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Rocco Macchiavello and Josepa Miquel-Florensa

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

Rocco Macchiavello
London School of Economics

Josepa Miquel-Florensa
Toulouse School of Economics

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Abstract

This paper compares integrated firms, long-term relationships and markets, and how they adapt to shocks in the Costa Rican coffee chain. The industry is characterised by significant uncertainty. Supply failures responses to unanticipated increases in reference prices reveal that integration and relationships reduce opportunism. Trade volumes responses to weather-induced increases in supply reveal that relationships provide demand assurance, although less than integration does. This benefit of integration is offset by costs when trading outside of the integrated chain. The evidence supports models in which firms boundaries alter temptations to renege on relational contracts and, consequently, the allocation of resources.

Keywords: Vertical Integration, Relational Contracts, Adaptation, Demand Uncertainty, Supply Chain.

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

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1 Introduction

Since Coase (1937) seminal contribution, economists in fields as diverse as industrial organization, international trade, public economics and corporate finance have been interested in understanding how resource allocation within firms differs from allocation between firms.[1] Classic theoretical contributions recognize contractual imperfections as the keystone of any theory of the firm (see, e.g., Gibbons (2005)).[2] While the motives for integration are likely to differ across industries, repeated relationships between firms, such as those frequently observed in supply-chains, might also mitigate the same contractual imperfections.[3] Can long-term relationships between firms replicate the allocation of resources achieved by integration? Answering this question requires distinguishing long-term relationships and arm's length market transactions as alternative organizational forms to integration. Such a distinction could have important policy implications, particularly in developing countries where institutional constraints limiting the efficiency of both markets and firms make informal relationships between firms relatively more prevalent (see, e.g., Greif (1997), Fafchamps (2004)).

The rapid progress registered by the theoretical literature that followed the seminal work by Baker et al. (2002) stands in sharp contrast with the paucity of empirical evidence. This is due to a number of empirical challenges that must be overcome in order to compare integration against both long-term relationships and arm's length market transactions between firms. First, transactions of identical products under different organizational forms are rarely observed, particularly so within firms. Second, it is difficult to observe operational differences resulting from the relevant contractual imperfection. These challenges are shared by all empirical studies of vertical integration. Third, relationships between firms must be distinguished from arm's length market trade. This is rarely possible since transacting parties' identities are seldom recorded in standard datasets.

This paper compares integrated firms and long-term relationships and how they adapt to a variety of shocks in the Costa Rica coffee chain. Besides its intrinsic interest, the environment allows us to overcome the empirical challenges highlighted above.[4] Due to regulations in the industry, all transactions of coffee between suppliers

[1]In the United States transactions *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]Gibbons (2005) distinguishes between theories in which firm boundaries align ex-ante incentives from those in which they shape ex-post governance decisions, such as adaptation to changing circumstances. Grossman and Hart (1986); Hart and Moore (1990), Holmstrom and Tirole (1989, 1991), Holmstrom and Milgrom (1994) are prominent examples of the first type; Simon (1951), Williamson (1971, 1975, 1979, 1985) and Klein et al. (1978) of the second.

[3]See, e.g., Macaulay (1963), Klein and Leffler (1981), McLeod (2007) on relationships and Sako and Helper (1998) and Menard (2004) on supply chains.

[4]It is estimated that coffee cultivation is the main source of livelihood for 25 million farmers

(mills) and buyers (mostly exporters) – including those within integrated firms – are recorded by the industry regulator. These records specify unusually detailed product characteristics and allow us to compare trade of the same product across a variety of organizational forms: backward integrated firms (*integration*); long-term relationships between firms (*relationships*); and arm's length trade between firms (the *market*).[5] Furthermore, because we observe transactions along the whole chain – from farmers, to mills, to exporters, to foreign buyers – we can compare operational differences in adaptation to a variety of shocks across organizational forms holding constant product and firm characteristics that might drive organizational decisions.[6]

Before presenting the main results, a detailed description of the Costa Rica coffee sector highlights key adaptation needs of mills and buyers. Our conversations with industry practitioners and industry reports suggest that demand and supply assurance concerns play a prominent role in the industry.[7] Buyers demand reliable deliveries to fulfill commitments in export markets. Mills value guaranteed demand so as to reduce inventory risk and avoid selling coffee at a discount when the subsequent harvest approaches. The main analysis investigates how organizational forms adapt to shocks and the extent to which they mitigate supply and demand assurance concerns. We use increases in reference prices as shocks to mills temptations to side-sell to study supply failures and the nature of relationships. We then consider weather-induced shocks to supply to study demand assurance.

We first investigate how organizational forms mitigate supply failures due to mill's opportunism. We adapt the incentive compatibility constraint in Baker et al. (2002, 2011) to our context and derive a number of testable predictions. Unanticipated increases in reference prices over the duration of a contract change the mill's temptation to side-sell and default on the contract. Under backward integration, however, the buyer owns the mill and the coffee and, therefore, the mill cannot side-sell: the reneging temptation is independent of reference prices. If relationships provide future rents, mills will resist larger temptations to default on contracts with long-term partners

worldwide, mostly smallholders. The coffee chain shares many aspects with other agricultural value chains in developing countries.

[5]Roughly 40% of coffee in the industry is exchanged within integrated firms, 40% within relationships (defined as mill-buyer pairs that trade for at least three consecutive years) and the remaining 20% in the market. There is essentially no time variation in the integration status of mills and buyers over the sample period.

[6]According to Williamson (1991), adaptation to changing circumstances is the central problem of economic organizations. Crucially for our purpose it is also easier to empirically study adaptation since shocks, and the corresponding operational responses, can be observed. Marginal effects of non-contractible investment on non-contractible payoffs, which are central to other theories, are much harder to observe (see, e.g., Whinston (2003) for a discussion).

[7]This is consistent with a number of trading patterns we observe in the industry (forward sale contracts are pervasive; mills face significant inventory risk; and prices feature both advance-purchase and end-of-season discounts). For industry reports, see, e.g., I.T.C. (2012), I.C.O. (2014) and World Bank (2015).

relative to contracts signed at arm's length.

We find ample support for the theoretical predictions by investigating how the likelihood of mill's contract default responds to unanticipated increases in world prices during the duration of the contract.[8] When parties transact at arm's length, a 20% unexpected increase in world prices during the duration of the contract nearly doubles the likelihood of contract default. In contrast, contract cancellations within both integrated firms and long-term relationships between firms are unrelated to unexpected increases in reference prices.[9]

Integration and relationships between firms mitigate supplier's side-selling and improve supply assurance.[10] Relative to arm's length market trade, relationships provide higher future rents to mills. Rather than exclusively relying on the contract enforcement provided by the regulator, relationships between firms also entail a relational contract in which current temptations to cheat are deterred by the future value of the relationship.

We therefore investigate demand assurance as a source of value created by relationships. Mills have demand assurance concerns due to idiosyncratic and aggregate demand variation that arise once production decisions have been sunk. These demand assurance concerns are particularly strong in times of large supply. We therefore explore how trade volumes transacted across organizational forms adapt to exogenous increases in supply. We take advantage of industry seasonality to isolate exogenous drivers of supply from other confounding factors. Weather conditions during the growing season, which occurs months before the coffee is harvested and processed by the mills, induce exogenous variation in the availability of coffee around the mill at the time of harvest. This allows us to examine the extent to which integration and long-term relationships provide demand assurance.

In response to exogenous increases in supply, integrated mills sell essentially all additional production to their buyers. Integrated buyers provide complete demand assurance to their mills. Long-term relationships also provide substantial demand assurance, albeit to a lesser extent than integration. A one ton exogenous increase in

[8] To avoid confusion we refer to transactions both *within* firms as well as *between* firms as contracts, since reporting and cancellation requirements do not vary across organizational forms.

[9] We compute contract-specific price surprises as the ratio between realized spot market prices at the delivery date and contracting date future prices quotes for the delivery date. The specification controls for market conditions (including delivery date fixed effects); mill-buyer pair fixed effects; extremely detailed product fixed effects; as well as interactions between both product and transacting parties' characteristics with price surprises. Contractual defaults are associated with lower future trade volumes and a higher likelihood that the mill and the buyer do not trade again in the future.

[10] While easier to observe, default on signed contracts are only the tip of the iceberg: a buyer will be concerned that a mill might renege on a promise to sign contracts and trade at a future date. Appendix II further investigates supply assurance matching transaction-level export data with aggregate imports of coffee in export markets to construct buyer-specific time-varying demand shocks. In response to exogenous increases in demand buyers source a disproportionate share of coffee from relationships, a further indication that relationships provide supply assurance.

mill production translates into approximately 0.7 additional tons sold through relationships. In fact, while we reject that integration and relationships provide the same degree of demand assurance, we cannot reject the hypothesis that relationships buy a constant share of the mill's total production.[11]

Relative to relationships, vertical integration allows parties to trade larger volumes and achieve superior demand and supply assurance. Our last set of results investigates the extent to which these advantages are offset by the costs of integration. Integration is associated with worse trading conditions when both selling and sourcing outside the integrated chain. Integrated mills have exclusive relationships with their integrated buyers and very seldom sell excess production outside. These outside sales always occur at arm's length. When selling at arm's length, mills that have a nearly exclusive relationship with a buyer receive lower prices for the same quantity of the same coffee sold under identical market conditions. These costs of selling outside are consistent with dual sourcing in the face of uncertain demand: integrated buyers own capacity to satisfy only a share of their demand and source the rest from independent suppliers, like in Carlton (1979) model. Integrated buyers absorb all the production originating from their mills and reduce sourcing from outside suppliers when weather conditions at their own mills are particularly good. Exploring heterogeneity in adaptation to both price and weather shocks, we show that relationships between integrated buyers and independent suppliers do not provide demand assurance and have lower value than similar relationships involving non-integrated buyers.

In summary, the evidence strongly supports models in which firm boundaries change temptations to renege on relational contracts and, through this channel, impact resource allocation (see, e.g., Baker et al. (2002, 2011)). In our particular context, integration provides complete demand and supply assurance, like in models by Green (1974) and Carlton (1979). Relational contracts between firms also provide demand and supply assurance, albeit to a lesser extent than integration. The advantage of integration is offset by higher costs when trading outside, which is necessary due to uncertainty. This suggests that integration will be the preferred choice for firms that need to trade large volumes and have particularly strong demand and supply assurance concerns, consistently with patterns in the industry we document in the descriptive section. These observations also have policy implications for the regulation of export oriented agricultural chains in developing countries, which we discuss in the conclusions.

[11] These results are obtained aggregating mill's seasonal sales at the marketing channel (integration, relationships and market) level and controlling for season and mill fixed effects as well as interactions of weather conditions with time invariant mill characteristics (including those correlated with organizational forms). The results are robust to different measures of weather conditions; alternative definition of relationships; and alternative samples.

The paper merges two strands of empirical literature: the literature on vertical integration and the literature on relational contracts. The main contribution to the former is to compare integration against both long-term relationships and arm's length market trade between firms.[12] The most closely related work is Forbes and Lederman (2009, 2010). They show that airlines are more likely to integrate on routes that require more frequent adaptation, and that integrated airlines perform better than non-integrated ones when adaptation needs increase. We also compare adaptation across organizational forms focusing on operational responses to shocks. Mullainathan and Scharfstein (2001) find that non-integrated producers of waterproof plastic react more strongly to market demand, while integrated producers focus on internal demand. Our results are in line with their evidence. None of these studies compare integration against long-term relationships between firms.

The paper also contributes to the recent literature on relationships between firms (see, e.g., Antràs and Foley (2015), Gil and Marion (2012) for contributions; Lafontaine and Slade (2012) and Gil and Zanarone (2014) for reviews). Macchiavello and Morjaria (2015a); Barron et al. (2015) and Gil et al. (2016) provide evidence on the importance of relational adaptation in the flower, movie distribution and airline industries respectively. None of these papers study vertical integration.

The paper also relates to the literature on firms, contracts and relationships in developing countries (see, e.g., Andrabi et al. (2006), Banerjee and Duflo (2000), Banerjee et al. (2001), Banerjee and Munshi (2004), Fafchamps (2000, 2004), Macchiavello (2010), McMillan and Woodruff (1999)). Vertical integration has received less attention.[13] A growing literature studies market structure in domestic value chains, particularly in agriculture (see, e.g., Atkin et al. (2015), Atkin and Donaldson (2016), Casaburi and Macchiavello (2016), Casaburi and Reed (2016) and Mookherjee et al. (2015, 2016)). Blouin and Macchiavello (2013), Fafchamps and Hill (2008), De Janvry et al. (2015), Dragusano and Nunn (2014), Macchiavello and Morjaria (2015b) and Martinez (2016) study various aspects of the industrial organization of the coffee chain. None of these papers focuses on vertical integration.[14] Finally, following Antràs (2003) a large literature has studied intra-firm trade in international transactions. Costinot et

[12] The empirical literature on vertical integration can be divided into three separate strands (see Lafontaine and Slade (2007) for a review). The majority of studies asks "What determines firm boundaries?" (see, e.g., Monteverde and Teece (1982), Masten (1984), Joskow (1985), Antràs (2003), Baker and Hubbard (2003) and Gil (2007)). A smaller literature asks "Do firm boundaries matter?" (see, e.g., Gil (2009), Atalay et al. (2014)). Our main results are most closely related to this second strand. A third strand focuses on exclusionary aspects (see, e.g., Hart and Tirole (1990) and Hortascu and Syverson (2007)). We do not relate to that literature.

[13] Acemoglu et al. (2009), Macchiavello (2012) and Alfaro et al. (2016) provide cross-country-industry analyses.

[14] 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. We borrow from Blouin and Macchiavello (2013) the use of unanticipated shocks to reference prices to study default.

al. (2011) specifically focus on adaptation. We focus on exporters vertical integration in the domestic market.

The rest of the paper is organized as follows. Section 2 provides background information on the Costa Rican coffee sector and presents descriptive evidence. Section 3 distills predictions from an incentive compatibility constraint à la Baker, Gibbons and Murphy (2002, 2011) and tests them using unanticipated shocks to reference prices. Section 4 investigates demand assurance using weather shocks. Section 5 studies the trade-off associated with integration. Section 6 considers alternative explanations that do not appear to be key drivers of organizational forms in our context. Section 7 discusses policy implications and concludes.[15]

2 Industry Background

This section provides background information and descriptive evidence. We begin with the key characteristics of the coffee chain and its regulations in Costa Rica. We then describe market participants (mills and buyers) and define long-term relationships. We have two main objectives. The first is, as usual, to illustrate variations in the data. The second is to identify the key concerns of market participants. To do so, we let theoretical models of demand uncertainty guide us in the exploration of organizational forms and trading patterns in the industry. The descriptive evidence suggests that demand and supply assurance concerns are important for mills and buyers, respectively. This motivates the two shocks that are investigated in the next two sections: Section 3 studies responses to unanticipated shocks to reference prices, and investigates supply failures due to mill's opportunism; while Section 4 takes advantage of industry seasonality and considers responses to weather-induced increases in expected supply (which aggravate demand assurance concerns).

2.1 The Coffee Value Chain in Costa Rica

Industry Background

The cultivation of coffee was introduced in Costa Rica in the late eighteenth century. The importance of coffee for the Costa Rican economy grew considerably during the nineteenth century when coffee was the main export crop. The country ranks 14th among the world's coffee producers and exports the vast majority of its coffee (see I.C.O. (2015)). Coffee is produced in seven regions that differ in altitude, climate and harvest timings (Table A1 and Figure A1 in the Appendix).

[15] Appendix I provides further details on the data and industry regulations; Appendix II explores supply assurance concerns using exogenous increases in buyers demand.

Figure 1 describes the coffee chain. Coffee cherries are harvested by farmers and delivered to mills within a few hours of harvest. Mills remove the pulp from the cherries, then wash and dry the bean. After these processes, the output becomes storable and is called parchment coffee.[16]

Mills sell parchment coffee to domestic buyers. Buyers consolidate 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 analysis compares trade within backward *integrated* firms (buyers owning mills) with trade between firms. We distinguish arm's length trade between firms (*market*) from repeated trade between firms (*relationships*).[17]

Figure 2 illustrates the unfolding of the coffee season. During the growing season, which lasts approximately from August to November, weather conditions influence the amount of coffee eventually harvested by farmers. Coffee is harvested and processed by mills during the harvest season, from December to April. Finally, sales contracts are executed before the beginning of the following harvest season. To reduce risk, parties contract for future delivery even before the beginning of harvest (forward sale contracts). The Coffee Futures C contract for Arabica milds traded at the New York commodity exchange provides the key reference price for the sales contracts in the physical market.[18]

Industry Regulations

In Costa Rica, the production, processing, marketing and export of coffee are all undertaken by the private sector. The state regulates the sector through the Instituto del Cafe de Costa Rica (ICAFE). The key aspect of the regulation is the "Sistema de Liquidación Final"(see Figure A2). For the system to be implemented, all transactions of coffee along the chain are registered as contracts with the regulator. This requirement applies to all transactions independent of ownership structure: the terms of transactions must be registered for trade between firms as well as within integrated chains.[19] The regulations generate uniquely detailed data along the entire domestic

[16] 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 a higher and more consistent quality.

