Vertical Integration and Relational Contracts: Evidence from the Costa Rica Coffee Chain

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Abstract

When contracts are incomplete, market trade might be substituted by relational contracts or integration. This paper compares vertical integration and relational contracts between coffee mills and buyers in Costa Rica. Detailed data on transactions between and within firms reveal that integrated trade is shielded from demand uncertainty, a key force shaping market transactions. Relational contracts between firms display trading patterns qualitatively similar to those within integrated chains but do not achieve the same degree of market assurance. Integration, however, comes at the cost of worse relationships with independent suppliers. The evidence strongly supports models in which firms boundaries alter temptations to renege on relational contracts and, consequently, the allocation of resources. Policy implications for export-oriented agricultural chains in developing countries are discussed.

Keywords: Firm Boundaries, Vertical Integration, Relational Contracts, Forward Contracts, Supply Assurance.

JEL Codes: D23, L14, L22, O12, Q13.

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1 Introduction

Since Coase (1937) seminal contribution, economists have been interested in understanding how resource allocation within firms differs from allocation between firms. This question is of central importance in fields as diverse as industrial organization, international trade, public economics, corporate finance, and development.[1] Theoretical contributions recognize contractual imperfections as the keystone of any theory of the firm must be laid (see, e.g., Gibbons (2005)).[2] However, in many real-world circumstances contractual parties can also deal with these very same contractual imperfections by resorting to relational contracts - informal agreements in which temptations to renege on past promises are deterred by the value of future transactions.[3] A full understanding of how firm boundaries affect resource allocation, therefore, requires comparing integration against both relational contracts and market transactions between firms.[4] In a set of seminal theoretical contributions, Baker et al. (2002, 2006, 2011) develop repeated-game models to undertake such a comparison.

This paper compares trade *between* firms (repeated as well as non-repeated) against trade *within* integrated firms studying coffee mills sales to domestic buyers in the Costa Rica coffee chain. We test the two central insights of the framework in Baker et al. (2002, 2006, 2001), namely: 1) when trade is frequently repeated, firm boundaries do not matter; and 2) firm boundaries affect the parties' temptations to renege on a given relational contract. We find ample support for these predictions. Relational contracts between firms are qualitatively (but not quantitatively) similar to trade within integrated firms. We also provide direct evidence that firms boundaries alter temptations to renege on relational contracts, the central tenet of the theory.

Three challenges must be overcome to test the theory. First, transactions both within and between firms must be observed. Second, selection of heterogeneous transactions into organizational forms must be confronted. Third, temptations to renege on the relational contract must be examined. While the first two challenges are shared with empirical work testing most theories of the firm, the third one is intrinsic to test a

[1] In the United States transactions that occur *within* firms account for roughly the same share of aggregate value added as transactions *between* firms (Lafontaine and Slade (2007)). Roughly one-third of world trade occurs within firm boundaries (Antràs (2003)).

[2] Prominent theoretical contributions include Williamson (1971, 1975, 1985); Klein et al. (1978); Grossman and Hart (1986); Hart and Moore (1990), Holmstrom and Tirole (1991), Holmstrom and Milgrom (1994), Hart and Holmstrom (2010)

[3] See, e.g., Macaulay (1963), Klein and Leffler (1981), McLeod (2007).

[4] For clarity, we call non-repeated transactions between firms the "market" and repeated transactions between firms "relational contracts". There are, of course, relational contracts also within firms but we refer to those simply as integrated trade.

theory that combines the integration decision within a relational contract framework.

The Costa Rica coffee chain provides an environment in which empirical progress can be made along all three dimensions. The analysis focuses on sales of coffee between mills and domestic buyers (either exporters or domestic roasters). A rich variety of organizational forms is observed, including (non-repeated) market transactions as well as long-term relationships between firms and vertical integration. First, due to regulations in the industry, all transactions of coffee between mills and buyers – including those occurring within firms – are recorded by the coffee board. Second, the coffee board specifies extremely detailed standards. We observe more than three-hundred different types of (parchment) coffee.[5] This allows for a comparison of the terms of sales (volumes, prices and timing) of the exact same physical product across organizational forms. Third, observable unanticipated changes in international coffee prices provide exogenous variation to the temptation to renege on the (relational) contracts. This allows to study how different organizational forms shape those temptations.

Before comparing vertical integration against relational contracts between firms, we must understand the key concerns faced by transacting parties in the market. Numerous conversations with industry practitioners and industry reports suggest that demand uncertainty is important for both mills and buyers.[6] Three facts confirm this hypothesis: 1) forward sale contracts are pervasive; 2) mills face significant inventory risk; 3) prices feature both advance-purchase and end-of-season discounts.[7] Trade within integrated firms, however, doesn't display any of these patterns. Integrated firms buy from the market only if their own integrated supply isn't sufficient and (conversely) sell to market only if internal demand isn't sufficient. Integration insulates trade from market forces and overcomes demand uncertainty concerns.

Why would trade under integration differ from market trade? Although contracts are generally well-enforced in our context, we argue that promises on *whether* a contract is signed and, if yes, at which conditions, are not enforceable. Parties face the risk of not being able to secure appropriate (forward) contracts when needed. Relational contracts between firms could overcome demand uncertainty concerns if they replicate the non-contractible timing and pricing patterns associated with integrated trade.

Armed with this understanding of the market, the theoretical section distills the

[5]For comparison, these hundreds types of parchment coffee span only two 10-digit U.S. HS codes (0901110015 and 0901110015), the most disaggregated product classification typically used in empirical analysis of international trade.

[6]See, e.g., reports by I.T.C. (2012), I.C.O. (2014) and World Bank (2015).

[7]These facts are implied by models with demand uncertainty (see, e.g., Carlton (1978), Dana (1998)).

two key testable predictions of the Baker, Gibbons and Murphy (2002, 2006, 2011) framework.[8] The central insight of the model is that firm boundaries affect temptations to renege on the relational contract. The key challenge in testing the theory is that the relational contract is not directly observable. We tackle the problem from two angles. First, we derive an *indirect* test of the theory: when trade is frequently repeated, firm boundaries do not matter. This implies that age effects in relationships between firms should mimic level effects associated with integrated trade. Second, we derive a *direct* test of the key tenet of the theory. Once a forward contract has been signed, the mill's temptations to deviate (as well as actual deviations, if any) become observable. Under non-integrated ownership, extreme realizations of reference prices create large temptations for the mill to renege. Under integrated ownership, however, the reneging temptation is independent of the supply price. Contractual defaults in response to unanticipated changes in reference prices can be used to test these predictions. Finally, a corollary of the relational contract logic is that better outside options reduce parties' ability to sustain relational contracts. Vertically integrated buyers are, ceteris paribus, at a disadvantage in sustaining relational contracts with independent suppliers precisely because they control (future) internal supply. This extension suggests that the benefits of integration imply its costs and provides a third set of testable implications of the framework.

The empirical section provides strong support for these predictions. Trade within integrated firms is compared to relational contracts between firms along three dimensions: prices, timing of contracting and, conditional on a contract, default.[9] On all three dimensions, estimated age effects show that relational contracts between firms qualitatively look like integrated trade. Quantitatively, however, only a handful of relationships replicate the magnitude of the effects associated with integration. On all three dimensions, moreover, integrated buyers are at a disadvantage in developing relationships with independent suppliers, consistent with the view that those relationships are less valuable precisely because of control over (future) internal supply.[10]

These results, derived from an analysis at the transaction level, hold controlling for detailed product, time and relationship (i.e., mills and buyer pair) fixed effects

[8] We focus on general implications of the framework that hold across a large set of applications rather than specific predictions to the model in Baker et al. (2002).

[9] Reported prices within integrated firms might confound other forces, such as removal of double marginalization or transfer pricing. The timing of contracting and default are therefore our preferred outcomes in the empirical analysis.

[10] The evidence is consistent with further specific predictions of Baker et al. (2002). Integration discourages the mill's manager from undertaking costly actions that increase the value of sales outside the relationship. Consistently with this assumption mills owned by integrated buyers receive lower prices when selling on the market.

as well as mill and buyer time varying controls. They are, therefore, not driven by selection at the firm and/or product level nor by differential exposure to demand and supply shocks across firms. To further understand selection, however, we also explore buyers and mills characteristics associated with backward integration. Mills owned by downstream buyers are larger and located in areas with better, but more variable, growing conditions. Backward integrated buyers are larger and export through advance contracts with foreign importers. These results lend further support to the hypothesis that, in our context, integration solves supply assurance concerns.

Taken together, the results portray a coherent picture of how trade within firms differs from both market trade and relational contracts between firms. The final sections of the paper discuss the implications for theories of the firm and for policies in export-oriented agricultural chains in developing countries.

Related Literature

This paper merges two strands of empirical literature: the literature on vertical integration and the literature on relational contracts. With respect to the former (for reviews, see Lafontaine and Slade (2007) and Bresnahan and Levin (2012)) the paper makes two contributions. First, vertical integration is compared against a broader set of alternative organizational forms, including both relational and non-relational contracts between firms. Second, the paper develops precise empirical tests for the general predictions of the Baker, Gibbons and Murphy (2002, 2006, 2011) framework. A large share of the literature on vertical integration relates to antitrust concerns and exclusionary aspects (see, e.g., Hart and Tirole (1990) and Hortascu and Syverson (2007) for overviews). We study a product which is globally traded and, therefore, concerns about foreclosure and other anti-competitive concerns are less likely to be relevant. This allows us to focus on aspects of integration more closely related to adaptation and non-contractability. Within this strand of work, the majority of empirical studies of vertical integration focus on the question "what determines firm boundaries?" (see, e.g., Monteverde and Teece (1982), Masten (1984), Joskow (1985), Antràs (2003), Gil (2007), Forbes and Lederman (2009), Atalay et al. (2014), Alfaro et al. (2015)). Forbes and Lederman (2009) show that airlines tend to integrate routes that require more adaptation. Our results on the characteristics of buyers and mills belonging to backward integrated chains echo their findings. Following seminal papers by Antràs (2003) and Antràs and Helpman (2004), a large and still growing literature in trade has studied determinants of intra-firm trade in international transactions (see Antràs

(2015) for a review).[11] We also study exporters, but focus on the vertical integration decision along the domestic supply chain. As also noted in Bresnahan and Levin (2012), a much smaller literature has asked whether "firm boundaries matter?," i.e., focused on behavioral and operational differences between integrated and non-integrated trade (see, e.g., Mullhainatan and Sharfstein (2001), Hortacsu and Syverson (2007), Gil (2009), Forbes and Lederman (2010), Atalay et al. (2014)). This paper falls more squarely within this second strand. The notable study by Atalay et al. (2014) uses plant level data from the US Longitudinal Business Database combined with the Commodity Flow Survey and find remarkably low levels of internal shipments across plants within vertically integrated firms. In contrast, we study a context in which integration is strongly associated with internal trade. In a study of integration between vinyl chloride monomer (VCM) and waterproof plastic manufacturers, Mullainathan and Scharfstein (2001) find that non-integrated VCM producers react more strongly to market demand while integrated producers focus on internal demand. While our results are in line with their evidence, the granularity of our data allows us to more precisely identify the channels through which integration affects firm's operations. In addition, we compare integration against both a market with forward contracts and relational contracting between firms.

The paper also contributes to the recent literature on relational contracts between firms (see, e.g., Lafontaine and Slade (2012) and Gil and Zanarone (2014) for reviews). Methodologically, Macchiavello and Morjaria (2015a) analysis of relational contracts in the flower industry is most closely related. We also use age effects to proxy relationship value; side-selling opportunities to proxy temptations to deviate; and unanticipated shocks to test theoretical predictions. Age effects are also used in, e.g., Banerjee and Duflo (2000), Kellogg (2011), Gil and Marion (2012), and Antràs and Foley (2015). Temptations to deviate are also exploited in Barron et al. (2015). Blouin and Macchiavello (2013) and Gil et al. (2016) exploit both temptations to deviate and unanticipated shocks. Barron et al. (2015) and Gil et al. (2016) provide convincing evidence on the importance of (relational) adaptation in the movie distribution and airline industry respectively. In a cross-country sample of contracts between coffee exporters and foreign importers Blouin and Macchiavello (2013) show that parties adopt formal contracts to allocate scarce relational capital, as in Klein (2000) (see, also, Gil (2013)). We borrow from them the use of unanticipated shocks to reference prices to study default. None of these papers compares relational contracts

[11] Within this literature, Costinot et al. (2011) identifies adaptation as a key driver of intra-firm trade.

to vertical integration.

Finally, the paper relates to the literature on firms, contracts, and organizational forms in developing countries. Banerjee and Duflo (2000), Banerjee et al. (2001), Banerjee and Munshi (2004), Fafchamps (2000, 2004), Macchiavello (2010), Macchiavello and Morjaria (2015b), McMillan and Woodruff (1999), Mookherjee et al. (2015, 2016) are examples of empirical studies focusing on the importance of relationships. While vertical integration has been relatively neglected, a recent paper by Breza and Liberman (2015) study how regulatory limits to trade credit contracts led to an increase in backward integration of a large Chilean retailer.[12] Mullainatthan and Sukhankar (2014) compare farmers outcomes between cooperative and private mills. Andrabi et al. (2006) study flexible specialization in response to demand uncertainty among subcontractors in Pakistan. Fafchamps and Hill (2005, 2008), De Janvry et al. (2015), Dragusano and Nunn (2014), Macchiavello and Morjaria (2015b) and Martinez (2016) study various facets of the industrial organization of the coffee chain. None focuses on vertical integration.[13]

Roadmap

The rest of the paper is organized as follows. Section 2 describes the Costa Rican coffee sector, its regulations and the data used in the analysis. Section 3 provides evidence that demand uncertainty is an important feature of this market. Section 4 distills testable predictions from Baker, Gibbons and Murphy (2002, 2006, 2011) framework. Section 5 tests those predictions in the data. Section 6 presents a number of additional results and discusses implications for existing theories of the firm. Section 7 discusses policy implications for export-oriented agricultural chains in developing countries and concludes.

2 Industry Background and Data

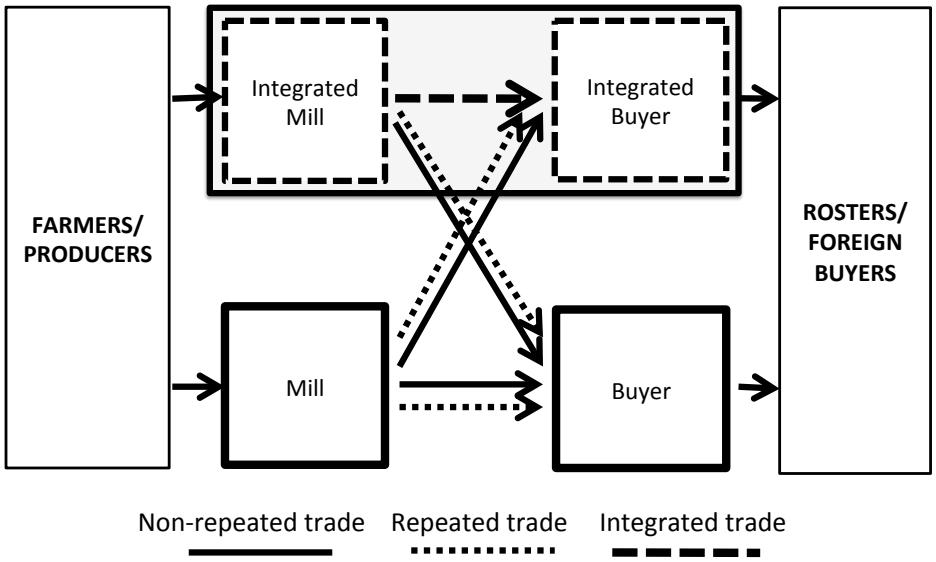
2.1 The Coffee Value Chain in Costa Rica

The cultivation of coffee was introduced in the Meseta Central in Costa Rica in the late eighteenth century. Coffee's importance for the Costa Rican economy grew considerably during the nineteenth century when coffee was the main export crop for decades. Costa Rica ranks 14th among world's coffee producers (see I.C.O. (2015)). Costa Rica

[12] Acemoglu et al. (2009) and Macchiavello (2012) provide cross-country-industry analyses of contractual institutions and vertical integration.

[13] Dragusano and Nunn (2014) and Martinez (2016) also use some of the Costa Rican data in this paper but focus on fair trade and product differentiation respectively.

