Long-Term Contracts and Repeated Interaction: Evidence from the Costa Rican Coffee Market

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Abstract: We use contract-level data from the Costa Rican coffee industry to explore the relationship between formal and relational contracts—in particular, the relationship between long-term contracting and repeated interaction. Long-term contracts may be useful in this industry for many reasons, including price hedging, assurance of supply, and—especially in the case of differentiated beans (those with a designation regarding sustainability or place of origin)—to protect against hold-up when an exporter makes specific investments in developing and marketing a blend of differentiated beans provided by a limited number of mills. However, long-term contracts in this setting may be costly and difficult to enforce. As a result, long-term contracts may be more effective and more attractive on balance (given that they do come with costs of inflexibility) when employed between frequently contracting parties who can use the power of relational contracting to improve the enforceability of the long-term formal contract. The empirical analysis demonstrates that in fact more frequently contracting firms are more likely—other things equal—to employ long-term contracts than are infrequently contracting firms; this is especially so for differentiated beans. The result persists when we address identification problems such as unobservable heterogeneity and endogenous matching through fixed effects and instrumenting strategies. We interpret this as evidence that relational contracting acts as a complement to formal contracting by improving the enforceability of formal contracts.

I. Introduction

Scholars in contract and organizational economics have long sought to understand the relationship between explicit and implicit contracts. Both theoretical and empirical contributions demonstrate that there can be an interactive effect—that is, that the frequency of contracting and the power of implicit contracting supported by repeated game considerations may have consequences for the formal contracts chosen by contracting parties. This literature explores a variety of mechanisms, explicit contract features, and settings, and shows that the devil is in the details. Implicit and explicit contracts are neither always complements (where repeated interaction supports use of stronger formal contracting practices) nor always substitutes (where repeated interaction obviates the need for stronger formal contracting and instead replaces it). The effect can go either way, depending on the mechanism, the contracting hazards, and the particulars of the setting. A subsequent draft will expand significantly on both the theoretical and empirical literatures that address these questions.

We explore this classic question specifically with respect to the choice of length of the formal contract: does implicit contracting lead to longer or shorter explicit contracts? We provide a theoretical model that shows why we might reasonably expect a relationship of complements in this case, especially when formal contract enforceability is imperfect: implicit contracting can help to mitigate the temptation to renege on a long-term contract, thereby making it worthwhile to go to the expense of writing formal long-term contracts. We also present empirical evidence from the Costa Rican coffee market to show that this pattern is in fact present in this market. Moreover, the empirical results withstand a variety of empirical strategies for addressing omitted variable bias, endogenous matching of buyers and sellers, and other empirical challenges.

This paper contributes to the literature on the interaction between implicit and explicit contracting by focusing specifically on contract length, an aspect of formal contracts not previously highlighted in this literature, and by bringing to these questions a novel dataset that has many compelling features. These include the granularity of the observations; the large number of players and incidence of multi-transaction and multi-partner players (allowing robust use of fixed effects); and the existence of parallel, related markets in which the same players contract, allowing an exploration of economic linkages across markets.

II. Theoretical Considerations

Long-term contracts may have a variety of benefits for the trading partners. They may allow the contracting firms to ensure supply of a raw material for a buyer, ensure demand for an output for a seller, enable economizing on various logistics and transportation costs by creating predictability in volumes, serve to hedge price risk, and so on. They may also encourage the firms to make specific investments in a joint output that would not be made absent the contract because of concerns of ex post hold-up.

Whatever the benefits provided, a long-term contract also imposes a variety of costs on the firms. These include the ex ante forecasting, planning, negotiating, legal, and other costs incurred at the outset in writing the contract. In addition, abiding by the long-term contract may have ex post costs in periods when more favorable trading opportunities arise, which must be foregone in order to honor the long-term contract. To be meaningful, a long-term contract must provide some incentive to forego these opportunities to increase profits by reneging on the long-term contract. These incentives may arise from breach penalties when contracts are enforceable by formal means or from loss of future gains from trade when the contract is enforced through the logic of repeated contracting or implicit contracts.

The benefits of the formal long-term contract are realized exclusively when and if the contract is honored. The costs, in contrast, are to a large extent incurred up front in the writing and negotiating of the contract. As a result, two important intertemporal linkages arise. First, a long-term contract is likely to be attractive today only if it is expected to be honored in a future period. Second, absent strong, low-cost contract enforcement, such a long-term contract is likely to be honored in that future period only if the promise of additional gains in periods still further in the future are sufficient reward for abiding by the contract in periods when reneging is short-term profitable. Thus, repeated interaction in this case may sustain through an implicit contract mechanism the reliability or enforceability of an explicit long-term contract, allowing the advantageous long-term contract to be written with confidence that it will be honored. This is portrayed intuitively in Figure 1.