[17] Trade within firms is always repeated. There are also mills that are registered exporters and are, therefore, *forward* integrated. Mills can be either privately owned or a cooperative. By definition, cooperatives are owned by farmers and cannot belong to backward integrated chains. Some cooperatives form horizontal alliances as part of marketing consortia. Forward and backward integrated chains look and behave differently. For simplicity, this paper excludes trade within forward integrated chains. Results are robust to its inclusion. Differences across the two types of integration are explored in a separate paper.

[18] As in several commodity markets, physical markets for coffee operate alongside futures markets. The majority of futures contracts are traded for other futures contracts, i.e., futures contracts are rarely "called" for actual delivery. Due to their liquidity futures markets provide useful price revelation mechanisms and effective tools for risk management.

[19] To avoid confusion we refer to transactions both within firms as well as between firms as contracts

chain. Each contract must specify a quantity of coffee, a price, a signing date, a delivery date and an extremely detailed product classification. Our analysis focuses, for the most part, on the volumes and timing of trade rather than prices, which might be harder to interpret within firms transactions.[20]

As a result of the regulations, ICAFE enforces standards and contracts. A contract between a mill and a buyer must specify one of 47 different kinds of coffee (standard, organic, mill-specific differentiated product lines, etc.) and, for each category, the bean's type, quality and preparation (in 8, 13 and 12 categories, respectively). In total, we observe 687 unique products over the sample period. As a matter of comparison, these hundreds of products span only two ten-digit HS codes (0901110015 and 0901110025), the finest level of product classification typically used in international trade.

Buyers and mills sign fixed price contracts that specify the exact type and quantity of coffee, a delivery date and a price. Many contracts are signed in advance for future delivery. Swings in market conditions leave parties exposed to counterparty risk: if prices go up (down), mills (buyers) have an incentive to renege on the deal. The board enforces contracts and only allows mills to cancel contracts for one of the following reasons: (A) when both parties agree to substitute the contract for another with a higher price; (B) when the mill does not have enough quantity (B) or quality (C) of coffee to honor the contract; and (D) for exceptional causes to be evaluated by the regulator.

2.2 Organizational Forms: Descriptive Evidence

Mills, Buyers and Contracts

Table 1 provides summary statistics for the last harvest season in our sample.[21] Panel A presents mills' characteristics. Mills owned by buyers account for 30% of coffee transacted. The ten largest mills account for 53% of production. Mills have operated on average six years under current ownership during the sample period, had an average of 3.67 buyers per year, sold 11.5% of their output to backward integrated buyers, and exported 78% of their produce.

Panel B presents buyers' characteristics. The buyer's side of the market is more concentrated. The ten largest buyers have a combined market share of 77% and backward integrated buyers account for 52% of market trade. Buyers have operated an

since reporting and cancellation requirements do not vary across organizational forms.

[20]The process and the data used in the analysis are described in further detail in Appendix I. This type of regulation is by no means unique to Costa Rica. For example, Guatemala, Nicaragua, El Salvador and Burundi have adopted, at some point, similar regulations. The Kenya and Rwanda tea sectors are currently regulated along similar lines.

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

average of 6.23 years during the sample period, have about four suppliers per year and export 40% of their purchases: size is positively correlated with share exported.

Panel C reports contracts characteristics. Each season about 4,000 contracts are registered. Approximately 20% of the contracts are for the national market, and around 45% involve an integrated buyer. Forward contracts are pervasive. The average contract is signed about three months before scheduled delivery. Delivery occurs within a week of the signing date in less than 40% of the contracts.

Relationships

A mill and a buyer are defined to be in a relationship if they trade for at least four consecutive harvest seasons. This definition classifies a mill and a buyer as being in a relationship from the first time they trade, provided they eventually trade at least four seasons consecutively. The definition is, therefore, forward looking but selects relationships based on success. A forward looking definition better captures the role of future rents in sustaining cooperation highlighted by the theoretical literature.[22] Panel D in Table 1 presents the characteristics of the relationships for the last harvest season in our sample. In that season, a total of 178 relationships were active. The average relationship accounts for 33% of mill sales and for 22% of the buyer's sourcing. Relative to integrated trade, relationships between non-integrated parties have smaller volumes, lower shares of exports, and sign longer contracts.

A key difference between relationships and integrated trade is exclusivity: mills owned by downstream buyers sell almost everything within the integrated chain. Table 2 reports average shares of coffee sold (sourced) through different channels in each season, and highlights how mills (buyers) typically use a combination of organizational forms. Non-integrated mills market approximately 60% of their produce through relationships and the remaining 40% in the market. Mills owned by buyers essentially sell all of their produce (96%) to their buyers. Integrated mills do not have relationships with outside buyers and sporadically sell in the market (4%). Non-integrated buyers split their sourcing between relationships (49%) and market (51%). Backward integrated buyers source 56% of their coffee from their own mills, with the remaining split between relationships (20%) and market (23%). Due to the large size of the integrated buyers, 46% of relationships involve an independent mill and an integrated buyer. In summary, approximately 40% of coffee is exchanged within relationships, 20% in the market, and the remaining 40% within integrated firms. These shares have remained relatively stable throughout the sample period (see Figure A3 and Table A2).[23]

[22] The baseline definition is also, admittedly, somewhat arbitrary. We present robustness checks when defining a mill and buyer to be in a relationship if they trade for at least N consecutive harvest seasons, letting N vary from two to eight (our baseline is three).

[23] Due to the lack of similar data it is difficult to benchmark these figures. In the Peruvian anchovetas industry (for which similar data is available) relationships also account for two-thirds of between firms

Correlates of Vertical Integration and Relationships

Are integrated mills (buyers) different from the non-integrated ones? Are they, in particular, different from those that predominantly sell (source) through relationships? Tables 3 and 4 present cross-sectional correlations and find that both mill and buyer characteristics associated with integration are also associated with the use of relationships. Notwithstanding this similarity, the main difference is that integrated mills (buyers) are larger than otherwise similar firms that mostly sell (source) through relationships.

Table 3 presents cross-sectional correlations between mill characteristics and organizational forms in marketing channels. Columns (1) to (3) report results from a multinomial logit in which mills' characteristics are correlated with the mill's organizational form. Column (4) estimates a probit model on integration status omitting independent mills selling mostly through relationships. The predicted integration score is correlated with the use of relationship as marketing channel on the sample of non-integrated mills in Columns (5) and (6). We distinguish three organizational forms: mills owned by downstream buyers; independent mills that sell most of their produce through relationships; and other independent mills. The results show that the size of the mill, measured in tons of processing capacity, the age of the mill and variability in weather conditions around the mill are associated with both a higher likelihood of integration and with marketing through relationships.[24] Size and age are more strongly associated with integration than with the use of long-term relationships, while there is no statistical difference for the variability of growing conditions.[25]

Table 4 performs a similar analysis for buyers. The results show that the size of the buyer, measured by the amount of traded coffee, the age of the buyer and the share of coffee exported are associated with both a higher likelihood of backward integration and with sourcing through relationships. Buyer size and share exported are more strongly associated with integration than with the use of relationships. Relative to the domestic market, exports are likely characterized by different downstream supply-chain arrangements. We match exporters to customs data and investigate the relationship between supply-chain arrangements in export markets and organizational forms used for sourcing in the domestic market. Conditional on exporting, the share directly

trade. Due to a reform of the quota system, the share of integrated trade has increased from 30% to 60% in recent years. See Natividad (2014). We thank José Martinez for sharing these figures.

[24]Variability is a z-score of across harvest season variability in rainfall and temperature deviations from ideal conditions. Suitability is an index measured as the standardized z-score of deviations from ideal altitude, rainfall and temperature conditions. Suitability for coffee growing correlates with integration, but not with relationships possibly reflecting the fact that integrated mills are owned by well-established domestic groups that have operated in the industry for decades.

[25]The result on variability in weather conditions echoes findings in Forbes and Lederman (2009) on airline integration in the U.S. and is consistent with market assurance concerns as further discussed below.

exported to roasters (as opposed to traders), the share of advance export contracts, just-in-time deliveries and the concentration of buyers in foreign markets correlate with both integration and with the use of relationships in sourcing.

2.3 Organizational Forms and Demand Uncertainty

While by no means conclusive, these correlations suggest that demand uncertainty might be a key feature of this industry. Vertical integration and relationships might be strategies buyers and mills use to mitigate the consequences of demand uncertainty (Carlton (1979), Williamson (1979)). This would be consistent with our conversations with industry practitioners as well as industry reports (e.g., I.T.C. (2012), I.C.O. (2014) and World Bank (2015)).[26]

Demand uncertainty arises in markets in which firms face idiosyncratic and aggregate demand shocks once production decisions have been sunk. These conditions fit the coffee industry well. After harvest is completed, the vagaries of weather and harvest conditions in competing locations worldwide induce fluctuations in demand and prices. Buyers also face idiosyncratic demand shocks from their downstream supply chains. 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.

Figure 3 shows that demand uncertainty is an important concern in this market. This figure plots the difference between processed coffee and coffee committed for sales during the course of the harvest campaign. For each day relative to the beginning of harvest, the left vertical axis reports the average net inventory position of different types of mills across seasons. We consider three types of mills: those owned by integrated buyers; those selling mostly through relationships; and those selling mostly through the market.

Three features of the market are consistent with the implications of models with demand uncertainty (see, e.g., Carlton (1978) and Dana (1998)). First, mills and buyers sign forward sale contracts even before the beginning of harvest. This gives a negative net inventory position early in the season: mills commit to sales of coffee they haven't yet received from farmers and processed. Second, mills carry a significant inventory risk. The negative balance is reduced and is turned into positive as the mills start receiving coffee during the harvest. The balance peaks towards the end of the harvest and then decreases as mills sell processed coffee. Finally, mills accept lower prices in order to reduce inventory risk. On the right-hand vertical axis, Figure

[26] In particular integrated buyers dual sourcing, integrated mills exclusivity and correlations between both mills and buyers characteristics and organizational forms are consistent with Carlton (1979) model of vertical integration under demand uncertainty.

3 also reports estimated seasonality effects on prices. Prices are, respectively, 4.15% and 5.7% lower for contracts signed before the beginning and well after the end of the harvest. Mills accept lower prices so as to avoid having to sell coffee at a discount later on in the season.[27]

Figure 3 suggests that integration and relationships mitigate demand assurance concerns. Mills owned by buyers sell almost all of their produce within their integrated chains and face less demand uncertainty: they sign fewer contracts before the beginning of harvest; carry a lower balance of processed coffee throughout the entire season; and are never left with unsold coffee at the end of the season. Mills that sell most of their coffee through relationships have inventory positions comparable to those of integrated mills and lower than those of mills selling mostly through arm's length contracts. These mills reduce inventory risk by signing relatively more forward contracts before the beginning of the harvest season with their long-term buyers.

The similarity between trade under integration and inside relationships is further illustrated in Figure 4. The left panel compares the timing of deliveries across the three organizational forms. Integration and relationships deliver coffee just-in-time (i.e., before the end of the harvest season). In contrast, only 20% of coffee exchanged between firms at arm's length is delivered before the end of the harvest. The right panel shows that spot contracts (i.e., those for delivery within a week) account for 60% of arm's length market trade between firms but for only 20% of trade in relationships and under integration.[28]

In summary, descriptive evidence reveals that demand uncertainty is a key feature of the industry. Demand uncertainty generates demand and supply assurance concerns for mills and buyers. The evidence also hints at integration and long-term relationships as mitigating those concerns. In the next section, we use shocks to reference prices to investigate if integration and long-term relationships mitigate *supply* failures due to mill's opportunism. Section 4, instead, uses weather induced supply shocks to investigate if integration and long-term relationships provide *demand* assurance to mills.

[27]See Table A3 for regression results and details about the specification. The estimated effects are large relative to buyers and mills margins. Note that lower prices before the beginning of the harvest do not necessarily reflect higher risk aversion of the mills relative to buyers. Even in a competitive market with risk neutral buyers and sellers advance purchase discounts simply reflect a lower risk of capacity underutilization (see Dana (1998)).

[28]The timing of contracts registered by (integrated) exporters reflects trading patterns in the downstream market. From a risk management perspective, exporters try to match contract signing in export market with contracts within the domestic chain.

3 Shocks to Mills' Temptations and Supply Failures

This section uses unanticipated shocks to reference prices to investigate whether different organizational forms achieve superior supply assurance by curbing the mill's temptation to side-sell. In so doing, the section also asks whether relationships between firms involve a relational contract. A large share of trade between firms takes place in long-term relationships: what supports this repeated trade? One possibility is that repeated trade between firms relies entirely on contracts enforced by the regulator without any exchange of informal promises. Another possibility, however, is that long-term relationships also involve an informal relational contract between mills and buyers. Distinguishing between these two possibilities is important for two reasons. First, markets in which relational contracts are important behave differently from markets that rely exclusively on formal enforcement (see, e.g., Dixit (2004) and Rodrik (2008) on barriers to entry and Williamson (1979) and Fehr et al. (2009) on price rigidities). Second, if mills and buyers exclusively rely on formal contracts enforced by the regulator to achieve the desired level of demand and supply assurance, we should be sceptical that integration is needed to mitigate the consequences of demand uncertainty.

This section first distills testable predictions from adapting an incentive compatibility constraint à la Baker et al. (2002, 2011) to our context; it then develops an empirical strategy to test these predictions; and finally tests them studying how the likelihood of contract default responds to unanticipated spikes in reference prices. The strategy identifies the extent to which different organizational forms reduce supply failures due to a form of mill opportunism.

3.1 Conceptual Framework

In a relational contract (see, e.g., MacLeod and Malcomson (1989), Baker et al. (1994), Levin (2003)), parties promise to undertake certain costly non-contractible actions in exchange for future rewards. Parties trade-off future *rents* against current *temptations* to renege on such *promises.* The main difficulty in providing evidence that a relational contract is in place is that the promises exchanged, the temptation to deviate and the future rents are typically not directly observable in the data.

In our context, parties adapt to demand uncertainty by *promising* to trade in the future. Temptations arise from changing market conditions: when better trading opportunities become available it becomes costly to fulfill past promises to trade. From an empirical point of view, it is key to distinguish promises to sign a contract later on from promises after a contract is signed. Before a contract is signed, promises to sign a contract at a later date allow parties to avoid signing contracts too early, which can turn out to be costly if market conditions change. Both mills and buyers can renege on these promises. These promises, and the corresponding temptations to renege on them, are, however, not observable. After a contract is signed, however, the promise to deliver and 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 transparent opportunity to test for the presence of a relational contract between mills and buyers.

In an influential set of papers, Baker, Gibbons and Murphy (2002, 2011) (henceforth, **BGM**) study the interaction between relational contracts and firm boundaries.[29] They offer two central insights. First, firm boundaries matter because they change the temptation to deviate and, therefore, the amount of cooperation that can be sustained in the relationship. Second, if the value of future rents is sufficiently high (e.g., because trade is very frequently repeated) firm boundaries do not matter. A simple adaptation of the incentive constraint in their framework to our context allows us to derive a number of testable predictions.

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

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

$$\delta(V^o_{mill} - U^o_{mill}) \geq (p_w - p_c)T(_{p,t'}, o)q_c. \quad (1)$$

The mill defaults on the contract if the temptation to side-sell, $(p_w - p_c)T(_{p,t'}, o)q_c$, is larger than the future value of the relationship, $(V^o_{mill} - U^o_{mill})$. While the left-hand side of the above constraints is not directly observed (it depends on parties' discount

[29] Baker et al. (2002) emphasize the importance of ex-ante incentive alignment while Baker et al. (2011) develop the agenda studying *adaptation* to ex-post shocks. The contracting problems studied in this paper are more closely related to this later work.

factor; on strategies to be played in the continuation game following both delivery and default; etc.), key elements of the right-hand side are. The logic of the test, then, is to exploit exogenous shocks to the right-hand side of the constraint to infer properties of its left-hand side. For a given contract, exogenous shocks to the right-hand side of the constraint are provided by unanticipated swings in reference prices p_w.

A number of testable predictions follow. First, integrated mills have fewer defaults and those defaults do not depend on market conditions p_w. In backward integrated chains the buyer owns the coffee and, therefore, side-selling is not a concern. Second, if relationships provide larger future rents to sustain the relational contract they will have fewer defaults when the reference price p_w unexpectedly increases.[30] We summarize these in the following:

Predictions:

[i] *Unanticipated increases in market prices lead to contract default in arm's length market transactions (no future rents), but*

[ii] *not within integrated firms, and*

[iii] *less so inside long term relationships (if those entail a relational contract).*[31]

3.2 Empirical Strategy

Exogenous variation in the right-hand side of the constraint is needed to test the predictions. Although prices p_c and quantities q_c are directly observable, they are not exogenous: parties might set them to reflect the inherent risk of contract default associated with a given transaction. To generate exogenous variation in the mill's temptation to default, we borrow the empirical design in Blouin and Macchiavello (2013). The price negotiated at time t, p_c, reflects the contracting parties' expectations about prevailing market prices at delivery date t', denoted $\mathbf{E}\left[p_w^{t'}|t\right]$. Variation in realized market prices p_w relative to expectations induces exogenous variation in the temptation to renege on the contract. Futures markets quote for every contracting date t expected future prices for deliveries at t'. This overcomes the empirical challenge of

[30] Unexpected changes in market prices might also change continuation values V_{mill}^o and U_{mill}^o on the left-hand side of the incentive constraints. The change in the *difference* between the two continuation values, however, will be smaller (and might even have the opposite sign) than the change in the right-hand side of the incentive constraint unless the discount factor δ is implausibly large.

