

Firm and Market Response to Saving Constraints: Evidence from the Kenyan Dairy Industry *

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Abstract

This paper documents how saving constraints can spill over into other markets. When producers value saving devices, trustworthy buyers can offer them infrequent payments—a commitment tool—and purchase at a lower price. This affects the nature of competition in the output market. We present a model of this interlinked saving-output market for the case of the Kenyan dairy industry. Multiple data sources, experiments, and a calibration exercise support its microfoundations and predictions concerning: *i*) producers' demand for infrequent payments; *ii*) an asymmetry across buyers in the ability to credibly commit to low frequency payments; *iii*) a segmented market equilibrium where buyers compete by providing either liquidity or saving services to producers; *iv*) low supply response to price increases. We discuss additional evidence from other contexts, including labor markets, and derive policy implications concerning contract enforcement, financial access, and market structure.

Keywords: Saving Constraints; Imperfect Contract Enforcement; Interlinked Transactions; Competition; Trust; Agricultural Markets.

JEL Codes: O12, L22, O16, Q13.

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1 Introduction

A growing body of literature documents the importance of saving constraints for households and enterprises in the developing world (see, e.g., Karlan et al., 2014). Limited financial access and commitment problems, among other factors, drive down saving levels. While prominent strands of literature have studied how imperfections in one market affect other markets, they have mostly focused on missing labor, insurance, and, particularly, credit markets.¹ This paper studies how saving constraints can impact output markets, by affecting producers’ sales choices, buyers’ competition strategies, and equilibrium prices and profits.

We posit a novel mechanism that leads saving constraints to spill over into output markets and we provide theory and evidence to support it. Saving-constrained producers value buyers’ *infrequent* payments as a commitment device. In a market with these features, contrary to standard trade credit, delayed payments, which combine many small payments in one lump sum, are associated with lower unit prices. Buyers may then compete for supply through the provision of infrequent payments. Under limited contract enforcement—a defining feature of many markets in developing countries—only buyers who can *credibly* promise to pay producers at a later time can offer such payments. By showing that output buyers also provide a saving device and that producers pay for this service, the research unveils interlinked transactions between saving markets and output markets: a form of interlinkage that, to the best of our knowledge, had not been previously noted in the literature (Bardhan, 1991).

As we discuss below, this mechanism may be relevant for a broad class of markets that feature small, saving-constrained producers, including agricultural value chains and labor markets. In this paper, we focus on the dairy industry in Central Kenya—the largest agricultural subsector in the country (and in many other developing countries). Milk buyers that offer different frequencies of payments coexist in the market. Small traders, who pay relatively high prices on a daily basis, compete with a large buyer (a cooperative) that pays

¹For example, Bolton and Scharfstein (1990), Manova (2013), and Guiso et al. (2013) are influential examples of how imperfections in the credit market affect firm competition, international trade, and labor markets, respectively. Within the development literature, nowadays classical contributions are, e.g., explanations of sharecropping (Stiglitz, 1974; Braverman and Stiglitz, 1982), labor tying (Bardhan, 1983; Mukherjee and Ray, 1995), rotating savings and credit associations (Besley et al., 1993; Anderson and Baland, 2002), joint liability lending (Ghatak and Guinnane, 1999; Ghatak, 2000), and risk-sharing networks (Coate and Ravallion, 1993; Udry, 1994). De Janvry et al. (1991) discusses how specific market failures can induce *prima facie* puzzling farmer behaviors.

at the end of the month. Many farmers sell milk to the buyer offering less frequent (and lower) payments and a large share of these farmers sell *every day* both to the large buyer and to traders.

The paper combines several tools to investigate the proposed mechanism: a theoretical model, two experiments, analysis of administrative and survey data, and a simple calibration. The model first provides microfoundations for a market featuring saving-output interlinked transactions: *i*) producers have a demand for an indivisible good (for instance, a lumpy input for their business) and for commitment devices, arising from time-inconsistent preferences and sophistication; *ii*) the possibility of strategically defaulting on delayed payments determines buyers' (in)ability to offer low frequency payments. In equilibrium, under certain conditions, credible buyers offer low frequency payments and “charge” producers for this saving service by buying their output at a lower price. Producers with differing saving goals sort into different buyers and some sell to both types of buyers to satisfy both liquidity needs and saving goals. The framework then delivers additional predictions on producers' response to price increases and to liquidity incentives, suggesting that the linkage between saving and output markets affects other dimensions of firm strategies, such as price competition.

The first part of the empirical analysis provides evidence on the two microfoundations of the model. We conduct two “choice experiments” in which the cooperative offers farmers the opportunity to choose between various payment frequencies. Results from the first experiment show that farmers have a strong preference for low frequency payments: farmers turn down a 15% price increase to access monthly payments (rather than daily ones). The second experiment shows that demand for commitment is an important driver of this preference for infrequent payments. Analysis of survey data confirms these findings. Additional evidence suggests that farmers trust the cooperative more than the traders. Farmers share little information about traders and express concerns that they would default if they purchased output on credit. A calibration of the traders' incentive compatibility constraint confirms that, given prevailing prices, the benefits from defaulting on the delayed payments due to the farmer are larger than the benefits of paying (i.e., the discounted profits from continuing to provide low frequency payments in subsequent months).

The second part of the empirical analysis tests equilibrium predictions of the model. Analysis of administrative and survey data shows that farmers who sell to the cooperative

are more likely to set saving goals and to reach them. Moreover, farmers use earnings paid at different frequencies for different purposes (i.e., food consumption vs. dairy inputs). Finally, a randomized field experiment tests model predictions concerning the farmers' response to increases in the cooperative price and to the provision of additional liquidity. Consistent with the predictions of the model, the delivery response to price increases is weaker when payments are made at a lower frequency. In addition, building upon the literature on self-control and personal rules, we provide evidence for a rule of thumb followed by many producers: selling to the cooperative in the morning to save, selling to traders in the afternoon to get liquidity. Evidence from administrative data on deliveries to the coop lends further support to these findings, suggesting this rule may further limit supply responsiveness to price changes.

The proposed mechanism applies to a broad class of markets. In the final part of the paper, we discuss examples from several other settings. Survey data from a tea contract farming scheme in Kenya, from manufacturing sector workers in Myanmar, and from seasonal workers in Rwanda provide additional evidence in line with the main findings of the study. The analysis is also consistent with several features of firm-to-firm relationships and labor markets: trade credit flowing from small to large firms; the role of large organizations in the historical shift from daily payments to less frequent ones; the existence of *Thirteenth Salaries*—an additional monthly salary workers in many countries receive around Christmas.

The linkage between saving and output markets—realized through low frequency payments—has several welfare implications. First, it is the very availability of low frequency output payments that can help farmers reach their saving goals, potentially fostering investment and consumption smoothing. Second, due to the lack of alternative financial management tools, buyers who can offer low frequency payments can extract a substantial portion of the surplus in the output market transaction. Third, limited contract enforcement interacts with missing saving markets: Because of limited enforcement, only a subset of buyers with enough credibility can offer low frequency payments to the producers, with limited competition along this margin.

Several policy lessons follow from these findings. First, there are potential benefits from *large buyers* in output and labor markets in the developing world, as these buyers may be well-suited to help producers overcome commitment issues through low frequency payments. Many observers are concerned about market power of large buyers in agricultural value

chains. Our evidence provides one source of barrier to entry, the ability to credibly promise low frequency payments, but it also qualifies excessively negative views of large buyers if size is a prerequisite for such payments. Moreover, low prices to producers might reflect their willingness to pay for illiquidity rather than excessive market power downstream. Second, our results unveil a novel benefit of improving contract enforcement in agricultural markets. By increasing the number of buyers who can commit to low frequency payments, better enforcement may have an impact similar to better access to saving products, while potentially occurring in a cheaper and more decentralized fashion. Third, better access to (commitment) saving products may enable producers to capture a larger share of the output market surplus. More broadly, improving access to financial products may impact agricultural markets in ways so far unnoticed.

The paper is related to several strands of research. First, by unveiling a linkage between saving and output markets, it expands the literature on market failures and interlinked transactions.² Bardhan (1980), Bardhan (1991) and Bell (1988) summarize this theoretical literature.³ More recently, Casaburi and Reed (2014), Ghani and Reed (2014), Casaburi and Willis (2015), Macchiavello and Morjaria (2015a), and Macchiavello and Morjaria (2015b) offer primarily empirical contributions. In particular, Casaburi and Willis (2015) find that bundling an agricultural insurance product with a large contract farming scheme in Kenya leads to significantly higher take-up rates. Although in a rather different setup and with a different focus, our findings complement theirs since insurance and saving markets both require small agents trusting larger service providers (see also Dercon et al., 2015). Macchiavello and Morjaria (2015a) provide evidence from Rwanda that competition reduces the use of interlinked transactions, including second payments (i.e., payments made to the farmers at the end of the harvest season).⁴

²Bell (1988) defines an interlinked transaction as “one in which the two parties trade in at least two markets on the condition that the terms of all such trades are jointly determined” (p. 797).

³The model shares insights with the literature on barriers to entry. However, it doesn’t fit within standard frameworks to study either preemption or predation (see, e.g., Tirole, 1988, and Wilson, 1992). The model is closer in spirit to Aghion and Bolton (1987) in which contracts (and, in our framework, a relational one) are used as barriers to entry. The model also draws from the relational exchange and community enforcement literatures (see, e.g., Kranton (1996) and Ghosh and Ray (1996)).

⁴Additional relevant studies on reputation and interlinked transactions include Fafchamps and Minten (1999) and Fafchamps and Minten (2002) on the importance of relationships for agricultural traders, Mitra et al. (2013) on structure in the West Bengal potato sector, and Deb and Suri (2013) and Bardhan et al. (2013) as examples of recent theoretical contributions in the area. Greif (1989), Greif (1993), and Fafchamps

Second, the paper is related to, but distinct from, the literature on trade credit (see, e.g., Petersen and Rajan, 1997; Burkart and Ellingsen, 2004; Giannetti et al. (2011)). In these studies, trade credit emerges as a result of a demand for credit from buyers and of the fact that suppliers have an advantage (e.g., better information, lower transaction costs) in extending credit. In our framework, suppliers' demand for infrequent payments is an important determinant of delayed payments. A key distinction then is that suppliers may receive *lower* prices for delayed payments (i.e., a negative interest rate). Moreover, we focus on asymmetries across buyers in the ability to offer infrequent payments, rather than asymmetries across multiple potential sources of finance.

Third, the paper relates to the literature on the relationship among organizational forms, behavioral biases, and contract design. In the context of the labor market, Kaur et al. (2010) and Kaur et al. (2014) build on Clark (1994) and argue that modern factories reduce procrastination in effort provision. The emergence of the factory system has also been associated with a shift from daily payments to (semi-)monthly wages (Engerman and Goldin, 1991). We argue that the ability of large factories to credibly promise regular monthly payments may also help address self-control issues in spending habits. In addition, a (mostly) theoretical literature explores competition and contract design with time-inconsistent consumers/buyers, as opposed to producers/sellers (see, e.g., Della Vigna and Malmendier, 2004; Heidhues and Kőszegi, 2010; Basu, 2014; Kőszegi, 2014).⁵

Fourth, the paper contributes to a growing body of evidence that studies the demand for and the impact of saving products in developing countries (see, e.g., Ashraf et al., 2006; Dupas and Robinson, 2013; Kast et al., 2012; Brune et al., 2014). The excellent review by Karlan et al. (2014) remarks how the role of trust in shaping constraints in saving markets—a central issue for our analysis—remains an open area.⁶ The timing, frequency, and mode of payments have been argued to be an effective saving tool in a variety of contexts (Bertrand et al., 2004; Banerjee and Mullainathan, 2010).⁷ In addition, a large literature focuses on

(2004) provide further illustrations of how institutions develop to harness reputational forces.

⁵Fischer and Ghatak (2010) explores theoretically the implications of time-inconsistent preferences for microfinance borrowing. Ambec and Treich (2007) and Basu (2011) study the role of Roscas as commitment devices.

⁶Dupas et al. (2014) report anecdotal evidence that low trust in banks limits usage of saving accounts in a sample of unbanked individuals in Western Kenya.

⁷Brune and Kerwin (2014) provide experimental evidence from public employment programs in low-income countries.

consumption smoothing across paychecks (see, e.g., Stephens, 2003; Stephens, 2006; Shapiro, 2005; Mastrobuoni and Weinberg, 2009). In particular, Stephens and Unayama (2011) and Berniell (2015) study the impact of earnings frequency on consumption.⁸ We innovate on this research by providing a reason that *less* frequent payments may be welfare-improving, as they facilitate saving for indivisible goods.

The rest of the paper proceeds as follows. Section 2 provides background information on the study setting. Section 3 presents the model and relates it to the empirical strategy. Section 4 shows that farmers value the coop’s low frequency payments and that this arises from a demand for commitment. Section 5 shows that the ability to credibly commit allows the coop to satisfy producers’ demand for low frequency payments but prevents smaller traders from doing so. Section 6 tests additional model predictions on buyers’ coexistence in the market and on the supply response to price increases under saving-output linkages. Section 7 offers concluding remarks and presents evidence on the relevance of the proposed mechanism for other markets.

2 Study Setting

The dairy industry is the largest agricultural sector in Kenya, contributing to approximately 14% of agricultural GDP and 3.5% of total GDP (Government of Kenya, 2012). Small-scale farmers, owning up to three cows, are responsible for about 80% of the production (Wambugu et al., 2011). Our project takes place in Kiambu district, in Central Kenya. Two main types of buyers coexist in the region. The first is a large coop with about 2,000 members, one of the oldest in the industry. The coop collects milk at its 24 collection centers, which are open at fixed hours every day in the morning and in the afternoon, and then processes it at its processing plant. The second is a large number of traders purchasing smaller quantities of milk. These are primarily small informal traders, such as itinerant traders delivering milk to the nearby towns or local restaurants and to Nairobi (about one hour away). In the first stage of the value chain (i.e., the sale from the farmer to the first buyer), milk is a homogeneous good: There is no systematic quality testing or quality-based pricing. The coop and the traders then sell milk to processors or to final consumers (local or in Nairobi).

⁸See Parsons and Van Wesep (2013) for a theoretical analysis.