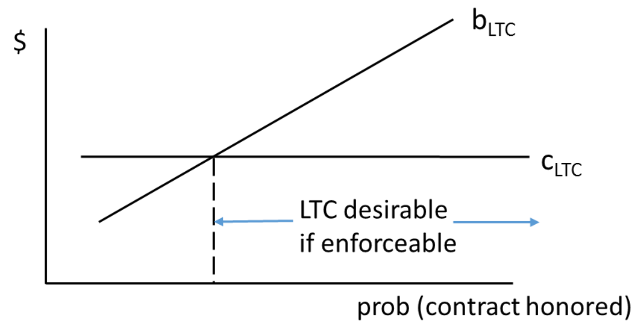

Figure 1a. Per-period costs (c_{LTC}) and benefits (b_{LTC}) of long-term contracting

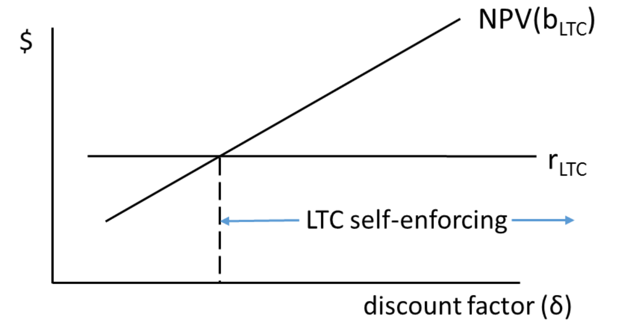

Figure 1b. Per-period gain to reneging on LTC (r_{LTC}) and NPV of continued long-term contracting

The left panel illustrates that the per-period benefits (which are realized only when the LTC is honored) are increasing in the likelihood that the LTC will be honored, while the per-period costs of writing the LTC are fixed. When the contract is likely to be honored, expected benefits exceed the costs and it is on balance attractive to the contracting parties. The right panel illustrates that the contract becomes enforceable thanks to the power of repeated interaction. The per-period gain to reneging on the LTC contract is constant in the discount factor, whereas the NPV of the future value of the relationship, which provides the implicit incentive to honor the LTC, is increasing in the discount factor. For strong enough implicit contracting (a high enough discount factor), the LTC is enforceable through the power of implicit contracting.

This logic implies that long-term contracting would be more likely to be used in the presence of repeated interaction, since that repeated interaction provides the enforceability of the LTC that may otherwise be lacking. In this sense, this logic implies that formal, explicit contracting (here embodied in longer term contracts) is a complement to relational, implicit contracting (here embodied in the discount factor or importance of repeated interaction). It is this relationship that we seek to explore and test in this paper.

To make this more concrete, consider a simple example in which long-term contracts extend from one period to the next (this theoretical logic is explored more fully in Corts (2017)). A buyer (who processes an input to create a product for a final market) and a seller (with unit demand and supply, respectively) each have the opportunity to earn surplus of v by transacting in a spot market. However, with probability $g<1/2$ the seller (but not the buyer) may have the opportunity to earn surplus of $v + z$. If the buyer makes an investment of k in one period in tailoring its product to this specific seller's input, then the buyer and that particular seller can realize joint surplus of 2(v + w) by transacting with each other in the following period (rather than the joint surplus of 2v they get by trading in the spot market in the usual case. Denote the discount factor d.

Assume z>2w. Then with ex post surplus bargaining per the usual assumptions (each party gets its outside option plus half the remaining surplus), the surplus captured by each party is as follows. Without the investment in the prior period, the buyer always gets v, and the seller gets v with probability 1-g and v+z with probability g. With the investment in the prior period, the buyer and seller each get v+w with probability 1-g. Note that with probability g the seller does not transact with this seller (because z>2w, there is not enough surplus to keep the seller interested in the transaction, even though bargaining would shift the entire 2w to the seller), and the investment is wasted; the buyer captures v and the seller captures v+z.

Because this model is illustrative and not complete, focus on one specific and natural potential deal the buyer and seller could reach: the buyer agrees to make the investment in every period, and the seller agrees that the buyer will receive v+w in every period. This involves the buyer paying the seller w out of its surplus in the fraction g of periods in which it has the very high outside option, opts out of the transaction, and strands the specific investment. In the fraction 1-g of periods in which the buyer does transact with the seller, this surplus is simply the surplus earned according to the bargaining rule.

Assume that k is small enough that the buyer will make the investment under the above contract (ie, it is willing to make the investment if it trusts that is will be compensated w even if the seller has a better outside option): k<dw. This follows from the comparison of what the buyer can earn with and without the investment; the buyer prefers to invest if –k + d[v+w]>dv.

In addition, assume that k is big enough that the buyer will not make the investment absent the above contract (ie, it is not willing to make the investment if it believes it will be compensated w only in the 1-g fraction of the periods in which this is guaranteed by the bargaining rule): k>d(1-g)w. This follows from the comparison of what the buyer can earn with and without the investment; the buyer prefers not to invest if –k + d[v+(1-g)w] < dv.

Together, these conditions indicate that we are focusing on an intermediate k (d(1-g)w<k<dw) such that the buyer will make the investment if and only if there is a long-term

contract ensuring it receives w even in the periods in which the seller prefers to trade with another buyer.

Note also that this condition on k (specifically the upper bound $k<dw$), together with the assumption that $g<1/2$, also implies that the investment is efficient: expected joint surplus is higher if the investment is made than if not. Joint surplus is higher with the investment if $-k + dg(2v+z) + d(1-g)(2)(v+w) > d(2v+z)+d(1-g)(2v)$, which reduces to $k<2d(1-g)w$. This condition $k<2d(1-g)w$ is a weaker condition than the upper bound $k<dw$ already assumed.

