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

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Abstract

Despite extensive evidence that preferences are often time-inconsistent, there is only scarce field evidence of willingness to pay for commitment. Infrequent payments may naturally provide commitment for lumpy expenses. Multiple experiments in the Kenyan dairy sector show that: *i)* farmers are willing to incur sizable costs to receive infrequent payments and demand for commitment is an important driver of this preference; *ii)* poor contract enforcement, however, limits competition among buyers in the supply of infrequent payments; *iii)* in such a market, the effects of price increases on sales depend on both buyer credibility and payment frequency. Infrequent payments are common in many goods and labor markets, but they may not be competitively offered when contracts are not enforceable.

Keywords: Saving Constraints; Commitment; Agricultural Markets; Contract Enforcement; Interlinked Transactions.

JEL Codes: O12, O16, D90, Q13.

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1 Introduction

Despite a great deal of evidence showing that individual preferences are often time-inconsistent, there is only scarce field evidence of willingness to incur sizable costs for commitment (Laibson, 2015; DellaVigna, 2017). *Infrequent payments*, which are common in many goods and labor markets, may provide commitment to save for lumpy expenses by combining many small payments in one lump sum. We show experimentally that Kenyan dairy farmers are willing to sell milk to a given buyer at substantially lower prices if they receive infrequent payments and that demand for commitment is an important driver of this preference. Additional experiments, however, show that many buyers lack the credibility to offer infrequent payments, thus limiting competition on this margin. Infrequent payments may provide financial commitment in a natural way, but poor contract enforcement may increase the cost at which they are offered.

In the study setting, farmers sell milk daily to a large buyer (a cooperative) or to small, itinerant traders. In two *"demand experiments"*, the large buyer privately offers farmers the option to choose between different payment frequencies for the subsequent month. In the first experiment, 86% of farmers pick monthly payments over daily payments even when price for daily payments is 15% higher. In the second experiment, 91% of farmers turn down the option to choose every day whether to be paid that day or at the end of the month, thus preferring to "tie their hands" at the beginning of the month. The choice of this dominated strategy suggests that farmers value specifically the commitment that infrequent payments provide and it cannot be explained by some of their other potential benefits, like lower transaction costs. Additional lab-in-the-field experiments support this interpretation.

The price of this commitment device, and thus the welfare implications for farmers, depend on whether it is competitively supplied or not (DellaVigna and Malmendier, 2004). We thus also study the supply side of infrequent payments (i.e., the demand side of the milk market). A puzzling aspect of our context is that, despite the existence of many buyers competing to buy milk, only the large buyer pays monthly. Unlike daily payments, monthly payments require the seller to trust that the buyer will pay the due balance at the end of the month. Two lab-in-the-field *"supply experiments"* —in which we endow farmers with additional milk and match them with traders from the same village —show that lack of credibility constrains traders' ability to offer monthly payments. When we exogenously make traders credible, farmers' willingness to sell for monthly payments (vs. daily payments) raises from 14% to 90%. An additional experimental design shows that farmers are worried about traders' strategic default, not about traders' ability to hold money until the end of the month (i.e., not about traders' saving constraints).

These results establish that producers have a strong demand for infrequent payments but that poor contract enforcement limits many buyers in their ability to supply them. In such a market, the effects of price increases on sales should thus depend on i) buyer credibility and ii) the frequency of buyer payments. We test these predictions experimentally. First, when a non-credible buyer increases the price under monthly payments, sales to that buyer respond less than in the case of a credible buyer. Intuitively, producers anticipate that a buyer who has to pay a higher amount at the end of the month is more tempted to default. We confirm this prediction implementing the supply experiments described above at multiple price points. Second, a temporary increase in the price paid by a credible buyer raises sales to that buyer more if producers can also choose each day between monthly and daily payments than if only monthly payments are offered. Another field experiment finds evidence consistent with this prediction (albeit with p-value 0.21) The proposed mechanism may thus alter the nature of price competition in the market (Atkin and Donaldson, 2015).

These experimental results raise several questions: how do monthly payments facilitate commitment despite farmers contemporaneously selling for daily payments to traders? And why can't small traders commit to offer monthly payments despite interacting with farmers on a repeated basis? To shed light on these and other questions, we develop a model of demand and supply of infrequent payments. The framework nests sophisticated $\beta\delta$ producers who save to buy an indivisible good in an otherwise standard model of relational contracts with buyers of heterogeneous credibility. By preventing selves during the month from diverting the amount saved up to that point, monthly payments provide commitment and naturally arise in equilibrium. The commitment, however, is expensive: the most credible buyer sets monthly prices to prevent entry of less credible competitors in the lucrative monthly payment market. Because of limited competition in the supply of monthly payments, delayed payments are associated with lower prices, i.e., a negative interest rate. A small-scale lab-in-the-field experiment confirms that, indeed, many traders would be willing to offer monthly payments at prevailing prices. A calibration of their incentive constraint, however, shows they would not be able to credibly do so, in line with the experimental findings.

Since producers and buyers exchange, concurrently, the milk and the saving service (i.e. the infrequent payment), these two transactions are said to be *interlinked* (Bardhan, 1991). A large literature has documented how *credit constraints* generate interlinkages between the exchange of goods and credit services.[1] Instead, this paper uncovers a previously unnoticed interlinkage between the transaction of goods and saving services, generated by *saving constraints*.[2] The proposed mechanism is also distinct from standard trade credit (Petersen and Rajan, 1997; Breza and Liberman, 2017). Trade credit arises from a buyer's demand to reduce working capital requirements by delaying the timing of payments. In our mechanism, instead, saving-constrained sellers demand to bundle many small payments in a (delayed) lump sum.[3]

The proposed interlinkage with saving transactions may be relevant for a broad class of markets, including other agricultural value chains and labor markets. The paper concludes presenting additional suggestive evidence on demand and supply of infrequent payments using original survey data from three other settings: a tea contract farming scheme in Kenya; manufacturing sector workers in Myanmar; and seasonal workers in Rwanda. The demand for infrequent payments may also have implications for cash transfer design (Banerjee, 2016).[4] We also relate our findings to the historical shift from daily payments to less frequent ones and to common institutions such as tax refunds and *Thirteenth Salaries* (an additional monthly

[1]Classic examples in development include interlinkages of credit with crop sales (Bell, 1988), land tenancy (Braverman and Stiglitz, 1982) and labor provision (Bardhan, 1983; Mukherjee and Ray, 1995). Casaburi and Reed (2017), Casaburi and Willis (2017), Ghani and Reed (2017) and Macchiavello and Morjaria (2015a) offer recent empirical contributions. Imperfect contract enforcement lies at the heart of this literature. See, e.g. Macchiavello and Morjaria (2015b), Blouin and Macchiavello (2017) and, for a creative experimental approach, Bubb et al. (2016). More broadly, we build on the large literature on agricultural markets and institutions in Sub-Saharan Africa (Fafchamps, 2003).

[2]Examples of such saving constraints include limited access to financial institutions, theft, requests from family members and friends, and self-control problems (see, e.g., Karlan et al., 2014).

[3]As in standard trade credit, infrequent payments are delayed. A buyer could offer infrequent payments and overcome the lack of credibility paying in advance for the entire monthly deliveries. No buyer offers this type of advance payment since farmers would have high temptation to default on promised deliveries.

[4]In personal communication, Paul Niehaus reported to us that, in ongoing work, recipient of *Give Directly* transfers have strong preferences for infrequent disbursements.

salary paid around Christmas). Finally, we discuss policy implications. For instance, improving contract enforcement in agricultural markets may improve the terms under which buyers offer financial commitment to producers.

The paper is related to several strands of research, besides the one on interlinked transactions. There is by now abundant evidence that individual preferences are time-inconsistent and that commitment devices help in choices as diverse as saving, effort provision, and smoking (see Duflo et al., 2011 on fertilizer use among maize farmers in Kenya and Bryan et al., 2010 for a review). Despite this substantial body of results, there is however only scarce field evidence of willingness to incur sizable costs for commitment (Laibson, 2015; DellaVigna, 2017).[5] One exception is a recent paper by Schilbach (2017) who, in a sample of Chennai rickshaw peddlers, finds that over half are willing to sacrifice money worth about 10% of their daily income to receive incentives to remain sober. Those subjects exhibit a demand for commitment on non-financial behavior. In Beshears et al. (2011), only about a quarter of the subjects are willing to incur a very small cost for the commitment plan. In contrast, we show a very large demand for financial commitment achieved through costly infrequent payments.[6]

Second, the paper contributes to the literature on saving constraints in developing countries. A growing body of evidence studies the impact of saving products (see, e.g., Dupas and Robinson, 2013a). Several recent papers have shown how the mode of payment (i.e., cash vs. direct deposit) affects saving (see, e.g., Brune et al., 2016 and Blumenstock et al., 2017.) We instead focus on demand for and (constraints to) the supply of infrequent payments.[7]

Finally, the paper studies the interaction among organizational forms, behavioral biases, and contract design. Kaur et al. (2010) and Kaur et al. (2015) argue that modern factories help self-control in effort provision. We suggest that the ability of larger, more credible buyers

[5]For example, in the pioneering study by Ashraf et al. (2006), those subjects (28%) who opt for commitment do not actually have to pay for it.

[6]A large literature has focused on Roscas, which often pay negative returns and might also help overcoming self-control problems (e.g., Gugerty, 2007). Roscas however also help dealing with requests from friends and family members, provide insurance, have lower transaction costs and other benefits (see Besley et al., 1995 for an early review).

[7]A literature on payday effects in rich countries argues that increasing the frequency of payments may enhance welfare by improving consumption smoothing (see, e.g., Stephens, 2003). Our results suggest that, in an environment in which agents do have access to liquid forms of payment, infrequent payments help with lumpy expenses. Haushofer and Shapiro (2016) and Brune et al. (2017) find experimental support for this mechanism.

(or employers) to promise regular monthly payments may also help address self-control issues in spending habits.

The rest of the paper proceeds as follows. Section 2 provides background information on the study setting. Section 3 presents two *demand experiments*, which show that farmers value infrequent payments and that this arises at least in part from a demand for commitment. Section 4 presents two *supply experiments*, which show that buyer credibility affects farmers' willingness to sell for monthly payments and that lack of credibility arises primarily from strategic default concerns. Section 5 discusses, theoretically and empirically, additional implications of the interlinkage between saving and output markets on pricing and competition. Section 6 concludes, presenting survey evidence on the relevance of the mechanisms proposed here for other markets and discussing policy implications.

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, typically owning between one and three cows, are responsible for about 80% of the production (Wambugu et al., 2011). Our project takes places in Kiambu County, 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 24 collection centers, which are open at fixed hours every day in the morning and in the afternoon. The second is a large number of informal traders purchasing smaller quantities of milk. These are primarily small itinerant traders who deliver milk to the nearby towns or local restaurants and to Nairobi (about one hour away). Both types of buyers sell milk to processors or to final consumers (local or in Nairobi). Approximately half of the dairy farmers in the coop's catchment area regularly sell milk to the coop.

Farmers milk cows twice a day (morning and afternoon). Since most farmers lack refrigerators, sales also typically occur twice a day. The coop and to the traders differ in their frequency of payment. The coop pays farmers once a month, typically the first week of the subsequent month for deliveries, mostly through direct deposits into the farmer bank account.

Traders pay mostly on a daily basis and sometime weekly, in cash or through M-Pesa.[8]

Initial focus groups suggested that farmers value the coop's monthly payment as a saving device. We then conducted a survey with approximately 500 farmers that sell both to the coop and to traders (this serves as the baseline for the randomized controlled trial described in Section 5.2). 95% of the respondents prefer that the coop pay at the end of month, rather than daily or weekly. Figure 1-Panel A shows that 82% of the farmers state that they set saving goals and that, among these farmers, 87% state they reach these goals most of the time, 71% that the coop helps reach these goals and 79% that they would be less likely to reach the saving goals if the coop paid weekly. The survey also suggested that credibility may be important in shaping a buyer's ability to supply infrequent payments. Figure 1-Panel B shows that farmers *do not want* the traders to provide less frequent payments: Only 18% of the farmers would like traders to pay less often. Moreover, when asked about the main reason for this preference, 68% of these respondents state that they are worried traders would default on the contract ("escape") if left with holding too much money from the farmers.

In summary, based on this survey descriptive evidence, we hypothesize that farmers may value infrequent payments and that credibility largely affects a buyer's ability to provide infrequent payments to farmers. The experiments presented in Section 3 and 4 test these hypotheses.[9]

3 Producers' Demand for Infrequent Payments

This section provides experimental evidence on whether and why farmers value infrequent payments. A first experiment shows that farmers selling to the coop are willing to accept a 15% lower price to receive monthly payments rather than daily payments. A second experiment shows that farmers value specifically the commitment offered by infrequent payments. Both experiments were conducted in Fall 2014. We also present additional lab-in-the-field and survey evidence.

[8]Appendix B.2 provides more details on the buyers and on the differences across them.

[9]The town where the cooperative is located hosts several bank branches. Most farmers indeed report having a bank account (see Table 1). Therefore, simple absence of financial institutions is unlikely to be a primary driver of barriers to saving for the population we study. In addition, about 65% of the farmers report saving in saving groups (*chamas*). Mobile money (*M-Pesa*) is also widespread. This makes it clear that infrequent payments are not the only saving tool. The theory and experimental designs of this paper shed light on why demand for infrequent payments is high even if other saving products are available.