Farmers milk cows twice a day (in the morning and in the afternoon). Since most farmers lack refrigerators, sales also typically occur twice a day. However, the frequency of payments varies substantially across buyers. The cooperative pays farmers at once for the deliveries of any given month, typically in the first week of the subsequent month. Most traders instead pay farmers on a daily basis. Traders pay a significantly higher price than the coop.⁹ The coop sources from a large share of farmers. Our estimates suggest that between 40% and 50% of dairy farmers in its catchment area sell to the coop. In addition, evidence from survey and administrative data suggests that about half of the farmers selling to the coop also sell to traders *every day*. Farmers might use their dairy income for different purposes, including regular consumptions expenditures or lumpy purchases such as feed, veterinary expenses, farm upgrading, and schooling fees.

This paper combines two sources of data: administrative data from the coop and original survey data. The administrative data include member-level deliveries of milk to the coop from June 2013 through September 2014. The deliveries are recorded separately for morning and afternoon. The original surveys are structured as follows. There are three groups of farmers: (1) farmers that sell to the coop in the morning but not in the afternoon; (2) farmers selling to the coop both in the morning and in the afternoon; and (3) farmers not selling to the coop. First, as baseline for the randomized controlled trial described in Section 6, we conducted a detailed survey of a sample of members in group (1).¹⁰ Second, we conducted a shorter survey on a random sample of farmers among the remaining farmers that regularly sell to the coop (group 2).¹¹ Third, we conducted a listing exercise of all dairy farmers in six random villages in the catchment area of the coop to collect basic information on group (3). The listing includes information on the number of cows owned, on whether the farmers sell to the coop, and on their saving goal behavior.

The modules of the detailed survey cover a variety of aspects related to household charac-

⁹The coop's payments differ from those of the traders along three dimensions: they are *monthly*, *delayed*, and (mostly) paid through *direct deposits* to farmers' bank accounts. As described below, the combination of these features may help farmers to reach their saving goals. In the rest of the paper, we combine these three features in the expression *low frequency payments* without unbundling these components.

¹⁰As this sample served as baseline for the experiments described in Section 6.2 we excluded farmers in the bottom and top delivery deciles to reduce dispersion in outcomes and increase power. The final sample, which is representative of this subpopulation, included 654 farmers, of which 596 (91%) were successfully interviewed.

¹¹These are the other members targeted for the two choice experiments described in Section 4.

teristics and dairy farming. In particular, the survey was designed paying particular attention to elicit information on different types of buyers, their relationships with farmers, and the benefits farmers receive by selling to each type. Table 1 presents basic farmer descriptive statistics from the main survey sample. The survey targeted the household member in charge of managing milk production. Of the respondents, 43% are men. The average respondent has 1.5 active cows producing milk at the time of the survey. A handful of farmers have 10 or more cows. Average production is 11.95 kg (afternoon production is about two-thirds of morning production). Of the households, 20% hire at least one worker on dairy farming. Dairy farming is just one of several income-generating activities undertaken by farmers in this rural area. About 50% of respondents report crop farming as their main other source of income.¹²

The paper documents farmers' strong demand for the coop low frequency payments. Producers' cooperatives, however, are often thought to provide additional benefits (see, e.g., Bonin et al., 1993). The view on governance and performance of cooperatives in developing countries is, however, more mixed (see, e.g., Banerjee et al., 2001; Sukhtankar, 2015). It is nevertheless important to discuss the relevance of other potential benefits the coop may provide. First, farmers may take loans from the coop. However, survey data suggest only 7.5% do and "loans" mostly take the form of advances on milk *already* delivered.¹³ The coop also sells inputs at some of its collection centers: This may reduce transaction costs, but 90% of farmers report being unsatisfied with the quality and price of these inputs. Second, while farmers report that most traders are available every day, the coop's demand may be more reliable in peak production season. However, since the coop does not condition present purchases on past deliveries, coop's purchase guarantee in the peak season cannot explain why farmers sell to the coop in the rest of the year. Third, 75% of respondents report they derive a sense of pride from selling to the coop. Fourth, the cooperative does not make second payments at the end of the year. In sum, there are certainly other benefits farmers may obtain from the coop, but their extent seems to be limited. Nevertheless, it is important to isolate the benefit monthly payments provide to farmers. This is the goal of the theory and evidence of Section 3 and Section 4, respectively.

¹²The shorter survey that targeted farmers selling to the coop both in the morning and afternoon reveals that these farmers have similar demographics, though they have more cows on average: 2.2 vs. 1.5.

¹³The coop does not offer asset-collateralized loans such as the ones described in Jack et al. (2015).

3 Theory

This section presents a simple model of the interlinked saving-output market structure studied in the empirical analysis. The model is developed and analyzed with three goals in mind. First, it microfounds two key features of the market: Farmers have a demand for low frequency payments; traders cannot offer low frequency payments (while the large buyer can). These microfoundations also guide the empirical approach and experimental design used to directly test the theory’s assumptions.¹⁴ Second, building on these assumptions, the framework rationalizes the patterns described in Section 2. In doing so, it shows that the large buyer “charges” farmers for the saving services it provides and that the threat of competition from traders along this margin limits the amount of surplus it can extract from the farmers. Third, it delivers additional testable predictions on the sorting of farmers into different marketing channels and on the ambiguous impact of price competition strategies when the saving-output interlinkage occurs. Appendix A and B present proofs and a discussion of assumptions and extensions.

3.1 Setup

Consider a village with a continuum of mass N of homogeneous farmers, free entry of small traders, and a large buyer. Time is an infinite sequence of months, m . Each month is divided into four *periods*, $t = 1, 2, 3, 4$. Farmers have quasi-hyperbolic preferences across periods, with $\beta < 1$ and $\delta < 1$. They are sophisticated about their time inconsistency. In each of periods $t = 1, 2$, farmers are endowed with one unit of non-storable milk. Selling milk is their sole source of income and farmers cannot borrow. Farmers can save cash from one period to the next within the same month, earning interest rate $(1 + r) = 1/(\delta + \epsilon)$, with $\epsilon \rightarrow 0$.¹⁵ In periods $t = 1, 2, 3$, the farmers derive utility $u(c) = c$ from consumption of a perfectly divisible good c (whose price is normalized to one).¹⁶ Following Besley et al.

¹⁴Note that we microfound the demand for low frequency payments assuming farmers *do* have access to a saving technology but are time-inconsistent. While this microfoundation appears to be borne out in the data, the key results of the model can also be obtained from a model with time-consistent farmers that do not have access to a (sufficiently good) saving technology.

¹⁵For simplicity, we abstract from farmer’s intrapersonal strategies and saving across months (see, e.g., Strotz, 1955; Laibson, 1997; Bernheim et al., 2015). See Appendix B for a discussion.

¹⁶As is well-known in this class of models, an additional consumption period, $t = 3$, is needed to unveil the role of time inconsistency. For simplicity, we assume there is no milk production in this third period.

(1993) and Anderson and Baland (2002), we introduce a demand for an indivisible good that is purchased and consumed in the last period, $t = 4$. The indivisible good costs D and gives utility Δ , with $\Delta > D$. Farmers cannot buy the indivisible good just by saving a period worth of sales but they can if they save the entire milk production.¹⁷ These assumptions imply that farmers always prefer to consume the divisible good in earlier periods and that they only save to purchase the indivisible good.

The large buyer and the traders maximize discounted profits (at common discount factor δ) by buying milk from farmers and selling it to consumers at exogenous price v .¹⁸ Both the large buyer and the traders can decide whether to pay in each period $t = 1$ and $t = 2$ (i.e., daily payments) or at $t = 4$ (i.e., low frequency payment). Buyers who pay daily compete à la Bertrand, bid up the price to $p_D = v$, and make zero profits. In contrast, due to imperfect contract enforcement, low frequency payments require a credible (i.e., self-enforcing) promise of future payments.

Traders need to satisfy an additional incentive constraint to resist the temptation to strategically default. Upon defaulting on a farmer, the trader is randomly re-matched with a different farmer. We assume there are two types of farmers: *informed farmers* have public knowledge (i.e., they know the history of actions of the traders with any other farmer); *uninformed farmers* do not (i.e., they know only the past actions a trader took when dealing with them). We assume that in each period after a default, a trader faces a probability $\gamma \leq 1$ to meet an uninformed farmer. For simplicity, we assume that the large buyer can commit to always honor the promise of low frequency payments. In our context, this modeling choice captures in a parsimonious way the difference between small itinerant traders and the coop’s sourcing from permanent collection centers.¹⁹

Within each month, the timing of events is as follows. Before any production takes place, the large buyer first and then traders post a contract type (either daily payment or low

¹⁷That is, $\frac{v}{\delta^3} < D < v(\frac{1}{\delta^3} + \frac{1}{\delta^2})$, with v defined below.

¹⁸The assumption that the large buyer (i.e., the coop) maximizes profits fits well with the environment under study. Anecdotal evidence and studies such as Banerjee et al. (2001) and Sukhtankar (2015) support the view that often cooperatives do not maximize welfare of all members. Our framework can be extended to allow the large buyer to also care about farmer’s welfare without compromising the main results.

¹⁹The extension in Appendix B microfounds the assumption that the large buyer is credible (*and* also that the large buyer chooses not to offer daily payments). The assumption of a single large (and, therefore, credible) buyer fits the context of our study but can be relaxed. Even with multiple credible buyers, sufficient rents through lower purchase price must be provided to overcome the temptation to default on the (delayed) payments due to the farmers.

frequency payment) and a price. Farmers then produce and make their sales, consumption and saving decisions. Fourth, if any low frequency payment has been promised, the large buyer makes the payment while the traders decide whether to renege or not. Finally, the farmers purchase the indivisible good if they have sufficient funds. We start by considering the subgame perfect equilibrium in the stage game. We then consider pure strategy stationary subgame perfect equilibria of the infinitely repeated game, focusing on conditions under which the large buyer is the only buyer offering low frequency payments.

3.2 The Stage Game

The stage game can be solved by backward induction. Since in the last period traders would always default on low frequency payments, farmers will never accept low frequency payments from them. Thus, traders only offer daily payments and competition drives the daily price p_D to v . Assume the large buyer has decided to offer low frequency payments at price p . Whether farmers use the large buyer as a saving tool or save part of the income from their sales to the traders depends on preference parameters and the relative prices that farmers take as given in the second step of the stage game.²⁰ Denoting with s_t the amount saved by the farmer from selling to traders (and receiving daily payments) and with x_t the amount sold to the large buyer (with low frequency payments) in period $t = 1, 2$, the farmer's utility at $t = 1$ is given by

$$U_1 = c_1 + \beta\delta(c_2 + \delta c_3 + \mathbf{I}\delta^2\Delta), \quad (1)$$

where $c_1 = v(1 - x_1) - s_1$ and $c_2 = v(1 - x_2) - s_2 + \frac{s_1}{\delta}$ and, \mathbf{I} is an indicator function equal to 1 if the farmer purchases the indivisible good.

In order for low frequency payments to help farmers buy the indivisible good, two conditions must be met. First, farmers must care enough for the indivisible good. Second, farmers must not be able to save on their own. The following proposition summarizes the unique subgame perfect equilibrium of the stage game:

²⁰For expositional simplicity, we solve the stage game assuming that farmers can save either by selling to the large buyer *or* by saving income from selling to traders, but cannot do both. In the infinitely repeated game this assumption is derived as an equilibrium outcome.

Proposition 1:

1. Traders offer daily payment at $p_D = v$.
2. If $\beta \leq \frac{D}{\Delta} \leq \beta(2 - \beta)$, the large buyer offers low frequency payments at price $p = \hat{p}_F \equiv \frac{D}{\beta\delta^2\Delta((1-\beta)\delta+1)}v$.
3. Under the same conditions, farmers purchase the indivisible good by selling to the large buyer $x_1^* = \frac{Dv-p\beta\delta^2\Delta}{pv}$ and $x_2^* = \frac{\beta\delta^2\Delta}{v}$ and consume revenues from sales to traders (i.e., $s_1 = s_2 = 0$).

We provide an intuition of the proof. When deciding how much to save from the daily payment revenues, Self1 (Self2) must take into account that, in the subsequent period, Self2 (Self3) may spend the money to purchase a larger amount of the divisible good rather than carrying the saving balance over to the last period and purchase the indivisible good. If $\beta > \frac{D}{\Delta}$, the degree of time inconsistency is low enough that farmers can save enough to purchase the indivisible good just by selling to traders and do not need to sell to the large buyer. If $\beta \leq \frac{D}{\Delta}$, farmers' temptation is strong enough that they cannot commit to save daily payments and are therefore willing to sell at lower prices under low frequency payments in order to purchase the indivisible good. The large buyer then sets the lowest possible price that still induces farmers to accept low frequency payment. That price is $p = \hat{p}^F$. However, when buying at this price, the coop obtains positive profits only if $\frac{D}{\Delta} \leq \beta(2 - \beta)$.

3.3 The Repeated Game

An infinite repetition of the equilibrium in the stage game, with the large buyer as the only provider of low frequency payments, is obviously one of the equilibria of the repeated game. However, in an infinite horizon, traders may be able to commit not to default. We are interested in characterizing under which conditions the large buyer can set prices so that traders are *not* able to credibly promise low frequency payment. We assume the condition $\beta \leq \frac{D}{\Delta} \leq \beta(2 - \beta)$ holds throughout.

3.3.1 Traders

We focus on the stationary equilibrium that maximizes the large buyer discounted payoffs. We derive conditions under which a trader that takes the price offered by the large buyer as

given would be able to deviate and credibly offer low frequency payments. Consider such a deviation in which a trader offers low frequency payments at price \hat{p}^T and denote with \hat{x}_t^T the resulting quantity the trader buys in period t . If farmer accepts the trader's offer she is punished by the large buyer who will refuse to purchase from her in the future. In order to attract the farmer, then, the trader must offer a deal that allows the farmer to purchase the indivisible good solely from his promised low frequency payment.²¹

The deviating trader faces the maximum temptation in $t = 4$, once he has already purchased the milk and needs to pay for \hat{x}_1^T and \hat{x}_2^T . Let's consider a one-period deviation where he defaults for one month and then reverts to pay future sales with low frequency payments. The harshest punishment inflicted by an *informed farmer* is to not accept low frequency payments offer from any trader who has defaulted in the past. *Uninformed farmers* only punish traders who defaulted on them in the past. Let's consider the following strategies: *i*) the traders do not default, *ii*) informed farmers accept offers only from traders who have never defaulted before, and *iii*) uninformed farmers accept offers from traders they have not yet interacted with and punish traders who defaulted on them in a previous relationship.²² Following standard algebra, the trader's offer is credible if the following condition holds:

$$\hat{p}^T \leq \delta(1 - \gamma) \frac{\hat{x}_1^T + \delta \hat{x}_2^T}{\hat{x}_1^T + \hat{x}_2^T} v. \quad (2)$$

The left hand side, given by $(\hat{p}^T)(\hat{x}_1^T + \hat{x}_2^T)$, is the amount promised to the farmer, i.e., the trader's temptation to deviate. The right hand side is the discounted value of the relationship with the farmer. Note that, the larger is γ , the share of uninformed farmers, the easier for the trader to find an uninformed farmer with whom to build a new relationship and, therefore, the lower the value of the relationship with the current farmer. The deviating trader will make an offer that maximizes his profits subject to the above incentive constraint and the farmer's participation constraint. The farmer's participation constraint, in turn, depends on the price set by the large buyer at the beginning of the period. The large buyer

²¹This begs the question as to why the large buyer tolerates farmers selling to traders for liquidity purposes. The answer is that the large buyer doesn't offer daily payments and the participation constraint of the farmer is binding. See Appendix B for details.

