Competition on Agricultural Markets and Quality of Smallholder Supply: The Role of Relational Contracting and Input Provision by Traders

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Abstract: We analyze how market power by traders on local agricultural spot markets affects investment in crop quality by smallholders. We consider a context with "imperfect institutions" —without formal enforcement of contracts and with incomplete input markets. Farmers and traders can engage in relational contracting where the promise of future rents supports current cooperation. We analyze informal contracting under the shadow of side-selling by the farmer, and ask how changes in the competitiveness of local markets affect flows of inputs in relational contracts. Our most important finding is that making local markets more competitive implies that fewer farmers are included in relational contracting with traders, and that farmers who remain in such relationships receive less support from traders. We document empirical evidence from local wheat markets in Ethiopia that is consistent with the theory.

Keywords: market power, agricultural markets, technology transfer, quality investment, trader

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1. Introduction

The idea that competitive markets foster innovation and promote growth and welfare is one of the maxims of economics.[1] Through selection and incentive effects, competition causes productivity growth, raises quality, and lowers prices for downstream agents in the value chain in the long-run. However, this belief rests on the assumption that markets are embedded in a context of "good institutions", where trading agents have access to low-cost mechanisms of third-party contract enforcement. In weakly-institutionalized contexts, as prevailing in rural areas in many low-income countries, it is not evident that economic performance improves as markets become more competitive. We analyze this issue using the case of smallholder production in Africa as a motivating example.

The modernization of smallholder farming is an important component of most strategies to reduce rural poverty in agriculture-based economies. However, modernization and intensification of smallholder farming are impeded by narrow profit margins that curb incentives to "invest" in quality-enhancing inputs. Imperfect competition on local commodity markets is commonly seen as a factor contributing to small margins for producers (e.g. Bartkus et al. 2021). If the benefits of investments in quality-enhancing inputs and practices are "creamed off" by traders with market power, then farmers may respond by supplying low quality output.[2] A common concern is that low product quality limits access to high-value supply chains, and could lock rural producers into poverty.

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[1] An exception is that the presence of market power may create rents that enable firms to implement research and development efforts that support innovation (e.g., Aghion et al., 2005).

[2] Smallholders respond strongly to market incentives when deciding about the appropriate quality level of their supply. For example, bulking and mixing of smallholder supply at the local level, before grading occurs, creates a well-known lemons problem because farmers are paid based on average quality rather than the quality of their supply. This attenuates incentives to supply high-quality output. Research in the horticulture, dairy, and cereal sectors suggests this problem can be effectively countered by certification of individual supply (Saenger et al., 2014; Bernard et al., 2017; Treurniet, 2020; Anissa et al., 2021).

This paper aims to use theory to explore the complex relationship between the intensity of competition on local agricultural markets and the quality of smallholder supply. Complementing the perspective that imperfect competition lowers crop prices and erodes incentives for quality production, we propose that market power by traders may foster relational contracting in contexts with imperfect rural factor markets and poor contract enforcement institutions. Trader market power on local spot markets makes spot market trading less attractive for farmers. Constraints for contracting are relaxed as the risk of side-selling is attenuated — *stimulating* technology transfer.[3] In our model, traders supply quality-enhancing inputs to liquidity-constrained smallholders who otherwise cannot access these. Equilibrium strategies are analyzed to study how imperfect competition between traders affects cooperation between traders and farmers, and the resulting quality of agricultural output. The main conclusion from the theory is that promoting competition between traders on spot markets (i) leaves the quality of output provided by "spot market farmers" unaffected, (ii) reduces the quality of output provided by farmers in a relational contract with a trader (intensive margin), and (iii) reduces the share of farmers in such a relationship (extensive margin).

The contribution of this paper is threefold. First, we highlight the interdependency between relational contracting and traditional spot markets in an environment where input markets are incomplete and formal contracts cannot be enforced. Second, we study how changes in the intensity of competition on local spot markets affect both the extensive and intensive margin of relational contracting—which farmers are included in relationships, and how much support do they receive from traders? Therefore, this paper contributes to the thin

[3] Smallholders may engage in contracting for several reasons, including improved risk management, reduced transaction costs, a guaranteed market outlet, or obtaining credit. We focus on access to quality-enhancing inputs.

literature on value chain development and technology transfer. Third, using observational data from wheat markets in Ethiopia we explore whether predictions are consistent with facts.

The paper is organized as follows. In section 2 we discuss the existing literature on competition between traders and the quality of agricultural produce when (formal) contracting opportunities and factor markets are imperfect. In section 3 we introduce our model of relational contracting on agricultural markets—focusing on the risk of hold-up by the farmer. We ask how competition on spot markets affects the selection of farmers for relational contracting, and shapes the informal contracts that can be negotiated. Finally, in section 4 we present data for a sample of Ethiopian wheat markets and demonstrate that key model predictions are consistent with observations.

2. Competition and crop quality

Imperfect competition can be sustained if there are natural or man-made barriers to entry in the intermediated trade sector, which is easy to imagine in the context of remote and thinly-populated areas.[4] What evidence exists for the belief that traders have "market power" and earn super-normal profits? Unobserved trader cost and services complicate assessment of this issue, and the available evidence is rather scant and appears mixed. Dillon and Dambro (2017) review the evidence for African crop markets and conclude that these markets are fairly competitive.[5] This follows from analyses based on commodity prices and trader profits, market concentration ratios, and barriers to entry and exit on market. However, more recent experimental studies provide a more mixed picture. While Casaburi and Reed (2019) find

[4] For example, Kopp and Brümmer (2017) find that remoteness and market size are determinants of trader market power in the context of the Indonesian rubber trade. Other factors conducive to the persistence of trader market power are fixed entry costs (Bartkus et al. 2021), interlocking credit and output markets (e.g., Subramanian and Qaim, 2011; Kopp and Brümmer, 2017), crop perishability (e.g., Singh, 2002), lock-in investments by farmers (Sexton 2011), or large-scale contract farming (e.g., Sivramkrishna and Jyotishi, 2008).
[5] See, for example, Fafchamps et al. (2004), Osborne (2005), and Sheldon (2017) for more details.

evidence of pass-through of subsidies provided to cocoa traders in Sierra Leone (in the form of relaxed credit constraints for farmers—an example of interlinked transactions), Bergquist and Dinerstein (2020) document that maize markets in Kenya are not competitive. Windfall benefits are incompletely passed-through to producers, and traders collude to retain the bulk of the surplus created through trade. A careful non-experimental study highlights the importance of search costs as a determinant of imperfect competition between traders (Casaburi et al., 2013).

The intensity of competition in rural markets remains a contested issue, and there is also little agreement about its effects.[6] Generally speaking, economists believe that "an increase in competition on one side of the market is beneficial for agents on the other side of the market" (Swinnen et al., 2015, p.201). Ample evidence is consistent with this insight, also from low-income countries (e.g., Jensen and Miller, 2018, and Busso and Galiani, 2019). In the context of simple spot market trading between farmers and traders, analyzed below, more competition between traders might increase the share of the crop´s value accruing to the farmer. However, the welfare effects of more intense competition vary with the institutional context, particularly with the contract environment.