Figure 1: 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 and, therefore, some buyers are vertically integrated backward. Trade of coffee, therefore, can take four configurations: within firms, and between firms. Between firms we distinguish trade that involves only integrated buyers, only integrated sellers, or non-integrated buyers and sellers. The paper focused on the relationships between mills (sellers) and buyers and compares integrated trade with the various forms of trade in the market.

exports the vast majority of its coffee as fully washed and is generally regarded as a "success story" in terms of product quality and differentiation. Coffee is produced in seven regions that differ in altitude and climate and, therefore, in harvest timings (see Figure A1 and Table A1 in the Appendix).

Figure 1 describes the coffee chain. Coffee cherries are produced by farmers and sold to mills (also known as coffee washing stations or "beneficios"). Farmers harvest coffee cherries from trees. The coffee bean is obtained by removing the pulp from the cherries within hours of harvest. After being washed and dried the bean becomes storable. These stages (depulping, washing and drying) are undertaken by mills. At this stage of the chain the output is called parchment coffee (or "cafe oro").[14]

Mills sell parchment coffee to domestic buyers. Buyers consolidate, mix and mill the coffee before selling to foreign buyers or to domestic roasters. This stage of the chain offers a remarkable variety of organizational forms and is the object of our analysis. The present analysis focuses on sales of undifferentiated ("convencional") parchment

[14]In other countries the coffee cherry is directly processed by farmers. This so called "dry method" (in contrast to the "wet method" performed by mills) is extremely uncommon in Costa Rica. The washed method generally produces higher and more consistent quality.

coffee and compares trade within backward integrated firms (buyers owning mills) with trade between firms.[15] Trade of coffee, then, takes four configurations, illustrated in Figure 1: 1) trade *within* integrated firms; and, *between* firms, trade between 2) integrated buyers with non-integrated sellers; 3) integrated sellers with non-integrated buyers; and 4) non-integrated buyers and sellers. In addition, trade between firms can be relational or non-relational (i.e., market). We define trade between a mill and a buyer to be relational if it spans more than one harvest season and non-relational otherwise. Trade within firms is always relational.

The analysis focuses on backward integration and sales of undifferentiated coffee for expository simplicity: to test the theory we need to identify the salient aspects of the relational contracts between buyers and mills and this is more easily accomplished focusing on *a* specific set of concerns and motives for integration. Section 6, however, discusses how results differ for sales of differentiated coffee as well as similarities and differences between backward and forward integration.

2.2 Industry Regulations

In Costa Rica 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".[16]

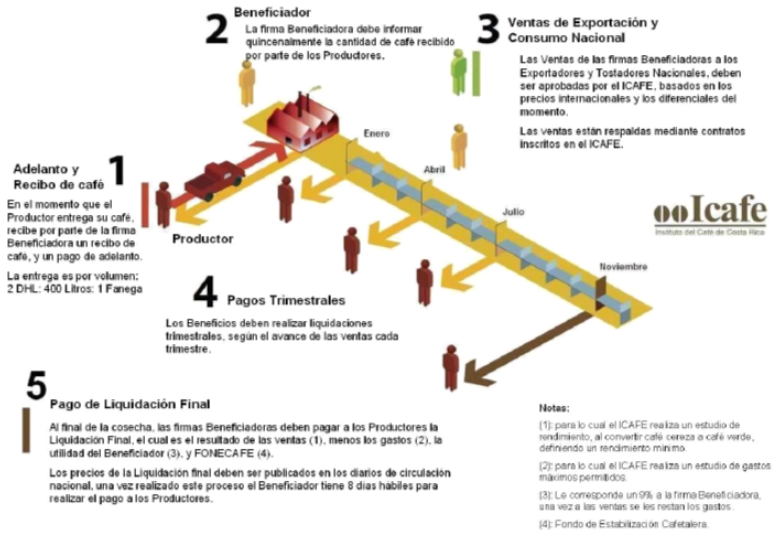
The key aspect of the regulation is the System of Final Liquidation (i.e., "Sistema de Liquidación Final"). The main feature of the system is to enforce contracts between farmers and mills and between mills and exporters. For the system to be implemented, all transactions of coffee along the chain must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

[15] There are also mills that own exporting licenses and are, therefore, *forward* integrated. An additional distinction is between privately owned mills and cooperatives (which are collectively owned by farmers). Some cooperatives form horizontal alliances as part of marketing consortia.

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

Figure 2: The Costa Rica System



The Figure describes the Costa Rica system (Proceso de Liquidacion). 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).

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 mills and buyers 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 A2 in the Appendix shows that the regulation leaves substantial margins for price negotiations: at any date there is significant variation in contracted prices.

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 according to a formula 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.[17]

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.[18]

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). A total of 336 different types of parchment coffee are observed in the data.[19] The board also protects parties from counterpart risk. As documented below, 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 and only 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 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.

2.3 Data and Descriptive Statistics

Data Description

The primary data source is the ICAFE. The data include information on a total of 44282 contracts between mills and buyers spanning 12 harvest seasons (from 2001-

[17]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.

[18]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).

[19]Mills can furthermore register up to three differentiated product lines of coffee, in addition to the undifferentiated ("convencional") line we focus on. 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.

2002 to 2012-2013). 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 2006-2007. Just over 1% of the contracts are canceled, with significant variation across seasons (from about 2% in 2010-2011 to 0.5% in 2012-2013). Information about contracts is complemented by the following data: 1) history of operation and mills ownership type during the sample period; 2) mills location matched to a vector of geographical characteristics; 3) payments made to farmers (advance payments, trimestral and final liquidations); 4) mills reported and audited costs; 5) bi-weekly reports on coffee sourced by mills and number and location of farmers supplying each mill; 6) export contracts. The time coverage varies across the different data.

Descriptive Statistics

Table 1 provides summary statistics for the 2011/12 harvest season focusing on sales of undifferentiated coffee only.[20] Panel A presents mills' characteristics. Out of 175 mills, approximately 5% are owned by buyers, i.e., are part of backward integrated chains. In addition, 14% of mills are cooperatives. The ten largest mills account for 53% of production. Backward integrated mills account for 30% and cooperatives have a similar market share. Mills have operated on average 6 years under current ownership during the sample period, had an average of 3.35 buyers per year, sold 12% of their output to backward integrated buyers and exported 76% of their produce. The last column shows that mills owned by buyers are larger, older, sell to fewer buyers (in fact, sell almost everything to "their" buyer) and export more. They are not different from the rest in terms of unit prices and unit costs.

Panel B presents buyers' characteristics. Of the 149 buyers, 5% are backward integrated. The buyer's side of the market is more concentrated. The ten largest buyers have a combined 77% market share, while backward integrated buyers account for 52% of market output. This implies that backward integrated buyers source approximately 60% internally and the rest on the market. Buyers have operated an average of 6.23 years in the market, have about 4 suppliers per year and export 40% of their purchases (which implies that size is positively correlated with share exported). The last column shows that backward integrated buyers are larger, have more suppliers, export more and (possibly as a result) pay higher prices.

Panel C presents relationships' characteristics. A relationship is here defined as

[20]The industry has been relatively stable throughout the sample period (see Table A2 for summary statistics). The only significant change has been the entry of a larger number of micro-mills in recent years. Those mills account for a very small share of aggregate production.

a unique mill-buyer pair that has traded positive amounts for more than one season. There is a total of 394 such pairs, approximately 40% of which involve an integrated buyer (while only 1% involve an integrated seller). The average relationship is 2.5 years old, exported 66% of its product and traded 1.2 different products. Panel D reports characteristics of the contracts. Approximately 20% of the contracts are for the national market, and around 50% involve an integrated buyer.

3 Demand Uncertainty and Vertical Integration

Before comparing vertical integration and relational contracts between firms, we must understand the key concerns of market participants. Numerous conversations with practitioners and industry reports suggest that demand (and, conversely, supply) assurance considerations are important for both mills and buyers.[21] This Section begins by describing non-relational trade *between* firms (i.e., the "market") along several dimensions. The patterns strongly support demand uncertainty being a key concern. The Section then compares trade *within* vertically integrated firms against non-relational trade *between* firms along the same dimensions. Trade within integrated firms displays radically different patterns consistent with lower demand and supply uncertainty within the integrated chain.

3.1 Market Trade and Demand Uncertainty

Demand assurance concerns arise in markets in which there are idiosyncratic and aggregate demand shocks, once production decisions have been sunk.[22] These conditions fit the coffee industry well. From the viewpoint of a mill, demand uncertainty originates from two sources. First, buyers (mostly exporters) need to manage stocks to timely deliver coffee to downstream roasters facing uncertain demand in the retail market. Second, after harvest is completed, the vagaries of weather and harvest conditions in competing locations worldwide induce fluctuations in the (expected) demand and price. Since parchment coffee can be stored up to at most the following harvest, inventories can only partially help to navigate demand shocks and mills face the risk of holding unsold stocks at the end of the season. Building on theoretical work, we document three facts consistent with demand uncertainty being important in this market.[23]

[21] See, e.g., reports by I.T.C. (2012), I.C.O. (2014) and World Bank (2015).

[22] That is, we are not concerned with shocks affecting availability of supply.

[23] The analysis is mostly based on Dana (1998) and Carlton (1978) (see also Deneckere and Peck (1995) and Cachon (2004)).

Fact 1: Forward Contracts A first implication of demand uncertainty is that mills (and buyers) have incentives to sign forward contracts.[24] Figure 3 confirms this to be the case. Contract duration is defined as the difference between the delivery date and the contract signing date. Less than 40% of contracts are "spot", i.e., the delivery occurs within a week of the signing date. Contracts are signed with significant advance: less than 50% of contracts are signed within a month of delivery date, and the average contract is signed approximately 3 months in advance.

Fact 2: Inventory Risk A second implication of demand uncertainty is that mills carry the risk of unutilized capacity, i.e., holding unsold coffee at the end of the season. Figure 4 shows this to be the case. The Figure plots on the horizontal axis the number of days since the beginning of the harvest season in the region around the mill. The vertical axis reports the difference between the coffee processed and the coffee committed for sale by the mill up to that point (as a percentage of the total coffee processed during the season). The figure averages data across mills and harvest seasons. Before the beginning of harvest mills run a negative balance: forward contracts are signed even before harvest begins. The negative balance is reduced and is turned into positive as the mills start receiving coffee during harvest. The balance peaks towards the end of harvest and then decreases as mills sell the processed coffee. On average, non-integrated mills remain with approximately 7% of processed coffee unsold at the time the following harvest begins: non-integrated mills are indeed exposed to significant inventory risk.

Fact 3: Inverted-U Prices A final implication of demand uncertainty is that prices display an inverted-U pattern during the course of the season. First, models of markets with demand uncertainty and forward contracting predict advance-purchase discounts. The intuition is as follows: firms carry excess capacity to serve consumers in peak periods; the pricing structure across markets must cover marginal costs and capacity costs; spot prices must then reflect the cost of carrying underutilized capacity. Second, unsold stock of coffee at the end of the season ("inventory risk") implies excess supply and lower prices.

[24] We study the physical market for Costa Rican coffee. In the coffee trade, as in several other commodity markets, physical markets operate alongside futures markets, in which contracts for future delivery of coffee (rather than coffee itself) are traded. The majority of futures contracts is traded for obligations in other futures contracts, i.e., contracts of coffee are very rarely "called" for actual delivery. Futures contracts are principally used for risk management. The high number of transactions makes future markets extremely useful price revelation mechanisms and futures prices provide key reference prices for contracts in physical markets. In Section 5.3 the evolution of futures prices over the contract's duration is used to study contractual default.

Figure 5 describes seasonality patterns in unit prices and confirms this implication. The (harvest) season is divided into weeks, with week zero representing the first week in which mills start receiving coffee cherries in the region. For each week in the season (from approximately two months before the beginning of the harvest) week dummies are estimated on unit prices (logs) controlling for week fixed effects, product fixed effects and buyer-seller pairs fixed effects. Identification is therefore obtained from across regions variation in the timing of harvest. The continuous blue line reports smoothed estimates of the estimated week dummies. The Figure shows that mills receive lower prices both from contracts signed early in the season and contracts signed at the end of it. This seasonality in prices strongly supports the predictions of models with demand uncertainty.[25]

3.2 Market vs. Integrated Trade

Vertical integration has long been seen as a solution to demand and supply uncertainty (see, e.g., Carlton (1979)). Firms integrate backward to satisfy the most stable part of their uncertain demand while sourcing externally to satisfy demand in excess of owned capacity. If that is the case, trade *within* integrated firms is expected to be radically different from trade in the market. Figures 3, 4 and 5 also present contracting, inventory and pricing patterns associated with integrated trade. All figures show a stark difference between market trade and integrated trade.

Figure 3 shows that integration substitutes for both spot and forward contracting. Mills within integrated chains rarely need spot contracts to adjust their inventory position. Conversely, mills within integrated chains do not need to contract much in advance as internal demand satisfies their capacity most of the time.[26] Figure 4 shows that integrated mills sign fewer contracts before the beginning of harvest, display a lower balance of processed coffee throughout the entire season and are never left with unsold coffee at the end of the season (i.e., face much lower inventory risk).[27] Finally,

[25]The estimated effects on prices (between -2% and +1%) are actually quite large relative to average buyers (6%) and mills (9%) profit margins. (Unreported) Results show that these estimates are substantially larger if estimated off time variation rather than region-specific seasonality patterns (6% and 3.5% before the beginning and after the end of harvest respectively). These effects are not driven by differences in the quality of coffee transacted since those are controlled for by product fixed effects (which include an indicator of when the coffee was harvested).

[26]Table 9 below shows that backward integrated exporters are more likely to export through advance contracts. From a risk management perspective it is then optimal to match contract duration in export market with (reported) contracts within the integrated chain.

[27]These findings are econometrically confirmed by (unreported) results on the intensive and extensive margins of trade. Conditional on detailed product, season, seasonality and relationships fixed effects, trade within integrated firms is relatively less likely to occur before the beginning or after the end

Figure 5 shows that trade within integrated firms doesn't display the inverted-U pricing pattern observed in the market. This evidence confirms that trade within integrated firms is less subject to uncertainty and doesn't need to rely on forward contracts before harvest nor spot contracts to sell unsold stocks after the end of the harvest campaign.

Figure 6 provides further support to the hypothesis that vertical integration mitigates demand uncertainty. Figure 6 reports the shares of coffee bought and sold on the market by (backward) vertically integrated firms. Each dot represents a backward integrated firm in a given season. The vertical axis is the share of coffee bought in the market. The horizontal axis gives the share of coffee sold on the market. The Figure shows that in any given season integrated firms source from the market only if own supply isn't sufficient and (conversely) sell to market only if internal demand isn't sufficient. Market trade (represented by the crosses) display a radically different pattern.

3.3 Defining the Relational Contract

In sum, the evidence confirms that demand uncertainty is a key concern in the market that is mitigated by vertical integration. Can relational contracts also mitigate demand uncertainty? If yes, how would the relational contract look like? To answer these questions we proceed in two steps: first, we distinguish what is contractible (i.e., enforced by the board) from what isn't (i.e., informally enforced). Then, we let integrated trade reveal how (a well-functioning) relational contract should look like.

What is Contractible? What isn't?

Once a contract has been signed, the board provides enforcement: only around 1% of contracts are canceled/defaulted upon. However, promises on *whether* a contract is signed and, if yes, at which conditions, are not enforceable. That is, parties face the risk of not being able to secure appropriate (forward) contracts when needed. In a relational contract, parties promise to sign contracts at certain conditions (prices, quality, length) at appropriate timing. If demand uncertainty is a key concern, the buyer promises to sign contracts and absorb capacity; the mill promises to deliver the coffee as per contract.

How long in advance should parties lock in the formal contract? Parties face a trade-off between securing demand/supply and counterpart risk. If realized spot

of the harvest campaign. Conditional on a contract being signed, traded volumes display the same pattern.

market prices are much higher than expected, a mill will want to renege on a promised delivery locked in at a lower price.[28] Contracts of longer duration are, therefore, riskier as they leave parties exposed to larger fluctuations in market conditions and fetch lower prices both because they provide demand assurance and because they leave the buyer relatively more exposed to strategic default.[29]

Defining Cooperation: How does integrated trade look like?