²²We also consider the following strategies: *i*) informed farmers accepting a trader's offer if he has not defaulted before, *ii*) uninformed farmers rejecting all offers, and *iii*) traders not defaulting. We note these cannot be part of an equilibrium: An uninformed farmer would have an incentive to deviate and accept the trader's low frequency payment offer.

can prevent the trader offering low frequency payments by setting the price such that the incentive compatibility constraint of the trader cannot be satisfied. The following proposition is obtained:

Proposition 2: *Given p and $p_D = v$, a trader would be able to credibly offer low frequency payments to the farmer if $p \leq \hat{p}^T \equiv \frac{\delta(1-\gamma)D}{D+(1-\gamma)(1-\delta)\beta\delta^3\Delta}v$.*

3.3.2 The Large Buyer

The large buyer posts a price taking into account the incentive constraint of the trader described in equation 2.²³ The following proposition summarizes the large buyer pricing behavior in the repeated game:

Proposition 3: *In the repeated game, the large buyer offers low frequency payments while traders offer daily payments at $p_D = v$. The large buyer pays $p = \hat{p}^F$ if $\frac{D}{\Delta} \geq \beta(2-\beta)\delta^4(1-\gamma)$ and $p = \hat{p}^T$ otherwise.*

Intuitively, if the demand for low frequency payments is relatively low, the binding constraint for the large buyer is the farmer's willingness to sell at a lower price when receiving low frequency payment. If the demand for low frequency payments is relatively high, then the binding constraint for the large buyer is the threat of competition from other traders along the low frequency payment provision margin.

We discuss a number of features of this equilibrium, which we test later. First, according to *Proposition 1*, farmers sort among buyers based on their utility from reaching the saving target (Δ). However, this relationship is nuanced. Farmers who do not sell to the large buyer could be either those whose Δ is low enough or those whose Δ is high enough that they do not need to use the coop monthly payments to save. Second, the same farmer sells, in the same day, both to the cooperative and to the traders, as documented above.²⁴ Third, the

²³To be precise, at the beginning of the game the large buyer posts a plan, i.e., a sequence of prices and buying policies for all future periods *on-* and *off-* the equilibrium path. As is well-known, in the optimal stationary equilibrium of this game the two formulations are equivalent (Abreu, 1988) and we therefore avoid the unnecessary notational complexity associated with the plan.

²⁴In the model, no farmer sells only to the large buyer (while such farmers exist in the data, see Figure 7). A simple extension in which (some) farmers have access to alternative sources of daily income and the desired amount of saving increases with income easily accommodates this feature.

equilibrium features a purchase price that is lower for low frequency payments than for daily ones (and has to do so if the trader IC is binding).

3.4 Supply Responses to Contract Changes

The fact that (some) firms compete simultaneously on the output market and on the saving market may affect the impact of standard firm competition strategies. Here, we consider price competition, focusing on a *temporary* price increase. When the buyer providing low frequency payments raises its price, this generates an income effect: Farmers can achieve their saving goals with fewer purchases. This income effect may reduce deliveries to the buyer. On the other hand, the standard price effect may increase them.

To shed light on this ambiguous effect of price increases, we must slightly modify our model to allow farmers to smooth the consumption of the divisible good across periods (in the baseline version, a farmer will only save to purchase the durable good). We replace the linear utility with a logarithmic one, $u(c) = \ln(c)$. All the previous results hold qualitatively though the algebra is more tedious (results available upon request). The demand for consumption smoothing induced by the concave utility induces a final set of testable predictions concerning the farmers' response to price and liquidity incentives provided by the cooperative. The results are summarized in *Proposition 4*:

Proposition 4: *Consider a temporary (for $t = 1$) large increase in the price paid by the large buyer from p to $p' > p_D$*

P4.1 *The impact on deliveries to the large buyer at $t = 1$ is ambiguous.*

P4.2 *If the option to be paid in cash (i.e., a liquidity incentive) is added to the price increase, deliveries at $t = 1$ increase by a larger amount (and equal production levels).*

We provide a brief discussion of these results. In response to a price increase, deliveries might increase or decrease depending on whether the (positive) price effect or the (negative) income effect dominates (i.e., the farmer can achieve the same desired saving with lower deliveries). If on top of the large price increase, farmers are also given the option to be paid

in cash, they will simply switch all the deliveries to the large buyer and the standard price effect necessarily dominates. Section 6.2 provides an empirical test.

3.5 Bringing the Theory to the Data

The empirical work presented in the remainder of the paper follows closely the steps of the theory. The table below summarizes the empirical strategy to test each key assumption and prediction of the model. In the first two empirical sections (i.e., Section 4 and Section 5), we provide evidence in support of the two microfoundations of the model: *i*) farmers have a demand for low frequency payments, which arises from a demand for commitment (*Proposition 1*); *ii*) traders face credibility concerns when offering monthly payments (*Proposition 2*). The evidence relies on a combination of incentivized choice experiments, survey and administrative data analysis, and a simple calibration exercise.

The second part of the empirical work (i.e., Section 6) focuses on the equilibrium predictions (*Proposition 3*) and the comparative statics of the model (*Proposition 4*). First, using administrative and survey data, we provide additional evidence on the patterns of coexistence of buyers who purchase with very different terms. Second, we run a randomized experiment to test the impact of an increase in the prices paid by the large buyer and to assess how this interacts with the frequency of payments.

4 Demand for Low Frequency Payments

This section explores the first assumption and core prediction of the model: Farmers have demand for low frequency payments which is satisfied by the coop payment structure. In a first experiment, the coop offers farmers the choice between different payment frequencies. A second choice experiment documents that the demand for low frequency payments stems from a demand for commitment devices, as assumed in the model. Additional survey evidence supports the experimental findings and illustrates the role played by the cooperative in helping farmers to reach their saving goals.

Roadmap Table: From Theory to Empirics

Theory Prediction	Empirics
<i>Proposition 1</i> : Farmers value low frequency payments as a commitment device.	<i>Section 4</i> : Experiments.
<i>Proposition 2</i> : Traders face credibility concerns when offering low frequency payments.	<i>Section 5</i> : Survey data, model calibration.
<i>Proposition 3 (E 1)</i> : Buyers coexist <i>across</i> and <i>within</i> farmers, who sort based on their demand for saving.	<i>Section 6.1</i> : Survey and administrative data.
<i>Proposition 4</i> : In saving-output inter-linked market, the impact of price competition is mitigated.	<i>Section 6.2</i> : Experiments, administrative data.

4.1 Demand for Low Frequency Payments

In the model presented in Section 3, the cooperative can purchase milk at a lower price since, in equilibrium, it is the only buyer that provides low frequency payments. The evidence is consistent with this result. Figure 1 reports the share of traders that pay daily or weekly for the milk, as reported by farmers. For the vast majority of the respondents, all traders pay more frequently than monthly (and, mostly, daily). Figure 2 plots the distribution of the highest prices paid by traders in June 2014 as reported by farmers. The vertical red line shows the coop price. The evidence, consistent with extensive focus groups run prior to the survey, is that traders pay significantly higher prices than the coop. The difference is stark: The price paid by the coop is approximately 7 Kenyan shillings lower than the average price paid by the traders. This corresponds to a 25% price gap. Appendix Figure C.1 shows that the gap is even larger once we account for differences in transport costs farmers face to deliver milk to the two types of buyers.²⁵

As mentioned in Section 2, there are certainly other potential reasons that might allow

²⁵We asked farmers about the highest price paid by these traders. Asking about the highest price provides a more accurate description of a farmer’s outside option and allows for a much more accurate benchmarking of the incentive interventions in Section 6. The resulting upward bias is unlikely to qualitatively alter the results since the price paid by the coop is in the left tail of the reported traders’ price distribution.

the cooperative to purchase milk from farmers at a significantly lower price and thus may explain part of the price gap. To assess the specific extent to which low frequency payments are an important determinant of farmers' willingness to sell to the coop and disentangle them from other factors, we would want to manipulate the timing of payments to farmers while holding constant the type of buyer and the other services (or lack of) provided. The experiments described below implement such a test.

The coop offered a representative sample of 102 farmers the option to receive payment for their deliveries on a daily basis for the subsequent month.²⁶ The daily payment method perfectly mimicked the one used by traders. Farmers deciding to opt for the daily payment would be paid at the collection center, in cash, upon delivery. In addition, the coop offered farmers a price increase of 5 Kenyan shillings per liter (a 16% increase) if they chose the daily payment. Thus, the additional price associated with daily deliveries substantially reduced the gap between the trader price and the coop price. In doing so, the choice experiment quantifies the share of farmers willing to forgo a large increase in price (16%) in order to retain the low frequency payments on a monthly basis.

The experiment was completed for 96 of the 102 targeted members (94.1%). The first bar in Figure 3 summarizes the results. We find that only 14% of the farmers choose the daily payment option. A large majority of farmers (86%) are willing to forgo a substantial increase in price in order to retain the monthly payment option. The evidence, therefore, is consistent with farmers having a high demand for low frequency payments from the coop.²⁷ When asked the motivation for their choice to select the monthly payments, farmers reported the following as the main reasons: *i*) they try to achieve saving targets (47%); *ii*) they do not trust themselves to handle the cash properly (26%); *iii*) the spouse wants to receive money on the coop account at the end of the month (14%). Interestingly, lack of trust in workers delivering milk, lack of proper saving technology, and pressure to share income with family members, friends, and neighbors were rarely cited as reasons.²⁸

²⁶In practice, the coop management informed farmers the coop was piloting new payment systems to increase its deliveries. For the piloting phase, the farmer was offered the option to enter a lottery that would determine actual daily payments for the following month.

²⁷The experimental evidence is also consistent with the financial diaries of Collins et al. (2009), ch. 7, which suggests that poor households often receive negative interest rates on savings. For instance, in West Africa, participants of *osusus*—a form of saving group—often pay deposit collectors a share of their savings.

²⁸While a *status quo* bias among respondents might inflate reported preference for the monthly payment, it is reassuring that the motivations provided by the farmers point to such a clear role of saving targets in

As a complement to these experimental results, the baseline survey provides insights into farmers' attitudes regarding savings and into the role the coop's low frequency payment plays in helping farmers reach their saving goals. Figure 4 summarizes this evidence. First, 82% of the farmers state that they set saving goals, and 87% of these state they reach these goals most of the time. Second, farmers perceive the coop as an important device to meet these goals. Of the farmers who state they set saving goals, 71% say that the coop's monthly payments help in reaching these goals. In addition, 79% say that they would reach these goals less often if the coop paid weekly (instead of monthly). Moreover, while 77% of farmers report that traders' immediate payments provide them with the liquidity they need for daily purchases, 95% of farmers report that coop's infrequent payments allow them to save.²⁹

Finally, correlation analysis between farmer characteristics and the demand for the coop low frequency payments provides additional evidence. Table 3, Column (1) shows that the likelihood that farmers set saving goals is higher for farmers who earn regular income from another occupation and for those who report saving in a bank. In addition, present bias is positively correlated with this outcome, suggesting a certain degree of sophistication in our population. Column (2) also shows that farmers who report saving in a bank are more likely to reach these goals. Turning to the relation between the coop and the saving goal outcomes, Column (3) shows that having another regular occupation reduces the likelihood the farmer states that the coop helps reaching the saving goals. When looking at those farmers who claim they would reach the goals less frequently if the coop made weekly payments, a pattern of several interesting correlations emerges. First, larger milk producers, as measured by the number of cows, claim they would be less affected by this change. Second, regular income from another occupation lowers again the mean outcome. Third, the impact of the payment frequency on achieving the saving goals is particularly large for present biased farmers, consistent again with a degree of sophistication. To summarize, the survey evidence indicates that the monthly payments offer an additional service to the farmers.

shaping their choices.

²⁹Focus groups with dairy farmers in several areas of Kenya provide additional suggestive evidence consistent with the above findings (Morton et al., 2000).

4.2 Low Frequency Payments as a Commitment Device

While the specific determinants of the demand for low frequency payments are not necessary to derive the resulting implications for output markets, understanding the effects of policy changes, including cooperative sourcing strategies, requires a fuller picture of the sources of the demand for low frequency payments. The survey evidence reported above suggests low frequency payments could act as a commitment device. We assess the relevance of time-inconsistent preferences in generating a demand for low frequency payment using an additional experiment, which targeted another random sample of 100 active members (and reached 95 of these). Farmers were offered the opportunity to choose every day whether they wanted to be paid in cash or at the end of the month for their deliveries. Farmers had to decide whether to accept this flexibility option or stay with the monthly payment option. Regardless of the option chosen, farmers received an extra of KSh 5 per liter of milk delivered for that month. Importantly, the farmer retains control every day on whether to exercise the option to be paid daily or not.

If the demand for low frequency payment arose from reasons other than the demand for commitment (e.g., safety concerns, lack of alternative saving technologies, transaction costs), a farmer should always opt for the flexible payment scheme. The flexible payment can always replicate the cash flow profile of the monthly payment (if the farmer never exercises the cash option) and it is strictly better if there is minimal uncertainty on traders' availability or prices (in addition, the KSh 5 price increase matches the trader prices for a non-negligible share of farmers). A farmer whose demand for low frequency payment arises from a demand for commitment, instead, will demand to retain the monthly payment.³⁰ The second bar in Figure 3 summarizes the results. An extremely high share of farmers, 93%, turns down the flexibility option. This share is even higher than the results from the first choice experiment (86%).³¹

³⁰Farmers may dislike the flexibility option because they want to avoid a daily “cost of thinking” (see, e.g., Dekel et al., 2001; Ergin and Sarver, 2010; Ortoleva, 2013). However, if this was the only motivation driving the results of the second choice experiment, as opposed to a demand for a commitment device, farmers should chose once and for all the daily payment over the monthly option in the choice experiment presented in Section 4.1.