3.1 Demand Experiment 1: Do Producers Value Infrequent Payments?

Our main hypothesis is that farmers have a demand for coop's infrequent payments. If this is correct, farmers should be "willing to pay" for infrequent payments. The first experiment (*DE1*) aims at testing *if* farmers value infrequent payments:

Demand Experiment 1 (*DE1*): *Farmers choose between two options concerning payments for their deliveries to the coop in the subsequent month: i) daily payments, at a 15% higher price, or ii) monthly payments.*

The experiment identifies farmers' demand for infrequent payments holding constant other features of the coop's demand (for example, other potential benefits, such as inputs, loans, demand reliability, or an intrinsic preferences for selling to the coop.) The coop management informed farmers that the coop was piloting new payment systems to offer a better service and increase deliveries from members. The coop offered farmers a price increase of 5 Kenyan shillings per liter (a 15% increase) if they chose the daily payment. The meeting where information was provided and choices were made was held privately. Farmers choosing monthly payments were paid through direct deposit. Farmers opting for the daily payment were given the choice of being paid in cash or through mobile money transfers (it was not logistically feasible for the coop to arrange for daily direct deposits).[10] The experiment targeted a sample of 102 active members, randomly drawn from a list of farmers selling to the coop. 96 of these 102 farmers completed the experiment (94.1%).

3.2 Demand Experiment 2: Do Producers Value Commitment?

Why would farmers value infrequent payments? A second demand experiment tests whether the demand for commitment is an important determinant of the demand for infrequent payments. We elicit whether farmers are willing to forgo flexibility to retain commitment. The second demand experiment is as follows:

Demand Experiment 2 (*DE2*): *Farmers choose between two options concerning payment for their deliveries to the coop in the subsequent month: i) a "flexibility" option that,*

[10] Therefore, while transaction costs are similar between mobile money transfers and direct deposit, any remaining difference may contribute to a preference for monthly payments. We delve into this issue with the design of *Demand Experiment 2* and in the discussion in Section 3.3.

each day, allows farmers to choose whether to be paid that day or at the end of the month for milk delivered that day, or ii) monthly payments.

DE2 targeted another sample of 100 active members (drawn from the same population as *DE1*), reaching 95 of these. The coop offered these farmers a "flexible option" that allows them to choose every day whether they wanted to be paid daily or at the end of the month for their deliveries. Regardless of the option chosen (i.e., flexibility or monthly payments), farmers received an extra of KSh 5 per liter of milk delivered for that month. The farmer retained control every day on whether to exercise the option to be paid daily or not. As in *DE1*, farmers exercising the flexible payment option could choose whether to be paid in cash or via mobile money transfer.

The main idea behind *DE2* is that, through the flexible payment option, farmers can always replicate the cash flow profile of the monthly payment (if the farmer never exercises the daily payment option). Without the demand for commitment, the flexible payment then is strictly better if there is minimal uncertainty on daily cash needs or on traders' availability and prices.[11] In particular, if the only barriers to savings were theft concerns, transaction costs, or family pressure, but not self-control problems, farmers should choose the flexibility to get daily payments in any given day they may need them (e.g. if cash needs in any given day are particularly high). *DE2* thus tests whether demand for commitment is *a* driver of the demand for infrequent payments. Table 1-Panel A presents summary statistics on the farmers who participated to the demand experiments.

3.3 Demand Experiments: Results

Farmers' Choices. In *DE1*, a large majority of farmers (86%) is willing to forgo a substantial increase in price in order to have the monthly payment option. The first bar in Figure 2 summarizes the results. The evidence, therefore, is consistent with farmers having a high demand for infrequent payments from the coop. The second bar in Figure 2 summarizes the results of *DE2*. A very high share of farmers, 93%, turns down the flexibility option. The combination of the two designs suggests that, while other reasons, like transaction costs or

[11] Without such uncertainty the flexible payment option is still *weakly* better. In addition, the KSh 5 price increase is higher than the trader prices for about half of the farmers. For these farmers, even without uncertainty, the flexibility option thus still makes it harder to commit since offering cash at the point of sale induces a stronger temptation for the farmer.

safety concerns, may still play a role, demand for commitment is a primary driver of demand for infrequent payments.[12]

Additional survey evidence supports the experimental results. We asked farmers the motivation for their choices.[13] Farmers who choose infrequent payments mention that they try to achieve saving targets (47% in *DE1*, 42% in *DE2*) and that they do not trust themselves to handle the cash properly (26%, 36%).[14] As we describe in Appendix B.1, the experimental results are also consistent with evidence from the farmer baseline survey on: correlation between farmer characteristics and self-reported saving goals and habits (Appendix Table C.1); spending habits across income paid at different frequency (Appendix Figure C.1), and sorting across farmers into selling to the coop based on saving goals (Appendix Table C.2).[15] Farmers' demand for infrequent payments is also consistent with the observed market price gap between monthly and daily payments: traders, who mostly pay daily, typically pay farmers a price per liter that is about 20% higher than the coop, who pays monthly (e.g., KSh 38 vs. KSh 31 in October 2014; this gap is stable across seasons and years). Obviously, many other differences between the coop and the itinerant traders may contribute to this gap, though (see Appendix B.2 for details on these differences and on price data collection).

Elasticity of Demand for Infrequent Payments. In the implementation of the two demand experiments, we were constrained by the coop's request to offer treatments at one price point only. Therefore, the experimental results are not informative of farmers' demand *schedule* for infrequent payments. To study the price elasticity of farmers' demand for infrequent payments, we implemented an additional lab-in-the-field experiment. The incentivized experiment elicited the farmer reservation price for daily vs. monthly payments for an endowment of three liters of milk (approximately 30% of a cow daily production).

[12]Farmers selling to the coop typically make more than half of their sales to the coop. The fact that most farmers chose monthly prices implies that we cannot study experimentally the sale choice response to different frequencies of payments. In addition, the low variation in the choices of farmers in both *DE1* and *DE2* implies that we do not find consistent correlation patterns between choices and farmer characteristics.

[13]When eliciting the motivations, enumerators coded the respondent's answer without prompting options.

[14]14% in *DE1* and 17% in *DE2* mention that the spouse (typically the husband) wants to receive money on the coop account at the end of the month, suggesting that, in these cases, the wife, while managing the dairy business, does not have the authority to change the payment frequency.

[15]The experimental evidence is also consistent with the financial diaries of Collins et al., 2009, 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, thus earning negative interest rates (Besley et al., 1995).

Farmers receive monthly payments through bank deposit while they have the option to receive daily payments in cash or mobile money.

Figure 3 shows that essentially no farmer chooses daily payments if the price is lower or equal to the one offered by the coop for monthly payments. The percentage of farmers choosing daily payment increases to 80% when the price gap increases to 10 KSh, i.e., one-third of the coop's monthly price. Although the results cannot be directly compared to those of the field demand experiments (where farmers had to make a decision for the entire month), they i) confirm farmers' willingness to incur costs to receive infrequent payments; and ii) trace out a relatively elastic demand for infrequent payments.[16]

Status Quo Bias, Costs of Thinking. A potential concern with the experimental designs is that, since the coop pays monthly, farmers' choices may be driven by *status quo bias* (see, e.g., Samuelson and Zeckhauser, 1988 and Kahneman et al., 1991). Several pieces of evidence mitigate this concern. First, farmers' motivations to choose monthly payments are mostly consistent with a demand for infrequent payments, arising from a demand for commitment. Second, the results of the additional lab-in-the-field experiments in Figure 3 show that many farmers do switch if given sufficient incentives to do so. Third, in Section 4, we present a supply experiment where the vast majority of farmers is willing to sell for monthly payments (vs. daily payments) *to small traders* when experimental manipulation makes these traders sufficiently credible. This is a stark departure from the status quo. Fourth, Casaburi and Macchiavello (2015) shows that farmers in the same population do respond to a change in the incentives provided by the coop, when this threatened stricter enforcement for side-selling. In sum, besides the direct evidence from the survey, there is abundant evidence that farmers in the sample are willing to switch between different payments frequencies (and, more generally, to change their supply behavior) if they are given incentives to do so.

Another possible explanation for the results of *DE2* is that farmers may dislike the flexibility option because they want to avoid a daily "cost of thinking" (Ortoleva, 2013) or a "cost of keeping track" (Haushofer, 2015). However, if this was the only motivation driving

[16]Since more farmers sell to the coop in the morning than in the afternoon, in this lab-in-the-field experiment we also tested whether willingness to pay for commitment was higher in the afternoon than in the morning. Results, however, show no difference in the required price to accept daily payments across times of the day.

the results of *DE2*, as opposed to a demand for a commitment device, farmers should choose once and for all the daily payment over the monthly option in *DE1*. Similarly, even in *DE2*, farmers could simply inform the coop at the beginning of the month that they wanted to get paid daily for the rest of the month.

Why Such a Large Demand for Infrequent Payments? Our experimental results thus show that farmers have a strong demand for the commitment offered by infrequent payments. What could drive such a large demand? We hypothesize that infrequent payments have better commitment properties than other saving products. Farmers do have access to other saving tools including, possibly, commitment ones: 65% are members of saving groups and 75% save in a bank account.[17] Further, commitment saving products, like the mobile-based *M-Shwari Lock Saving Account*, are available in Kenya.[18] So, why would the infrequent payment from the coop be a better commitment tool?

First, the model in Section 5.1 (and Appendix A) highlights that a credible buyer is in a particular good position to induce commitment since it can put pressure on the farmers to ensure deliveries. The punishment for side selling embedded in the relational contract with the coop may help the farmer overcome her temptations. The additional punishment effect built in the relational contract provides an additional incentive for the farmer to overcome temptations, even if she had access to other (commitment) saving tools.[19] Second, payment withholding implies the farmer cannot access funds till the end of the month, which would be the case if the farmer had to make deposits in a (commitment) account. Third, the experiments target farmers selling to the coop, which represent about half of the farmers in the region. Selection into selling to the coop may be based, at least in part, on farmers' demand for commitment (see Appendix B.1 for survey evidence on this hypothesis).

Other Benefits of Infrequent Payments. While DE2 isolates the demand for commitment, infrequent payments may certainly have other benefits. We discuss two of the main

[17]Among others, Dupas and Robinson (2013a), Dupas and Robinson (2013b), Prina (2015), Kast and Pomeranz (2014), and Callen et al. (2016) study the impact of saving products in developing countries.

[18]We note, however, that these commitment products often feature additional fees or reduced interest for early withdrawals, rather than a full limitation of access. As an example, the *M-Shwari Lock Saving Account* penalizes early withdrawals with a mere interest rate reduction of one percentage point. In addition, saving accounts with commitment features offered by commercial banks require an average initial deposit of \$430, an order of magnitude larger than the monthly revenues for most coop members (Ravi and Tyler, 2012).

[19]Casaburi and Macchiavello (2015) provides evidence on the coop's punishment strategies.

ones. Infrequent payments may in principle help hide money from other household members or from family and friends (i.e. solve *other-control* problems). However, because information on the flexibility option is private, results in *DE2* capture demand for commitment arising from self-control problems: if pressure from family was the main concern, farmers should privately pick the flexibility option and exert it if the marginal utility from consumption in any given day is particularly high, even if they had to share those money with other household or family members. In addition, the farmers' motivations reported above point at a rather limited role for other-control problems as a source of demand for infrequent payments.[20]

Second, different transaction costs associated with direct deposit may represent another benefit of infrequent payments.[21] For instance, farmers may value lower transaction costs to make further deposits, or higher transactions costs incurred to withdraw money. Three considerations, however, suggest that differences in transaction costs are unlikely to explain the large demand for monthly payments. First, in both demand experiments, we reduced these differences. While, as discussed in Section 3.1, it was too costly for the coop to make daily direct deposits, farmers choosing daily payments had the option to get them in cash (which mimics how most traders pay) or mobile money transfers (which closely, though not perfectly, mimic the direct deposit used by the coop). If anything, a preference for either of the two specific modes of payment should increase demand for daily payments. Second, in the incentivized lab-in-the-field "supply experiments" presented in Section 4, farmers receive both daily and monthly payments through mobile money transfers. As we will see, farmers still exhibit a high demand for infrequent payments even in that case. Finally, lower transaction costs alone cannot explain results in *DE2*. If the only difference between monthly payments and daily payments were transaction costs (rather than commitment), a farmer should always opt to retain the flexibility to get daily payments in any given day she may need them.

[20] In the baseline survey, approximately 30% of farmers report to have been approached by others for financial help in the previous three months. The timing of these requests is however not correlated with that of coop's payment. Concerns over workers handling cash do not seem to be important either.

[21] A recent empirical literature documents how the mode of payment (i.e., cash vs. direct deposit) affects saving and spending. See, e.g., Brune et al. (2016), Brune and Kerwin (2017), Somville and Vandewalle (forthcoming), Blumenstock et al. (2017).

4 Buyers' Supply of Infrequent Payments

Farmers are willing to incur sizable costs to receive infrequent payments. The welfare consequences of such demand depend on whether this commitment device is competitively supplied or not (DellaVigna and Malmendier, 2004). Survey evidence shows that, while the large buyer pays monthly, essentially all the small traders pay daily. There are potentially many reasons why this happens. For instance, traders might be unable to offer infrequent payments if they are also saving constrained. Or farmers may have preferences for infrequent payments that are specific to the cooperative, e.g., due to mental accounting and spending habits or a desire to help the coop by providing trade credit. We hypothesize that a key reason is that traders cannot supply infrequent payments due to their *limited credibility*. This section presents evidence from two lab-in-the-field experiments we conducted in Summer 2017 to test this hypothesis and distinguish it from competing explanations. The evidence shows that, under poor contract enforcement, a trader credibility matters for his ability to offer infrequent payments: farmers are not willing to accept monthly payments from small traders because they are concerned traders would default on the amount due at the end of the month.

