Contexts

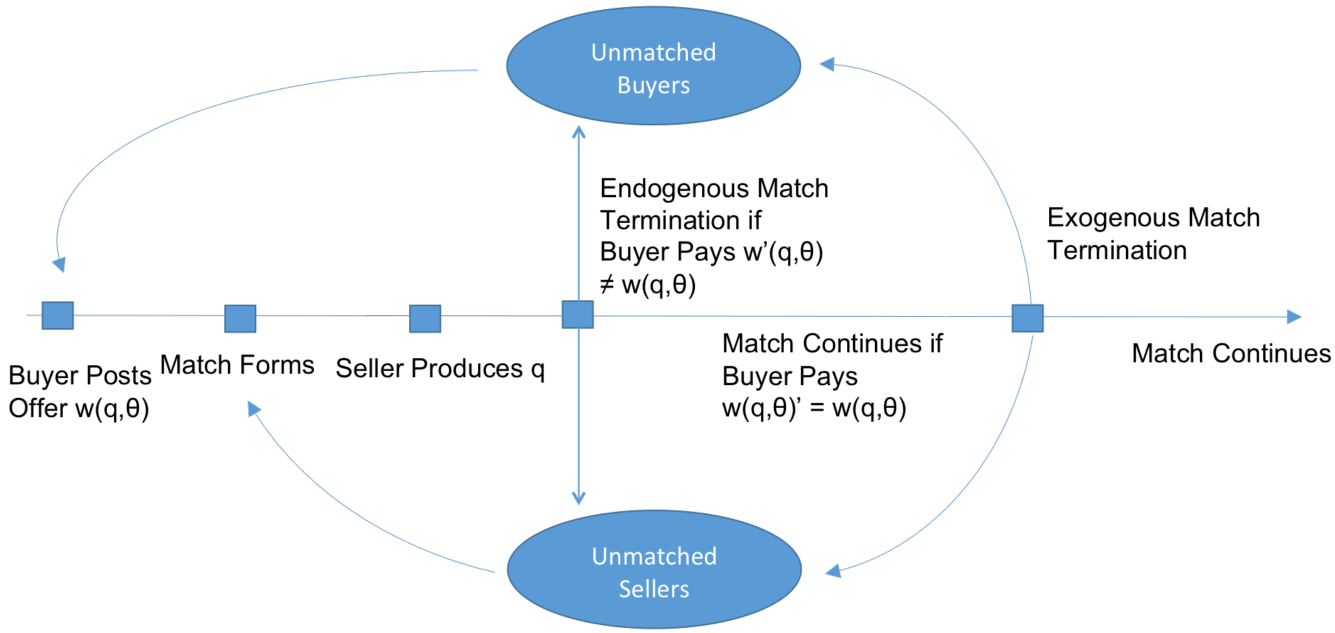


Figure 2: Diagram of Contracting Process