This logic has implications for both the *timing* and *pricing* of contracting. Trade within integrated firms along these two dimensions allow us to identify the key dimensions of the relational contract. First, conditional on delivery date, integrated firms can afford to wait longer to align contracted prices with market conditions and, therefore, register with the board shorter contracts. Second, integrated capacity is allocated more certain demand and is therefore less likely to be unutilized than non-integrated capacity. Zero profits, then, require that output is sold from non-integrated capacity above (marginal) cost. This implies that internal sourcing is cheaper than market sourcing.[30]

Table 2 provides support for both predictions. The Table considers all contracts signed by vertically integrated buyers. Columns 1 to 3 focus on contract length, Columns 4 to 6 on prices. The results compare both contract dimensions with the integrated mills and with independent suppliers. Columns 1 to 3 find that, on average, integrated buyers sign contracts that are thirty days shorter when sourcing internally rather than on the market. The difference shrinks to 15 days shorter contract duration when we account for a host of additional controls, including delivery date fixed effects. Results on prices are similar. Simply controlling for buyer fixed effects, contract volumes, region and seasonality, Column 4 finds that integrated buyers pay almost 7.3% higher prices when sourcing outside. This large difference, however, could be due to differences in product characteristics or in the timing of contracting. Column 5 shows that this is only partially the case. Including both detailed product and contract date fixed effects, results show that integrated buyers still pay approximately 3% more for the same coffee, on the same day, when sourcing in the market relative to internal supply. Column 6 shows that this result is not due to differences at the mill level. Even after controlling for mill characteristics (which include mill type, size and audited

[28] In principle, if realized market prices are much lower than expected, the buyer has an incentive to renege on the contract. As noted above, the board doesn't allow this type of contract cancellations.

[29] Table A3 provides econometric evidence. Controlling for detailed product categories, season fixed effects, signing dates fixed effects and mills' and buyers' fixed effects longer contracts fetch lower prices.

[30] This mechanism is analogous to the argument for advance purchase discounts and distinct from standard argument such as the removal of double marginalization or transfer pricing. Because reported prices within integrated firms might also reflect these forces, the timing of contracting is our preferred contractual dimension in the empirical analysis.

costs) and for region specific season and seasonality effects, integrated buyers still pay approximately 1.5% more when buying in the market. This effect, which might appear small, accounts for a sizable share of buyers margins (which average 6%).

Summary: how do relational contracts look like?

In sum, even with forward sale contracts, parties might not achieve perfect supply and market assurance: a suitable forward contract might not be available when needed and, conditional on contracting, parties remain exposed to opportunism. In the absence of integration, relational contracting offers an alternative to achieve the desired level of demand and supply uncertainty. By exchanging promises within a relational contract, non-integrated parties can (try to) mimic the trading patterns associated with integration. If that is the case, relational contracts between firms will display shorter contracts (conditional on a delivery date, parties can wait longer to adjust the contract to market conditions) and lower prices (mills face less uncertain demand).

4 Bringing Baker et al. (2002) to the Data

In a series of papers, Baker, Gibbons and Murphy (1994, 2002, 2006 and 2011) - henceforth **BGM** - study the interaction between formal contracting (of which firms boundaries is a special case) and relational contracting. This section distills testable predictions from their framework. Since we are interested in general predictions that hold across applications, we do not extend **BGM** to formally derive specific predictions for our context.[31] We instead describe the framework in some generality and apply its insights to our context.[32]

4.1 Relational Contracts and Firms Boundaries

In the relational contract framework (see, e.g., MacLeod and Malcomson (1989), Levin (2001)), parties have informal agreements to undertake certain costly non-contractible actions in exchange for future rewards. Parties trade off future rents against current

[31] This would require extending the model along four dimensions: 1) allows for enforceable contracts; 2) model demand uncertainty; 3) consider multiple suppliers; and 4) allow for on the equilibrium path default and trade outside the relationship.

[32] Baker, Gibbons and Murphy (2002) - henceforth **BGM02** - is most closely suited to our analysis: it is empirically relevant (relational contracting between independent firms coexists alongside vertical integration in our context); and its key insights can be directly tested in the data. Furthermore, a prediction of **BGM02** is that integration is an optimal response to widely varying supply prices. This result provides an alternative explanation to Carlton (1979) for why vertical integration delivers supply assurance and fits the evidence in Section 3 well.

temptations to deviate. A necessary condition for a given relational contract to be sustainable is that the value of the future rents in the relationship is larger than the temptation to renege. The central insight in **BGM** is that firms' boundaries change temptations to deviate.

Consider a mill and a buyer. There are three organizational forms: market (i.e., non-relational trade between firms); relational contracting between firms; and vertical integration (in which the buyer owns the mill).[33]

Following the evidence presented in Section 3, the key costly non-contractible actions to be undertaken by parties are as follows. First, the mill and the buyer promise to sign (forward) contracts at certain conditions (prices, quality, length) at appropriate timing. This might be costly to either party if better trading opportunities are available or if it is better to wait before committing to a contract. Then, the mill might undertake non-contractible investment e at cost $C(e;\eta)$ to increase the value of trade (e.g., prioritize certain preparation types).[34] Finally, conditional on a contract having been signed, the mill must resist the temptation to renege on the contract and default when market prices are much higher than the locked in price. Let's index the strength of this temptation by θ.[35]

The central insight of the model is that firm boundaries affect temptations to renege on the relational contract. The key challenge in testing the theory is that the relational contract is not directly observable. In particular, in the data we observe *if* a (forward) contract is signed (and its terms), but do not observe the underlying promise. We also do not observe non-contractible investments by the mill. Once a contract is signed, however, we do observe temptations to renege and if a default occurs. This suggests two approaches to derive testable implications. A first *indirect* approach to test the theory is to derive predictions on how the organizational forms chosen in equilibrium behave. A second *direct* approach is to examine how firm boundaries change temptations to deviate.

4.1.1 Indirect Test: Equilibrium Organizational Forms and Age Effects

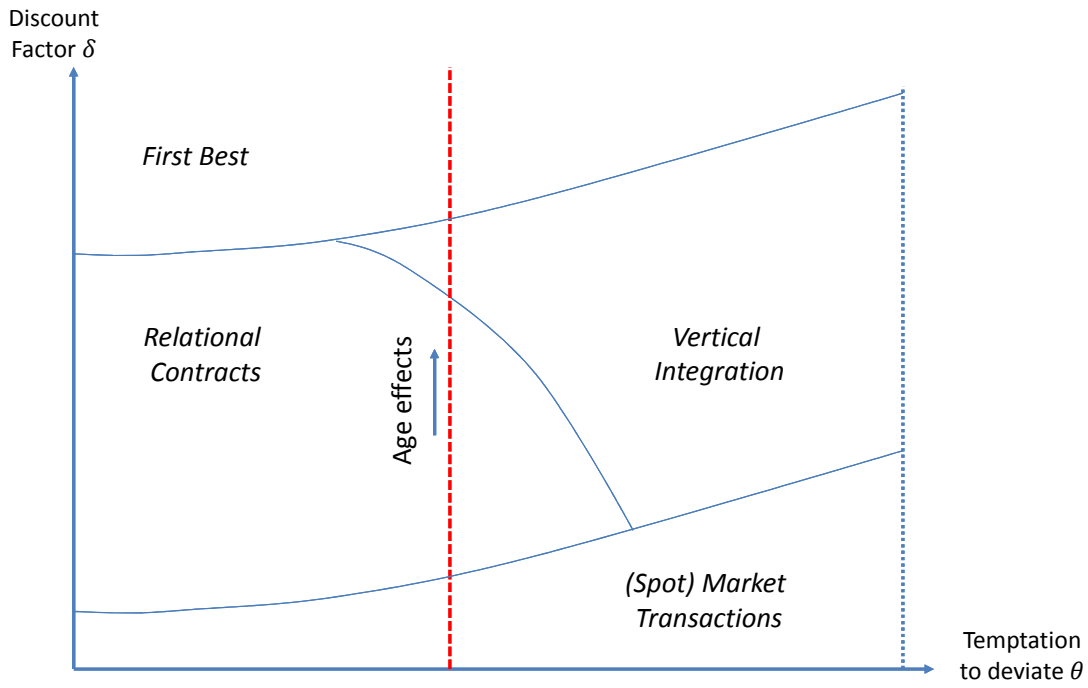
BGM02 derives the organizational forms that maximizes joint surplus (and is, therefore, chosen in equilibrium) as function of *i)* the frequency of interactions between

[33]Non-relational employment (the buyer owns the mill but no relational contract is used) is not empirically relevant in our context. We follow **BGM02** and ignore forward integration (the mill owns the buyer). See Section 6 for a discussion.

[34]The buyer might also have to exert effort, e.g., to find buyers. For expository simplicity, we follow **BGM02** and focus on the mill incentives only.

[35]Recall that the board doesn't allow buyers to cancel contracts.

Figure 7: Efficient Organizational Form



the parties - indexed by the common discount rate δ; *ii)* the strength of the mill's temptation to renege - indexed by θ.; and *iii)* the returns to the mill's non-contractible efforts - indexed by η.

In **BGM02** whether the parties are integrated or nonintegrated affects their temptations to renege on a given relational contract. In some situations, the reneging temptation is lower between integrated parties; in others, the reneging temptation is lower between nonintegrated parties. Figure 7 illustrates the equilibrium organizational form as a function of the two parameters δ and θ. Holding constant θ, standard logic implies that a higher δ facilitates cooperation. If δ is very high, both integration and non-integration can achieve the first best and the organizational form doesn't matter. If δ is very low, instead, no relational contract can be sustained regardless of the adopted organizational form, and trade occurs in the market. For intermediate values of δ the choice between integration and non-integration matters.

Vertical integration assigns ownership of the coffee to the buyer and, therefore, eliminates the mill's temptation to side-sell once market conditions are much more favorable than those agreed in the contract. Holding constant δ, then, vertical integration emerges for higher values of θ. The frontier separating the regions in which integra-

tion and non-integration are optimal is downward sloping. The logic is as follows. By definition, along the frontier, the two organizational forms produce the same surplus. If θ is higher, the temptation to deviate under non-integration must be compensated by better incentives, i.e., η must be such that equivalent surplus across organizational forms can be achieved at lower δ.

From Figure 7, a first empirical test can be derived. Consider an environment, like ours, in which all three organizational forms are observed: market trade, relational contracting and integration. Controlling for θ and η (i.e., product characteristics, costs drivers and market conditions, ...) a higher δ implies that the terms of the relational contract between firms converge to the terms of trade observed within integrated firms. That is, when trade is frequently repeated, firm boundaries do not matter. A higher δ is associated with more frequent trade and a higher relationship's value. Once relationship and time effects are controlled for, the number of previous interactions between parties (in short, the age of the relationship) provides an empirical measure of the frequency of trade in the relationship.[36] From the discussion in Section 3, recall that integrated trade displays shorter contracts and lower prices. Therefore, we have the first set of testable predictions:

P1: *Integrated trade displays lower prices and, conditional on delivery date, shorter contracts. Relationships between firms converge to the pricing and timing of integrated trade (i.e., the age of the relationship negatively correlates with unit prices and contract length).*

4.1.2 Direct Test: Temptations to Deviate and Mill's Incentive Constraints

A key advantage of our setting is that, once a contract is signed, the mill's temptation to deviate (as well as actual deviations, if any) become directly observable. Hence, although contract cancellations are quite rare in the sample, they provide a very transparent opportunity to test the logic in **BGM02**. This provides a *direct* test of the key tenet of the theory.

Consider a mill that has signed a contract for delivery of quantity q_c at price p_c. The price p_c negotiated at the time of contracting is tied to parties expectations about prevailing market prices at delivery. Let p_w be the spot market price at delivery and

[36]Note that **BGM02** features stationary dynamics in which age effects are entirely driven by selection. Models of relational contracting with persistent asymmetric information or limited transfers instead display non-stationary dynamics in which, conditional on survival, age causes changes in contractual outcomes. Although this difference doesn't matter for deriving the test, in the empirical analysis we distinguish the two.

$T(\theta, o)$ the share of contracted coffee the mill can side-sell and organizational form o, with θ a (time varying, product specific) measure of market liquidity. If p_w is much higher than anticipated, an independent mill will want to renege on the contract and try to take advantage of improved market conditions, i.e., $T(\theta, ni) > 0$. The central insight of **BGM02** is that when the mill is owned by the buyer it doesn't own the coffee and, therefore, cannot sell it outside (i.e., T(θ,int) = 0). Denote with V_m^o and U_m^o the continuation values under organizational form o for the mill following delivery and default respectively. The dynamic incentive compatibility constraint for the mill gives the condition under which the mill delivers the coffee. The constraint is given by

$$\delta(V_m^o - U_m^o) \geq (p_w - p_c)T(\theta, o)q_c. \tag{1}$$

A number of testable predictions immediately follow. First, integrated mills have fewer defaults and those defaults do not depend on market conditions p_w. Second, the age of the relationship between firms negatively correlates with default; particularly so when market prices p_w are higher.

P2: *Unanticipated increases in market prices lead to contract default but **i)** not within integrated firms, and **ii)** less so as relationship's age increases.*

4.1.3 The Costs of Integration

Finally, the logic of **BGM02** also implies costs associated with integration. There are two types of costs. The first costs associated with integration can be derived from a multi-party extension of **BGM02**. As noted above, integrated buyers own capacity only covers the most stable part of their demand. Independent suppliers are used to cover demand in excess of own capacity. The structure of the dynamic incentive constraint reveals that better outside options hinder parties ability to sustain relational contracts. This has implications for the ability of integrated buyers to develop relational contracts with independent suppliers. If control over integrated capacity implies a better outside option, a vertically integrated buyer has, ceteris paribus, a disadvantage in sustaining relational contracts with independent suppliers. This introduces an endogenous cost of integration. Empirically, this leads to the following prediction:

P3: *Consider trade between between independent suppliers and integrated buyers: 1) the age of the relationship doesn't correlate with prices and contract length; 2)*

unanticipated market price increases lead to higher contract cancellation.[37]

Second, integration assigns control over outside sales to the buyer. This reduces the mill's incentives to generate valuable trading opportunities outside the relationship. Most of the time, coffee is delivered to the integrated buyer and, therefore, limiting those costly investments is beneficial for the relationship. Occasionally, however, the integrated mill might have to sell outside (e.g., when buyer's demand is lower than integrated capacity). When this happens, an integrated mill will sell at worse conditions than non-integrated mills.

P4: *Holding everything else constant, integrated mills receive lower prices when selling coffee to independent buyers.*

4.2 Summary of Predictions

Figure 8 summarizes the testable predictions derived from the theory. The figure considers the three key dimensions of contracting: prices, length and - conditional on a contract being signed - strategic default. Predictions are derived for trade within integrated firms (in levels) as well as for age effects along different types of trade involving different types of firms. In total, the figure reports eight predicted correlations and a number of additional placebos. Integrated trade has lower prices, shorter contracts and less default (First row). Between non-integrated firms, the age of the relationship negatively correlates with prices, length of contracts and default (Second row). When integrated buyers source from independent mills, relationships do not display the same positive patters and strategic default is more likely (Third row). Finally, as a placebo, there shouldn't be relationship effects within integrated firms.[38]

[37] That is, for the same contract and temptation to deviate, the same supplier will be more likely to strategically default on a contract signed with an integrated buyer.

[38] For simplicity, Figure 8 doesn't include **P4** which is however tested in Section 6.

Figure 8: Summary of Predictions

	Prices	Contract Length	Strategic default
Integrated trade	− (P1)	− (P1)	− (P2)
Age effects:			
Between Firms	− (P1)	− (P1)	− (P2)
Integrated Buyers: Outside	0 (P3)	0 (P3)	+ (P3)
Integrated Buyers: Within	0	0	0

5 Empirical Results

This section reports the main empirical results following closely the predictions summarized in Figure 8. Relational contracts between firms are first compared to vertical integration with respect to prices and timing of contracting. Then we analyze strategic default.

5.1 Timing and Length of Contracts

We begin by describing the use and timing of forward contracts across the three organizational forms: market, integrated trade and relational contracts between firms.[39] Figure 9 describes the use of forward contracts. The Figure reports the cumulative share of coffee sold by length of contract, measured in weeks. The length of the contract is defined as the difference between the date in which the contract is signed and the date at which the coffee is supposed to be delivered. Contracts of length zero are spot contracts. Longer contracts are forward contracts. The figure shows that 60% of coffee exchanged in non-relational trade between firms (i.e., the market) occurs through spot contracts. In contrast, the share of coffee sold spot within integrated firms as well as between firms with long-term relationships is only 20%. Moreover, the Figure shows that the distributions of contract length of relational contracts between firms and integrated trade is almost identical.

Figure 10 compares the timing of deliveries across the three organizational forms. The Figure reports the cumulative share of coffee sold by delivery date, measured in weeks from the end of the harvest campaign in the region. The figure shows that only

[39]For illustrative purposes, Figures 9 and 10 only focus on established relationships in their fourth or more consecutive season.

20% of coffee exchanged in the market (blue solid line) is delivered before the end of the harvest campaign. In contrast, within firms (red dotted) and between firms with long-term relationships (blue dashed), coffee is continuously delivered as it is received and processed by the mill. As predicted by **BGM02**, established relationships between firms behave very similarly to integrated trade.