³¹The two results are, however, not directly comparable since a relative price increase to incentivize switching was offered only in the first experiment. Note that such asymmetric design is directly derived from the model given the different purposes of the two choice experiments.

Further survey evidence supports the above results. Farmers' responses when asked about the motivations for sticking to the monthly payment when offered the flexible arrangement are similar to the ones for the first choice experiment. Approximately 42% of those choosing the monthly option state that the main reason for doing so is that they want to reach a specific saving target. Another 36% of the farmers state that they don't trust themselves to handle cash properly. Consistent with the design, the share reporting this as the main reason for their choice is higher in the second choice experiment than in the first one. Finally, 17% of the farmers mention that their spouse wants to receive the money at the end of the month on the cooperative account.

The results of this second choice experiment show that farmers have a strong demand for commitment devices. While a growing body of literature has documented demand for commitment (see, e.g., Ashraf et al., 2006; Bryan et al., 2010), the share of farmers turning down the flexibility option in our second choice experiment is higher than most other studies. Two considerations apply. First, farmers who sell to the coop are a selected sample. The model predicts, and evidence reported below confirms, that farmers may self-select into selling to the cooperative based on their demand for commitment. Second, the choice to save through the coop is part of broader portfolio allocation strategy that possibly includes other more liquid sources of income.

Finally, we briefly consider other potential sources for the strong demand for low frequency payments. First, perfectly rational farmers may demand less frequent payments if they face recurrent lumpy expenditures for which they set saving goals (Fafchamps et al., 2014) and do not have access to a cheap and/or secure saving technology. However, approximately 70% of our respondents participate in saving groups (*Chama*) and/or have an account with a bank (on which they make an average of three deposits per month). This would suggest that farmers have the ability to save if necessary.

Second, a demand for low frequency payments could arise from agency problems within the dairy farm. In several cases, the owner of the cows is not the same person that operates the dairy business on a daily basis, the worker. Approximately 25% of the farmers in the sample report hiring additional labor to take care of the cows and deliver milk. In other cases, approximately 40%, the husband typically owns the cows while the wife takes care of the day to day management. When this is the case, the wife might remain in charge of the

cash money used for daily expenses while the husband expects to receive income at the end of the month to cover recurring input expenses for the business. Consistent with this, as reported above, about 15% of the farmers who chose the monthly payment instead of the daily/flexible one mentioned intra-household concerns as motivation for their choices.

To summarize, both the choice experiment results and the evidence from the baseline are consistent with the hypothesis that farmers value the coop’s low frequency payments as they provide an effective tool for savings. In addition, the demand for commitment devices seems to be the main driver, though certainly not the only one, for the demand for low frequency payments. While a demand for low frequency payments—regardless of its sources—is needed to understand how saving constraints spill over onto the milk market, evidence that a demand for commitment underlies it deepens our understanding of the mechanisms and the potential welfare consequences of a variety of interventions.

5 Low Frequency Payments and Buyer Credibility

This section discusses the asymmetry across buyers in the provision of low frequency payments. *Proposition 3* predicts that, in equilibrium, prices would be such that traders cannot credibly promise low frequency payments. An experimental approach is not well suited for testing this prediction. Consider a trader who offers a farmer the option to be paid at the end of the month (for a portion of the sales). The farmer may reject the monthly payment for many reasons besides lack of credibility, for instance if the implicit interest rate offered with the monthly price is too low. Furthermore, working with many small buyers would present many logistical challenges. Instead, we first provide survey evidence on the gap in credibility between the coop and the traders and on the differing extent to which farmers share information about the two buyers. Second, a simple calibration, based on the equilibrium conditions of the model, quantifies the share of uninformed farmers, γ . We show that, depending on the traders’ discount rates, a lower bound for γ is between 15% and 20%—a range strongly supported by the survey evidence.

5.1 Survey Evidence

The evidence so far suggests that farmers value the low frequency payments and this may help the coop purchase milk from farmers at substantially lower prices than those paid by traders. Other traders do not provide these low frequency payments in the current market equilibrium. As documented in Figure 1, essentially all traders (93%) pay more frequently than monthly. In fact, most traders pay daily. Why, then, don't traders also provide low frequency payments to farmers? The question is even more puzzling if one considers that small traders are likely to be liquidity constrained and would, therefore, presumably benefit from delaying payments to the farmers.³² The model introduced an asymmetry in the contracts available to the traders and the cooperative: The cooperative can always credibly offer low frequency payments at the end of the month, while (small) traders must satisfy an incentive constraint.³³ In equilibrium, then, the prices are such that traders cannot commit to resist the default temptation.

Survey modules were designed to directly elicit farmers' perceptions of buyers' ability to credibly promise low frequency payments. Figure 5 presents several findings in this regard. First, farmers *do not want* the traders to provide less frequent payments. We ask farmers whether they would feel comfortable with traders paying less often than they currently do. Only 18% of the farmers would like traders to pay less often. Moreover, when asked about the main reason for their preference regarding trader payment frequency, 56% of the respondents (and 68% of those who said they did not want traders to pay less frequently) state that they are worried traders would default on the contract ("escape") if left with holding too much money from the farmers.³⁴ Second, these negative perceptions of traders are reflected in direct comparisons with the coop. Farmers trust traders much less than (members of) the coop: Trust in other coop members or in members of the coop's board averages 2.4. In contrast, trust in traders averages 1.6, significantly lower. In addition, 78% of the respondents report that the coop is more reliable in payments.

³²On the other hand, the coop receives a larger share of its sale payments on a monthly basis. This introduces a buyer demand for trade credit. In standard models, this results in a price premium associated with trade credit. In contrast, the experimental and survey results show that farmers accept a significant discount for monthly payments. The evidence is inconsistent with an equilibrium driven solely by the buyer demand for trade credit.

³³Appendix B provides a microfoundation for this assumption.

³⁴The second most frequent reason is that farmers use traders' payments as a source of day-to-day liquidity.

We hypothesize that in our context, buyer’s size and farmer information are some of the factors driving the competitive advantage of the coop in offering low frequency payments. The cooperative is a large buyer that purchases milk from fixed premises scattered across villages. Defaulting against one farmer would then trigger punishment from many farmers and be very costly for the coop. This form of community enforcement lends credibility to the coop (see, e.g., Bernheim and Whinston, 1990; Kandori, 1992; Levin, 2002; Rob and Fishman, 2005, for similar logic). A large number of farmers would share information and punish the coop if the coop was to renege on payments to some farmers. As a result, the gains from the coop’s perspective of defaulting on the payments to *one* farmer are likely to be smaller than the costs of not being able to source from *enough* farmers in, say, the village or collection center. In the language of our model, the coop’s γ (i.e. the likelihood to find new uninformed farmers after a default) is equal or close to zero. In the survey the average respondent reports discussing issues related to coop pricing policies and management with 2.3 other members from the village. This is significantly higher than members’ interaction about dairy practices, which averages at 1.16.

Further direct evidence on farmers’ communications about coop policies and pricing schemes is provided by an interesting information episode. In March 2014, the cooperative issued a letter to some farmers to remind them of the statutory provision according to which members are supposed to sell all milk to the cooperative (Casaburi and Macchiavello, 2015). Approximately 45% of the farmers in our sample received the letter. An additional 23% of farmers report knowing about the letter from other farmers. Conditional on not having received the letter, farmers were more likely to report having knowledge of it in villages in which a higher share of farmers received the letter and in which farmers report knowing a higher share of other villagers. This evidence confirms that farmers do share information about even relatively minor coop changes to procedures or policies.³⁵

On the other hand, traders are small: Of the farmers, 92% report that none of the traders that purchased milk in their village is an agent (or buys on behalf) of another larger buyer. Traders are mostly small itinerant buyers who sell milk either to restaurants or bars in the

³⁵A larger buyer, however, has also more to gain by defaulting simultaneously against all farmers. So, why doesn’t this happen? First, the coop would then incur a loss by not being able to utilize invested capital. Second, such a default by the coop would trigger bankruptcy procedure, i.e., a costlier form of punishment triggered by the legal system. Finally, the fact the cooperative is formally owned by the farmers might offer an additional deterrent.

local area or take milk to Nairobi. These small itinerant traders, in contrast, can default on one farmer and then simply move on to a different village where information about the default hasn't spread. In other words, the (relational) contract between the small trader and the farmer must be bilateral. When defaulting on a farmer, the trader can easily find an alternative farmer that is not aware of this default. Consistent with this observation, when asking the number of traders operating in a village, we find relatively little agreement across respondents (81.5% of the farmers report there is at least one trader in the village, with a conditional average of 5.2): Village fixed effects explain only 9.5% of the variance in the number of traders in the village (as reported by the survey respondents). Analysis of traders' names also finds low levels of agreement. Finally, the data point to a high level of turnover of traders. When asked about the trader that has operated in the village for *longest*, the median answer is just five years.³⁶ This suggests relatively little community enforcement available to coordinate punishment against defaulting traders.

We note that other factors not captured in the model may prevent traders from credibly offering monthly payments. First, they may face time inconsistency and thus be unable to save the amount paid daily by the farmer if they cannot access appropriate commitment devices.³⁷ Second, traders might also lack access to a saving technology. Third, adverse selection on traders' discount factor or probability of default would decrease the the low frequency payment price farmers would be willing to accept from traders. Fourth, they may lack the (accounting) skills to arrange monthly payments.

Finally, we discuss why farmers may prefer infrequent payments to other forms of commitment and why traders cannot solve the credibility problem by transferring farmers' daily payment to a bank account. First, both farmers and traders would have to incur substantial transaction costs to transfer the money daily or to verify the payments. Second, the account on which the trader would deposit the money should have additional features that allow the farmer to commit. Otherwise, farmers might withdraw money as soon as it becomes available. To the best of our knowledge, local banks do not offer accounts featuring these stark

³⁶Furthermore, assuming the exit of a representative trader is distributed according to an exponential function, and using the formula for the expected value of the maximum of N such independent random variables, we can estimate an annual probability of trader exit of around 0.4.

³⁷The coop as an institution may not face the same challenges arising from time inconsistency that the traders face. For instance, the coop's internal financial systems help ensure the timely disbursement of monthly payments to the farmers.

commitment options. In addition, the payment withholding represents a stronger form of commitment than depositing into bank accounts as the latter requires an intermediate step during which farmers have access to money. Third, the coop may be in a particular good position to induce commitment since, in the spirit of the equilibrium described in Section 3.3, it may put pressure on the farmers to ensure steady output deliveries.

5.2 Trader Incentive Constraint Calibration

As a complement to the survey evidence of the previous section, we provide a back-of-the-envelope calibration of a trader’s incentive compatibility constraint associated with an offer of low frequency payments. To this purpose, we adapt the model developed in Section 3 to mimic empirical features of the study setting: A month now includes 30 days ($t = 0, 1, \dots, 29$); production and consumption of the divisible good occur every day; deliveries to the coop do not vary systematically across days of the month, $x_1^* = x_2^* = \dots = x_{29}^*$ (in Section 6.2, we discuss this last point more in detail).³⁸ The modified incentive constraint, adapted from Equation 2, shows the conditions under which a trader would *not* be able deviate and offer low frequency payments, given (observed) equilibrium prices:

$$p \geq \frac{1}{30} \delta (1 - \gamma) \frac{1 - \delta^{30}}{1 - \delta} v \equiv p_{empirical}^T \quad (3)$$

Proposition 3 suggests that, in equilibrium, the coop will set prices so that the inequality will be (weakly) satisfied. Thus, the model provides a tool to check which values of γ (the likelihood a trader finds an uninformed farmer after defaulting on a previous low frequency payment) are compatible with observed prices being an equilibrium of the model. We use the survey data to calibrate the prices, $p = 31$ and $p_D = 38$. For each (annualized) δ , we then compute the *minimum* level of γ that would prevent traders from credibly committing to low frequency payment. Figure 6 presents the results. A trader with an annual discount rate of .66 (.5), equivalent to an annual interest rate of 50% (100%), will not be able to commit to low frequency payment as long as the (monthly) likelihood of being matched with a new uninformed farmer is above 18% (16%). The survey evidence presented in Section 5.1

³⁸The exercise yields qualitatively similar results if we use the simplified incentive compatibility constraint of Equation 2.

suggests that the value of γ is very likely to be above this threshold, which is consistent with traders being unable to overcome the temptation to default. Appendix Figure C.2 shows how these bounds vary when *i*) the monthly price traders could offer were higher than the coop's (for instance because the current monthly price reflects other benefits the coop provides) and *ii*) an additional parameter capturing trader time inconsistency is included.

To summarize, this section showed that, relative to traditional, itinerant buyers, the cooperative has a competitive advantage in satisfying farmers demand for low frequency payments. Credibility concerns and informational frictions are primary drivers of the terms of transactions. Unlike smaller traders, the cooperative, a large player, can commit to hold farmer revenues for a month. The economies of scale implied by these forces also suggest that there are substantial barriers to entering the market with a scale that allows competing with the coop.

At this point, it is useful to summarize the welfare implications arising from the theory and evidence presented so far. First, in an environment featuring saving constraints and time inconsistency, low frequency payments provided by some buyers may help farmers reach their saving goals, potentially fostering investment and consumption smoothing. Second, this comes at a cost: Due to the lack of alternative financial management tools (including, as we document below, appropriate commitment devices), buyers who can offer low frequency payments can extract a substantial portion of the surplus in the output market transaction. Third, limited contract enforcement and missing saving markets interact: because of limited enforcement, only some buyers—in our case, one *large* buyer—can *credibly* offer low frequency payments to the producers, with limited competition along this margin.

Several policy lessons follow from the results. First, as large buyers may be better suited to offer low frequency payments, there are potential benefits of policies that foster the emergence of large buyers in output and labor markets in the developing world. The results point to a source of barrier to entry—the ability to credibly promise low frequency payments—but also qualify excessively negative views of large buyers if size is a prerequisite for such payments. Second, our results unveil an additional benefit of improving contract enforcement in agricultural markets. By increasing the number of buyers who can commit to low frequency payments, better enforcement could have an impact similar to better access to saving products, while potentially occurring in a cheaper and more decentralized fashion. Third,

we complement existing research by showing that better access to saving and, more specifically, appropriate saving commitment products, would have positive (and large) benefits for producers, by allowing them to capture a larger share of the output market surplus. More broadly, improving access to financial products will impact agricultural markets in ways that so far have remained unnoticed.