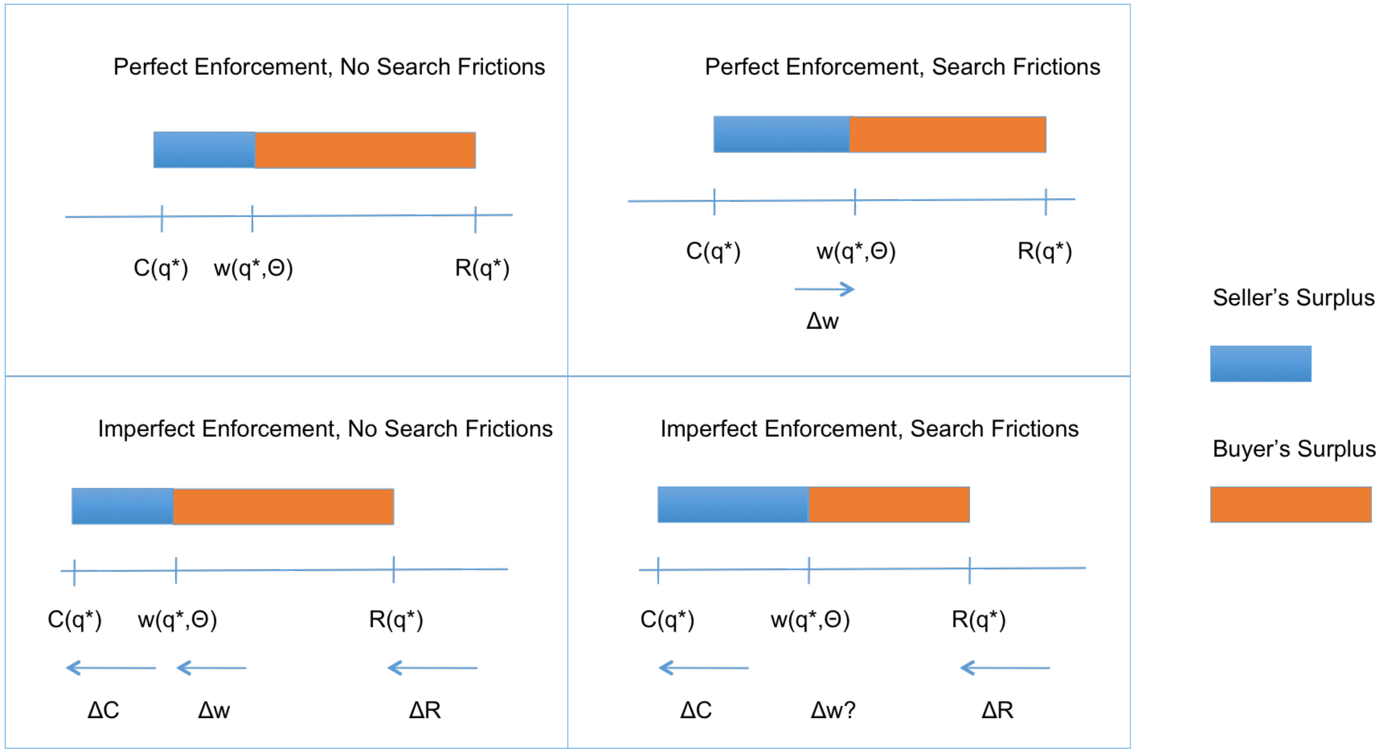
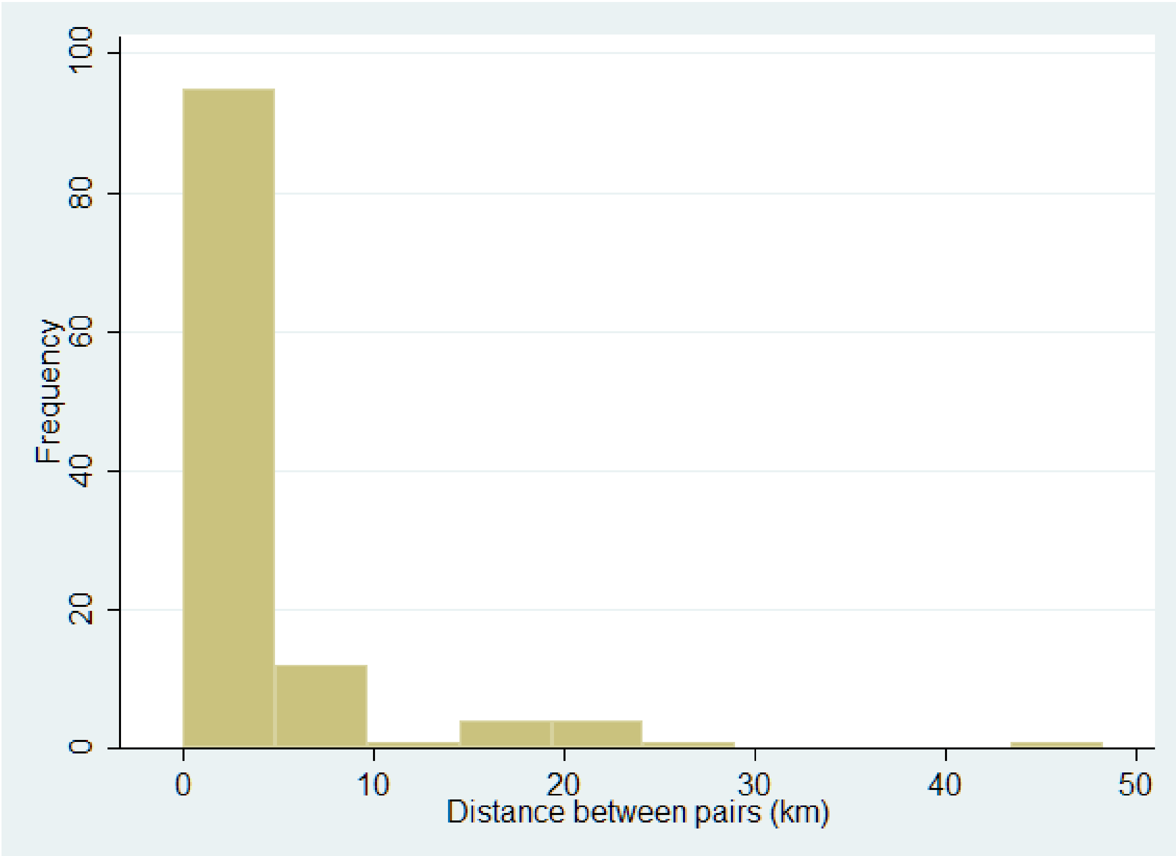


