Vertical Integration and Inter-Firm Relationships in the Costa Rica Coffee Chain

Rocco Macchiavello
London School of Economics

Josepa Miquel-Florensa
Toulouse School of Economics

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We compare transactions within integrated firms and in long-term relationships between firms in the Costa Rica coffee chain. We unveil a qualitative difference between these two organizational forms: the size of forward sales supported by long-term relationships is limited because better opportunities arising after the forward transaction is agreed might tempt the seller into default. Integration shifts ownership of coffee away from the seller and removes such temptations. We model this difference and exploit weather-induced supply shocks to test for constraints to forward trade. We show that forward trade in long-term relationships is constrained, while forward trade within integrated firms and spot trade are not. The evidence supports models in which firm's boundaries alter parties' ability to enforce past promises to trade.

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1. Introduction

A large share of economic transactions takes place within integrated firms.[1] Since Coase (1937) seminal contribution, a central question in economics has been to understand how transactions within integrated firms differ from those between firms. Classic theoretical contributions place various forms of contractual imperfections at the heart of theories of the firm (see, e.g., Gibbons (2005)). Long-term relationships between firms, however, can also mitigate those imperfections (Baker et al. (2002), Levin (2003)). Understanding how firm boundaries matter, then, calls for a comparison of transactions taking place within integrated firms with those in long-term relationships between firms. Standard datasets, however, do not record the identity of transacting parties nor transactions within integrated firms, thus preventing such comparison.

This paper compares transactions within integrated firms with those in long-term relationships between firms in the Costa Rica coffee chain.[2] Within this setting, we shed light on a qualitative difference in the size distribution of transactions under the relational arrangement in comparison to vertically integrated firms. Figure 1 reports the histogram of the volume of transactions between coffee mills (suppliers) and exporters (buyers) under the two organizational forms. The largest observed transaction in long-term relationships is at the 90th percentile of the distribution of transactions within integrated firms. In what follows this difference will be interpreted as indicating that the scale of operations that can be supported under long-term relationships is limited by the possibility that a mill might be tempted to default on promised deliveries should better trading opportunities arise. By shifting ownership of the coffee away from the mill, integration removes such temptations and allows parties to transact volumes beyond the critical size. There are of course several other explanations for the pattern observed in Figure 1. The rest of the paper develops and implements empirical tests to distinguish our hypothesis from alternative ones.[3]

[1]Transactions within firms account for roughly half aggregate value added in the U.S. (Lafontaine and Slade (2007)) and one-third of world trade (Antràs (2003)).

[2]We begin with a descriptive analysis that distinguishes long-term relationships from arm's length relationships between firms. The analysis reveals that transactions within integrated firms are remarkably similar to those in long-term relationships and, at the same time, radically different from those in arm's length relationships.

[3]Although specific, the context under examination presents distinctive advantages for our analysis: i) all transactions of coffee between mills and exporters are reported to the regulator; and ii) weather-induced variation in supply facilitates our empirical strategy. Regulations allow mills (but not exporters) to cancel forward contracts, e.g., for lack of inventories to honor the contract. The asymmetry motivates our focus on backward integration throughout the paper. Appendix I details the regulations and Appendix II provides evidence on contract cancellations.

We formalize our hypothesis with a model in the spirit of Baker et al. (2002). The model captures salient features of the industry that we document in Section 2. Similarly to Carlton (1979) buyers value reliable supplies to fulfil commitments in export markets (supply assurance) and mills dislike holding unsold inventories that sharply depreciate once the subsequent harvest begins (demand assurance).[4] Coffee is thus traded through both spot contracts and forward contracts. Spot contracts are those in which coffee is delivered shortly after the contract is signed. These contracts do not provide demand and supply assurance but are perfectly enforced. Forward contracts are promises to deliver coffee agreed upon months before actual delivery. These contracts provide demand and supply assurance but, in the absence of perfect contract enforcement, carry the risk of being defaulted upon if market conditions change.

Relationships consist of buyer-seller pairs in which the seller owns the coffee and, therefore, can potentially default on forward contracts. Forward contracts must thus be enforced relying on the (future) value generated by the relationship. At times of high production, mills would like to ensure demand by committing large volumes through forward contracts. Buyers, however, might be concerned that large volumes of promised deliveries might not be honored if market conditions change and the seller finds alternative buyers. Parties must then constrain the amount of coffee traded forward to satisfy the seller's incentive constraint and mitigate the risk of default. Integration, instead, consists of buyer-seller pairs in which the buyer owns the coffee and, therefore, the seller cannot sell to alternative buyers and default. The main prediction of the model is that the share of coffee sold forward in long-term relationships declines when the mill's production increases beyond a certain threshold. No such effect arises under integration.[5]

Testing whether long-term relationships, but not integrated firms, are indeed constrained in the amount of coffee traded forward requires exogenous variation in the volume of coffee parties *would like* to trade forward. We take advantage of the fact that weather conditions in the area where the mill is located during coffee growing season (i.e., two to four months before harvest and physical trade of coffee take place) induce exogenous variation in the amount of coffee produced by the mill and, thus, the amount parties would like to trade forward.

We test the predictions of the model exploiting weather conditions around

[4]Numerous reports describe these aspects of the coffee trade (see, e.g., I.T.C. (2012), I.C.O. (2014), World Bank (2015)).

[5]In equilibrium both integration and long-term relationships avoid defaults. This, however, happens for different reasons: mills owned by buyers cannot default while long-term relationships avoid defaults by constraining the amount of coffee traded forward.

the mill during coffee growing season. We investigate specifications at the mill-season level, at the relationship-season level, and at the contract level. We begin the analysis with mill-level specifications. Controlling for mill and season fixed effects we confirm that, indeed, weather conditions during the growing season are strongly and linearly associated with subsequent mill's production volumes during the harvest season. Following exceptionally good weather conditions, mills sell a lower share of coffee through forward contracts, suggesting that the constraint can bind at the mill level.

Relationship-level specifications allow to control for buyer-seller pair fixed effects and are closer to the spirit of the model. The share of coffee sold through forward contracts in long-term relationships decreases following exceptionally good weather conditions. We find no such effect within integrated firms (for which the constraint is not relevant) nor following exceptionally bad weather conditions (when the constraint is never binding). These specifications do not control for potentially confounding time-varying mill-specific shocks that might correlate with weather realizations and the timing of sales differentially across organizational forms. To control for those, we would like to control for mill-season fixed effects, but that is prevented by the fact that weather conditions also vary at the mill-season level. We thus explore additional specifications in which weather conditions are interacted with relationship's age. These specifications allow to control for mill-season fixed effects. Consistently with the model's predictions, results reveal that relationships becomes less constrained in the amount of forward trade as they age.[6]

Weather conditions could alter the availability of coffee types that vary across organizational forms in their timing of sales. To address this concern we test the predictions of the model with specifications at the contract level. These allow to control for extremely detailed product fixed-effects, thus removing the concern mentioned above. Holding constant the type of coffee traded, we show that long-term relationships are less likely to sign forward contracts following exceptionally good weather conditions. No such effect is detected within integrated firms. Furthermore, consistently with the model's logic, we show that the effect is present on the sample of contracts for undifferentiated coffee beans (for which the mill can potentially find alternative buyers) but not for differentiated ones (for which finding alternative buyers is much harder).

The empirical analysis in the body of the paper focuses on the main predic-

[6]We perform additional robustness checks, including specifications with buyer-season fixed effects. The results are robust to several changes to the baseline specification.

tion of the model. The model yields several other predictions that are tested in the Appendices. Appendix 2 provides direct support for the key assumptions in the model using contract-level specifications. We first document that default on forward contracts is indeed a concern by showing that unanticipated world price spikes over the duration of the contract increase the likelihood of default. Consistently with the model's assumption, we show that this happens between firms trading at arm's length but not within integrated firms nor in long-term relationships. In the model the costs of integration arise from the assumption that it is difficult for integrated firms to sell coffee to third parties. We provide direct evidence for this assumption as well. In rare cases where mills owned by buyers sell outside their chain, coffee trades at a lower price than when an identical sale is done by independent, but otherwise similar, mills. The model also delivers predictions on which mills and buyers' characteristics should correlate with integration. For instance, the model predicts that integrated mills are larger, located in places with higher average suitability for coffee but more variable growing conditions. Appendix 3 provides cross-sectional evidence supporting these predictions as well. We also show that common motives for integration, e.g., sourcing specific inputs and gaining operational efficiency, do not differ between integration and long-term relationships in our sample.

In summary, this paper offers what is, to the best of our knowledge, the first explicit comparison of trade patterns under integration and under long-term relationships between firms. Our descriptive analysis reveals that transactions under these two organizational forms are similar to each other and, at the same time, radically different from those observed between firms trading at arm's length. A qualitative difference between integration and long-term relationships, however, arises because integration removes seller's ability to default on past promises to trade. This evidence supports the central tenet of Baker et al. (2002)'s theory of firm boundaries.

Related Literature: Our main contribution is to explicitely compare vertical integration to long-term relationships between firms. We do so by building upon the theoretical model in Baker et al. (2002). The paper thus contributes to two empirical literatures: an established literature on vertical integration (see, e.g, Lafontaine and Slade (2007) and Bresnahan and Levin (2012) for reviews) and a newer, but rapidly growing, literature on inter-firm relationships (see, e.g., Lafontaine and Slade (2012) and Gil and Zanarone (2016) for reviews). The main contribution to the former is to distinguish long-term relationships and arm's length relationships between firms as alternatives to vertical integration.[7] Most studies ask "What determines firm boundaries?" Classical contributions in which vertical integration is the dependent variable include Monteverde and Teece (1982), Masten (1984), Joskow (1985), Baker and Hubbard (2003), Forbes and Lederman (2009). A smaller literature asks "Do firm boundaries matter?" Our analysis is most closely related to this second strand. Due to the identification challenges arising from endogenous selection, most progress has been made by studying integrated firms' differential response to shocks, like we do. For example, Mullainathan and Scharfstein (2001) find that non-integrated producers of waterproof plastic react more strongly to market demand while integrated producers focus on internal demand; Forbes and Lederman (2010) show that integrated airlines perform better than non-integrated ones when adaptation needs increase. More recently Hansman et al. (2018) show that integrated suppliers respond more to demand for quality in the Peru fish-meal industry. None of these papers explicitely compares integration to long-term relationships between firms. The empirical literature on vertical integration does not appear to have tested for the central tenet of Baker et al. (2002) model.[8]

The paper also contributes to the emerging literature on relationships between firms (see, e.g., Antràs and Foley (2015), Gil and Marion (2013)). Macchiavello and Morjaria (2015); Barron et al. (2018) and Gil et al. (2018) provide evidence on the importance of relational adaptation in the flower, movie distribution and airline industries respectively. Like Macchiavello and Morjaria (2015) we derive testable predictions from the seller's incentive compatibility constraint. Unlike their paper, however, we compare inter-firm relationships to integrated ones (which they do not consider).[9] Blouin and Macchiavello (2017) develop and implement an empirical test to identify strategic default in the international coffee market. Strategic default on forward contracts is the main contractual friction in our analysis. We thus apply their test in Appendix II to confirm that strategic default is indeed a concern in our context as well. Blouin and Macchiavello (2017), however, do not compare relationships to integration and do not study how the form of trade

[7]Our focus on a specific industry complements across-industry (and, even, country) studies such as Acemoglu et al. (2009), Acemoglu et al. (2010), Alfaro et al. (2016), Alfaro et al. (2018b), Alfaro et al. (2018a), Antràs (2003), Atalay et al. (2014), Atalay et al. (2018), Costinot et al. (2011), and Macchiavello (2012). We focus the reminder of our discussion on industry studies.

[8]A third strand studies exclusionary aspects (see, e.g., Hart and Tirole (1990) and Hortaçsu and Syverson (2007)). We do not relate to that literature.

[9]Besides the different focus, the empirical strategy is also different. We use exogenous *on*-the-equilibrium path variation in supply to reveal how parties constrain the amount of forward trade to take into account incentive constraints. In Macchiavello and Morjaria (2015), instead, the test for reputational forces relies on an unanticipated *off*-equilibrium-path supply shock.

responds to supply-shocks.[10]

The rest of the paper is organized as follows. Section 2 provides background information on the Costa Rican coffee sector and presents descriptive evidence. Section 3 develops a model à la Baker et al. (2002) and derives testable predictions. Section 4 tests those predictions using weather shocks. Section 5 offers concluding remarks. Appendix 1 provides further details on the data and industry regulations; Appendix 2 provides direct evidence on the two key assumptions of the model; Appendix 3 tests further predictions.

2. Background and Descriptive Analysis

This section provides background information on the Costa Rica coffee chain. Contractual practices reveal that supply and demand assurance concerns are important for buyers and sellers. We then distinguish long-term relationships from arm's length relationships between firms. We document how transactions within integrated firms are remarkably similar to those in long-term relationships and, at the same time, radically different from those in arm's length relationships. Despite this similarity, we also document a *discontinuity* at the firm's boundary: integrated firms trade significantly larger volumes of coffee forward (but not spot) than otherwise similar inter-firm relationships. This evidence motivates the model in Section 3.

2.A. Background and Regulations

Figure 2 describes the Costa Rica coffee chain.[11] Coffee cherries are harvested by farmers and delivered to mills within a few hours of harvest. Mills remove the pulp from the cherries, then wash and dry the bean. After these processes, the output becomes storable and is called parchment coffee. Mills sell parchment coffee to domestic buyers. Buyers consolidate the coffee before selling to foreign buyers or to domestic roasters. Transactions between mills and buyers are the object of our analysis. In a typical season there are approximately 180 (150) active mills

[10] Martínez (2015), Corts and Martínez (2018) and Dragusanu and Nunn (2018) use some of the data in this paper to study product differentiation, evolution of contract length in interfirm relationships and the impact of fair trade respectively. Fafchamps and Hill (2008), de Janvry et al. (2015), Macchiavello and Morjaria (2016) study other aspects of the coffee chain in different contexts. None of these paper studies vertical integration.

[11] Introduced in Costa Rica in the late eighteenth century, coffee quickly became the country's main export crop. The seven regions in which coffee is produced (Table A.1 and Figure A.1) make Costa Rica the 14th largest producer of coffee in the world.

(buyers) with the 10 largest accounting for 53% (77%) of transacted volumes (see Table 1). The industry has been relatively stable throughout the sample period (see Table A.2).

The state regulates the sector through the Instituto del Cafe de Costa Rica (ICAFE). Regulations implement the "Sistema de Liquidación Final"(see Appendix 1 for details). All transactions of coffee along the chain, regardless of ownership structure (i.e., whether they happen between independently owned firms or within integrated firms), are registered as contracts with the regulator. Each contract specifies a quantity of coffee, a price, a signing date, a delivery date and an extremely detailed product classification (404 unique coffee bean types). Our analysis focuses on the volumes and timing of trade and not on prices which are harder to interpret for transactions occurring within integrated chains.

2.B. Contractual Practices: Spot vs. Forward Contracts

Contractual practices reveal the importance of ensuring demand and supply in a market characterized by significant uncertainty. On the supply side, weather conditions during the growing season (from August to November) influence the volume of coffee eventually harvested by farmers and processed by mills. Although parchment coffee is storable, its market value sharply depreciates at the time the following harvest begins. Inventories can thus only partially help to navigate demand shocks and mills face the risk of holding unsold stocks at the end of the season. On the demand side, both during and after the harvest season (from December to April), the vagaries of weather in competing locations worldwide induce fluctuations in demand and prices. Buyers also face idiosyncratic demand shocks from importers and roasters downstream.

To manage these risks parties contract in advance for future delivery through forward contracts.[12] The average contract is signed about three months before scheduled delivery (see Table 1). Figure 3 illustrates the average length of the contracts signed at different points in the season. Parties sign forward contracts well before harvest begins. As the season unfolds contracts become shorter. Eventually, just before the beginning of the following harvest, all contracts are spot, i.e., for nearly immediate delivery.

[12] Physical markets for coffee operate alongside futures markets. Futures contracts are rarely "called" for actual delivery. Due to their liquidity, futures markets provide reference prices for the physical market. The Coffee Futures C contract for Arabica milds traded at the New York commodity exchange is the main reference price for the Costa Rica beans. In a country like Costa Rica the very largest exporters might hedge in the futures market but smaller exporters and mills do not.

Pricing patterns show both advance purchase discounts and inventory risk as predicted by models with demand uncertainty (e.g., Carlton (1978) and Dana (1998)). Figure 4 shows an inverted-U relationship between contract length and unit prices. Relative to contracts signed during the harvest season, forward contracts signed before the beginning of harvest have approximately 5% lower prices. The forward discount arises due to higher expected capacity utilization guaranteed by forward sales.[13] Spot contracts signed just before the following harvest also feature approximately 5% lower prices as mills sell inventories that will soon depreciate. These estimates control for detailed product and season fixed effects (see notes to the Figure for details) and are large relative to both buyers and mills margins.

2.C. Organizational forms: Integration, Relationships and Markets

Our analysis compares trade within backward *integrated* firms (buyers owning mills) and trade between firms. We distinguish arm's length trade between firms (*market*) from repeated trade between firms (*relationships*).[14] A mill and a buyer are defined to be in a relationship from the first time they trade provided they eventually trade at least three seasons consecutively. According to this definition, approximately 40% of coffee is exchanged within relationships, 20% in the market, and the remaining 40% within integrated firms. These shares have remained relatively stable throughout the sample period (see Figure A.4 and Table A.2).[15]

Similarity between Integration and Relationships:

The length and timing of contracts within integrated firms are remarkably similar to those in long-term relationships and, at the same time, very different from those in arm's length relationships. The left panel of Figure 5 shows contract duration. Contracts in which delivery occurs within a week of the signing date account for 60% of arm's length market trade between firms but for only 20% of trade in relationships and under integration. The right panel in Figure 5 compares the timing of coffee sales along the season. Integration and relationships sell coffee earlier: by the time harvest begins, integrated chains and inter-firm relationships have already committed 40% of the coffee traded during the entire

[13] Risk aversion on either buyers' or mills' side is not necessary to generate a forward discount.