Imagine a context with imperfect factors and input markets. Smallholders are liquidity-constrained due to lack of access to formal credit, and unable to purchase quality-enhancing inputs (e.g., see Dillon and Barrett, 2016). Traders purchasing output from smallholders can provide inputs in kind, or provide cash to the farmer, where the value of the

[6] The potential effects of market power are complex and many, even in contexts with good enforcement institutions. For example, Swinnen and Vandeplas (2010) mention possible efficiency gains due to (i) scale economies, (ii) reduced transaction costs, or (iii) extra investments in productivity-enhancing research, development, and innovation. In addition, (iv) conditions elsewhere in the value chain are important (e.g., is concentration necessary to wield countervailing power?), and (v) under specific conditions an increase in market power may reduce opportunities for collusion by agents in that particular node of the chain.

(in-kind) loan is later deducted from the payment that farmers receive upon delivery.[7] If third-party enforcement of agreements is not feasible, informal agreement should be self-enforcing (e.g., Ghosh and Ray, 1996). The promise of future rents from cooperation should prevent contracting parties from reneging and pursuing short-term gains. Such agreements between smallholders and traders are analyzed by Fafchamps (2004), Swinnen and Vandeplas (2010), Swinnen et al. (2015), and Kuijpers and Swinnen (2016). An interesting insight is that imperfect competition between traders can help resolve contract enforcement and technology transfer problems. Without third-party enforcement, agreements are vulnerable to hold-up issues, default, renegotiation, diversion or side-selling (e.g., Upton and Lentz, 2017). In such a second-best context, market power by traders implies that farmers cannot easily renege by turning to the spot market. This fosters cooperation—creating scope for efficiency gains.[8]

There exists little empirical work on the relation between competition and quality in the context of weakly-institutionalized agricultural markets.[9] We are aware of two papers dealing with these issues. First, Ghani and Reed (2018) study the relationship between fishermen and retailers when the latter provide an intermediate input (ice) to the former. Prioritizing preferred fishermen when ice is scarce, the supply of ice helps to maintain customer loyalty and support relational contracting. Ghani and Reed (2018) show that the

[7] Traders charge interest for such loans, either a positive interest rate for loans in cash or an inflated price discount upon delivery for in-kind loans. In our model we abstract from interest, but see Kopp and Brümmer (2017) for interest rates and "strategic indebtment" of smallholders by traders—an alternative channel via which traders can ensure market power in specific trading relationships.

[8] The so-called "modern agricultural market" paradigm explores similar issues in the context of imperfectly-competitive US agricultural markets with large-scale processors (e.g., Sexton, 2013).

[9] A larger literature explores other issues related to relational contracting in agriculture. Levin (2003) shows that relational incentive contracts are stationary even in the presence of asymmetric information about the other agent´s type (adverse selection) or behavior (moral hazard). Machiavello and Morjaria (2015) introduce learning about the other agent´s type and find that relational contracts can be non-stationary. Casaburi and Machiavello (2019) study infrequent payments as a savings commitment device for dairy farmers with time-inconsistent preferences. The ability to supply this service depends on the milk buyer´s incentive to renege.

entry of new ice suppliers facilitates switching between fishermen and retailers. Competition between retailers changes the nature of the agreements between retailers and fishers (customer loyalty is bought through the provision of credit rather than ice), which improves fishermen's productivity and raises welfare. In contrast, Machiavello and Morjaria (2021) find that introducing competition has adverse effects. They study relational contracting between coffee growers and a monopsonistic miller. Entry by a competing mill *lowers* the quantity and quality of beans supplied by smallholder farmers. Competition makes relational contracting more difficult by facilitating side-selling by farmers. Competition increases the risk for mills to invest in the provision of complementary inputs and services —reducing overall productivity and performance.

Our work extends existing theory. We explicitly analyze both the *extensive* and *intensive* margin of relational contracting — exploring the extent to which relational contracts are inclusive and efficient. We also explicitly link relational contracting to a model of trading on spot markets. Machiavello and Morjaria (2021) study the effects of entry by a competing coffee mill, which is assumed to raise the (exogenous) coffee price that farmers may obtain elsewhere. This raises the minimum price that the incumbent mill should pay to avoid side-selling by the farmer. Instead, in our model traders and farmers can meet either on the spot market or engage in a relationship, prices are determined endogenously, and competition affects the returns to either marketing channel. Surplus creation and distribution are a function of the intensity of local competition between traders through the interaction of the two trading regimes.[10]

[10] Swinnen and Vandeplas (2010) and Swinnen et al. (2015) also do not model competition between traders explicitly. They assume that informal contracts are supported by a reputation cost in case the party reneges (a parameter). This model is tied together by assumptions about how competition affects reputation costs.

3. A model of relational contracting

Below we present a model of relational contracting by a farmer and trader. First, however, we describe the default outcome for farmers and traders who are *not* in a relationship, based on Cournot competition between traders on the local spot market – a model of Cournot oligopsony. Traders engage in either relational contracting or spot market trading because they have a limited quantity of working capital for transacting. On spot market j there are M_j traders.[11] Consider a model where the farmer produces a unit of output, and can improve the quality of that unit by allocating (additional) effort e to production or handling (e.g., storage). This involves a cost $c(e)$ for the farmer. If farmer i is unable to sell his unit to the trader he consumes it himself, generating a default value v which is independent of quality.[12] We assume farmers may carry their output to the local market and incur a per unit transport cost of λ. Define the travel distance from farmer i to the nearest local market as d_i and assume that d is uniformly distributed across the range $[d^*-w, d^*+w]$, where d^* and w are parameters. The sum of effort, opportunity and travel cost for farmer i are equal to $c(e)+v+d_i\lambda$, where the farmer chooses effort level e optimally (see below).

If output is sold, the trader transports it at fixed cost τ to a processor or consumers in an urban center. The unit price on the final market equals $P(e)$, reflecting quality differentials due to farmer effort; $P' > 0, P'' < 0$. We assume that there are gains from trading, at least for a subset of farmers located sufficiently close to the market, or that $P(e)-\tau > c(e)+v+(d^*-w)\lambda$.

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[11] For simplicity we treat the number of traders as given. For models with free entry in the trading sector and an endogenous number of traders, refer to, for example, Antras and Costinet (2011) or Krishna and Sheveleva (2017).

[12] For example, the farmer only cares about the nutritional value or taste of his crop, and not about its color, shape or size. Processors may care about the distribution of the size of individual kernels, something that is less important for the farming household. In addition, the extraction rate is a quality attribute that is relevant for processors (e.g., in relation to drying costs) and much less for farmers.

3.1 Spot market trading

Farmers and traders meet on a local spot market. Motivated by the Ethiopian wheat market example explored below, we assume farmers use donkey carts, motor cycle taxis or other high-cost transport technologies to visit the local market and bring a unit of their crop. This is sold to one of the (identical) traders present. Among other factors, the intensity of competition between traders determines the unit price p paid to farmers. Farmer i will only engage in trading if her returns are positive, or when $p>c(e)+v+d_i\lambda$. This defines an extensive margin for spot market trading, which generates an upward sloping supply curve as only the subset of $F(\cdot)=\frac{\frac{p-c(e)-v}{\lambda}-(d^*-w)}{2w}$ will engage in trade (where F is the CDF of the uniform distribution).