Figure 3: Diagram of Mechanisms Impacting Equilibrium Payments and Quality Levels

Figure 4: Distribution of Distances Between Matched Pairs



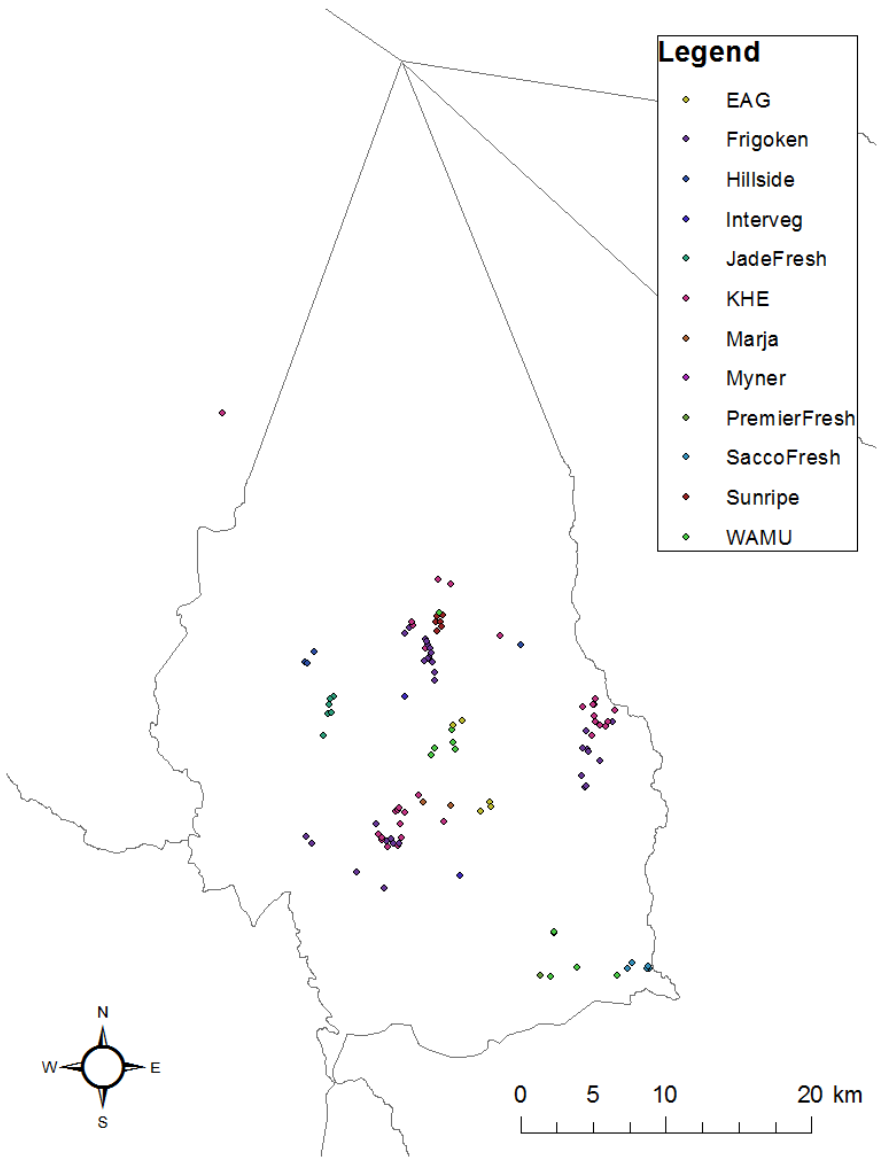


Figure 5: Map of Sampled Farmers with Contracts and Corresponding Buyers