[14] Trade within firms is always repeated.

[15] The definition of relationships is forward looking to better capture the future rents needed to sustain cooperation highlighted by the theoretical literature. The baseline definition selects relationships based on success and is somewhat arbitrary. We thus present robustness checks using alternative definitions as well as specifications using a continuous measure of relationship's age.

season. For firms trading at arm's length the figure is 20%. In both cases, the entire distributions of transactions under integration and long-term relationships almost perfectly overlap. The similarity between integration and relationships is consistent with the hypothesis that both organizational forms adress similar contracting imperfections. In this context, integration and relationships provide demand and supply assurance, consistently with the theoretical analysis in Carlton (1979), industry reports (e.g., I.T.C. (2012), I.C.O. (2014), World Bank (2015)) and conversations we had with industry practitioners.

Difference between Integration and Relationships:

Integration and long-term relationships, however, differ in important respects. Integrated chains are exclusive, inter-firm relationships are not. Table 2 reports average shares of coffee sold (sourced) through different organizational forms in each season by type of mills (buyers). Mills owned by downstream buyers sell 96% of their production within the integrated chain and the remaining 4% on the market. Non-integrated mills, instead, sell approximately 60% of their produce through relationships and the remaining 40% on the market.[16]

Discontinuity at the Firm's Boundary:

Building upon Figure 1, Figure 6 uncovers a *discontinuity at the firm boundary.* Integrated relationships trade significantly larger volumes of coffee than nearly exclusive inter-firm relationships of mills with identical capacity. Given the differences in size (Table 1) and exclusivity (Table 2) between the two organizational forms we construct a "control" group of inter-firm relationships by considering only those that are nearly exclusive (i.e., account for at least 90% of the mills sales) and by comparing mills within the same decile of the mill size distribution.[17] This yields a sample of 41 inter-firm relationships to be compared to 21 integrated relationships. In each mill's size group integrated relationship trade significantly larger volumes of coffee than non-integrated mills (left panel). The difference, however, is entirely driven by integrated chains trading larger volumes of coffee forward (middle panel). In contrast, in *none* of the size bins integrated

[16] Backward integrated buyers source 56% of coffee from their own mills with the remaining split between relationships (20%) and market (23%). Buyer's dual sourcing and integrated mill's exclusivity are consistent with Carlton (1979) model of vertical integration under demand uncertainty.

[17] We define *large* mills as those in between the (75^{th}) and the (90^{th}) percentiles in the size distribution, *very large* mills those in between the (90^{th}) and the (95^{th}) percentiles, and *huge* those above the 95^{th} percentile. There are no integrated mills outside the top quartile of the size distribution. Despite the binary nature of the comparison, we refer to it as a *discontinuity* to reflect the two continous "running variables" (mill's size and relationship exclusivity) held constant in the comparison.

relationships trade larger volumes of coffee spot (right panel).[18]

In summary, the similarity between integration and relationships is consistent with the hypothesis that both organizational forms address similar contracting imperfections. Building upon Figure 1 in the Introduction, however, we have also documented a qualitative difference (the *discontinuity at the firm's boundary*) in the size of forward transactions under long-term relationships in comparison to vertically integrated firms. In what follows this difference will be interpreted as indicating that the scale of operations that can be supported under a relational arrangement is limited by the possibility that contractual parties might default on a forward transaction if market conditions change. By shifting ownership of the coffee integration removes the possibility of such defaults and thus allows parties to transact forward volumes beyond the critical size. This, however, comes at the cost of making it harder to sell outside the integrated chain. As in Baker et al. (2002), this trade-off generates a *discontinuity* in the form of trade at the firm's boundary. The next Section develops a model along the lines of Baker et al. (2002) and derives from its incentive compatibility constraint a formal test for whether long-term relationships (but not integrated firms) are constrained in the amount of forward (but not spot) trade. The main prediction and the two placebos are then tested in Section 4.

3. Theoretical Framework

In a nutshell, the model is as follows. A buyer and a seller first choose an organizational form to maximize expected joint profits. After they have chosen the organizational form, they can trade at two dates: before production takes place (*forward* trade) and after (*spot* trade). They face two types of uncertainty. When choosing the organizational form, they do not know how much coffee the seller will produce. When deciding how much to trade forward they do not know the price that will prevail in the spot market when coffee must be physically exchanged.

Forward and spot trade, however, differ. Forward contracts provide insurance but carry the risk of being defaulted upon. In particular, at the time of delivering the coffee the spot market price might be much higher than anticipated at the time the forward contract was signed. When this is the case the seller has an incentive to default on the forward contract and find an alternative buyer that pays a higher

[18] Table C.1 in Appendix 3 shows that the discontinuity is robust to the inclusion of several mill and buyer controls.

price. Spot contracts, instead, are signed after price uncertainty is resolved. They do not provide insurance but do not carry any risk of being defaulted upon since coffee is exchanged with no delay.

We compare *relationships* and *integration*. Integration consists of buyer-seller pairs in which the buyer owns the coffee produced and, therefore, the seller cannot default on the forward contract. Relationships consist of buyer-seller pairs in which the seller owns the coffee and forward contracts are enforced relying on the (future) value generated by the relationship. This advantage of integration, however, comes at the cost of making it harder to sell outside the chain.[19] Buyers and sellers can also trade in the spot *market*, where contracts are perfectly enforceable and no future relationship value is needed.[20]

We first introduce the basic set-up under perfect contract enforcement, then consider the possibility of strategic default and study the resulting trade-off between integration and relationships. Finally, we derive testable predictions.

3.A. Set-Up and Benchmark

Players and Timing:

An exporter and a mill (henceforth, buyer and seller respectively) trade coffee. The timing of events is as follows (see Figure 7). At time $t = 0$, the buyer and the seller chose the organizational form. Two organizational forms o are available: integration $o = I$ (when the buyer owns the seller and, therefore, the coffee) and relationship $o = R$ (when, instead, the seller retains ownership of the coffee produced). Both parties have deep pockets and agree to the organizational form that maximizes expected joint profits using lump-sum transfers to adjust ex-ante pay-offs as required. At $t = 1$, weather conditions during the growing season ω are drawn from a cumulative distribution $\omega \sim W(\omega)$. At $t = 2$ parties can sign *forward* contracts. At $t = 3$ harvest takes place resulting in production $Q = \omega$.[21]

[19] This trade-off is microfounded in Baker et al. (2002) and well substantiated in our data (see Appendix 2 for details). To quote directly from their paper: "We assume that ownership of the asset conveys ownership of the good. (In fact, the asset could simply be the legal title to the good.) Thus, if the upstream party owns the asset, then the downstream party cannot use the good without buying it from the upstream party, whereas if the downstream party owns the asset, then he already owns the good. In addition, we assume that the good produced by the upstream party can be used either in the downstream party's production process or in an alternative use, and that the upstream party's actions affect the good's value in both these uses." (p. 41).

[20] In the model, therefore, arm's length market trade and the *spot* market coincide. In practice, buyers and sellers trading at arm's length also sign forward contracts, albeit much less frequently than in relationships (as shown in Section 2). For simplicity the model abstracts from this possibility.

[21] The model can be extended to endogeneize production without altering its main predictions.

At $t = 4$ the spot market price p is drawn from a cumulative distribution $p \sim F(p)$ symmetric around its expected value $\overline{p}$ and with support $p \in [0, (1 + \mu)\,\overline{p}]$. Finally, at $t = 5$ *spot* contracts are signed and executed, forward contracts are executed or defaulted upon.

Payoffs:

Both players are risk-neutral. Demand assurance concerns are formalized as follows. Sellers face a downward sloping demand in the spot market. Specifically, a mill selling a share σ of production Q only obtains a fraction $p^S = (1 - \phi\sigma)\,p$ of spot market p, with $\phi \in [0, 1]$. The parameter ϕ captures inventory risk described in Section 2 and, as in Carlton (1978), the notion that firms are not free to sell any quantity at prevailing market prices. Supply assurance concerns are formalized as follows. The buyer values one unit of coffee forward $v^F = v$ and one unit of coffee spot $v^S = \beta p$, with $\beta < 1$. That is, buyers that integrate or source through relationships are relatively more willing to pay for forward coffee than those trading at arm's length.[22] For simplicity, we assume $\beta = 0$. We capture advance purchase discounts and inventory risk documented in Figure 4 assuming that $\overline{p} > v > (1 - \phi)\,\overline{p}$.

No Default Benchmark:

Consider first the case in which forward contracts are perfectly enforced. After observing weather during the growing season ω parties maximize joint profits by allocating production Q between spot and forward sales. Let σ be the share sold spot. The pair solves

$$\max_{\sigma \in [0,1].} (1 - \sigma)Qv + \sigma Q \int_p p\,(1 - \phi\sigma)\,dF(p).$$

The (necessary and sufficient) first order condition implies:

$$\sigma^* = \left(\frac{\overline{p} - v}{2\overline{p}\phi}\right), \sigma \in (0, 1/2)\,, \tag{1}$$

The share sold spot σ^* is decreasing in buyer's willingness to pay in the forward market (v) and in spot market illiquidity ϕ and increasing in expected spot market price $\overline{p}$. Under this benchmark model, σ^* is constant in production Q.[23]

[22] Consistently with this Appendix 3 shows that backward integration and supply relationships are chosen by exporters signing forward contracts with foreign buyers.

[23] Appendix 3.C shows that if the seller is risk-averse σ^* is a *decreasing* function of Q. Table 3 in the next Section, however, shows that σ^* is indeed constant under normal weather conditions during the growing season $\omega = Q$. The evidence thus supports the functional forms that we chose primarily to simplify the model's algebra.

3.B. Relationships vs. Integration

We now introduce the possibility of strategic default on forward contracts and explore the trade-off between relationships and integration.

Relationships:

Suppose the buyer and the seller have signed a forward contract for quantity z at price π. At $t = 5$, i.e., after observing the spot price p, the seller decides whether to default on the contract or not weighting the costs and benefits of her choice. The main potential benefit is being able to sell the coffee at a higher price. In practice the main cost is worsening the relationship with the buyer. If the seller honors the contract her pay-off is $\pi \times z + \mathbf{U}^R$. If she defaults her pay-off is instead given by $p \times z + \mathbf{U}^D$. Let $\mathbf{V} = \mathbf{U}^R - \mathbf{U}^D$ be the difference between the continuation values following honoring ($\mathbf{U}^R$) and defaulting on ($\mathbf{U}^D$) the forward contract respectively.[24] The seller defaults on the forward contract if

$$\mathbf{V} \leq (p - \pi)\, z \tag{2}$$

At the forward contracting stage, parties agree to trade quantities that are robust to strategic default. This places an upper limit on the amount of coffee parties can trade forward, i.e., $z \leq z^F(\mathbf{V})$. This bound captures in a reduced form the intuition that, when contracts can be defaulted upon, the amount of trade is constrained by the value of the relationship between parties ($z^F(\mathbf{V})$ is increasing in $\mathbf{V}$). This is a robust prediction common to relational contract models. Note, however, that it is the amount of coffee traded *forward* that is constrained. In contrast, the amount of coffee traded *spot* is not constrained. This distinction provides a *placebo* we test for in the data.[25]

The bound implies that the pair is constrained in the amount traded forward when production Q is large. Let $Q^F = z^F/(1-\sigma^*)$ be the production level at which the pair becomes constrained and $\sigma^F = \frac{Q-z^F}{Q}$ the share sold spot by a constrained relationship. The share sold spot by the relationship, σ^R, is then given by

[24] In the data we observe actual contract defaults, not renegotiations. We take renegotiation failures as a fact of commercial life, without providing microfoundations. In practice, following a default the buyer suffers costs that depend, inter alia, on contractual arrangements downstream which are private information. Similarly, the seller's benefits depend on actual offers received from alternative buyers, which are also private information. Asymmetric information can thus prevent efficient contract renegotiation.

[25] The structure of the IC constraint suggests that parties have an incentive to set the forward price π as high as possible. The buyer, however, must also be given incentives to sign the forward contract, i.e., $\pi \leq v$.

$$\sigma^R[Q] = \begin{cases} \sigma^F[Q] & \text{if } Q \geq Q^F \\ \sigma^* & \text{otherwise.} \end{cases} \tag{3}$$

The share sold spot in a relationship *increases* when weather conditions during harvest season ω (and, thus, production Q) are exceptionally good. The share is otherwise constant, including under exceptionally bad weather conditions. This provides a further *placebo* we test for in the data.

Integration:

Under integration the buyer owns the coffee and, therefore, the seller cannot default on the forward contract. On the other hand, integration makes it harder to sell to other buyers. In the presence of uncertainty, this is costly as the pair might need to sell excess production to other buyers. For simplicity alone we assume that an integrated mill selling to other buyers on the spot market gets a price $p = 0$. The integrated seller thus sells the entire production Q forward to the buyer, i.e., $\sigma^I = 0$. This has two implications: i) by assumption, the integrated mill sells everything inside the integrated chain, as documented in Section 2; ii) the share traded spot inside the integrated chain doesn't depend on weather conditions ω.

3.C. Predictions

The model captures the facts documented in Section 2, including the difference in exclusivity and the *discontinuity at the firm's boundary.* Holding constant production Q, the volume of coffee traded forward within non-integrated relationships is truncated from above due to the possibility of default. There is thus a discontinuity at the firm's boundary in the amount of coffee traded forward.[26]

The main predictions of the model are derived from the incentive compatibility constraint. In equilibrium both integration and inter-firm relationships avoid contractual defaults. This happens for different reasons, though: mills owned by buyers *cannot* default while inter-firm relationships avoid default by constraining the amount traded forward.

To empirically test the model, then, we need to test if long-term relationships between firms are constrained in the amount they trade forward while integrated relationships are not. The key empirical challenge is to find observable and exogenous variation in the amount mills would like to trade forward. The model

[26] The logic also extends to the case in which the buyer demands coffee spot. Unlike forward coffee, however, spot coffee is not affected by the possibility of default. As documented in Section 2, then, the discontinuity at the firm's boundary should only be observed for coffee traded forward, but not for coffee traded spot.

provides guidance on how that can be done. The model relates the share of coffee sold spot σ^R and σ^V to mill's production Q.[27] A key advantage of our setting is that weather conditions during the growing season, ω, are strongly related to the mill's production ($\omega = Q$). Furthermore, weather conditions during the growing season are also exogenous and directly observed in the data. We thus test the following predictions:

Weather Conditions and the Form of Trade:

1. *The share of coffee sold spot inside a relationship increases under exceptionally good weather conditions during the growing season;*
2. *There is no effect for exceptionally bad weather conditions (placebo 1);*
3. *There is no effect for integrated relationships (placebo 2);*
4. *If relationship's value* $\boldsymbol{V}$ *increases in relationship's age the effect in [1.] declines as relationships age;*
5. *There is no effect for coffee types that are difficult to side-sell (placebo 3).*[28]

The next Section tests these predictions and finds support for all of them in the data. Before presenting the results, we discuss empirical evidence supporting the two key assumptions in the model. Appendix 2 provides details and results. The first assumption is that forward contracts are subject to strategic default. In the Appendix we implement the test for strategic default developed in Blouin and Macchiavello (2017). The test relies on exogenous variation in the mill's temptation to default. This is done by constructing contract-specific measures of price surprises, defined as the ratio between the realized spot price at delivery and the expected spot market price at delivery at the time parties signed the contract. A key advantage is that at every contracting date t futures markets quote expected future prices for deliveries at t', thereby overcoming the empirical challenge of proxying for parties expectations about future prices.

[27] The model's prediction is on the share of coffee sold spot by the mill. By setting $\beta = 0$ the model implies the buyer never buys coffee spot. As mentioned above, this assumption is a simplification. With $\beta > 0$ the buyer sources positive amounts spot and the predictions hold at the relationship level as well. In the empirical session we test predictions both at the mill and at the relationship level.

[28] This last observation comes from the fact that for coffee beans that are difficult to side-sell the incentive constraint (Equation 2) is never binding. The functional forms of the model also imply that σ is constant under normal weather conditions under both organizational forms. We also test this additional prediction.

In equilibrium both integration and inter-firm relationships avoid contractual defaults. Although the model abstracts from this possibility, in practice buyers and sellers trading at arm's length also sign forward contracts (albeit much less frequently than integrated firms and long-term relationships, as documented in Section 2). We exploit these contracts to identify strategic default. Using contract-level specifications which control for buyer-seller, season, seasonality and extremely detailed product fixed effects, we show that *i)* unanticipated increases in world prices are associated with higher likelihood of default on forward contracts signed between parties trading at arm's length; *ii)* this doesn't happen within integrated firms (mill cannot side-sell); *iii)* nor within long-term relationships (parties constrain forward trade to satisfy the incentive constraint (Equation 2)). Furthermore, consistently with the idea that observed defaults are not commonly agreed upon renegotiations, we find that parties' future trade deteriorate following a default.[29]

The second assumption is that mills owned by buyers get lower prices when selling to other buyers. Support for this assumption also comes from contract-level specifications. We show that mills owned by buyers obtain 4.3% lower prices than otherwise similar independent mills when selling identical amounts of identical coffee under identical market conditions. We also discuss in the Appendix theoretical microfoundations for why that might be the case.

Finally, the model makes a number of additional predictions regarding which mills characteristics correlate with organizational choices. The model predicts that integrated mills are larger and located in places with higher suitability for coffee cultivation but more variable growing conditions. These predictions are formally derived and empirically tested in Appendix 3. The evidence supports these predictions as well. Note that in the specifications below we control for these characteristics (and their interaction with weather conditions) while testing our main hypothesis.

4. Evidence

This Section tests predictions [1.] to [5.] of the model. We test the predictions at the mill-season, buyer-mill-season and contract level. The predictions are tested exploiting exogenous idiosyncratic variation in weather conditions around the mill during the growing season.

[29] As mentioned earlier, the regulator allows mills, but not buyers, to cancel forward contracts (under specific circumstances). Accordingly, we also document an *asymmetric* effect in which positive price surprises increase the likelihood of default while negative ones do not.