6 Buyer Coexistence, Sorting and Supply Elasticities

This section focuses on the equilibrium predictions and the comparative statics of the model. First, using administrative and survey data, we provide additional evidence on the patterns of coexistence across buyers (*Proposition 3*). Second, we run a randomized experiment to test the impact of an increase in the prices paid by the large buyer and to assess how this interacts with the frequency of payments (*Proposition 4*).

6.1 Buyer Coexistence

About half of the farmers in the catchment area of the coop sell to the coop. Table 2 presents results from the listing of dairy farmers conducted in six villages in the catchment area of the cooperative. According to Column (1), farmers who set saving goals are 20 percentage points more likely to sell to the coop (86% vs. 66%). The results are robust when controlling for the number of cows owned by the farmers and then for village fixed effects, Column (2) and Column (3). Column (4) focuses on how often farmers reach these goals (on a 1 to 6 scale). The average score is 3.55 for those selling to the coop and 3.2 for those who do not. The coefficient on the coop dummy shrinks when controlling for the number of cows, Column (5), and it becomes non-significant when including village fixed effects. Overall, while the cross sectional nature of the data poses an obvious caveat to a causal interpretation of these results, this evidence is consistent with the theory result predicting an extensive margin sorting of farmers between the coop and the traders on the basis of the farmer saving goals. When interpreted through the lens of the model, the results suggest that for those farmers who do not sell to the coop, $\frac{D}{\Delta} > \beta(2 - \beta)$: They either derive low utility from saving (i.e., high $\frac{D}{\Delta}$) or they face a degree of time inconsistency such that they cannot commit to save through the coop (i.e., low β).

We then focus on the intensive margin sorting: To which extent do farmers who sell to the coop also sell part of their milk to other buyers? Milk is produced (and sold) twice a day: in the morning and in the afternoon. While afternoon production is around two-thirds of morning production, afternoon deliveries to the coop are about one-third of the morning deliveries. Figure 7 shows the distribution of the number of days with deliveries across members in May 2014 (conditional on more than 10 deliveries). Among these farmers, 80% sell to the coop in the morning at least 29 days. On the other hand, the afternoon distribution is quite bimodal: Of the members, 45% never delivered milk in the afternoon while 27% delivered at least 29 days, with little mass at intermediate values. We interpret this as *prima facie* evidence that many farmers sell to other buyers in the afternoon.

Survey data sheds additional light on this pattern. For farmers in the main sample, we can construct measures of “loyalty” to the coop, defined as the ratio between sales to the coop and the production available for sales. Production available for sales is the difference between total production and home consumption (including feeding calves), as reported by farmers in the survey. Figure 8 illustrates the distribution of this measure of loyalty. We find that about 85% of the farmers in the sample sell at least some milk to other buyers.³⁹ Conditional on selling to other traders, the average sold to other buyers is 45% of the available milk. Consistent with Figure 7, we also find that both measures of loyalty are much higher in the morning than in the afternoon (details available on request).⁴⁰ Transport costs, driven by the time required to deliver the milk (Figure C.1), are a likely explanation for this pattern. As a result of these travel costs, it is efficient for most farmers to travel to the coop only once a day. The desired amount to be saved is large enough to imply that farmers prefer to sell to the cooperative in the morning and to other traders in the afternoon.

Finally, we consider the model insight that farmers choose a portfolio of buyers to meet both their liquidity needs and their saving goals. This view is strongly supported by the different ways farmers use the money earned from the traders and from the coop. The survey asked how farmers spent the income generated by sales to traders and to the coop in May 2014. Figure 9 illustrates the results. The lumpy income from the coop is predominantly

³⁹When looking at self-reported figures, we find that 45% of the farmers sell to other traders.

⁴⁰There is no marked difference in buyer availability between morning and afternoon. The coop collection centers open at both times. Survey data suggest that about 50% traders are available to purchase both in the morning and the afternoon. Among those available only part of the day, about 40% (60%) are available only in the morning (afternoon).

(almost 40%) used to finance lumpy expenses in the dairy business, such as purchase of feed and equipment. The corresponding figure for sales to the traders is only 16%. Similarly, significantly larger shares of lumpy income obtained from the coop are used for savings, 15%, or for school fees, 10%, against 6% and 5%, respectively, for income derived from traders. On the other hand, the largest share of the income derived from traders is spent on current expenses, such as purchasing food (55%). The corresponding share for the coop is much lower, at 21%. To summarize, farmers use for different purposes money paid with different frequency by different buyers.⁴¹

6.2 Supply Responses to Contract Changes: Price and Liquidity

The final part of the paper studies how, in an interlinked saving-output market, producers' sales respond to price and liquidity incentives. *Proposition 4* in Section 3 guides the empirical approach. Specifically, as the coop would like to increase afternoon deliveries, we designed an experiment to test the impact of price and liquidity incentives on afternoon deliveries.

In the experiment, 398 farmers surveyed at baseline were randomly assigned to three groups: two treatments (150 in each) and one control group (98). In the first treatment, farmers were informed that for the subsequent three days they will receive a bonus of KSh 10 (an increase of approximately 30% relative to the baseline price) for their afternoon deliveries. For more than 75% of the farmers, the price increase is higher than the price paid by the best traders. In the second treatment, in addition to the price increase for the afternoon deliveries, farmers were given the option to choose on a daily basis whether, for the deliveries in that day, they wanted to receive payment in cash on the spot or to retain the standard monthly payment. The farmers were given the opportunity to be paid in cash for morning and/or afternoon deliveries for the three days according to their choice.

The randomization was stratified by farmer location (i.e., four zones) and baseline delivery levels. Table 4 confirms that the randomization worked overall. However, the proportion of male respondents differs across the two treatment groups (significant at 5%) and the proportion of farmers reporting access to traders differs across the flexibility and the control

⁴¹This is consistent with the model of Banerjee and Mullainathan (2010) and with evidence from Haushofer and Shapiro (2013), who find that monthly transfers from an unconditional cash transfer program are more likely than lump-sum transfers to improve food security, while lump-sum transfers are more likely to be spent on durables.

group (significant at 10%). All the results presented below are robust to the inclusion of these covariates. Around 6% of the treatment farmers could not be reached before the intervention. The success rate in reaching target members was similar across the two groups. Delivery data are available on the whole sample. As we have delivery data for all farmers, the empirical analysis follows an *intention-to-treat* difference-in-differences specification:

$$y_{it} = \eta_i + \beta Post_{it} + \gamma Bonus_i * Post_{it} + \delta(Bonus + Flexibility)_i * Post_{it} + \epsilon_{it} \quad (4)$$

where the outcome variable captures farmer i (afternoon) deliveries to the coop in day t . For each farmer, we include the three days of the intervention ($Post_{it} = 1$) and the same three calendar days of the month before the treatment ($Post_{it} = 0$). Note that the model includes farmer fixed effects, which subsume the treatment group dummies.

Figure 10 summarizes the findings. The *bonus* treatment (the large price increase) has only a minor impact on the afternoon deliveries. The *bonus+flexibility* treatment induces a larger change, though this is still small in absolute value. Table 5 confirms the results. We first focus on kilograms delivered to the coop in the afternoon. Column (1) presents an OLS using only observations from the three days of the experiment. Column (2) shows results from a difference-in-differences model. Column (3) reports the estimation of the model presented in Equation 4. Columns (4)-(6) and (7)-(9) present a similar analysis for a binary indicator if the farmer delivered any afternoon milk and for morning deliveries (kg), respectively.

Consistent with *Proposition 4.1*, which predicts an ambiguous impact of a price increase due to the opposite effect of income and substitution effects, the large bonus treatment has a small impact on afternoon deliveries (0.12 kg per day). The flexibility group, where 30% of the farmers choose the afternoon flexibility option, displays an increase in afternoon deliveries of 0.25 kg per day and an increase in the likelihood that farmers deliver any afternoon milk of 6.8 percentage points, compared with a baseline level of zero. While, as per the prediction in *Proposition 4.2*, the point estimate on this treatment is larger than the one on the bonus treatment, the difference in coefficients is not significant at conventional levels and the overall impact is still quite small in absolute level.

Several deviations from our model could help explain the limited response to the flexibility treatment. First, the very large price increase may still not be large enough to match the

trader net prices, inclusive of transport costs. Survey evidence, however, suggests that this could be true for at most a small minority of farmers. Second, some farmers may not have enough milk to sell, once accounting for consumption and other domestic usages. However, at least 45% of the farmers sell milk in the afternoon to the traders and this estimate is likely to be a lower bound because of under-reporting. Third, if farmers sell to traders with whom they have relationships, the farmer might be unwilling to jeopardize the relationship with the trader to earn a substantial price increase from the coop for a limited amount of time. This hypothesis is also at odds with survey evidence. While we do not know whether farmers always sell to the same trader, 90% of the farmers report that the traders do not provide any additional service, which we would expect if relationships were important. Consistent with some of the above explanations, Table 6 shows suggestive evidence that the impact of the *Bonus + Flexibility* treatment is stronger for farmers with higher (morning) delivery levels (Column 1), for those who are less loyal to the coop (Column 2, though this is not significant at conventional levels), and for those who report access to another trader (Column 3).

A final possibility for the limited responsiveness of both treatments is that farmers follow a simple heuristic when making their sales: they sell to the coop in the morning as a saving tool and to traders in the afternoon for liquidity. In the presence of time-inconsistent preferences, simple heuristics, such as rules of thumb, might help agents resisting temptations.⁴² Administrative data from the coop on deliveries by day of the month support the interpretation based on such rules of thumb. An impatient farmer may sell more to the coop toward the end of the month, as this time gap between delivery and payment is smaller. A farmer who values the commitment device provided by the coop's low frequency payment may sell more to the coop early in the month, as the implicit saving period is longer. The data, however, feature a completely flat profile across days of the month. Figure 11 shows the average coop deliveries per day 2014 in both morning and afternoon. In addition, as mentioned in Figure 7, the distribution of the number of afternoon deliveries per month is bimodal: Most farmers either sell every day or never. Furthermore, very few farmers deliver amounts of milk that systematically differ between the beginning and the end of the month. Overall, this evidence, consistent with findings from various focus groups, confirms that few

⁴²See, e.g., Bénabou and Tirole (2004) and Bernheim et al. (2015) for a theoretical discussion and Dupas and Robinson (2014) for empirical evidence.

farmers optimize their delivery behavior depending on the day of the month.⁴³ It also alleviates concerns that specific features of the experiment, such as the short duration, may have driven the low responsiveness we found in the experiment. An implication of this rule of thumb is that it would be a potentially risky decision for the coop to extend flexible payment to farmers. Providing more flexible payment might lead farmers to change their perception of the coop as provider of low frequency payments. This might be one of the main sources of competitive advantage for the coop.⁴⁴

To summarize, this section documented a market equilibrium where the coop competes by providing low frequency payments and other buyers compete by offering higher prices and daily payments. In this market, two key dimensions of standard firm competition, prices and liquidity, interact in a nuanced way. Finally, additional evidence suggests that behavioral biases—in particular simple rules of thumb adopted by sophisticated time-inconsistent agents that value low frequency payments—also drive farmer supply choices.

7 External Validity and Concluding Remarks

The paper has documented how saving market imperfections spill over into other markets. In accord with a theoretical framework of this interlinkage, the empirical analysis—based on administrative data, surveys, and multiple experiments—provided evidence on producers’ demand for low frequency payments; buyers’ asymmetry in their ability to credibly promising them; an output market in which many producers sell contemporaneously to buyers offering

⁴³In an additional (incentivized) framed field experiment, farmers were randomly assigned to choose between monthly and daily payments in a scenario where they had to sell milk to the coop in the morning or afternoon for that day. Results show no difference in the required price to accept daily payments between morning and afternoon. It is likely the experimental design did not achieve the desired framing effect. We also note that the results of the framed field experiment are consistent with the choice experiments described in Section 4: 3.5% of the farmers accepted a daily price lower than the coop prevailing monthly price; most farmers required at least 5 Ksh (29.3%), 8 KSh. (18.3%) or 10 Ksh (27.2%) above the current price to choose the daily payment. The share of farmers willing to accept a 5Ksh price increase for daily payments is larger in the framed field experiment than in the choice experiments, though still small: this is consistent with the fact that the former concerned payment frequency for only one *day* of sales and the latter concerned one *month* of sales.

⁴⁴These risks add to the standard difficulties in implementing change when practices are complementary, as emphasized in the management literature (see, e.g., Milgrom and Roberts, 1990, and Brynjolfsson and Milgrom, 2013). By implementing piecemeal changes, the organization might compromise the effectiveness of other unchanged practices. In addition, scaling-up a more flexible payment system would require the coop to implement a significant adjustment to its cash-flow management and administrative tools.

different purchasing terms; and implications for firm competition strategies, such as price increases. Unveiling this interlinkage leads to a range of novel welfare and policy implications.

While the study is based on a specific setting, its findings are of interest for a broad class of markets featuring saving-constrained producers. In the spirit of Deaton (2010), we believe the theory presented in the paper plays a key role for any external validity consideration. The empirical analysis (including, but not limited to, randomized experiments) is designed to test theoretical predictions that, under the stated assumptions, are valid beyond the specific context. In addition, the close link between the model and the empirics provides a battery of (related) tests to assess the actual relevance of the proposed mechanisms in other settings. In this final section, we present original survey evidence from a variety of contexts lending support to the mechanisms described in this paper. We focus on our two key ingredients: 1) producers' demand for infrequent payments; and 2) buyers' asymmetry in delivering them.

Figure 12 considers producers' demand for infrequent payments in the Kenya tea sector and among line supervisors in large garments factories in Myanmar. In both cases, the Figure reports patterns remarkably consistent with those documented for our dairy farmers. In many agricultural value chains large buyers source through low frequency payments. An ideal example is provided by smallholder tea contract farmers selling to large companies (UNCTAD, 2009). During harvest season, tea farmers pick leaves and sell them multiple days per month (10-20 days depending on the timing of the season). The high frequency at which tea leaves are picked opens up the possibility for the existence of both frequent and infrequent payments. We conducted a survey with 111 such farmers in Western Kenya. Indeed, the survey confirms that large buyers (cooperatives and large estates) pay monthly while smaller traders predominantly (68%) pay daily. Figure 12 shows that 81% of the respondents mention monthly payments as their preferred payment frequency and 95% say monthly payments help with saving. The results are consistent with those from the dairy context and are relevant to understand contract farming schemes more generally. Alongside prices, payment frequencies may be an important determinant of side-selling in contract farming schemes. Farmers may choose to sell to small traders, thus defaulting on their contract with large buyers, to achieve a balanced liquidity/lumpy income portfolio.