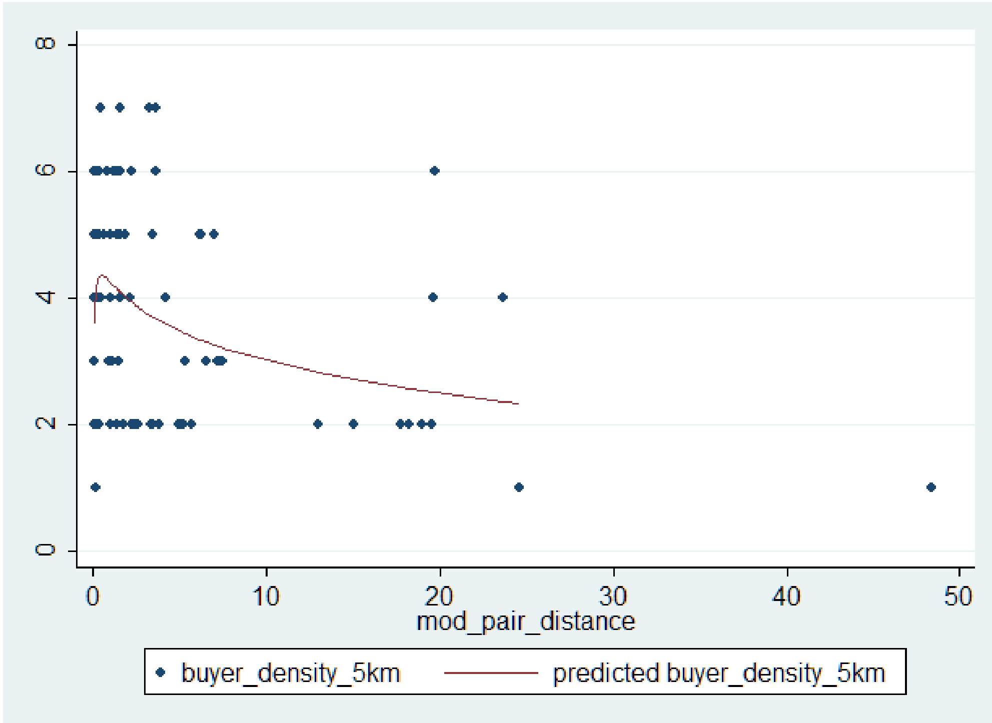


Figure 6: Plot of Buyer Density vs Pair Distance

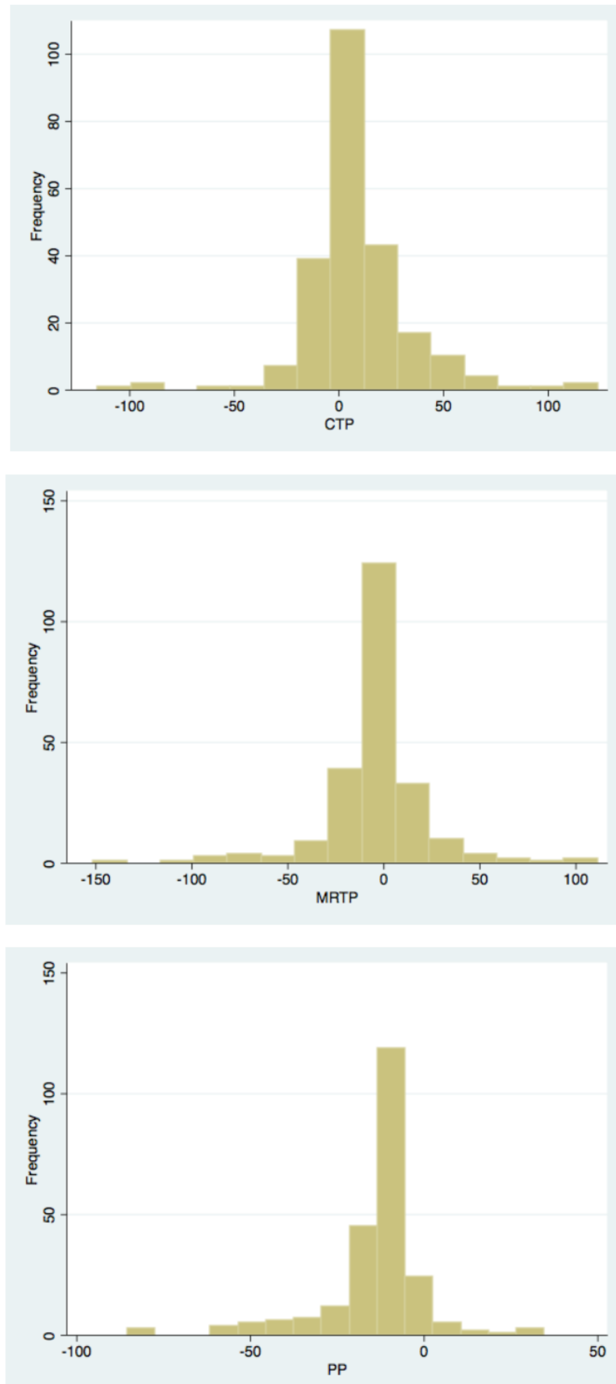


Figure 7: Distributions of Reservation Payments for Sampled Farmers, by Buyer Reliability