4.A. Weather During Growing Season and Mill's Production

We take advantage of industry seasonality to isolate exogenous drivers of mill's coffee supply from other confounding factors. Weather conditions during the growing season (typically from August to November) induce exogenous variation in the availability of coffee around the mill at the time the coffee is harvested and processed (December to April). Since coffee must be processed within hours of harvest and there are high transport costs in the country-side, mills respond to local availability of coffee by increasing purchases from farmers. More favorable weather conditions during the growing season then translate into larger mill production.

We construct a mill-season specific index for weather conditions during the growing season, W_{ms}, by matching daily rainfall and temperature records to the mill location. We average both daily rainfall and temperature during the growing season and construct a standardized z-score of the two. Column 1 in Table 3 presents results from the specification:

$$y_{ms} = \alpha_m + \mu_s + \beta \times W_{ms} + \varepsilon_{ms} \tag{4}$$

where y_{ms} is tons of coffee produced by mill m in season s, α_m are mill fixed effects and μ_s are season fixed effects. The inclusion of mill and season fixed effects implies that we identify reduced form responses of mill's seasonal production to idiosyncratic weather conditions during the growing season around the mill, W_{ms}. Mill fixed effects control for time-invariant mill characteristics, including those that might drive the choice of organizational forms. The error term ε_{ms} is allowed to be correlated across mills in the same region within a given harvest season. Column 1 shows that a one standard deviation increase in weather conditions during the growing season is associated with approximately 113 tons higher seasonal production at the average mill. The effect is both economically and statistically significant.

The model's predictions, however, are about non-linear responses to exceptionally good weather conditions. For this reason, Column 2 allows for non-linearities in the reduced form relationship between weather conditions and production. We consider a kink-specification in which the relationship between weather conditions W_{ms} and production is continuous but allowed to have a different slope under exceptionally good (i.e., above the 90^{th} percentile) and bad (i.e., below the 10^{th} percentile) realizations of the weather index. The term $\beta \times W_{st}$ is thus replaced by $\beta_1 NW_{ms} + \beta_2 * GW_{ms} + \beta_3 BW_{ms}$ with NW, GW and BW denoting normal, good and bad weather conditions during the growing season respectively.[30] Results cannot reject a linear relationship between weather conditions W_{ms} and production. The estimated coefficient under exceptionally good weather (105.96) is almost identical (p-value 0.9) to the one estimated under normal weather conditions (92.49).

4.B. Mill-Season Specifications

The relationship between weather conditions during the growing season and mill's production is thus linear. Columns 3 and 4 in Table 3 test predictions [1.] and [2.] of the model at the mill-season level. The dependent variable is the share of coffee sold spot by the mill in that season. Spot contracts are those with duration shorter than 30 days. Column 3 shows that, overall, there is no relationship between the weather index W_{ms} and the share of coffee sold spot. Column 4 allows for a specification with kinks as in Column 2. Consistently with prediction [1.] the share of coffee sold spot is significantly higher at times of exceptionally good weather conditions (p-value 0.02). Furthermore, consistent with prediction [2.] no differential relationship is found at times of exceptionally bad weather conditions (p-value 0.815). Recall that, as shown in Appendix 3.C, the share sold spot would be *decreasing* in weather conditions if the mill was risk-averse. So, the results are not driven by the mill's risk aversion. In fact, the share of coffee sold spot is constant under normal weather conditions, consistently with the functional forms chosen in the model.

4.C. Mill-Buyer-Season Specifications

The spirit of the model is best captured by analysing what happens at the buyer-mill level. This is done in Table 4. Columns 1 and 2 report results from the specification

$$\sigma_{bms} = \alpha_{bm} + \gamma_s + \beta_1 * NW_{ms} + \beta_2 GW_{ms} + \varepsilon_{bms} \tag{5}$$

where σ_{bms} is the share of coffee sold spot between mill m and buyer b in season s, NW_{ms} and GW_{ms} are the seller-season specific index of normal and good weather conditions during the growing season as defined above. The specification, therefore, allows for a kink in the relationship between weather conditions and the

[30] That is, $NW = min\{max\{W_{ms}, W^{10}\}, W^{90}\}$, $GW = max\{0, W_{ms} - W^{90}\}$ and $BW = min\{0, W_{ms} - W^{10}\}$.

share of coffee sold spot. The empirical specification includes buyer-seller bs pair fixed effects, thereby controlling for time invariant characteristics of both buyers and sellers as well as their match. The pair specific fixed effects also absorb sellers fixed characteristics, including those that might drive selection into the organizational form. The error term ε_{bms} is arbitrarily correlated over time within bs pairs.

Between firms, the model predicts a constant relationship under normal weather conditions ($\beta_1 = 0$) and a positive relationship at times of exceptionally good weather conditions ($\beta_2 > 0$). *Within* integrated firms, instead, the model predicts $\beta_1 = 0$ and $\beta_2 = 0$.[31]

Columns 1 finds supporting evidence for prediction [1.]: the share traded spot in non-integrated relationships increases during exceptional weather conditions, but not under normal weather (p-value 0.09). Columns 2 and 3 investigate predictions [2.] and [3.], i.e., the two (*placebo*) tests. Column 2 repeats the exercise on the sample of integrated relationships and, as predicted, finds no differential effect of good weather on the share of coffee transacted spot (p-value 0.93). Finally, Column 3 allows for a differential effect of negative weather (as defined in Table 3). As predicted by the model, we find no differential effect of negative weather (unreported p-value 0.60) while the differential effect of good weather becomes larger in magnitude and more precisely estimated (p-value 0.03). The baseline specification thus provides strong support for Predictions [1.], [2.] and [3.].

Robustness to Baseline Definitions:

The baseline specification in (5) defines spot contracts as those shorter than 30 days and exceptionally good weather conditions during the growing season as those above the 90^{th} percentile of the weather index. In addition, the weather index is calculated using daily rainfall and temperature records at the mill's location. Figure 8 explores robustness of the baseline results along all these dimensions. The Figure reports estimated coefficients β_1 and β_2 (and related confidence intervals) from 24 regressions in which the baseline definitions are modified. Spot contracts are defined as those with duration shorter than 15, 21, 30 and 45 days; weather thresholds are placed at the 85^{th}, 90^{th} and 95^{th} percentiles; and the weather index is calculated both at the mill's location as well as within the broader mill's catchment areas. This gives a total of $4 \times 3 \times 2 = 24$ specifications. The Figure ranks the resulting 24 specifications with respect to the estimated coefficient β_2 for good weather. In all 24 specifications β_2 is positive, statistically significant

[31] As shown in Appendix 3.C $\beta_2 < \beta_1 < 0$ for a risk-averse mill. The prediction $\beta_2 > max\{0, \beta_1\}$ is thus intrinsic to the incentive compatibility constraint.

and different from the effect of normal weather β_1 which is always small and precisely estimated to be zero. Across the 24 specifications, the estimated β_2 ranges from approximately 0.1 to 0.3, with the baseline definitions in Table 4 yielding estimates in the middle of the range. The baseline results are thus remarkably robust to the definitions of both spot contracts and weather conditions.

Specifications with Relationship's Age:

The baseline specification controls for relationship (i.e., buyer-mill pair) fixed effects. This implies that time-invariant characteristics at both the mill and buyer level, including those that could drive selection into organizational forms, are controlled for. The specification, however, does not control for time invariant shocks nor for the fact that the effects of the weather realization during the growing season could affect mills differentially along dimensions that correlate with organizational and contractual forms. To perfectly control for both possibilities, the ideal specification would include mill-season fixed effects. Mill-season fixed effects, however, cannot be included in the baseline specification, as they would completely absorb the variation in weather conditions, which is also at the mill-season level.

We therefore pursue an alternative strategy. The strategy relies on testing for the interaction between the weather variable and proxies for relationship value $\mathbf{V}$ (prediction [4.]). Including such interactions generates variation at the mill-buyer-season level which then allows to include mill-season fixed effects, thereby perfectly controlling for the potential confounders described above. The model delivers clear predictions on such interactions: higher relationship's value $\mathbf{V}$ relaxes the incentive constraint and, therefore, reduces the share of coffee transacted spot. By the same logic, a higher $\mathbf{V}$ also attenuates the effect of good realization of weather conditions. The interaction between relationship's value and good weather conditions should thus be negative. Building on the recent literature on relationships between firms (see, e.g., Macchiavello and Morjaria (2015) and Antràs and Foley (2015)) we use relationship's age as a proxy for relationship's value $\mathbf{V}$. The value of the relationship $\mathbf{V}$ increases with relationship's age either due to selection effects (more valuable relationships survive longer) or due to other causal forces (e.g., reputation).

Column 4 in Table 4 reports the results. Age is measured as the number of seasons the buyer and the seller have previously transacted. For ease of interpretation, we report results with age measured as deviation from the sample mean, so that the level coefficients can be interpreted as the effect of weather conditions on the share traded spot for the average relationship in the sample. Consistent with prediction [4.] we find that *i)* good weather conditions increase the share of coffee traded spot for all relationship; *ii)* relationship's age negatively correlates with the share traded spot; *iii)* the interaction between good weather and relationship's age is negative and statistically significant; and *iv)* no effect is found, either in levels or as interaction, for normal weather conditions.

Exploiting this new source of variation, Column 5 includes mill-season fixed effects. The inclusion of mill-season fixed effects remove concerns that idiosyncratic shocks at the mill level, or interactions of weather conditions with characteristics that correlate with organizational and contractual forms, might drive the results. Results are remarkably robust. Of course, as weather conditions are now absorbed in the fixed effects, the specification does not identify the level effect of weather conditions. Column 5 shows that relationship's age negatively correlates with the share traded spot; that the interaction between good weather and relationship's age is negative and statistically significant; and that there is no effect for the interaction with normal weather conditions. The estimated coefficients are very similar in magnitude to those in Column 4 and are now more precisely estimated.

Some of the baseline results could potentially be consistent with buyers simply not having sufficient demand for coffee sold forward. Column 6 adds buyer-season fixed effects to the specification with mill-season fixed effects in Column 5. The inclusion of buyer-season fixed effects controls for buyer specific idiosyncratic shocks, including a limited demand for forward sales. Results are consistent with those in Column 5. First, relationship's age is associated with a lower share of coffee sold spot in the relationship. Second, the estimates show that the effect of good weather conditions is reduced in older relationships (p-value 0.12). Finally, relationship's age doesn't change the effect of normal weather conditions. Although the inclusion of many additional fixed effects reduces the available variation in the data, the evidence in Column 6 suggests that the baseline results are not driven by idiosyncratic time-varying shocks, including buyer's demand for forward coffee.[32]

4.D. Contract-Level Specifications

A final concern is the possibility that good weather conditions impact not just the volume but also the quality, or type, of coffee available to the mill. If buyers in different organizational forms have differentially lower forward demand for the type of coffee that is relatively more abundant under good weather conditions, this could potentially explain prediction [1.] (but not prediction [4.] nor, possibly,

[32]Unreported results show that simply controlling for buyer's total and forward purchases of coffee in the season from other sellers yield nearly identical, but more precise, point estimates.

placebos [2.] and [3.]). Appendix Figure C.1 however offers *prima facie* evidence that this is unlikely to be the case: different organizational forms trade very similar product types.

Table 5 directly addresses this concern by testing the predictions with contract-level specifications. This allows to directly control for extremely detailed product-type fixed effects. Besides allowing to control directly for product quality, specifications at the contract level allow to test whether the effects of weather conditions vary by product type. In particular, side-selling opportunities should matter less for coffee that is traded through labels and certifications, as the market for such coffee types is less liquid (Prediction [5.]). The specification is as follows:

$$\sigma_{cbmpt} = \alpha_{bm}+\gamma_t+\mu_p+\beta_1 * min[W_{ms}-\overline{W}^{90},0]+\beta_2 * max[0,W_{ms}-\overline{W}^{90}]+\eta * Z_{cbmpt}+\varepsilon_{cbmpt} \tag{6}$$

where σ_{cbmpt} is a dummy taking value equal to one if contract c between buyer b and mill m signed at date t for coffee of type p is spot (i.e., shorter than 30 days) and zero otherwise. As in the baseline specification buyer-mill pair fixed effects α_{bm} are controlled for. In addition, we flexibly control for the time the contract is signed by including signing date month-season fixed effects γ_t as well as for polynomials of contracted volume Z_{cbmpt}. Finally, as per ICAFE regulations, the contract must specify the type of bean, the quality of parchment, the preparation type and a product category. This allows us to include 403 product-specific fixed effects μ_p.[33] The error term ε_{cbmpt} is arbitrarily correlated over time within bs pairs.

Column 1 in Table 5 reports the baseline estimates on the sample of contracts signed by non-integrated relationships. Results confirm that contracts signed after good weather conditions during the growing season are significantly more likely to be spot. Column 2 shows that, again, there is no relationship between weather conditions during the growing season and whether coffee is traded spot within integrated relationships. Columns 3 and 4 replicate the results using as dependent variable the length of the contract, defined as the number of days in between the contract signing and delivery dates. Results confirm that good weather conditions

[33] Contract specify type of bean (8 categories), quality (7 categories), and preparation (8 categories). Moreover, ICAFE allows mills to register up to three different differentiated product lines of coffee, in addition to an undifferentiated ("convencional") line. This provides a uniquely fine product classification. As a matter of comparison note that these hundreds of products span only two ten-digit HS codes (0901110015 and 0901110025 (Arabica coffee, not roasted with and without certified origin)). The ten-digit HS code is the finest level of product classification typically used in empirical analysis of international trade.

during the growing season are associated with shorter contracts for non-integrated relationships. Once again, no relationship between weather conditions and the length of contracts is detected for non-integrated relationships. Results thus confirm predictions [1.], [2.] and [3.] even in specifications at the contract-level.

Columns 5 and 6 investigate if the degree of product differentiation matters for the results. Prediction [1.] is derived from the possibility that the mill strategically defaults on forward contracts by side-selling coffee to alternative buyers. A mill's ability to side-sell crucially depends on the market liquidity for the coffee: more differentiated coffee (e.g., those carrying producers brand, labels and certifications) offer fewer opportunities to side-sell. Consistent with this hypothesis, Figure C.2 shows that the aggregate volume of trade in a particular coffee type (a proxy for market liquidity) *negatively* correlates with the share of that coffee type transacted at arm's length. That is, integration and long-term relationships are used relatively more for coffee types that are more commonly traded and for which mills might more easily find side-selling opportunities. Columns 5 and 6 directly test for this hypothesis by splitting the sample of contracts between firms according to whether the traded coffee is differentiated or not. Consistently with prediction [5.] results show that there is no effect of good weather on the likelihood of signing a spot contract for differentiated coffee and that all the effect is driven by undifferentiated (convencional) coffee.[34]

Taken together, the results in Tables 3, 4, 5 and in Figure 8 provide strong support for Predictions [1.] to [5.]. The hypothesis is confirmed at three different levels of aggregation: mill level, relationship level and contract level. Exceptionally good weather conditions during the growing season are associated with less forward contracting between firms, but not within integrated firms. This is consistent with the hypothesis that, by removing the possibility of side-selling coffee, vertical integration allows to trade larger volumes of coffee forward. The results are not driven by non-linear effect of weather on production; nor by different definitions of spot and forward contracting; nor by different definitions for good weather conditions; nor by mill-season specific shocks (including differential response to weather shocks along dimensions that might correlate with organizational forms); nor by limited demand at the buyer level (which can be controlled for by buyer-season fixed effects); nor by differences in the type of coffee traded by different organizational forms.

[34]The hypothesis is further confirmed by tests for strategic default in Appendix 2.

5. Conclusions

Contractual imperfections are at the center of all main theories of firm boundaries. Repeated relationships between firms can, in practice, also mitigate contractual imperfections. In order to understand how firm boundaries matter, then, it is necessary to compare transactions taking place within integrated firms with those in long-term relationships between firms. This paper has offered what is, to the best of our knowledge, the first example of such a comparison. We carried out an empirical analysis of the Costa Rica coffee chain, a context that, despite its simplicity, offers a number of methodological advantages. By distinguishing long-term relationships from arm's length relationships between firms, we were able to document that transactions within integrated firms are remarkably similar to those in long-term relationships and, at the same time, radically different from those in arm's length relationships.

Despite the similarity, we were also to shed light on a qualitative difference in the size of forward transactions under the relational arrangement in comparison to vertically integrated firms. We interpreted this difference as indicating that the scale of operations supported under long-term relationships is limited by the possibility that a seller might be tempted to default on promised deliveries should better trading opportunities arise. By shifting ownership of the coffee away from the seller, integration removes such temptations and allows parties to transact volumes beyond the critical size. We formalized our hypothesis with a model in the spirit of Baker et al. (2002) and tested its assumptions and predictions exploiting both idyosincratic weather and international price shocks. The evidence confirms that the risk of default constrains the volume of forward trade in long-term relationships. No such effect is detected within integrated firms. The evidence supports models in which asset ownership changes temptations to renege on past promises to trade, as in Baker et al. (2002).

The analysis can be extended to consider demand uncertainty as in Carlton (1978). Difficulties in selling outside the integrated chain rationalizes the pattern described in Table 2 according to which backward integrated buyers source from both integrated and independent suppliers. Larger buyers with forward commitments in export markets demand larger volumes of forward coffee and have stronger incentives to integrate backward. Appendix 3 provides empirical evidence supporting these additional implications.[35] Integration thus comes with

[35] A common prediction of models of vertical integration and supply assurance is that the market generates too much integration (Carlton (1979), Bolton and Whinston (1993) and Kranton and Minehart (2000)). This observation might have implications for the regulation of agricultural

both costs and benefits whose relative importance depend on the market's competitive structure. Understanding the two-way relation between market structure and organizational forms is an important avenue for future research.

chains in emerging markets.