5.2 Length of Contracts and Prices: Age Effects

We now test predictions **P1** (and **P3**) on (lack of) age effects. Age of the relationship is measured with the number of previous signed contracts (in hundreds). This allows us to control for both time and relationship cohort effects providing the closest empirical approximation to the frequency of trade δ. The regression controls for volume of trade on the contract (polynomial), detailed product fixed effects, market conditions at the time of contracting, mills characteristics (including region specific season and seasonality patterns, volume processed, and costs) and relationships fixed effects. This rich set of controls aims at holding constant confounders (summarized by θ and η), at either the product, time or firm level.

We begin examining timing of contracts in Table 3.[40] Column 1 focuses on non-integrated buyers and their relationships with non-integrated suppliers (prediction **P1**). It shows a negative, large and statistically significant age effect on leadtime. Columns 2 to 4 focus on integrated buyers only. Column 2 considers age effects in the relationship between integrated buyers and non-integrated mills (prediction **P3**). We see that relationship age has a negative and significant effect on contract length on the relationship between integrated buyers and independent mills, but with a coefficient less than half (and statistically different from) the one in Column 1. Column 3 shows that trade within integrated firms occurs with contracts that are on average of 20 days shorter. Column 4 considers age effects within the firm (i.e., the placebo). As expected, there is no relationship between past trade and timing of contracts within the firm.

Delivery date fixed effects are controlled for in all Columns. This is done because the theoretical prediction is that, conditional on a delivery date, parties in better relationships can afford to wait longer before locking in a contract.[41]

[40] Alongside contractual defaults (see Section 5.3), the timing of contracts is our preferred outcome variable since prices (tested in Table 4) might confound other aspects of integration, e.g., removal of double marginalization and transfer pricing. The Table reports results by splitting the sample across the different types of relationships. Identical results are obtained in the overall sample using interaction terms.

[41] Conversely, conditional on contracting date, we expect good relationships and integration to be

The robustness and mechanics of the results in Column 1 are further explored in Table A4. For comparison, Column 1 in the Table reports the baseline specification (Column 1 in Table 3). Column 2 shows that measuring age of the relationship as calendar time delivers qualitatively similar results. A concern with the baseline specification is that results overweight longer relationships (since they account for a higher number of observations). Column 3 re-weights observations by the inverse of the total number of contracts observed in the relationship and finds even stronger results. Columns 4, 5 and 6 disentangle whether the estimated age effect arises due to selection or not. Columns 4 and 5 only estimate age effects on the first (three) season of relationships that survived their first (three) season(s).[42] The specification, therefore, estimates age effects on a balanced, albeit selected, sample of relationships. Column 6, instead, compares contract length in the first year of relationships with duration above / below the median. Both sets of specifications suggest that estimated age effects are not exclusively due to selection effects.

Table 4 repeats the exercise considering price as dependent variable.[43] The results are highly consistent with the patterns on prices in Table 3 and confirm the theoretical predictions. Column 1 considers again the relationships of non-integrated buyers with independent mills, showing that relationship age negatively correlated with the prices (prediction **P1**). Columns 2 to 4 focus on integrated buyers only. Column 2 considers age effects in the relationship between integrated buyers and non-integrated mills (prediction **P3**). As expected, the age of the relationship doesn't correlate with unit prices.

Table A5 presents robustness checks along the lines of those performed for the price results in Table A4. Negative age effects on prices are detected using a different measure of age based on calendar time (Column 2) as well as re-weighting observations to avoid oversampling longer relationships (Column 3, although the coefficient is less precisely estimated). Columns 4 and 5 detect negative age effects on a balanced, although selected, sample of relationships lasting longer than one and three years respectively. Column 6, instead, compares prices in the first year of relationships with duration above / below the median. Again, both sets of specifications suggest that estimated age effects are not exclusively due to selection effects.

associated with longer contracts. Duration is associated with a higher temptation to renege and only integrated firms or well established relationships are able to sustain larger temptations. Unreported evidence confirms the prediction that the age of the relationship is positively correlated with contract duration (as vertical integration is) for non-integrated buyers but not for integrated buyers.

[42] To avoid left censoring, we consider only relationships that begun after the first year in our sample.

[43] Again, the Table reports results by splitting the sample across the different types of relationships. Identical results are obtained in the overall sample using interaction terms.

In sum, the evidence on contract length and unit prices strongly supports the predictions of the theoretical framework. As predicted by the theory, relationships between firms (but not those involving an integrated buyer) converge to the patterns associated with integrated trade: parties sign shorter contracts (conditional on a delivery date, parties trust each other and can wait longer to adjust the contract to market conditions) and agree on lower prices (as mills face less uncertain demand). While relational contracts converge to the patterns associated with integration, from a quantitative point of view, the estimates in both Tables 3 and 4 confirm that very few relationships achieve the age necessary to obtain the same decrease in prices associated with integration. The required age is given by the ratio between the estimated coefficients in Column 1 and 3 of Table 3 (resp. Table 4). Both Tables imply quantitatively similar results: 72 (resp. 64) previous contracts are required for relationships between independent mills and buyers to replicate the level effect associated with integration. Only just over 5% of observed relationships in the sample achieve this number of transactions. In both Tables, the estimates imply that no relationship between integrated buyer and independent mill achieves the age necessary to replicate integration.

5.3 Strategic Default (prediction P2)

A key advantage of our setting is that, once a contract is signed, the mill's temptation to deviate (as well as actual deviations, if any) become observable. Hence, although contract cancellations are quite rare in the sample, they provide an opportunity to directly test the logic in **BGM02**. This section studies contract cancellations and tests predictions **P2**.

Consider a mill and an exporter that have signed a forward sale contract at a certain date t_c for a future delivery at date $t'_c > t$. The fixed price negotiated at time t, p_c^t, reflects contracting parties expectations about prevailing spot market prices at date t', denoted $\mathbf{E}\left[p_w^{t'}|t_c\right]$. If, at time t', spot market prices $p_w^{t'}$ are much higher than those anticipated at the time of signing the contract, the mill will have a strong temptation to renege on the contract.

The key challenge to test for this type of default is to proxy for expectations of future reference prices. The coffee sector provides the advantage that liquid world futures markets for arabica coffee exist. This implies that for every contracting date t expected future prices for deliveries at, or near to, delivery date t' are observed. For each contract c signed between mill m and buyer b at date t for deliveries at t') we construct a measure of price surprise as

$$P_{cbstt'} = \frac{p_w^{t'}}{\mathbf{E}\left[p_w^{t'}|t\right]}, \tag{2}$$

i.e., as the ratio between the realized spot price at delivery and the expected price at delivery at the time of contracting.[44]

While the board provides contract enforcement and protects parties from counterpart risk, it allows mills to cancel contracts under specific circumstances. A mill might get away by pretending to not have managed to produce the required coffee. In contrast, buyers are not allowed to cancel contracts and are therefore not able to (strategically) default by refusing to accept coffee prepared according to contract specifications. As a result, we expect an asymmetric effect of price surprises and to detect opportunistic default only when the mills have incentives to default.

Strategic Default: Results

Figure 11 reports preliminary evidence on how positive price surprises are disproportionately associated with strategic default. The left panel considers negative price surprises. Consistent with the fact that the board enforces contracts, there is no statistical difference in the distribution of negative price surprises for contracts that are and are not renegotiated. The right panel shows that positive price surprises are, instead, disproportionately associated with contract cancellations. This asymmetry is consistent with mills being able to opportunistically default (e.g., by claiming to not have the exact coffee type stipulated in the contract).

Table 5 confirms the results using regression analysis. The Table reports results from regressions in which the dependent variable is a dummy taking value equal to one if the contract is "canceled", i.e., defaulted, and zero otherwise. Overall, just over 1% of the fixed price contracts in the sample are renegotiated. A linear probability model is used to accommodate the numerous fixed effects included in later specifications, but results are similar with alternative specifications. Column 1 confirms that price surprises are associated with (strategic) default. Controlling for exporter-mill pairs, price surprises are associated with an increase in the likelihood of default. A doubling of prices during the duration of the contract period more than doubles the chances of contract default. Columns 2 to 6 distinguish 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 increases more than 10 times the likelihood of default. In contrast, negative price surprises do not lead to

[44] We borrow this empirical design from Blouin and Macchiavello (2013).

contract default.

Results in Columns 1 and 2 could be driven by a host of confounding factors. For example, the size of the temptation to renege on the contract is proportional to the contracted volume, and will also depend on how easy it is to side-sell the product. Column 3 adds detailed product fixed effects and contract volume controls. Column 4 also includes additional region-specific season and seasonality fixed effects, interactions between mills characteristics (size, location, ownership type) and contract date fixed effects. Results are remarkably robust: positive price surprises increase the likelihood of contract default.[45]

Columns 5 and 6 include relationship's age, defined again as the number of previous contracts (in hundreds) between the exporter and the mill. The estimates in Column 5 show that the age of the relationship is associated with a lower likelihood of default. This is consistent with either selection ("better" relationships last longer and are less likely to have defaults) as well as with a causal impact of relationship age on the value of the relationship and, therefore, on the likelihood of default. Column 6 includes the interaction between the age of the relationship and the measure of price surprise. Relationship's age mitigates the likelihood of default only in relatively older relationships.

Table 6 tests prediction **P2** by distinguishing across different types of relationships (like in Tables 3 and 4). Column 1 considers again the relationships of non-integrated buyers with independent mills. Relationship age negatively correlates with contract default when there are positive price surprises. Columns 2 to 4 focus on integrated buyers. Columns 2 and 3 focus on the relationships between integrated buyers and independent mills. As expected (prediction **P3**), Column 2 shows that positive price surprises have a much stronger impact on contract cancellations within this sample of relationships. Columns 3 offers a direct comparison with the specification in Column 1. The results confirm the predictions. Although the two sample behave qualitatively in a similar manner, the effect of a positive price surprise at the beginning of a relationship is twice as large in the sample involving integrated buyers. As expected, column 4 shows that positive price surprises do not lead to contract cancellation within integrated firms. Even when considering the attenuating effect of relationship's age, the estimates imply that approximately 5% of the relationships in Column 1 reach the age necessary to

[45]Table A6 shows that contract cancellations are unlikely to be agreed by both parties and are most likely associated with default. The Table shows that past contract cancellations are associated with worse relationship outcomes (relationship's death, future contract volumes) if they happened on contracts with positive price surprises.

replicate the (zero) effect of price surprises on cancellation within integrated trade. The corresponding figure for relationships in Column 2 is less than 1%.

6 Further Results and Discussion

6.1 Prediction P4: Further Costs of Integration

In the spirit of property rights models (see, e.g., Grossman and Hart (1986)), **BGM02** show that backward integration reduces the mill's incentives to (undertake non-contractible investments to) develop marketing options outside the firm. Although we do not directly observe those investments, an implication is that a mill owned by a buyer will receive lower prices when selling to outside buyers (prediction **P4**).[46]

Columns 1 to 4 in Table 7 provide evidence that, indeed, integrated mills selling in the market receive lower prices than non-integrated mills. The results focus on transactions between firms (excluding transactions within firms). By including contract volumes and buyer fixed effects, Column 1 finds that integrated mills receive 17% lower prices when selling to the same buyer than non-integrated mills. As noted above, this difference could be driven by differences in product characteristics or in the timing of sales. Controlling for detailed product and contract date fixed effects, Column 2 shows that integrated mills still receive a 11% price discount when selling to the same buyer. Columns 3 and 4 consider additional controls, including mill's characteristics such as costs, size, location and ownership types. Estimates show that, when selling the same volume of the same coffee on the same date to the same buyer, integrated mills still receive approximately 12% lower prices than comparable mills with similar size, costs and location.[47]

6.2 Differentiated Coffee

The analysis so far restricted attention to sales of undifferentiated ("convencional") coffee. Approximately 20% of the contracts in our sample, however, are for sales

[46] Another possibility is that, in the presence of asymmetric information in the output market, vertically integrated mills that try to sell on the market face an adverse selection problem. We focus on undifferentiated coffee in a context in which the board enforces contracts based on very detailed standards. Coffee transacted within Costa Rica is highly commodified and adverse selection problems are unlikely to be severe.

[47] Extending the logic on the costs of integration, note that mills owned by buyers do not form *any* relationship with independent buyers. As integrated buyers receive approximately 60% of their demand from owned capacity, an integrated mill almost never needs to sell in the market.

of differentiated coffee. How do these sales compare to those we focused on? From a conceptual point of view, differentiated coffee is more specific, i.e., will be characterized by lower side-selling opportunities $T(\theta)$. While demand and supply assurance concerns might still play a role, the higher lock-in naturally provided by differentiation reduces concerns about strategic defaults and the motives for integration.

Consistently with this reasoning, (unreported) results show that: *i*) a significantly lower share of differentiated coffee is traded within integrated firms; *ii*) the timing and pricing patterns are qualitatively similar, but quantitatively smaller, to those observed for undifferentiated coffee; *iii*) backward integrated buyers *do not* have a disadvantage in building relationships with suppliers - presumably because internal supply is a poor substitute for differentiated coffee; *iv*) contractual defaults are rarer. As expected, only the results in Table 6 on strategic default do not hold for differentiated coffee (due to both smaller sample size and lower incentives to default).

6.3 Understanding Selection

Besides supporting the predictions of **BGM02**, the evidence also suggests that demand and supply assurance considerations might be important motives for backward integration in the industry. To further explore this hypothesis we look at cross-sectional correlates of integration at both the mill and the buyer level.

Table 8 explores mills characteristics that correlate with integration. Integration is a dummy taking value equal to one if the mill is owned by a downstream buyer. Columns 1 to 6 estimate a logit model considering different characteristics separately. There are three characteristics that appear to be correlated with integration: size, age and suitability for coffee growing around the mill.[48] Column 7 considers all characteristics at once, in addition to region fixed effects. The results mostly confirms the findings in Columns 1 to 6, but also show that variability in growing conditions around the mill negatively correlates with integration. These results are confirmed by a multinomial specification that investigates correlates of both backward and forward integration. The fact buyers own mills in locations that have *more* suitable but *less* variable growing conditions is consistent with backward integration responding to a demand for steady supply.

Table 9 performs a similar analysis investigating buyers characteristics (focusing on the sample of exporters). Columns 1 to 7 consider the following characteristics

[48] Odd ratios reported, all independent variables are standardized. Suitability is given by (minus) the standardized z-score of deviations from ideal altitude, rainfall and temperature conditions.

separately: size, average export prices, age and percentages of exports to traders (as opposed to roasters), through advance contracts, and of differentiated coffee. When considering all variables simultaneously, Column 8 shows that only size and percentage of exports through advance contracts correlate with backward integration. Columns 9 and 10 perform a multinomial analysis and confirm the results. The results suggest that those exporters that are likely to have a higher demand for supply assurance tend to integrate backward.

These results show that buyers and mills belonging to backward integrated chains are different from the rest. The results in the previous section control for these differences: by including relationships (i.e., buyer-mill pair) fixed effects, the specifications account for (time invariant) differences across firms. Mills and buyers with characteristics that are associated with integration could, however, behave differently because they are subject to different time varying shocks.

The regressions presented above (Tables 2 through 7) already control for time-varying version of mills characteristics associated with integration. In particular, the specifications control for mills total output during the season, as well as region specific season and seasonality fixed effects (that control for relevant geographical conditions and weather shocks). Table 10 explores the extent to which buyers time varying characteristics affect the results. The Table reproduces the main specifications in Tables 2, 3, 4 and 6 including buyer-season and buyer-seasonality effects. Those controls account for potentially time varying shocks at the buyer level (e.g., an increase in demand or a default from the main client) as well as buyer-specific seasonality patterns (in, e.g., delivery commitments to foreign buyers). The Table finds that results are broadly consistent when including these additional sets of controls.

6.4 Forward Integration

The analysis so far has restricted attention to backward integration. A distinctive feature of our context is that it allows to distinguish between backward (buyers owning mills) and forward (mills holding export licenses) integration. A number of mills are integrated downstream and hold export licenses that allow them to export directly their produce. Conversations with industry practitioners suggest that this integration strategy has different motives than those driving backward integration. While backward integration appears to be driven by supply assurance concerns, direct exports allow the mill to remove middlemen margins and provide higher incentives to develop differentiated marketing channels downstream. The available empirical evidence broadly

support this interpretation. While forward integration shares some of the characteristics of backward integration (e.g., in both cases integrated firms tend to be older and larger), Tables 8 and 9 show that forward integration is associated with rather different characteristics. Forward integrated mills tend to export to traders (rather than large roasters), export less through advance contracts, and are more strongly associated with differentiated coffee. In addition, several forward integrated mills are farmers cooperative.[49]

Given the differences in the motives for vertical integration, forward integration doesn't display the timing and pricing patterns associated with backward integration. Consistently with the idea that forward integration provides better incentives for the mill to develop marketing channels, (unreported) results show forward integrated mills obtain *higher* prices when selling to outside buyers. While the effect is rather small (approximately 1.5%), the evidence overturns the corresponding figure for backward integrated firms (prediction **P4**).