[31] Two remarks on the theory. As pointed out by **BGM**, the integrated firm could also entail a relational contract between the buyer (owner) and the mill (employee). Our empirical strategy and data limitations do not allow us to directly test whether integration also entails such a relational contract. Second, in most models of relational contracts default *does not* occur along the equilibrium path. To generate default along the equilibrium path one would need to extend the model to allow for imperfect (public) monitoring or private monitoring.

proxying for expectations of future prices, which are typically unobservable. For each contract signed between mill m and buyer b at date t of season s for deliveries of product p at date t' we construct a measure of price surprise as:

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

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

$$d_{mbpstt'} = \eta_{mb} + \delta_{st} + \mu_{sp} + \gamma_{tp} + \beta_o^+ \times P_{mbpstt'}^+ + \beta_o^- \times P_{mbpstt'}^- + \varphi X_{mbpstt'} + \varepsilon_{mbpstt'} \tag{3}$$

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

3.3 Main Results

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

Table 5 reports the regression results. Column (1) confirms that price surprises are associated with contract default (prediction **[i]**). Column (2) distinguishes between positive and negative price surprises. Results confirm the postulated asymmetry: positive price surprises lead to a large increase in the likelihood of default. A doubling of prices during the duration of the contract more than doubles the chances of contract default. In contrast, negative price surprises do not lead to contract default. Column (3) includes an exhaustive list of contract level controls and confirms the result.

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

3.4 Robustness and Discussion

Figure 5 explores the robustness of our findings to alternative definitions of relationships. The figure reports estimates from the baseline specification in Column (4) using different thresholds for the definition of relationships. Regardless of the threshold used to define relationships, unanticipated price surges increase the likelihood of contract default in arm's length market trade between firms but not in long-term relationships between firms or integrated trade.

Different organizational forms might trade products with different characteristics which might affect the ability of a mill to get the contract canceled by the board and/or side-selling opportunities. Although the baseline specification already controls for a detailed set of product specific season and seasonality effects, we investigate the robustness of the results to the inclusion of interactions between product characteristics and price surprises. Figure 6 shows that the differential effect of price surprises on defaults across organizational forms is robust to the inclusion of interactions between product characteristics and price surprises. This reflects the fact that the product mix does not vary systematically across organizational forms, as we discuss further in Section 6.[32]

It is also possible that parties agree to cancel contracts in order to adapt to changed circumstances. Table A4 shows that contract cancellations are unlikely to be agreed by both parties and are most likely associated with strategic default. The table shows that past contract cancellations are associated with worse trading outcomes. In particular, a mill and a buyer pair are more likely to never trade again in the future and, conditional on trading, trade lower volumes following a contract default that occurred under positive price surprises. This is consistent with the logic of repeated games models with imperfect monitoring (e.g., Green and Porter (1984)). While the buyer might not be sure that the contract default is due to opportunism, she will tailor the punishment on observable signals (including the price surprise).

Finally, it is worth noting that many contracts signed between firms transacting at arm's length are not defaulted upon despite large price surprises. This is likely due to a combination of factors. First, not all price increases present side-selling opportunities: it might be difficult to strategically default. Second, although the regulator does not disclose to the public information on defaulted contracts nor (as far as we know) punishes the mill for defaulting, the mill might have reputational concerns in the market. For example, members of the regulatory board (which includes representatives of farmers, mills and buyers) might spread information. Note, however, that by controlling for mill and buyer pair fixed effects, as well as for interactions of price surprises with mill and buyer characteristics, we implicitly control for variables that might affect the spread and intensity of these reputational concerns.[33] The logic of the test, then, is to assess whether in addition to these factors the different organizational forms still affect the temptations to, and likelihood of, default.

To summarize, the evidence is consistent with integration and long-term relationships being able to mitigate supplier's opportunism and improve supply assurance. As noted above, however, contract cancellations are rare and the associated quantitative effect might be small. Defaults on signed contracts are likely to be only the tip of the iceberg: buyers will be much more concerned about the mill's temptation to re-

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

[33]Consistent with this hypothesis, strategic defaults are mostly driven by arm's length transactions of smaller mills.

nege on promises to sign contracts, since those are not enforced by the regulator. To investigate supply assurance, in Appendix II we match transaction-level data on the export activities of buyers with aggregate imports of coffee from Latin and Central American countries in foreign markets so as to construct idiosyncratic demand shocks (similar to "Bartick" instruments for buyers' demand). The evidence shows that in response to increases in demand, buyers source a disproportionate share of coffee from relationships.

4 Demand Assurance and Weather Shocks

Having investigated supply assurance, we now turn to demand assurance. The results in the previous section suggest that, relative to arm's length market trade, relationships provide future rents to the mills. That is, relationships are valuable. The descriptive evidence in Section 2 suggests that demand assurance might be an important source of value created by relationships. This section investigates this hypothesis.

Demand assurance concerns are particularly strong at times of large anticipated supply. When mills expect high production they are particularly keen to secure demand in advance. To investigate the extent to which the different organizational forms provide demand assurance to mills, we therefore study how sales volumes channeled through different organizational forms respond to exogenous increases in supply. To isolate exogenous drivers of supply from other confounding factors, we take advantage of industry seasonality. In particular, weather conditions during the growing season induce exogenous variation in the availability of coffee around the mill at the time of harvest. The timing is key: the growing season occurs months before and does not overlap with the time at which coffee is harvested and processed by mills. This section first explores the relationship between idiosyncratic weather realizations during the growing season and the mill's seasonal production, as well as the reduced form relationship between weather conditions and sales through different organizational forms. We then instrument the mill's seasonal production using weather conditions during the growing season to investigate the mill's propensity to sell additional supply across the different channels. In stark contrast to arm's length market trade, integration provides complete demand assurance to mills. In between integration and arm's length market trade, long-term relationships provide a significant amount of demand assurance to mills.

4.1 Weather During Growing Season and Mill's Production

Weather conditions during the growing season, from August to November, affect aggregate coffee production during the harvest campaign, from December to April. Coffee must be processed within hours of harvest. As a result, mills respond to local availability of coffee by increasing purchases from farmers: more favorable weather realizations during the growing season translate into larger mill production.[34]

Figure A5 shows that weather conditions during the growing season strongly correlate with production at the mill level. We construct a weather index as the standardized z-score of average rainfall and temperature realization around the mill during the growing season. The figure plots non-parametric *lowess* regression between residuals of the weather index and residuals of aggregate mill production on mill and season fixed effects.

The corresponding regression results are reported in Table 6. We estimate the following specification:

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

where y_{ms} is a measure of mill m production in season s, α_m are mill fixed effects and μ_s are the season fixed effects. The inclusion of season and mill fixed effects implies that we identify responses to idiosyncratic weather conditions during the growing season, W_{ms}. Furthermore, mill fixed effects control for time-invariant mill characteristics, including those that might drive the choice of organizational forms.[35] Finally, ε_{ms} is an error term arbitrarily correlated within mills over time and across mills within harvest season.

The dependent variable y_{ms} is aggregate seasonal mill production in logs in Panel A and in levels in Panel B. The table reports estimates from different samples. Column (1) focuses on the whole sample, while Columns (2) and (3) split the sample between independent mills and mills owned by buyers, respectively. Finally, due to the large differences in size across mills and the descriptive evidence discussed in Section 2, Column (4) reports results for the large independent mills, defined as those that have capacity at least as large as the smallest mill owned by an integrated buyer. These mills are therefore more directly comparable to integrated mills.

Column (1) shows that, controlling for mill and season fixed effects, a one standard deviation increase in the weather index increases mill production by 202 tons (28%).

[34] The relationship between weather realizations around the mills and mills' seasonal production depends, inter alia, on the degree of competition in the local market and on mill's sourcing strategies. We control for these and other possible confounders as explained below but explore mill's sourcing in a separate paper.

[35] Recall that there is essentially no time variation in the integration status of mills over time.

Columns (2) and (3) distinguish independent mills and mills owned by backward integrated buyers, respectively. Integrated mills are larger and, therefore, the same increase in weather translates into a larger absolute increase in production relative to non-integrated mills (378 and 127 tons, respectively). However, the percentage increase is larger for non-integrated mills than for integrated mills (30% and 21% respectively). Finally, Column (4) exclusively focuses on large independent mills. For these mills, a one standard deviation increase in the weather index increases mill production by 242 tons (44%).

4.2 Reduced Form

Mills vary by the set of organizational forms they can use to sell coffee. All mills split their sales between two organizational forms. Mills owned by backward integrated buyers do not sell through relationships: they either sell within the integrated chain or at arm's length in the market. Independent mills, by definition, do not sell through the integrated channel and split sales between relationships and arm's length market trade. To allow for the possibility that mills could respond along channels they might not use in equilibrium in any given season, we aggregate observations and create a balanced panel at the season-mill-organizational form level. When a mill does not use a specific organizational form, that observation is assigned a zero trade volume.[36]

To investigate the extent to which the different organizational forms provide demand assurance, Panel C in Table 6 focuses on the reduced form relationship between non-market sales and the weather index. That is, the dependent variable y_{ms} is the volume sold through relationships by independent mills and within the integrated chain by integrated mills. As a benchmark, consider the case in which buyers in long-term relationships do not provide any demand assurance to the mill. Provided the mill produces enough coffee to satisfy buyers' demand, exogenous increases in mill production will have a zero effect on sales through those buyers. The entire additional production will be channeled through the market. Conversely, if the buyers in long-term relationships provide complete demand assurance to the mill, the entire increase in production will be sold through relationships. An intermediate scenario is one in which buyers in long-term relationships provide partial demand assurance and commit to purchase a constant share of the mill's aggregate production. In this case, exogenous increases in mill production translate into increases in sales proportional to the average share sold through those buyers.

[36] If we were to track all potential buyers, as opposed to marketing channel, we would need to define the set of potential buyers for each mill and then impute many zeros. This would complicate the interpretation.

Results in Panel C show that long-term relationships provide demand assurance, albeit not to the same extent as integration. Overall, a one standard deviation increase in the weather index increases the mill's non-market sales by 172 tons (Column (1)). Splitting the sample, we find that a one standard deviation increase in the weather index increases independent mills' sales to relationships by 83 tons (Column (2)) and sales trough the integrated channel by 384 tons (Column (3)). The comparison between estimates in Panel B and Panel C reveals that mills owned by integrated buyers essentially channel the whole increase in production through the integrated chain. Independent mills, in contrast, channel approximately two thirds of the increase in production through relationships. Interestingly, this response is not different across independent mills of different size (Column (2) and Column (4)).

Demand assurance concerns are particularly strong at times of large anticipated supply. When mills expect high production, they are particularly keen to secure demand in advance. Table 7 provides further evidence that relationships and integration provide demand assurance investigating the timing of contracting. Conditional on sales through a given organizational form taking place, the table investigates differential responses in the timing of contracting across organizational forms. In response to a one standard deviation increase in the weather index, mills owned by backward integrated buyers start registering contracts within the integrated chain 49 days earlier. Similarly, independent mills start registering contracts 63 days earlier. In stark contrast to the response within the integrated and relational channels, the timing of contracting in the arm's length market trade does not respond to exogenous increases in supply. This evidence confirms that mills use the integrated and relational channels to secure demand early on in the season, and mostly rely on arm's length market trade for unsold coffee later on in the season.

Additional unreported reduced form specifications show that unit prices, both conditional and unconditional on product characteristics, do not respond to weather conditions. The lack of a price response shouldn't be surprising for at least three reasons: i) we focus on idiosyncratic weather conditions in an otherwise well-integrated market; ii) world prices are used as reference prices; and iii) the regulator enforces minimum prices based on differentials. Further results in Section 6 show no differential effect of weather conditions during the growing season on mill operating costs during harvest nor on the characteristics of products transacted. The lack of response along the price, cost and product margins encourages us to directly investigate the mill's marginal propensity to sell additional production through different marketing channels by instrumenting mill production with weather conditions during the growing season.

4.3 Propensity to Sell: 2SLS Results

The results in Tables 6 and 7 suggest that relationships and integration provide demand assurance to mills. Table 8 directly investigates the mill's propensity to sell additional coffee through different organizational firms. The corresponding specification is given by:

$$Q_{ms}^{NM} = \alpha_m + \mu_s + \beta \times Q_{ms} + \varepsilon_{ms} \tag{5}$$

where Q_{ms}^{NM} is tons of coffee sold through non-market channels by mill m in season s and Q_{ms} is mill's aggregate production. As before, α_m and μ_s are mill and season fixed effects, respectively, and ε_{ms} is an error term arbitrarily correlated within mills over time and across mills within a season.

The table reports both OLS specifications (Panel A) and 2SLS specifications (Panel B). In Panel B, aggregate mill production Q_{ms} is instrumented using the weather index, W_{ms}. The corresponding first stages are given by Panel B in Table 6. As a benchmark, the table also reports the average share sold in the non-market channel. The estimated coefficient β gives the marginal propensity to sell coffee through non-market channels.[37]

Panel A reports OLS specifications and shows that an additional ton of coffee produced by the mill translates into an increase in non-market sales between 0.74 and 0.97 tons, depending on the type of mill. The marginal propensity to sell additional coffee is larger within the integrated channel (Column (3)). For independent mills, the propensity to sell additional coffee through relationships is still high (around 0.75) and, again, doesn't vary with mill size (Columns (2) and (4)).

The OLS coefficients, however, are likely biased. Two different forces pull the bias in opposite directions. On the one hand, models of markets under demand uncertainty predict that idiosyncratic supply and demand shocks arising later in the season are cleared through market transactions. For example, following the closure of a nearby competing mill, a mill produces more and sells the additional production in the market. Similarly, a buyer experiencing an idiosyncratic demand shock after its relational suppliers have committed capacity will look out for other mills with excess capacity to fulfill the additional demand. This force generates a downward bias. On the other hand, mills might produce more in response to anticipated higher demand from their integrated or relational buyers. This type of supply assurance is entirely consistent with evidence discussed in Section 3 and Appendix II and generates an upward bias.

Panel B reports 2SLS estimates and confirms the main results. Conventional tests

[37] The estimated coefficient β depends on how sales through the two marketing channels co-move, in particular $\beta = (cov(Q^{NM}, Q^{M})/(var(Q^{NM} + Q^{M})) + \rho^2$ where ρ is the average share sold in the non-market channel and $Q_{ms}^{M} = Q_{ms} - Q_{ms}^{NM}$ is the quantity sold through arm's length market trade. As a benchmark, if relationships buy a constant share of the mill's production then $\beta = \rho$.

show very strong first stages throughout all specifications. First, the marginal propensity to sell through the non-market channel is significantly different from zero for all types of mills. Integration and long-term relationships do provide demand assurance. Second, integration provides complete demand assurance: we cannot reject that the integrated buyer absorbs the entire increase in production. Third, long-term relationships provide an incomplete, but still economically significant, degree of demand assurance. Regardless of mill size, approximately 0.66 additional tons are sold through long-term relationships for each additional ton of production. Even when restricting attention to larger mills, we can reject the hypothesis that the degree of demand assurance provided by relationships equals the complete assurance provided by integration. Fourth, for large mills, we cannot reject the hypothesis that long-term relationships buy a constant share of the mill production (Column (4)). Smaller independent mills, in contrast, sell a disproportionate share of additional production through long-term relationships. Finally, for independent mills, the instrumented coefficient is smaller than the OLS coefficient. Although the difference is not statistically significant, this provides further support to the hypothesis that mills also provide supply assurance to buyers with whom they have relationships.

4.4 Robustness

The results are robust to different specifications, including: i) different definitions of relationships; ii) inclusion of controls; iii) different instrumental variables; and iv) different sample cuts and definitions of large mills.

Figure 7 explores the robustness of the findings to alternative definitions of relationships. The figure reports estimates from the 2SLS specifications in Panel B of Table 8 using different thresholds for the definition of relationships. A mill and a buyer pair are defined to be in a relationship if they trade at least N consecutive seasons. The specifications are estimated letting the threshold N vary from two to eight seasons. For the sake of clarity, Figure 7 focuses on the comparison between the estimated responses for integrated trade and for relational trade of large mills. Although the magnitudes change across specifications, the response of integrated trade is always larger than the response inside relationships. At the same time, the response inside relationships is always larger than the average share sold by the mills through relationships: relationships also provide substantial demand assurance to mills, albeit not to the same extent of integration. Note that as the threshold necessary for a pair to be classified as a relationship increases, more and more relationships are classified as arm's length trade and, therefore, the estimated response diverges from the response under integration.