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Table 1: **Descriptive Statistics (2011/12 Season)**

Panel A: Sellers Characteristics

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Cooperative	184	0.126	0.333	0	1
Quantity (tons)	184	5,675	12,359	2,300	76,431
Average price	184	4.583	0.846	2.602	7.932
% Exported	184	0.777	0.263	0	1
Number of Buyers	184	3.665	2.927	1	21
% Sold to Integrated Buyers	184	0.115	0.281	0	1

Panel B: Buyers Characteristics

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Quantity (tons)	171	6,090	24,658	0.440	261,336
Average price	171	4.114	1.086	1.807	7.065
% exported	171	0.409	0.463	0	1
Number of Suppliers	171	3.935	8.562	1	64
% Bought from Integrated Seller	171	0.022.	0.126	0	1

Panel C: Contract Characteristics

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Vertical Integrated Buyer	4133	0.453	0.498	0	1
Vertical Integrated Seller	4133	0.143	0.350	0	1
Vertically Integrated Relationship	4133	0.143	0.350	0	1
Quantity (kilo)	4133	24,965	29,827	31.44	259,817
Contract Length (days)	4133	98.59	123.5	0	365
Export market	4133	0.800	0.400	0	1

Panel D: Relationship Characteristics

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Age (seasons)	178	6.69	3.45	4	12
Quantity (tons)	178	230	416	0.1	2570
Average Contract Length (days)	178	126.7	108.9	0	361
% of Mill Sales	178	0.33	0.33	0	1
% of Buyer Sourcing	178	0.22	0.34	0	1
% Exported	178	0.74	0.40	0	1

The Table provides summary statistics for the 2011/12 harvest season (See Table A.2 for evolution of key variables over the sample period). Panel A presents the summary statistics for mills. Cooperative is a dummy that takes value one if the mill is owned by a farmer's cooperative. Quantity is in tons of parchment coffee. Price is a weighted average price for a Kg of coffee, in dollars. % Exported is the share of production destined to the export market. Number of Buyers is the number of different trading partners in the season. % Sold to Integrated Buyers refers to backward integrated buyers only. Panel B presents the summary statistics for buyers (exporters and domestic rosters). Variables are similarly defined. Panel C presents the summary statistics at the contract level. Vertical Integrated Buyer/Seller/Relationship are dummies taking value equal to one depending on the integration status of the relevant parties involved (buyer/seller/both). Quantity is in kilos. Contract Length is the difference in days between delivery date and signing date. Export market is a dummy taking value equal to one if the coffee is destined for the export market. Panel D presents summary statistics for relationships. A mill-buyer pair are defined to be in a relationship if they have traded at least four consecutive years during the sample period. By definition then, the minimum relationship's age is four seasons. Quantity is in tons of coffee. Average contract length is a weighted average of contract length signed in the relationship. % of mills sales (buyer sourcing) is the share of the mill sales (buyer purchases) accounted for by the relationship. % exported is the share of coffee traded in the relationship destined for the export market.

Table 2: **Use of Organizational Forms**

	(1)	(2)	(3)	(4)
	Mills: % Sold		Buyers: % Sourced	
	Non-Integrated	Integrated	Non-Integrated	Integrated
Between Firms:				
Market	38%	4%	51%	23%
Relationships	62%	0%	49%	20%
Within Firms:				
Integration	–	96%	–	56%
N. of Mills / Buyers	144	25	145	10

The Table summarizes the use of the three organizational forms by mills and buyers depending on their integration status. A mill and a buyer are defined to be in a relationship if they have traded at least four consecutive seasons during the sample period. To avoid censoring, Mills and Buyers that do not operate at least four seasons over the sample period are omitted. This excludes micro-mills and occasional exporters that account for a negligible share of aggregate volumes. Figures are averages across firms and harvest seasons. Forward integrated chains are excluded.

Table 3: **Weather, Production and % Sold Spot: Mill Level**

	(1)	(2)	(3)	(4)
	Mill Production (in Tons)		% Sold Spot	
(Normal) Weather	113.84***	92.49*	-0.01	-0.02
	(32.26)	(51.216)	(0.02)	(0.034)
Good Weather		105.96		0.20**
		(86.98)		(0.09)
Bad Weather		196.19*		0.00
		(109.95)		(0.08)
Dep. Variable Mean	795.06	795.06	0.36	0.36
Test Bad = Normal (p-value)		0.51 (0.475)		0.05 (0.815)
Test Good = Normal (p-value)		0.02 (0.902)		5.15 (0.023)
Observations	1,502	1,502	1,502	1,502
Mill FE	Yes	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes

Robust standard errors clustered at the region-season level are reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. The Table shows that exogenous idiosyncratic weather conditions around the mill during the growing season affect mill production. Weather W_{ms} is a z-score index of daily rainfall and temperatures during the growing season (August to November) around the mill. Columns 2 and 4 use a kink specification where the effect of weather conditions during the growing seasons is allowed to vary for good weather (i.e., above the 90th percentile) and for bad weather (i.e., below the 10th percentile) of the weather realizations. Mill's production is tons of coffee produced by mill m in season s. The % sold spot is the share of the mill seasonal production that is sold through contracts of duration shorter than 30 days.

Table 4: **Testing Model's Predictions: Relationship Level**

	(1)	(2)	(3)	(4)	(5)	(6)
			% Sold Spot			
Normal Weather	0.0012	-0.0257	-0.0065	0.0012		
	(0.019)	(0.078)	(0.029)	(0.026)		
Good Weather	0.1494*	-0.0513	0.2697**	0.1843**		
	(0.087)	(0.335)	(0.124)	(0.087)		
Bad Weather			0.0344			
			(0.073)			
Relationship's Age				-0.0213**	-0.0344***	-0.0324***
				(0.010)	(0.006)	(0.006)
Normal Weather × Relationship's Age				0.0020	0.0011	-0.0008
				(0.007)	(0.004)	(0.005)
Good Weather × Relationship's Age				-0.0338	-0.0483**	-0.0320+
				(0.026)	(0.020)	(0.020)
Dep. Variable Mean	0.41	0.29	0.41	0.41	0.41	0.41
Integrated Pairs (Sample)	No	Yes	No	No	No	No
test Good = Normal	2.84 (0.09)	0.01 (0.94)	4.74 (0.03)	4.29 (0.04)		
test Good = Normal (Age Interaction)				0.91 (0.17)	5.04 (0.02)	2.06 (0.15)
Observations	6,074	365	6,074	6,074	6,074	6,074
R^2	0.675	0.292	0.675	0.679	0.167	0.393
Season FE	Yes	Yes	Yes	Yes	−−	−−
Relationship FE	Yes	Yes	Yes	Yes	No	No
Mill-Season FE	No	No	No	No	Yes	Yes
Buyer-Season FE	No	No	No	No	No	Yes
Buyer FE	−−	−−	−−	−−	Yes	−−

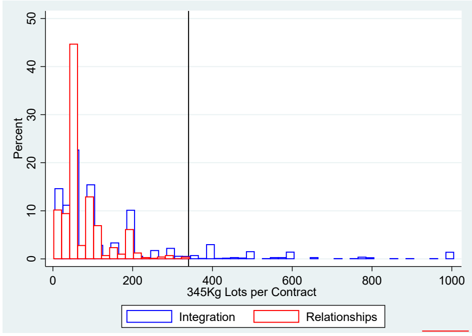
Robust standard errors clustered at the relationship level are reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. The weather index W_{ms} is a z-score index of daily rainfall and temperatures during the growing season (August to November) around the mill. Normal, Good and Bad weather are defined as $NW = min\{max\{W_{ms}, W^{10}\}, W^{90}\}$, $GW = max\{0, W_{ms} - W^{90}\}$ and $BW = min\{0, W_{ms} - W^{10}\}$ respectively with W^z being the z percentile of weather realizations in the sample. The % sold spot is the share of coffee sold by mill m to buyer b in season s through contracts of duration shorter than 30 days. Relationship's age is in the number of season the buyer and seller in the pair have traded (up to that point) and is measured in deviations from the sample average to facilitate interpretation of interaction terms.

Table 5: **Testing Model's Predictions: Contract Level Specifications**

	(1)	(2)	(3)	(4)	(5)	(6)
	Spot Contract =1		Contract Lenght		Spot Contract =1	
Normal Weather	-0.025*	0.09	9.01+	-24.15	0.10	-0.033**
	(0.014)	(0.066)	(5.775)	(17.806)	(0.029)	(0.014)
Good Weather	0.203***	0.135	-45.691***	-10.356	0.061	0.213***
	(0.047)	(0.247)	(15.534)	(67.046)	(0.127)	(0.056)
Dep. Variable Mean	0.34	0.28	149.17	130.13	0.38	0.33
Integrated Pairs (Sample)	No	Yes	No	Yes	No	No
Product Type	All	All	All	All	Differentiated	Convencional
test Good = Normal	17.72 (0.00)	0.11 (0.74)	11.35 (0.00)	0.17 (0.68)	0.15 (0.70)	18.22 (0.00)
Observations	35,231	6,345	35,231	6,345	6,414	28,817
Season-month FE	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Relationship FE	Yes	Yes	Yes	Yes	Yes	Yes

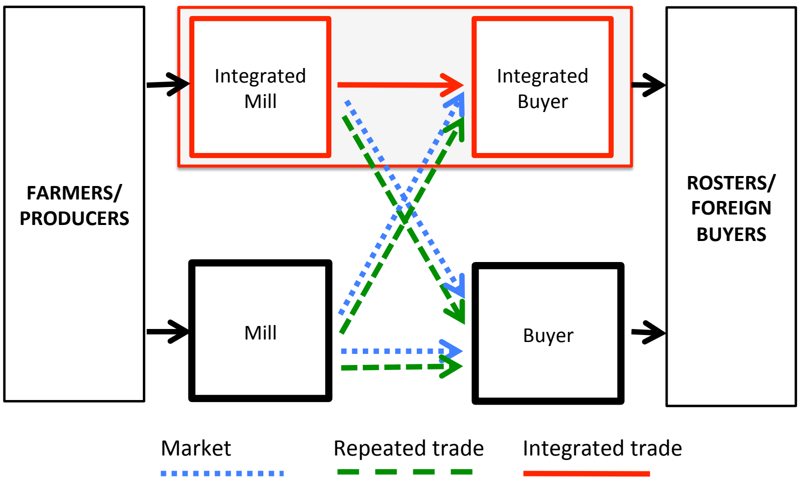
Robust standard errors clustered at the mill-buyer level are reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. The weather index W_{ms} is a z-score index of daily rainfall and temperatures during the growing season (August to November) around the mill. Normal and Good weather are defined as $NW = min\{max\{W_{ms}, W^{10}\} and W^{90}\}$, $GW = max\{0, W_{ms} - W^{90}\}$ respectively with W^z being the z percentile of weather realizations in the sample. Unreported specifications show that results are robust to the inclusion of Bad weather as in Table 4. A contract is spot if its length is shorter than 30 days. Contract length is defined as the difference (in days) between the delivery date and the signing date in the contract. Differentiated contracts are those for coffee with producer specific product lines (brand, certifications, etc.). Convencional contracts do not carry such labels.

Figure 1: **Contract Volumes & Organizational Forms**



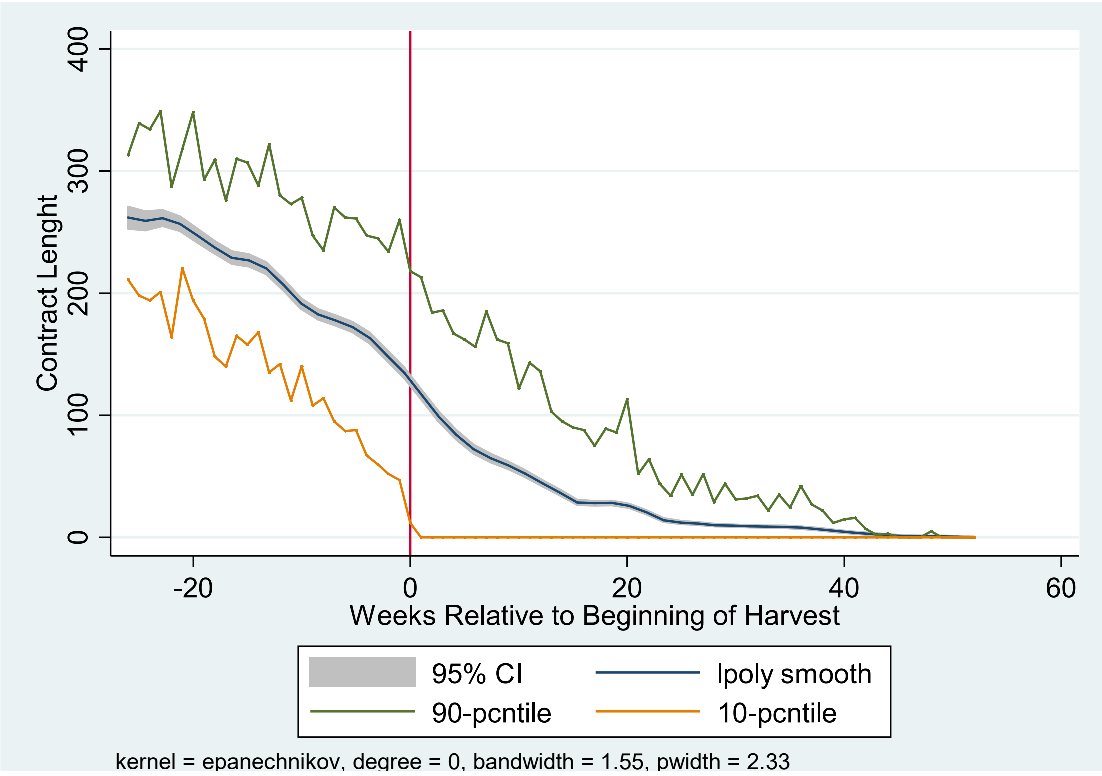
The Figure reports the histogram of the size of forward contracts (defined as those signed at least four weeks before delivery) across two organizational forms: *within* (backward integrated) firms (**Integration**); *between* firms in long-term relationships (**Relationships**). Relationships are mill-buyer pairs that trade at least four consecutive seasons. As shown in Section 2, integrated mills are larger and sell almost all their production to their downstream buyers. The Figure takes into account these differences by restricting attention to long-term relationships of mills of similar size that also sell at least three quarters of their production to their main buyer.

Figure 2: **Coffee Value Chain**



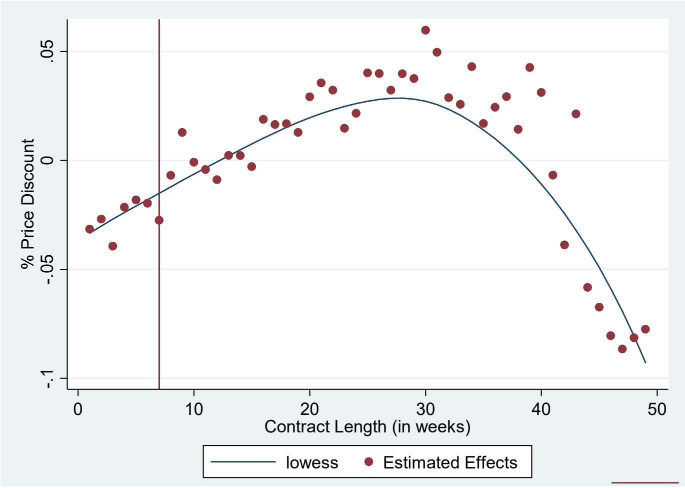
The Figure describes the coffee value chain in Costa Rica. Coffee cherries are produced by farmers and sold to Mills (Coffee Washing Stations or Beneficios). Mills sell parchment coffee to domestic buyers. These consolidate, mix and mill the coffee before selling to foreign buyers or to domestic rosters. As illustrated by the picture, some mills are owned by buyers, i.e., some buyers are backward vertically integrated. We compare coffee transactions across three main organizational forms: *within* (backward integrated) firms (**Integration**); *between* firms in long-term relationships (**Relationships**); and *between* firms trading at arm's length (**Market**).

Figure 3: **Contract Length During the Coffee Season**



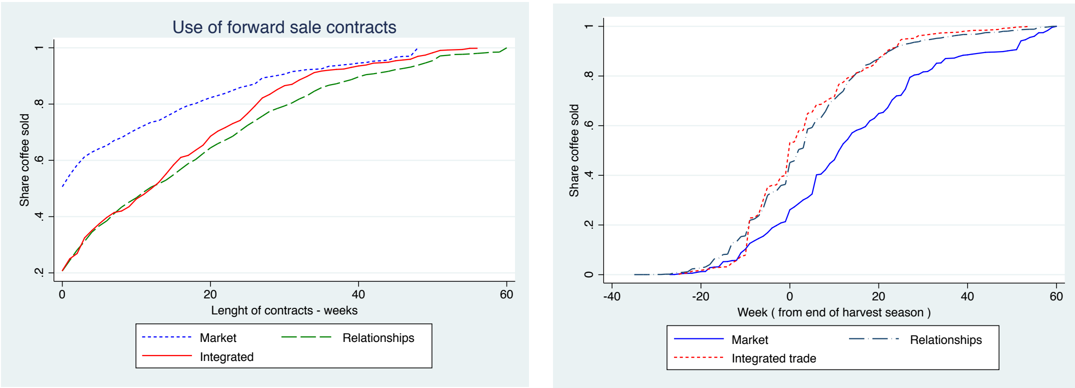
The Figure illustrates the distribution of contract length over the course of the season. Contract length (reported on the vertical axis) is defined as the difference between the delivery date and the signing date of the contract. The timing of the harvest season (reported on the horizontal axis) is measured in weeks relative to the region-specific beginning of harvest. Mills and buyers sign forward contracts to ensure demand and supply in a market characterized by significant uncertainty. The Figure shows that parties start signing long forward contracts (up to nine months in advance of delivery) around 20 weeks before the onset of harvest. As the season unfolds, contracts become shorter. Once the harvest season ends, essentially all contracts are spot, i.e., for (nearly) immediate delivery.