We consider symmetric equilibria where all traders behave the same. Traders decide how much grain to buy, q, given other trader's quantities. Aggregate quantity $Q=\Sigma_M q$ enters the traders' profit function through the inverse supply curve:

$$p=\frac{2wQ+(d^*-w)}{\lambda}+v+c(e) \tag{1}$$

and each trader maximizes the following profit function;

$$\pi_T=(P(e)-\tau-p)q. \tag{2}$$

The solution of (2) gives us the optimal quantity of crop bought by each trader:

$$\hat{q}=\frac{(P(e)-\tau-v-c(e))\lambda-(d^*-w)}{2w}-\sum q, \tag{3}$$

so that in a symmetric equilibrium:

$$\hat{q}=\frac{(P(e)-\tau-v-c(e))\lambda-(d^*-w)}{2w(1+M)}. \tag{3'}$$

Substituting in (1) gives us an expression for the equilibrium Cournot price, p^c:

$$p^c = \frac{M(P(e)-\tau)+(d^*-w)/\lambda+v+c(e)}{1+M}. \quad (4)$$

Three insights follow from this stylized model. First, if local agricultural markets become more competitive, because the number of traders increases, then prices paid to smallholders increase; $\frac{\partial p^c}{\partial M} > 0$. Second, the farmer chooses an efficient quality level for the output she produces and trades, and this quality level is independent of the intensity of competition between traders. Farmers selling their output choose effort to maximize the following objective function;

$$\pi_{F,i} = \frac{M(P(e)-\tau)+(d^*-w)/\lambda+v+c(e)}{1+M} - d_i\lambda - c(e). \quad (5)$$

Denote the farmer´s optimal effort level by $\hat{e}$, which is implicitly defined by $P' = c'$. While traders offer higher prices if competition is more intense (or as M increases), the pass-through of the premium is complete and correctly incentivizes the farmer to invest in quality. Observe that this is an artefact of the Cournot oligopsony model—underinvestment in quality may occur for alternative specifications of the process describing how the surplus is distributed between the farmer and trader.[13]

Third, observe that farmer travel cost to the nearest market determines whether or not she would engage in spot market trading. Define $\hat{d}$ as the critical distance where the farmer is indifferent between trading on the market (and obtain $\pi_{F,i}(\hat{d})$ as defined in (5)) and consuming the crop herself (and obtain v). Farmers "far away from spot markets" (i.e. with $d_i > \hat{d}$) will not trade on spot markets because of excessive transport costs, and farmers

[13] If, instead, we assume bilateral bargaining over the surplus between trader and farmer, then part of the surplus accrues to the trader and the farmer invests too little effort in improving crop quality. A more competitive market (where farmers have greater bargaining power) then implies that farmers obtain a greater share of the crop's value, so that investments in quality are increasing in the number of traders. This is formally illustrated in Appendix 1.

living sufficiently close to markets ($d_i < \hat{d}$) will trade. In what follows we focus on the latter type of farmers.

With Cournot competition, income for farmer *i* and traders is as follows;

$$\pi_{F,i}^C = \frac{M(P(\hat{e})-\tau-c(\hat{e}))+(d^*-w)/\lambda+v}{1+M} - d_i\lambda, \quad \text{and} \tag{6a}$$

$$\pi_T^C = P(\hat{e}) - \tau - \frac{M(P(\hat{e})-\tau)+(d^*-w)/\lambda+v+c(\hat{e})}{1+M}. \tag{6b}$$

Not surprisingly, these conditions imply that more intense trader competition increases farmer income $\frac{d\pi_F^C}{dM} > 0$ and reduces trader income: $\frac{d\pi_T^C}{dM} < 0$.

3.2 Relational contracting

The Cournot oligopsony model rests on the assumption that farmers and traders meet on the local market and engage in one-time trading. However, as discussed above, outcomes may improve if farmers and traders play a repeated game. In what follows we consider the case where traders can visit farmers on their farm before the growing season, engage in farm gate bargaining, and offer an agreement to start sustained cooperation. Some farmers are not selected for relational contracting (see below), and traders compete Cournot-style for the output of these excluded farmers on the various spot markets after the growing season.

We assume a farmer can only be visited by one trader – for example the one with lowest social distance costs (e.g., kinship links or co-ethnicity; affecting communication and trust and, hence, "contacting and contracting" costs).[14] The reason may be that social distance

[14] The assumption that farmers receive one relational contracting offer implies that farmers who reject the contract (or who break it—see below) will have to trade on the local spot market. It also implies that traders can ignore the risk of potential "relational contracting" offers by other traders. Introducing such competition between traders to engage in a relationship implies introducing another constraint that the trader would have to respect when proposing a relarional contract (the value to the farmer of the "next best" contract proposed by the trader with the next-lowest transaction costs).

is public information, so that other traders know that they cannot outbid the lowest-cost trader and are therefore unwilling to travel to the farm. Such a matching process relies on trader heterogeneity that is easily included in the model. For example, we introduce exogenous and farmer-specific "matching costs" for each trader k: D_{ik}. Selected farmers are visited by trader k with the lowest realization of D_{ik}.

Assume crop quality can be improved if the farmer uses an additional input provided by the trader. This input is not available to the farmer himself, perhaps due to an imperfection on the capital market—farmers cannot obtain credit and are liquidity-constrained.[15] We also assume that formal contracting institutions, supported by third-party enforcement, are excessively expensive. This could be due to fixed costs associated with formal verification and judication (combined with small traded volumes), or because some relevant margins are unobservable to outsiders. As a result, traders and farmers have to negotiate informal contracts that are sub-game perfect and do not require outside enforcement. Cooperation is supported by the threat of breaking up the relation in case of defection by one of the partners, so that future rents of cooperation are lost. We also assume that information about farmers reneging on a relational contract is "public" (i.e., either perfect observability of trading behavior, or full information sharing between traders), so that cheating one trader automatically implies foregoing all opportunities of future cooperation—the reneging farmer is permanently relegated to the spot market.[16] Both agents choose a grim trigger strategy of punishment.

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[15] Alternatively, the buyer may have lower transaction costs due to economies of scale or access to better information.

[16] We assume coordinating on joint punishment of cheating farmers is incentive-compatible for traders. This may be because reneging today is a strong *signal* of the propensity of the same farmer to renege again tomorrow (i.e.,

Denote the quantity of the complementary input offered by the trader to the farmer by z. The trader also chooses the level of effort that the farmer has to supply. For simplicity, assume that the complementary input does not affect the marginal return to labor, and that the trader chooses effort level $e = \hat{e}$ (which she is able to verify — i.e., no asymmetric information).[17] The crop´s price on the final market is $P(z;\hat{e})$, with $P_z > 0, P_{zz} < 0$. Consider the case where the trader seeks to write a profit-maximizing contract that includes *z* units of the complementary input. When considering a relational contract for farmer i, trader k´s objective function reads:

$$max_z\ P(z;\hat{e}) - \tau - \gamma z - \rho_i - D_{ik}, \quad (7)$$

where γ is the unit cost of the input, ρ_i is the compensation offered to farmer i, and other parameters are as defined above.[18] The trader has to consider two participation constraints, for the farmer and himself. Respectively:

$$\rho_i - c(\hat{e}) \geq \pi_{F,i}^{C}, \text{ and} \quad (8a)$$

$$P(z;\hat{e}) - \tau - \gamma z - \rho_i - D_{ik} \geq \pi_T^C. \quad (8b)$$

In addition, an incentive compatibility constraint for farmers is relevant. The new input raises the crop´s value and creates an incentive for farmer *i* to renege on the relational contract and

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the farmer reveals to be of the "bad type"). Alternatively, traders may form a coalition with second-order punishment or reputation costs for individual traders who team up with the wrong farmer traders may form a coalition that engages in second-order punishment of traders who engage with the "wrong farmer" (e.g., ostracism, expulsion from the club, reputation cost—see Aoki 2001). Greif (1993) discusses another mechanism why fully-informed traders may refuse to engage with farmers who cheated in the past. His mechanism is driven by expectations about the probability of the farmer being invited to be in future relationships, which determines the payment that should be offered today to keep the farmer behave honestly.