We posit that the proposed mechanism has several implications for labor markets. Figure 12 also reports results from a survey of 34 Myanmar garment factory workers (specifically, line

supervisors). All the respondents mention that monthly is the preferred payment frequency and 84% state that monthly payments help reach their saving goals. In a broader historical perspective, the establishment of the factory systems was accompanied by a shift toward monthly payments (Engerman and Goldin, 1991). Clark (1994) argued that the monitoring associated with the factory system helped worker dealing with self-control in effort provision. Our results suggest that it can also help with self-control in saving and spending habits.⁴⁵

The second ingredient of our analysis is that larger firms are better positioned to offer such low frequency payments. Figure 13 provides further support. In a survey of 198 coffee mills in Rwanda, the Figure documents a strong correlation between firm size and the likelihood the firm pays its (seasonal) workers on a monthly basis: 71% of the firms in the top quartile of the size distribution pay monthly but only 30% of the firms in the bottom quartile do.⁴⁶ The figure is qualitatively consistent with the evidence from the dairy and tea markets in which large buyers (cooperatives and estates) pay less frequently than small traders. We believe this mechanism unveils an additional benefit of larger, modern organizations in fostering growth, by increasing saving and asset accumulation.

Beyond agricultural value chains and labor markets, our evidence is also relevant for the analysis of trade credit contracts between firms. Trade credit often flows from small to large firms (Petersen and Rajan, 1997; Klapper et al., 2011). Our paper suggests that, among other reasons (e.g., buyer market power), this may arise because small saving-constrained producers have a demand for “trade saving.” To summarize, the interlinkage described in this paper may apply to several markets that feature saving-constrained producers, thus affecting their structure and functioning. While we are aware the examples in this section are just a first step, we hope they will provide motivation for future research.

⁴⁵A variety of labor markets institutions aim at helping workers save, e.g., in anticipation of high expenses during festivities. These include *Employee Christmas Clubs*, which are common in the United States, Eid Bonuses paid by government and large firms in Bangladesh ahead of Eid-al-Fitr, and *Thirteenth Salaries*, which employers pay to workers in December in Brazil, Germany, and Philippines, among other countries. In Italy, a recent policy (*Legge di Stabilità 2015*) gave some workers the option to cash a portion of their severance pay. Media reports suggest that less than 1% of the workers took up this opportunity (*La Repubblica, 2015*).

⁴⁶We thank Ameet Morjaria for sharing the data.

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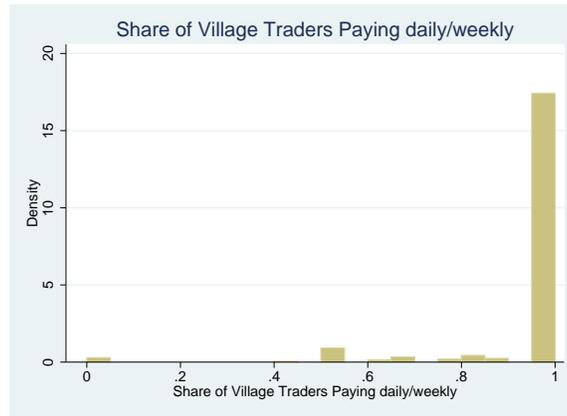
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Figures

Figure 1: Payment Frequencies



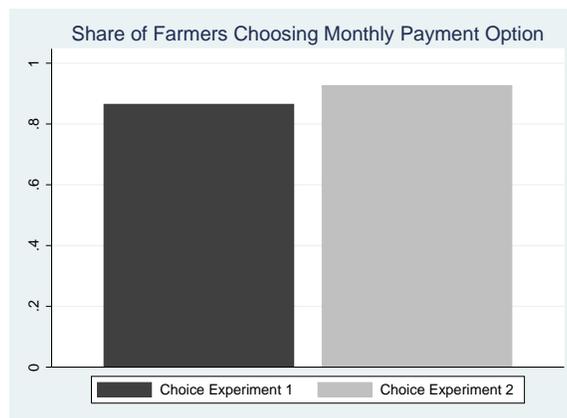
Notes: The figure presents the distribution the frequency of trader payments. For each observation, the value of the variable is the share of traders paying more frequently than once a month out of the total number of trader in the village, as reported by the farmer in the baseline survey. The sample is restricted to farmers reporting at least one trader in the village.

Figure 2: Prices



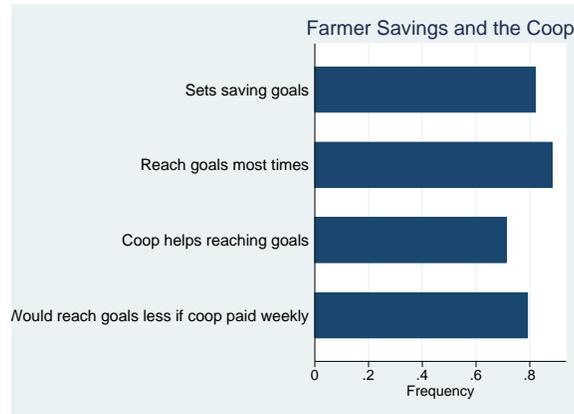
Notes: The graph presents the distribution of prices paid by the best trader in the village, as reported by the farmers in the baseline survey. The vertical red line captures the cooperative milk price.

Figure 3: Choice Experiments



Notes: The figure presents results from the choice experiments reported in Section 4. The first bar focuses on the first choice experiment. It reports the share farmers targeted by the experiment (N=96) who said they would prefer monthly payments to daily payments with a bonus of KSh 5, from a baseline of 31. The second bar focuses on the second choice experiment. It reports the share of farmers targeted by the experiment (N=95) who said they prefer the monthly payment to the “flexibility” option, which would allow them to choose every day whether to be paid daily or monthly.

Figure 4: Savings and the Coop



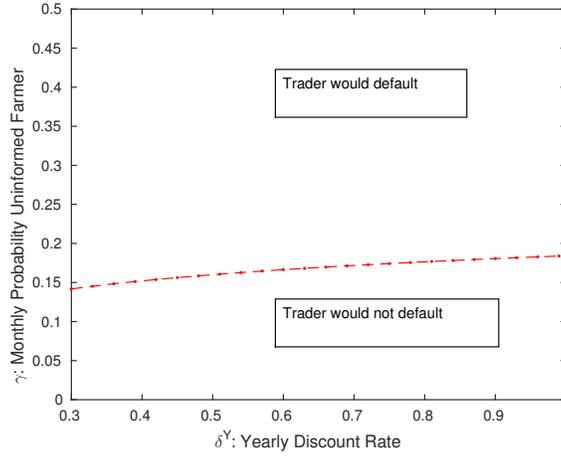
Notes: The figure presents summary statistics on farmer savings behavior and on the role of the coop in helping savings. All the variables are binary indicators. For the first variable, “*Set saving goals*”, we use the entire baseline sample. For the other variables, we restrict the sample to those farmers who state they set saving goals. “*Would reach goals less if coop paid weekly*” takes value one if a farmer answers “less often than I do currently” to the question “If the coop paid every week, how often would you reach your saving goals?”

Figure 5: Traders



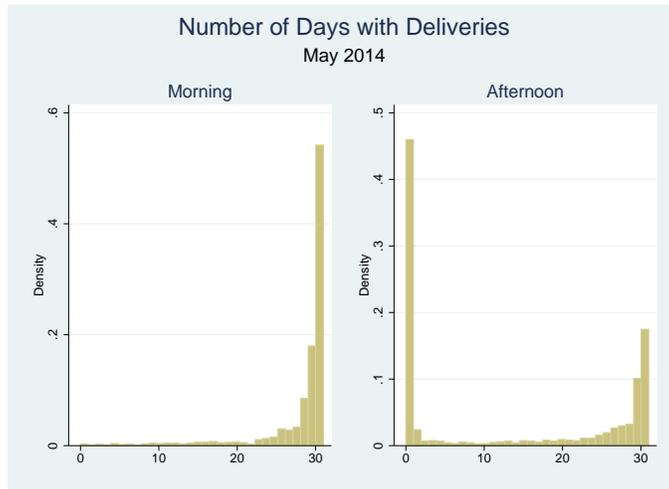
Notes: The figure presents summary statistics on farmer attitudes toward traders other than the coop. The binary indicators “*Trusts coops more than traders*” and “*Coop more reliable than traders in payments*” are equal to one if the trust score or the payment reliability score are strictly larger for the coop than for other buyers, respectively.

Figure 6: Trader Incentive Constraint Calibration



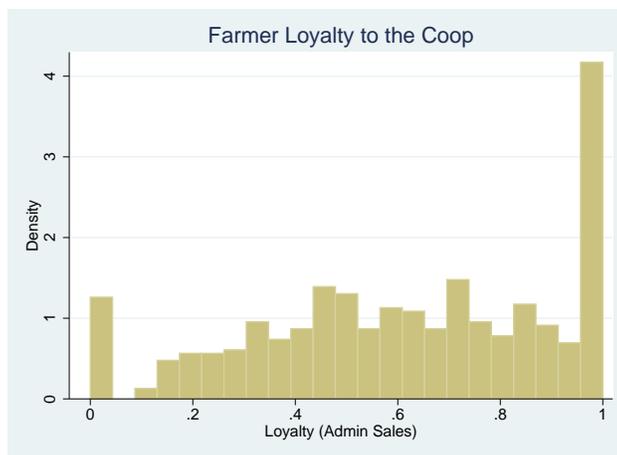
Notes: The figure shows pairs (δ^Y, γ) that satisfy the inequality of the incentive constraint of the empirical model (Equation 3)—where δ^Y is the annual discount factor and γ is the likelihood a trader matches with an *uninformed farmer* after a default. p and v are calibrated at KSh 31 and 38, respectively. A trader defaults if γ is below the frontier described by the dashed line in the figure.

Figure 7: Number of Days with Deliveries



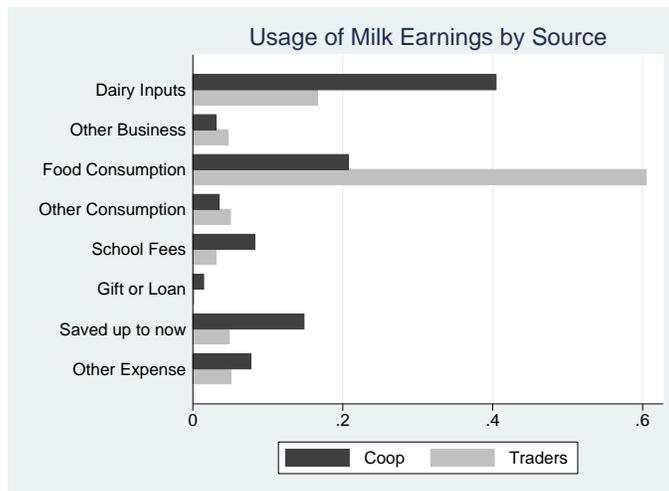
Notes: The left (right) histograms present the distribution of the farmer-level number of days with positive deliveries to the coop in the morning (afternoon) in a month (measured in May 2014).

Figure 8: Farmer Loyalty to the Coop



Notes: The Loyalty variable is computed as the ratio between sales to the coop and production available for sales. Production available for sales is defined as the difference between production and home consumption (including feeding calves). Deliveries to the coop are obtained from cooperative records.

Figure 9: Usage of Milk Earnings



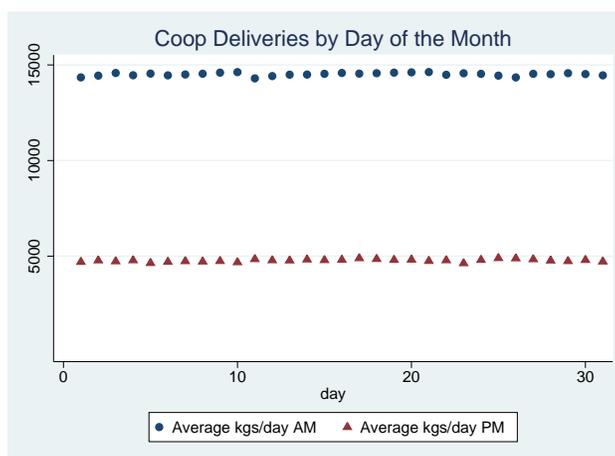
Notes: The figure describes how farmers use milk earnings from the coop and from other buyers, respectively. For each farmer-buyer, we compute the share of expenses on a certain item relatively to the total earned by the farmer from that buyer.

Figure 10: Bonus Experiment Afternoon Deliveries



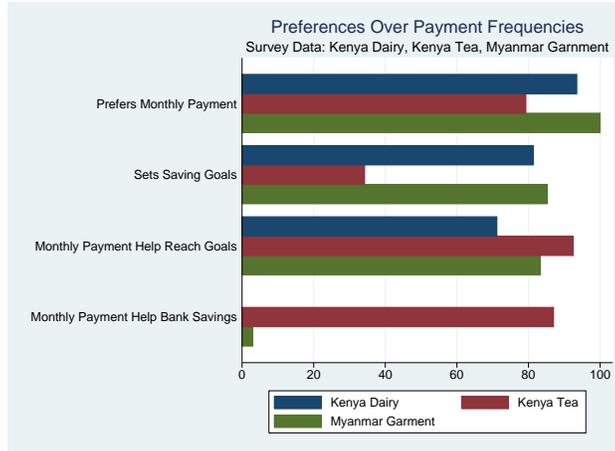
Notes: The figure reports average afternoon deliveries for the randomized experiment presented in Section 6.2. Days 1 to 3 refer to the days of the experiment. Days -3 to -1 refer to the same calendar days of the month before the experiment.

Figure 11: Average Coop Milk Deliveries by Day of the Month



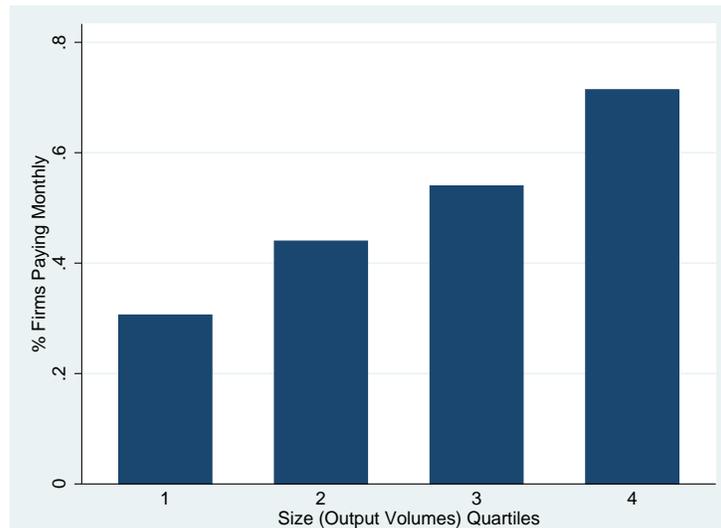
Notes: The figure shows milk deliveries in 2014 by day of the month (1st to 31st) for both morning and afternoon deliveries (measured in kilograms). For each day, we average deliveries among the months that include that day. We obtain similar results when removing month fixed effects to account for the fact that months have different end days.