Therefore, the parties are mutually better off under this contract, and it would satisfy the buyer's incentive constraint, ensuring ex ante investment in every period. It is a very attractive long-term contract that ensures efficient relationship-specific investments, if it is enforceable. However, the seller has the incentive to reneg in a one-shot version of this game. In the event that it has an attractive outside offer, it prefers to refuse to pay the promised w and still collect the v+z from the outside option rather than to abide by that contract ($v+z>v+z-w$).

This is precisely where the repeated relationship increases the attractiveness of the long-term contract. It can provide the implicit contracting power to make the posited long-term contract self-enforcing, enabling these efficient investments. In this model, one must check only the case with the high outside option for the seller because the other case is self-enforcing by construction as it mimics the bargaining rule. Thus, the contract is self-enforcing if the seller prefers to pay the buyer w in this period and continue working in a repeated relationship in which the buyer makes the investment each period to claiming the full z (not paying the buyer w) in the current period and forever after forgoing the gains from the buyer's investments: $v+z-w + d/(1-d)[(1-g)(v+w)+g(v+z-w)] > v+z + d/(1-d)[(1-g)v+g(v+z)]$.[1] This simplifies to $d>1/[2(1-g)]$, which implies a threshold d between 0 and 1 (because $0<g<1/2$). Thus, the LTC is self-enforcing only for large enough discount factors. Repeated interaction makes long-term contracting more feasible and more attractive. Implicit contracting strengthens (here, lengthens) formal contracts.

Note that one could argue that the implicit contracting power of repeated interaction in this case renders unnecessary the LTC itself. Where we have interpreted it as making the LTC enforceable and therefore worth undertaking, one could also interpret it as having made the LTC

[1] In this literature, the standard assumption is that once a party has reneged on an implicit contract it can never again enter a new implicit contract, but can earn only what a one-shot game bargaining solution implies in each period.

redundant and unnecessary. This is technically correct in this simple model. That is, the posted LTC need not be written down (need not be a "formal contract") for the logic of the above analysis to apply; the entire arrangement could be part of the implicit relational contract. This is in essence the logic of some arguments in the literature that implicit and formal contracts should be substitutes. In any case, the underlying theoretical principle this model illustrates is that the implicit contracting power from repeated interaction has made the intertemporal linkage between the buyer's investment and the seller's subsequent payment (when it opts out of the bilateral relationship) feasible, credible, and desirable. Whether or not this intertemporal linkage is written down as a formal contract is not something this model can address; the model is equally accommodating of both interpretations. As discussed more fully in the remainder of the text, in our particular empirical application every transaction must be governed by a written contract; we believe that this makes our interpretation of this model especially relevant in this empirical context.

III. Institutional Setting

The coffee bean industry in Costa Rica is comprised of three sets of vertically-related players: growers (more than 50,000), mills (more than 200), and exporters (more than 50). Growers are the producers of the raw agricultural output, coffee cherries. Coffee cherries are delivered to mills, which remove the pulp of the cherries and wash and dry the coffee beans; these minimally processed beans are then sold as inputs to exporters. The exporters are specialized intermediaries between the local industry and international buyers, which are primarily coffee roasters and coffee traders in importing nations. The exporters purchase coffee beans from different mills to create both branded and non-branded blends that they sell to international buyers.[2]

The "Instituto de Café" (ICAFE), the coffee industry supervisory board in Costa Rica, was established to monitor the relationship between actors in the industry in order to verify that upstream actors receive a "fair share" of the value created in the value chain. While mills and exporters negotiate the conditions for each transaction bilaterally without the intervention of ICAFE, they must submit their contracts to the ICAFE in a standardized form for final approval.

[2] This institutional setting and dataset are described and developed more fully in a previous paper by one of the authors (Martinez, 2015).

The transacting parties typically negotiate a unit price in terms of a basis plus a differential. The Intercontinental Exchange (ICE) Futures U.S. Coffee "C" Contract provides the price basis, which constitutes the greatest portion of the unit price. The differential is a positive or negative value negotiated bilaterally depending on the attributes of the coffee under exchange. The role of ICAFE is to verify that the price negotiated in each contract meets a reasonable minimum level according to the prevailing market conditions to prevent excessive shifting of rents downstream. In practice, the rejection of a proposed contract is an extraordinarily rare occurrence.

Until 2001, all coffee produced in Costa Rica was treated as a homogeneous input. This model did not provide strong incentives for industry participants to invest in the quality attributes and sustainability standards that an emerging and rapidly growing segment of the developing coffee market was starting to demand. In 2002, facing the "Coffee Crisis" with coffee beans at their lowest real prices in 100 years, and with the opportunity to tap into this new market segment, ICAFE established a new program to stimulate the production of coffee with differentiated attributes. The program entailed significant changes in the operation of both growers and mills. To participate in the market for "differentiated" beans, growers had to meet strict quality standards, adhere to sustainable farming practices, and/or come from defined and protected geographic origins. Mills also had to invest in new production lines dedicated exclusively to the processing of the differentiated coffee cherries. Finally, pricing for "differentiated" coffee diverged from that of the "standard" product, reflecting the differing values of these inputs to the downstream actors, and creating a mechanism by which growers and mills could recoup investments in meeting the strict standards for differentiated beans.

ICAFE almost implements a standardized quality classification scheme across both standard and differentiated beans. This quality classification scheme classifies coffee beans along three dimensions: bean type, quality grade, and preparation. Bean type encompasses eight categories based on a grower's geographic location and agro-climatic conditions. Quality grade identifies seven different grade levels, based on the density of parchment coffee. Finally, preparation comprises six different sub-categories based on the tolerance of physical defects for the coffee beans ready for sale.