4.1 Supply Experiment 1: Does Buyer Credibility Matter?

The first experimental design is as follows:

Supply Experiment 1 (*SE1*): *Farmers sell milk to a trader they know and choose how to split these sales between daily and monthly payments under two credibility treatments for the* <u>*monthly*</u> *payments. In the "guaranteed" treatment (**G**), the experimenter guarantees the monthly payment to the farmer by deducting it from the trader payment. In the "non-guaranteed" treatment (**NG**), the trader decides whether to pay the farmer at the end of the month or default. Daily payments are guaranteed in both treatments.*

To test whether credibility matters, the first experiment varies the credibility of the trader when offering monthly payments (credibility is not a concern in daily payments). We then test whether farmers are relatively more willing to sell the same milk to the same trader under infrequent payments when the trader is more credible. We conduct lab-in-the-field experiments with farmers and traders that know each other, as described below. It is obviously possible that farmers do not have complete trust in the experimenter, either. This would make it harder to detect differences between treatments **G** and **NG**. To check robustness of our findings to market conditions (and, as we discuss in Section 5.2, to understand implications for sale responses to prices increases), each farmer plays each pair of credibility treatments at three different price levels for the monthly payments (KSh 40, 50, or 60), while keeping the daily price at KSh 40, for a total of six games.[22]

4.2 Supply Experiment 2: Why Does Buyer Credibility Matter?

Why may farmers not trust traders with monthly payments? A second supply experiment aims at distinguishing between two scenarios. A possibility is that farmers believe that, in the absence of a payment guarantee mechanism, the trader would simply decide to keep the money and default at the end of the month. Another possibility is that farmers instead believe that the trader also faces saving constraints and would default simply because he is not able to hold the due balance until the end of the month.

The second supply experiment tests whether trader's saving constraints alone matter in shaping the farmer's sale decisions:

Supply Experiment 2 (*SE2*): *Farmers choose whether to sell to the trader for non-guaranteed monthly payments or for daily payments under two treatments concerning the traders' monthly non-guaranteed payments. In the standard non-guaranteed (**NG**) treatment, traders receive their payments daily and are thus potentially saving constrained. In the "no trader saving constraints" non-guaranteed treatment (**NG**$_{nc}$), traders receive their payments for the entire month at the end of the month. The farmer is informed about the trader's payment mode before he decides whether to sell for monthly or daily payments.*

Therefore, in a seventh game, which otherwise is identical to the game with non-guaranteed monthly payment at price 50 KSh, the experimenter pays the trader for the entire month at the end of the month. This ensures the trader would have enough cash to pay the farmer, if he wished so. The farmer is informed about this. If the farmer believes that traders' *saving constraints* prevent him from paying at the end of the month, monthly sales in this last game should be larger than in the corresponding non-guaranteed treatment. If, instead, the farmer

[22]Prices in the lab-experiment-in-the-field twist the price gap observed in the market to take into account that farmers must also trust the experimenters and that the choice is over additional milk, i.e., after farmers might have already met their demand for monthly payments by selling to the coop.

is concerned that the trader strategically defaults on due payments, relaxing the trader's saving constraint should not affect farmers' split between daily and monthly payments.

Implementing the Lab-in-the-Field Experiments. We list sixty farmers in four villages within the catchment area of the cooperative. We ask farmers to list milk traders they are familiar with and that operate in the same village. We then contact traders and verify they do know the farmers that listed them. Of the sixty targeted farmers, fifty-five came to the experimental sessions (all the traders confirmed their availability). Table 1-Panel B presents summary statistics on the farmers who participated to the supply experiments.

Each farmer plays once each of the seven games in random order. In each game, the farmer is endowed with three liters of milk per day (approximately equal to the amount produced by a cow in the afternoon) per thirty days. The farmer must sell this milk to the trader she is matched with. The farmer decides, once for the entire month, how to split her daily endowment of milk between two forms of payments from the trader: daily and monthly. The trader pays the farmer a "farmer price" (unless he defaults). This price, and whether it is guaranteed or not, varies across games as described above. The experimenter pays the trader a "trader price," which is constant across games at KSh 60 per liter. All payments, regardless of whether they are daily or monthly, occur via mobile money transfer, thereby removing differences in the mode of payment across payment frequencies. At the end of the experimental session, one of the seven games is randomly drawn and payment proceeds according to the outcomes of that game.

Unlike the demand experiments, which are conducted as field experiments, the supply experiments are lab-in-the-field experiments. In this controlled environment, we can shock traders' credibility (*SE1*) and cash availability for monthly payments (*SE2*) for specific transactions (i.e., "within" farmers). Implementing such a design as a field experiment would be significantly more challenging, if not altogether impossible.[23] Therefore, we pay particular attention in designing lab-in-the-field experiments that closely mimic actual transactions.

[23] First, we would need to vary treatments across traders, not across transactions within farmer-trader pairs. This would require interacting over a prolonged period of time with a much larger number of itinerant and unlicensed traders, a task notoriously difficult. Second, it would also require monitoring daily transactions between traders and farmers (and the form of payments) in an informal setting. Third, it would require persuading traders to participate and accept a lower amount of money to deduct the farmer's price in the treatment **G**. Finally, the coop, which is also the main partner in our study, did not endorse fieldwork that would *de facto* match its members to competitor traders risking to further compromise members loyalty.

First, we play the games with actual farmers and traders that are accustomed to sell milk under conditions (frequency of payment and prices) similar to those in the games. Second, we make sure to match farmers and traders that operate in the same villages and know each other. This guarantees that the farmer's choice in the one-shot interaction in the lab captures real-life perceptions about the credibility of traders she could actually sell to.

4.3 Supply Experiments: Results

Trader Credibility and Farmer Choices. Figure 4 presents the results. For each of the seven games, we show: i) the proportion of farmers who sell at least some milk for monthly payments (Panel A); ii) the average liters sold for monthly payments (Panel B). Consistent with the field evidence, when monthly payments are not guaranteed, very few farmers opt for monthly payments. The fraction of farmers selling a positive amount of milk for monthly sales raises from 0.14 in the non-guaranteed games to 0.9 in the guaranteed ones. Similarly, average amount sold for monthly payments increases from 0.34 liters (out of an endowment of three liters) in the non-guaranteed treatments to approximately 2.6 liters when the monthly payment is guaranteed.

Table 2 reports estimates from regressions with farmer fixed effects. Columns (1)-(3) compare guaranteed and non-guaranteed treatments at each price point, while Column (4) reports results pooling the six games together. The drop in monthly sales in the non-guaranteed treatment is very large, statistically significant, and holds at different price levels.

Column (6) in Table 2 explores whether traders' saving constraints drive farmers' choices. This is not the case (as confirmed by comparing the fourth and fifth bar in Figure 4). In the $\mathbf{NG}_{nc}$ treatment, paying traders at the end of the month—while removing trader saving constraints and ensuring that they would have enough money to pay farmers at the end of the month—does not significantly change farmers' monthly payment choices on either the extensive or the intensive margin. The evidence therefore suggests that, when monthly payments are not guaranteed, farmers are primarily concerned about the possibility that the traders might strategically default, not about their ability to hold money.

Although not the primary goal of the supply experiments, the results also confirm farmers' strong preference for infrequent payments. Under the guaranteed treatment, farmers overwhelmingly choose monthly payments. The results hold across a range of prices, including equal price under daily and monthly payment. The findings of Section 3 thus hold even when the mode of payment is constant between daily and monthly payments (since both are paid through mobile money transfer) and when the choice of monthly payments implies departing from the status quo (since, when the experimental treatments make them credible, the vast majority of farmers sells for monthly payments *to small traders*, who usually pay daily.).

Discussion. These results show that traders' credibility affects farmers' willingness to accept infrequent payments. This is very consistent with the survey evidence described in Section 2 (see Figure 1- Panel B). Farmers appear to trust traders a lot less than the coop. While many reasons could account for this difference, we note that the two types of buyers differ in farmers' ability to carry out an (informal) punishment strategy in case of payment default. Traders are mostly small and itinerant buyers and are characterized by relatively high turnover.

Our survey reveals that, even within a village, there is little agreement across farmers in the number and identity of traders operating in the village. As a result, there is little community enforcement available to coordinate punishment against delinquent traders: a trader can default on one farmer and then move to a different village where information about the default has not spread. In contrast, the coop is a large and visible institution, buying regularly at fixed premises (i.e., the collection centers) and with a well-known headquarter. Our survey also shows that farmers routinely discuss coop's management and affairs.[24] Defaulting against even one farmer could trigger punishment from many farmers and be very costly for the coop.

Taken together, the results from the supply experiments support the hypothesis that, under poor contract enforcement, the possibility of strategic default severely limits a trader's ability to offer monthly payments. In another small-scale experiment, we also verify that, if given the opportunity, there would be many traders willing to offer monthly payments at current prices.[25]

[24]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). Although only 45% of the farmers in our sample received the letter, 23% report knowing about it from other farmers. The average respondent in the survey reports discussing issues related to coop pricing policies and management with 2.3 other members from the village (significantly higher than interactions about dairy practices (1.16)). Farmers who had not received the letter were more likely to report having knowledge of it if *i)* they report knowing a higher share of other villagers and *ii)* a higher share of farmers received the letter.

[25]We play incentivized lab-in-the-field experiments with sixteen of the traders mentioned by the farmers

5 Implications of the Saving-Output Interlinkage

The experiments presented so far establish producer demand for infrequent payments and constraints in buyers' supply of infrequent payments. These results raise several questions. For instance, how do monthly payments facilitate commitment even if farmers can sell for daily payments to traders? May the relationship with the buyer further help farmers achieve commitment? And why can't small traders commit to offer monthly payments despite interacting with farmers on a repeated basis? To shed light on these and other questions, Appendix A presents a model of supply and demand of infrequent payments. The model also shows that, relative to a textbook market, the interlinkage between savings and output transactions implies that farmers' sale responses to price increases depend on buyer credibility and on the frequency of payments. Section 5.1 describes the model key assumptions and results. Section 5.2 tests the implications of the model with several experimental designs and a calibration exercise.

5.1 Model Setup and Results

Setup. The key assumptions of the model are as follows. Producers and buyers interact over an infinitely repeated time horizon (i.e., an infinite number of months, each comprising several days). Sophisticated $\beta\delta$ producers are endowed with a certain amount of non-storable milk to sell every day. They derive utility from daily consumption and, once a month, from an indivisible good (i.e., a lumpy expense).[26] They can save to purchase the indivisible good through a regular (liquid, actuarially fair) saving technology or through (illiquid) monthly payments, which provide a lump sum at the end of the month.[27]

Buyers compete for producers' milk by offering contracts that differ in price and in whether deliveries are paid for daily or at the end of the month. There is no court enforcement and all

in the above supply experiments. Traders choose whether they offer farmers daily or monthly payments and are guaranteed that the farmer will accept the transaction regardless of their choice. We set the monthly price to be paid to the farmers to be KSh 5 per liter lower than daily prices, thus lower than the difference in market prices. Still, a majority of traders (55%) chooses to pay the farmers monthly.

[26]The demand for lumpy expenses follows the modeling of Besley et al. (1993). Afzal et al. (2015) provides recent empirical evidence.

[27]While the model emphasizes the role of saving constraints, it also makes the assumption that producers cannot borrow. The main results are robust if there is a sufficiently imperfect credit market. See Appendix A.3 for a discussion of this and other aspects of the model.

arrangements must be self-enforcing. Unlike daily payments, monthly payments are therefore subject to buyers' strategic default. The buyer's cost of defaulting depends on the probability that, following a default, he is matched to a new producer who is not aware of the previous default. We denote this probability with γ. Buyers differ in γ and thus in their credibility.

Model Results. The first result concerns producers' sales under monthly payments. If their β is at intermediate levels, producers will sell part of their milk under monthly payments to save for the purchase of the indivisible good.[28] Monthly payments provide commitment since they prevent future selves from diverting the amount saved up to that point of the month to other goods. The model also illustrates an important reason why infrequent payments from a credible buyer may be a better commitment device than other forms of illiquidity: in an infinitely repeated game logic, a credible buyer can threaten producers to stop purchasing in the future if producers fail to sell (and thus to save) in the current period. Under this relational contract, a farmer may be able to save for the indivisible good using the buyer infrequent payments, even if he would not be able to do so with other illiquid saving devices.[29]

Second, the model sheds light on how buyers with different credibility compete. As credibility does not matter for daily payments, free entry implies zero profits on daily payments. For monthly payments, however, the most credible buyer sets a price that, although below the price for daily payments, is sufficiently high to prevent other buyers from credibly offering monthly payments. In other words, the most credible buyer ensures that the incentive constraint of the less credible ones is violated.[30] The large buyer pricing explains why traders cannot be credible, even if they interact with farmers over an infinite horizon. In equilibrium, producers sell enough under monthly payments to buy the lumpy good and sell the rest of their milk under daily payments for consumption purposes. Therefore, a segmentation between the "daily payment" market and the "monthly payment" market emerges.

[28]Intuitively, if β is too high, a producer can save on her own, If β is too low, monthly payments won't be sufficient to induce saving.

[29]In the resulting contract sales for monthly payments might either increase or decrease during the month depending on the structure of incentive constraints. If production was harder to monitor the resulting contract might require a constant amount to be sold to the coop per day. This would be consistent with actual sales patterns observed in the data (see Appendix Figure C.6). The observed "flat profile" is not consistent with simple inter-temporal optimization within the month (which predicts an increasing profile) nor with monthly sales simply reflecting the implicit value of commitment (which predicts a decreasing profile instead).