[17] See Levin (2003) for models of relational contracting with adverse selection or moral hazard.

[18] Observe that trader travel cost, τ, does not vary across farmers. This may be due to the fact that, compared to farmers, they have access to a low-cost transportation technology (like a pick-up) so that small differences in local procurement cost are small and can be ignored.

side-sell his valuable crop on the spot market instead. The farmer´s incentive compatibility constraint reads as follows:

$$\left\{\frac{M(P(z,\hat{e})-\tau)+(d^{*}-w)/\lambda+v+c(\hat{e})}{1+M}-d_i\lambda-c(\hat{e})\right\}+\frac{(1-\mathrm{r})\Pi_{F,i}^{C}}{r}\leq\frac{\rho_i-c(\hat{e})}{r}. \qquad (9a)$$

Condition (9a) spells out that summing the net profit of one-time reneging (side-selling, as captured by the term in curly brackets on the LHS) and the present value of the flow of spot market trading in all future periods (the second term on the LHS) should not exceed the present value of relational contracting (the RHS). In (9a), r is the (common) discount rate, representing the farmer's (and trader's) level of patience. We rewrite (9a) as:

$$\rho_i\geq\Pi_{F,i}^{C}+c(\hat{e})+\frac{rM}{1+M}\{P(z;\hat{e})-P(\hat{e})\}. \qquad (9b)$$

The trader should provide a payment that compensates the farmer for foregone income and effort cost (the first two terms on the right-hand side of (9b)), and an efficiency premium. In a relationship, farmers earn more than on the spot market. The efficiency premium is needed to prevent side-selling of the high-value crop, and effectively implies a form of profit sharing between trader and farmer. Observe that the efficiency premium decreases as the farmer is more patient, and approaches zero as $r\rightarrow 0$. In contrast, when the farmer is infinitely impatient ($r\rightarrow 1$), the efficiency premium approaches the complete price premium. Condition (9b) is more stringent than (8a), so the latter can be omitted. Assume that for the trader´s optimal solution (9b) holds as an equality — the trader pays the lowest possible price to the farmer.

There is no risk of reneging by the trader (it is easy to verify that the trader's incentive constraint is less stringent than her participation constraint), so trader k´s problem with respect to the choice of the optimal input level is given by:

$$max_z\ P(z;\hat{e})-\tau-\gamma z-\Pi_{F,i}^{C}-c(\hat{e})-D_{ik}-\frac{rM}{1+M}\{P(z;\hat{e})-P(\hat{e})\}, \qquad (10)$$

subject to constraint (8b).

We now solve for extensive and intensive margins of relational contracts: who is offered a contract, and what does the contract look like? We start with the latter question.

3.2.1 Competition and the intensive margin

Consider an existing trader-farmer match, where the trader's participation constraint is *not* binding. The trader chooses the optimal level of input provision, z^*, by taking first derivatives of the profit function. Input provision is implicitly defined by the following equality:

$$P_z = \gamma \frac{1+M}{1+M-rM} > \gamma. \tag{11}$$

In words, the marginal benefit of input provision should equal the marginal cost, or the sum of the input cost augmented by the increment of the efficiency premium. In equilibrium, the trader *under-supplies* inputs relative to the socially-optimal outcome as the efficiency premium acts as a "tax" on the generation of value. Differentiation of (11) yields:

$$\frac{dz}{dM} = \frac{r}{P_{zz}(1+M-rM)} < 0. \tag{12}$$

More competition on agricultural markets induces traders to supply *smaller* quantities of the quality-enhancing input. If traders have less market power on the spot market, the (expected) returns to side-selling for farmers goes up, which tightens the farmer´s incentive compatibility constraint. As a result, smaller quantities of z can be provided, and farmers produce output of lower quality and less value.

Prediction 1: *More intense competition between traders on local spot markets shifts the intensive margin of relational contracting inward. Traders provide less inputs to farmers, which lowers quality of the crop produced by farmers in an informal relationship.*

3.2.2 Competition and the extensive margin

Traders cannot engage in relational contracting with every farmer. Farmers are heterogeneous in terms of their distance to the spot market, d_i, and hence differ in terms of their costs of accessing the spot market. Traders can only engage in a relationship with farmers living far away from local spot markets ($d_i > \hat{d}$), as these farmers will not renege on their contracts. Hence, more valuable contracts can be negotiated. The trader´s participation constraint (8b) defines the "critical farmer" with whom the trader can have a relational contract. Substituting (6a-b) and (9b) in (8b), and solving as an equality, yields the extensive margin of contracting:

$$d_i = \tilde{d} = \frac{1}{\lambda}\left[\gamma z + D_{ik} + \left(\frac{rM-1-M}{1+M}\right)(P(z;\hat{e}) - P(\hat{e}))\right]. \tag{13}$$

All farmers with $d_i \leq \tilde{d}$ have high potential earnings on the spot market and cannot engage in relational contracting. How does the extensive margin shift as new traders enter the spot market? After some manipulation, and using first order condition (11), it can be shown that the threshold value shifts out if local markets become more competitive:

$$\frac{d\tilde{d}}{dM} = \frac{1}{\lambda}\left[\gamma \frac{dz}{dM} + \left(\frac{rM-1-M}{1+M}\right)P_z \frac{dZ}{dM} + \frac{r}{(1+M)^2}(P(z;\hat{e}) - P(\hat{e}))\right] = \frac{r}{\lambda(1+M)^2}(P(z;\hat{e}) - P(\hat{e})) > 0. \tag{14}$$

This means that relational contracting becomes less inclusive—fewer farmers qualify for a relationship with a trader. The reason, again, is that the incentive compatibility constraint becomes more binding as local spot market prices increase.

Prediction 2: *More intense competition between traders on local spot markets shifts the extensive margin of relational contracting outward. Traders provide inputs to fewer farmers, which lowers quality of the crop produced by farmers who lose their informal relationship.*

What happens after (policy) interventions make local markets more "competitive", for example by issuing a larger number of permits to traders or by investing in infrastructure to reduce trader transport costs? The model predicts that this will reduce average crop quality: (i) while it does not affect crop quality produced by spot market farmers ($\frac{d\hat{e}}{dM} = 0$), (ii) it reduces crop quality produced by farmers losing their relationship with a trader ($\frac{d\tilde{a}}{dM} > 0$), and (iii) it also reduces crop quality produced by farmers remaining in such a relationship ($\frac{dz}{dM} < 0$).

4. A motivating example: Wheat trading in Ethiopia

We collected panel data on product quality, the intensity of local competition, and relational contracting in local wheat markets in rural Ethiopia, between December 2019 and March 2020 (see Figure A1). We use these data to probe whether our theoretical predictions make sense. Importantly, it is well-understood that the sample of markets is small and that endogeneity issues invalidate causal interpretations of our correlations. For example, being in a relationship with a trader is unlikely to be a random event. We, therefore, hasten to clarify that the data presented in this section serve as a *motivational example* only—not as a formal test of any specific theory. Nevertheless, we believe the patterns in these data are interesting (and encouraging for this sort of modeling).