Exporters may procure coffee beans through some combination of spot market transactions, forward contracts, ongoing (multi-delivery) long-term contracts, and vertical integration with investment in milling facilities of their own. The selection of sourcing strategy is a crucial decision, especially in the case of differentiated beans since these beans are specialized and scarce, with the aggregate of these fragmented segments together accounting for only 22% of sales in the market. Exporters need to be able to ensure a supply of beans of appropriate types in order to meet their ongoing obligations to their customers, to meet market demand, and to protect their specific investments in developing and marketing differentiated blends against hold-up.

However, each sourcing strategy is imperfect and comes with costs. Long-term contracts and vertical integration can seemingly stabilize supply, but these strategies come with inflexibility and costs of their own. Long-term contracts may not be perfectly or costlessly enforceable when shocks in coffee demand and supply create incentives to renege. Moreover, ICAFE allows mills to cancel contracts when they do not have enough coffee to honor their agreement and for exceptional causes assessed by the board. While vertical integration presumably involves fewer contracting hazards, vertically integrated exporters may face inflexible supply with insufficient processing capacity in the face of high demand realizations. Moreover, they may find it difficult to develop and sustain long-term relations with independent mills precisely because the mills know that integrated exporters will prefer the certainty of their internal supply in the future (Macchiavello & Miquel-Florensa, 2016).

IV. Data

Our data come from the "Instituto de Café (ICAFE)," the industry supervisory board in Costa Rica. The board compiles this information to monitor the transactions between industry participants. The dataset contains the universe of forward and term contracts negotiated between all mills and exporters between October 1st, 2007, and September 30th, 2012, comprising five "crop years" extending from October 1 of one year to September 30 of the following year. The dataset excludes contracts between processing mills and local roasters, which represent about 10 percent of the total volume produced in the country. There are 12,769 contracts in the dataset, between 114 exporters and 197 processing mills, governing the trade of 379,000 metric tons (MT) of coffee beans with a total contract value of US$1.47 billion over the 5-year period. Out of these, 2,811 contracts concern beans in the differentiated market (72,000 MT worth US$0.29 billion).

Our interest is in the arm's length transactions between independent mills and exporters. For a host of reasons, the contracting practices of partially vertically integrated firms may be complex and subject to different considerations from those that determine the choices made by independent firms engaged in arm's length contracting. In order to be conservative with respect to the influence of such firms on our results, we eliminate from our dataset every transaction involving either a buyer or seller who is partially vertically integrated (that is, engages in a transaction, even once during our sample period, in which the buyer and seller have common ownership). Thus, the dataset we employ contains only contracts in which both firms are truly independent arm's length contractors for *all* of their demand or supply. The resulting dataset contains 8083 contracts between 70 buyers (exporters) and 179 sellers (mills).

The unit of analysis of this study is the contract, as the fundamental question we ask is whether contract duration is influenced by relational contracting (i.e., repeated interaction between pairs of buyers and sellers). A contract in this industry is a standardized document that specifies the transacting parties; price; quantity; market (standard or differentiated); bean type, quality, and preparation; signing date; and date of delivery (date of final delivery if the contract involves multiple deliveries). From this, it is straightforward to construct the variables of interest. Summary statistics for these variables are presented in Table 1.

The average duration of a contract is 115 days (median 65 days). The vast majority of contracts (95%) are a year or shorter, and a 25% of the contracts are essentially spot contracts with a week or less elapsing between signing and delivery. The average number of contracts between parties that make at least one transaction with each other in a crop season is 6.1 contracts (median 2 contracts). One third of contracts are one-off contracts—that is, situations in which the contracting pair engages in only that one contract in a given crop year (these firms typically have other contracts in that same crop year, but no other contracts with the same counterparty).

To give a sense of the relative size of the players in the industry, it is useful to consider some summary statistics (these and all subsequent statistics refer only to our set of firms that do not engage in vertically integrated transactions). It may be tempting, especially given the historical motivations for the creation of ICAFE, to think of this market as characterized by very large exporters that one might reasonably expect to be more powerful and more sophisticated than very small mills. However, it is important to remember that mills are not the growers, but rather are cooperative or commercial enterprises of some scale. In addition, once one excludes the vertically integrated exporters, the remaining independent exporters are for the most part not enormous multinational agribusiness enterprises.

Exporters are on average less numerous and larger than mills. However, the differences are not overwhelming. Each year, there are between 36 and 44 exporters buying from between 114 and 136 mills. Exporters average 42 contracts a year, totalling 1,200,000 MT and $4.6m, while mills average 18 contracts a year, totalling 519,000 MT and $1.4m.

In addition, it is important to get a sense of the extent to which buyers and sellers interact in a larger marketplace. In our sample (excluding transactions involving vertically integrated firms), a mill on average contracts with 3.3 different exporters to move its product in a given crop year, while an exporter on average contracts with 24.9 mills to procure its raw materials in a given crop year.

V. Econometric Approach

As described in section II, the central empirical question we seek to answer is whether repeated interaction affects the use of explicit long-term contracts. We posit that repeated interaction will have this affect, as predicted by the model of section II. Such a model makes two main, related predictions. First, repeated interaction will lead to greater use of long-term contracts. Second, this should be especially true for classes of transactions (in our setting, those involving differentiated beans) that we expect to reap especially large benefits from long-term contracts when enforceable.