A starker difference between forward and backward integration is illustrated in Figure 12, which revisits Figure 6. The Figure reports the shares of coffee bought and sold on the market by vertically integrated firms. A unit of observation is a vertically integrated firm in a given season. The vertical axis is the share of coffee bought in the market. The horizontal axis gives the share of coffee sold on the market. In any given season, both forms of integration mostly trade on the axes: they *do not* contemporaneously buy and sell large volumes of coffee on the market. The two form, however, differ in the axis they trade on. Backward integrated firms (red dots) mostly trade on the vertical axis: they very rarely sell outside and instead need to complement internal supply with outside sourcing. This is highly consistent with supply assurance motive, as buyers own capacity only to satisfy the most stable part of their uncertain demand. Forward integrated firms (green dots), in contrast, mostly trade on the horizontal axis: they often do sell outside but are rarely engaged in marketing other mills' produce. Appropriating some of the marketing rents for their produce is likely to be the motive for forward integration.[50]

[49]The cooperative status of the mill perfectly predicts integration: by definition, cooperatives cannot be part of backward integrated chains. Several cooperatives are also part of exporting consortia, a hybrid organizational form loosely related to forward integration.

[50]For example, cooperatives that acquire fair trade certification have strong incentives to own an export license since fair trade rules require *all* actors along the chain to be certified, potentially restricting the number of available buyers.

6.5 Discontinuity at the Firm's Boundaries

The evidence in the previous section showed that relational contracts between firms display contractual patterns (pricing, length of contracts and default) qualitatively similar to those observed within integrated firms. Quantitatively, we noted that only a handful of relationships between firms achieve the same reduction in prices and contract length. We now ask whether trading patterns are discontinuous at the firms boundaries.

Figure 12 also asks whether non-integrated chains characterized by relational contracts behave in the same way. Corresponding figures for long term relationships (blue crosses) are also reported. The blue lines (thin, medium, thick) interpolate the figures for new, young and old relationships. As age of the relationship increase, the blue line moves towards the red line associated with backward integration. The figure, however, also shows that relational contracts between firms *do not* converge to the same trade patterns associated with integration. In particular, relational contracts between firms do not become exclusive: even well established relationships between firms do not trade on the axes.

6.6 Discussion

The results presented have both theory and policy implications. On the theory side, the evidence supports models in which firm boundaries change temptations to renege on relational contracts and, through this channel, matter for resource allocation. The evidence rejects models featuring ex-post (efficient) contracting, such as Grossman-Hart-Moore Property Rights model (and Bolton and Whinston (1992) model of supply assurance, which builds on it). Governance structures shape ex-post adaptation, as in transaction Costs theories (e.g., Williamson (1971, 1975, 1985)) and Baker et al. (2011).[51]

At the same time, the evidence does support the key *methodological* insights of Grossman and Hart (1986), as discussed in, e.g., Tadelis (2016). First, we find evidence of both costs and benefits associated with integration within a unified framework. Second, the evidence makes sense of directional integration, i.e., differences between backward and forward integration. The evidence shows that the two forms of integration behave differently and likely have different purposes.

[51] The evidence on the discontinuity at the firm's boundary suggests a multi-party extension of the Baker et al. (2002, 2006, 2011) framework in which integration with one partner limits the scope of relational contracting with other partners.

Older theories of firm boundaries did not offer microfoundations to distinguish integration from contracts. Among these older theories, the patterns in the data are very consistent with Carlton (1979) model of vertical integration and supply assurance, but reject others (e.g., Arrow (1969) model based on price discovery).

7 Conclusions and Policy Implications

This paper has presented an empirical analysis of vertical integration between buyers and mills in the Costa Rican coffee sector. The analysis has taken advantage of uniquely detailed data on (the terms of) transactions both *between* and *within* firms to compare vertical integration against both relational and non-relational trade between firms. We started documenting evidence consistent with demand uncertainty and supply assurance motives being important considerations in the market under study. We then documented that trade within firms is insulated from these market forces and behaves very differently from non-relational trade between firms (i.e., the "market"). Finally, we compared vertical integration with relational contracts between firms to investigate *why* firms boundaries matter. We distilled and tested for the key insights of the Baker et al. (2002, 2006, 2011) framework. Although relational contracts between firms behave qualitatively like integrated trade, quantitatively they do not achieve the same degree of demand and supply assurance. Finally, we have shown that the logic behind the benefits of integration also implies costs, in particular with respect to forming valuable relationships with independent suppliers. The results support the view that firm boundaries change temptations to renege on relational contracts and, through this channel, matter for resource allocation. In addition, the paper also contributes to our understanding of the two-way relationship between market structure and firms' boundaries - two aspects that the literature has often analyzed separately (see, e.g., Bresnahan and Levin (2012)).

Policy Implications

This work also has policy implications relevant for export-oriented agricultural chains in developing countries. First, to the extent that supply assurance considerations are a motive for integration in this type of chains – a possibility entirely consistent with our evidence – markets tend to generate too much integration relative to the social optimum. This prediction holds true in the Carlton (1979) model, but also in property-rights models such as Hart and Tirole (1990), Bolton and Whinston (1993) and in network models such as Kranton and Minheart (2000). Parties have an incentive

to integrate when demand is volatile, i.e., precisely when ex-post efficiency considerations would require better adaptation in the allocation of scarce upstream capacity to downstream demand. By vertically integrating, exporters force non-integrated mills to face an even more uncertain market demand.

Vertically integrated firms appear to be able to shift profits downstream by paying lower prices. Additional results show that this doesn't translate into lower downstream (F.O.B.) prices at the export gate, presumably since coffee is a globally traded commodity. We conjecture that this negative effect of integration on prices within the domestic chain is larger in environments in which regulations do not protect farmers as in Costa Rica. Taken together, these two mechanisms lend some support to the view that agricultural chains dominated by backward integrated buyers might be detrimental to farmers' welfare and market efficiency (see, e.g., Talbot (1997), Gibbon and Ponte (2005), Daviron and Ponte (2005), Bair (2009)).

A number of policy remedies exist to curtail the negative effects of vertical integration. The most radical example is given by structural policies (e.g., forced divestitures and line of business restrictions).[52] These policies are not uncommon in export-oriented agricultural chains: Ethiopian coffee, Cocoa in Ghana and Cotton in Tanzanian are examples of chains in which regulations have banned vertical integration between processors and exporters altogether. It has been argued that these policies may involve substantial transaction costs of disentangling activities and jeopardize the benefits of integration. The evidence in this paper suggests that relational contracts between firms can partially substitute for integration and likely reduce these costs.[53]

Less intrusive policies allow for integration but include forms of price controls and/or price linkages, like those observed in Costa Rica. The specific aim of ensuring minimum prices to farmers and curb transfer pricing forces the regulation to "pierce the veil" of firm boundaries: minimum pricing rules are enforced both *within* and *between* firms. Similar regulations are observed in other contexts, e.g., the tea sector in Kenya and Rwanda.

A fuller understanding of the effects of vertical integration on market efficiency and farmers welfare, however, requires taking into account additional forces specific to agricultural value chains in developing countries. A tendency towards excessive integration might be balanced by two additional forces: access to credit and excessive entry. First, backward integration might relax mill's credit constraints. Mills have

[52]Famous examples include AT&T divestiture in 1984 and forced vertical separation between breweries and pubs in the U.K. in 1989.

[53]If integration by one firm increases incentives to integrate for other firms (see, e.g., Gibbons et al.(2012)) the benefits of integration bans are possibly amplified.

very high working capital requirements and downstream buyers are often important providers of finance (see, e.g., Blouin and Macchiavello (2013) and Macchiavello and Morjaria (2015)). In environments in which contracts are hard to enforce, buyers might have to acquire control over the mill in order to prevent loan default.[54] The bulk of mill's working capital requirements, however, originates from payments to farmers for the coffee cherries. By guaranteeing payments at the end of the harvest campaign the process of final liquidation implemented in Costa Rica reduces working capital requirements and likely removes this as a motive for integration.

Second, mills entry involves significant fixed costs. Business-stealing effects can then lead to inefficient duplication and excessive entry. Imperfect contract enforcement between farmers and mills can also generate a tendency towards excessive entry (see Macchiavello and Morjaria (2015b) for evidence in the Rwanda market). These concerns have often led to regulations such as zoning requirements and catchment areas in agricultural chains (see, e.g., Mullainathan and Sukhtankar (2014) for an example in sugar). The negative externalities imposed by integrated buyers on independent mills may be socially desirable if they discourage mills entry. The regulation in Costa Rica facilitates contract enforcement between farmers and mills, reestablishes the positive effects of competition, and further curbs social benefits of integration.

Finally, higher margins might give vertically integrated exporters incentives to develop demand in downstream markets. This could be beneficial for the industry as a whole, by pushing prices and contractual conditions towards more favorable terms for farmers. Price risk is likely to be a key deterrent of investments to develop marketing channels directly by producers. Governments have intervened by creating marketing boards (see, e.g., coffee in Colombia). The contract enforcement provided by ICAFE reduces price-risk for mills and producers and likely encourages investment in developing downstream demand through alternative organizational forms. This is consistent with the relative prevalence of forward integration, alliances and consortia in the industry. These alternative organizational forms might achieve higher exporters' margins while curbing the negative externalities associated with backward integration.

A number of exciting avenues for future research remain open. First, a fuller understanding of the effects of the Costa Rica regulations on market efficiency requires a more structural analysis. Second, a favorable political context is needed to implement

[54] Theoretically, the relationship between access to finance and vertical integration is quite subtle (see, e.g., Aghion and Tirole (1994), Legros and Newman (1996) and Macchiavello (2010)). For empirical work see, e.g., Acemoglu et al. (2009), Macchiavello (2012), Breza and Liberman (2014) and Skrastins (2015).

Costa Rica's regulations (see Paige 1997). Countries attempting similar regulations have faced resistance from large exporters. An understanding of the political economy behind optimal regulations also awaits future work.

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A Tables

Table 1: Descriptive statistics

Variable	N. Obs.	Mean	St. Dev.	Min	Max	Int. vs. Non-Int.
Panel A: Sellers Characteristics						
Vertically Integrated	175	0.05	0.21	0.00	1.00	–
Cooperative	175	0.14	0.34	0.00	1.00	–
Age	175	5.93	3.78	1.00	11.00	2.89**
Quantity	175	437.52	1036.60	0.23	7643.15	2572***
Average Price	175	4.48	0.76	2.64	7.07	0.39
Unit Processing Costs	154	128.5	229.84	64.37	815.21	-40.72
Number of Buyers	175	3.35	2.57	1.00	16.00	-1.94**
Herfindhal Index of Buyers	175	0.65	0.27	0.15	1.00	0.17**
% Sold to Integrated Buyers	175	0.12	0.29	0.00	1.00	0.92***
% Exported	175	0.76	0.27	0.00	1.00	0.15*
Panel B: Buyers Characteristics						
Vertically Integrated	149	0.05	0.21	0.00	1.00	–
Consorcio of Exporters	149	0.01	0.12	0.00	1.00	–
Age	149	6.23	4.01	1.00	11.00	4,25***
Quantity	149	513.86	2143.58	0.18	21889.74	6045,27***
Average price (weighted)	149	4.04	1.09	1.81	7.07	0,99**
Number of Suppliers	149	3.89	8.28	1.00	60.00	23,50***
Herfindal Index of Suppliers	149	0.70	0.40	0.00	1.00	-0.58***
% Bought from Integrated Seller	149	0.02	0.11	0.00	1.00	0.36***
% Exported	149	0.39	0.46	0.00	1.00	0.45***
Panel C: Relationships Characteristics						
Vertical Integrated Buyer	394	0.38	0.49	0.00	1.00	
Vertical Integrated Seller	394	0.00	0.05	0.00	1.00	
Relationship age (in years)	394	2.52	3.01	0.00	10.00	
Quantity	392	99.25	238.82	0.044	1967.397	
Price	392	4.42	1.13	1.79	9.30	
Share Exported	392	0.66	0.44	0.00	1.00	
Number of Products	394	1.21	0.57	1.00	5.00	
Panel D: Contract Characteristics						
National market	2967	0.21	0.41	0.00	1.00	
Vertically Integrated Relationship	2967	0.14	0.35	0.00	1.00	
Vertical Integrated Buyer	2967	0.49	0.50	0.00	1.00	
Vertical Integrated Seller	2967	0.14	0.35	0.00	1.00	
Quantity	2967	25805.74	31760.07	31.44	189750.00	
Leadtime	2967	108.4	136.36	0.00	907.00	

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 1 provides summary statistics for the 2011/12 harvest campaign for standard (convencional) coffee. Panel A refers to mills. Vertical Integrated is a dummy =1 if the mill is owned by an exporter/roaster. Cooperative is a dummy =1 if the mill is owned by a cooperative. Age (censored) is the number of harvest campaigns the mill operates in our dataset. Quantity is in 000 of tons of convencional parchment coffee. Price is a weighted average price for a Kg of coffee, in dollars. Unit processing costs refers to audit processing costs per fanega - 258 Kg of beans. % Sold to Integrated Buyers refers to backward integrated buyers only. The last column reports unconditional mean differences in the relevant variable between integrated mills and non-integrated ones. Panel B refers to buyers (exporters and domestic rosters). Variables are similarly defined. The last column reports unconditional mean differences in the relevant variable between integrated and non-integrated buyers. Panel C presents the summary statistics for non-integrated active relationships (mill buyer pairs). Number of products refers to the number of product specifications (quality, type, preparation) transacted. Panel D presents the summary statistics for contracts. Leadtime is defined as the difference in days between contract signature and delivery.

Table 2: External Trade of Integrated Firms

	[1]	[2]	[3]	[4]	[5]	[6]
Dependent Variable:	Advance contracting, days			Unit Price (ln)		
Buyers:	Integrated					
Mills:	All					
Integrated	-28.02***	-13.44***	-14.83***	-0.0732***	-0.0289***	-0.0163*
	(5.734)	(4.102)	(4.732)	(0.0170)	(0.00881)	(0.00926)
Contract Volume (Polynom.)	yes	yes	yes	yes	yes	yes
Region X Season FE	yes	yes	yes	yes	yes	yes
Month sale X Region	yes	yes	yes	yes	yes	yes
Date FE	no	Delivery	Delivery	no	Contract	Contract
Product FE	no	yes	yes	no	yes	yes
Mill Controls	no	no	yes	no	no	yes
Buyer FE	yes	yes	yes	yes	yes	yes
Observations	11,685	11,685	11,685	11,685	11,685	11,685
R-squared	0.202	0.726	0.726	0.842	0.960	0.961

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 2 focuses on vertically integrated buyers and compares the timing and pricing of their contracts through internal and market sourcing. In all columns OLS are estimated, a contract between a mill and a buyer is an observation. In columns [1], [2] and [3] leadtime (defined as the difference between the date of delivery and the signing date) is the dependent variable. In columns [4], [5] and [6] the log of price per Kilo is the dependent variable. Integrated, then, is a dummy=1 if the contract is with a mill owned by the buyer. Contract volume includes a third-degree polynomial in Kilos of coffee on the contract. Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Contract dates fixed effects are dummies for the date in which the contract is signed, and Delivery dates fixed effects are dummies for the date in which the coffee in the contract is delivered. Season fixed effects refer to the harvest campaign. Region fixed effects refer to the region where the mill is located. The sample period covers the harvest campaigns from 2001/02 to 2011/12. Buyers fixed effects are dummies for buyer. Mill controls include: Unit costs (audited processing costs for the mill for the corresponding type of coffee in the harvest campaign), type of mill and size. Standard errors are clustered at the relationship level.