[30]Preventing competition from other buyers is not necessarily the binding constraint. The most credible buyer must also pay enough to induce producers to sell for infrequent payments.

Third, the segmentation implies that farmers' sale response to a (temporary) price increase depends on the buyer's credibility and on the payment frequency. The response to a monthly price increase is lower (and could be negative) for less credible buyers. This happens because a temporary increase in the promised monthly price also raises the buyer's temptation to default: he has to pay a larger amount to the farmer while his future continuation value is unaffected. Anticipating this, the farmer is more reluctant to increase sales, relative to the case in which the buyer can credibly commit to the monthly payment. A temporary price increase from a credible buyer also elicits a stronger sale increase if offered with the choice between monthly and daily payments for each delivery, relative to the case in which only monthly payments are offered. When only the monthly payment is available, the selling and saving decisions are bundled. On the saving margin, the price increase allows farmers to achieve the saving goal with fewer sales. This dampens the sale response (and, could in principle, even generate a negative sale response). When the same price increase is associated with the choice of daily and monthly payment, the separation between the selling and saving decisions is restored and supply simply responds to the standard price effect.

5.2 Evidence on the Implications: Pricing and Sale Responses

Pricing: Calibration of the Trader Incentive Constraint. Under the pricing equilibrium of the model, traders should not be able to credibly offer monthly payments at prevailing market prices. To explore this implication, we present a back-of-the-envelope calibration of the trader incentive constraint derived in the model. The exercise complements the results from the supply experiments presented in Section 4. Before presenting the results, it is useful to sketch the logic of the dynamic incentive constraint. Consider a trader who has bought, over the course of a month, a certain amount of milk from the farmers and must pay at the end of the month. The amount the trader should pay at the end of the month shapes his temptation to default. In deciding whether to default or not, the trader will weigh the immediate financial gains from defaulting against the future losses with the farmer and the broader community. The continuation value following a default is increasing in the per-period probability that, after a default, the trader meets a new producer not informed about his past cheating and, therefore, still willing to sell to him (as discussed, we denote this probability with γ). The trader incentive constraint thus puts a cap on the largest monthly price he can credibly promise to repay.

Given market prices p^M and p^D for monthly and daily payments respectively, the trader is *not* able to credibly offer monthly payments if:

$$p^M \geq \frac{1}{30}\delta(1-\gamma)\frac{1-\delta^{30}}{1-\delta}p^D. \tag{1}$$

The trader cannot commit to monthly payments unless the price for monthly payments is sufficiently below the price for daily payments (see Appendix A.2 for a derivation). Intuitively, the highest price the trader can commit to is increasing in δ (the trader daily discount factor) and in the daily price p^D. It is also decreasing in γ, since a higher probability of finding a new farmer to match with after a default reduces the cost of defaulting on any given farmer.[31]

Armed with this expression, we can ask whether at prevailing market prices, and for reasonable values of the parameters δ and γ, the trader is indeed able to commit to monthly payments. From the survey we calibrate $p^{Monthly} = 31$ and $p^{Daily} = 38$ (the prevailing prices in October 2014). For each (annualized) discount factor, δ^Y, we then compute the *minimum* level of γ that would prevent traders from credibly committing. The range of considered discount factors δ spans plausible annual returns to capital for traders, from 5% to 233.33%. Figure 5 presents the results. A trader defaults if γ is above the frontier described by the dashed line in the figure. Across discount factors, the frontier for γ lies between 0.14 and 0.18. The graph thus shows that, at current market prices, traders would be able to commit to monthly payments only if information about previous defaults spread quickly across farmers (i.e., if γ were very low). However, the survey evidence discussed in Section 4.3 suggests low levels of information sharing about traders, and thus limited opportunities for community punishment.[32]

Buyer Credibility and Sale Responses: Experimental Evidence. The experimental design for the supply experiment described in Section 4 allows us to test whether

[31]In the model, default on one farmer triggers punishment from farmers the trader tries to match in subsequent periods, but not from other farmers the buyer is currently buying from. Allowing for this collective punishment would imply that the optimal deviation for the trader would be defaulting on all the farmers he buys from. If the opportunity to find new uninformed farmers, γ, is invariant with size, the trader incentive constraint when allowing for collective punishment would be identical to our baseline framework. However, γ may be decreasing in the number of farmers the buyer deals with. In practice, most traders are small itinerant buyers with limited capacity. We therefore abstract from differences in size across traders and focus on the difference between the traders and the large credible buyer.

[32]Appendix Figure C.4 explores robustness to monthly prices and traders' time-inconsistency.

buyer's credibility affects sale responses to higher prices. Each farmer played the game at different prices. The monthly payment price varied between KSh 40, 50, and 60 (the daily payments price was always KSh 40). Column (5) in Table 2 provides support for the model's implication. In a regression of sale outcomes (binary or level), the interaction coefficients between the KSh 50 or KSh 60 price dummies and the non-guaranteed treatment are always negative (though they are significant at conventional levels only for the KSh 50 price dummy). This suggests that the sale response in the non-guaranteed monthly payments is flatter than the one for the guaranteed monthly payments.

Payment Frequency and Sale Responses: Experimental Evidence. An additional field experiment (*"Price and Liquidity Experiment"*), conducted in Fall 2014, tests whether sale responses to price increases depend on payment frequency. The prediction is relevant for farmers that sell to both the coop and to traders. We therefore focus on a sample of 398 farmers that regularly sell to the coop in the morning but not in the afternoon, and thus are likely to sell to traders in the afternoon.[33] Farmers 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 per liter (an increase of approximately 30% relative to the baseline price) for afternoon deliveries. In the second treatment, in addition to the price increase, farmers were given the option to choose on a daily basis whether, for the deliveries in that day, they wanted to receive immediate payment or to retain the standard monthly payment. The farmers were given the opportunity to be paid daily for morning and/or afternoon deliveries for the three days according to their choice. The randomization was stratified by farmer location (four zones) and baseline delivery levels.[34]

Figure 6 summarizes the findings. The *bonus* treatment (the large price increase) has a positive but small impact on the afternoon deliveries. As predicted, the *bonus+flexibility* group has a larger impact. Table 3 confirms the results. We focus on kilograms delivered

[33] Appendix Figure C.2 shows that many farmers sell to the coop (almost) every day of the month and (almost) never in the afternoon. Appendix Figure C.3 provides an attempt to measure farmers' sales to traders.

[34] Appendix Table C.3 suggests that the randomization worked overall. The proportion of male respondents differs across the two treatment groups (p-value=0.052) and the proportion of farmers reporting access to traders differs across the flexibility and the control group (p-value=0.079). Around 6% of the treatment farmers could not be reached before the intervention (comparable across treatment groups).

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 a panel specification, with farmer fixed effects. The flexibility group displays an increase in afternoon deliveries of 0.24-0.29 kg per day, compared with a baseline level of zero. While, as hypothesized, the point estimate on this treatment is larger than the one on the bonus treatment (0.13-0.15 kg), the p-value of the difference in coefficients is 0.21-0.29.[35]

Several factors could a quantitatively small differences. Our preferred explanation is that the difficulty in distinguishing sales to traders and own consumption made it difficult to target farmers that could respond to the intervention and yielded relatively small and noisy responses. Consistent with this, Appendix Table C.4 shows that the impact of the $Bonus + Flexibility$ treatment is stronger for farmers that could respond: those with higher (morning) delivery level (Column 1), those who are less loyal to the coop (Column 2), and those who report access to another trader (Column 3). Overall, while acknowledging the low precision of the estimates, the results present suggestive evidence that the sale response to price increases depends on the frequency of payments.[36]

6 Conclusion

The paper has provided experimental evidence on demand and supply of infrequent payments. Farmers are willing to incur a sizable cost to receive monthly payments for some of their milk and that demand for commitment is an important driver of this preference. Only credible buyers can supply infrequent payments. Lack of buyer credibility arises from strategic default considerations, not from their own saving constraints. Through infrequent payments, transactions over a saving service are interlinked with milk transactions. Addi-

[35] A binary indicator equal to one if the farmer sold any afternoon milk delivers similar results (Columns (4)-(6)). Columns (7)-(9) show results for morning deliveries. As expected, the point estimate for the bonus treatment is negative though, again, large standard errors prevent us from drawing any conclusion.

[36] Based on survey responses, the limited response is unlikely to be driven by either the large price increase not being sufficient to match traders' prices (inclusive of transport costs) nor by farmers unwillingness to jeopardize relationships with traders. To make sure that the (slightly) larger NPV associated with the bonus+flexibility treatment does not drive the results, we ran the experiment at the beginning and at the end of the month, thereby randomly varying the NPV difference across treatment. We find no difference in treatment effects across the two groups.

tional theoretical and experimental results suggest that this previously unnoticed interlinkage alters pricing and competition.

The Interlinkage in Other Markets. While this study is based on a specific setting, we conjecture its findings might be relevant for a broad class of markets featuring saving-constrained producers. In this final section, we discuss evidence from other settings. While the discussion is surely not sufficient to establish the relevance of the proposed mechanisms in other contexts, it nevertheless provides suggestive evidence that could motivate further research. First, evidence from other parts of the Kenyan dairy sector supports our results and interpretation. Studying dairy farmers in Nandi County, in Rift Valley, Geng et al. (2017) shows that farmers sell to buyers paying at different frequencies to balance saving and cash needs. In another location in Rift Valley, Kramer and Kunst (2017) shows that most dairy farmers self-reported deferring milk payments in order to save for lump-sum expenses. In their setting, 66% of dairy farmers report selling to the coop because it can be trusted to save money for later, even if the coop pays a lower price than other buyers. These findings are also confirmed in focus groups with dairy farmers in several areas of Central Kenya (Morton et al., 2000) and in ongoing work we are conducting in a different town in the Kiambu County.[37]

Beyond the Kenyan dairy sector, Figure 7-Panel A presents survey evidence on producers' demand for infrequent payments in another agricultural value chain (the Kenyan tea sector) and in a labor market setting (workers in large garments factories in Myanmar). In both cases, the graph reports patterns remarkably consistent with those among our dairy farmers. In many agricultural value chains, large buyers source through infrequent payments. An example is provided by smallholder tea contract farmers, who pick leaves and sell them multiple days per month (10-20 days depending on the timing of the season). In a survey of a random sample of 100 such farmers in Western Kenya, 81% mention monthly payments as their preferred payment frequency and 95% say monthly payments help save.

Beyond agricultural markets, the model in Appendix A can be reinterpreted with workers supplying labor: both milk and labor are supplied daily and are non-storable. In 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

[37] In many of these contexts, the large buyers pay at the end of the month a price lower than the price smaller traders pay daily. However, this is not true everywhere (Jack et al., 2016; Geng et al., 2017). Obviously, other differences across buyers can shape the specific price gap in each setting.

help them reach their saving goals. In a broader historical perspective, the establishment of the factory system was accompanied by a shift toward (semi-)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 (Kaur et al., 2015 provides experimental evidence). Our results suggest that it can also help with self-control in saving and spending habits.[38]

Our analysis also suggests that larger firms might be better positioned to offer infrequent payments. In the tea setting, the survey shows that large buyers (cooperatives and large estates) pay monthly but smaller traders predominantly (68%) pay daily. Figure Figure 7-Panel B provides further suggestive evidence. In a survey of 198 coffee mills in Rwanda, the graph 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.

To summarize, the interlinkage described in this paper may apply to several markets that feature saving-constrained producers (or workers). While we are aware the evidence in this section is just a first step that could be accounted for by different mechanisms, we nevertheless hope it will provide motivation for future research.

Policy Implications. Our analysis lends itself to a number of policy relevant considerations. First, producers' demand for infrequent payments suggest that these are an effective and natural commitment saving device, which is common in the real world. Policies promoting infrequent payments (for instance in labor contracts or cash transfers) may thus foster investment and purchase of durable goods. More work is needed to understand how to optimally structure payments to both help fund lumpy expenses and ensure consumption smoothing.

In addition, while infrequent payments may naturally target sophisticated individuals, attracting naive producers would require paying higher prices, as naive individuals do not recognize the commitment value of infrequent payments. There is no guarantee the market

[38]A 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% took up this opportunity (*La Repubblica, 2015*).

will extend infrequent payments to all those who need them.[39] Consistent with this observation, a survey from a random sample of farmers in our study setting shows that farmers who do not regularly sell to the coop are less likely to achieve saving goals (Appendix Table C.2). Exploring the sorting of producers and workers with varying degrees of sophistication across different organizational forms is a further avenue for future research.

Second, our results emphasize the role of poor contract enforcement as a barrier to competition in the provision of infrequent payments. By increasing the number of buyers who can credibly commit to infrequent payments, better enforcement may have an impact similar to improving the terms of saving products (e.g., increasing the interest). This logic thus unveils a novel benefit of improving contract enforcement in agricultural markets.

[39]See DellaVigna and Malmendier (2004) and Eliaz and Spiegler (2006) for a theoretical analysis of competition, sophistication and welfare, including the possibility that naive types end up with exploitative contracts.