In order to answer these questions, we will first assess correlations of contract length and contracting frequency and explore how this varies by bean type. However, we identify a number of reasons that this correlation might arise spuriously, as result of measurement concerns or as a result of endogenous matching of contracting parties. We explore a variety of techniques to attempt address these concerns and identify the effect of interest based on underlying exogenous variation.

Regression model structure

All our regression models share a basic structure. In all cases the unit of observation is the contract, and the dependent variable is log(contract duration). In addition, all models include as regressors a measure of contracting frequency, a measure of seller scale, contract volume, and fixed effects for buyer-year, bean quality, bean preparation, and bean type. Contracting frequency is measured in two ways: (1) as the count of contracts between a buyer-seller pair in a given year, and (2) as the log of the aggregate volume of all contracts between the pair in a given year. When the "count" measure is used, the measure of seller scale is the corresponding count measure (*seller # contracts*). When the "aggregate volume" measurement of contracting frequency is used, the measure of seller scale is the corresponding *seller volume* measure. Both the pair's aggregate contract volume and the seller's annual contract volume are logged.

For reasons described below, we also include specifications in which the contracting frequency measure (in both its count and volume versions) is separated into two components. In this case the count (or volume) of standard bean contracts is measured and included as a regressor separately from the count (or volume) of differentiated bean contracts.

Measurement concerns

Simple variable definitions and measurement concerns could induce spurious correlations in contracting frequency and contract length in several ways. Perhaps the simplest problem is that unobserved buyer or seller characteristics could affect both variables of interest, inducing spurious correlation as a result of omitted variable bias. For example, it is possible that the largest buyers both sign the most contracts and deal in the bean types most at risk from hold-up related to specific investments, leading them to have more contracts with all sellers and to use longer-term contracts to address contracting hazards (thereby inducing a spurious positive correlation between contracting frequency and contract length). To address this, all specifications include fixed effects for buyers (or alternative, more granular fixed effects that subsume these) and a measure of seller scale (or, in some cases, seller fixed effects).

A second concern is that there exists a mechanical connection between contract frequency and contract length. For example if for some unobservable reason a firm chooses to use only short contracts (and holding contract volume fixed), the firm will certainly need to engage in more contracts to achieve any given level of aggregate volume—that is, if one uses only short-term contracts (of a given size), one will need to use more of them (to reach a given aggregate volume). This in general would create a mechanical and spurious negative correlation between contracting frequency and contract length. Note that this would bias the results against our hypothesized finding. We employ two strategies for addressing this. First, we conduct all our analysis using two separate measures of contracting frequency. One is based on the number of contracts (which could be subject to the problems just described); the other is based on the aggregate volume of contracts, which would not be subject to this spurious mechanical linkage. Second, we examine the linkage of contracting frequency and contract length *across bean types*. That is, we assess in the data whether a pair's increased contracting frequency in standard beans affects that pair's contract length in contracts governing differentiated beans. The increased contracting frequency in a different bean type *should* affect the strength of the implicit contract and affect enforceability of contract's in the *other* bean type, but it should *not* affect contract length in the *other* bean type in the mechanical way just described.

Endogenous matching

The empirical contracting literature pays special attention to the spurious correlation between contacting party characteristics and contract form that can arise as a result of endogenous matching. In a seminal paper on the subject, Ackerberg and Botticini (2002) study an example in which *riskier* crops appear to be grown under contract forms that leave growers *more* exposed to risk and *less* insured by wealthy landowners in Renaissance Italy. They show that this can be explained as the result of the riskier crops being matched with wealthier growers who were less in need of insurance from landowners. That is, the problematic transaction is endogenously matched both to particular agents and to particular contract forms. They demonstrate a technique for addressing this problem, which was later also employed by Corts and Singh (2004) in the context of offshore drilling contracts, in which instrumental variables techniques are used to identify exogenous variation in agent characteristics at the contract level (subject to endogenous matching) based on the characteristics of *potential* agents at a more aggregate level (not subject to exogenous matching). This is also the technique we employ in this paper. Since the approach is well-established, we review it only briefly here.

The problem in our context would arise if, for example, a buyer who worked with a particular type of differentiated bean decided that to address the inherent contracting hazards it needed *both* to use a long-term contract *and* to buy its beans primarily (and frequently) from the most reputable seller. In this case, the contracting frequency with this seller is *not* exogenous variation at all. Rather, it is correlated with unobserved contract characteristics that led to the use of the long-term contract; the correlation between contracting frequency and contract length is again spurious, in effect as a result of omitted variables correlated with both buyer characteristics and contract length.

The solution presented by the Ackerberg and Botticini (2002) paper is to instrument for contracting frequency of a realized buyer-seller pair with the characteristics of the pool of alternative sellers that the buyer could plausibly have considered. In Ackerberg and Botticini's (2002) and Corts and Singh's (2004) implementations of this technique, geographical proximity is used to identify potential trading partners. In the present paper, we use proximity in product space (that is, sellers also offering beans that are similar in quality, type, and preparation) to construct the variables representing characteristics of potential trading partners that are used to instrument for the contracting frequency of the realized trading pair. Specifically, for each contract, we identify as potential sellers all sellers who are party to at least one contract in this bean category (same type, quality, preparation, differentiation). For the specific buyer involved in this contract, we then compute the number of contracts (or aggregate volume of contracts) between each of these potential sellers. This measure of contracting intensity is then averaged across these potential sellers to create the instrumental variable reflecting the average relationship characteristics of the potential sellers, which is then used to instrument for the characteristics of the observed buyer-seller pair.