Figure 4: **Pricing Patterns: Forward Discount and Inventory Risk**



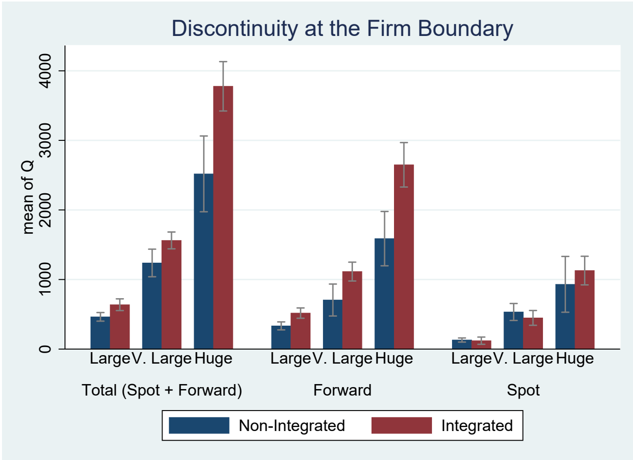
The Figure illustrates pricing patterns implied by models with demand uncertainty (e.g., Carlton (1978) and Dana (1998)). The vertical axis reports residuals from contract-level regressions on the sample of contracts signed between firms trading at arm's length. The dependent variable is the log of price per Kilo. The regression includes (404) product, region-specific season and seasonality fixed-effects. A third-degree polynomial of Kilos of coffee in the contract and a dummy indicating whether the contract is for the national or export markets are also included. The residuals are then plotted against contract length (binned, in weeks). The Figure shows an inverted-U relationship between contract length and unit prices. Relative to contracts signed during the harvest season, forward contracts signed before the beginning of harvest have approximately 5% lower prices. Such *forward discount* arises due to lower costs (i.e., higher expected capacity utilization) guaranteed by forward sales in the presence of uncertainty. Risk aversion on either buyers' or mills' side is neither necessary nor sufficient to generate a forward discount. Spot contracts just before the new harvest also feature approximately 5% lower prices. This price discount reflects the *inventory risk* faced by mills as they sell unsold inventories that will soon sharply depreciate once the new harvest crop is available. The estimated discounts are large relative to both buyers and mills margins.

Figure 5: **Contract Length and Timing of Sales**



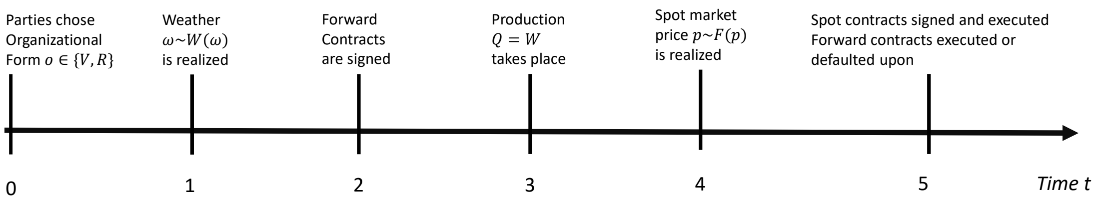
The Figure shows that relationships and integration have similar patterns with respect to the form and timing of trade. The Left Panel reports the cumulative share of coffee sold by delivery date by organizational forms. The delivery date is measured in weeks relative to the beginning of the harvest campaign in the region of the mill. The Right Panel reports the cumulative share of coffee sold by length of contract, measured in weeks, across organizational forms. The length of the contract is defined as the difference between the delivery date and the contract signing date. In both cases, patterns of trade within integrated firms look much more similar to patterns inside long-term relationships than in the market. The Figures are constructed averaging contracts and excluding trade inside forward integrated chains.

Figure 6: **Discontinuity at the Firm's Boundary**



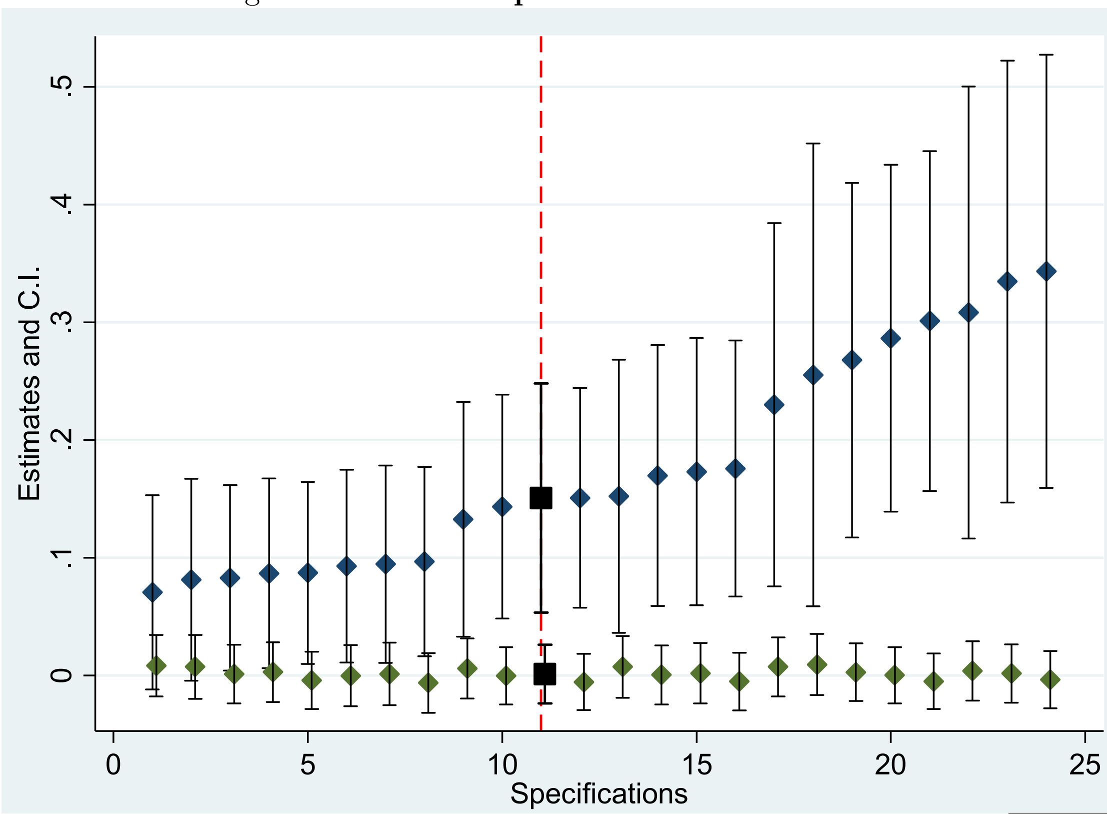
The Figure illustrates the discontinuity at the firm boundary. The Figure reports the average seasonal volume of trade, measured in tons of coffee, across different samples of relationships. We construct the sample of "control" non-integrated relationships as follows. First, we compare relationships of mills within the same decile of the mill size distribution: *Large* mills are those in between the (75^{th}) and (90^{th}) percentiles in the size distribution; *Very Large* mills those in between the (90^{th}) and the (95^{th}) percentiles, and *Huge* those above the 95^{th} percentile. There are no integrated mills outside the top quartile of the size distribution. Second, we only consider relationships that account for at least 90% of the sales of a given mill. Despite the binary nature of the comparison, we refer to it as a *discontinuity* to reflect the two continuous "running variables" (mill's size and relationship exclusivity) held constant in the comparison. The Figure shows that integrated relationships trade significantly larger volumes than nearly exclusive non-integrated relationships of equally large mills. The entire difference is driven by forward trade (for which removal of side-selling matters) whilst no difference is detected for spot trade (placebo).

Figure 7: **Timing of the seasons contracting.**



The Figure presents the timing of events in the model. At time $t = 0$, the buyer and the seller chose the organizational form. Two organizational forms o are available: integration $o = I$ (when the buyer owns the seller and, therefore, the coffee) and relationship $o = R$ (when, instead, the seller retains ownership of the coffee produced). Both parties have deep pockets and agree to the organizational form that maximizes expected joint profits using lump-sum transfers to adjust ex-ante pay-offs as required. At $t = 1$, weather conditions during the growing season, ω, are drawn from a cumulative distribution $\omega \sim W(\omega)$. At $t = 2$ parties can sign *forward* contracts. At $t = 3$ harvest takes place resulting in production $Q = \omega$. At $t = 4$ the spot market price p is drawn from a cumulative distribution $p \sim F(p)$. Finally, at $t = 5$ *spot* contracts are signed and executed, forward contracts are executed or defaulted upon.

Figure 8: **Baseline Specification: Robustness**



The Figure reports estimated coefficients β_1 and β_2 from 24 different regressions (Equation 5). Across all 24 specifications we find $\beta_1 = 0$ and $\beta_2 > 0$ as predicted by the model. Estimates for the baseline specification are reported in Column 1 of Table 4. The 24 regressions differ in their definition of spot contracts (shorter than 15, 21, *30* and 45 days); threshold for good weather (85, *90*, and 95 weather percentile); and definition of the weather index (at the *mill* or averaged over the catchment area). The Figure ranks the resulting 24 specifications based on the point estimates for β_2. The baseline specification (highlighted with the reference line in the Figure) uses variables defined in *italics* and ranks 11th out of the 24 specifications.

Appendix i. The Costa Rica Coffee Chain: Context, Regulations and Data (For Online Publication)

i.1. Regulations

In Costa Rica coffee is produced in seven regions (see Figure A.1 and Table A.1). The production, processing, marketing and export of coffee are undertaken by the private sector. The state regulates the sector through the Instituto del Cafe de Costa Rica (ICAFE), a non-governmental public institution established by law in 1961. ICAFE represents the interests of farmers, processors and exporters. The main objective of the law, stated in its first article, is "to achieve an equitable system of relationships between producers, processors and exporters of coffee that guarantees a rational and secure participation of each stage in the coffee business".[36]

The key aspect of the regulation is the System of Final Liquidation (i.e.,"Sistema de Liquidación Final"). The main feature of the system is to enforce contracts between farmers and mills and between mills and exporters. For the system to be implemented, all transactions of coffee along the chain must be registered with the board. The process, illustrated in Figure A.2, is as follows:

1. *Reception of coffee cherries and initial payment.* Immediately after harvest, farmers deliver coffee to a mill. Farmers are free to deliver to any mill. Upon delivery, the mill issues a receipt for the coffee. The law establishes that the receipt has the value of a contract. The receipt records the date, type, quantity of coffee and payment, if any.

2. *Contracts between mills and buyers.* Every sale contract between a mill and a buyer must be registered with and approved by the coffee board. A contract is defined by a type and quantity of coffee, signing and delivery dates, and a price. Without disclosing it to market participants, the board sets minimum prices based on differential against prevailing international prices. Figure A.3 shows that the regulation leaves substantial margins for price negotiations: at any date there is significant variation in contracted prices. Figure A.3 shows that undisclosed minimum prices do not bind.

3. *Payment to farmers.* Every three months, mills make payments to farmers according to sales up to that point. At the end of the harvest campaign, the mills pay the farmers a final liquidation. The final liquidation is computed

[36]For further details, see: www.icafe.go.cr.

according to a rule that detracts from the mill's sales *i*) audited processing costs, *ii*) allowed profit margin, *iii*) any previous amount paid to farmers, *iv*) a contribution to the national coffee fund. The final price for each mill is published in newspapers and the corresponding payments to farmers must be executed by the mills within eight days of publication.[37]

To compute the final liquidation price, the regulation requires mills to submit all contracts with buyers for approval. This requirement applies to all transactions between mills and exporters, independently of their ownership structure. This implies that terms of transactions are observed for both trade between and within firms. Vertical integration is allowed and transfer pricing (in which prices are artificially depressed to shift profits downstream) is prevented by rejecting contracts with prices below the undisclosed minimum.[38] Due to the difficulty of interpreting prices for coffee traded within firm integrated firms, the empirical analysis focuses on volumes and timing of transactions, not on prices.

Registering contracts with the board improves enforcement. The board enforces standards: the contract must specify type of bean (8 categories), quality of parchment (7 categories) and preparation type (8 categories). Mills can furthermore register up to three differentiated product lines of coffee, in addition to the undifferentiated ("convencional"). This gives a total of 404 observed unique products. These hundreds of products span only two ten-digit HS codes (0901110015 and 0901110025), the finest level of product classification typically used in international trade.

The board also protects parties from counterpart risk. Buyers and sellers often sign forward contracts for future delivery. Sharp changes in (international) market conditions leave parties exposed to strategic default: if prices go up (down), mills (buyers) will want to renege on the deal. The board only allows mills to cancel contracts under specific circumstances. The board allows mills to cancel contracts for one of the following reasons: (A) when there is agreement by both sides to substitute the contract for another one with a better price, (B) when the mill does

[37]The system facilitates risk management and reduces mills working capital requirements. The final price paid to farmers depends on international market conditions prevailing throughout the entire season, rather than just at harvest time. Since farmers are mostly paid after sales, mills have lower working capital needs. This type of regulations are by no means unique to Costa Rica. For example, Guatemala, Nicaragua, El Salvador and Burundi have adopted, or tried to adopt, similar regulations. The Kenya and Rwanda tea sectors are currently regulated along similar lines.

[38]It is not unusual for vertical integration between producers and exporters to be banned altogether in this type of chains (see, e.g., the Ethiopia coffee chain before the creation of the commodity exchange, cocoa in Ghana, cotton in Tanzania).

not have enough coffee to honor the contract, (C) when the mill does not have coffee of the quality established in the contract to deliver, and (D) for exceptional causes to be evaluated by the coffee board (see Appendix 2 for an analysis of contractual defaults).

i.2. Data

The primary data source is the ICAFE. Together with the annual reports, used to construct the descriptive tables, we obtained detailed information on transactions between mills and buyers, and on buyer's characteristics.

- *Transactions*: The data on contracts includes information on 44282 contracts between mills and buyers spanning 12 harvest seasons (from 2001/02 to 2012/13). Approximately a quarter of all contracts are for the national market while the remaining are for export. Information on contracts cancellations is available from season 2006/07 onward, and includes the reason for the contract cancellation.

- *Mills*: From the 2006/07 seasons onward we are able to match the transaction data with information on mills operation from the ICAFE. This includes information on the operating costs, and information on sourcing (bi-weekly reports of all coffee sourced by mills (by two broad categories)). We complement this information by reconstructing, through a mix of ICAFE records, interviews and internet searches, the history of mill's operation and ownership type during the sample period. To do so we extensively rely on information on the location of the mills, which we then complement with detailed geographic data, including both geographic characteristics, historical weather data and infrastructures.

- *Buyers and Exporters*: Information on buyers includes whether they own a mill and history of operation. This information is compiled through a combination of ICAFE records, internet searches and interviews. For the subset of buyers that are exporters we match the information with transaction level customs records from season 2006/07 onward (information on foreign buyers is available for seasons 2008/09 to 2012/13 only). We match this information with data on coffee imports by the countries that source from Costa Rica obtained from the Commodity Trade Statistics Database.

- *Daily prices*: We collect daily world coffee prices for coffee from public sources. Specifically, we collect price data on the Coffee C future contract

(KC) traded in New York, the world benchmark for Arabica coffee. The contract prices physical delivery of a standard quantity (37,500 pounds) exchange-grade green beans, from one of 20 countries of origin (including Costa Rica) in a licensed warehouse to one of several ports in the U. S. and Europe. Costa Rica coffee trades at par (i.e., with no premium or discount). Contracts are listed for the months of March, May, July, September and December and are traded up to one business day prior to the last notice day (which is seven business days prior to first business day of delivery month). So, for each date in the sample, we observe prices for the next four delivery months. We match each transaction in our sample to the nearest subsequent delivery date: e.g., a contract signed on April 1st for delivery on November 30th is assigned the future price for December delivery. The contract specific price surprise is then given by the ration between the December listed price at the contract delivery date divided by the December listed price at the contract signing date.

- *Weather Instruments*: The weather information comes from the daily information on rain and temperature at the 25 weather stations located in the coffee producing areas. The information is compiled by the Instituto Meteorológico Nacional (IMN) of Costa Rica. The location of the weather stations and the mills allowed for a matching of temperature and rain on the mill's location and catchment area.

Table A.1: **Coffee producing regions**

Regions:	Coto Brus	Los Santos	Perez Zeledon	Turrialba	Central Valley	West Valley	North
Harvest season (aprox.):							
Start:	September	November	August	June	November	November	July
End:	February	March	February	February	March	February	December
Share of cherries produced (by season):							
2005-2006	8.6%	27.4%	14.7%	6.9%	19.7%	21%	1.8%
2006-2007	11.4%	30.5%	13.9%	7.5%	17.1%	17.4%	2.2%
2007-2008	7.8%	29.4%	12.9%	7.6%	19.4%	21.2%	1.7%
2008-2009	9.2%	29.9%	11.9%	7.4%	18.2%	21.7%	1.7%
2009-2010	9.1%	32.2%	13.7%	6.9%	18.3%	18.6%	1.2%
2010-2011	6.5%	31.6%	10.1%	6.9%	20.6%	23%	1.3%
2011-2012	9.5%	29.5%	12.8%	7.7%	17.1%	21.3%	2%

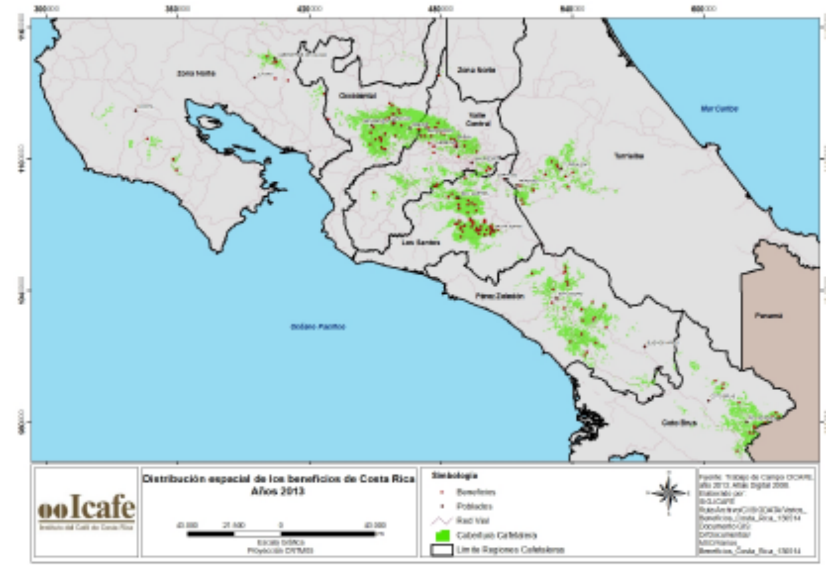
Source: Annual reports, ICAFE.