Tables A5 and A6 in the Appendix present further robustness checks to the 2SLS specifications in Table 8. The effect of weather conditions on mill production and sales might depend on mill characteristics that correlate with organizational forms. Descriptive evidence in Section 2 shows that mill size is strongly correlated with organizational forms. The baseline specification splits the sample to directly compare large integrated mills with similarly large independent mills. Table A5 in the Appendix shows that results are robust to alternative definitions of mill size. Besides mill size, Table 3 shows that age, suitability and variability in growing conditions are associated with integration. By definition, farmers' cooperatives cannot be owned by buyers, but might have a differential response of production to weather conditions. Table 8 (Panel B) includes the interactions between all of those characteristics and weather conditions, and shows that results are robust. Table A6 also reports 2SLS results using different instruments for mill production. We consider rainfall and temperature separately as well as the z-index constructed over the entire mill catchment area. Results are robust across all different specifications.

To summarize, adaptation of trade volumes to weather conditions suggest that: i) long-term relationships provide substantial demand assurance; ii) albeit to a lesser extent than integration does. Integrated mills essentially sell the entire production to their integrated buyers. Integrated buyers absorb all the additional production originating from their mills and provide them with complete demand assurance. Relationships with buyers also provide substantial demand assurance to non-integrated mills, although to a lower extent: a share of the additional production must be sold in the market later in the season.

5 Trade-Off: Costs and Benefits of Integration

The results presented so far have emphasized the qualitative similarities between integration and long-term relationships, and the stark contrast between these organizational forms and arm's length market trade. Quantitatively, however, integration provides more complete demand assurance to mills and supply assurance to buyers. An important question then is whether integration entails costs such that it is a preferred organizational form for certain firms but not for others. This section investigates this trade-off and shows that integration allows the trade of larger volumes at the cost of making it harder to trade with other parties. Integration should be the preferred organizational form for firms that need to trade very large volumes and have particularly strong demand and supply assurance concerns.

5.1 Discontinuity at the Firm's Boundary

Descriptive evidence in Section 2 shows that both mill and buyer size are more strongly associated with integration than with long-term relationships. Section 3 shows that integration eliminates the mill's temptation to renege on contracts and side-sell. Appendix II shows that mills also provide supply assurance to buyers. Taken together, these results suggest that integration might be needed to trade particularly large volumes, which would otherwise give mills enormous temptation to seek better trading opportunities and renege on past promises to trade.[38]

Figure 8 provides evidence in support of this hypothesis. As noted in Section 2, an important difference between integration and long-term relationships is exclusivity: integrated mills sell only within the integrated chain, while independent mills rarely sell to only one buyer. Integrated mills, however, have much larger capacity than non-integrated mills. To investigate whether integration is associated with larger trade volumes we therefore compare trade volumes of integrated relationships against trade volumes of nearly exclusive relationships of mills of similar size.

Figure 8 shows that integrated relationships trade higher volumes of coffee than (nearly) exclusive relationships of mills of comparable size. This figure reports on the y-axis the average volumes of coffee traded by different types of relationships in a given season. Relationships are classified according to: i) the size of the mill, and ii) the degree of exclusivity. Mills are classified into three categories: small (1st quartile of size distribution), medium (2nd and 3rd quartiles) and large (4th quartile). All but one of the integrated mills are in the 4th quartile confirming that integrated mills are larger. For each independent mill, only the relationship that accounts for the largest share of sales in a given season is considered. Relationships are split by the share of a mill's sales that they account for (deciles at 60%, 70% ... 100%). Two patterns emerge. First, the figure confirms that integrated trade is exclusive: integrated trade always accounts for more than 90% of the mill's sales. Second, volumes transacted within firms are statistically larger than those transacted by nearly exclusive relationships of mills of comparable size. There is a discontinuity in trade volumes at the firm's boundary.

The discontinuity can be interpreted under the light of the theoretical models à la **BGM**. In these models, integration can emerge as the chosen organizational form for two different reasons. For a given set of parameters, integration might emerge either because it achieves higher surplus than relationships or because relationships are not sustainable (see, e.g., Gibbons et al. (2016)). In this second case, we expect a discontinuity in observable outcomes. Consistent with the side-selling logic, the

[38] We refer here to promises to trade, i.e., to sign contracts. The contract-level analysis of defaults in Section 3 controls for contract volumes.

observed discontinuity suggests that relationships might not be sustainable at the large trade volumes achieved by integration.

5.2 Trading Outside

Relative to long-term relationships, integration comes with the benefit of enabling firms to trade larger volumes and achieve superior demand and supply assurance. Are there costs associated with this? Inspired by models of vertical integration, we investigate two potential sources of costs. First, we investigate the common assumption that integration entails costs when *selling* excess production outside. For example, in Carlton (1979) model of vertical integration and demand assurance, this assumption is necessary to generate dual sourcing: integrated buyers own the capacity to satisfy the stable part of demand, and source the rest from independent suppliers. Second, we explore costs of *sourcing* outside. The relational contract logic suggests that control over integrated capacity reduces, all else equal, the value of relationships with independent suppliers.

Selling Outside the Integrated Chain

Table A7 in the Appendix provides some empirical support for Carlton (1979) assumption by comparing the sales of integrated mills to outside buyers with those of independent mills. Integrated mills receive 9.5% lower prices than independent mills when selling outside. The table, however, also shows that the costs of outside sales assumed by Carlton (1979) appear to be mostly driven by *exclusivity* rather than *integration* per se. The price gap halves when controlling for detailed quality, volumes and timing effects. Crucially, it drops to a statistically insignificant 1.4% when arm's length market sales of integrated mills are compared against similar arm's length sales of independent mills that sell at least 70% of their coffee to their main buyer. The negative price gap is associated with exclusivity, rather than integration per se. The gap is not explained by selection on product characteristics and/or market conditions, which are controlled for. The effect could be due to either: i) lower mill incentives to generate valuable trading opportunities outside of the exclusive relationship/integrated chain (as in Baker et al. (2001)); or ii) buyers' unwillingness to offer better terms to mills they know they won't be able to trade with in the future.[39]

Sourcing Outside the Integrated Chain

A multi-party extension of the incentive compatibility constraint sketched in Section 3 suggests that relationships between backward integrated buyers and independent mills

[39] Consistent with this second hypothesis unreported results show that long-term relationships are different from arm's length market trade already at the time of their first transaction.

have, all else equal, lower value. First, integrated buyers use independent suppliers only to cover demand in excess of own capacity: independent suppliers might expect less *future* business in relationships with backward integrated buyers (i.e., lower δ). Second, the incentive constraint highlights the central role of outside options: the higher the party's continuation value following misbehavior, the lower the temptations the relationship is able to resist. If control over integrated capacity implies a better outside option, a vertically integrated buyer will be at a disadvantage in sustaining relationships with independent suppliers.[40] Relative to otherwise similar relationships, those involving integrated buyers should have lower future value and display lower levels of cooperation.

Table 9 (re-)examines the response to various shocks distinguishing relationships that involve an integrated buyer from those that do not. Column (1) revisits the contract level results in Table 5 by considering contract defaults in response to unanticipated increases in reference prices. This provides a direct comparison of the future value across relationships that involve integrated buyers and those that do not. Results show that, all else equal, relationships involving integrated buyers are more fragile. Unexpected increases in reference prices lead to default in relationships that involve backward integrated buyers but not in otherwise similar relationships that do not involve those buyers.[41]

Column (1) shows that relationships involving backward integrated buyers can resist lower temptations (i.e., have lower future value). If this is the case, they should also display lower amounts of cooperation. Column 2 shows that this is indeed the case by revisiting results in Table 6. Demand assurance is our observable form of cooperation. The unit of observation is a relationship in a given season and the dependent variable the tons of coffee traded. In response to positive weather shocks that increase mill demand assurance concerns, relationships involving backward integrated buyers do not increase trade volumes, while those not involving integrated buyers do: integrated buyers do not provide demand assurance to independent suppliers.

Column (3) investigates supply assurance by considering the response of trade volumes to demand shocks (see Appendix II for details on the construction of the demand shock and further results). In response to demand shocks in export markets trade volumes respond positively confirming that long-term relationships also provide supply assurance to buyers. The response to these demand shocks is not different between relationships that involve integrated buyers and those that do not. Expectations about

[40] The incentive constraint above only depends on the mill's continuation value following a default, U^o_{mill}. However, since parties can use transfers to sustain cooperation, a standard implication of relational contracts models is that the *sum* of continuation values determines the amount of temptations that can be resisted in the relationship.

[41] The specification also includes relevant interactions with negative price surprises which are, as expected, all insignificant.

future trade volumes might not be the primary force driving the lower future value of relationships involving integrated buyers.

Column (4) focuses on the sample of relationships involving integrated buyers only and offers direct evidence of the outside option effect. Positive weather shocks at the mill owned by the integrated buyer *reduce* the volume traded in relationships with independent suppliers. Integrated buyers prioritize internal supply: at times of abundant supply at the owned mill, integrated buyers reduce purchases from independent suppliers including those from which they source repeatedly [42]

These results suggest that relationships involving integrated buyers have lower value and provide mills with lower levels of market assurance. Table A8 in the Appendix shows that buyers pay higher prices for identical purchases of coffee when sourcing externally and that age effects on prices are very small inside relationships involving integrated buyers. Integrated buyers must compensate independent mills for lower level of demand assurance through higher prices. Integration comes with the cost of making it harder to develop relationships with external suppliers.

5.3 Summary

In summary, relative to long-term relationships, backward integration shifts ownership of coffee to the buyer and completely removes the mill temptation to look for better trading opportunities and side-sell. The evidence supports models (such as **BGM**) in which firm boundaries change temptations to renege on relational contracts and, through this channel, matter for resource allocation. In particular, integration provides demand and supply assurance like in the models by Green (1974) and Carlton (1979). These older theories of integration, however, did not offer microfoundations and assumed exogenous costs of integration. In contrast, our evidence suggests that long-term relationships between independent firms can also provide demand and supply assurance, albeit to a less complete extent than integration. This advantage of integration comes at the cost of making it harder to trade outside, which is necessary due to demand uncertainty.

This has implications for the kind of firms that should chose to integrate. The costs associated with selling excess capacity imply that buyers never fully integrate to satisfy all their demand and, therefore, also use independent suppliers. Under the shadow of owned capacity integrated buyers are, however, at a disadvantage in sustaining relationships with independent suppliers. Given this, firms that process and require very large volumes of coffee integrate, while other firms use long-term relationships

[42]Results hold if weather at the independent mill is controlled for or not, i.e., spatially correlated weather shocks do not drive the results. Consistently with the partial demand assurance provided by relationships documented in Section 4, no similar spillover is found on the sample of non-integrated buyers that have multiple relationships.

partly sustained by relational contracts, to achieve significant degrees of supply and demand assurance. This logic might also rationalize the market configuration described in Section 2.[43]

6 Organizational Forms: Products and Costs

The main goal of this paper is to compare how different organizational forms adapt to shocks. We consider adaptation to reference prices, supply and demand shocks holding constant mill and buyer characteristics. Although our primary goal is not to explain what drives the choice of organizational forms, it is useful to explore the extent to which other margins correlate with organizational forms in our environment. This section shows that product specificity and operational efficiency, two of the most commonly considered margins, *do not* appear to be strongly correlated with organizational forms.

Product Specificity

A prominent argument for vertical integration is to secure the supply of highly differentiated inputs. A distinctive advantage of our setting is that we have extremely detailed information on the type of coffee transacted. Contracts between mills and buyers specify several categories of coffee, alongside the bean type, quality and preparation type. In total, we observe 687 unique products over the sample period. As a matter of comparison, these hundreds of products span only two ten-digit HS codes (0901110015 and 0901110025), the finest level of product classification typically used in international trade. We have already taken advantage of this detail by controlling for product fixed effects in contract-level specifications. We can, however, also explore the extent to which product characteristics vary across the different organizational forms.

Figure A6 shows that different organizational forms trade very similar coffee. The figure shows that the overall distribution of products traded inside relationships and within firms is remarkably similar. Product specificity is unlikely to be a major driver of organizational forms in this context. Across product types, Figure A7 shows that the aggregate volume of trade in a particular coffee type *negatively* correlates with the share of that product that is transacted at arm's length. That is, integration and long-term relationships appear to be used relatively more for coffee types that are more commonly traded. This correlation stands in stark contrast with product specificity being a driver of integration and/or relational sourcing, and is consistent

[43] Baker et al. (2002) model predicts that integration is preferred when market conditions are highly variable, providing a micro-foundation for Carlton (1979) observation. The relational contract logic appears to be able to micro-found other contractual assumptions central to these older theories. In a market in which most transactions happen within integrated chains or relationships sustained by informal promises buyers and sellers will not be able to buy and sell any desired quantity at prevailing prices.

with demand and supply assurance concerns: it is precisely for products that are more commonly traded that parties might find better trading opportunities and renege on past promises to trade.

Integration and, to a lesser extent, long-term relationships provide demand assurance to mills. A possibility is that it is harder to find buyers willing to provide such demand assurance for types of coffee that are particularly sensitive to weather conditions. Figure A8 shows that this is unlikely to be the case. For each type of coffee, we estimate a measure of supply sensitivity to weather conditions during the growing season (conditional on mill and season fixed effects). The figure shows that product sensitivity to weather conditions doesn't vary systematically across organizational forms.

Operating Costs

Another prominent rationale for vertical integration is to increase production efficiency. This could happen through better coordination of operations along the chains or by incentivizing particularly important non-contractible specific investments. Each season, mills report their audited operating costs. Operating costs are separately reported for differentiated and undifferentiated coffee and include outlays associated with transport of coffee during harvest, running the mill, financing, marketing of coffee and personnel costs. The costs do not include the price of coffee paid to farmers. This allows us to compare unit operating costs across organizational forms.

Table A9 reports results. Columns (1) and (2) focus on across mill comparisons. The specifications includes interactions of region, harvest season and product type to control for time-varying growing conditions around the mill, as well as several time-invariant mill characteristics. Column (1) shows that mills owned by backward integrated buyers do not have significantly lower processing costs than independent mills. Backward integration, therefore, does not appear to be associated with higher operational efficiency. Column (2) introduces, for the sample of non-integrated mills, a dummy equal to one for mills that sell mostly through relationships. Relative to mills not selling through relationships, integrated mills have significantly lower operating costs. However, integrated mills have identical unit costs to non-integrated mills that sell mostly through relationships. The evidence suggests that factors as well as outcomes which might correlate with integration and use of relationships might relate to operating costs. However, reducing operating costs is unlikely to drive the choice between integration and long-term relationships.[44]

The adaptation of different organizational forms to shocks to reference prices, sup-

[44]Columns (3) to (5) investigate mill's operating costs response to weather conditions during the growing season (the index, temperature and rainfall respectively). We find no evidence that operating costs respond differentially to weather shocks across organizational forms.

ply and demand is not consistent with models of firm boundaries that assume ex-post efficient contracting and exclusively focus on ex-ante incentive alignment (e.g., Grossman and Hart (1986), Hart and Moore (1990) and Bolton and Whinston (1992) model of supply assurance). In our environment, organizational forms shape ex-post adaptation, as in much of the work of Williamson, Klein and, more recently, Baker et al. (2011). At the same time, the evidence supports key *methodological* insights in 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, there are stark differences between backward and forward integration: the two forms of integration behave differently and likely have different purposes. We study the differences between these two organizational forms and their consequences for farmers welfare in a separate paper.[45]

7 Conclusions and Policy Implications

Can long-term relationships between firms replicate the allocation of resources achieved by integration? This paper compared integrated firms and long-term relationships between firms and how they adapt to a variety of shocks in the context of the Costa Rica coffee chain. The evidence strongly supports models in which firm boundaries change temptations to renege on relational contracts and, through this channel, impact resource allocation (see, e.g., Baker et al. (2002, 2011)). In this particular context, both organizational forms are used to mitigate the consequences of demand uncertainty and provide both demand and supply assurance, like in the models by Green (1974) and Carlton (1979). Relative to long-term relationships, however, integration achieves more complete demand and supply assurance. These benefits of integration, however, are offset by higher costs when both selling and sourcing outside the integrated chain, which is at times necessary due to inherent uncertainty in the environment. This suggests that integration will be the preferred choice for firms that need to trade large volumes and have particularly strong demand and supply assurance concerns, consistently with observed patterns in the industry.

These observations also have policy implications for industry regulation, particularly in the context of export oriented agricultural chains in developing countries. To

[45] A different strand of theoretical work considers anticompetitive effects of vertical integration. Hart and Tirole (1988) distinguish three reasons why firms might vertically integrate to foreclosure the market: ex-post monopolization, scarce needs and scarce supply. The first case, in which a relatively efficient upstream producer integrate downward to restrict output in the final market, is clearly not relevant in our context. In the other two scenarios an upstream and a downstream firm merge to ensure that they trade with each other. This mechanism echoes the supply assurance motives in Carlton (1979) (see also Bolton and Whinston (1992) and Kranton and Minheart (2000)) and is consistent with some of the evidence in the paper.

the extent that demand and supply assurance concerns are a motive for integration in these chains, a possibility entirely consistent with our analysis, theoretical models suggest that there will be too much integration relative to the social optimum: a buyer and a seller that integrate provide demand and supply assurance to each other, but make the environment more volatile for everybody else. That is, parties have stronger incentives to integrate precisely when social efficiency would require better adaptation in the allocation of demand to capacity. This prediction holds in a variety of models that differ in microfoundations for demand and supply assurance concerns, such as Carlton (1979), Hart and Tirole (1990), Bolton and Whinston (1993) and Kranton and Minheart (2000). These considerations 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)).