Table 3: Contract timing - Relationship age and integration

	[1]	[2]	[3]	[4]
Dependent Variable:	**Advance contracting, days**			
Sample:	Between Firms	Between Firms	Between & Within	Within Firms
Buyers:	Non-Integrated	Integrated	Integrated	Integrated
Mills:	Independent	Independent	All	Integrated
Age of the Relationship	-25.11***	-9.485**		-1.733
	(3.787)	(3.954)		(2.903)
Vertical Integration			-17.98***	
			(5.423)	
Contract Volume (Polynom.)	yes	yes	yes	yes
Product FE	yes	yes	yes	yes
Market Conditions	Contract	Contract	Contract	Contract
Date FE	Delivery	Delivery	Delivery	Delivery
Time Varying Mill Controls	yes	yes	yes	yes
Region X Season FE	yes	yes	yes	yes
Month sale X Region	yes	yes	yes	yes
Buyer FE	–	–	yes	yes
Relationship FE	yes	yes	no	no
Observations	10,668	7,612	11,274	3,662
R-squared	0.275	0.225	0.135	0.188

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 3 compares relationships with independent mills between integrated and non-integrated buyers. In all columns OLS are estimated and a contract between a mill and a buyer is an observation. The dependent variable is the leadtime (defined as the difference between the date of delivery and the signing date). Age of the relationship is measured in number of past contracts (in 00) between the mill and the buyer. Vertical Integration is a dummy=1 if trade occurs within an integrated firm. Controls include contract volume (third-degree polynomial in Kilos of coffee on the contract). Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Season fixed effects refer to the harvest campaign. Region fixed effects refer to the region where the mill is located. Relationships FE are dummies for buyer-mills pair that have ever traded. Market conditions at contract date include the NYC price on that date, the expected price increase, the number of contracts registered in that date, and the average and standard deviation of prices registered. Sample restrictions exclude trade within forward integrated relationships. Standard errors are clustered at the relationship level.

Table 4: Contract pricing - Relationship age and integration

	[1]	[2]	[3]	[4]
Dependent Variable:		**Unit price (ln)**		
Sample:	Between Firms	Between Firms	Between & Within	Within Firms
Buyers:	Non-Integrated	Integrated	Integrated	Integrated
Mills:	Independent	Independent	All	Integrated
Age of the Relationship	-0.0229***	0.00496		-0.00583
	(0.00691)	(0.00627)		(0.00418)
Vertical Integration			-0.0146*	
			(0.00777)	
Contract Volume (Polynom.)	yes	yes	yes	yes
Product FE	yes	yes	yes	yes
Market Conditions	Contract	Contract	Contract	Contract
Time Varying Mill Controls	yes	yes	yes	yes
Region X Season FE	yes	yes	yes	yes
Month sale X Region	yes	yes	yes	yes
Buyer FE	–	–	yes	yes
Relationship FE	yes	yes	no	no
Observations	10,668	7,612	11,274	3,662
R-squared	0.932	0.947	0.936	0.949

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 4 compares relationships with independent mills between integrated and non-integrated buyers. In all columns OLS are estimated and a contract between a mill and a buyer is an observation. The dependent variable is the log of price per Kilo. Age of the relationship is measured in number of past contracts (in 00) between the mill and the buyer. Vertical Integration is a dummy=1 if trade occurs within an integrated firm. Controls include contract volume (third-degree polynomial in Kilos of coffee on the contract). Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Season fixed effects refer to the harvest campaign. Region fixed effects refer to the region where the mill is located. Relationships FE are dummies for buyer-mill pairs that have ever traded. Market conditions at contract date include the NYC price on that date, the expected price increase, the number of contracts registered in that date, and the average and standard deviation of prices registered. Sample restrictions exclude trade within forward integrated relationships. Standard errors are clustered at the relationship level.

Table 5: Forward sale contracts and Strategic Default

	[1]	[2]	[3]	[4]	[5]	[6]
Dependent Variable:	**Contract Cancellation (=1)**					
Sample:	Between Firms					
Price Surprise (+ if split =1)	0.0260**	0.0343**	0.0410**	0.0361*	0.0371*	0.0409**
	(0.0106)	(0.0144)	(0.0189)	(0.0198)	(0.0198)	(0.0196)
Negative Price Surprise		0.00928	0.0112	0.0115	0.0132	0.0146
		(0.0123)	(0.0163)	(0.0171)	(0.0172)	(0.0176)
Relationship Age					-0.00469**	-0.00169
					(0.00201)	(0.00204)
Relationship Age X (+) Price Surprise						-0.0514***
						(0.0176)
Date FE	no	no	Contract	Contract	Contract	Contract
Contract Volume (Polynom.)	no	no	no	yes	yes	yes
Product FE	no	no	no	yes	yes	yes
Season FE X Region FE	no	no	no	yes	yes	yes
Month sale X Region FE	no	no	no	yes	yes	yes
Price surprise X Mill controls	no	no	no	yes	yes	yes
Relationships FE	yes	yes	yes	yes	yes	yes
Price Surprise Split	no	yes	yes	yes	yes	yes
Observations	14,904	14,904	14,904	14,904	14,904	14,904
R-squared	0.192	0.192	0.170	0.181	0.182	0.183

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 5 provides evidence that forward sale contracts are vulnerable to strategic default. Forward sale contracts are defined as those signed at least one month prior to delivery. Alternative definitions yield identical results. 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. Only forward sales contracts (leadtime > 1 month) are considered. 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. Product FE are a set of (111) dummies for product types (preparation, quality and bean grading). Season fixed effects refer to the harvest campaign. Region fixed effects refer to the region where the mill is located. Mill controls include mill size. Relationships fixed effects are dummies for buyer-mills pair that have ever traded. The sample period covers the harvest campaigns from 2004/05 to 2012/13. Sample restrictions exclude trade within forward integrated chains. Standard errors are clustered at the relationship level.

Table 6: Strategic default and relationships

	[1]	[2]	[3]	[4]
Dependent Variable:	**Contract Cancellation (=1)**			
Sample:	Between Firms	Between Firms		Between & Within
Buyers:	Non-Integrated	Integrated		Integrated
Mills:	Independent	Independent		All
Positive Price Surprise	0.0361	0.0790**	0.0770**	0.0872***
	(0.0327)	(0.0327)	(0.0324)	(0.0305)
Relationship Age	-0.000610		0.00737	
	(0.00223)		(0.0100)	
Relationship Age X (+) Price Surprise	-0.0348**		-0.0360***	
	(0.0177)		(0.0129)	
Integrated Trade X (+) Price Surprise				-0.0577*
				(0.0360)
Date FE	Contract	Contract	Contract	Contract
Contract Volume (Polynom.)	yes	yes	yes	yes
Product FE	yes	yes	yes	yes
Season FE X Region FE	yes	yes	yes	yes
Month sale X Region	yes	yes	yes	yes
P. Surprise X Mill Controls	yes	yes	yes	yes
Relationships FE	yes	yes	yes	yes
Price Surprise Split	yes	yes	yes	yes
Observations	7,512	6,136	6,136	8,278
R-squared	0.136	0.179	0.181	0.397

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 6 shows that relational contracting mitigates opportunism. Only forward sales contracts are considered. Forward sale contracts are defined as those signed at least one month prior to delivery. Alternative definitions yield identical results. 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. Age of the relationship is measured in number of past contracts (in 00) between the mill and the buyer. Integrated trade is a dummy=1 if trade occurs within an integrated firm. Product FE are a set of (111) dummies for product types (preparation, quality and bean grading). Season fixed effects refer to the harvest campaign. Region fixed effects refer to the region where the mill is located. Relationships fixed effects are dummies for buyer-mill pairs that have ever traded. Controls interacted with price surprise include mill level controls (size). The sample period covers the harvest campaigns from 2004/05 to 2012/13. Sample restrictions exclude trade within forward integrated chains. Standard errors are clustered at the relationship level.

Table 7: External Trade of Integrated Firms

	[1]	[2]	[3]	[4]
Dependent Variable:	Unit Price (ln)			
Buyers:	Non-Integrated			
Mills:	All			
Integrated	-0.167***	-0.125***	-0.129***	-0.135***
	(0.0478)	(0.0328)	(0.0324)	(0.0328)
Contract Volume (Polynom.)	yes	yes	yes	yes
Date FE	no	Contract	Contract	Contract
Product FE	no	yes	yes	yes
Contract Controls	no	no	yes	yes
Season X Region FE	yes	yes	yes	yes
Month sale X Region	yes	yes	yes	yes
Mill Controls	no	no	no	yes
Buyer FE	yes	yes	yes	yes
Observations	12,431	12,431	12,431	12,375
R-squared	0.846	0.943	0.944	0.944

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 7 focuses on contracts between buyers and mills that are not integrated with each other. It compares the price obtained in the market by integrated and non-integrated mills. Integrated, then, is a dummy=1 if the mill is owned by a buyer. In all columns OLS are estimated, a contract between a mill and a buyer is an observation and the log of price per Kilo is the dependent variable. Contract volume includes a third-degree polynomial in Kilos of coffee on the contract. Contract controls include age of the relationship (number of past contracts) and advance time (difference between delivery and contract date). Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Contract date fixed effects are dummies for the date in which the contract is signed. Season fixed effects refer to the harvest campaign. Region fixed effects refer to the region where the mill is located. The sample period covers the harvest campaigns from 2001/02 to 2011/12. Buyers fixed effects are dummies for buyer. Mill controls include: Unit costs (audited processing costs for the mill for the corresponding type of coffee in the harvest campaign), type of mill and size. Sample restrictions exclude trade within forward integrated chains. Standard errors are clustered at the relationship level.

Table 8: Forward and Backward Integrated Chains (Mills)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
						Mills				
Dep. Variable:	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Forward Integration	Backward Integration	Cooperative
Model:	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Multinomial Logit		Logit
Size	2.583***						2.153*	9.139***	12.67***	1.426
	(0.785)						(0.913)	(6.057)	(8.352)	(0.312)
% Differentiated		1.462					1.453	2.225***	2.045*	1.470
		(0.400)					(0.533)	(0.552)	(0.793)	(0.361)
Suitability			18.31***				179.1***	3.687*	777.6***	0.450**
			(15.11)				(340.1)	(2.605)	(1,903).	(0.175)
Variability				0.944			0.117**	0.742	0.0496***	1.420
				(0.353)			(0.126)	(0.470)	(0.0563)	(0.854)
Distance to Port					0.718		0.125**	1.887	0.191	0.539
					(0.254)		(0.132)	(0.974)	(0.212)	(0.205)
Age						2.567*	1.205	2.196	1.501	3.779***
						(1.409)	(0.702)	(1.190)	(0.879)	(1.778)
Region FE	No	No	No	No	No	No	Yes	Yes		Yes
Observations	175	175	175	175	175	175	175	175	175	175
Pseudo R2	0.299	0.0252	0.158	0.000467	0.00870	0.0801	0.492	0.508	0.508	0.276

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 8 reports results from a logit model on the backward integration of a mill, and a multinomial logit model in which the integration status of a mill (backward integrated = owned by an exporter, forward integrated = with export license, and non-integrated) is predicted based on mills characteristics. All independent variables are standardized. Odd ratios are reported. A coefficient > 1 (respectively < 1) implies the corresponding independent variable is positively (respectively negatively) associated with the corresponding definition of integration. Size measures the volume of coffee processed by the mills for the 2011/12 harvest campaign. Age is the number of harvest campaigns the mill is observed in the data before the 2011/12 harvest campaign. Share differentiated is the share of differentiated coffee processed by the mill. Cooperative is a dummy = 1 if the mill is a cooperative. 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. The Table shows that backward and forward integration have different characteristics. Backward integration is mostly associated with size and good but uncertain growing conditions. Forward integration is associated with product differentiation, good and stable growing conditions.

Table 9: Forward and Backward Integrated Chains (Buyers)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Exporter									
Dep. Variable:	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Backward Integration	Forward Integration	Backward Integration
Model:	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Logit	Multinomial Logit	
Size	2.560***							2.152*	0.947	2.260
	(0.598)							(0.934)	(0.460)	(1.169)
FOB price		0.338						0.218	0.864	0.227
		(0.245)						(0.262)	(0.229)	(0.293)
Age			2.138***					2.122*	2.997***	3.520**
			(0.618)					(0.852)	(0.766)	(1.821)
% Exported				0.323				0.107***	0.754	0.107***
				(0.229)				(0.0772)	(0.272)	(0.0792)
% Traders					1.019			0.00665	7.291**	0.0245
					(0.709)			(0.0280)	(6.396)	(0.0979)
% Advance						2.992***		4.908**	1.231	4.798**
						(0.954)		(3.844)	(0.373)	(3.617)
% Harvest							0.907	0.0380***	0.695	0.0270***
							(0.199)	(0.0397)	(0.270)	(0.0320)
Observations	97	97	97	97	97	97	97	97	97	97
Pseudo R2	0.318	0.0311	0.132	0.101	6.13e-06	0.125	0.000980	0.570	0.399	0.399

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 9 reports results from a logit model on the backward integration of an exporter, and a multinomial logit model in which the integration status of an exporter (backward integrated = owns mills, forward integrated = export license owned by a mill, and non-integrated) is predicted based on buyer characteristics. All independent variables are standardized. Odd ratios are reported. A coefficient > 1 (respectively < 1) implies the corresponding independent variable is positively (respectively negatively) associated with the corresponding definition of integration. Size measures the volume of coffee exported for the 2011/12 harvest campaign. Average FOB prices refer to exports for the 2011/12 harvest campaign. Age is the number of harvest campaign the exporter is observed in the data before the 2011/12 harvest campaign. % to Traders is the share sold to large traders. Traders are defined large if they are among the 100 largest foreign buyers sourcing from Costa Rica. Advance contracts measures whether the exporter contracts with foreign buyers in advance (a weighted average of the order of export sale and order of export contract signing). % sold at Harvest is the share of coffee exported before the harvest season is concluded. The export data covers the seasons from 2008/09 to 2011/12 inclusive. The Table shows that backward and forward integration have different characteristics. Backward integration is mostly associated with size, concentration in downstream markets, advance contracts and rapid delivery to Roasters. Forward integration is associated with age of the firm in the market and sales to intermediaries.

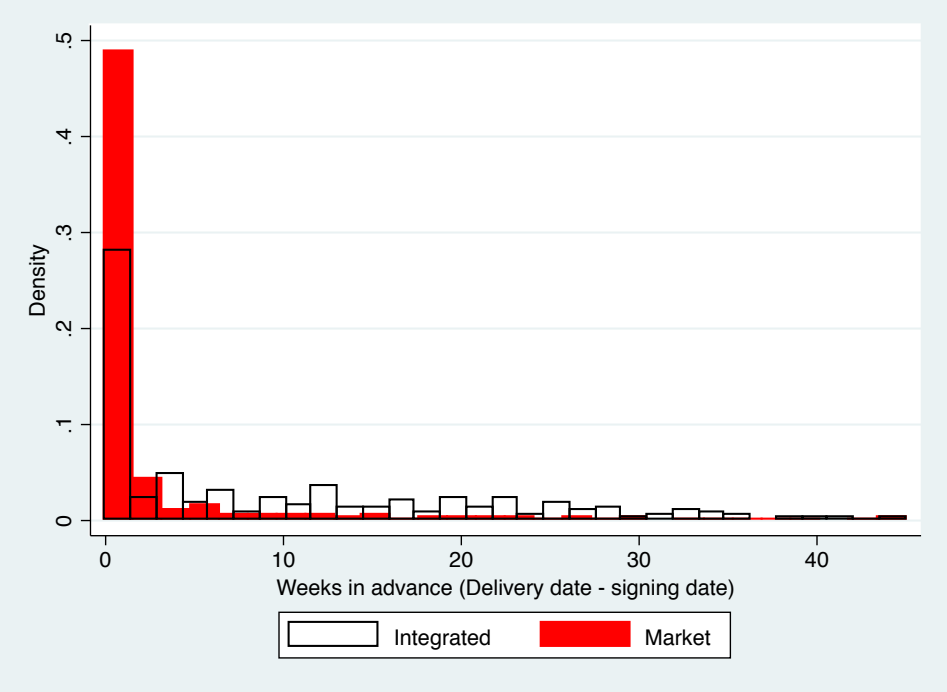
Table 10: Robustness - Time Varying Buyers Effects

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Dep. Variable:	Price (ln)	Advance Contracting	Price (ln)	Advance Contracting	Price (ln)	Advance Contracting	Contract Cancellation	Contract Cancellation
Corresponding [Table].[Column]	[2].[3]	[2].[6]	[4].[1]	[3].[1]	[4].[2]	[3].[2]	[6].[1]	[6].[2]
Integrated Trade	-0.0200***	.-14.702***						
	(0.0091)	.(4.690)						
Relationship Age			0 .004396	.-18.4912***	.-0.0060	.-6.995*	0.0432*	.-0.00545**
			(0.0097)	-5,375	(0.0051)	-4,081	(0.02708)	(0.0026)
Positive Price Surprise							0.04688	.0.0781***
							(0.03324)	(0.03165)
Relationship Age X							.-0.0267	.-0.04845**
(+) P. Surprise							(0.01702)	(0.01916)
Buyer Season FE	yes	yes	yes	yes	yes	yes	yes	yes
Buyer Seasonality FE	yes	yes	yes	yes	yes	yes	yes	yes
Buyer Controls X Price Surprises	–	–	–	–	–	–	yes	yes