Table A.2: **Active Mills and Exporters (per season)**

	Mills	Exporters	Total production (in 46Kg. Bags)	Share exported
2002-2003	92	105	2875199	89.78%
2003-2004	96	112	2746909	87.09%
2004-2005	98	113	2487636	80.78%
2005-2006	108	109	2284243	79.58%
2006-2007	124	127	2327199	79.58%
2007-2008	133	124	2435526	85.30%
2008-2009	140	124	2061265	84.48%
2009-2010	155	123	1887812	84.12%
2010-2011	166	134	2062384	82.17%
2011-2012	175	149	2316932	86.66%
2012-2013	175	108	2160865	81.31%

Source: Annual reports, ICAFE. The main change in the industry over the sample period has been the entry of many micro-mills (Column 2). These mills however account for a negligible share of aggregate production.

Figure A.1: **Geographical location of mills**



Costa Rica has 7 different coffee producing regions: Central Valley, Turrialba, Coto Brus, Los Santos (Tarrazú), Pérez-Zeledón, West Valley and North. These regions differ on altitude, and they are distributed between low areas - less than 1000m. altitude - and high areas - over 1200m.- where soils are of volcanic origin. The different regions have significant variation on timing of the harvest season, that starts from june to november depending on the region and lasts on average three months.

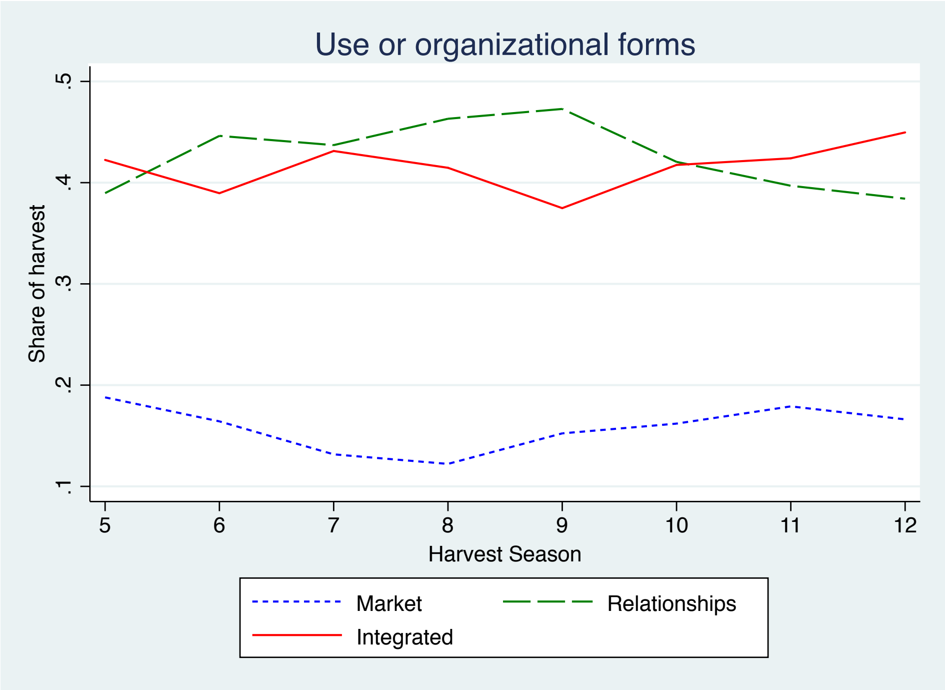
Figure A.2: **The Costa Rica System**

Note: The Figure describes the Costa Rica system (Proceso de Liquidación). At harvest time (stage 1) when the farmer delivers coffee to the mill, (s)he receives a receipt for the delivery and an advance payment. The mill must report every 15 days the amount of coffee received from farmers (stage 2). The sales of processed coffee by the mill to exporters and domestic roasters must be approved by the National Coffee Board (ICAFE). Approval is given for sales with prices in line with international market prices and differentials (stage 3). The sales are contracts enforced by the Board. The mills pays farmers every three months, according to the advances agreed in stage 1 (stage 4). Finally, at the end of the harvest season, based on sales, costs, allowed profits for mills and contribution to the national coffee fund, the final liquidation to farmers is established. The final prices paid to farmers must be published in newspapers and the corresponding payments to farmers must be executed within 8 days by the mills (stage 5). Figure translated from the ICAFE site.

Figure A.3: **Within Date Variation in Prices**

Note: The Figure presents the time series of daily prices from 2010 to 2014. The Figure reports daily information on the maximum, minimum and average price on contracts registered that day, alongside the nearest listing of the KC contract. The Coffee C future contract (KC) traded in New York is the world benchmark for Arabica coffee. The contract prices physical delivery of a standard quantity (37,500 pounds) exchange-grade green beans, from one of 20 countries of origin (including Costa Rica) in a licensed warehouse to one of several ports in the U. S. and Europe. Costa Rica coffee trades at par (i.e., with no premium or discount). The Figure shows that i) prices in Costa Rica closely follow the evolution of the standard KC price; and ii) at each point in time there is substantial variation across contracts in prices, i.e., the (undisclosed) minimum floor is not binding for most contracts.

Figure A.4: **Use of Organizational Forms**



The Figure reports the share of coffee sold by relationships under each organizational form (baseline definition) for seasons 2004/5 to 2011/12. A mill-buyer pair are defined to be in a relationship if they have traded more than four consecutive years during the sample period. By definition then, observations for the first (last) three seasons over the sample period are left (right) censored (see Table A.2 for details). The first three seasons over the sample period are omitted. The decline in the share of relationships for the last three seasons over the sample period is due to right censoring.

Appendix ii. Assumptions: Discussion and Evidence (For Online Publication)

The theoretical model in Section 3 makes two key assumptions: **A1)** sellers can (strategically) default on a forward contracts if market conditions change; and **A2)** integration reduces a mill's ability to sell outside the integrated chain. This Section provides direct evidence of the relevance of these assumptions in our context.

ii.1. ***A1: Strategic Default on Forward Contracts***

This section implements the empirical test for strategic default developed in Blouin and Macchiavello (2017) on our sample of contracts. The test relates the likelihood of contract default to unanticipated increases in world coffee prices during the duration of the forward contract. We test for the presence of strategic default using forward contracts signed between mills and buyers that trade at arm's length. We also show that, consistently with the model's predictions, there is no strategic default in integrated firms (the mill does not own the coffee, and thus cannot side-sell) nor in long-term relationships between firms (parties limits the amount of coffee traded forward so as to satisfy the incentive constraints). Hence, although contract cancellations are quite rare in the sample, they provide a transparent opportunity to test for strategic default. That contract cancellations are rare is not surprising (in fact, in the model, there is no contract default along the equilibrium path). In practice defaults on signed contracts are likely to be only the tip of the iceberg. Mills and buyers might be concerned about counter-party temptations to renege on promises to sign contracts at a later date. The advantage to study default on signed contracts is that those are observable, while promises to sign contracts at a later date are not.

i) Conceptual Framework: Consider a mill and a buyer that at a certain date t have signed a contract for delivery of quantity z_c at price π_c at a future date $t' > t$. Let p_w be the realized spot market price at delivery and $T(\phi_{p,t'}, o)$ the share of contracted coffee the mill can side-sell. $T(\phi_{p,t'}, o)$ depends on time varying, product p specific, market liquidity $\phi_{p,t'}$ and on the organizational form under which the transaction is undertaken ($o \in \{R, I, M\}$). In particular, the transaction can take place between firms trading at arm's length in the market ($o = M$), between firms in a relationship ($o = R$) or within an integrated firm in which the mill is owned by the buyer ($o = I$).

If p_w is much higher than anticipated, an independent mill ($o \in \{M, R\}$) has an incentive to renege on the contract and try to take advantage of improved market conditions (i.e., $T(\phi_{p,t'}, o) > 0$). When the mill is owned by the buyer ($o = I$), however, it doesn't own the coffee and cannot side-sell it (i.e., $T(\phi_{p,t'}, v) = 0$). Denote with V^o_{mill} and U^o_{mill} the continuation values under organizational form o for the mill following delivery and default, respectively. Let $\mathbf{V} = V^o_{mill} - U^o_{mill}$ be the value of the relationship. The dynamic incentive compatibility constraint for the mill is:

$$\mathbf{V} \geq (p_w - \pi_c)T(\phi_{p,t'}, o)z_c \tag{7}$$

The mill defaults on the contract if the temptation to side-sell, $(p_w - \pi_c)T(\phi_{p,t'}, o)z_c$, is larger than the future value of the relationship, $\mathbf{V}$. While the left-hand side of the above constraints is not directly observed (it depends on parties' discount factor; on strategies to be played in the continuation game following both delivery and default; etc.), key elements of the right-hand side are. The logic of the test, then, is to exploit exogenous shocks to the right-hand side of the constraint to infer properties of its left-hand side. For a given contract, exogenous shocks to the right-hand side of the constraint are provided by unanticipated swings in reference prices p_w. First, integrated mills are predictd to have fewer defaults and those defaults to not depend on market conditions p_w. Second, if relationships are characterized by larger future rents $\mathbf{V}$ they will also have fewer defaults when p_w unexpectedly increases.[39]

Predictions:

[i] *Unanticipated increases in market prices lead to contract default in arm's length relationships between firms (low* $\mathbf{V}$*), but*

[ii] *not within integrated firms (mill cannot side-sell), and*

[iii] *not inside long-term relationships (high* $\mathbf{V}$*).*

ii) Empirical Strategy: Exogenous variation in the right-hand side of the constraint is needed to test the predictions. Although prices π_c and quantities z_c are directly observable, they are not exogenous: parties set them to reflect the inherent risk of default associated with a given transaction. To generate exogenous

[39] Unexpected changes in market prices might also change continuation values V^o_{mill} and U^o_{mill}. The change in their *difference* $\mathbf{V}$, however, will be smaller (and might even have the opposite sign) than the change in the right-hand side of the incentive constraint.

variation in the mill's temptation to default, we borrow the empirical design in Blouin and Macchiavello (2017). The price negotiated at time t, π_c, reflects the contracting parties' expectations about prevailing market prices at delivery date t', denoted $\mathbf{E}\left[p_w^{t'}|t\right]$. Variation in realized market prices p_w relative to expectations induces exogenous variation in the temptation to renege on the contract. Futures markets quote for every contracting date t expected future prices for deliveries at t'. This overcomes the empirical challenge of proxying for expectations of future prices, which are typically unobservable. For each contract signed between mill m and buyer b at date t of season s for deliveries of product p at date t' we construct a measure of price surprise as:

$$P_{mbpstt'} = \frac{p_w^{t'}}{\mathbf{E}\left[p_w^{t'}|t\right]}, \tag{8}$$

i.e., as the ratio between the realized spot price at delivery and the expected price at delivery at the time of contracting. Recall that the regulator allows mills, but not buyers, to cancel contracts under specific circumstances. As a result, we expect an *asymmetric* effect of price surprises on contract default. Positive price surprises should be associated with a higher likelihood of default; while negative price surprises should not. The empirical specification is then given by:

$$d_{mbpstt'} = \eta_{mb} + \delta_{st} + \mu_{sp} + \gamma_{tp} + \beta_o^+ \times P_{mbpstt'}^+ + \beta_o^- \times P_{mbpstt'}^- + \varphi X_{mbpstt'} + \varepsilon_{mbpstt'} \tag{9}$$

where $d_{mbpstt'}$ is a dummy taking value one if the contract is canceled by the mill and zero otherwise, η_{mb} are mill-buyer pair fixed effects, δ_{st} are contracting date fixed effects, μ_{sp} are product-season fixed effects, γ_{tp} are product-seasonality fixed effects, $X_{mbpstt'}$ are further controls and $\varepsilon_{mbpstt'}$ an error term arbitrarily autocorrelated within mill-buyer pairs. Controls include third degree polynomials of contracted volume, which directly affects the temptation to default, and contract duration. The combination of η_{mb}, δ_{st}, μ_{sp} and γ_{tp} controls for time-varying product-specific market conditions. A linear probability model is used to accommodate the numerous fixed effects included in the specifications. The price surprise $P_{mbpstt'}$ is flexibly interacted with organizational form dummies β_o distinguishing the effect of positive ($P_{mbpstt'}^+ = max\{P_{mbpstt'}, 1\}$) and negative ($P_{mbpstt'}^- = min\{P_{mbpstt'}, 1\}$) price surprises.

iii) Main Results: Descriptive statistics suggest differences in contract cancellations across organizational forms that are consistent with the predictions. Over the sample period, 1.88% of all contracts between parties transacting at arm's length are canceled. The corresponding shares for trade within long-term relationships and within integrated firms are 0.90% and 0.81% respectively. In both cases, the difference with the share of contract cancellations in transactions at arm's length is statistically significant (p-value<0.01). Furthermore, contract cancellations in arm's length transactions are associated with larger price surprises. The average price surprise on contracts canceled between parties transacting at arm's length is 7.5%, while for contracts canceled inside relationships and integrated firms is 0.5% (again, both differences are statistically significant).

Table B.1 reports the regression results. Column 1 confirms that price surprises are associated with contract default (prediction [**i**]). Column 2 distinguishes between positive and negative price surprises. Results confirm the postulated asymmetry: positive price surprises lead to a large increase in the likelihood of default. A doubling of prices during the duration of the contract more than doubles the chances of contract default. In contrast, negative price surprises do not lead to contract default. Column 3 includes an exhaustive list of contract level controls and confirms the result.

Column 4 interacts price surprises with organizational form dummies. The results confirm predictions [**i**], [**ii**] and [**iii**]. Positive price shocks are not associated with default inside integrated firms: since the buyer owns the coffee, the mill cannot take advantage of better opportunities and side-sell. Positive price shocks are also not associated with default for contracts between firms that are in a relationship: future rents are high enough to deter strategic default. The relationship between positive price shocks and default is entirely driven by transactions occurring at arm's length. Column 5 also includes region-specific season and seasonality fixed effects, as well as interactions between mills characteristics and price surprises. Results are robust: positive price surprises increase the likelihood of contract default in market transactions, but not in relationships or within firms. Specifications in Columns 4 and 5 also include, without reporting them, all relevant interactions with negative price surprises. As expected, none of the estimated coefficients is statistically different from zero.

iv) Robustness and Discussion: Figure B.1 explores the robustness of our findings to alternative definitions of relationships. The figure reports estimates from the baseline specification in Column 4 using different thresholds for the definition of relationships. Regardless of the threshold used to define relationships, unanticipated price surges increase the likelihood of contract default in arm's length market trade between firms but not in long-term relationships between firms or integrated trade.

Different organizational forms might trade products with different characteristics which might affect the ability of a mill to get the contract canceled by the board and/or side-selling opportunities. Although the baseline specification already controls for a detailed set of product specific season and seasonality effects, we investigate the robustness of the results to the inclusion of interactions between product characteristics and price surprises. Figure B.2 shows that the differential effect of price surprises on defaults across organizational forms is robust to the inclusion of interactions between product characteristics and price surprises. This reflects the fact that the product mix does not vary systematically across organizational forms.[40]

It is also possible that parties agree to cancel contracts in order to adapt to changed circumstances. Table B.2 shows that contract cancellations are unlikely to be agreed by both parties and are most likely associated with strategic default. The table shows that past contract cancellations are associated with worse trading outcomes. In particular, a mill and a buyer pair are more likely to never trade again in the future and, conditional on trading, trade lower volumes following a contract default that occurred under positive price surprises. This is consistent with the logic of repeated games models with imperfect monitoring: while the buyer might not be sure that the contract default is due to opportunism, she will tailor the punishment on observable signals (including the price surprise).

Finally, it is worth noting that many contracts signed between firms transacting at arm's length are not defaulted upon despite large price surprises. This is likely due to a combination of factors. First, not all price increases present side-selling opportunities: it might be difficult to strategically default. Second, although the regulator does not disclose to the public information on defaulted contracts nor (as

[40]The product characteristics considered are i) differentiated vs. undifferentiated coffee, ii) sensitivity of the coffee type to weather conditions; iii) the relative concentration of demand and supply of the type of coffee; iv) the type of preparation; v) average volumes of coffee transacted. The last specification considers all of these characteristics together. A priori, the effect of these characteristics on the likelihood of default is ambiguous. On the one hand, it should be easier for the mill to claim to not have the required quantity/quality of coffee for products that are not commonly traded. On the other hand, products that are commonly traded have better side-selling opportunities and, therefore, higher temptations. Results reflect this ambiguity. Price surprises are relatively more associated with contract defaults for undifferentiated coffees (i.e., not certified/branded). Within those, however, the effect is stronger for the many products that are relatively less common.

far as we know) punishes the mill for defaulting, the mill might have reputational concerns in the market. For example, members of the regulatory board (which includes representatives of farmers, mills and buyers) might spread information. Note, however, that by controlling for mill and buyer pair fixed effects, as well as for interactions of price surprises with mill and buyer characteristics, we implicitly control for variables that might affect the spread and intensity of these reputational concerns. The logic of the test, then, is to assess whether in addition to these factors the different organizational forms still affect the likelihood of default.