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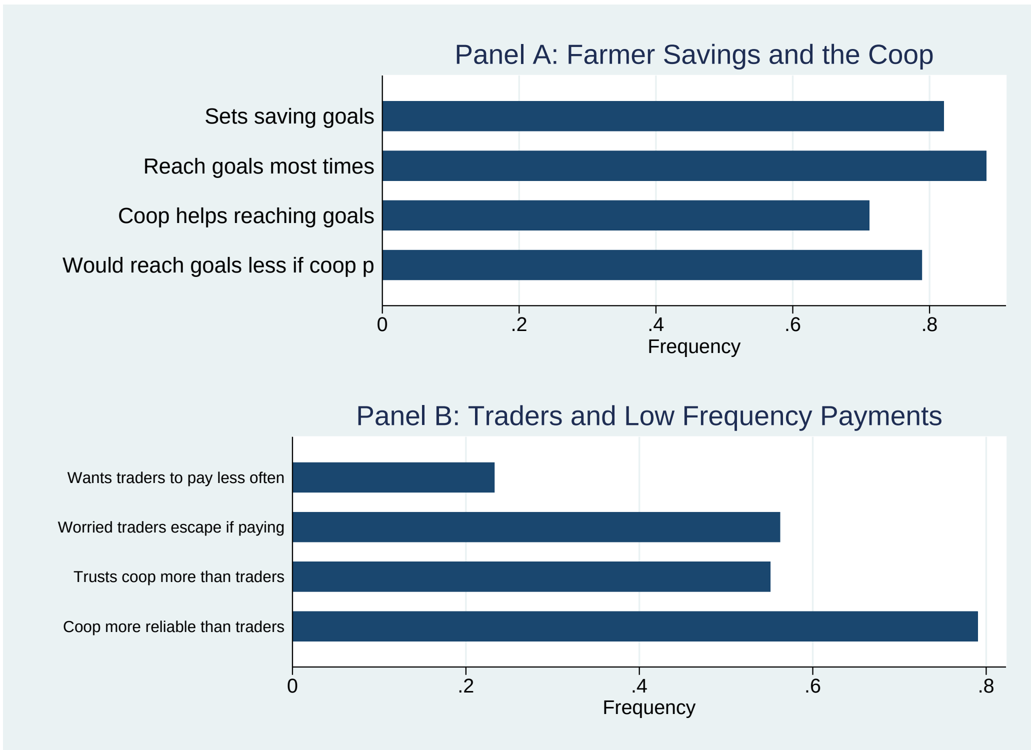
Figures

Figure 1: Descriptive Evidence: Farmers, Traders, and Infrequent Payments



Notes: Panel A presents summary statistics on farmer savings behavior and on the role of the coop in helping savings. All the variables are binary indicators and the horizontal bars display the frequency of farmers agreeing with the statement in the baseline survey. 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?" Panel B 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. In the survey, the variable *Trust* for either the coop and the buyer is measured on an index from 1 to 4 and the average difference between the two is 0.853.

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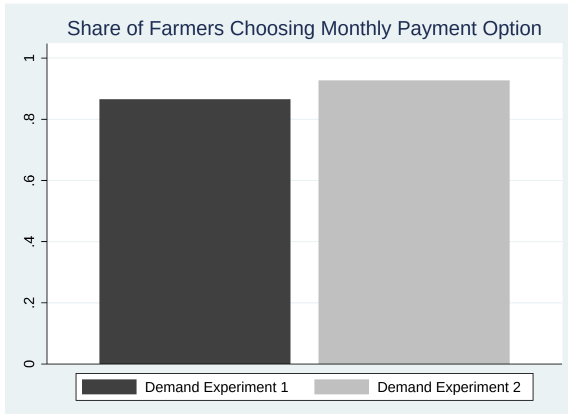
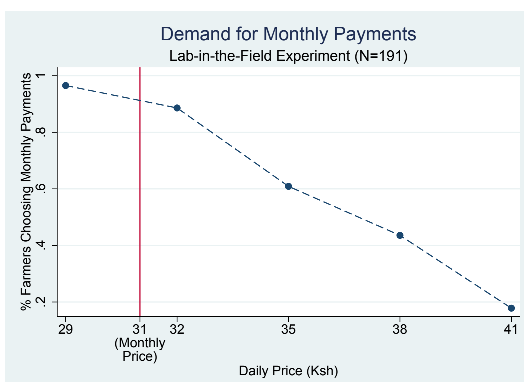
Figure 2: Demand Experiments: Farmers' Demand for Infrequent Payments



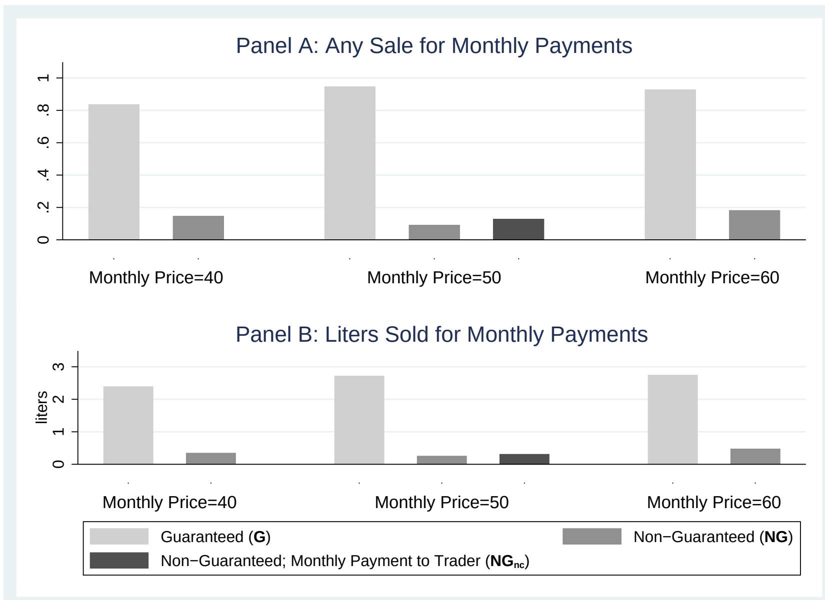
Notes: The figure presents results from the demand experiments reported in Section 3. The left bar focuses on the first demand experiment. It reports the share of farmers who choose monthly payments over daily payments with a bonus of KSh 5 (from a baseline of KSh 31). The right bar focuses on the second demand experiment. It reports the share of farmers who chose monthly payments over the "flexibility" option, which would allow them to choose every day whether to be paid daily or monthly.

Figure 3: Demand Lab-in-the-Field Experiment



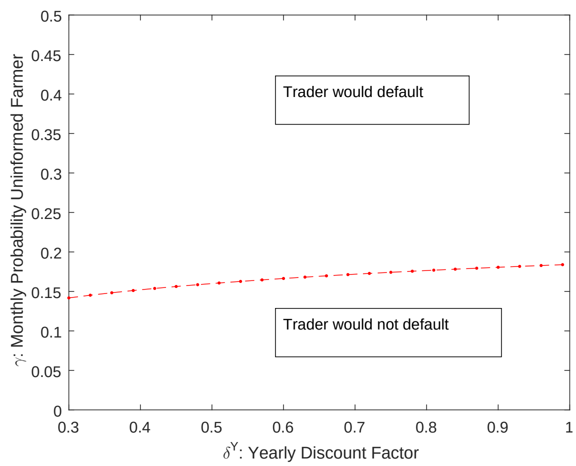
Notes: The figure presents results from the demand lab-in-the-field experiment described in Section 3.3 (*Elasticity of Demand for Infrequent Payments*). This lab-in-the-field experiment followed a within-subject design: farmers decided whether to sell three liters of milk for monthly or daily payments at various prices per liter for the monthly payment option. The y-axis reports the share of farmers who prefer monthly payments at five price points. The vertical line represents the (constant) price per liter under monthly payments.

Figure 4: Supply Experiments: Trader Credibility and Monthly Sales



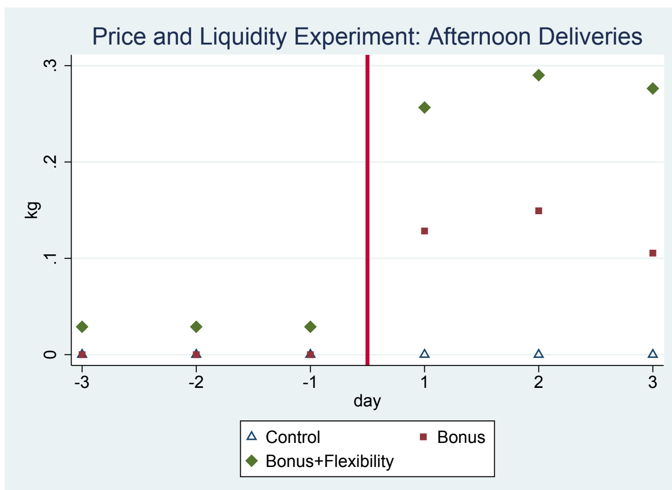
Notes: The figure presents the results from the supply experiments presented in Section 4. Farmers played seven games in which they had to choose how much to sell on monthly vs. daily payments, out of an endowment of three liters. Farmers played the games in random order. The price per liter for daily payments was fixed at KSh 40 per liter. The price of monthly payments varied across games: KSh 40, 50, 60. Section 4 describes the three treatments concerning monthly payments: guaranteed (G), non-guaranteed (NG) and non-guaranteed with monthly payment to the trader (NG_{nc}). For each of the seven games, **Panel A** reports the proportion of farmers who sell a positive amount of milk for monthly payments and **Panel B** reports the average amount of daily liters sold for monthly payments out of the experimentally provided endowment. The endowment is equal to three liters per day for a month.

Figure 5: Trader Incentive Constraint Calibration



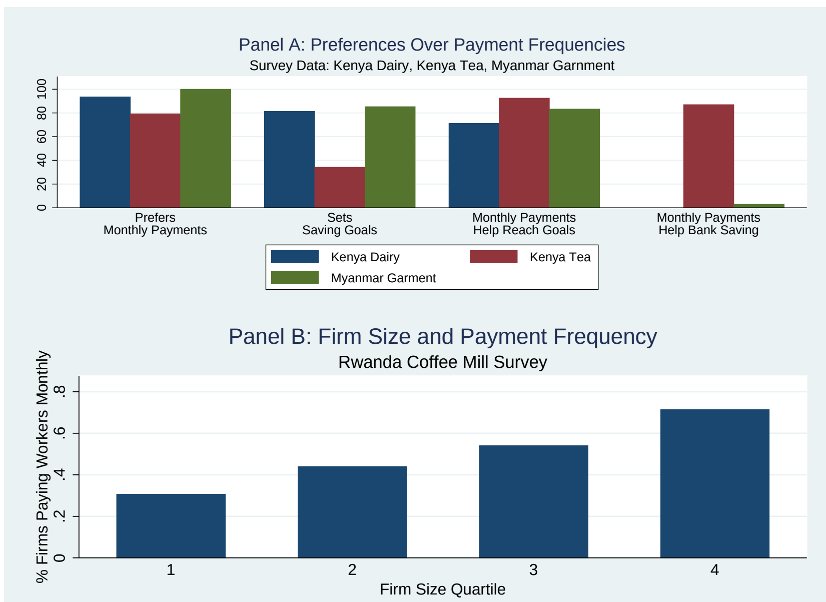
Notes: The figure shows pairs (δ^Y, γ) that satisfy the inequality of the trader incentive constraint of the empirical model (Equation 1)—where δ^Y is the annual discount factor and γ is the likelihood a trader matches with an *uninformed farmer* after a default. Monthly price p^M and daily price p^D are calibrated based on prevailing market prices at KSh 31 and 38, respectively. A trader defaults if γ is above the frontier described by the dashed line in the figure. The figure shows that unless farmers are implausibly well-informed about traders default, traders would not be able to commit to monthly payments. The result holds for a range of discount factors that imply annual interest rates spanning the plausible range of annual returns to capital to traders (from 5% to 233.33% in the figure). Appendix Figure C.4 shows robustness when varying monthly prices or allowing for trader time inconsistency.

Figure 6: Price and Liquidity Experiment



Notes: The figure presents the results of the *Price and Flexibility* randomized experiment described in Section 5.2. The experiment targeted farmers selling to the coop in the morning but not in the afternoon at baseline. 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 choose each day whether to be paid daily or at the end of the month. The y-axis reports average afternoon deliveries for the two treatment groups and the control group. 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 7: Survey Evidence from Other Settings



Notes: **Panel A** reports percentage of respondents agreeing with the four statements in three different surveys: dairy farmers in Kiambu, Central Kenya (left bar); tea growers in Kericho, Western Kenya (center bar); and line supervisors in garments factories in Yangon, Myanmar (right bar). **Panel B** 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 season. The figure shows larger mills pay *less* frequently. We thank Ameet Morjaria for sharing the data from Rwanda.

Tables

Table 1: Summary Statistics for Demand and Supply Experiments

	Panel A: Demand Experiments (N=191)		**Panel B: Supply Experiments** (N=55)	
Variable	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Male respondent	0.411	0.493	0.404	0.496
Respondent age	55.319	14.582	51.106	12.497
Household size	4.639	2.013	4.085	1.73
Number of cows	1.88	1.129	2.109	1.449
Daily milk production (lt.)	16.478	13.23	16.655	13.716
Sets saving goals	0.869	0.338	1	0
Saves in saving groups	0.652	0.478	0.638	0.486
Saves in bank	0.757	0.43	0.851	0.36
Hires workers for dairy	0.403	0.492	0.638	0.486
Knows any other village buyer	0.8	0.401	1	0

Notes: The table presents summary statistics for the farmers targeted in the demand experiments presented in Section 3 and in the supply experiments presented in Section 4. In Panel B, the mean of "knows any other village buyer" is equal to 1 by construction, since we only targeted farmers who did business with at least another buyer in the village.