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

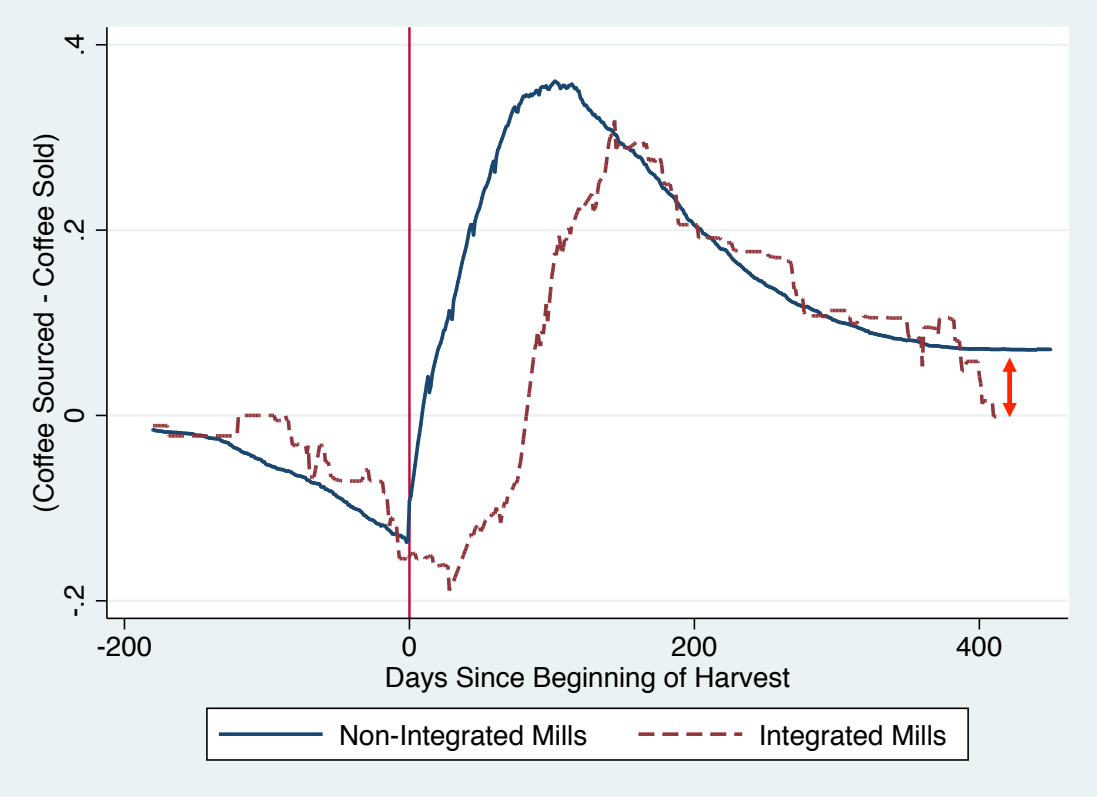
B Figures

Figure 3: Forward Sale Contracts



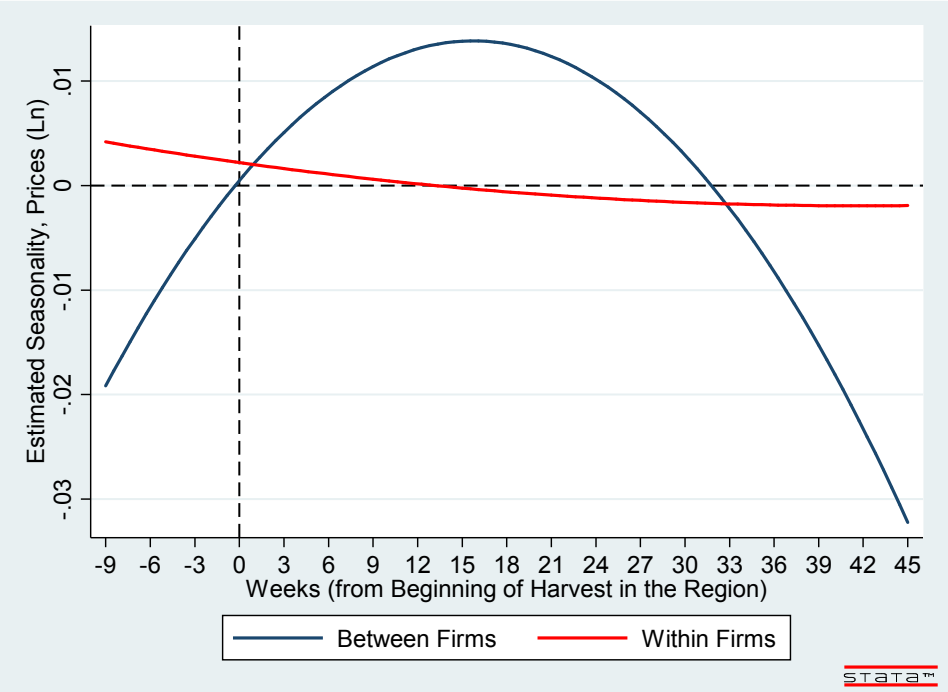
The Figure describes the distribution of forward sale contracts in the sample. The horizontal axis reports the number of weeks of advance between the date at which the contract is signed and the date at which delivery is supposed to happen. Almost 40% of the contracts signed are pure spot, i.e. delivery is due within a week of the date at which the contract is signed. Approximately 50% of the contracts signed, however, have an advance period longer than a month and a non-negligible share of contracts is signed for up to a year in advance. The sample period includes harvest campaigns 2005/06 to 2011/12.

Figure 4: Inventory risk



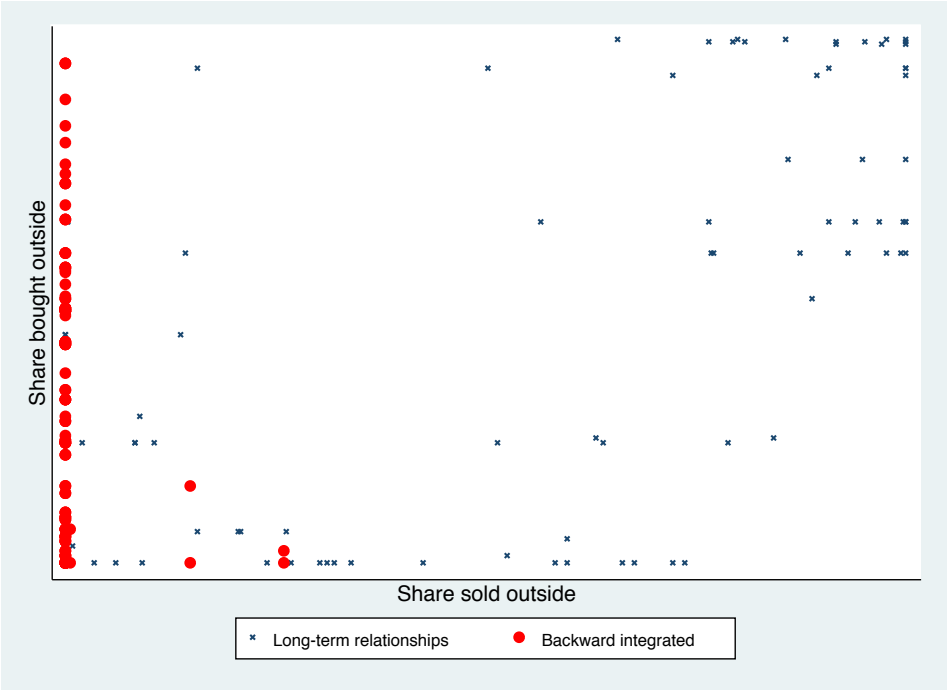
The Figure reports the evolution of sales and sourcing during the harvest season for mills belonging to backward integrated chains and non-integrated mills. The time is measured relative to the beginning of the harvest season in the region and average figures for all seasons available are reported. The vertical axis plots the difference between coffee sourced and coffee sold as a share of the coffee eventually sourced in that season. Non-integrated mills (blue solid line) start signing forward contracts before the beginning of the harvest campaign. As soon as harvest begins, however, the speed at which they source coffee is faster than the speed at which they sign sales contracts. Eventually, one year after the beginning of the harvest season, non-integrated mills are left with 5-7% unsold coffee. In contrast, integrated mills sign fewer contracts before harvest begins, the timing of sale contracts is more evenly spread out and as a result exposure (defined as coffee in stock relative to sold coffee) is always smaller. Eventually, integrated mills sell all coffee.

Figure 5: Market Assurance



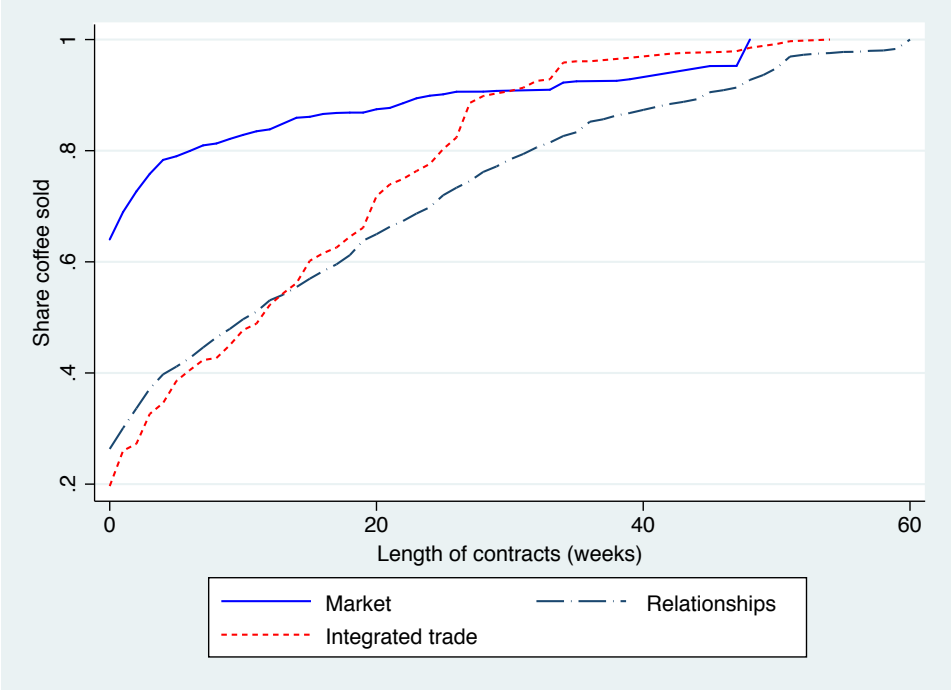
The Figure describes differential seasonality patterns in unit prices. The (harvest) season is divided into weeks, with week zero representing the first week in which mills start receiving coffee cherries in the region. For each week in the season (from one approximately two months before the beginning of the season until approximately one year after the beginning of the season) we estimate week dummies on unit prices (logs). The regression also controls for week fixed effects, product fixed effects and buyer-seller pairs fixed effects. Identification is therefore obtained from across regions variation in harvesting time. The Figure shows that, when considering trade between firms, mills receive lower prices from contracts early in the season and when they need to sell at later stages in the season, but that this patters is not observed in the trade within firms.

Figure 6: Supply Assurance



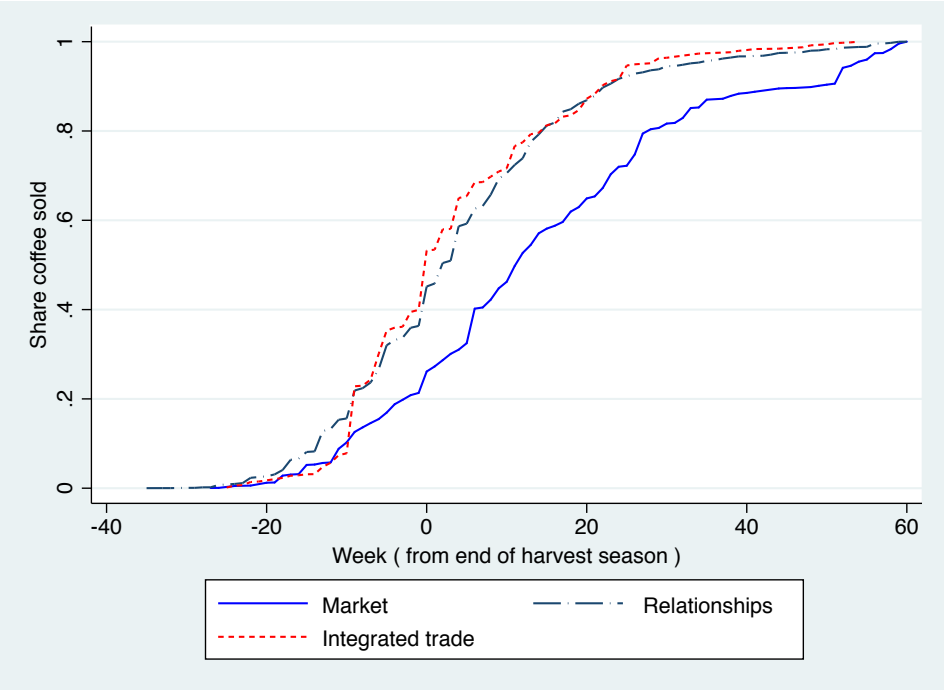
The Figure reports the shares of coffee bought and sold on the market by vertically integrated firms. A unit of observation is a vertically integrated firm in a given season. The vertical axis is the share of coffee bought in the market. The horizontal access gives the share of coffee sold on the market. If supply assurance considerations are important motives for integration, firms should only be on either the y-axis (they purchase in the market coffee only when their demand exceeds their production capacity) or on the x-axis (they sell in the market production in excess of their demand). As it can be seen, backward integrated firms (red dots) behave very consistently with supply assurance. Corresponding figures for long term relationships (blue crosses) are also reported.

Figure 9: Use of Forward Contracts: Market, Relationships and Firms



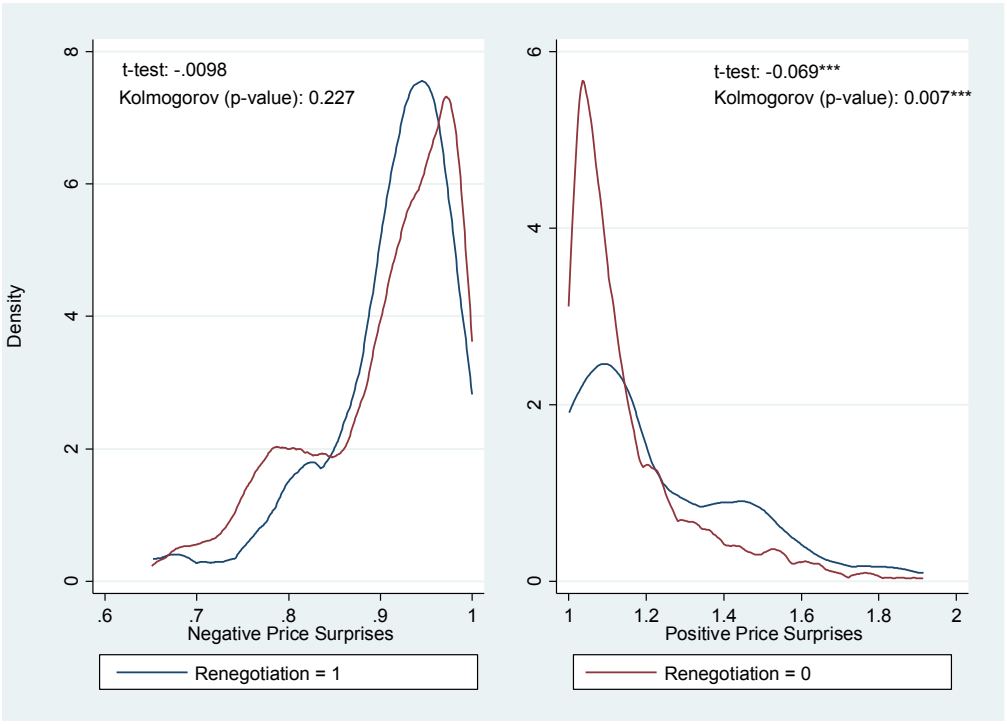
The Figure reports the cumulative share of coffee sold by length of contract, measured in weeks. The length of the contract is defined as the difference between the date in which the contract is signed and the date at which the coffee is supposed to be delivered. Contracts of length zero are spot contracts. Longer contracts are forward contracts. The figure shows that 60% of coffee exchanged between firms that do not have long-term relationships with each other is spot. In contrast, within firms and within long-term relationships more than one year of trade - the share of coffee sold spot is only 20%. Long-term relationships and trade within firms behave very similarly, with long-term relationships using even more forward contracting. Figure constructed with data from seasons 2008/9 to 2011/12. Figure excludes trade inside forward integrated relationships.