To summarize, the evidence strongly support assumption **A1:** forward contracts can be strategically defaulted upon by mills. Furthermore, as in the theoretical model, there is no strategic default within integrated chains (the mill cannot side-sell) and in long-term relationships between firms (strategic default is deterred by future relationship value **V**.)[41]

ii.2. ***A2: Outside Sales of Integrated Mills***

The second assumption of the model is that mills owned by backward integrated buyers receive lower prices when selling outside the integrated chain (assumption **A2**). This is a common, albeit rarely microfunded, assumption in the theoretical literature on vertical integration. The assumption provides a candidate explanation for the evidence in Table 2. As noted, a key difference between integration and long-term relationships is exclusivity, i.e., integrated mills sell essentially all their production within the integrated chain while independent mills rarely sell to one buyer only. We first present direct evidence supporting the assumption and then discuss theoretical microfoundations.

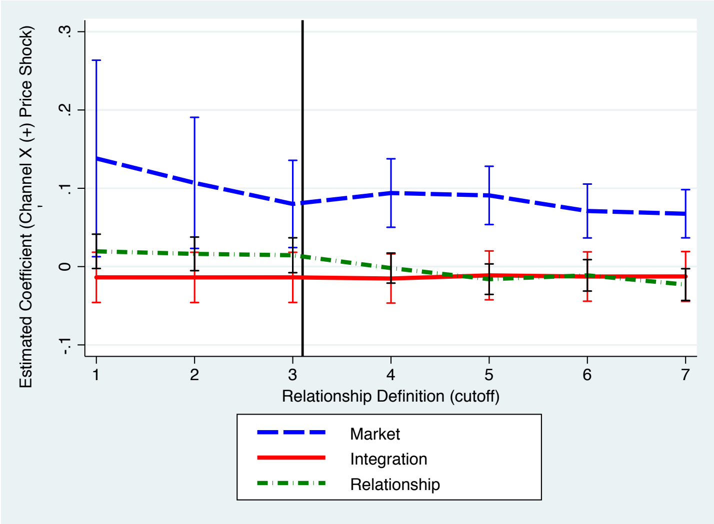
i) Evidence: Table B.3 compares the sales of integrated mills to outside buyers with those of independent mills. Column 1 shows that mills within backward integrated chains receive 9.5% lower prices than similar independent mills when selling outside. The specification controls for region-specific season and seasonality fixed effects and for mill characteristics. In particular, we can directly control for

[41]Indirectly the evidence also demonstrates that relationships between firms entail a relational contract (i.e., an informal arrangement in which the value of future cooperation deters opportunism) as opposed to being simply repeated trade. Distinguishing between these two possibilities is important because markets in which relational contracts are important behave differently from markets that rely exclusively on formal enforcement. In Baker et al. (2002) the integrated firm could also entail a relational contract between the buyer (owner) and the mill (employee). As we do not observe temptations for employees, our data does not allow us to test whether integration also entails a relational contract.

mill's seasonal operating costs, thereby ruling out the possibility that integrated mills are more efficient and simply pass-through some of their lower costs to their non-integrated buyers. Integrated mills might receive lower prices because they sell different volumes and types of coffee at different times of the season than non-integrated mills. Columns 2 shows that these factors explain only one third of the observed price gap. The specification controls for third degree polynomials of contract volumes; extremely detailed (404) product fixed effects; and contract-signing date fixed effects. Because integrated mills sell almost all their production within the chain, they never establish relationships with independent buyers. If buyers willing to source through relationships are willing to pay more, the price gap could simply reflect this difference. Column 3 excludes from the sample transactions between firms in long-term relationships, i.e., it only compares trade at arm's length of integrated and non-integrated firms. Even doing so, we still find a 4.3% price gap. Mills own by backward integrated buyers receive lower prices when selling identical amounts of identical coffee under identical market conditions than non-integrated mills. The evidence thus strongly support Assumption **A2**.

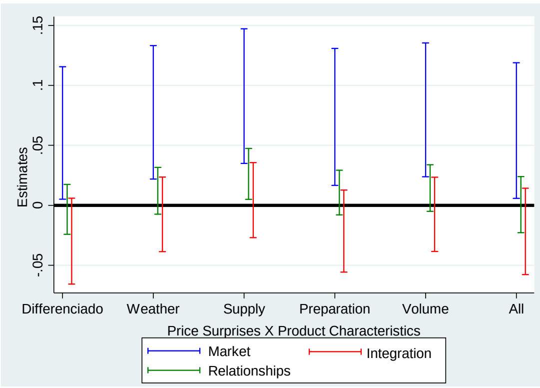
ii) Discussion and Microfoundations: The assumption is common in the literature on vertical integration. For example, it appears (without microfoundations) in Carlton (1979) and Kranton and Minehart (2000) models of vertical integration and demand uncertainty. In Carlton (1979) the assumption is necessary to generate the dual sourcing patterns documented in Table 2. The assumption has also been microfounded. For instance, in Baker et al. (2002) integration reduces supplier's incentives to engage in costly effort to improve her own outside option. In the original model such effort is always wasteful (since outside sales never occur) and the cost of integration arises from the buyer's difficulty in committing to high-powered incentives to induce productive effort for the relationship. Bolton and Whinston (1993) develop a property rights model à la Grossman and Hart (1986). In their model an outside buyer anticipates lower bargaining power when buying from a seller owned by a competitor. This reduces the outside buyer incentives to undertake relationship specific investments which, in turn, implies that trade outside the integrated chain happens rarely and at lower prices. In both models, thus, incentives to generate valuable outside trading opportunities are lower under integration, consistent with the evidence discussed above.

Figure B.1: **Price shocks - Robustness to Relationship Definition**



Note: The Figure shows that different definitions of relationships give qualitatively identical results. The y-axis reports estimated coefficients (and 95% confidence intervals) for the interaction between positive price surprises and marketing channels. The underlying estimated regressions are like those in Column 4 of Table B.1. The x-axis reports the cut-off r used to distinguish market and relationships: mill-buyer pairs that trade for more than r consecutive season are defined to be in a relationship. The Figure reports results from $r \in 1, 2, \ldots 7.$. The reference line at $r = 3$ is the baseline definition. As r increases more transactions inside "relationships" are classified as market. Across all specifications the main results are confirmed: positive price surprises i) are associated with contract default in the market; but ii) not inside integrated firms nor relationships.

Figure B.2: **Price shocks - Robustness to Product Characteristics**



Note: The Figure shows that the differential effect of price surprises on contract defaults is robust to the inclusion of interactions between product characteristics and price surprises. The y-axis reports estimated coefficients (and 95% confidence intervals) for the interaction between positive price surprises and organizational forms. The underlying estimated regressions are like those in Column 4 of Table B.1. The regressions are estimated separately including the interaction between price surprises and different product characteristics. Product characteristics are i) whether the coffee is differentiated or not, ii) a measure of sensitivity of the coffee type to weather conditions; iii) the relative supply of the type of coffee; iv) the type of preparation; v) the average volume of coffee transacted; vi) all those together. Results are remarkably robust, reflecting the fact that the product mix doesn't vary systematically across organizational forms (see Figure C.1).

Table B.1: **Price Surprises and Strategic Default**

	(1)	(2)	(3)	(4)	(5)
Dependent variable:			***Contract Cancellation = 1***		
Price Surprise	0.0152**				
	(0.007)				
positive		0.0192**	0.0219*		
		(0.009)	(0.013)		
negative		0.0066	-0.0040		
		(0.009)	(0.013)		
Positive Price Surprise X					
Market [0]				0.0800**	0.0700*
				(0.0387)	(0.0369)
Relationships [1]				0.0145	0.0135
				(0.0135)	(0.0133)
Integration [2]				-0.0137	0.00432
				(0.0222)	(0.0251)
F-test [0] vs. [1]				2.786*	2.145+
p-value				0.0953	0.143
F-test [2] vs. [1]				1.427	0.152
p-value				0.233	0.697
Observations	21,331	21,331	21,175	21,175	21,175
R-squared	0.154	0.155	0.309	0.310	0.310
Relationship definition	n/a	n/a	n/a	Baseline	Baseline
Mill-Buyer Pair FE	Yes	Yes	Yes	Yes	Yes
Contract controls	No	No	Yes	Yes	Yes
Day of sale and Product FE	No	No	Yes	Yes	Yes
Price surprise x controls	No	No	No	No	Yes

Robust standard errors (clustered by mill-buyer pair) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table shows that relationships and integration mitigate opportunism. In all columns OLS are estimated, a contract between a mill and a buyer is an observation and the dependent variable is a dummy=1 if the contract is canceled. Price surprise is defined as the ratio between the spot NYC price for Arabica at the date of delivery and the NYC future price for Arabica for the delivery date at the time the contract was signed. Positive (negative) price surprises are for ratios above (below) one. Controls include contract volume (third-degree polynomial in Kilos of coffee on the contract), contract duration, a dummy for national market contracts, the month of the contract signature, mill size and region where the mill is located. Product FE are a set of dummies for product types (preparation, quality and bean grading). Columns 4 and 5 also include the interaction between negative price surprises and organizational forms. All the (unreported) coefficients are nearly zero and none is significant. Controls interacted with price surprise include mill size, age, suitability and variability. The sample period covers the harvest campaigns from 2004/05 to 2012/13 for which data on contract cancellations are available. The sample excludes trade involving forward integrated mills.

Table B.2: **Consequences of default**

	(1)	(2)	(3)	(4)
Dependent variable:	Never Trade Again		Future Trade volumes	
Past Default			-18.8967	-19.2228
			(14.215)	(14.261)
Past default during positive price surprise	1.0006*	0.2094*		-56.4748***
	(0.561)	(0.118)		(20.144)
Observations	2,021	2,021	2,467	2,467
Mill-Buyer Pair FE	No	Yes	Yes	Yes
Season FE	Yes	Yes	Yes	Yes
Cohort FE	Yes	–	–	–
Model	Poisson	Linear	Linear	Linear

Robust standard errors (clustered at the mill-byer pair level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table shows that contract cancellations are unlikely to be agreed by both parties and are most likely associated with strategic default. The Table shows that past contract cancellations are associated with worse trading outcomes among the involved parties. We consider the likelihood that parties will never trade in the future and, conditional on trading, the volumes they trade. Both outcomes are worse following contract cancellation that happened at times of positive price surprises. A unit of observation is a buyer-mill pair in a given season. The sample covers years for which contract cancellations are available and in Columns 1 and 2 excludes the last year in the sample to avoid right censoring. Never trading again is a dummy taking value =1 if the mill-buyer pair has stopped trading in that season. Future trade volumes is the tons of coffee exchanged in the following season. Past default is a dummy taking value =1 if the mill-buyer pair has had at least one contract cancellation in that season or before. Past default during positive price surprise is a dummy taking value =1 if the pair has had at least one contract cancellation associated with a price surprise larger than 1.5.

Table B.3: **External Sales of Integrated Mills**

	(1)	(2)	(3)
Dependent variable:	***Unit price (ln)***		
Integrated Mill	-0.095**	-0.068***	-0.043*
	(0.043)	(0.017)	(0.024)
Observations	24,317	24,317	7,995
R-squared	0.75	0.93	0.94
Season x Region FE	Yes	Yes	Yes
Month of Sale X Region	Yes	Yes	Yes
Mill's Size and Costs	Yes	Yes	Yes
Contract Controls	Yes	Yes	Yes
Date FE	No	Contract	Contract
Product FE	No	Yes	Yes
Organizational Forms	M & R	M & R	M

Robust standard errors (clustered at the mill level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table investigates price differentials obtained by integrated mills when selling outside the integrated chain. In all columns OLS are estimated, a contract between a mill and a buyer is an observation. The dependent variables is the unit price (in logs). Integrated mill is a dummy equal to one if the mill is owned by a buyer. Mills controls are mill's size (capacity) and unit processing costs. Contract controls include a third-degree polynomial in Kilos of coffee on the contract, contract's length and a dummy indicating whether the contract is for the national or export markets. Products fixed effects are unique combinations of coffee category/preparation/type and quality. The sample excludes all integrated trade (backward and forward) and covers the years for which unit processing costs are available (2006/07 to 2011/12). Column 3 also excludes contracts between mills and buyers in a relationship.

Appendix iii. Extensions and Further Evidence (For Online Publication)

iii.1. ***Discontinuity at the Firm's Boundary***

Figure 6 provides a graphical illustration of the *discontinuity* at the firm boundary. The left panel of Figure 6 considers aggregate trade volumes, combining both spot and forward sales. The Figure shows that in each mill size group, integrated relationship trade significantly larger volumes of coffee than nearly exclusive relationships between firms. The middle and right panels distinguish between coffee sold forward and coffee sold spot. Using the baseline definition of spot contracts, the middle panel shows that across the three size bins integrated relationships trade larger volumes of coffee forward. In contrast, the right panel shows that in *none* of the three size bins integrated relationships trade larger volumes of coffee spot (placebo).

Regression analysis allows to confirm the findings in Figure 6 including additional controls. Table C.1 reports results from the specification

$$Q_{bmrs} = \alpha + \beta \times INT_{bm} + \sum_{d \in D} \gamma_d \times \mathbf{I}_m^d + \eta_m \times Z_{ms} + \eta_B \times Z_{bs} + \gamma_{rs} + \varepsilon_{bmrs} \quad (1)$$

where Q_{bms} is tons of coffee sold by mill m to buyer b in season s. The dummy INT_{bm} takes value equal to one if the buyer-mill pair is integrated and zero otherwise and the coefficient β is the main object of interest. As mentioned earlier, there is no time variation in the integration status of mills during the sample period. The specification, however, controls for several mill characteristics including i) dummies $\mathbf{I}_m^d$ for the mill size decile d; ii) other mill characteristics, Z_{ms}, including weather W_{ms} and time-invariant characteristics that correlate with the choice of organizational form (see the next section); iii) region-season fixed effects γ_{rs}. Similarly, we control for buyers characteristics Z_{bs}, such buyer's size; sourcing patterns with other sellers and characteristics that correlate with the choice of organizational form (see next section). As in Figure 6 we focus on the sample of nearly exclusive relationships, defined as those in which the buyer accounts for at least of 90% of the mill's sales in that season. Since we focus on nearly exclusive relationships of large mills there is not sufficient variation to include buyer fixed effects.

Columns 1 and 2 of Table C.1 show that integrated relationships trade significantly larger quantities. This is true when integrated relationships are compared to all relationships (Column 1) as well as when the comparison is restricted to nearly exclusive non-integrated relationships, i.e., those in which the buyer accounts for at least least of 90% of the mill's sales (Column 2). The estimated coefficient is economically and statistically significant. In Column 2, for example, integrated relationships trade 15% higher volumes than otherwise similar non-integrated relationships. Columns 3 and 4 split the volume of trade between forward trade (Column 3) and spot trade (Column 4). Results show that the entire difference in trade volume associated with integration is due to differences in forward trade. Columns 5, 6 and 7 show that the results are robust to the inclusion of several mill and buyer controls. Finally, Column 8 shows that the share of coffee traded forward is 14% higher for integrated relationships (relative to a sample mean of approximately 70%). The Table thus confirms the *discontinuity* at the firm boundary documented in Figure 6.

iii.2. ***Choice of Organizational Forms***

Theory: The model yields predictions regarding the choice of organizational forms. As a benchmark consider first the case of perfect contract enforcement. Expected joint profits at the time $t = 2$ are given by

$$\mathbf{E}\Pi^{*}\left[Q\right] = \rho Q, \text{ with } \rho = \left(v + \left(\frac{\left(\overline{p} - v\right)^{2}}{4\overline{p}\phi}\right)\right) > v. \tag{2}$$

For relationships, the corresponding level of expected profits is

$$\mathbf{E}\Pi^{R}[Q] = \begin{cases} \rho Q & \text{if } Q \leq Q^{F} = z^{F}/(1-\sigma^{*}) \\ vz^{m} + \sigma^{F} Q\overline{p}\left(1 - \phi\sigma^{F}\right) & \text{otherwise.} \end{cases} \tag{3}$$

For integration, expected profits before harvest are given by

$$\mathbf{E}\Pi^{I}[Q] = vQ \tag{4}$$

At time $t = 0$, then, the value of organizational form o is given by

$$\mathbf{\Pi}^{o} = \int_{Q} \mathbf{E}\Pi^{o}\left[Q\right] dW(Q). \tag{5}$$

Simple algebra yields that parties integrate if

$$\int_{Q \geq Q^*} \left(\rho Q - \mathbf{E}\Pi^R [Q]\right) dW(Q) \geq (\rho - v)\, \overline{Q} \tag{6}$$

The left-hand side is the cost of relationships: the inability to sell large volumes of coffee in the forward market. The right-hand side, instead, is the cost of integration: the loss in expected profits due to not being able to sell on the spot market if needed.[42] Inspection of condition (6) delivers intuitive comparative statics. First, vertical integration is preferred for larger mills, i.e., those with higher expected production $\overline{Q}$. Second, conditional on mill's capacity, vertical integration should also be preferred for mills in locations with more suitable conditions for coffee cultivation (which also increase $\overline{Q}$). Finally, conditional on expected production $\overline{Q}$, vertical integration is preferred in places with higher variance in growing conditions. Note that $\mathbf{E}\Pi^R [Q]$ is a continuous, increasing and weakly concave function of Q. The function is strictly concave if $Q \geq Q^F$. Furthermore, $\lim_{Q\to\infty} \frac{\partial E[Q]}{\partial Q} = (1-\phi)\, \overline{p} < v$. The last prediction thus follows from the fact that $\mathbf{E}\Pi^R$ is strictly concave for large Q while $\mathbf{E}\Pi^V$ is linear.

Evidence: Table C.2 presents cross-sectional correlations between mill characteristics and organizational forms in marketing channels.[43] The evidence supports the model predictions. We measure mill's size in tons of installed processing capacity. We measure average suitability for coffee and variability in growing conditions as follows. We combine historical information on weather patterns with geocoded information on each mill location. Average suitability is an index measured as the standardized z-score of deviations from ideal altitude, rainfall and temperature conditions. Variability, instead, is given by a z-score of across harvest season variability in rainfall and temperature deviations from ideal conditions over the decades for which we have weather data.