Structural policies (e.g., forced divestitures and line of business restrictions) have been used to curtail the negative effects of vertical integration.[46] Ethiopian coffee, Cocoa in Ghana and Cotton in Tanzania are examples of export-oriented agricultural chains in which regulations have banned vertical integration between processors and exporters altogether. These policies may involve substantial costs if integration is driven by efficiency considerations. These costs would be lower if relationships between firms can substitute for integration, as shown here. Regulations such as those in the Costa Rica coffee chain, or in the Kenya and Rwanda tea sectors, allow for vertical integration while piercing the veil of firm boundaries by overseeing transactions *between* and *within* firms. A more complete understanding of the effects of vertical integration on market efficiency, farmers welfare and optimal regulatory response requires a more structural approach that takes into account additional forces specific to agricultural chains in developing countries. This paper leaves this important endeavor for future research.

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

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Table 1: **Descriptive Statistics**

Panel A: Sellers Characteristics in Season 2011/12

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Cooperative	184	0.126	0.333	0	1
Age (seasons)	184	6,236	3,698	1	11
Quantity (tons)	184	5.675	12.359	2,300	76.431
Average price	184	4,583	0.846	2,602	7,932
% Exported	184	0.777	0.263	0	1
Number of Buyers	184	3,665	2,927	1	21
% Sold to Integrated Buyers	184	0.115	0.281	0	1

Panel B: Buyers Characteristics in Season 2011/12

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Age (seasons)	171	6.235	4.008	1	11
Quantity (tons)	171	6,090	24,658	0.440	261,336
Average price	171	4.114	1.086	1.807	7.065
% exported	171	0.409	0.463	0	1
Number of Suppliers	171	3.935	8.562	1	64
% Bought from Integrated Seller	171	0.0220	0.126	0	1

Panel C: Contract Characteristics in Season 2011/12

Variable	N. Obs.	Mean	St. Dev.	Min	Max
Vertical Integrated Buyer	4133	0.453	0.498	0	1
Vertical Integrated Seller	4133	0.143	0.350	0	1
Vertically Integrated Relationship	4133	0.143	0.350	0	1
Quantity (kilo)	4133	24,965	29,827	31.44	259,817
Contract Length (days)	4133	98.59	123.5	0	393
Export market	4133	0.800	0.400	0	1

Panel D: Relationship Characteristics in Season 2011/12

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

The Table provides summary statistics for the 2011/12 harvest campaign (please refer to Table A2 for evolution of key variables over the sample period).
Panel A presents the summary statistics for mills. Cooperative is a dummy that takes value one if the mill is owned by a farmer's cooperative. Age is the number of harvest campaigns the mill operates over the sample period dataset. Quantity is in tons of parchment coffee. Price is a weighted average price for a Kg of coffee, in dollars. % Exported is the share of production destined to the export market. Number of Buyers is the number of different trading partners for produced in the season. % Sold to Integrated Buyers refers to backward integrated buyers only.
Panel B presents the summary statistics for buyers (exporters and domestic rosters). Variables are similarly defined.
Panel C presents the summary statistics at the contract level. Vertical Integrated Buyer/Seller/Relationship are dummies taking value =1 depending on the integration status of the relevant parties involved (buyer/seller/both). Quantity is in kilos. Contract Length is the difference in days between delivery date and signing date. Export market is a dummy taking value =1 if the coffee is destined for the export market.
Panel D presents summary statistics for relationships. A mill-buyer pair are defined to be in a relationship if they have traded more than four consecutive years during the sample period. By definition then, the minimum relationship's age is 4 seasons. Quantity is in tons of coffee. Average contract length is a weighted average of contract length signed in the relationship. % of mills sales (buyer sourcing) is the share of the mill sales (buyer purchases) accounted for by the relationship. % exported is the share of coffee traded in the relationship destined for the export market.

Table 2: **Use of Organizational Forms**

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

The Table summarizes the use of the three organizational forms by mills and buyers depending on their integration status. A mill and a buyer are defined to be in a relationship if they have traded more than four consecutive years during the sample period (baseline definition). To avoid censoring, Mills and Buyers that do not operate at least four seasons over the sample period are omitted. This excludes micro-mills and occasional exporters that account for a tiny share of aggregate volumes. Forward integrated chains are excluded. Forward integrated chains look very different. Forward integrated mills export approximately 30% of their produce directly and split the remaining between 46% in relationships and 22% in the market. They also only export coffee they produce (95%). Figures are averages across firms and harvest seasons (2001-2013).

Table 3: **Correlates of Integration and Relationships - Mills**

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

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

Table 4: **Correlates of Integration and Relationships - Buyers**

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

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table shows that buyer characteristics that predict integration also predict relational sourcing on the sample of non-integrated buyers. All independent variables are standardized. Size measures the average volume of coffee bought during the 2008-20011 harvest campaigns. Age is the number of harvest seasons the buyer has been operating (left censored). Share exported is the average percentage of sourced coffee that is exported by the buyer.
Columns (1) to (3) report results from a multinomial logit in which buyers characteristics are correlated with the buyer's organizational form. We distinguish three organizational forms: backward integrated buyers that own mills (coefficients in Column (1)); independent buyers that source most of their produce through long-term relationships (coefficients in Column (2)); and other independent buyers. Column (3) test for the equality of coefficients between the two forms.
Column (4) reports results from a probit model predicting weather a buyer is backward integrated. The predicted integration score in Column (4) is correlated with the percentage of the production sourced through relationships in Columns (5) to (6). The baseline definition of relationship (mill-buyer pairs that have traded more than three consecutive seasons are classified as relationships) is used.
Columns (7) and (8) focus on the sample of exporters for which information on the structure of relationships downstream is available. Column (7) reports results from a probit model predicting weather a buyer is backward integrated. Share sold to roasters, concentration of foreign buyers and share exported during harvest are computed matching transactions level export data that include the name of foreign customers. The predicted integration score in Column (7) is correlated with the percentage of the production sourced through relationships in Column (8) using the baseline definition of relationship (mill-buyer pairs that have traded more than three consecutive seasons are classified as relationships). All specifications exclude export licenses held by forward-integrated mills.
All specifications exclude forward-integrated chains. Results are similar if those are included. Characteristics associated with forward integrated are however quite different from those associated with backward integration. Most notably, cooperative cannot be, by definition, owned by downstream buyers but do often integrate forward.

Table 5: **Price Surprises and Strategic Default**

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

Robust standard errors (clustered by mill-buyer pair) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. This table shows that relationships and integration mitigate opportunism. In all columns OLS are estimated, a contract between a mill and a buyer is an observation and the dependent variable is a dummy=1 if the contract is canceled. Price surprise is defined as the ratio between the spot NYC price for Arabica at the date of delivery and the NYC future price for Arabica for the delivery date at the time the contract was signed. Positive (negative) price surprises are for ratios above (below) one. Controls include contract volume (third-degree polynomial in Kilos of coffee on the contract), contract duration, a dummy for national market contracts, the month of the contract signature, mill size and region where the mill is located. Product FE are a set of (311) dummies for product types (preparation, quality and bean grading). Columns (4) and (5) also include the interaction between negative price surprises and organizational forms. All the (unreported) coefficients are nearly zero and none is significant. Controls interacted with price surprise include mill size, age, suitability and variability (defined in Table 3). The sample period covers the harvest campaigns from 2004/05 to 2012/13 for which data on contract cancellations are available. The sample excludes trade involving forward integrated mills.

Table 6: **Weather and production**

	(1)	(2)	(3)	(4)
Panel A	Total Quantity Sold (ln)			
Weather index	0.2809***	0.3005***	0.2102**	0.4429***
	(0.063)	(0.078)	(0.084)	(0.121)
Panel B	Total Quantity Sold (tons)			
Weather index	202.0629***	127.2804***	378.6121**	242.8537***
	(61.179)	(40.015)	(158.753)	(66.519)
Panel C	Quantity Sold in Non-Market Channels (tons)			
Weather index	172.0602***	83.2776**	384.7616***	161.2698***
	(54.533)	(33.834)	(145.137)	(60.028)
Observations	927	835	92	213
Sample	All	Non-integrated	Integrated	Large non-int.
Season FE	Yes	Yes	Yes	Yes
Mill FE	Yes	Yes	Yes	Yes
Ratio (C/B):	0.85	0.65	1.02	0.66

Robust standard errors (two-way clustered at the mill and season level) in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table investigates the reduced form relationships between weather conditions during the growing season and mill's aggregate production, presenting results that correspond to Figure ??. Panel A reports results measuring mill's production in logs, Panel B measuring mill's production in levels, and Panel C looks at quantity sold in the non-market channels, i.e., integrated for integrated mills and relational for non-integrated ones (baseline definition). The Table reports results on the overall sample of mills (Column (1)) as well as splitting the sample between non-integrated (Column (2)) and integrated (Column (3)) mills. Column (4) presents the results for large non-integrated mills (defined as those with capacity larger than the smallest integrated mill). Weather conditions are the z-score of temperature and rainfall realizations around the mill during the growing season.

Table 7: **Weather Conditions and Timing of Sales**

	(1)	(2)	(3)	(4)
	Date of first season sales			
Mills	Integrated		Non-Integrated	
Channel	Non- market	Market	Non-market	Market
Weather index	-49.8246**	11.9369	-63.1050**	6.3002
	(22.859)	(30.549)	(29.900)	(20.116)
Observations	92	21	191	176
R-squared	0.058	0.003	0.019	0.000
Season FE	Yes	Yes	Yes	Yes
Mill FE	Yes	Yes	Yes	Yes
Weather definition	Index	Index	Index	Index

Robust standard errors (two way clustered at the mill and season level) in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table investigates the reduced form relationships between weather conditions and the timing of sales across firms and organizational forms. For each season, mill and marketing channel we define the calendar date in which the mill begins signing sale contracts. Columns (1) and (2) focus on integrated mills and distinguish between the integrated channel and the market channel. Columns (3) and (4) focus on large non-integrated firms (those with capacity larger than the smallest integrated mill) and distinguish between the relational and the market channels. The Table shows that the integrated and relational channels respond to exogenous increase in supply by starting to contract earlier in the season while market transactions do not. Integration and relationships provide demand assurance. Weather conditions are the z-score of temperature and rainfall realizations around the mill during the growing season.

Table 8: **Propensity to Sell and Demand Assurance**

	(1)	(2)	(3)	(4)
	Quantity Sold in Non-Market (tons) - OLS			
Mill quantity (tons)	0.9299***	0.7630***	0.9662***	0.7417***
	(0.032)	(0.072)	(0.026)	(0.075)
	Quantity Sold in Non-Market (tons) - IV			
Mill quantity (tons)	0.8515***	0.6543***	1.0162***	0.6641***
	(0.052)	(0.109)	(0.040)	(0.124)
Observations	927	835	92	213
Sample	All	Non-integrated	Integrated	Large Non-Integrated
Season FE	Yes	Yes	Yes	Yes
Mill FE	Yes	Yes	Yes	Yes
Cragg-Donald Wald F test	63.03	72.39	7.277	36.76
Average share (ρ)		0.47	0.96	0.64
Test Coef = Average share		2.85*	1.73	0.03
p-value		0.0912	0.1888	0.8656
Column (3) vs (4), Panel B:				
Chi 2				4.48**
p-value				0.0344

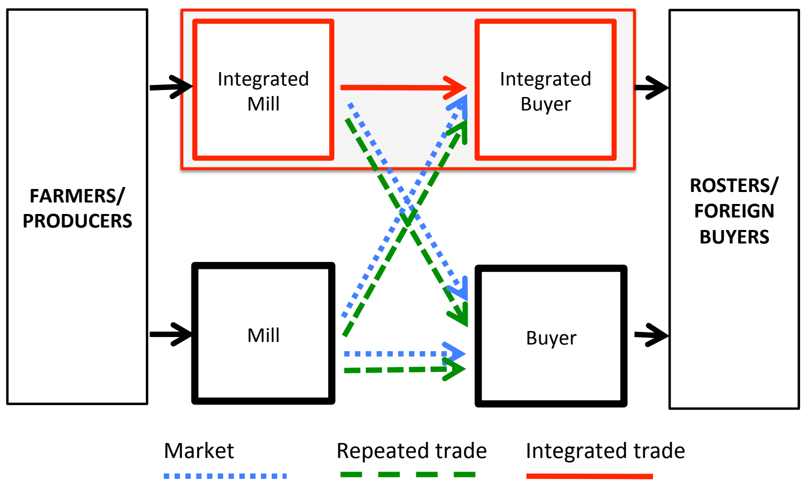
Robust standard errors (two way clustered at the mill and season level) in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table investigates the propensity to sell additional production to the non-market channels (integration for integrated mills and relational for non-integrated mills). Panel A reports OLS results and Panel B 2SLS results (with corresponding first stages in Table 6). The Table reports results on the overall sample of mills (Column (1)) as well as splitting the sample between non-integrated (Column (2)) and integrated (Column (3)) mills. Column (4) presents the results for large non-integrated mills (capacity over the smaller integrated mill). Weather conditions are the z-score of temperature and rainfall realizations around the mill during the growing season.

Table 9: **Heterogeneity**

	(1)	(2)	(3)	(4)
Dependent variable:	***Default***	***Quantity traded***		
Non-Integrated Buyer X Shock	-0.0205	28.97**	11.8879*	
	(0.024)	(10.01)	(7.040)	
Integrated Buyer X Shock	0.0564*	3.04	24.3356+	
	(0.034)	(7.90)	(16.677)	
Own Shock				16.5919
				(20.242)
Shock to Mills owned by integrated buyer				-32.2231**
				(14.737)
Observations	11,876	1,602	1,301	676
R-squared	0.331	0.617	0.349	0.372
Shock	Price Surprise	Weather	Foreign Demand	Weather
Relationship Definition	Baseline	Baseline	Baseline	Baseline
Controls	Yes	yes	yes	yes
Season FE	Yes	yes	yes	yes
Partners FE	Relationship	Buyer	Seller	Seller

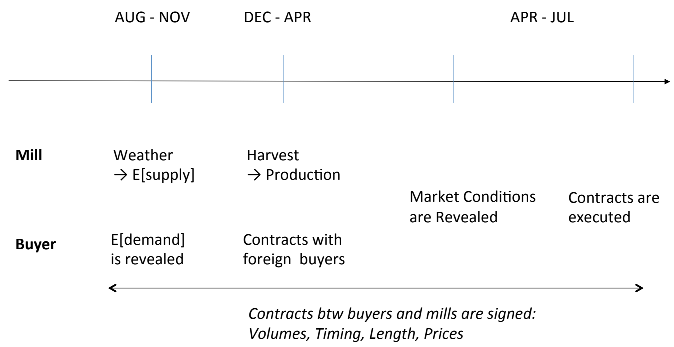
Robust standard errors (cluster relationship) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table explores heterogeneous responses to shock between relationships that involve backward integrated buyers and those that do not. The Table shows that relationships involving backward integrated buyers are more fragile and provide less demand assurance. In all Columns, the sample is restricted to trade within relationships and excludes forward integrated chains. Column (1) reproduces the specification in Column (4) of Table 5 distinguishing the effect of positive price surprise by type of relationships. The unit of observation is a contract, and the dependent variable a dummy taking value equal to one if the contract is canceled. In Columns (2) to (4) the dependent variable is tons of coffee traded inside a relationship in a given year. Column (2) uses the baseline weather condition as supply shock. Column (3) uses foreign demand like Table A10 in the Appendix. Column (4) focuses on the sample of relationships with backward integrated buyers only, and distinguishes between weather conditions at the supplying mill and at the mills owned by the integrated buyers.