Figure 12: Pay Period Preferences: Three Surveys



Notes: The figure reports percentage of respondents agreeing with the four statements in three different surveys: dairy farmers in Kiambu, tea growers in Western Kenya, and line supervisors in garments factories in Yangon.

Figure 13: Rwanda Coffee Mills Survey



Notes: The figure reports the percentage of coffee mills in Rwanda paying monthly wages (as opposed to biweekly, weekly and daily wages) to seasonal employees during the 2015 harvest campaign. The figure shows larger mills pay *less* frequently. We thank Ameet Morjaria for sharing the data.

Tables

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Male Respondent	0.425	0.495	0	1	583
Respondent Age	55.635	15.685	18	94	578
Household size	5.091	2.073	1	14	592
Number of Cows	1.446	1.292	0	25	592
Dairy Production (kg)	11.951	7.483	1	64	568
Avg Deliveries (kg) in June 2014	4.327	2.628	0	20.027	595
Loyalty	0.621	0.292	0	1	544
Loyalty AM	0.714	0.282	0	1	558
Loyalty PM	0.501	0.491	0	1	549
Hire workers for dairy	0.268	0.443	0	1	594
Any Other Village Trader	0.815	0.389	0	1	594
Present Biased	0.122	0.328	0	1	565
Difference Trust Coop-Trader	0.853	1.135	-2	3	539
Saves in Saving Groups	0.702	0.458	0	1	591
Saves in Bank	0.74	0.439	0	1	589
Regular Income from Other Occupation	0.201	0.401	0	1	596
HH member manages money not cows	0.295	0.456	0	1	543

Notes: The table presents summary statistics from the farmers targeted in the main baseline survey. 2014. *Mean Daily Deliveries* are from coop administrative data and refer to September 2014. Both production and delivery variables are measured in kilograms. *Loyalty* variables are defined as ratios between sales to the coop and production available for sale (defined as the difference between production and home consumption, including feeding calves). A farmer is defined as *present biased* if she is more impatient when splitting money between today and next week than when splitting money between next week and the subsequent one. *Trust* for either the coop and the buyer is measured as an index from 1 to 4. Therefore, their difference can span -3 to 3. *Regular Income from Other Occupation* refers to permanent employee, civil servant, artisan, trader, and self-employed.

Table 2: Farmer Saving Behavior and Sales to the Coop

	Set Saving Goals			Reach Goals		
	(1)	(2)	(3)	(4)	(5)	(6)
Sells to Coop	0.206*** (0.040)	0.184*** (0.042)	0.206*** (0.047)	0.358*** (0.131)	0.255* (0.133)	0.173 (0.149)
Y Mean (No-Coop)	0.664	0.664	0.664	3.207	3.207	3.207
N.Cows	N	Y	Y	N	Y	Y
Village FE	N	N	Y	N	N	Y
Observations	408	408	408	302	302	302

Notes: The analysis uses data from the dairy farmer listing exercise, which targeted a random sample of dairy farmers. The binary variable “Set saving goals” is not missing for 408 of these farmers. The variable “Reach Goals” takes value from 1 (never reach the goals) to 6 (always reach them). The variable is defined only for those farmers who state that they set saving goals. Standard errors are robust to heteroskedasticity. *p<0.1, **p<0.05, ***p<0.01.

Table 3: Baseline Correlations

	Set Saving Goals	Reach Goals	Coop Helps Goals	Reach Less if Weekly Pyt
	(1)	(2)	(3)	(4)
Number of Cows	-0.003 (0.014)	0.002 (0.005)	0.009 (0.013)	-0.026** (0.010)
Avg Deliveries (kg) in June 2014	0.003 (0.007)	0.009* (0.005)	0.008 (0.008)	0.007 (0.008)
Loyalty	0.071 (0.067)	0.058 (0.057)	0.141* (0.085)	-0.041 (0.075)
Any Other Village Trader	0.025 (0.042)	-0.046 (0.036)	0.100* (0.056)	0.098* (0.054)
Present Biased	0.087** (0.039)	0.033 (0.039)	0.008 (0.063)	0.103** (0.045)
Difference Trust Coop-Trader	0.022 (0.014)	-0.006 (0.012)	0.004 (0.018)	0.036** (0.016)
Saves in Saving Groups	0.137*** (0.039)	-0.037 (0.034)	0.075 (0.048)	0.067 (0.044)
Saves in Bank	0.074* (0.040)	0.097** (0.041)	-0.016 (0.048)	-0.096** (0.040)
Regular Income from Other Occupation	-0.004 (0.040)	-0.023 (0.037)	-0.113** (0.056)	-0.098* (0.052)
HH member manages money not cows	0.095*** (0.031)	0.040 (0.031)	0.015 (0.046)	-0.033 (0.042)
R^2	0.075	0.049	0.056	0.082
Dependent Variable Mean	0.821	0.883	0.712	0.789
Observations	591	495	496	497

Notes: The table presents correlation between several measures of saving behavior, as measured in the baseline survey, and other farmer covariates. Refer to Table 1 for a description of the covariates. For each of the covariates, the regression also includes a binary indicator for whether that covariate is missing (and missing values in the variables are replaced with an arbitrary negative value). Standard errors are robust to heteroskedasticity. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Price and Liquidity Experiment: Balance Table

	Bonus [M]	Bonus+Flex [F]	Control [C]	P-value [M-F]	P-value [M-C]	P-value [F-C]	N
Male Respondent	.3706 (.4846)	.4765 (.5011)	.4123 (.4948)	.052*	.825	.319	389
Respondent Age	58.39 (15.90)	54.96 (15.98)	56.12 (15.05)	.136	.323	.455	387
Household size	4.945 (2.185)	5.306 (1.928)	5.163 (2.064)	.133	.73	.425	395
Number of Cows	1.383 (.6874)	1.346 (.6754)	1.448 (.6904)	.849	.426	.28	394
Average Daily Deliveries in Sep 2014	3.963 (2.257)	4.051 (2.413)	4.216 (2.262)	.826	.199	.302	398
Loyalty	.6632 (.2476)	.6582 (.2516)	.6713 (.2529)	.597	.881	.618	376
Loyalty AM	.7814 (.2225)	.7669 (.2221)	.7611 (.2210)	.405	.659	.743	383
Loyalty PM	.4978 (.5004)	.5057 (.4997)	.5429 (.4943)	.552	.742	.213	378
Hire workers for dairy	.2229 (.4176)	.2516 (.4354)	.2551 (.4381)	.314	.625	.835	397
Any Other Village Trader	.8367 (.3708)	.8807 (.3251)	.7755 (.4193)	.25	.468	.079*	396
Present Biased	.1313 (.3390)	.1103 (.3144)	.1086 (.3129)	.62	.538	.816	374
Difference Trust Coop-Trader	.7591 (1.121)	.9851 (1.126)	.9418 (1.109)	.158	.488	.523	358
Saves in Saving Groups	.6418 (.4810)	.7302 (.4452)	.7395 (.4411)	.121	.09*	.831	396
Saves in Bank	.7260 (.4475)	.7105 (.4550)	.7938 (.4066)	.822	.274	.224	395
Regular Income from Other Occupation	.2094 (.4083)	.2105 (.4090)	.2142 (.4124)	.961	.572	.897	398
HH member manages money not cows	.2463 (.4324)	.2739 (.4475)	.3333 (.4739)	.694	.271	.146	377

Notes: The table reports summary statistics and balance tests for the randomized experiment presented in Section 6.2. Farmers in the *Bonus* group received an increase in milk price of 10 Kenyan shillings for afternoon deliveries. Farmers in the *Bonus+Flexibility* group received the same price increase and the option to be paid daily. The randomization was stratified by farmer location (i.e., four zones) and baseline delivery levels (i.e., above/below median). We report p-values based on specifications that include stratum fixed effects. *p<0.1, **p<0.05, ***p<0.01.

Table 5: Price and Liquidity Experiment: Main Results

	Kg PM			Kg PM (dummy)			Kg AM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post*Bonus (γ)		0.128** (0.050)	0.128** (0.050)		0.043*** (0.015)	0.043*** (0.015)		-0.223 (0.283)	-0.223 (0.283)
Post*(Bonus+Flexibility) (δ)		0.245** (0.098)	0.245** (0.098)		0.068*** (0.020)	0.068*** (0.020)		-0.009 (0.316)	-0.009 (0.316)
Post		-0.008 (0.008)	-0.008 (0.008)		-0.004 (0.004)	-0.004 (0.004)		-0.218 (0.211)	-0.108 (0.205)
Bonus	0.153** (0.062)	-0.000 (.)		0.047*** (0.017)	-0.000 (0.000)		-0.319 (0.259)	-0.336 (0.304)	
Bonus+Flexibility	0.286*** (0.105)	0.029 (0.029)		0.074*** (0.022)	0.007 (0.007)		-0.281 (0.293)	-0.420 (0.302)	
R^2	0.186	0.028	0.038	0.252	0.038	0.054	0.506	0.008	0.011
p-value $\gamma = \delta$	0.211	0.287	0.286	0.235	0.315	0.315	0.886	0.496	0.496
Control Group Mean (Post Period)	0.000	0.000	0.000	0.000	0.000	0.000	4.110	4.110	4.110
Farmer FE			X			X			X
Farmers	398	398	398	398	398	398	398	398	398
Observations	1194	2388	2388	1194	2388	2388	1194	2388	2388

Notes: The table presents the results of the randomized experiment presented in Section 6.2. The table reports three measures of daily deliveries: kilograms delivered in the afternoon, a dummy for whether the farmer delivers any milk in the afternoon, and kilograms delivered in the morning. For each farmer, the regression includes a maximum of six observations. Three observations come from the experiment days ($Post = 1$) and three from the same calendar days in the previous month ($Post = 0$). For each outcome, the first model (Columns (1), (4), (7)) is an OLS run only on the three $Post$ observations, controlling for the average level of the outcome in the three baseline observations. The second model (Columns (2), (5), (8)) is a difference-in-differences. The third model (Columns (3), (6), (9)) adds farmer fixed effects to the difference-in-differences. Standard errors are clustered at the farmer level. In Columns (1), (4), and (7), p -value $\gamma = \delta$ comes from testing that the coefficients on $Bonus$ and $Bonus+Flexibility$ are equal. In the other columns, from testing that the coefficients on $Post*Bonus$ and $Post*(Bonus+Flexibility)$ are equal. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Price and Liquidity Experiment: Heterogeneous Treatment Effects

	(1)	(2)	(3)
Post*Bonus (γ)	-0.009 (0.066)	0.059 (0.036)	0.294 (0.182)
Post*(Bonus+Flexibility) (δ)	-0.273 (0.223)	0.413** (0.197)	0.046 (0.045)
Post*Bonus*Average Daily Deliveries in Sep 2014	0.034 (0.023)		
Post*(Bonus+Flex)*Average Daily Deliveries in Sep 2014	0.128* (0.074)		
Post*Bonus*Loyalty PM		0.093 (0.087)	
Post*(Bonus+Flex)*Loyalty PM		-0.314 (0.205)	
Post*Bonus*Any Other Village Trader			-0.235 (0.185)
Post*(Bonus+Flex)*Any Other Village Trader			0.228* (0.121)
R^2	0.087	0.051	0.043
Dependent Variable Mean	0.082	0.080	0.076
Farmer FE	X	X	X
Farmers	398	378	396
Observations	2388	2268	2376

Notes: The table presents heterogeneous treatment effects for the randomized experiment presented in Section 6.2. The dependent variable is the kilograms of milk the farmer delivers to the coop in the afternoon. We report results from the difference-in-differences model with farmer FE from Table 5, Column 3. Refer to the notes of Table 5 for further details on the specification. Refer to Table 1 for a description of the covariates. Standard errors are clustered at the farmer level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A Proofs

Proof of Proposition 1

In the stage game, traders would default if offering low frequency payment, so they offer daily payment and Bertrand-compete (*Proposition 1.1*).

Self 3 incentive constraint puts a cap on the amount of savings *Self 2* can leave: $\frac{s_2}{\delta^2} - D + \beta\delta\Delta \leq \frac{s_2}{\delta}$. Given $s_2 = D\delta^2$, the constraint is binding if $\beta > \frac{D}{\Delta}$ (first inequality of *Assumption 1*).

Consider a farmer who purchases the indivisible by saving through the coop low frequency payments, so that $p(x_1 + x_2) = D$. *Self 1* of such a farmer sets deliveries x_1, x_2 to maximize her utility of *Self 1*, conditional on the incentive constraint of *Self 2*. For a given monthly price p , the incentive constraint of *Self 2* is $(1 - \hat{x}_2)v + \beta\delta^2\Delta \geq v$. Since *Self 1* always wants to anticipate consumption as much as possible (subject to implementing a saving plan that induces *Self 2* and *Self 3* to buy the indivisible) the constraint must be binding: $x_1^* = \frac{Dv - p\beta\delta^2\Delta}{pv}$ and $x_2^* = \frac{\beta\delta^2\Delta}{v}$ (*Proposition 1.3*).

To induce the farmer to sell (part of) her output through monthly payments, the monthly price must be such that her utility when purchasing the indivisible is larger than the utility when not purchasing it: $U_1^x \equiv v - x_1^*v + \beta\delta(v - x_2^*v + \delta^2\Delta) = U_1^s - v(x_1^* + \beta\delta x_2^*) \geq v(1 + \beta\delta)$. The inequality (strictly) holds if $p = \hat{p}_F \equiv \frac{D}{\beta\delta^2\Delta((1-\beta)\delta+1)}v$ (*Proposition 1.2*). This price must be low enough that the coop makes (discounted) profits on the monthly payments $v(x_1^* + \delta x_2^*) - \delta^3 p(x_1^* + x_2^*) \geq 0$, or $\beta(2 - \beta) \geq \frac{D}{\Delta}$ (second inequality of *Assumption 1*). This completes the Proof. —

Proof of Proposition 2

In the last period of a given month, $t = 4$, a trader can resist the temptation to default on the amount due to the farmer if: $-p(x_1^* + x_2^*) + \delta \sum_{s=0}^{\infty} \delta^{4s} (v(x_1^* + \delta x_2^*) - \delta^3 p(x_1^* + x_2^*)) \geq \delta \sum_{v=0}^{\infty} \delta^{4s} (1 - \gamma)^s \sum_{s=0}^{\infty} \gamma \delta^{4s} (v(x_1^* + \delta x_2^*) - \delta^3 p(x_1^* + x_2^*))$. After substituting for x_1^* and x_2^* and some algebra, we obtain the inequality of Equation 2.