Figure 10: Timing of Delivery: Markets, Relationships, Firms



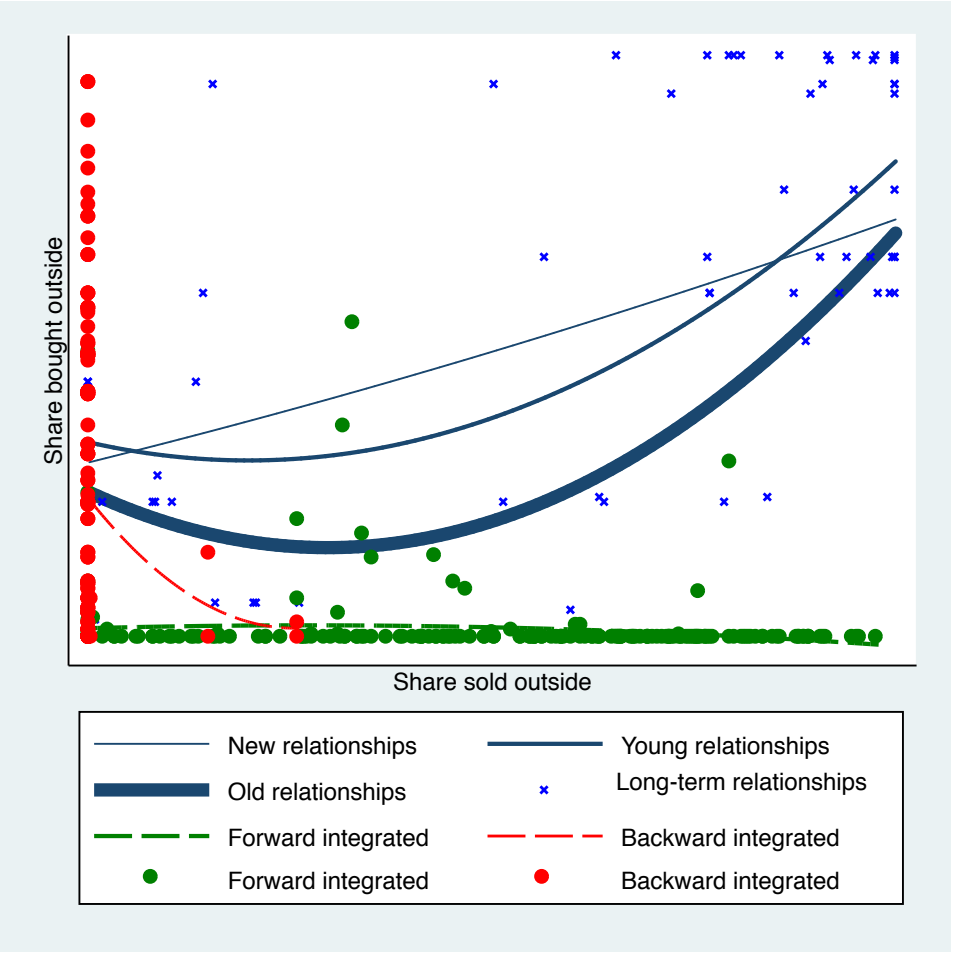
The Figure reports the cumulative share of coffee sold by delivery date, measured in weeks from the end of the harvest campaign in the region. The figure shows that only 20% of coffee exchanged between firms that do not have long-term relationships (blue solid line) with each other is delivered before the end of the harvest campaign. In contrast, within firms (red dashed) and within long-term relationships more than one season of trade - (blue dashed), coffee is continuously delivered as it is received and processed by the mill. Long-term relationships and trade within firms behave very similarly. Figure constructed with data from seasons 2008/9 to 2011/12. Figure excludes trade inside forward integrated relationships.

Figure 11: Price Surprises and Renegotiation



The Figure tests for the relationship between fixed-price contract renegotiation and price surprises, focusing on conventional coffee for which international prices are most relevant. Price surprise is defined as the ratio between the international market price at the date of delivery and the international future market price for the date of delivery at the time the contract was stipulated (i.e., registered with the National Coffee Board). A ratio below one implies a negative price surprise (which gives buyers incentives to renegotiate); while a ratio above one implies a positive price surprise (which gives sellers incentives to renegotiate). The left panel considers negative price surprises. Consistent with the fact that the board enforces contracts, there is no statistical difference in the distribution of negative price surprises for contracts that are and are not renegotiated. Sellers, however, can potentially claim not having the exact coffee type stipulated in the contract and can, therefore, opportunistically attempt to renegotiate prices. The right panel shows that positive price surprises are disproportionately associated with contract renegotiation.

Figure 12: Boundaries of the firm



The Figure reports the shares of coffee bought and sold on the market by vertically integrated firms. A unit of observation is a vertically integrated firm in a given season. The vertical axis is the share of coffee bought in the market. The horizontal access gives the share of coffee sold on the market. If supply assurance considerations are important motives for integration, firms should only be on either the y-axis (they purchase in the market coffee only when their demand exceeds their production capacity) or on the x-axis (they sell in the market production in excess of their demand). As it can be seen, backward integrated firms (red dots) behave very consistently with supply assurance. Forward integrated firms (green dots), in contrast, often do sell on the market even when engaging in selling coffee purchased on the market. Appropriating some of the marketing rents downstream is likely to be a motive for forward integration. Corresponding figures for long-term relationships main trader, relationships lasting longer than 8 years - (blue crosses) are also reported. The blue lines (thin, medium, thick) report the interpolated figure for new zero to 4 years -, young 5 to 8 years - and old more than 8 years - relationships. Although as age of the relationship increase the blue line moves towards the red line associated with backward integration, the figure shows that long-term relationships do not converge to the trade patterns associated with integration.

C Appendix Tables

Table A1: 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 A2: Active mills and exporters per season selling conventional coffee

	Mills	Exporters	Total production (in 46Kg. Bags)	Share exported
2001-2002	93	111		
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.

Table A3: Characteristics of Forward Sale Contracts, Partial Correlations

	[1]	[2]	[3]	[4]
Dependent Variable:	Leadtime (standarized)			
Contract Volume (standarized)	0.130***	0.0975***	0.0781***	0.0821***
	(0.0199)	(0.0179)	(0.0141)	(0.0150)
Price per Kg (standarized)	-0.101***	-0.261***	-0.164***	-0.137***
	(0.0330)	(0.0371)	(0.0362)	(0.0358)
Season FE	yes	yes	yes	yes
Product FE	no	yes	yes	yes
Date FE	no	no	Contract	Contract
Buyer & Mill FE	no	no	no	yes
Observations	12.628	12.628	12.628	12.628
R-squared	0.033	0.121	0.371	0.444

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table A3 shows that leadtime (defined as the difference between the date of delivery and the signing date) negatively correlates with unit prices and positively correlates with contract volumes. In all columns OLS are estimated and a contract between a mill and a buyer is an observation. The variables leadtime, contract volumes and unit prices are all standardized. Product FE is a set of (187) dummies for product types (preparation, quality and bean grading). Season fixed effects refer to the harvest campaign. The sample period covers the harvest campaigns from 2006/07 to 2011/12. Standard errors are clustered at the relationship level. Sample restrictions exclude trade inside (forward and backward) integrated relationships.

Table A4: Supply Assurance and Relationships: Robustness

	[1]	[2]	[3]	[4]	[5]	[6]
Dependent Variable:	Advance contracting, Days					
Robustness:	Baseline	Diff. Age Measure	Re-weighting	No-selection (first year)	No-selection (first 3 years)	Initial Selection (first year)
Relationship Age	-24.46***	-18.33***	-27.38***	-29.09***	-43.61***	-2.595
	(3.719)	(3.312)	(4.096)	(10.21)	(8.728)	(5.468)
Contract Volume (Polynom.)	yes	yes	yes	yes	yes	yes
Product FE	yes	yes	yes	yes	yes	yes
Date FE	Contract	Contract	Contract	Contract	Contract	Contract
Time Varying Mill Controls	yes	yes	yes	yes	yes	yes
Buyer FE	–	–	–	–	–	yes
Relationship FE	yes	yes	yes	yes	yes	–
Sample of Buyers	Non-Integ.	Non-Integ.	Non-Integ.	Non-Integ.	Non-Integ.	Non-Integ.
Observations	10,668	10,668	10,668	2,148	3,429	2,606
R-squared	0.237	0.234	0.407	0.516	0.263	0.447

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table A7 presents robustness tests on Table 4 for non-integrated buyers. In all columns OLS are estimated and a contract between a mill and a buyer is an observation. The dependent variable is the advance time (difference between the date the contract is signed and the delivery is due). In Column 1, age of the relationship is measured in number of past contracts (in 00) between the mill and the buyer – the baseline specification (Column 1 in Table 4). Column 2 measures age of the relationship as calendar time. Column 3 re-weights observations by the inverse of the total number of contracts observed in the relationship. Columns 4 and 5 only estimate age effects on the first (three) season of relationships that survived their first (three) season. Column 6 explores age effects across the three different organizational forms using the entire sample. Controls include contract volume (third-degree polynomial in Kilos of coffee on the contract). Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Market conditions at contract date include the NYC price on that date, the expected price increase, the number of contracts registered in that date, and the average and standard deviation of prices registered. Relationships FE are dummies for buyer-mill pairs that have ever traded. Sample restrictions exclude trade within forward integrated chains. Standard errors are clustered at the relationship level.

Table A5: Supply Assurance and Relationships - Robustness

	[1]	[2]	[3]	[4]	[5]	[6]
Dependent Variable:	Unit Price (ln)					
Robustness:	Baseline	Diff. Age Measure	Re-weighting	No-selection (first year)	No-selection (first 3 years)	Initial Selection (first year)
Relationship Age	-0.0219***	-0.0188***	-0.0587***	-0.124	-0.0826***	-0.00969
	(0.00694)	(0.00698)	(0.0118)	(0.167)	(0.0297)	(0.00891)
Contract Volume (Polynom.)	yes	yes	yes	yes	yes	yes
Product FE	yes	yes	yes	yes	yes	yes
Date FE	Contract	Contract	Contract	Contract	Contract	Contract
Time Varying Mill Controls	yes	yes	yes	yes	yes	yes
Buyer FE	–	–	–	–	–	yes
Relationship FE	yes	yes	yes	yes	yes	–
Sample of Buyers	Non-Integ.	Non-Integ.	Non-Integ.	Non-Integ.	Non-Integ.	Non-Integ.
Observations	10,668	10,668	10,668	2,148	3,429	2,606
R-squared	0.930	0.930	0.952	0.952	0.934	0.933

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table A6 presents robustness tests on Table 3 for non-integrated buyers. In all columns OLS are estimated and a contract between a mill and a buyer is an observation. The dependent variable is the log of price per Kilo. In Column 1, age of the relationship is measured in number of past contracts (in 00) between the mill and the buyer − the baseline specification (Column 1 in Table 3). Column 2 measures age of the relationship as calendar time. Column 3 re-weights observations by the inverse of the total number of contracts observed in the relationship. Columns 4 and 5 only estimate age effects on the first (three) season of relationships that survived their first (three) season. Column 6 explores age effects across the three different organizational forms using the entire sample. Controls include contract volume (third-degree polynomial in Kilos of coffee on the contract). Market conditions at contract date include the NYC price on that date, the expected price increase, the number of contracts registered in that date, and the average and standard deviation of prices registered. Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Relationships FE are dummies for buyer-mill pairs that have ever traded. Sample restrictions exclude trade within forward integrated chains. Standard errors are clustered at the relationship level.

Table A6: Consequences of Default

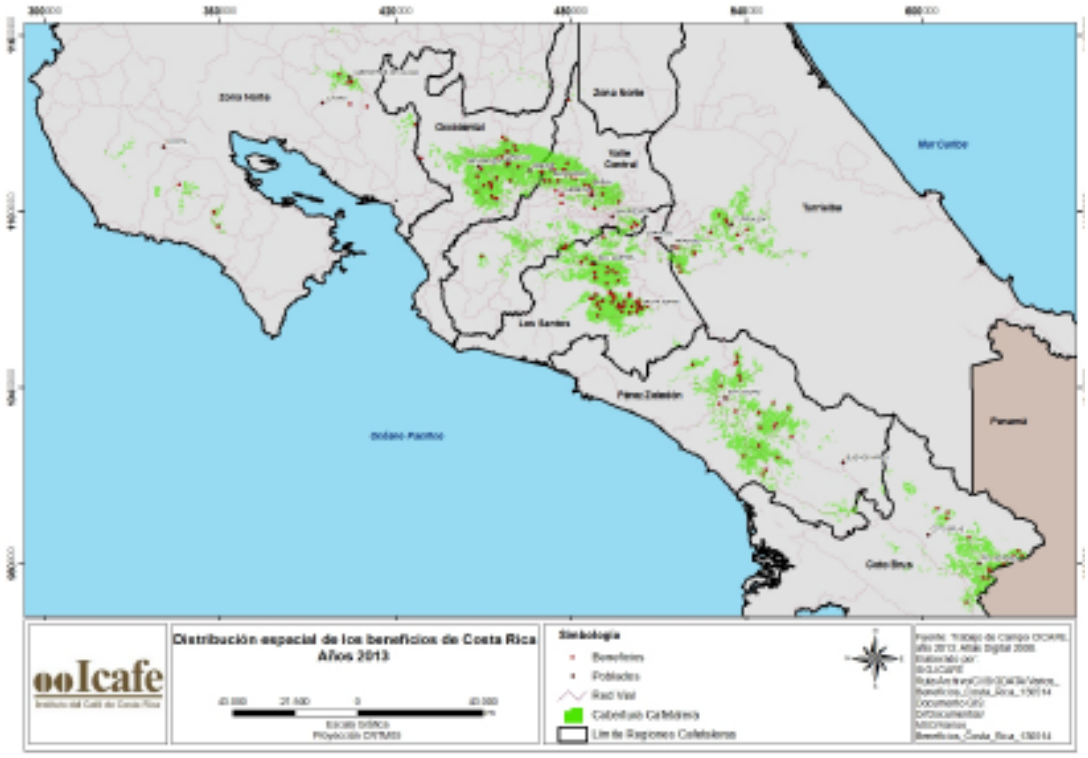
	[1]	[2]	[3]	[4]	[5]	[6]
Dependent Variable:	**Relationship End**				**Future Trade Volume**	
Past Default	0.279**	0.332*	-0.289***	-0.241**	-1.394	-4.732
	(0.174)	(0.203)	(0.106)	(0.108)	(12.26)	(11.66)
Past Default During Positive Price Surprises	2.817	2.754	0.234**	0.172	-23.42	-25.06*
	(1.836)	(1.760)	(0.113)	(0.114)	(15.30)	(15.00)
Controls	no	yes	yes	yes	yes	yes
Relationships FE	no	no	yes	yes	yes	yes
Season Fixed Effects	yes	yes	yes	yes	yes	yes
Cohort Fixed Effects	yes	yes	yes	–	yes	–
Model	Poisson	Poisson	Linear	Linear	OLS	OLS
Observations	2,755	2,755	2,755	2,755	2,449	2,449
R-squared			0.660	0.674	0.841	0.842

Clustered standard errors (relationship) in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table A8 shows that past contract cancellations are associated with worse relationship outcomes if they happened on contracts with positive price surprises. A unit of observation is a relationship in a given season. In Columns [1] to [4] the outcome is whether the relationship ended. In Columns [5] and [6] is the volume of trade in the relationships. Columns [1] and [2] estimate a Poisson model and report odds ratios. A coefficient > 1 (respectively < 1) implies the corresponding independent variable is positively (respectively negatively) associated with the end of the relationship. Controls include mill's volume and age of the relationship. Trade within backward and forward integrated relationships is excluded. Standard errors are clustered at the relationship level.

D Appendix Figures

Figure A1: 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 A2: Price Evolution



Figure A2 plots for each day where a contract had been registered the minimum, average and maximum prices of the contracts registered on that day, and the NYC price. We see that the spread of prices is important, showing that the minimum price constraint is not binding and that the regulation leaves substantial margins for price negotiation.