Figure 1: **The Coffee Value Chain**



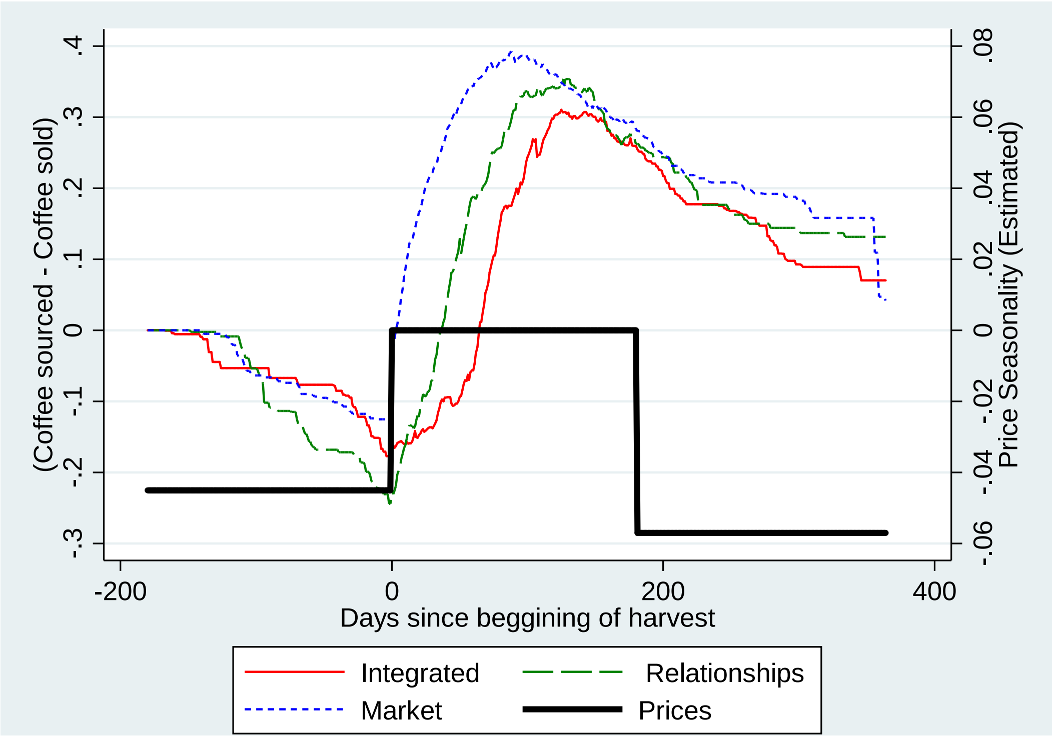
The Figure describes the coffee value chain in Costa Rica. Coffee cherries are produced by farmers and sold to Mills (Coffee Washing Stations or Beneficios). Mills sell parchment coffee to domestic buyers. These consolidate, mix and mill the coffee before selling to foreign buyers or to domestic rosters. 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.

Figure 2: **Timing of Contracts, Production and Sales**



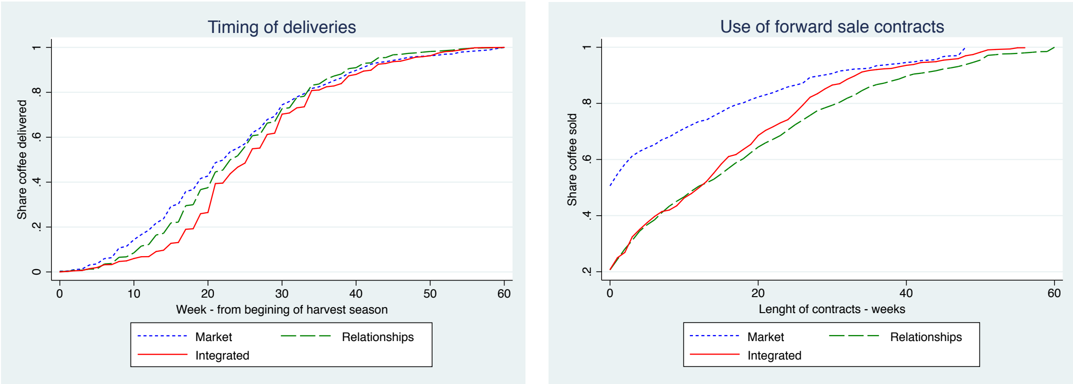
The Figure illustrates the unfolding of the coffee season. During the growing season (approximately from August to November) weather conditions influence the amount of coffee eventually harvested by farmers. Coffee is harvested and processed by mills during the harvest season (December to April). Finally, coffee is delivered (and contract sales are executed) as coffee is processed and until the beginning of the following harvest season, when newer (and more valuable) coffee becomes available. To reduce risk, parties sign contracts throughout the entire season, including contracts for future delivery signed even before the beginning of harvest (forward sale contracts).

Figure 3: **Inventory Risk**



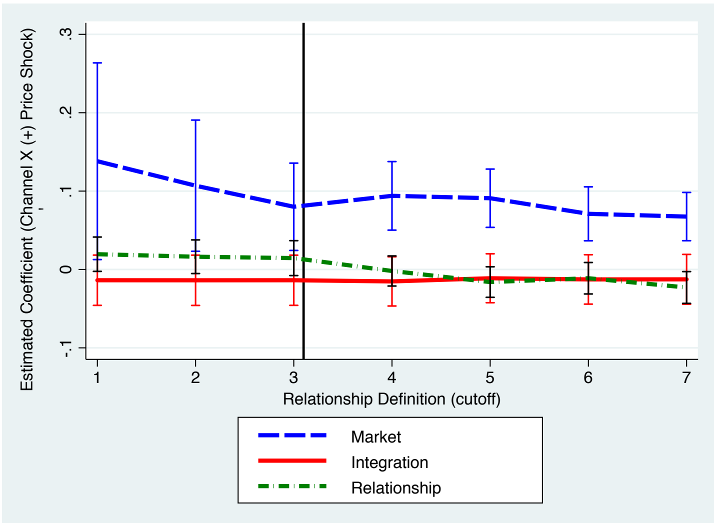
The Figure shows that demand uncertainty is an important concern in this market. The Figure plots the difference between processed coffee and coffee committed for sales as a share of the coffee eventually sourced in that season during the course of the harvest campaign. For each day relative to the beginning of harvest, the left vertical axis reports the average net inventory position of different types of mills across seasons. Three types of mills are considered: those owned by integrated buyers, those selling mostly through long-term relationships, and those selling mostly through arm's length market trade. A mill is classified as selling through relationships when it sells more than half of its coffee through relationships (baseline definition). The time is measured relative to the beginning of the harvest season in the region. Average figures for all seasons where data on coffee received by the mill is available (2008/9 to 2011/12) are reported. Mills start signing forward contracts before the beginning of the harvest campaign. As harvest begins mills source coffee faster than they sign sales contracts. Eventually, one year after the beginning of the harvest season mills are left with a certain percentage of unsold coffee. Mills are willing to pay a price to reduce inventory risk. The Figure also reports (on the right vertical axis) estimated seasonality effects on prices. All else constant, prices are approximately 4.15% lower for contracts signed before the beginning of harvest. Mills are willing to accept lower prices to avoid having to sell coffee after the end of the harvest season when prices are, all else constant, 5.7% lower (see Table A3 for regression results). Relative to mills selling mostly through arm's length contracts, integrated mills sign fewer contracts before harvest begins and have lower exposure to demand risk. Mills that sell most of their coffee through long-term relationships have inventory risk comparable to those of integrated mills and lower than the one of mills selling mostly through arm's length contracts. Relative to integrated ones, mills selling through long-term relationships reduce inventory risk by signing more forward contracts before the beginning of harvest season with their long term buyers.

Figure 4: **Timing of Delivery and Contract Length**



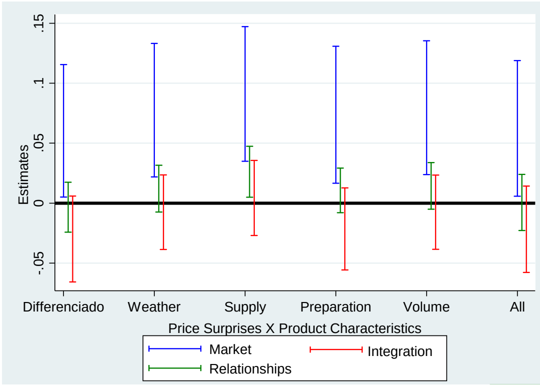
The Figure shows that relationships and integration have similar patterns with respect to the form and timing of trade. The Left Panel reports the cumulative share of coffee sold by delivery date by organizational forms. The delivery date is measured in weeks relative to the beginning of the harvest campaign in the region of the mill. The Right Panel reports the cumulative share of coffee sold by length of contract, measured in weeks, across organizational forms. The length of the contract is defined as the difference between the delivery date and the contract signing date. In both cases, patterns of trade within integrated firms look much more similar to patterns inside long-term relationships than in the market. The Figures are constructed averaging contracts seasons 2008/9 to 2011/12 and excluding trade inside forward integrated chains.

Figure 5: **Price shocks - Robustness to Relationship Definition**



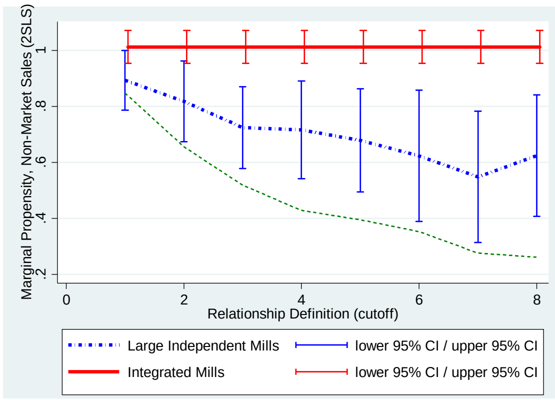
The Figure shows that different definitions of relationships give qualitatively identical results. The y-axis reports estimated coefficients (and 95% confidence intervals) for the interaction between positive price surprises and marketing channels. The underlying estimated regressions are like those in Column (4) of Table 5. The x-axis reports the cut-off r used to distinguish market and relationships: mill-buyer pairs that trade for more than r consecutive season are defined to be in a relationship. The Figure reports results from $r \in 1, 2, ...7.$. The reference line at $r = 3$ is the baseline definition. As r increases more transactions inside "relationships" are classified as market. Across all specifications the main results are confirmed: positive price surprises i) are associated with contract default in the market; but ii) not inside integrated firms nor relationships.

Figure 6: **Price shocks - Robustness to Product Characteristics**



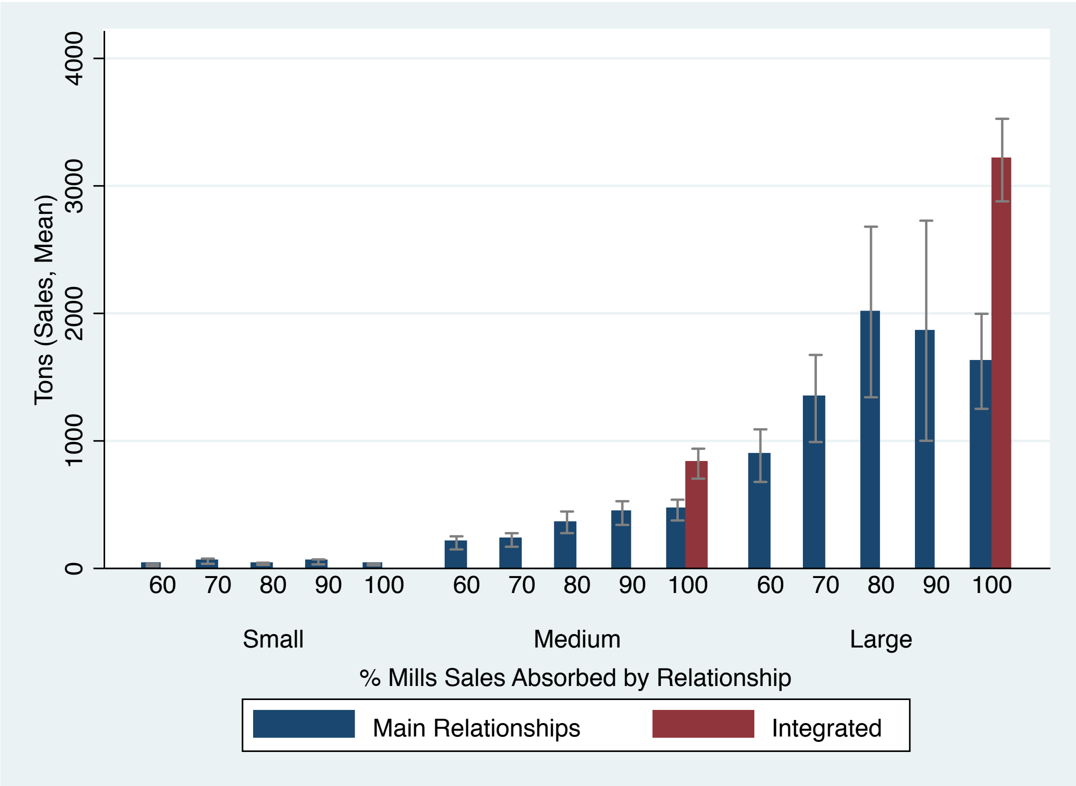
The Figure shows that the differential effect of price surprises on contract defaults is robust to the inclusion of interactions between product characteristics and price surprises. The y-axis reports estimated coefficients (and 95% confidence intervals) for the interaction between positive price surprises and organizational forms. The underlying estimated regressions are like those in Column (4) of Table 5. The regressions are estimated separately including the interaction between price surprises and different product characteristics. Product characteristics are i) whether the coffee is differentiated or not, ii) a measure of sensitivity of the coffee type to weather conditions; iii) the relative supply of the type of coffee; iv) the type of preparation; v) the average volume of coffee transacted; vi) all those together. Results are remarkably robust, reflecting the fact that the product mix doesn't vary systematically across organizational forms (see Figure **??**).

Figure 7: **Weather Shocks - Robustness to Relationship Definition**



The Figure shows that the results on demand assurance in Section 4 are robust to different definition of relationships. The y-axis reports estimated coefficients (and 95% confidence intervals) for the 2SLS estimates of the propensity to sell additional coffee through non-market channels. The specifications correspond to Columns (3) and Columns (4) of Panel B in Table 8. The x-axis reports the cut-off r used to distinguish market and relationships: mill-buyer pairs that trade for more than r consecutive season are defined to be in a relationship. The figure reports results from $r \in 1, 2, 3, \ldots 8.$. The cut-off $r = 3$ gives the baseline definition. The solid line reports estimated propensity to sell through the integrated channel by integrated mill. The dash-dot line reports propensity to sell through the relational channel by large independent mills. Finally, the thin dotted line reports the average share of coffee sold through relationships ρ by the large independent mills using the different cut-offs r. The three main results hold regardless of cut-off r used: i) relationships provide demand assurance; ii) albeit to a less extent than integration; iii) the point estimate is always larger than ρ. Note that as r increases more transactions inside "relationships" are classified as market: the estimates diverge from integration.

Figure 8: **Discontinuity at the Firm Boundary**



The Figure shows that integrated relationships trade higher volumes of coffee than (nearly) exclusive relationships for mills of comparable size. On the y-axis the Figure reports average (and confidence interval) volumes of coffee traded by different types of relationships in a given season. Relationships are classified according to i) size of the mill, and ii) degree of exclusivity. Mills are classified in three categories: small (1st quartile of size distribution), medium (2nd and 3rd quartiles) and large (4th quartile). All but one integrated mills are in the 4th quartile (one mill in the 3rd quartile). Only main relationships are considered. Main relationships are those that account for the largest share of sales for a mill in a given year. Main relationships are split by the share of a mill's sales their account (deciles at 60%, 70% ... 100%). All integrated relationships have exclusivity near 100%. The Figure shows that compared to (nearly) exclusive relationships of mills of comparable size integrated relationships trade higher volumes. The Figure excludes forward integrated mills.

Appendix I. Regulations Details and Data (For Online Publication)

I.1 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".[47]

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 A2, is as follows:

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

2. *Contracts between mills and buyers.* Every sale contract between 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 A3 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 rule that detracts from the mill's sales *i*) audited processing costs, *ii*) allowed profit margin, *iii*) any previous amount paid to farmers, *iv*) a contribution to the national coffee fund. The final price for each mill is published in newspapers

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

and the corresponding payments to farmers must be executed by the mills within eight days of publication.[48]

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.[49] Figure A4 shows that undisclosed minimum prices do not bind. The main empirical analysis focuses on volumes and timing of transactions, not on prices.

Registering contracts with the board improves enforcement. The board enforces standards: the contract must specify type of bean (8 categories), quality of parchment (7 categories) and preparation type (8 categories). A total of 336 different types of parchment coffee are observed in the data.[50] 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 under specific circumstance. The board allows mills to cancel contracts for one of the following reasons: (A) when there is agreement by both sides to substitute the contract for another one with a better price, (B) when the mill does 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.

I.2 Data

The primary data source is the ICAFE. Together with the annual reports, used to construct the descriptive tables, we obtained detailed information on transactions between

[48] 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.

[49] 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).

[50] 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.

mills and buyers, and on buyer's characteristics.

- *Transactions*: The data on contracts includes information on 44282 contracts between mills and buyers spanning 12 harvest seasons (from 2001-2002 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 onward, and includes the reason for the contract cancellation.

- *Mills*: From the 2006-2007 seasons onward we are able to match the transaction data with information on mills operation from the ICAFE. This includes information on the operating costs, the prices paid to farmers, the rate of coffee conversion from cherries to beans. Information on sourcing of coffee is also available in two forms: i) bi-weekly reports of all coffee sourced by mills (by two broad categories) and ii) aggregate volumes and number of farmers supplying each mill by season and location. We complement this information by reconstructing, through a mix of ICAFE records, interviews and internet searches, the history of mill's operation and ownership type during the sample period. To do so we extensively rely on information on the location of the mills, which we then complement with detailed geographic data, including both geographic characteristics, historical weather data and infrastructures.

- *Buyers and Exporters*: Information on buyers includes whether they own a mill and history of operation. This information is compiled through a combination of ICAFE records, internet searches and interviews. For the subset of buyers that are exporters we match the information with transaction level customs records from season 2006-2007 onward (information on foreign buyers is available for seasons 2008-2009 to 2012-2013 only). We match this information with data on coffee imports by the countries that source from Costa Rica obtained from the Commodity Trade Statistics Database.