Wheat is an essential agricultural commodity in Ethiopia, supplied by 5 million smallholders (CSA, 2014). Between 1995 and 2013, the annual growth rate of wheat production equaled 7.5 percent. Production now equals some 3.9 million tons, and Ethiopia is the largest Sub-Saharan Africa (SSA) wheat producer (Minot et al., 2015). However, adoption of modern technologies is incomplete, and markets are spatially segregated. Formal contract enforcement is lacking or too expensive, and much of the trade at the local level is therefore governed by informal arrangements. As a result, the wheat value chain is quite complex (Gabre-Madhin and Goggin, 2005; Gebreselassie et al., 2017).

Wheat is mainly bought by local traders in production areas. They purchase wheat throughout the *woreda* and sell it to retailers or millers. Markets are located in rural and urban areas, and are open from once every two weeks to every day, depending on the market's importance. The number of markets is large, but bad road conditions and lack of access to motorization increase farmers' travel time — reducing opportunities for spatial arbitrage. Most smallholders sell their produce on the same market, typically small quantities multiple times per year. In contrast, traders typically frequent multiple markets in a rotational fashion.[19] At the local level, some evidence suggests traders have market power (Osborne, 2005), perhaps because of the remoteness of markets combined with asymmetric (price) information, license costs and formal restrictions regulating entry in the trader sector. Unlike cooperatives, traders provide immediate payment, which is valued by liquidity-constrained farmers.

A formal system of grading and standards exists for wheat, but quality assessment and certification are limited to large consignments. Smallholder farmers are excluded from this system given the small size of individual transactions and the large fixed costs to use this service (Abate et al., 2021; Anissa et al., 2021). Instead, traders assess wheat quality based on observables and weight. Observational characteristics include the moisture rate, the rate of impurities, and the varietal mixture (Abate and Bernard, 2017). Increasing wheat quality is possible but costly for farmers in terms of time (effort) and money (Kadjo et al., 2016). It requires sorting, drying, and sometimes purchasing specific inputs (e.g., seed of specific varieties). Average quality is low, reflecting small volumes and insufficient storage capacity. Since many farmers are liquidity-constrained, traders may help farmers access inputs, sometimes via provision of credit.

4.1 Data

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[19] The movement of traders is conducive to the spreading of information about defaulting farmers.

We collected data on local wheat markets in Ethiopia's wheat-producing areas in two rounds during the 2019/2020 marketing season: (i) late 2019 and (ii) early 2020. During the first wave we visited 60 markets. Fieldwork during the second wave was cut short by COVID-19, so we visited only 58 of these markets. We aimed to randomly select 30 farmers per market to obtain a representative sample of farmers trading wheat on that market day. Following Krishna and Sheveleva (2017), we use the number of traders relative to the number of farmers on market *j* at time *t* as our proxy for the intensity of trader *competition* for market *j* at time *t*.[20] We also asked farmers whether they are in a more or less permanent *relationship* with any specific trader (our measure of relational contracting for farmer *i*). Such a relationship involves the promise to trade, possibly facilitated exchanging inputs or providing credit.[21] We compute the share of farmers in a relationship (*share of farmers in relation* for market *j* at time *t*).

Wheat quality is measured using both objective and subjective measures. First, our objective measure is based on a sample of one kg of wheat bought from farmers on 60 markets (during wave 1) and 58 markets (wave 2). We assessed wheat quality based on three criteria: (i) *extraction* rate, the quantity of flour that can be obtained from 1 kg of wheat; (ii) *moisture* rate, negatively correlated with nutrition value and associated with spoilage; and (iii) *impurity* rate, the share of matter in the sample other than wheat. The sample was graded as low, medium, or high quality for each attribute, with higher scores corresponding with higher quality. Unfortunately, the COVID-19 pandemic prevented timely quality assessment of wheat purchased on 13 markets during both waves. Wheat from 12 markets was graded with a 6-months delay, and for one market all samples were lost. Storage conditions during this

[20] We obtain qualitatively similar but statistically weaker results if we use the number of traders instead of the trader-farmer ratio as competition proxy.
[21] Unfortunately, we lack information about input or credit provision.

delay were poor, so wheat quality of the 12-market subsample was compromised at the time of measurement. Therefore, our preferred sample consists of 47 markets for which we have measured quality in a timely fashion. The results of the (near) total sample of 59 markets are provided in an Appendix.

Importantly, the impurity and moisture rate are observable characteristics — impurity is easily assessed by looking in the wheat bag, and experienced traders can assess moisture. In contrast, measuring the extraction rate requires a specific tool that traders do not own (World Bank, 2018, Anissa et al. 2021). Ethiopian wheat traders do not use equipment to measure quality but rely on their senses (as informal interviews with traders confirm).

Our second quality measurement is only available for the sample of 58 markets visited during the second survey wave. During this wave, we asked farmers to provide a (subjective) self-assessment of the *quality* of the wheat they supplied (either low, medium, or high).

In Appendix Table A1 we show that wheat prices positively correlate with impurity and subjective wheat quality. The spot market only rewards observable quality and presumably only attributes that are observable to *both* the trader and farmer (farmer unknowingly supplying high-quality crop will likely be underpaid and receive a relatively low price). For extensive analysis of the returns to quality on local markets, refer to Do Nascimento Miguel (2022). Previous work on quality premiums (e.g., Kadjo et al., 2016; Abate and Bernard, 2017) also suggests that impurity is the characteristic most easily observable for both traders and farmers, and most important for prices.

We also collected information on farmer demographics, plots, quantities supplied, and market characteristics. Finally, we introduce *woreda* fixed effects in our estimates (and time fixed effects where appropriate). *Woredas* are administrative units encompassing multiple markets within the same agro-ecological zone. Summary statistics of our variables are provided in Appendix Table A2.

4.2 Competition and the intensive margin

We first probe our theoretical predictions concerning the intensive margin, and ask whether variation in the quality of wheat supplied by farmer *i* on market *j* at time *t* (Q_{ijt}) is correlated with the level of competition on local market *j* at time *t*, with own relationship status, and the interaction between these two variables:

$$Q_{ijt} = \alpha + \beta Competition_{jt} + \gamma Relation_{ijt} + \delta Competition_{jt} \times Relation_{ijt} + \theta X_{ijt} + \mu_j + \rho_t + \varepsilon_{ij} \quad (15)$$

Coefficient β captures the effect of competition on wheat quality for spot market farmers who are not in a relationship, γ captures the effect of being in a relationship on wheat quality, and (β+δ) captures the effect of competition for farmers who are in a relationship. We test the theoretical prediction that $\delta<0$. Dependent variables Q_{ij} are dummy variables equal to one if the farmer supplied high-quality wheat according to specific measures, and zero otherwise. Vector *X* captures farmer and market covariates. The terms μ_j and ρ_t are woreda and time fixed effects, respectively. As mentioned, our main analysis of objectively measured wheat quality is based on the subsample of 47 markets where we could measure quality without delay. We report the results in Table 1. We cluster standard errors at the local market level in all models.[22]

<< Insert Table 1 here >>

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[22] Results of the full sample, including the 12 markets where we measured quality with a 6 months delay, are reported in Table A3. While the signs of the relevant coefficients are unaffected, not surprisingly significance levels are compromised by the increased variance of our quality variable.