Table 2: Supply Experiments

Monthly Price (KSh)=	40	50	60	40, 50, 60		50
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Any Monthly Sale (dummy)						
Non-Guaranteed	-0.691***	-0.855***	-0.745***	-0.764***	-0.691***	-0.691***
	[0.063]	[0.048]	[0.059]	[0.030]	[0.052]	[0.054]
Price=50				0.027	0.109**	
				[0.037]	[0.052]	
Price=50 *Non Guaranteed					-0.164**	
					[0.074]	
Price=60				0.064*	0.091*	
				[0.037]	[0.052]	
Price=60 *Non Guaranteed					-0.055	
					[0.074]	
Monthly Payment to Trader*						-0.018
Non Guaranteed						[0.054]
Mean Y Baseline Group	0.836	0.945	0.927	0.903	0.903	0.145
Observations	110	110	110	330	330	165
Panel B: Monthly Sales (liters)						
Non-Guaranteed	-2.045***	-2.464***	-2.273***	-2.261***	-2.045***	-2.045***
	[0.186]	[0.143]	[0.173]	[0.089]	[0.154]	[0.161]
Price=50				0.118	0.327**	
				[0.109]	[0.154]	
Price=50 *Non Guaranteed					-0.418*	
					[0.218]	
Price=60				0.241**	0.355**	
				[0.109]	[0.154]	
Price=60 *Non Guaranteed					-0.227	
					[0.218]	
Monthly Payment to Trader*						-0.036
Non Guaranteed						[0.161]
Mean Y Baseline Group	2.391	2.718	2.745	2.618	2.618	0.345
Observations	110	110	110	330	330	165

Notes: The table presents the results from the supply experiments presented in Section 4. Farmers played seven games in which they had to choose how much to sell on monthly vs. daily payments, out of an endowment of three liters. Farmers played the games in random order. The price per liter for daily payments was fixed at KSh 40 per liter. The price of monthly payments varied across games: KSh 40, 50, 60. Section 4 describes the three treatments concerning monthly payments: guaranteed (G), non-guaranteed (NG) and non-guaranteed with monthly payment to the trader (NG_{nc}). The dependent variable in **Panel A** is a dummy equal to one if a farmer sells a positive amount of milk for monthly payments and in **Panel B** is the amount of liters the farmer sells for monthly payments (out of an endowment of three liters). Columns (1), (2), and (3) report results for *Supply Experiment 1*, when the monthly price is equal to KSh 40, 50, and 60, respectively. Column (4) pools the previous samples. Column (5) shows heterogeneity in the impact of price increases by guaranteed treatment (see discussion in Section 5.2). Column (6) presents the results of *Supply Experiment 2*, comparing monthly sales among the G, NG and NG_{nc} treatments (at KSh 50 for monthly payments). All specifications include farmer fixed effects. Standard errors are clustered by farmer. *p<0.1, **p<0.05, ***p<0.01.

Table 3: Price and Liquidity Experiment

	Kg PM			Kg PM (dummy)			Kg AM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post*Bonus (γ)		0.128**	0.128**		0.043***	0.043***		-0.223	-0.223
		(0.050)	(0.050)		(0.015)	(0.015)		(0.283)	(0.283)
Post*(Bonus+Flexibility) (δ)		0.245**	0.245**		0.068***	0.068***		-0.009	-0.009
		(0.098)	(0.098)		(0.020)	(0.020)		(0.316)	(0.316)
Post		-0.008	-0.008		-0.004	-0.004		-0.218	-0.108
		(0.008)	(0.008)		(0.004)	(0.004)		(0.211)	(0.205)
Bonus	0.153**	-0.000		0.047***	-0.000		-0.319	-0.336	
	(0.062)	(.)		(0.017)	(0.000)		(0.259)	(0.304)	
Bonus+Flexibility	0.286***	0.029		0.074***	0.007		-0.281	-0.420	
	(0.105)	(0.029)		(0.022)	(0.007)		(0.293)	(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 *Price and Flexibility* randomized experiment described in Section 5.2. The experiment targeted farmers selling to the coop in the morning but not in the afternoon at baseline. 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 table reports three measures of daily deliveries: kilograms delivered in the afternoon; a dummy for whether the farmer delivers any milk in the afternoon; 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. In Columns (1), (4), and (7), the row "*p-value* $\gamma = \delta$" reports the p-value from testing equality of the coefficients on *Bonus* and *Bonus+Flexibility*. In the other columns, the row "*p-value* $\gamma = \delta$" reports the p-value from testing equality of the coefficients *Post*Bonus* and *Post*(Bonus+Flexibility)*. Standard errors are clustered at the farmer level. *p<0.1, **p<0.05, ***p<0.01.

Appendix

A A Model of Interlinkages between Saving and Good Transactions

We model how producers' demand for infrequent payments and buyers' ability to credibly provide them interact in a market setting. While the model draws from the study setting, it aims at providing a more general framework to study the interlinkage of transactions involving goods and saving services. In addition, the model guides the empirical analysis in Section 5. First, it delivers a trader incentive constraint we can calibrate. Second, it illustrates how sale responses to price increases vary with buyer credibility and payment frequency, which we test with several experimental designs.[40]

A.1 Baseline Model

A.1.1 Setup

Producers. Consider a market with a unitary mass of homogeneous producers. Time is an infinite sequence of months, m. Each month is divided into three *periods*, $t = 1, 2, 3$. Producers have quasi-hyperbolic preferences across periods, with $\beta < 1$ and $\delta < 1$. They are sophisticated about their time inconsistency.[41] In each of periods $t = 1, 2$, producers are endowed with one unit of non-storable output (milk). Producers cannot borrow. They can save cash from one period to the next within the same month, earning interest rate $(1 + r) = 1/(\delta + \epsilon)$, with $\epsilon \to 0$. In periods $t = 1, 2$, producers derive utility $u(c) = c$ from consumption of a perfectly divisible good c (whose price is normalized to one). Following Besley et al. (1993) and Anderson and Baland (2002), we introduce a demand for an indivisible good that is purchased and consumed in the last period, $t = 3$. The indivisible good costs D and gives utility $\Delta > D$. We assume producers cannot afford to buy the indivisible good just by saving one period worth of sales but they can if they saved the entire production. Therefore, producer utility in a given month at $t = 1$ is $U = c_1 + \beta\delta(c_2 + \delta I \Delta)$, where I is an indicator function equal to 1 if the producer purchases the indivisible good. These assumptions imply that producers always prefer to consume the divisible good in earlier periods and that they only save to purchase the indivisible good.[42,43]

Buyers. There are $N + 1$ buyers, indexed $i = 0, 1, 2, ..., N$. We refer to buyer 0 as the large buyer and to buyers $i = 1, 2, ..., N$ as small buyers. Buyers maximize discounted profits (at common discount factor δ) by reselling producers' output at exogenous price v. Buyers compete on prices and on whether they pay producers in each period $t = 1$ and $t = 2$ (i.e., daily payments) or at $t = 3$ (i.e., infrequent payments).[44] If

[40] Section A.1 presents the baseline model. Algebra and several extensions including, among others, producer heterogeneity, bundling of daily and infrequent payments, buyers' objective function and heterogeneity, producer access to credit, personal rules, and heuristics, are in Appendix A.3.

[41] We microfound the demand for infrequent payments assuming farmers *do* have access to a saving technology but are time-inconsistent and thus face "internal" saving constraints. While this microfoundation appears to be borne out in the data, the key results of the model can also be obtained in a framework with time-consistent farmers that do not have access to a (sufficiently good) saving technology (i.e., "external" saving constraints).

[42] Allowing a general concave utility function and/or that farmers also derive utility from consumption of the divisible good in $t = 3$ would make algebra more cumbersome without providing additional insights or altering the key results.

[43] We assume producers are not able to implement intertemporal commitment plans and save across months by herself (Bernheim et al., 2015). We discuss this assumption more in detail below.

[44] For notational simplicity, we assume buyers pay a per period interest rate of $1/\delta$ when paying at the end

multiple buyers offer the same payment frequency, they compete à la Bertrand. Bertrand competition among small buyers ensures that the sale price per liter is equal to v when selling for daily payments.

For expositional simplicity, we proceed in two steps. We first consider the case in which the large buyer provides infrequent payments under perfect contract enforcement, i.e., defaults on monthly payments are not possible. We then remove perfect contract enforcement and allow any buyer to offer monthly payments. Monthly payments are however subject to contractual hazard: at $t = 3$, a buyer can renege on the promised payment. When doing so, he faces a default cost. Buyers differ in their default costs.[45]

A.1.2 When and Why Do Infrequent Payments Help Save?

Producers Saving on Their Own. As a starting point, consider the case of a producer who, in a given month, must save on her own using the liquid saving technology. In $t = 2$, the producer decides to save D/δ and purchase the indivisible good in $t = 3$, rather than consuming, if $v + s_1 - D/\delta + \beta\delta\Delta \geq v + s_1$, where s_1 is the amount the producer saved in $t = 1$. The inequality holds if $\beta \geq \frac{D}{\delta^2\Delta} \equiv \hat{\beta}$. In addition, since $v/\delta < D$, self 1 must also save $s_1^P = \delta^2(D - v/\delta)$. She chooses to do so if $v - s_1^P + \beta\delta^2\Delta \geq v(1 + \beta\delta)$, or $\beta \geq \frac{\delta D - v}{\delta\Delta - v} \equiv \tilde{\beta}$. Since $v/\delta^2 < D$, $\tilde{\beta} < \hat{\beta}$. Therefore, a producer will be able to save on her own to buy the indivisible good if $\beta \geq \hat{\beta}$. In the rest of the section, we assume this condition is *not* satisfied and we study the conditions under which illiquid payments induce the producer to purchase the indivisible good, when the producer cannot save for its purchase on her own.

Infrequent Payments as a Saving Device. Consider now the case where the large buyer pays a price per liter p at the end of the month ($t = 3$). Why might this help? Producers obtain higher utility when using the illiquid payments at $t = 3$ to buy the indivisible good, rather than to consume the standard divisible good. Therefore, by selling a sufficient amount x_1 to the large buyer in $t = 1$, self 1 can induce self 2 to contribute to the purchase of the indivisible good by saving $s_2^* = (D - px_1)/\delta$. Formally, self 2 will save for the indivisible good if $v - ((D - px_1)/\delta) + \beta\delta\Delta > v$ or $x_1 \geq \frac{\delta^2(D-\beta\Delta)}{p} \equiv x_1^*$. In turn, self 1 will be willing to provide this minimum amount of illiquid savings to self 2 if $(1 - x_1^*)v + \beta\delta((v - s_2^*) + \delta\Delta) \geq (1 + \beta\delta)v$, which holds if $p \geq v\frac{D-\beta\Delta}{\beta\Delta(1-\beta)} \equiv p^*$.

When can the illiquid payment help? Only if the large buyer can make a (zero) profit from infrequent payment: $p \leq v$, which holds if $\beta \geq 1 - \sqrt{\frac{\Delta - D}{\Delta}} \equiv \beta^*$.[46] If this condition holds, producers can buy the indivisible good if the large buyer provides infrequent payments, but not by saving on their own.

Relational Contracts and Punishment Threats. As discussed in the paper, a buyer who offers infrequent payments can further help producers save by threatening to punish them if they fail to sell (and thus to save) on a regular basis. In doing so, the buyer introduces an additional reason to sell for illiquid payments in the current month: the value of continuing doing so in the future. In this section, we study this mechanism formally. We focus on the stationary relational contract that maximizes the large buyer profits subject to incentive and participation constraints for the farmers. In the resulting relational contract the large buyer sets a price p for deliveries and requires the producer to sell x_1 and x_2 in period 1 and 2 respectively, such that $p(x_1/\delta^2 + x_2/\delta) = D$. If the producer ever deviates, the large buyer will never accept deliveries from that producer in the future. In this arrangement the producer saves for the indivisible good only through illiquid payments from the large buyer. Note that the producer still sells part of its produce to

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of the month. This eliminates a trade credit motive and delivers a more transparent algebra. All results are unaffected if we remove this assumption.

[45]To avoid a lengthy taxonomy of cases, the analysis focuses on interior solutions. This is without loss of generality as there always exists a rescaling of parameters D and Δ such that all assumptions are verified and interior equilibria exist.

[46]The threshold β^* corresponds to the case in which producers sell at v and save in an illiquid bank account that pays at $t = 3$, rather than through the coop infrequent payments.

traders for daily consumption. The large buyer tolerates this as requiring complete loyalty from the producer would violate her constraints.[47]

Self 2 sells to the large buyer if $v(1 - x_2^{**}) + \beta\delta\left(\Delta + \delta V^{\Delta}\right) \geq v + \beta\delta\left(\delta V^0\right)$, where $x_2^{**} = \delta(\frac{D}{p} - \frac{x_1}{\delta^2})$ $V^{\Delta} = \frac{(1-x_1)v+\delta(1-x_2)v+\delta^2\Delta}{1-\delta^3}$ and $V^0 = \frac{1+\delta}{1-\delta^3}v$ are the continuation values when maintaining or leaving the relation, respectively. The inequality holds if $x_1 \geq \delta^2 \frac{Dv(1-(1-\beta)\delta^3)-p\beta\Delta}{pv(1-\delta^3)} \equiv x_1^{**}$. Thus, x_1^{**} is the minimum level of (infrequent payment) sales that self 1 must make to the large buyer to induce self 2 to sell to the large buyer, too. Self 1 will chose to sell this amount if $p \geq Dv\frac{1+(1-\beta)^2\delta^3}{(2-\beta)\beta\Delta} \equiv p^{**}$.