One can think of this endogenous matching problem in the following way. Consider a contract between buyer i and seller j of bean type k in period t. The contract length for this transaction (L_{ijkt}) depends on characteristics of the buyer, seller, bean type, and the buyer-seller pair (specifically, their contracting frequency or the power of the implicit contract between them—call this R_{ijkt}), as well as an error that contains factors such as unobservable transaction characteristics. At the same time, R_{ijkt} (the contracting frequency with the *chosen* trading partner) is determined by characteristics of the transaction, the buyer, and the contract length, as well as an error that contains factors such as unobservable transaction characteristics (e_{ijkt}). The goal of this approach is to instrument for R_{ijkt} with variables that do not contain that error e_{ijkt}. There are several logical possibilities. The one already described focuses on the "j" (the identity of the seller); the IV strategy described uses characteristics of other sellers ("-j") that would help to determine R_{ijkt} but not because of anything specifically to do with seller "j".

There are two other ways that we (more partially) address this endogenous matching concern. One approach is to focus on the "k"—that is, the bean type, standard or differentiated. The frequency of pairwise contracting in one bean type ("-k") may have an effect on choice of contract length for bean type "k" while at the same time being unlikely to reflect unobserved characteristics of the transaction in another bean type "k" (it may still of course reflect unobservable seller or buyer-seller pair characteristics). We explore these cross-effects in which contracting frequency in one bean type may affect the contract length for the *other* bean type.

The other approach is to focus on the "t"—that is, the time period. The logic in this case is that the frequency of pairwise contracting in one period ("-t") may have an effect on contract choice in period "t" while at the same time being unlikely to reflect unobserved characteristics of transactions in that period "t" (though it could still reflect unobservable seller or buyer-seller pair characteristics).

These latter two alternatives may seem to be weaker solutions than the IV strategy relying on characteristics of potential trading partners. However, both of these latter two approaches push the concern back onto buyer and seller (rather than transaction-level) unobservables, which are more easily addressed through the more stringent fixed-effects specifications presented in the results section.

VI. Results

Table 2 presents regression results that demonstrate our main empirical result: more intensive contracting between two parties is associated with the use of longer contracts. The six regressions in this table present the results from each of our three estimation methods: OLS, IV using lagged contracting intensity as an instrument, and IV using the "potential partner" characteristics as an instrument. Results for each of these three methods are presented for each of the two measurement approaches: contracting intensity measured as a count of contracts and as total pairwise contract volume in a year. Each of these six models includes all control variables described above, as indicated at the bottom of the table.

The coefficient of interest is the pairwise contracting intensity as measured by either contract counts or volume. A positive coefficient on these measures (the second and third row of results across the table) indicates that increased contracting intensity is associated with the use of longer contracts. Indeed, each of these coefficients is positive and significant in the first five specifications. In the sixth specification, the point estimate is positive and similar to that of the other specifications, although the standard error is larger. Thus, the effect that is present in OLS persists and remains fairly similar in magnitude under two alternative IV identification strategies that address the problems of omitted variables and endogenous matching.

To get a sense of the magnitude of the estimated relationship, consider the point estimates in columns v and vi. In column v's semi-log specification, the marginal effect of increasing contracting frequency by one additional contract is a 0.8% increase in contract length. Recall that the average contracting frequency for contracting pairs is 6 contracts. Thus, a simple exercise illustrative of the magnitudes can be derived by calculating the effect of an increase from a one-off contract to the mean level of contracting intensity, an increase of 5 contracts per year. The column v estimate indicates that an increase in contracting intensity from a one-off contract to the mean level of contracting intensity is associated with an increase in contract length of 4%, which—at the mean of contract length of 115 days—translates to about 5 days. In column vi's log-log specification, the coefficient is an elasticity: a 10% increase in pairwise volume is associated with a 2.1% increase in contract length.

Table 3 provides evidence in support of our second hypothesis, which is that this relationship between contracting intensity and contract length will be stronger for differentiated bean contracts, where we expect the gains from long-term contracting to be greater. Table 3 is laid out similarly to Table 2; each of the three identification strategies—OLS, IV with lags, and IV with potential partner characteristics—is presented twice, once with each measure of contracting intensity. What is new in this table is that the contracting intensity is interacted with the "differentiated" and "standard" indicator variables (where "standard" is simply one minus the value of "differentiated"). Presenting the interaction in this way means that we can read the estimated effects directly from the results table rather than having to add two coefficients from a main and interacted effect. Again, the objective in this exercise is to see whether the contract length of differentiated beans is more responsive to contracting intensity than is the contract length of standard bean contracts. If this is the case, the coefficient in the second row should be greater than that in the third row, or the coefficient in the fourth row should be greater than that in the fifth. In addition to comparing the point estimates, it is of course possible to compute the F-statistic for the hypothesis test that the coefficients are equal. P-values for the rejection of this hypothesis are presented at the bottom of each column.