In columns (1-6), we regress objective measures of wheat quality on our proxies of competition and "being in a relationship", and in columns (7-8) we used subjective wheat quality as the dependent variable. The quality measures in columns (1-4) are observable by traders and farmers (impurity is more straightforward to observe than moisture), but this is not the case for the measure in columns (5-6) — flour extraction rate. The number of markets varies slightly across criteria because there was no within-*woreda* variation in quality across farmers for a few markets. If the quality variable was collinear with the *woreda* fixed effect, the observation was dropped.

Observable and subjective quality measures are positively correlated with the intensity of local competition. However, this correlation is not statistically significant for the extraction rate (the unobservable quality attribute). This result is not consistent with our simple spot price prediction that the quality of farmers' supply does not vary with competition. Instead, this outcome is consistent with an alternative form of price formation on the spot market, where part of the quality premium is claimed by the trader (driving a wedge between marginal cost and marginal benefit of quality investments for the farmer).[23]

There is no clear and robust correlation between being in a relationship and our measures of wheat quality. This lack of a robust overall correlation may reflect that relational contracts do not only exist to raise quality (they may also be convenient, for example). However, the aggregate finding also hides heterogeneity. Our theory predicts that the quality of wheat supplied by farmers in a relational contract will vary with the intensity of

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[23] For example, such an outcome materializes in the case of bilateral bargaining over the surplus between the farmer and the trader. Therefore, we develop a bilateral bargaining model with endogenous wheat quality in Appendix 1. This model predicts that farmers supply higher quality wheat if they can secure a larger share of the value via bilateral bargaining or when they are selling their wheat on a spot market with more competition between traders (so that individual traders have less bargaining power).

competition via the incentive compatibility constraint of farmers; δ<0. This prediction is consistent with our data. In columns (2), (4), and (8), the interaction term is robustly negative and significant for our observable quality measures and the subjective measure. Hence, on average, farmers in a relationship produce lower-quality output when the number of traders per farmer on the local spot market is high (and the incentive compatibility constraint is "tight").[24]

It is interesting to observe in column (6) that we obtain an opposite result for the (unobservable) extraction rate. Farmers have no reason to invest in enhancing quality along this dimension as it does not affect the price they can negotiate (Table A1). We speculate this variable correlates with another observable variable that affects price, such as grain color. The finding that the predicted correlations are found only for observable measures suggests that the results in Table 1 might capture something more than just “associations” between variables (if biases from the correlational analysis are common across quality measures).

We find similar patterns for the subjective quality measure as for the observable quality measures. While farmers do not have access to certification services or quality assessment tools, their knowledge relies on experience and observable attributes. Anissa et al. (2021) and Do Nascimento Miguel (2022) demonstrated that farmers’ quality self-measurement is highly correlated with measured quality.

Result 1: *Correlations in our observational data are mostly consistent with model prediction 1. Observable crop quality in relational contracting goes down if the intensity of*

[24] The bilateral bargaining model in Appendix 1 produces a comparable comparative static prediction: according to this model, competitive spot markets also tighten the incentive compatibility constraint for farmers, enabling traders to provide less quality-enhancing inputs. This is readily verified by substituting the expression for π_F^{BB} for π_F^{C} in (10) and following the steps in the main text.

competition on local spot markets increases. However, the quality of wheat supplied by spot market farmers on "competitive markets" is higher than on markets where there is little competition between traders – a result that is not consistent with Cournot bargaining on spot markets.

4.3 Competition and the extensive margin

The theory predicts that more farmers will be included in relationships when the local spot market is less competitive (when traders have more market power). The reason is that the incentive compatibility constraint for the marginal farmer is relaxed when prices paid on local markets go down. In Table 2, we report correlations between the share of farmers in a relationship and the competitiveness of the local market. In both columns, we regress the share of farmers in a relationship in market *j* at time *t* on our measure of competition in market *j* at time *t*, with and without controls, in columns (1) and (2):

$$Share\ of\ farmers\ in\ relation_{jt} = \alpha + \beta Competition_{jt} + \gamma X_{jt} + \mu_j + \rho_t + \varepsilon_{jt}. \quad (16)$$

There exists a negative correlation between the intensity of competition and the share of local farmers in a relationship. Hence, and consistent with our theory, relational contracting is more inclusive when traders have more market power on local markets, and temptation to renege by farmers goes down.

<< Insert Table 2 here >>

The theoretical model was based on the assumption of farmers who are identical in all but one dimension: access to the nearest wheat market. This defines a "critical distance" threshold beyond which relational contracting can be supported. To probe this issue, we have access to two proxies for market access: a survey-based measure of travel time of farmer *i* to the nearest local market (in minutes) and distance between the farm household and the nearest wheat market (in kilometers).

$$Relation_{ijt} = \alpha + \beta Competition_{jt} + \gamma Distance_{ijt} + \delta Competition_{jt} \times Distance_{ijt} + \theta X_{ijt} + \mu_j + \rho_t + \varepsilon_{ij} \quad (17)$$

We provide correlations for both access proxies in Table 3, and they provide weak support for the theory. First, consider the interaction term. For farmers who need more *time* to travel to the market (column 1), more intense competition is associated with a lower probability of being in a relationship with a trader ($\delta<0$). We also find a negative correlation when using the travel *distance* measure instead (column 2). This suggests that relationships become less inclusive as competition intensifies — as predicted.

The theory also has a prediction regarding the "level effect" of market access: farmers with less access to markets are more likely to be in a relationship than farmers with better access: $\gamma>0$. This is not robustly evident from the data. While we obtain the expected result for our *distance* measure (column 2), the theory is not supported when we use *travel time* as a proxy for market access, for which we find no significant correlation with relational contracting ($\gamma=0$). This may be because the theory simplified matching costs for traders reaching out to farm households (which focused on the social distance between farmer i and trader k, but did not feature the geographical location of farmer i). While farmers living "far away" from markets are attractive partners for traders because of their low propensity to renege on agreements, this benefit may be eroded if trader transaction costs are high. The relation between distance and the probability of engaging in relational contracting will be more complex if traders' transaction costs increase in distance. This could be an important topic for future research.

<< Insert Table 3 here >>

Result 2*: Our results are mostly consistent with prediction 2 of our model. Fewer farmers are included in relational contracting if the competition on local spot markets increases. Moreover, farmers further away from local markets are crowded-out of relational contracting when markets become more competitive. However, the role of market access in the selection process of farmers for relational contracting is complex.*

5. Discussion and conclusions

This paper connects two key issues in agricultural underdevelopment—the perceived lack of competition on remote commodity markets and the low quality of smallholder supply. Our main result is an application of the well-known theory of the second-best (Lipsey and Lancaster, 1956). In a context with multiple market distortions (imperfect contracting and imperfect competition), addressing one distortion may reduce overall efficiency rather than increase it. We argue that policies aiming to increase competition between traders may impede relational contracting and decrease the quality of smallholder supply on local markets.

The reason is as follows. If formal contracting is expensive, relational contracting may emerge as a substitute. Relational contracting enables matched partners to negotiate the price of the crop as well as its quality and associated levels of input supply. We assume that traders can provide quality-enhancing inputs are inaccessible for farmers and develop a model where traders and farmers can either trade on the spot market or engage in a relationship. Hence, the opportunity cost of relational contracting is endogenously determined by (potential) earnings on the spot market. These latter earnings are a function of the intensity of competition: farmers fare better on the spot market as it becomes more competitive.