Under the assumption of perfect contract enforcement and no buyer default, the relational contract helps producers buy the indivisible good as long as the large buyer can make zero profit from the relation (in the next section we relax this assumption). This is the case if $p \leq v$, or $\beta \geq 1 - \sqrt{\frac{\Delta-D}{\Delta-D\delta^3}} \equiv \beta^{**}$, with $\beta^{**} < \beta^*$. Therefore, if $\beta^{**} \leq \beta < \beta^*$, the producer buys the indivisible good under the relational contract (which features both illiquid payment and punishment threat), but not with illiquid payments alone. In addition, for a given β, the large buyer prefers the relational contract equilibrium to the illiquid payments alone, since $p^{**} < p^*$, and thus its profits are higher. Conversely, even a producer with access to an illiquid saving technology might not use it if the buyer provides illiquid payments with the additional threat of future punishment if the producer deviates from the plan.[48]

A.1.3 Imperfect Enforcement and Buyer Competition on Infrequent Payments

We now consider the case where both the large and the small buyers can offer infrequent payments. We also allow buyers to default on the monthly payments due to producers (i.e. we introduce imperfect contract enforcement). We assume buyers differ in their cost of defaulting. Upon reneging on a promise made to a producer for payment at $t = 3$, small buyer i can move to an identical outside market. In each period after a default the small buyer has a probability $\gamma_S = \gamma \leq 1$ of being matched with a producer not informed about his past cheating and, therefore, willing to sell to him. In contrast, the large buyer cannot move to the outside market and, therefore, $\gamma_L = 0$. The difference in default costs can be driven, for instance, by different fixed costs: the large buyer may have invested in fixed premises and in building an internal bureaucracy, both of which reduce mobility. We characterize an equilibrium in which the large buyer sets prices such that small buyers are *not* able to credibly promise infrequent payments.[49]

The Small Buyers. Consider a deviation in which a small buyer offers a producer infrequent payments at price p and denote with $\hat{x}_t^S$ the resulting quantity the trader buys in period $t = 1, 2$. If the producer accepts the small buyer's offer, she is punished by the large buyer who will refuse to purchase from her in the future. To attract the producer, then, the small buyer must offer a deal that allows the producer to purchase the indivisible good solely from his promised low frequency payment. The deviating small buyer faces the maximum temptation in $t = 3$, once he has already purchased the output and needs to pay for deliveries $\hat{x}_1^S$ and $\hat{x}_2^S$.

Let's consider a one-period deviation where the small buyer defaults for one month and then reverts to pay future sales with infrequent payments upon meeting in the outside market a producer willing to sell to him (which happens in each period with probability γ). The continuation value of such a relationship with a producer is given by $V^S = \sum_{s=0}^{\infty} \delta^{3s}(v-p)(\hat{x}_1^S+\delta\hat{x}_2^S)$. The small buyer's offer is credible if paying the promised

[47]In the next section, we discuss reasons why the large buyer might prefer not to offer a bundle of daily and monthly payments.

[48]We are assuming that producers cannot stipulate intertemporal commitment plans across months by themselves. This could be the case, for example, if the farmer finds it difficult to carry out the punishment either because her future selves have a very strong temptation to renegotiate or because she forgets what caused deviating from the plan in the past, as in Bénabou and Tirole (2004).

[49]The model easily generalizes to the case in which $\gamma_0 \leq \gamma_1 \leq \gamma_2 < ... < \gamma_N$. This includes the case with multiple large buyers competing a la Bertrand on monthly payments.

amount and continuing the relationship gives a higher discounted value than defaulting and then searching for an uninformed producer in the outside market, that is: $-\frac{p}{\delta^2}(\hat{x}_1^S+\delta\hat{x}_2^S)+\delta V^S \geq \delta\sum_{m=0}^{\infty}\gamma(1-\gamma)^m\delta^{3m}V^S$. This can be rearranged as:[50]

$$p \leq \delta^3(1-\gamma)v \equiv \hat{p}^S \tag{A.1}$$

Intuitively, when the share of uninformed producers, γ, is high, it is easier for the small buyer to find a new supplier and, therefore, the value of the relationship with the current producer is lower.

The Large Buyer. The large buyer sets the price to maximize profits subject to three constraints.[51] First, he must pay a price higher than the highest price at which small buyers can credibly promise infrequent payments, $p \geq \hat{p}^S$. Second, he must pay a price high enough to induce producers to sell for infrequent payment: $p \geq p^{**}$ (as defined in the previous section). Third, the large buyer must also be credible: recalling that $\gamma^L = 0$, the large buyer can credibly offer infrequent payments if $p \leq \hat{p}^L \equiv \delta^3 v$. To summarize, the large buyer will offer monthly payments at price $p^+ = \max\left\{\hat{p}^S, p^{**}\right\}$ if $p^+ \leq \hat{p}^L$ (and will only offer daily payments otherwise). In this equilibrium, small buyers offer daily payments at price v. Therefore, $p^+ < v$: the price for infrequent (delayed) payments is lower than the price for daily payments.

A.2 Derivation of the Trader Incentive Constraint

Trader IC constraint. We now derive the trader IC constraint. In the last period of a given month, $t = 3$, a trader can resist the temptation to default on the amount due to the farmer if: $-p(x_1^*/\delta + x_2^*) + \delta\sum_{s=0}^{\infty}\delta^{3s}(v(x_1^*+\delta x_2^*) - \delta^3 p(x_1^*/\delta + x_2^*)) \geq \delta\sum_{m=0}^{\infty}\delta^{3m}(1-\gamma)^m\sum_{s=0}^{\infty}\gamma\delta^{3s}(v(x_1^*+\delta x_2^*) - \delta^3 p(x_1^*/\delta + x_2^*))$. Given $p(x_1^*/\delta + x_2^*) = D$, substituting for x_1^* and x_2^* and simple algebra delivers the inequality in (A.1). For the large buyer the constraint is given by the same expression after setting $\gamma = 0$. ||

We now derive the empirical version of the trader IC constraint used in the calibration (Equation 1). Denoting with δ the daily discount rate and with γ the monthly probability of finding an uniformed after a previous default, the incentive constraint for a trader sourcing x units of milk every day for a month and paying unit price p at the end of the month is given by

$$-30px + \delta\sum_{s=0}^{\infty}\delta^{30s}((\sum_{t=0}^{29}\delta^t vx) - 30\delta^{29}px)$$
$$\leq \delta\sum_{u=0}^{\infty}\delta^{30u}(1-\gamma)^u\sum_{s=0}^{\infty}\gamma\delta^{30s}((\sum_{t=0}^{29}\delta^t vx) - 30\delta^{29}px)$$

This inequality simplifies to

$$-30p + \frac{\delta}{1-\delta^{30}}(\frac{1-\delta^{30}}{1-\delta}v - 30\delta^{29}p) < \frac{\delta}{1-\delta^{30}}\frac{\gamma}{1-\delta^{30}(1-\gamma)}(\frac{1-\delta^{30}}{1-\delta}v - 30\delta^{29}p)$$
$$\Leftrightarrow p > \frac{1}{30}\delta(1-\gamma)\frac{1-\delta^{30}}{1-\delta}v \equiv p^T_{empirical}$$

as reported in the text. ||

[50] See Appendix A.2 for a derivation.

[51] To 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.

A.3 Model Discussion

Producer Heterogeneity and Price Discrimination. It is straightforward to extend the model to allow for farmers heterogeneity in, e.g., the degree of time-inconsistency β or the valuation for the indivisible good Δ. Consider for instance the case in which Δ_i differs across farmers and is distributed according to a strictly increasing and twice continuously differentiable cumulative function $G(\Delta_i)$ on support $\Delta_i \in [0, \infty)$. In this case the key result of the theory that the price paid by buyers offering monthly payments is lower than the daily price would still emerge in equilibrium. In addition, there would be a sorting of farmers with heterogeneous Δ_i into different marketing channels. The baseline model with identical producers doesn't allow for a discussion of price discrimination by the large buyer. The main insights of the model, however, are robust to (perfect) price discrimination. In the case with multiple large buyers, competition would obviously prevent discrimination. It is also worth to note that, in our study setting, price discrimination is ruled out by the cooperative bylaws. The cooperative management is reluctant to introduce forms of price discrimination because of prevailing norms and the fear of upsetting farmers that would receive a worse deal. The concern is that farmers paid lower prices would perceive to be treated unfairly and withdraw their deliveries to the coop.

(No) Bundling of Monthly and Cash Payments. So far we have assumed that the large buyer does not offer daily payments. Could the large buyer possibly profit from offering daily payments as well? To begin with, note that free entry implies that buyers make zero profits on daily payments. This implies that the only way the large buyer could profit from offering daily payments is through a bundling contract in which monthly payments are offered only to those farmers that supply all their production in both periods. Three considerations suggest that such bundling might not be profitable. First, if the farmer's participation constraint is already binding bundling would not increase profits. If farmers are heterogeneous but discrimination is not possible, bundling might even decrease profits. Second, to offer daily payments, the large buyer might have to incur higher costs. For example, it would have to monitor milk collectors to handle cash properly. These higher costs do not bring profits in the daily payment market, and might reduce profits making the large buyer less credible in offering the monthly payments. Finally, by offering daily payments the large buyer could make it harder for the farmer to sustain the commitment plan, thereby undoing its main source of profits.

Large Buyer's Objective Function. We have assumed all buyers maximize profits. Since in our study setting the large buyer is a cooperative, this might not be a natural assumption. The framework can be extended to allow the large buyer to have an objective function that includes producers' welfare, as well as buyer profits. The main results—i.e., monthly prices are lower than the daily prices and producers sort depending on their utility from indivisible good—still hold.

Payment Frequencies. The model focuses on the case in which there are only two payment frequencies: daily and monthly. This is in line with evidence from our context suggesting that the vast majority of traders do not offer any delayed payment, even at weekly frequencies. A natural question is why traders in practice do not offer delayed payments with shorter – e.g., weekly, or bi-weekly – frequencies. This would reduce the amount they promised to pay to farmer and give them more credibility. While we do not have conclusive evidence on this, we conjecture the following as a plausible explanation. Time-inconsistent farmers might not be able to carry forward intermediate amounts of money resulting from, e.g., weekly sales to buy indivisible goods at the end of the month. That is, farmers would only be able to buy smaller indivisible goods, for which they might not have a demand. This lack of demand could be in itself the result of farmers' longer exposure to the monthly payments from the coop.

Access to Credit. While the model emphasizes the role of saving constraints, it also makes the stark assumption that producers cannot borrow. The logic of the model survives the introduction of an informal credit market in which farmers borrow from lenders (including buyers). The reason is as follows. In the presence of limited contract enforcement, an informal credit market will develop only if the farmer can commit to repay the informal lender. It can be shown that there are parameters configurations such that a farmer isn't able to credibly borrow to purchase the lumpy good, but can stick to a saving plan that allows him to (and vice versa).

When the farmer can both credibly borrow in the informal market as well as stick to a saving plan, her welfare under the two scenarios depends on two opposing forces: competition vs. over-borrowing. Buyers do not face credibility issues when extending loans. If multiple buyers can offer loans, competition pushes prices up. On the other hand, time-inconsistent farmers might end up borrowing for lumpy goods their future selves regret if intra-personal rules are not powerful enough. So, even when an informal borrowing market is available, farmers might prefer the discipline provided by saving through the large buyer.

Furthermore, the presence of large buyers offering a saving tool undermines farmers' credibility when borrowing from traders: in the event of a default against a trader, the farmer can still buy desired lumpy goods in the future by selling to the large buyer. By offering this saving service, the large buyer prevents competition from traders offering credit without having to take on any default risk. In our context, producers have limited access to well-functioning formal credit markets, but they could borrow from either the large buyer, traders, or other informal sources to finance their lumpy consumption. Evidence from the survey reveals however that only 26% of farmers borrow from any source for their dairy business; and very few borrow from either traders or the coop. Finally, as discussed in Section 1, it must be noted that a market in which farmers borrow from buyers would look very different from the market under study under several dimensions.

Intra-Personal Plan. In the main text, we abstracted from producers' personal strategies across periods (see, e.g., Strotz, 1955; Laibson, 1997; Bernheim et al., 2015). These strategies could allow the producer to save the necessary amount to buy the indivisible good without infrequent payments. The intuition is as follows. Consider a producer 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 such personal rules wouldn't change qualitative features of the equilibrium we study but would provide further insights. First, note that given liquid savings, producers with sufficiently low β 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 producer would behave as described in the text: sell to small buyers for liquidity and to the large buyer to purchase the indivisible good. As in the baseline model, the producer 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 producer sticking to her plan and adjust deliveries accordingly. A sufficiently permanent increase in price with the offer of liquidity, however, could trigger the producer's default 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 overcome her self-commitment problem.

B Survey Evidence

B.1 Survey Evidence on Farmers' Demand for Infrequent Payments

The demand experiment results are consistent with, and further supported, by several additional pieces of survey evidence. First, as discussed in Section 3.3, Figure 1-Panel A shows that many farmers report they want the coop to may monthly and that monthly payments help save.

Second, Appendix Table C.1 suggests that having another regular occupation or being a larger producers is associated with a lower likelihood that the farmer states that the coop helps reaching the saving goals (Columns 3 and 4). In the same table, the role of the payment frequency in achieving the saving goals is particularly large for present-biased farmers, consistent with a certain degree of sophistication in our target population.

Third, correlation patterns from a very short survey administered to a representative sample of the overall farmers population in the area (i.e., including farmers that do not sell to the coop) further supports the hypothesis that the coop payments may be related to farmers' savings. Appendix Table C.2 shows that farmers who set saving goals are 20 percentage points more likely to sell to the coop (86% vs. 66%) and that farmers selling to the coop are more likely to reach their saving goals.