In fact, both of these interacted coefficients are positive in all six specifications (as with the pooled main effects in Table 2), and in all six specifications the coefficient on the interaction with differentiated beans is larger than the coefficient on the interaction with standard beans. In five of the six columns, the equality of the coefficients is rejected at 5% or better in the relevant

F-test. Moreover, the magnitudes are relatively stable, with the specifications all giving point estimates in which the effect on differentiated beans is between 1.9 and 3.5 times the size of the estimated effect on standard beans. Taking column v's estimates and applying the simple interpretation described above, these estimates imply, for example, that increases contracting frequency from a one-off contract to the average frequency is associated with standard bean contracts that are 4 days longer and differentiated bean contracts that are 13 days longer on average.

As discussed in section V, one important estimation challenge is to fully control for unobserved heterogeneity, particularly in the characteristics of the contracting parties. All our specifications employ fixed effects at the buyer level (actually, the buyer-year level), which is not too demanding of the data since the buyers are less numerous than the sellers. This absorbs a great deal of unobserved buyer heterogeneity. While all specifications also include some kind of control for seller scale, this is a much coarser control for seller characteristics, and one might reasonably worry that unobserved seller heterogeneity remains an important concern.

To address this, we also estimate the models of Table 3 with seller fixed effects included, which adds over 100 additional fixed effects. These results are presented in Table 4. Table 4 demonstrates that our main result (established in Table 2) is quite robust to these additional controls: both interacted coefficients are positive and significantly different from 0 in every specification. However, Table 4 also demonstrates that the evidence for our second hypothesis regarding the relative effect on differentiated and standard bean contracts (supported by Table 3) is more fragile. In 3 of the 4 specifications the point estimate is larger for differentiated beans than for standard beans. However, the difference in coefficient estimates is rejected by the F-test only in two cases and only at 10%. Moreover, one of those two cases with a marginally significant F-test result is the specification in which the relative magnitudes of the coefficients is the opposite of the relationship we hypothesized.

As discussed in section V, we also analyze the effect across bean types in order to address concerns about a possible mechanical relationship between contract length and the number of contracts. In the analysis presented thus far, the interacted effects of contracting intensity on each bean type have used measures of *total* contracting intensity—that is, the count of contracts or the aggregate volume of contracts *for both bean types*. In this last piece of analysis, we split the measurement of contracting intensity by bean type as well, allowing us to examine cross-effects such as how standard bean contracting intensity affects differentiated bean contract length. As described in section V, the concerns that this is meant to address are most likely to arise with the count measure of contracting intensity; we therefore limit this analysis to that measure.

Table 5 presents results in 6 columns. Here, each pair of columns represents one of the three identification strategies, while the two columns for each identification strategy present the results for one of the two bean type subsamples. Our first hypothesis that contracting intensity increases contract length would imply positive coefficients across the table. Indeed, of the 12 entries in the table, 11 coefficients have positive point estimates, with 9 of those significant at 5% or better. Our second hypothesis, that the effect is larger for differentiated beans, is harder to assess in this table because it is a hypothesis about comparisons *across* specifications. It does *not* imply that the first coefficient in a column is larger than the second coefficient in that column; rather it implies that the coefficient in the first column for each specification is larger than the same coefficient in the second column for each specification. In fact this pattern does hold for every pair of coefficients in which both are significant, but this is not tested formally due to the complexity of testing coefficient equality across specifications (especially, as in this case, when the specifications use different subsamples).

Recall that the primary goal for this set of models is to assess whether contracting intensity in one bean type has an effect on contract length in the *other* bean type for the same pair of contracting parties. Such evidence is much harder to explain away with alternative hypotheses since we have broken the link of unobservable transaction characteristics across bean types. Such evidence would present itself as positive coefficients in the "off-diagonals" where the contracting intensity measure does not match the contract subsample. That is, we are looking for positive coefficients in the shaded entries in the table. In the OLS specification, both of these entries are positive and significant, providing evidence of a relationship both between standard bean contracting frequency and differentiated bean contract length and also between differentiated bean contracting frequency and standard bean contract length. With instrumenting, the results are more uneven, but both types of cross-bean type effect remain positive and significant in one of the IV specifications, providing some evidence that such cross-bean type effects do exist and reinforcing our main finding of a positive relationship between contracting frequency and contract length.

VII. Conclusion

In our setting of the Costa Rican coffee industry, the evidence suggests that parties that contract frequently use longer contracts. We interpret this as a causal relationship because the main empirical finding is robust to multiple instrumental variables strategy that address concerns about unobserved heterogeneity, omitted variables, and endogenous matching of contracting parties. This finding is consistent with the theoretical model we present in which the power of repeated contracting increases the enforceability of formal long-term contracts, making them more attractive to contracting parties.