Proof of Proposition 3

The large buyers sets $p = \max\{\hat{p}^T, \hat{p}^F\}$. After some algebra, it can be derived that $\hat{p}^F \geq \hat{p}^T$ if $\frac{D}{\Delta} \geq \beta(2 - \beta)\delta^4(1 - \gamma)$.

Proof of Proposition 4

We consider the case where the large buyer can set different prices p_1, p_2 . Given the concavity of the period utility, the farmer may choose $s_1, s_2 > 0$. *Self 1* must choose x_1 so that *Self 2* incentive constraint is satisfied: $\ln(\frac{s_1}{\delta} + (1 - x_2)v - s_{2\Delta}) + \beta\delta \ln(\frac{s_2\Delta}{\delta}) + \beta\delta^2\Delta > \ln(\frac{s_1}{\delta} + v - s_{2N}) + \beta\delta \ln(\frac{s_2N}{\delta})$, where $s_{2\Delta}$ (s_{2N}) is the optimal level of saving *Self 2* chooses when buying (not buying) the indivisible good. $s_{2\Delta}$ is obtained from *Self 2*'s optimization when purchasing the indivisible, that is from maximizing $\ln(\frac{s_1}{\delta} + (1 - x_2)v - s_2) + \beta\delta \ln(\frac{s_2}{\delta}) + \beta\delta^2\Delta$. This leads to $s_{2\Delta} = A(\frac{s_1}{\delta} + (1 - x_2)v)$, where $A \equiv \frac{\beta\delta}{1 + \beta\delta}$. Similarly, one obtains $s_{2N} = A(\frac{s_1}{\delta} + v)$. Plugging $s_{2\Delta}, s_{2N}$ in *Self 2*'s IC and solving for the x_2 that makes the IC binding one finds $x_2 = B(1 + \frac{s_1}{v})$, where $B \equiv \frac{\exp(\frac{\beta\delta^2\Delta}{1 + \beta\delta}) - 1}{\exp(\frac{\beta\delta^2\Delta}{1 + \beta\delta})}$.

Since $x_1 = \frac{D-p_2x_2}{p_1}$, it can be shown that $x_1 = \frac{1}{p_1}(D - p_2B - \frac{s_1p_2B}{\delta v})$. Therefore $\frac{\partial x_1}{\partial p_1} = -\frac{\partial s_1}{\partial p_1} \frac{p_2B}{\delta v p_1} - \frac{x_1}{p_1}$, where the first term is the substitution effect and the second term is the income effect (in the linear case, the former is muted). We also note that $\frac{\partial x_2}{\partial p_1}$ has the same sign of $\frac{\partial s_1}{\partial p_1}$.

Given the optimal choices of x_1, x_2, s_2 derived above, *Self 1* chooses s_1 to maximize $\ln((1-x_1)v - s_1) + \beta\delta(\ln(\frac{s_1}{\delta} + (1-x_2)v - s_2) + \delta \ln(\frac{s_2}{\delta}) + \delta^2\Delta)$. This leads to $s_1^* = \frac{\beta\delta^2(Bp_2-p_1-D)-v(1-A)\delta(p_1\delta-Bp_2)}{(p_1\delta-Bp_2)(1+\beta\delta)}$. Since $\frac{\partial s_1^*}{\partial p_1} < 0$, $\frac{\partial x_1}{\partial p_1}$ has an ambiguous sign.

B Model Extensions and Discussion

This section provides a discussion of some of the assumptions made in the theoretical model in Section 3. The section begins by microfounding the assumptions of differential contract enforceability between the large buyer and the traders and also justifies why the large buyer might chose to not provide cash payments. We then discuss why the large buyer might tolerate sales to traders (or side-selling), at least to a certain extent. Finally, we discuss the implication of allowing the time-inconsistent farmer to follow intrapersonal rules.

Asymmetric Enforcement

The model assumes that the large buyer can commit to honor promises of delayed payments while traders' promise must be self-enforcing. There is a simple way to microfound this assumption.

Consider a village with N farmers. There are two buying technologies available. The traders' technology has zero fixed costs and allows trading a unit of milk. Given there is no fixed capital involved, upon renegeing on a contract, the trader can move to a different village in which a proportion γ of farmers are informed about his cheating. Given an infinite supply of traders, there is free-entry into this technology. Ignoring trade credit effects (i.e., discounting nominal prices) and assuming Bertrand competition, buyers using the small technology can offer a price for delayed payments at most equal to

$$\hat{p}^T \leq \delta(1 - \gamma)v. \quad (\text{B.1})$$

The second technology - call it collection center - requires paying a fixed capital cost κ and operating costs w (e.g., the wage of a milk collector). This fixed technology allows to buy from all N farmers in the village. However, because the technology is fixed, upon renegeing on the contract, it is not possible to move it to a different location.⁴⁷

If the large buyer offers infrequent payments, it has to be credible - i.e., make some profits. This also puts an upper bound on the monthly price paid by the large buyer, \bar{p}_m . The large buyer faces the strongest temptation to renege in sub-period $t = 4$, when the infrequent payment needs to be paid. Assuming the operating costs w are paid at the end of the fourth period, the incentive compatibility constraint for the large buyer is given by

$$-pN(x_1^* + x_2^*) + \frac{\delta}{1 - \delta^4} (vNx_1^* + \delta vNx_2^* - \delta^2 w - \delta^3 pN(x_1^* + x_2^*)) \geq 0$$

Rearranging terms, substituting for equilibrium quantities and ignoring trade credit effects we obtain the incentive constraint for the large buyer. Denoting with \hat{p}^M the price the large buyer pays for *monthly* deliveries, the constraint becomes

⁴⁷Note that we are again bundling two assumptions: the monitoring and the difference in costs/scale. However, the two can be easily unbundled in a model in which there are multiple villages. Imagine there are multiple identical villages ℓ ordered according to their distance from the large buyer headquarters and that the cost κ of operating the technology are increasing in distance. The large buyer will enter up onto a certain village, $\bar{\ell}$. Upon defaulting on any location, it will not be possible to make profits or be credible in any village further away. The payoff following a deviation in one village would then be followed by a pay-off of zero from that investment.

$$\hat{p}^M \leq \delta v \frac{ND}{(ND + \delta^3 w)}. \quad (\text{B.2})$$

Note that if $\frac{w}{N(x_1^* + x_2^*)} \rightarrow 0$ (i.e., the operating costs per-liter purchased are trivial) we obtain the same constraint as for the trader when $\gamma = 0$. We conclude that the collection center technology enables the large buyer to better commit than the small trader if and only if

Assumption T: $\frac{ND}{(ND + \delta^3 w)} > 1 - \gamma$,

This condition is more likely to be satisfied if there are more farmers in the location (higher N), if the cost of the indivisible good (and, therefore, aggregate deliveries) are larger (higher D), if the operating costs of the collection center are lower (lower w) and if the proportion of uninformed farmers is higher (higher γ).

Why doesn't the large buyer also pay cash?

So far we have assumed that the buyer operating the collection center technology doesn't offer cash payments. This assumption can also be derived from a minor extension of the model. Consider the case in which the large buyer decides to also offer cash payments. For this to be the case, the milk collector (assumed to be risk-neutral) must handle the necessary amount of cash. We simply assume that the milk collector is subject to the same agency problems of traders: she could run away with the money destined for the daily payments to the farmers. Note that in so doing we bundle liquidity and infrequent payment together, exactly as observed in reality. The assumption that the collector and the traders face the same agency problem captures the idea that, in practice, the trader themselves could be employed by the large buyer as collectors.

To pay cash, therefore, the large buyer needs to make sure the milk collector doesn't run away with the cash for the farmers. Consider the problem of the milk collector: he handles money at $t = 1, 2$ and gets paid w at $t = 3$.⁴⁸ The largest temptation to default is at $t = 1$, when the wage is a bit further away. If the milk collector runs away with the cash intended to pay the farmers, she gets her outside option forever which is equivalent to the wage w the large buyer would pay in the absence of agency problems. The wage paid to the collector to handle cash properly, w^D , must satisfy

$$\frac{\delta^2 w^D}{1 - \delta^4} \geq (1 - x_1^*) v N + \frac{\delta^2 w}{1 - \delta^4}.$$

Setting the constraint to equality, substituting into the large buyer incentive constraint and ignoring the possibility the coop can default on wage payments to the collector, we obtain the new incentive compatibility constraint for the coop. Denoting with \hat{p}^D the price the coop pays for *monthly* deliveries when also offering cash payments, we obtain

$$\hat{p}^D \leq \delta v \alpha \frac{ND}{(ND + \delta^3 w)}. \quad (\text{B.3})$$

for some constant $\alpha < 1$. This implies that the largest price the large buyer can pay for monthly deliveries when also offering cash payments is *lower* than when only offering monthly payments. To deter the milk collector from embezzling the cash destined to farmers, the large buyer ends up having higher costs in the

⁴⁸Paying the milk collector at $t = 3$ is optimal as the same wage can be used to deter deviations in both $t = 1$ and $t = 2$ (along the lines of the "reusability of punishments" as in Abreu et al. (1991)).

cash market. Given free entry of traders paying a daily price v , the large buyer cannot make profits on daily deliveries. To prevent default, however, the large buyer must still achieve a certain level of profits across its cash and monthly purchases.

In sum, there exist parameters configurations such that $\hat{p}^D \leq \hat{p}^T \leq \hat{p}^M$. This means the large buyer can credibly deter entry of traders if it offers monthly payments but not if it offers both monthly and daily payments. When this happens, the large buyer *endogenously* decides not to offer cash payments. The logic not only offers a microfoundation for one of our assumption, but it also provides an example of complementarity in management practices (e.g., Milgrom and Roberts, 1990; Brynjolfsson and Milgrom, 2013) and helps explaining the contractual structure observed in the market under examination. In addition, since the large buyer decides not to provide cash payments, it tolerates farmers selling to traders for the purpose of daily consumptions (but not for the purpose of savings).⁴⁹ This possibility might explain the commonly observed reluctance of cooperative institutional forms to enforce sanctions against defecting members (see Ostrom (1990) for famous examples and Casaburi and Macchiavello (2015) for an empirical analysis in our context.)

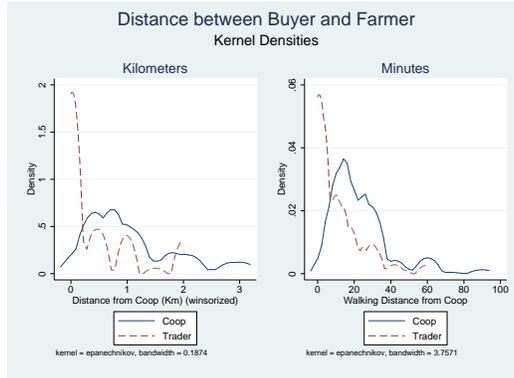
Farmers' Intrapersonal Rules

In the main text we abstracted from farmer's intrapersonal strategies across periods (see, e.g., Strotz, 1955; Laibson, 1997; Bernheim et al., 2015). These strategies could allow the farmer to save the necessary amount to buy the indivisible good while still selling to traders. The intuition is as follows. Consider a farmer that decides to follow a plan in which she saves sufficient funds to purchase the indivisible good on her own. Should any of her selves ever deviate, all future selves consume all their endowment every period and the indivisible good is never purchased again. This section offers an informal discussion of such an extension. While changing the parametric conditions under which our analysis is valid, allowing for this possibility wouldn't change qualitative features of the equilibrium we study but would provide further insights. First, note that given liquid savings, farmers with sufficiently low δ would not be able to implement the plan by themselves. That is, they would still demand infrequent payments from the large buyer. Second, it would still be in the large buyer interest to punish any farmer that saves by selling to traders. Third, along a stationary equilibrium path the farmer would behave as described in the text: sell to traders for liquidity and to the large buyer to purchase the indivisible good. As in the baseline model, the farmer would not react to a *temporary* increase in prices paid by the large buyer if not accompanied by a liquidity option. A temporary increase with a liquidity option would also see the farmer sticking to her plan and adjust deliveries accordingly. A sufficiently *permanent* increase in price with the offer of liquidity, however, could trigger the farmer's defaults against her future selves and abandoning the plan. This would destroy the equilibrium in which the large buyer makes positive profits. Finally, note that the punishment embedded into the relational contract with the large buyer helps the farmer overcoming her self-commitment problem.

⁴⁹This happens because the participation constraint of the farmer is not binding. Otherwise, the large buyer could require higher deliveries than those in the equilibrium under examination. Allowing for this yields more tedious algebra without much further insights.

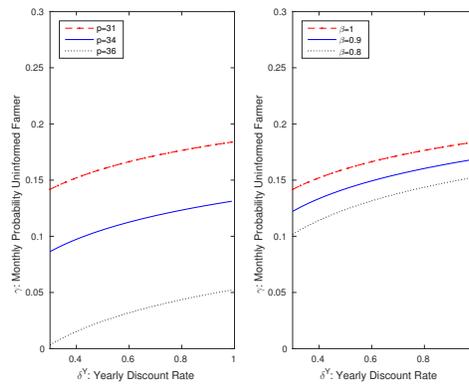
C Appendix Figures

Figure C.1: Distances to Sale Point



Notes: The figure presents kernel densities of the distance between the farmer and the buyer, as reported by the respondents in the baseline survey. The sample is restricted to farmers reporting at least one trader in the village. The left panel reports distance in kilometers. The right panel reports distance in minutes.

Figure C.2: Trader Incentive Constraint Calibration: Robustness



Notes: The figure presents robustness check to Figure 6. In the *left graph*, we vary the purchase price a trader would be able to offer when paying at low frequency. If part of the observed price gap comes from other benefits the coop offers, the trader will have to offer a higher price. This reduces the γ threshold that makes the trader unable to commit. In the *right graph*, we allow the trader to be $\beta\delta$ and show to which extent an increase in time-inconsistency (i.e., lower β) reduces the threshold γ threshold.