Relational contracts in which more inputs are transferred can be negotiated when the fallback position on the spot market is “worse” for farmers—when traders grab a greater share of the crop’s value. Our model shows that when competition between traders increases, they provide less enhancing-quality inputs to farmers, which lowers quality of the crop they supply in an informal relationship. Then, we identify the subset of farmers who can be included in relational contracting and explore the nature of the contract that is negotiated. We predict that more competition between traders lowers crop quality by crowding-out relational contracting. We present anecdotal evidence consistent with predictions about shifting intensive and extensive margins, using data from a sample of Ethiopian wheat markets. However, we hasten to add causal interpretations are necessarily speculative as we do not have exogenous variation in key variables.

Policy interventions that promote the competitiveness of local markets (more permits for traders, investments in rural infrastructure that reduce transport cost) may thus "backfire" in the sense that they undermine the ability to engage in relational contracts and commit to cooperative behavior. As a result, technology transfer may be stalled, and the value of farmers' agricultural production matched with a trader will decrease. The aggregate effect of such interventions on quality is therefore difficult to predict.

An important lsson is that interventions aimed at increasing competition on markets will have distributional consequences in addition to the (complex) effects on crop quality and efficiency. For instance, if relational contracts involve input provision by traders, farmers receive an efficiency premium to prevent side-selling — a form of profit sharing between trader and farmer. Policies that make local markets more or less competitive will directly affect the income of spot market traders, but will also have an effect on the set of farmers qualifying for an efficiency premium and the magnitude of that premium. Most reform measures will therefore create winners and losers among the population of farmers.

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Appendix 1: bilateral bargaining over the surplus between farmer and trader

Farmers and traders are randomly matched on a local spot market and bilaterally bargain over the surplus created by trading a unit of agricultural output. Trader and farmer bargain over the unit price *p* paid to the farmer for a unit of *given quality*—the farmer´s effort at that point in time is "sunk". The Nash bargaining solution for the match between a trader and farmer *i* solves;

$$p_i^N = \arg max_p \{(P(e_i) - \tau - p)^\alpha (p - v)^{1-\alpha}\}, \tag{A1}$$

where α is a measure of the bargaining power of the trader. We assume that the trader´s bargaining power varies with the intensity of competition on the local market, capturing that it is easier for farmers to walk away from a bargaining situation if the number of alternative trading partners is greater.[25] Consistent with the motivational example presented below, we define $\theta = \frac{N_T}{N_F}$ as the ratio of traders to farmers, which is a measure of the intensity of competition on the local market. Hence, $\alpha'(\theta) < 0$. The solution of (1) implies:

$$p_i^N = (1 - \alpha)[P(e_i) - \tau] + \alpha v. \tag{A2}$$

Variation in the crop´s default value v_i across farmers implies that crop prices paid to farmers also vary across matches. Assuming that trading is efficient so that the surplus of a traded unit exceeds the value of a self-consumed one $(P(e) - \tau > v)$, then two insights follow directly. First, if local agricultural markets become more competitive, the bargaining power of individual traders goes down, and prices paid to smallholders increase; $\frac{\partial p^N}{\partial \alpha} < 0$. Second, the

[25] In the literature, primitive bargaining power is usually assumed to depend on exogenous preference parameters such as the degree of impatience or risk aversion of bargaining agents (see Rubinstein 1982). In this model the intensity of competition, or the ratio of farmers to traders, is also assumed to be exogenous (see, for example, Antras and Costinot, 2011, for a more complex general equilibrium model with an endogenous number of traders).

quality of output produced and traded is inefficiently low, and increases in the intensity of competition between traders. Observe that farmers choose effort to maximize income;

$$\pi_F = (1-\alpha)[P(e_i) - \tau] + \alpha v - c(e_i). \tag{A3}$$

Denote the farmer´s optimal effort level by $\hat{e}$, which is implicitly defined by $(1-\alpha)P' = c'$. If the farmer had full bargaining power ($\alpha = 0$), he would choose the efficient level of effort and capture all the (extra) value that is created. For $\alpha > 0$, the farmer chooses an inefficient level of effort (from society´s perspective) because part of the benefits of producing quality is creamed off by the trader. Effort levels are decreasing in bargaining power of the trader and, hence, increasing in the intensity of trader-competition;

$$\frac{d\hat{e}}{d\alpha} = \frac{P'}{(1-\alpha)P'' - c''} < 0, \text{ and} \tag{A4}$$

$$\frac{d\hat{e}}{d\theta} = \frac{\alpha' P'}{(1-\alpha)P'' - c''} > 0. \tag{A5}$$

This explains the common intuition that market power compromises efficiency by undermining incentives for quality improvement by smallholders, and that interventions that make local markets "more competitive" will result in crops of greater value. Under bilateral bargaining, with different partners across different rounds of trading, the (expected) incomes are as follows;

$$\pi_F^{BB} = (1-\alpha)[P(\hat{e}_i) - \tau] + \alpha v - c(\hat{e}_i), \text{ and} \tag{A6}$$

$$E(\pi_T^{BB}) = \alpha[P(\hat{e}) - \tau - v]. \tag{A7}$$

Result A1: *Competition between traders raises spot market prices paid to farmers and increases average crop quality produced by farmers.*

Using (A6-7), the relational contracting model can be developed as in the main text. This model yields that (i) more intense competition on spot market shifts the intensive margin inwards (as Result 1 in the text) and may shift the extensive margin in or out.

Tables

Table 1: Competition, relational contracting and quality of wheat production

	Objective quality						**Subjective quality**	
	Moisture		***Impurity***		***Extraction rate***			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Competition	1.47^{***} (0.7)	1.99^{***} (0.76)	1.21^{**} (0.52)	1.51^{***} (0.46)	-0.58 (0.59)	-1.2^{*} (0.73)	1.33^{***} (0.45)	2.39^{***} (0.75)
Relationship	-0.09 (0.16)	0.17 (0.22)	0.01 (0.12)	0.12 (0.16)	0.11 (0.19)	-0.24 (0.24)	0.17 (0.24)	0.71^{**} (0.3)
Competition × relationship		-1.75^{**} (0.91)		-0.8^{*} (0.49)		2.39^{*} (1.39)		-3.06^{**} (1.61)
Constant	-0.51 (5.85)	-0.48 (5.71)	2.91 (2.36)	3.02 (2.36)	-10.09^{***} (3.6)	-10.3^{***} (3.73)	-6.56^{***} (1.74)	-6.78^{***} (1.56)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Spatial FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number farmers	2140	2140	1852	1852	2047	2047	1693	1693
Number markets	47	47	41	41	45	45	58	58

Notes*:* logistic regression models, dependent variable is wheat quality supplied by smallholders and equals to one if it is a high-quality wheat. Included controls: type of wheat product by farmer i, yearly wheat production by farmer i, quantity supplied by farmer i, plot size of farmer i, famer i distance to market j in kilometers, age of farmer i, gender of farmer i, distance market j to Addis Ababa (equals to one if the market is among the farthest from Addis), rank of market j (equals to one if it is the main district market), number of cooperatives and flour factories active on market j, market j weather on surveyed day, presence of a price information board on market j, altitude of market j, survey month (or week in columns (7) and (8)) and enumerators. Woreda fixed effects are included. Standard errors in parentheses are clustered at the market level. Significance levels: * p ≤0.1; ** p ≤0.05; *** p ≤ 0.01.