Columns 1 to 3 report results from a multinomial logit in which mills' characteristics are correlated with the mill's organizational form. Column 1 finds strong support for the predictions of the model: integrated mills are larger and located in regions with better, but more variable, growing conditions. Since relationships and integration deal with similar concerns, mill characteristics associated with integra-

[42] Note that $\frac{\partial \mathbf{E}\Pi^R[Q]}{\partial Q}_{|Q \leq Q^m} = \rho > v = \frac{\partial \mathbf{E}\Pi^V[Q]}{\partial Q} = v > \frac{\partial \mathbf{E}\Pi^R[Q]}{\partial Q}_{|Q > Q^m}$. There thus exists a unique critical volume of production, $\widehat{Q} > Q^m$, such that vertical integration yields higher expected profits than a relationship between non-integrated firms if $Q \geq \widehat{Q}$.

[43] A cross-sectional specification is necessary since both average suitability for, and variability in, coffee growing conditions do not vary over time.

tion should also be associated with the use of relationships. Column 2 reports the estimates for mills that sell the majority of their produce through relationships. Furthermore, Column 3 tests for differences across the two organizational forms. As predicted by the model, all three characteristics appear to be more strongly associated with integration than with long term relationships (albeit more variable weather conditions only with p-value 0.21). Columns 4 to 6 further explore the implication that integrated mills have similar characteristics to mills that sell the majority of their produce through long-term relationships. Column 4 estimates a probit model on integration omitting independent mills selling through relationships. Results confirm the model's predictions. Columns 5 and 6 correlate the predicted integration score from Column 4 with the use of relationship as marketing channel on the sample of non-integrated mills and confirm that characteristics associated with integration also correlate with the use of long-term relationships among independent mills.[44]

While the results are broadly supportive of the model's predictions, the cross-sectional nature of these specifications calls for caution. In particular, we do not claim that these characteristics, either in isolation or in combination, are key determinants of the choice of organizational form in our context. Although our primary goal is not to explain what drives the choice of organizational forms, it is useful to explore the extent to which other factors correlate with organizational forms in our context. As noted above, Figure C.1 shows that different organizational forms trade very similar types of coffee while Figure C.2 shows that, if anything, integrated and relational chains trade *less* differentiated coffee types. Product characteristics, and specificity in particular, are thus unlikely to be a major driver of organizational forms in this context. Table C.4 shows that integrated mills have identical unit costs to non-integrated mills that sell mostly through relationships. Gains in production efficiency are thus also unlikely to be a major driver of the choice between integration and relational trade in our context.[45]

[44] Table C.3 shows that buyer's characteristics associated with backward integration also correlate with the use of long-term sourcing relationships among non-integrated buyers. Furthermore, the evidence confirms that larger exporters with more stable downstream arrangements are more likely to integrate backward.

[45] A different strand of theoretical work considers anticompetitive motives for vertical integration. Some of the theoretical mechanisms reviewed in Hart and Tirole (1990) are consistent with some of the evidence in the paper. We cannot thus rule out that anticompetitive motives might be driving organizational choices.

iii.3. ***Seller Risk-Aversion***

The model in the main text derived the need for forward contracts from a downward sloping demand in the spot market. This subsection sketches a variant of the model in which forward trade arises due to the mill's risk aversion. Consider a risk-neutral buyer and a risk-averse seller. A unit of coffee bought in the forward market is worth v to the buyer. The price in the forward market is $\pi \leq v$, i.e., the buyer needs to make positive margins. The buyer and the seller chose the share they trade spot, σ, to maximize a weighted sum of the parties utility. Assuming equal bargaining power, the pair maximizes

$$\max_{\sigma} \underbrace{(v-\pi)(1-\sigma)Q}_{\text{Buyer's Payoff}} + \underbrace{\int_p u(\pi Q + (p-\pi)\sigma Q)\, dF(p)}_{\text{Seller's Payoff}}$$

where $F(p)$ is the distribution of spot prices and is assumed to be symmetric (around its mean $\overline{p} = \int p dF(p)$). The first order condition gives

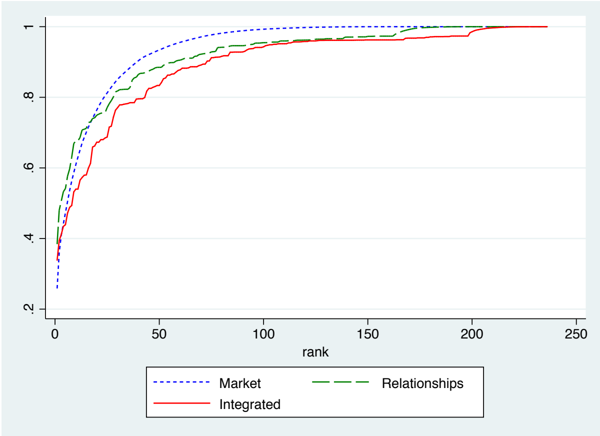
$$(v-\pi) = \int_p u'(\cdot)(p-\pi)\, dF(p).$$

Denote with σ^* the solution. The first order condition implies a number of interesting observations. First, an interior solution in which both the spot market and the forward market are used rationalizes the forward discount assumed in the main text. Specifically, positive margins ($(v-\pi) \geq 0$), risk aversion ($u'' < 0$) and symmetry of $F(\cdot)$ imply that an interior solution requires $\pi < \overline{p}$, i.e., there must be a forward discount. If this wasn't the case, the entire production would be sold forward. Second, the buyer's margins shouldn't be too high (i.e., π is bounded below). Looking at the corner solution with $\sigma = 0$, we must have $(v-\pi) < \int_p u'(\pi Q)(p-\pi)\, dF(p)$.

A second implication is that, holding constant the forward price π, the share sold spot σ^* is *decreasing* in production volume Q. To see why, note that higher Q lowers u'. Given $\pi < \overline{p}$ this effect can only be compensated by a reduction in σ. This last observation is of crucial importance since it establishes that risk-aversion, if anything, works against us finding a positive response of the share sold spot σ^* to exceptionally good weather conditions during the growing season.[46]

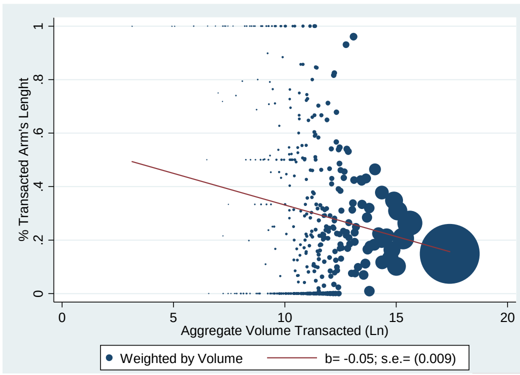
[46]It can be shown that assuming a risk-averse mill also doesn't alter the predictions of the model with respect to the selection into organizational forms.

Figure C.1: **Distribution of Products across Organizational Forms**



The Figure shows that different organizational forms trade very similar coffee. In our setting, contracts between mills and buyers specify several categories of coffee, alongside the bean type, quality and preparation type. In total, we observe 404 unique products over the sample period. The Figure is constructed as follows. First, rank products according to their volumes of trade between firms trading at arm's length. The horizontal axis reports the rank of the product and the vertical axis the cumulative distribution. The Figure shows that the overall distribution of product traded inside relationships and within firms is remarkably similar. Both curves lie close to the market curve and are concave most of the time. Product characteristics are unlikely to be a major driver of organizational forms in this context.

Figure C.2: **Volumes Traded and Organizational Forms**



A prominent argument for vertical integration is to secure the supply of highly differentiated inputs. The Figure however shows that across coffee types, the aggregate industry production (a measure of market liquidity) *negatively* correlates with the share of that product that is transacted at arm's length between firms. In our setting, contracts between mills and buyers specify several categories of coffee, alongside the bean type, quality and preparation type. In total, we observe 404 unique products over the sample period. As a matter of comparison, these hundreds of products span only two ten-digit HS codes (0901110015 and 0901110025), the finest level of product classification typically used in international trade. A unit of observation in the Figure is thus given by a product (defined as a bean type, quality, preparation combination). The vertical axis reports the share of that product transacted at arm's length. The horizontal axis reports the average amount of that product transacted in any given season (in logs). Integration and long-term relationships are used relatively more for coffee types that are more commonly traded. This correlation contrasts with product specificity being a driver of integration and/or relational sourcing. The correlation is however consistent with integration and relationships being used to mitigate side-selling concerns as more commonly traded products provide parties better opportunities to renege on past promises to trade.

Table C.1: **Discontinuity at the Firm's Boundary**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Traded Volume (Tons)	Traded Volume (Tons)	Forward Trade (Tons)	Spot Trade (Tons)	Traded Volume (Tons)	Forward Trade (Tons)	Spot Trade (Tons)	% Forward Trade
Integrated Relationship	656.77***	253.14***	243.27***	9.86	203.31	210.14*	-6.83	0.14***
	(114.31)	(97.26)	(88.47)	(47.69)	(154.23)	(125.72)	(74.33)	(0.04)
Dep. Variable Mean	893.39	1682.76	1183.03	499.73	1682.76	1183.03	499.73	0.71
Relationships Sample	All	Exclusive	Exclusive	Exclusive	Exclusive	Exclusive	Exclusive	Exclusive
Observations	667	241	241	241	241	241	241	241
R-squared	0.810	0.795	0.681	0.687	0.842	0.748	0.750	0.472
Size Quartile × Season FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE × Season	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mill Controls	No	No	No	No	Yes	Yes	Yes	Yes
Buyer Controls	No	No	No	No	Yes	Yes	Yes	Yes
Weather Realization	No	No	No	No	Yes	Yes	Yes	Yes

Robust standard errors clustered at the relationship level are reported in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. The Table tests the discontinuity at the firm's boundary prediction (H2). Traded volumes in Columns 1-7 are tons of coffee traded in the relationship in the season. The % Forward Trade is the percentage of coffee traded with forward contracts in that season in the relationships. Spot contracts are those of duration shorter than 30 days. Integrated Relationships is a dummy taking value equal to one if the buyer-mill pair is integrated and zero otherwise. Exclusive relationships are those in which the mill sells at least 95% of its seasonal production to the buyer. Mill controls are i) dummies $\mathbf{I}_m^d$ for the mill size decile d; ii) other mill characteristics, Z_{ms}, including weather W_{ms} and time-invariant characteristics that correlate with the choice of organizational form (H3 **Appendix III**); iii) region-season fixed effects γ_{rs}. Buyer controls are buyer's size; sourcing patterns with other sellers and characteristics that correlate with the choice of organizational form (see Appendix).

Table C.2: **Correlates of Organizational Forms (Mills)**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:				**Organizational Form**		
	Integration = 1	Majority Sold in Relationships = 1	F-Test (p-value)	Integration = 1	Majority Sold in Relationships = 1	% Sold in Relationships = 1
Integration score					0.71***	2.00**
					(0.16)	(1.03)
Capacity	2.17***	0.69+	8.62***	0.15**		
	(0.86)	(0.51)	0.00	(0.07)		
Age	0.37**	0.16***	2.09+	1.10***		
	(0.16)	(0.04)	0.15	(0.42)		
Suitability	2.72**	-0.00	5.09**	1.63**		
	(1.22)	(0.21)	0.02	(0.81)		
Variability	1.04*	0.43*	1.23	1.07**		
	(0.55)	(0.24)	0.28	(0.45)		
Observations		151		98	141	141
Sample		All		Excluding Relationships =1	Non-integrated	Non-integrated
Estimation		Multinomial		Probit	Probit	OLS

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table shows that mill characteristics that predict integration also predict sales through relationships on the sample of non-integrated mills. All independent variables are standardized. Capacity is proxied by the maximum volume of coffee processed by the mill during a two week period. Age is the number of harvest seasons the mill has been operating (left censored). Suitability is an index for suitability for coffee, measured as the standardized z-score of deviations from ideal altitude, rainfall and temperature conditions. Variability is a z-score of across harvest variability in rainfall and temperature deviations from ideal conditions. Region FE indicate the region where the mill is located. Columns 1 to 3 report results from a multinomial logit in which mills characteristics are correlated with the mill's organizational form. We distinguish three organizational forms: mills owned by downstream buyers (coefficients in Column 1); independent mills that sell the majority (i.e., more than 50%) of their produce through long-term relationships (coefficients in Column 2); and other independent mills. Column 3 tests for the equality of coefficients between the two forms. Column 4 reports results from a probit model predicting whether a mill belongs to a backward integrated chain. The predicted integration score in Column 4 is correlated with the percentage of the production sold through relationships in Columns 6. The baseline definition of relationship (mill-buyer pairs that have traded more than three consecutive seasons are classified as relationships) is used. All specifications exclude forward-integrated chains. Results are similar if those are included. Characteristics associated with forward integrated are however quite different from those associated with backward integration. Most notably, cooperative cannot be, by definition, owned by downstream buyers but do often integrate forward.

Table C.3: **Correlates of Organizational Forms (Buyers)**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:				**Organizational Form**		
	Integration = 1	Majority Sold in Relationships = 1	F-Test (p-value)	Integration = 1	Majority Sold in Relationships = 1	% Sold in Relationships = 1
Integration score					3.31***	0.72***
					(0.67)	(0.08)
Size	3.26**	1.73***	3.79**	1.97***		
	(0.94)	(0.51)	0.05	(0.46)		
Age	0.41*	0.36***	0.05	0.12+		
	(0.21)	(0.11)	0.82	(0.08)		
Share exported	8.31***	1.67**	8.61***	11.19***		
	(2.30)	(0.71)	0.00	(4.63)		
Observations		106		75	99	99
Sample		All		Excluding Relationships =1	Non-integrated	Non-integrated
Estimation		Multinomial		Probit	Probit	OLS

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table shows that buyer characteristics that predict backward integration also predict relational sourcing on the sample of non-integrated buyers. All independent variables are standardized. Size measures the average volume of coffee bought during the 2008-20011 harvest campaigns. Age is the number of harvest seasons the buyer has been operating (left censored). Share exported is the average percentage of sourced coffee that is exported by the buyer. Columns 1 to 3 report results from a multinomial logit in which buyers characteristics are correlated with the buyer's organizational form. We distinguish three organizational forms: backward integrated buyers that own mills (coefficients in Column 1); independent buyers that source mostly through long-term relationships (coefficients in Column 2); and other independent buyers. Column 3 test for the equality of coefficients between the two forms. Column 4 reports results from a probit model predicting whether a buyer is backward integrated. The predicted integration score in Column 4 is correlated with the percentage of the production sourced through relationships in Columns 5 to 6. The baseline definition of relationship is used. Columns 7 and 8 focus on the sample of exporters for which information on the structure of relationships downstream is available. Column 7 reports results from a probit model predicting weather a buyer is backward integrated. Share sold to roasters, concentration of foreign buyers and share exported during harvest are computed matching transactions level export data that include the name of foreign customers. The predicted integration score in Column 7 is correlated with the percentage of the production sourced through relationships in Column 8 using the baseline definition of relationship All specifications exclude export licenses held by forward-integrated mills.

Table C.4: **Unit processing costs**

	(1)	(2)	(3)	(4)	(5)
Dependent variable:			***Unit Processing Costs (ln)***		
Integrated Mill	-0.0053	-0.2229***			
	(0.058)	(0.077)			
Integration X Weather			-0.0145	0.0239	-0.0276
			(0.035)	(0.052)	(0.029)
Relationship Mill		-0.2447***			
		(0.073)			
Relation. Mill X Weather			-0.0518	-0.0165	-0.0499
			(0.056)	(0.070)	(0.039)
F-test [0] vs [1]		0.174	1.027	0.515	0.761
p-value		0.676	0.311	0.473	0.383
Observations	532	532	779	779	779
R-squared	0.072	0.162	0.007	0.007	0.006
Weather	–	–	Index	Temperature	Rainfall
Relationship Definition	Baseline	Baseline	Baseline	Baseline	Baseline
Season X Region X Product FE	Yes	Yes	Yes	Yes	Yes
Mill, Channel FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered at the mill level are reported in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The Table investigates whether the choice between an integrated and a relational chain correlates with differences in production efficiency. Such differences could arise due to, e.g., better coordination along the chain or better aligned non-contractible investments. Each season, mills report their audited operating costs. Operating costs are separately reported for differentiated and undifferentiated coffee and include outlays associated with transport of coffee during harvest, running the mill, financing, marketing of coffee and personnel costs. The costs do not include the price of coffee paid to farmers. This allows us to compare unit operating costs across organizational forms. Columns 1 and 2 focus on across mills comparisons. The specifications include interactions of region, harvest season and product line to control for time-varying growing conditions around the mill, as well as number of other time-invariant mill characteristics (altitude, slope, terrain ruggedness, average yearly rainfall and temperature, distances to railroads, port, road and Atlantic coast and type of mill). Column 1 shows that mills owned by backward integrated buyers do not have significantly lower processing costs than other mills. Column 2 introduces, for the sample of non-integrated mills, a dummy equal to one for mills that have sales through relationships above the median. Relative to mills not using relational contracts, integrated mills now have significantly lower costs. However, integrated mills have identical unit costs to non-integrated mills marketing through relationships. Columns 1 and 2 focus on across mill comparisons. The specifications includes interactions of region, harvest season and product type to control for time-varying growing conditions around the mill, as well as several time-invariant mill characteristics. Column 1 shows that mills owned by backward integrated buyers do not have significantly lower processing costs than independent mills. Backward integration, therefore, does not appear to be associated with higher operational efficiency. Column 2 introduces, for the sample of non-integrated mills, a dummy equal to one for mills that sell mostly through relationships. Relative to mills not selling through relationships, integrated mills have significantly lower operating costs. However, integrated mills have identical unit costs to non-integrated mills that sell mostly through relationships. The evidence suggests that factors as well as outcomes which might correlate with integration and use of relationships might relate to operating costs. However, reducing operating costs is unlikely to drive the choice between integration and long-term relationships. Columns 3 to 5 investigate mill's operating costs response to weather shocks during growing season (the index, temperature and rainfall respectively). The specifications focus on interactions between mill's organizational forms and weather shocks and include mills fixed effects. We find no evidence that operating costs respond differentially to weather shocks across organizational forms.