- *Daily prices*: We collect daily world coffee prices for coffee from public sources. Specifically, we collect price data on the Coffee C future contract (KC) traded in New York, the world benchmark for Arabica coffee. The contract prices physical delivery of a standard quantity (37,500 pounds) exchange-grade green beans, from one of 20 countries of origin (including Costa Rica) in a licensed warehouse to one of several ports in the U. S. and Europe. Costa Rica coffee trades at par (i.e., with no premium or discount). Contracts are listed for the months of March, May, July, September and December and are traded up to one business day prior to the last notice day (which is seven business days prior to first business day of delivery month). So, for each date in the sample, we observe prices for the next four delivery months. We match each transaction in our sample to the nearest subsequent delivery date: e.g., a contract signed on April 1st for delivery on November 30th is assigned the future price for December delivery. The contract specific price surprise is then given by the ration between the December listed price at the contract delivery date divided by the December listed price at the contract signing date. ICAFE also publishes daily information on the maximum, minimum and average price signed on contracts registered that day alongside the nearest listing of the KC contract. ICAFE however doesn't disclose minimum differentials applied for contract registration. Figure A4 presents the time series from 2010 to 2014 and shows that i) prices in Costa Rica closely follow the evolution of the standard KC price; and ii) at each point in time there is substantial variation across contracts in prices, i.e., the (undisclosed) minimum floor is not binding for most contracts.

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

Appendix II. Demand Shocks and Supply Assurance (For Online Publication)

Section 3 shows that integration and relationships between firms mitigate supplier's opportunism and improve supply assurance. Default on signed contracts, however, are likely to reveal only the tip of the iceberg: buyers' main supply assurance concerns likely involve the possibility that the mill might renege on a promise to sign contracts and trade at a future date. In this Appendix we investigate supply assurance further by analyzing how trade volumes within relationships respond to exogenous shocks to a buyer's demand. To construct exogenous shocks to a buyer's demand we match transaction-level export data with aggregate imports of coffee in export markets. The results show what in response to exogenous increases in demand both backward integrated and non-integrated exporters significantly increase coffee purchased from relationships.

Correlations between exporter characteristics and organizational forms suggest that relational sourcing might be used to achieve supply assurance. Exporters enter long-term supply arrangements with foreign buyers, either formal or informal. The structure of a buyer's downstream demand (share of advance contracts, share sold directly to roasters, concentration of foreign buyers) correlates with both backward integration and relational sourcing.

To formally investigate supply assurance we construct Bartik-like demand shocks for the sample of exporters. Exporter b sales to foreign market c are matched to aggregate imports of coffee in country c in year t to construct

$$Z_{bt} = \Sigma_c sh_{bc} \times I_{ct} \tag{6}$$

where I_{ct} are aggregate imports of coffee in country c in year t and sh_{bc} is the average share of coffee exporter by buyer b to country c during the sample period. The variable Z_{bt} captures idiosyncratic increases in demand originating from buyers exposure to different destination markets. Figure A9 confirms that Z_{bt} strongly correlate with aggregate sourcing at the buyer-year level. The Figure plots non-parametric *lowess* regression between (residuals of) the standardized demand index Z_{bt} and (residuals of) aggregate buyer's exports on buyer and season fixed effects. The empirical specifications closely follows those used in Section 4 to investigate trading response to weather conditions during the growing season. Table A10 reports the results. In the reduced form specification (Panel A) we estimate the following specification:

$$y_{bt} = \alpha_b + \mu_t + \beta_b \times Z_{bt} + \varepsilon_{bt} \tag{7}$$

where y_{bt} is the total export volume of buyer b in season t, $alpha_b$ are buyer fixed effects and mu_t are season fixed effects.

We estimate the relationship on three different samples of exporters: backward integrated, all non-integrated and large non-integrated. In all cases we find that the standardized demand shock positively correlates with aggregate exports. Relative to the mill results, however, the effect is considerably larger for the integrated buyers, as those are much larger than even the largest non-integrated ones.

Panels B, C and D consider as dependent variable y_{bt} the amount of exported coffee that is sourced through relationships. Panel B considers the reduced form, while Panel C and D consider the OLS and 2SLS specifications in which buyer's total export volumes are instrumented using the demand shock. An important difference with respect to the specifications investigating mills responses to weather conditions is that backward integrated buyers also use relationships to source coffee (see Table 2). We therefore report results from four different regressions: i) exported volumes sourced through owned mills by backward integrated buyers (Column (1)); ii) exported volumes sourced through relationships by backward integrated buyers (Column (2)); iii) exported volumes sourced through relationships by all non-integrated buyers (Column (3)) and iv) by large non-integrated buyers only (Column (4)).

The results suggest that relationships do provide supply assurance: irrespective of the sample an additional ton of export demand translates into 0.4 to 0.5 additional tons sourced through relationships (Panel D, Columns (2) to (4)). The point estimate is somewhat smaller for the integrated mills (although it is also less precisely estimated). As noted in Section 4, integrated mills sell everything they have to their integrated buyers. Given integrated buyers always need more, most of the time the integrated mill will not respond to increases in demand from the integrated buyers due to capacity constraints. This is consistent with the stark differences in the direction of the OLS bias for integrated buyers: the OLS coefficient is biased upward for the integrated channel (owned mill supply induces both higher internal sourcing and aggregate exports) and downward biased for relationships (for the opposite reason, since as shown in Table 9 integrated buyers substitute relational sourcing when owned supply increases).[51]

The results suggest relationships provide supply assurance. Relative to the price and weather shocks responses examined in the main text, these results should however be interpreted with greater caution. In particular, the constructed demand shocks confound exogenous increases in buyers demand that occur before and after suppliers production decisions have been made. This distinction is, however, key. In particular, changes in expected supply due to weather conditions before production takes place al-

[51]Results are robust to i) considering total volumes sourced rather than volumes sourced only for export markets; ii) alternative definitions of demand shock (using only imports from Latin American Countries); iii) both more and less conservative definitions of relationships.

low to clearly isolate demand assurance concerns; while changes in reference prices after production decisions are sunk allow to isolate side-selling opportunities. In contrast, increases in buyer's demand might be anticipated (in which case, we might expect the buyer to rely on relational sourcing to increase deliveries later on) or occur ex-post, in which case even a committed supplier might not be able to fully accommodate the additional demand.[52]

The evidence is consistent with a quid-pro-quo inside relationships: buyers provide mills with demand assurance; mills provide buyers with supply assurance. Before concluding, we investigate how prices evolve during the course of the relationship. An implication of models with demand uncertainty is that prices should reflect the cost of carrying underutilized capacity and unsold stocks (see, e.g., Carlton (1979), Dana (1998)). If relationships provide demand assurance to mills, then, we expect prices to decrease with the age of the relationships and converge to the level observed within integrated firms (which provide complete demand assurance).[53] This prediction is confirmed by results in Table A8. The result, derived from contract-level specifications similar to those in Section 3, holds controlling for detailed product, time and mills-buyer pair fixed effects as well as mill and buyer time varying controls.[54]

[52]Furthermore, as is common in this literature, the demand instruments do not yield particularly strong first stages. While the point estimates are reasonable results should be interpreted with caution.

[53]The quid-pro-quo could entail other forms of cooperation. For example, Blouin and Macchiavello (2013) and Macchiavello and Morjaria (2015) provide evidence that buyers are often provider of working capital finance to mills. This mechanism would also predict that prices decrease over the course of a relationship.

[54]While reported prices within integrated firms might confound other forces (e.g., removal of double marginalization, transfer pricing) a similar convergence between age effects inside relationships and integrated trade is observed with respect to timing of contracting and contract default. See Table A7 and Table A8 for further details.

Appendix III. Tables and Figures (For Online Publication)

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. The first part of the Table reports variation in typical harvest time across regions. This variation is used to identify price seasonality in prices and to construct indexes of weather suitability and variability and weather conditions during the growing season. The second part of the Table illustrates across season variation in production shares across seasons. This variation is related to the idiosyncratic variation in production at the mill-season level generated by weather conditions during the growing season.

Table A2: **Summaries**

Sales season	(1) Num. Mills	(2) Num. Buyers	(3) Num. Relationships	(4) Share Integrated	(5) Share Relationships	(6) Share Market	(7) Num. Contracts
2001-2002	94	113	123*	0.3983	0.2785	0.3230	3899
2002-2003	94	122	134*	0.3616	0.3423	0.2960	3457
2003-2004	98	118	143*	0.3895	0.3745	0.2358	3387
2004-2005	103	127	171	0.4407	0.3604	0.1987	3198
2005-2006	113	120	190	0.4224	0.3896	0.1879	3460
2006-2007	127	134	188	0.3895	0.4461	0.1642	3639
2007-2008	136	129	201	0.4312	0.4370	0.1316	3789
2008-2009	146	139	227	0.4146	0.4631	0.1221	3513
2009-2010	161	138	221	0.3748	0.4727	0.1523	3475
2010-2011	173	150	206**	0.4174	0.4205	0.1619	3821
2011-2012	184	171	178**	0.4240	0.3969	0.1790	4133
2012-2013	186	121	153**	0.449	0.3841	0.1662	3328
Unique Identifiers	287	356	277				43099

(*) Left Censored, (**) Right Censored. A mill-buyer pair are defined to be in a relationship if they have traded more than four consecutive years during the sample period. By definition then, observations for the first (last) three seasons over the sample period are left (right) censored. The contract level data cover the sample period spanning harvest seasons from 2001-02 to 2012-13 (12 harvest seasons). Column (1) reports the number of active mills in each season. The number of mills has increased over time due to the entry of micro-mills which account for a very small share of the market. Column (2) reports the number of buyers active in each season, including mills that have exported directly. Column (3) reports the number of active relationships in each season, according to the baseline definitions. Columns (4) to (6) describe the evolution of the share of trade occurring within integrated firms, within relationships and in the market respectively. Column (7) reports the number of contracts signed in each season. Throughout the sample the industry has been remarkably stable in both dimensions.

Table A3: **Seasonal evolution of prices**

	(1)	(2)	(3)	(4)
Dependent variable:		***Unit price (ln)***		
Pre-Harvest	-0.0254*	-0.0232+	-0.0449***	-0.0415***
	(0.015)	(0.015)	(0.016)	(0.016)
Post-Harvest	-0.0547***	-0.0552***	-0.0568***	-0.0570***
	(0.008)	(0.008)	(0.009)	(0.009)
Observations	5,618	5,618	2,279	2,279
Region Season FE	Yes	Yes	Yes	Yes
Region Seasonality FE	Yes	Yes	Yes	Yes
Product FE	Yes	Yes	Yes	Yes
Mill & Buyer FE	Yes	Yes	Yes	Yes
Contract controls	No	Yes	No	Yes
Arm's Length Trade only	Yes	Yes	Yes	Yes
Integrated Excluded	No	No	Yes	Yes

Robust standard errors (two-way clustered at mill and buyer level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15

The Table illustrates seasonality effects on prices. The coefficients estimated in Column (4) are reported in Figure 3. The unit of observation is a contract. Only contracts in arm's length market trade are included (i.e., those not involving parties within an integrated chain or in a long-term relationship). Columns (3) and (4) also exclude arm's length trade involving either an integrated buyer or mill. The dependent variable is the log of price per Kilo. Pre-Harvest (Post-Harvest) is a dummy taking value =1 if the contract is signed at a date preceding (following) region- and season- specific beginning (end) dates for the harvest computed using biweekly reports of coffee delivered by farmers to mills. As a result, the seasonality effects are estimated controlling for region-specific season and seasonality effects. Identification is therefore obtained from across regions variation in the timing of harvest. Product fixed-effects are a set of (311) dummies for product types (type, preparation, quality and bean grading). This allows to control for differences in the quality of coffee since those are controlled for by more than three hundreds product fixed effects (which include an indicator of when the coffee was harvested). Contract controls include a third-degree polynomial in Kilos of coffee on the contract and a dummy indicating whether the contract is for the national or export markets.

Table A4: **Consequences of default**

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

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

Table A5: **Robustness - Definition of large mill**

	(1)	(2)	(3)	(4)
	Quantity sold in relationships (tons)			
Mill quantity (tons)	0.6641***	0.5876***	0.6402***	0.6393***
	(0.124)	(0.137)	(0.114)	(0.129)
Observations	213	265	546	274
R-squared	0.647	0.627	0.644	0.644
Sample	Large non-integrated			
Size Cut-Off	LL	LLC	LL50	LL75
Season FE	Yes	Yes	Yes	Yes
Mill FE	Yes	Yes	Yes	Yes
Cragg-Donald Wald F test	36.76	38.72	53.64	33.41
Benchmark share	0.64	0.42	0.60	0.41
Chi2 (P-value)	0.03 (0.8656)	3.88** (0.0489)	0.01 (0.9259)	1.64 (0.2005)

Robust standard errors (two-way clustered at the mill and season level) in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table presents the robustness of Table 8 with alternative definition of large non-integrated mills. Columns (1) defines a non-integrated mill as large if it's production is larger than the smaller integrated mill. Column (2) if the mill has more capacity than the smallest integrated. Column (3) and Column (4) define a non-integrated mill as large if its production is larger than the median / 75th percentile respectively.

Table A6: **Robustness - Weather and production**

	(1)	(2)	(3)	(4)
	Quantity Sold in Non-Market (tons)			
Mill quantity (tons)	0.8515***	0.6543***	1.0162***	0.6641***
	(0.052)	(0.109)	(0.040)	(0.124)
Weather definition	Weather z-score at the Mill			
Cragg-Donald Wald F test	63.03	72.39	7.277	36.76
Mill quantity (tons)	0.8385***	0.6042***	1.0201***	0.5720***
	(0.060)	(0.113)	(0.044)	(0.152)
Weather definition	Temperature at the Mill (Standardized)			
Cragg-Donald Wald F test	62.98	63.89	8.116	36.30
Mill quantity (tons)	0.8990***	0.7274***	1.0314***	0.7501***
	(0.041)	(0.096)	(0.042)	(0.093)
Weather definition	Rainfall at the Mill (Standardized)			
Cragg-Donald Wald F test	47.10	43.96	6.222	21.90
Mill quantity (tons)	0.8635***	0.6658***	1.0208***	0.6815***
	(0.052)	(0.110)	(0.036)	(0.123)
Weather definition	Weather z-score in the Catchment Area			
Cragg-Donald Wald F test	61.43	67.00	7.635	35.32
Mill quantity (tons)	0.8567***	0.6692***	1.0405***	0.5397**
	(0.062)	(0.139)	(0.052)	(0.214)
Weather definition	Weather z-score at the Mill			
Instrument X (standardized) mill controls	Yes	Yes	Yes	Yes
Cragg-Donald Wald F test	56.66	60.68	8.305	24.92
Observations	878	786	92	210
Sample	All	Non-Integrated	Integrated	Large Non-Integrated
Season FE	Yes	Yes	Yes	Yes
Mill FE	Yes	Yes	Yes	Yes

Robust standard errors (two-way clustered at the mill and season level) in parentheses: *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. The Table presents the robustness of Table 8 with alternative weather measures (rain, temperature, and weather index at the mill catchment area) and to the inclusion of the interaction of the instruments with mill controls (being a cooperative mill, terrain suitability and variability of growing conditions). The Table reports results on the overall sample of mills (Column (1)) as well as splitting the sample between non-integrated (Column (2)) and integrated (Column (3)) mills. Column (4) presents the results for large non-integrated mills (those with capacity larger than the smallest integrated mill).

Table A7: **External Sales of Integrated Mills**

	(1)	(2)	(3)	(4)
Dependent variable:	***Unit price (ln)***			
Integrated Mill	-0.095**	-0.068***	-0.043*	-0.014
	(0.043)	(0.017)	(0.024)	(0.083)
Observations	24,317	24,317	7995	626
R-squared	0.75	0.93	0.94	0.98
Season x Region FE	Yes	Yes	Yes	Yes
Month of Sale X Region	Yes	Yes	Yes	Yes
Mill's Size and Costs	Yes	Yes	Yes	Yes
Contract Controls	Yes	Yes	Yes	Yes
Date FE	No	Contract	Contract	Contract
Product FE	No	Yes	Yes	Yes
Organizational Forms	M & R	M & R	M	M
Exclusive Mills Only	No	No	No	Yes

Robust standard errors (clustered at the mill level) in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$, + $p<0.15$. The Table investigates price differentials obtained by integrated mills when selling outside the integrated chain. In all columns OLS are estimated, a contract between a mill and a buyer is an observation. The dependent variables is the unit price (in logs). Integrated mill is a dummy=1 if the mill is owned by a buyer. Mills controls are mill's size (capacity) and unit processing costs. Contract controls include a third-degree polynomial in Kilos of coffee on the contract, contract's length and a dummy indicating whether the contract is for the national or export markets. Products fixed effects are 264 unique combination of coffee category/preparation/type and quality. The sample excludes all integrated trade (backward and forward) and covers the years for which unit processing costs are available. Column (3) also excludes contracts between mills and buyers in a relationship (baseline definition). Column (4) further excludes mills that are not exclusive, defined as mills that sell less than 70% of their produce to a single buyer in that season.