Table 2: Competition and the extensive margin of relational contracting

	Share farmers in relation	
	(1)	(2)
Competition	-0.55*** (0.16)	-0.54*** (0.16)
Constant	1.88*** (0.42)	0.41*** (0.12)
Controls	Yes	No
Spatial and time FE	Yes	Yes
Number farmers	3483	3483
Number markets	60	60

Notes: ordinary least square regression models, dependent variable is the share of farmers in a relationship. Included controls: type of wheat product by farmer i, yearly wheat production by farmer i, quantity supplied by farmer i, plot size of farmer i, farmer i distance to market j in kilometers, age of farmer i, gender of farmer i, distance market j to Addis Ababa (equals to one if the market is among the farthest from Addis), rank of market j (equals to one if it is the main district market), number of cooperatives and flour factories active on market j, market j weather on surveyed day, presence of a price information board on market j and altitude of market j. Woreda and surveyed month fixed effects are included. Standard errors in parentheses are clustered at the market level. Significance levels: * p ≤0.1; ** p ≤0.05; *** p ≤ 0.01.

Table 3: Competition, distance and the extensive margin of relational contracting

	Relationship	
	(1)	(2)
Competition	1.45 (1.75)	0.25 (1.23)
Travel time to market	0.09 (0.09)	
Distance to market		0.20* (0.12)
Competition × Travel time	-0.86** (0.40)	
Competition × Distance		-1.15** (0.52)
Constant	5.42** (2.57)	5.70** (2.62)
Controls	Yes	Yes
Spatial and time FE	Yes	Yes
Number farmers	3471	3471
Number markets	60	60

Notes: logistic regression models, dependent variable is a dummy equals to one if the farmer is in relational contracting. Included controls: type of wheat product by farmer i, yearly wheat production by farmer i, quantity supplied by farmer i, plot size of farmer i, famer i distance to market j in kilometers (only in column 1), farmer i travel time to market j in minutes (only in column 2), age of farmer i, gender of farmer i, distance market j to Addis Ababa (equals to one if the market is among the farthest from Addis), rank of market j (equals to one if it is the main district market), number of cooperatives and flour factories active on market j, market j weather on surveyed day and altitude of market j. Woreda and surveyed month fixed effects are included. Standard errors in parentheses are clustered at the market level. Significance levels: * p ≤0.1; ** p ≤0.05; *** p ≤ 0.01.

Appendix

Table A1: Wheat prices and wheat quality

	Objective Quality			**Subjective**
	Moisture	***Impurity***	***Extraction Rate***	
	(1)	(2)	(3)	(4)
Wheat Quality	-0.01 (0.01)	0.02*** (0.01)	0.01 (0.01)	0.2*** (0.01)
Constant	2.71*** (0.28)	2.69*** (0.27)	2.71*** (0.28)	2.88*** (0.17)
Controls	Yes	Yes	Yes	Yes
Spatial and Time FE	Yes	Yes	Yes	Yes
Number farmers	2133	2133	2133	1676
Number markets	47	47	47	58

Notes: OLS regression models, dependent variable is wheat price in Birr per kg obtained by farmer i (logarithmic form), wheat quality supplied by smallholders and equal to one if it is a high-quality wheat. Included controls: type of wheat product by farmer i, yearly wheat production by farmer i, quantity supplied by farmer i, plot size of farmer i, farmer i distance famer to market j, age of farmer i, gender of farmer i, distance market j to Addis Ababa (equals to one if the market is among the farthest from Addis), rank of market j (equals to one if it is the main district market), number of cooperatives and flour factories active on market j, market j weather on surveyed day, presence of a price information board on market j, altitude of market j. Woreda and week fixed effects are included. Standard errors in parentheses are clustered at the market level. Significance levels: * $p \leq 0.1$; ** $p \leq 0.05$; *** $p \leq 0.01$.

Table A2: Summary statistics

Variables	N	Min	Max	Mean	St.Dev
Impurity	2950	0	1	0.678	0.475
Test weight	2946	0	1	0.287	0.453
Moisture	2949	0	1	0.672	0.469
Subjective quality	1694	0	1	0.319	0.466
Competition	3484	0.004	0.932	0.133	0.157
Relationship	3484	0	1	0.546	0.498
Wheat	3484	0	1	0.94	0.237
Production	3484	7	55000	2723.263	3431.445
Quantity sell	3484	2	2500	83.084	129.959
Plot size	3484	0.025	12	0.984	0.907
Travel time	3483	0.25	240	58.004	46.144
Distance to Market	3472	0	60	6.405	5.331
Age	3484	12	100	36.373	13.586
Gender	3484	0	1	0.541	0.498
Distance to Addis Ababa	3484	0	1	0.471	0.499
Central market	3484	0	1	0.505	0.5
Cooperatives	3484	0	4	0.964	1.082
Flour factories	3484	0	8	1.612	2.142
Weather	3484	0	1	0.863	0.344
Information board	3484	0	1	0.017	0.130
Altitude	3484	1819	3072	2326.839	250.982

Notes: wheat is equal to one for bread wheat and zero for durum wheat, production and quantity sell are in kg, plot size is in Ha, travel time to market is in minute, distance to market in km, gender is equal to one for male and zero for female, distance to Addis Ababa is equal to one if the market is among the 50 percent farthest from Addis Ababa, cooperatives is the number of cooperatives that actively buy wheat in the market, number of flour factories is at the Woreda level, weather is equal to one if the surveyed day was not rainy, information board is equal to one if there is a price information board in the market, altitude is in meters.

Table A3: Competition, relational contracting and quality of wheat production (full sample of markets)

	Objective quality					
	Moisture		***Impurity***		***Extraction rate***	
	(1)	(2)	(3)	(4)	(5)	(6)
Competition	0.77 (0.76)	1.0 (0.86)	0.38 (0.66)	0.72 (0.61)	-0.4 (0.76)	-0.66 (0.86)
Relationship	-0.07 (0.16)	0.03 (0.23)	-0.08 (0.11)	0.02 (0.15)	0.16 (0.15)	0.04 (0.23)
Competition × relationship		-0.74 (1.0)		-0.8 (0.61)		0.88 (1.31)
Constant	-4.77 (3.21)	-4.86 (3.18)	-5.56** (2.9)	-5.63** (2.9)	-7.15* (3.87)	-7.0* (3.93)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Spatial FE	Yes	Yes	Yes	Yes	Yes	Yes
Number farmers	2803	2803	2637	2637	2616	2616
Number markets	56	56	53	53	50	50

Notes*:* logistic regression models, dependent variable is wheat quality supplied by smallholders and equal to one if it is a high-quality wheat. These models are based on the full sample of markets, including the 11 markets where we measured wheat quality with a 6-months delay. Included controls: yearly wheat yields by farmer i, farmer i travel time to market j, age of farmer i, gender of farmer i, distance market j to Addis Ababa (equals to one if the market is among the farthest from Addis), rank of market j (equals to one if it is the main district market), number of cooperatives active on market j, market j weather on surveyed day, presence of a price information board on market j, altitude of market j, farmers and traders growth rate between both surveys' round on market j, wheat price seasonality on market j, survey month and enumerators. Woreda fixed effects are included. Standard errors in parentheses are clustered at the market level. Significance levels: * $p \leq 0.1$; ** $p \leq 0.05$; *** $p \leq 0.01$.

Figure A1: Sampled *woreda* in the market survey