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Table 1: Summary statistics

	Mean	Std Dev	Min	Max
contract duration (days)	115.5	149.5	0	1,341
log(contract duration + 1)	3.5	2.1	0	7.2
differentiated (dummy)	0.17	0.38	0	1
pair's total contracts	28.4	29.9	1	123
pair's total volume (kg)	907,662	1,318,920	44	7,215,330
pair's total volume (log kg)	12.6	1.9	3.8	15.8
seller's total contracts	59.7	49.3	1	173
seller's total volume (kg)	1,747,797	1,654,286	506	7,215,330
seller's total volume (log kg)	13.6	1.7	6.2	15.8
contract volume (kg)	28,861	36,653	31.4	690,000

TABLE 2: Main Effect

Sample: Full

Dependent Variable: Log (contract days +1)

Identification	OLS				IV lags				IV potential partner			
Relationship Measure	Count		Volume		Count		Volume		Count		Volume	
Column	**i**		**ii**		**iii**		**iv**		**v**		**vi**	
differentiated	0.0062		0.0385		-0.0734		-0.0396		-0.0023		0.0212	
	0.0572		0.0572		0.0688		0.0693		0.0592		0.0676	
pair's total contracts	0.0079	**			0.0131	**			0.0079	**		
	0.0012				0.0021				0.0028			
pair's total volume (log)			0.2780	**			0.2838	**			0.2122	
			0.0248				0.0605				0.2062	
Other controls:												
seller's total contracts	X				X				X			
seller's total volume (log)			X				X				X	
contract volume (kg)	X		X		X		X		X		X	
Fixed effects:												
Buyer-year	X		X		X		X		X		X	
Seller												
Bean type	X		X		X		X		X		X	
Bean quality	X		X		X		X		X		X	
Bean preparation	X		X		X		X		X		X	
# Observations	8083		8083		5467		5467		7414		7414	
significance: * = 5%; ** = 1%												

TABLE 3: Interaction Effect

Sample: Full

Dependent Variable: Log (contract days +1)

Identification	OLS		IV lags		IV potential partner	
Relationship Measure	Count	Volume	Count	Volume	Count	Volume
Column	**i**	**ii**	**iii**	**iv**	**v**	**vi**
differentiated	-0.0317	-0.0905	0.1499	-0.4492 **	-0.0423	-0.2034
	0.0578	0.0644	0.1032	0.1070	0.0611	0.1053
diff X pair's total contracts	0.0159 **		0.0264 **		0.0224 **	
	0.0022		0.0035		0.0061	
std X pair's total contracts	0.0063 **		0.0115 **		0.0066 *	
	0.0012		0.0021		0.0029	
diff X pair's total volume (log)		0.4658 **		0.7778 **		0.6989 **
		0.0497		0.1241		0.2155
std X pair's total volume (log)		0.2463 **		0.2306 **		0.1994
		0.0258		0.0598		0.2074
Other controls:						
seller's total contracts	X		X		X	
seller's total volume (log)		X		X		X
contract volume (kg)	X	X	X	X	X	X
Fixed effects:						
Buyer-year	X	X	X	X	X	X
Seller						
Bean type	X	X	X	X	X	X
Bean quality	X	X	X	X	X	X
Bean preparation	X	X	X	X	X	X
F-test%	1%	1%	1%	1%	10%	5%
# Observations	8083	8083	5467	5467	7414	7414

significance: * = 5%; ** = 1%

%: F-test for equality of coefficients on std and diff contracts or volume

TABLE 4: Interaction Effect with Seller Fixed Effects								
Sample: Full								
Dependent Variable: Log (contract days +1)								
Identification	IV lags				IV potential partner			
Relationship Measure	Count		Volume		Count		Volume	
Column	**i**		**ii**		**iii**		**iv**	
differentiated	0.0240		-0.1541		-0.0209		0.4542	
	0.1151		0.1462		0.0961		0.2584	
diff X pair's total contracts	0.0653	**			0.0288	**		
	0.0123				0.0083			
std X pair's total contracts	0.0630	**			0.0205	**		
	0.0133				0.0071			
diff X pair's total volume (log)			0.7804	**			2.0802	**
			0.1969				0.6417	
std X pair's total volume (log)			0.5675	**			2.6704	**
			0.1618				0.9016	
Other controls:								
seller's total contracts	X				X			
seller's total volume (log)			X				X	
contract volume (kg)	X		X		X		X	
Fixed effects:								
Buyer-year	X		X		X		X	
Seller	X		X		X		X	
Bean type	X		X		X		X	
Bean quality	X		X		X		X	
Bean preparation	X		X		X		X	
F-test%	-		10%		-		10%	
# Observations	5467		5467		8083		8083	
significance: * = 5%; ** = 1%								
%: F-test for equality of coefficients on std and diff contracts or volume								

TABLE 5: Cross-Effect by Bean Type

Dependent Variable: Log (contract days +1)

Relationship Measure: Count

Identification	OLS				IV lags				IV potential partner			
Sample	Differentiated		Standard		Differentiated		Standard		Differentiated		Standard	
Column	**i**		**ii**		**iii**		**iv**		**v**		**vi**	
pair's diff contracts	0.0114	*	0.0111	**	0.0263	**	0.0069		-0.0056		0.0271	**
	0.0050		0.0039		0.0101		0.0062		0.0209		0.0100	
pair's std contracts	0.0438	**	0.0054	**	0.0655	**	0.0127	**	0.0182		0.0082	*
	0.0060		0.0014		0.0095		0.0022		0.0199		0.0033	
Other controls:												
seller's total contracts	X		X		X		X		X		X	
seller's total volume (log)												
contract volume (kg)	X		X		X		X		X		X	
Fixed effects:												
Buyer-year	X		X		X		X		X		X	
Seller												
Bean type	X		X		X		X		X		X	
Bean quality	X		X		X		X		X		X	
Bean preparation	X		X		X		X		X		X	
# Observations	1404		6679		1035		4432		1330		6084	
significance: * = 5%; ** = 1%												