Table A8: **Timing and pricing of contracts**

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	***Advance contracting, Days***			***Unit price (ln)***		
Buyers:	Non-Integrated	Integrated	Integrated	Non-Integrated	Integrated	Integrated
Sellers:	Independent	Independent	All	Independent	Independent	All
Relationship Age	-17.6156***	-14.5206**		-0.0191**	0.0033	
	(4.402)	(6.123)		(0.008)	(0.006)	
Integrated			-17.6349***			-0.0289***
			(3.574)			(0.008)
Observations	11,267	7,313	12,069	11,000	6,912	11,771
R-squared	0.813	0.728	0.713	0.958	0.978	0.966
Contract controls	Yes	Yes	Yes	Yes	Yes	Yes
Relationship FE	Yes	Yes	No	Yes	Yes	No
Season x Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Month of sale X Region	Yes	Yes	Yes	Yes	Yes	Yes
Date FE	Delivery	Delivery	Delivery	Contract	Contract	Contract
Market conditions	Contract	Contract	Contract	Contract	Contract	Contract
Product FE	Yes	Yes	Yes	Yes	Yes	Yes
Mill Controls	Yes	Yes	Yes	Yes	Yes	Yes
Buyer FE	No	No	Yes	No	No	Yes

Robust standard errors (clustered at the mill-buyer pair level) in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$, + $p<0.15$

The dependent variables are *Advance contracting in days*, defined as the difference between the date of delivery and the signing date, and the *log of price* per Kilo. Integrated, then, is a dummy=1 if the contract is with a mill owned by the buyer.

Contract controls include a third-degree polynomial in Kilos of coffee on the contract and a dummy indicating whether the contract is for the national or export markets. Buyers fixed effects are dummies for buyer. Region fixed effects refer to the region where the mill is located, and are interacted with the season (harvest campaign from 2001/02 to 2011/12) and the month in which the contract is signed. 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. Product FE is a set of (111) dummies for product types (preparation, quality and bean grading). Mill controls include the size of the mill (coffee traded in the season).

Table A9: **Unit processing costs**

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

Robust standard errors (cluster relationship) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15. This table reports results on unit processing costs across mills. Columns (1) and (2) focus on across mills comparisons. The specifications include interactions of region, harvest season and product line to control for time-varying growing conditions around the mill, as well as number of other time-invariant mill characteristics (altitude, slope, terrain ruggedness, average yearly rainfall and temperature, distances to railroads, port, road and Atlantic coast and type of mill). Column (1) shows that mills owned by backward integrated buyers do not have significantly lower processing costs than other mills. Column (2) introduces, for the sample of non-integrated mills, a dummy equal to one for mills that have sales through relationships above the median. Relative to mills not using relational contracts, integrated mills now have significantly lower costs. However, integrated mills have identical unit costs to non-integrated mills marketing through relationships. Columns (3) to (5) investigate mill's operating costs response to weather shocks during growing season (the index, temperature and rainfall respectively). The specifications focus on interactions between mill's organizational forms and weather shocks and include mills fixed effects. Across all specification we find no evidence that operating costs respond differentially to weather shocks across organizational forms.

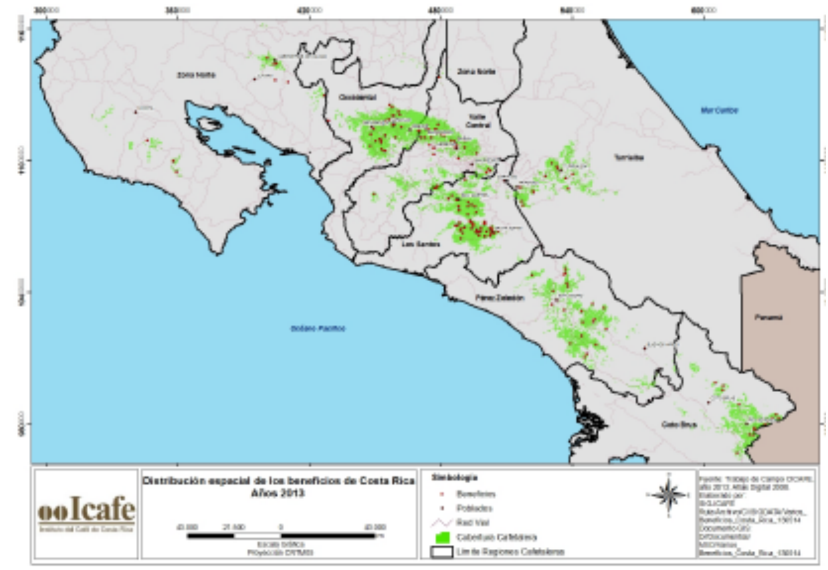
Table A10: **Quantity Sourced and Foreign Demand**

	(1)	(2)	(3)	(4)
Panel A	Total Quantity Sourced (tons)			
Foreign Demand Instrument	2,410.5385*		81.0685***	121.8436***
	(1,407.369)		(20.673)	(32.615)
Panel B	Quantity Sourced from Non-Market (tons)			
Foreign Demand Instrument	705.4289	1,180.4371***	28.8961+	42.8901
	(1,127.357)	(314.619)	(18.256)	(31.401)
Panel C	Quantity Sourced from Non-Market (tons) - OLS			
Total quantity sourced (tons)	0.8232***	0.1075	0.3763***	0.3833***
	(0.131)	(0.097)	(0.126)	(0.126)
Panel D	Quantity Sourced from Non-Market (tons) - IV			
Total quantity sourced (tons)	0.2926	0.4897*	0.3549**	0.3549**
	(0.304)	(0.258)	(0.165)	(0.165)
Cragg-Donald Wald F statistic	3.970	3.970	3.359	3.359
Observations	49	49	204	121
Sample	Integrated		All Non-integrated	Large Non-Integrated
Channel	Firm	Relationships	Relationships	Relationships
Season FE	Yes	Yes	Yes	Yes
Buyer FE	Yes	Yes	Yes	Yes
Average share	0.625	0.171	0.146	0.443
Test Coef = Average share	1.19	1.52	1.6	0.29
p-value	0.2747	0.217	0.2061	0.5934

Robust standard errors (two-way clustered at the buyer and season level) in parentheses. *** p<0.01, ** p<0.05, * p<0.1, + p<0.15

The Table investigates supply assurance using Bartik-like demand shocks for the sample of exporters. Exporter b sales to foreign market c are matched to aggregate imports of coffee in country c in year t to construct $Z_{bt} = \Sigma_c sh_{bc} \times I_{ct}$, where I_{ct} are aggregate imports of coffee in country c in year t and sh_{bc} is the average share of coffee exporter by buyer b to country c during the sample period. The variable Z_{bt} captures idiosyncratic increases in demand originating from buyers exposure to different destination markets. The Table reports reduced form results between Z_{bt} and total quantity sourced by the exporter (Panel A) and quantity sourced through non-market channels (Panel B). Panel C and D investigate propensity to source through non-market channel using OLS and 2SLS specifications. Regressions are run on the sample of integrated buyers (Columns (1) and (2)) and non-integrated exporters (Column (3)) and large non-integrated buyers (defined as those in the top quartile, Column (4)). The sample excludes forward integrated chains and only covers i) the sample of exporters, ii) season for which export data are available. Relationships provide supply assurance. Relative to the price and weather shocks responses in the main text these results should be interpreted with caution: the constructed demand shocks confound exogenous increases in buyers demand that occur before and after suppliers production decisions have been made. This distinction is key for the empirical design in the main text. Increases in buyer's demand might be anticipated (in which case, we expect the buyer to rely on relational sourcing to increase supply) or ex-post (in which case even a relational supplier might not be able to fully accommodate the additional demand and the market must be used.

Figure A1: Geographical location of mills

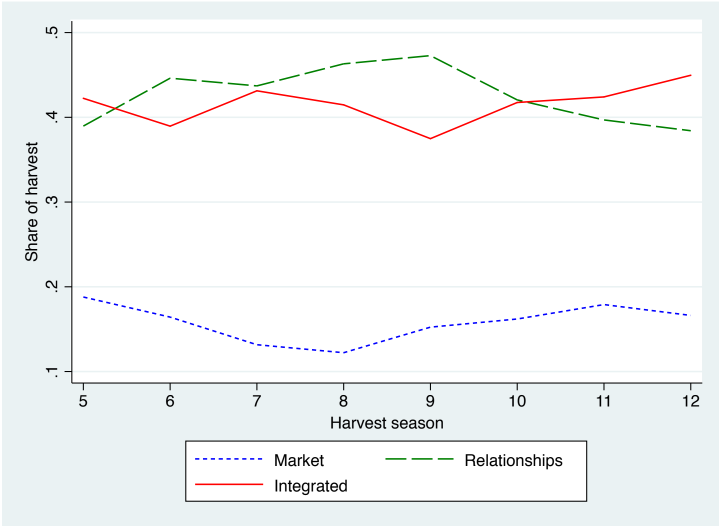


Costa Rica has 7 different coffee producing regions: Central Valley, Turrialba, Coto Brus, Los Santos (Tarrazú), Pérez-Zeledón, West Valley and North. These regions differ on altitude, and they are distributed between low areas - less than 1000m. altitude - and high areas - over 1200m.- where soils are 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: 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). Figure translated from the ICAFE site.

Figure A3: Use of Organizational Forms

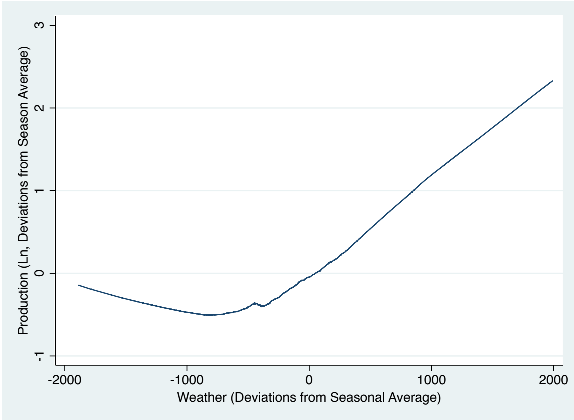


The Figure reports the share of coffee sold by relationships under each organizational form (baseline definition) for seasons 2004/5 to 2011/12. A mill-buyer pair are defined to be in a relationship if they have traded more than four consecutive years during the sample period. By definition then, observations for the first (last) three seasons over the sample period are left (right) censored (see Table A2 for details). The first three seasons over the sample period are omitted. The decline in the share of relationships for the last three seasons over the sample period is due to right censoring.

Figure A4: Within Date Variation in Prices

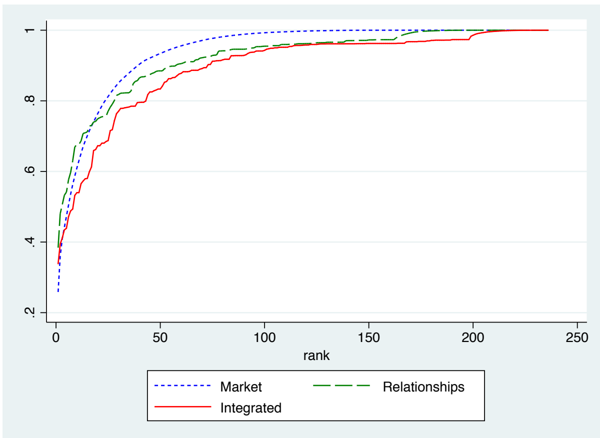
The Figure presents the time series of daily prices from 2010 to 2014. The Figure reports daily information on the maximum, minimum and average price on contracts registered that day, alongside the nearest listing of the KC contract. The Coffee C future contract (KC) traded in New York is the world benchmark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

Figure A5: Weather Conditions and Mills Production



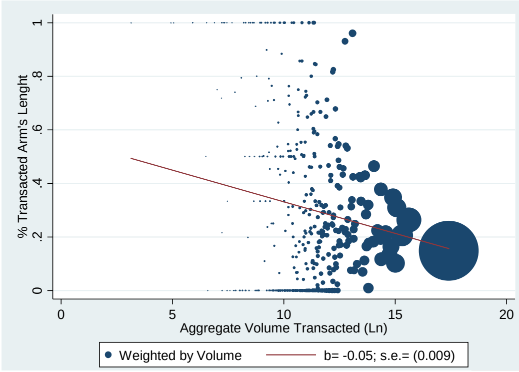
The Figure shows that weather conditions during the growing season strongly correlate with aggregate production at the mill level across seasons. The Figure plots non-parametric *lowess* regression between (residuals of) the weather index (a z-score of rainfall and temperature realization around the mill during the growing season) and (residuals of) aggregate mill production on mill and season fixed effects. The corresponding regression results are reported in Table 6. Controlling for mill's and season fixed effects, a one standard deviation increase in the weather index increases mill's production by 202 tons (28%). Integrated mills are larger and, therefore, the same increase in weather translates into a larger absolute increase in production relative to non-integrated mills (378 and 127 tons respectively). However, the percentage increase is larger for non-integrated mills than for integrated mills (30% and 21% respectively).

Figure A6: Distribution of Products across Organizational Forms



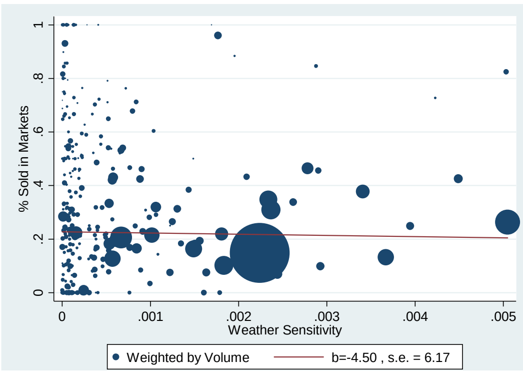
The figure shows that different organizational forms trade very similar mixes of products. The Figure is constructed as follows. First, rank products according to their volumes of trade in the market. The horizontal axis reports the rank of the product and the vertical axis the cumulative distribution. The curve for trade in the market is then monotonically increasing and concave since products are ranked according to their volumes of trade. Notably, the Figure shows that the overall distribution of product traded inside relationships and within firms is remarkably similar. Both curves lie close to the market curve and are concave most of the time. Product specificity is unlikely to be a major driver of organizational forms in this context.

Figure A7: Volumes Traded and Organizational Forms



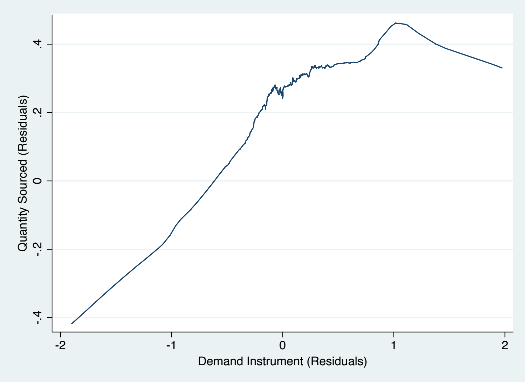
The Figure exploits detailed information on the type of coffee transacted to investigate if the aggregate volume of coffee transacted correlates with organizational forms. A unit of observation is a product (defined as a bean type, quality, preparation combination). The vertical axis reports the share of that product transacted at arm's length. The horizontal axis reports the average amount of that product transacted in any given season (in logs). Across product types, the aggregate volume of trade in a particular coffee type *negatively* correlates with the share of that product that is transacted at arm's length. Integration and long-term relationships are used relatively more for coffee types that are more commonly traded. This correlation contrasts with product specificity being a driver of integration and/or relational sourcing. The correlation is however consistent with integration and relationships being used to mitigate demand and supply assurance concerns: it is precisely for products that are more commonly traded that parties will be concerned about their trading partners finding better opportunities and renege on promises to trade.

Figure A8: Product Sensitiveness to Weather and Organizational Forms



The Figure exploits detailed information on the type of coffee transacted to investigate if product sensitivity to weather conditions during the growing season correlates with organizational forms. A unit of observation is a product (defined as a bean type, quality, preparation combination). The vertical axis reports the share of that product transacted at arm's length. The horizontal axis reports an estimate of the product sensitivity to weather conditions during the growing season. These are obtained by regressing mill's seasonal production of that product type on weather conditions, controlling for mills and season fixed effects. Only mills that produced the product at a given point in time are considered and zeros are then filled in. For each product a separate regression is estimated and the absolute value of the estimated coefficient is reported. The Figure shows that this measure of product sensitivity to weather conditions is uncorrelated with the share of coffee sold across the different organizational forms. The lack of correlation is robust regardless of weather products are weighted by the amount they are traded.

Figure A9: Foreign Demand and Buyer Sourcing



The Figure plots non-parametric *lowess* regression between (residuals of) the standardized demand index Z_{bt} and (residuals of) aggregate buyer's exports on buyer and season fixed effects. The Bartik-like demand index is constructed as follows. Exporter b sales to foreign market c are matched to aggregate imports of coffee from Central and Latin America in country c in year t to construct $Z_{bt} = \Sigma_c sh_{bc} \times I_{ct}$, where I_{ct} are aggregate imports of coffee in country c in year t and sh_{bc} is the average share of coffee exporter by buyer b to country c during the sample period. The variable Z_{bt} captures idiosyncratic increases in demand originating from buyers exposure to different destination markets.