Fourth, farmers report using money earned from the traders and from the coop for different purposes, as shown in Appendix Figure C.1. The monthly payment from the coop is predominantly (almost 40%) used to finance lumpy expenses in the dairy business, such as purchase of feed and equipment. The largest share of traders' daily payments is instead spent on current expenses, such as purchasing food (55%).[52] In sum, several additional pieces of survey evidence supports the results from the demand experiments: farmers value the coop's infrequent payments as those help overcoming saving constraints.

B.2 Survey Evidence on Buyers

As discussed in Section 3.3, small traders pay a higher price than the coop. This result holds in multiple seasons and years. First, in the baseline survey for the randomized experiment described in Section 5, we asked farmers about average trader price in December 2013, March 2014, and June 2014. These are 37-38 KSh per liter. We also ask about the price paid by the best trader and the figures are very similar, consistent with a competitive trading sector and low dispersion in daily payment prices. In this period the coop was paying between 29 and 31 KSh per liter. Second, for our demand experiment, we ask farmers about trader price in October 2014. The average price was KSh 38. The coop price in this period was KSh 31-32. Third, for the supply experiment described in section 4, we asked traders about the price they payed for milk in July 2017. Traders reported an average price of KSh 43, with average "high price" being KSh 47 and "low price" KSh 41. In this period, the coop price was KSh 35-36.

There are many reasons why farmers may be willing to accept a lower price from the coop. First, 75% of respondents report a sense of pride from selling to the coop. Second, 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.[53] 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 inputs' quality and prices. Third, 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 sales to the coop in other months. Fourth, about one-quarter of the farmers report they have attended a training organized by the coop over the last year. Fifth, there is essentially no quality testing done by either the coop or the large buyer, thus the difference in price cannot be driven by systematic differences in milk quality. Sixth, farmers may bear a higher transport cost when bringing milk to traders than to the coop collection center. However, average distance between the farmer and the sale point seems higher for the coop (Figure C.5). Finally, we note the cooperative does not make second payments at the end of the year.

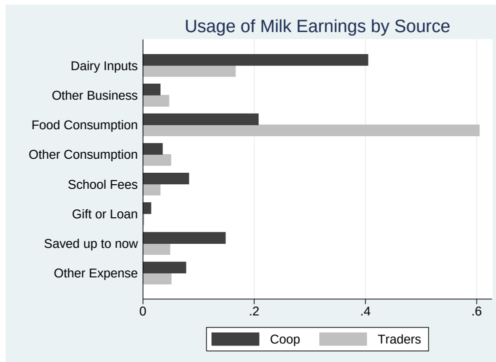
[52] The findings are consistent with the model of Banerjee and Mullainathan (2010) and with evidence from Haushofer and Shapiro (2016), who find that monthly transfers from an unconditional cash transfer program are more likely than lump-sum transfers to improve food security, while lump-sum transfers are more likely to be spent on lumpy expenses.

[53] The coop does not offer asset-collateralized loans such as the ones described in Jack et al. (2016).

C Appendix Figures and Tables

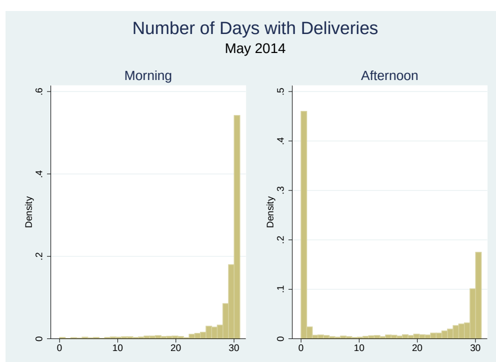
C.1 Appendix Figures

Figure C.1: Usage of Milk Earnings



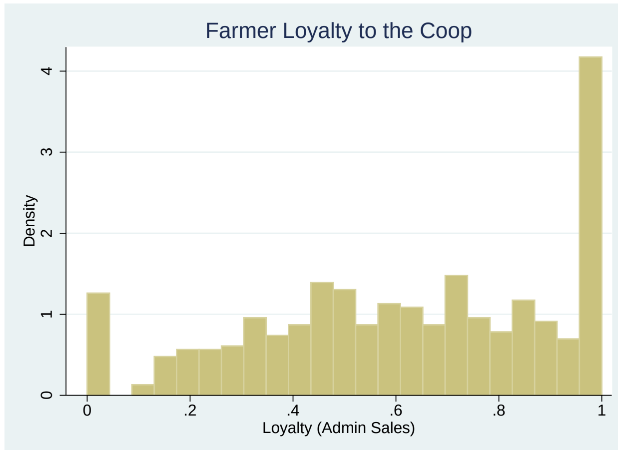
Notes: The figure describes how farmers use milk earnings from the coop and from other buyers, respectively. For each type of buyer, we compute the share of expenses on an item, relative to the total earned by the farmer from that buyer.

Figure C.2: Number of Days with Deliveries to the Coop



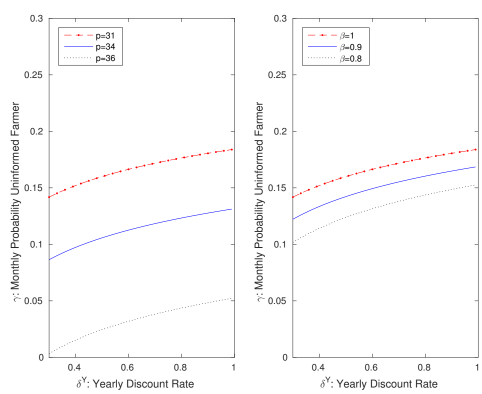
Notes: The left (right) histograms present the distribution of the farmer-level number of days with positive deliveries to the coop in the morning (afternoon) in a month (measured in May 2014). The Figure shows that many farmers sell to the coop (almost) every day of the month and (almost) never in the afternoon.

Figure C.3: Farmers' Loyalty to the Coop



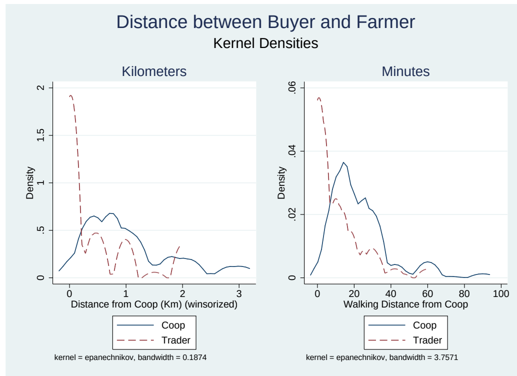
Notes: The *Loyalty* variable is defined as the ratio between sales to the coop and production available for sales among farmers in the main survey sample. Production available for sales is defined as the difference between production and home consumption (including feeding calves). Deliveries to the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

Figure C.4: Trader Incentive Constraint Calibration: Robustness



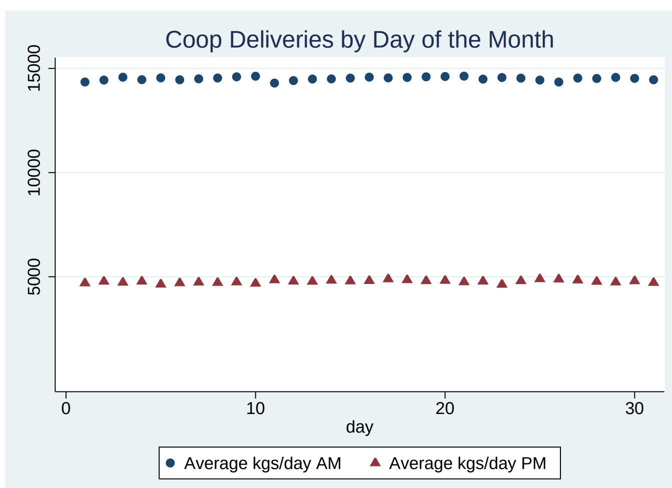
Notes: The figure presents robustness check to Figure 5. In the *left graph*, we vary the purchase price a trader would be able to offer when paying at infrequent. If part of the observed price gap comes from other benefits the coop offers, the trader will have to offer a higher price. This reduces the 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.

Figure C.5: 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.6: Average Coop Milk Deliveries by Day of the Month



Notes: The figure shows 2014 milk deliveries to the coop 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.

C.2 Appendix Tables

Table C.1: Baseline Correlations

	Set Saving Goals	Reach Goals	Coop Helps Goals	Reach Less if Weekly Pyt
	(1)	(2)	(3)	(4)
Number of Cows	-0.003	0.002	0.009	-0.026**
	(0.014)	(0.005)	(0.013)	(0.010)
Avg Deliveries (kg) in June 2014	0.003	0.009*	0.008	0.007
	(0.007)	(0.005)	(0.008)	(0.008)
Loyalty	0.071	0.058	0.141*	-0.041
	(0.067)	(0.057)	(0.085)	(0.075)
Any Other Village Trader	0.025	-0.046	0.100*	0.098*
	(0.042)	(0.036)	(0.056)	(0.054)
Present Biased	0.087**	0.033	0.008	0.103**
	(0.039)	(0.039)	(0.063)	(0.045)
Difference Trust Coop-Trader	0.022	-0.006	0.004	0.036**
	(0.014)	(0.012)	(0.018)	(0.016)
Saves in Saving Groups	0.137***	-0.037	0.075	0.067
	(0.039)	(0.034)	(0.048)	(0.044)
Saves in Bank	0.074*	0.097**	-0.016	-0.096**
	(0.040)	(0.041)	(0.048)	(0.040)
Regular Income from Other Occupation	-0.004	-0.023	-0.113**	-0.098*
	(0.040)	(0.037)	(0.056)	(0.052)
HH member manages money not cows	0.095***	0.040	0.015	-0.033
	(0.031)	(0.031)	(0.046)	(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 and other farmer covariates, measured in the baseline survey for the *Price and Liquidity Experiment*, described in Section 5.2. *Avg Daily Deliveries* are from coop administrative data. 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 KSh 200 between today and next week than between next week and the subsequent one. *Trust* for either the coop and the buyer is measured on 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. 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 C.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***	0.184***	0.206***	0.358***	0.255*	0.173
	(0.040)	(0.042)	(0.047)	(0.131)	(0.133)	(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 C.3: 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	.4765	.4123	.052*	.825	.319	389
	(.4846)	(.5011)	(.4948)				
Respondent Age	58.39	54.96	56.12	.136	.323	.455	387
	(15.90)	(15.98)	(15.05)				
Household size	4.945	5.306	5.163	.133	.73	.425	395
	(2.185)	(1.928)	(2.064)				
Number of Cows	1.383	1.346	1.448	.849	.426	.28	394
	(.6874)	(.6754)	(.6904)				
Average Daily Deliveries in Sep 2014	3.963	4.051	4.216	.826	.199	.302	398
	(2.257)	(2.413)	(2.262)				
Loyalty	.6632	.6582	.6713	.597	.881	.618	376
	(.2476)	(.2516)	(.2529)				
Loyalty AM	.7814	.7669	.7611	.405	.659	.743	383
	(.2225)	(.2221)	(.2210)				
Loyalty PM	.4978	.5057	.5429	.552	.742	.213	378
	(.5004)	(.4997)	(.4943)				
Hire workers for dairy	.2229	.2516	.2551	.314	.625	.835	397
	(.4176)	(.4354)	(.4381)				
Any Other Village Trader	.8367	.8807	.7755	.25	.468	.079*	396
	(.3708)	(.3251)	(.4193)				
Present Biased	.1313	.1103	.1086	.62	.538	.816	374
	(.3390)	(.3144)	(.3129)				
Difference Trust Coop-Trader	.7591	.9851	.9418	.158	.488	.523	358
	(1.121)	(1.126)	(1.109)				
Saves in Saving Groups	.6418	.7302	.7395	.121	.09*	.831	396
	(.4810)	(.4452)	(.4411)				
Saves in Bank	.7260	.7105	.7938	.822	.274	.224	395
	(.4475)	(.4550)	(.4066)				
Regular Income from Other Occupation	.2094	.2105	.2142	.961	.572	.897	398
	(.4083)	(.4090)	(.4124)				
HH member manages money not cows	.2463	.2739	.3333	.694	.271	.146	377
	(.4324)	(.4475)	(.4739)				

Notes: The table reports summary statistics and balance tests for the *Price and Flexibility* randomized experiment described in Section 5.2. 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. *Avg Daily Deliveries* are from coop administrative data. 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 KSh 200 between today and next week than between next week and the subsequent one. *Trust* for either the coop and the buyer is measured on 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. 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 C.4: Price and Liquidity Experiment: Heterogeneous Treatment Effects

	(1)	(2)	(3)
Post*Bonus (γ)	-0.009	0.059	0.294
	(0.066)	(0.036)	(0.182)
Post*(Bonus+Flexibility) (δ)	-0.273	0.413**	0.046
	(0.223)	(0.197)	(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 *Price and Flexibility* randomized experiment described in Section 5.2. 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. We report results from the difference-in-differences model with farmer FE from Table 3, Column (3). The dependent variable is the kilograms of milk the farmer delivers to the coop in the afternoon. Refer to the notes of Table 3 for further details on the specification. *Avg Daily Deliveries* are from coop administrative data. Both production and delivery variables are measured in kilograms. *Loyalty* variables are defined as ratios between afternoon sales to the coop and afternoon production available for sale (defined as the difference between production and home consumption, including feeding calves). Standard errors are clustered at the farmer level. *p<0.1, **p<0.05, ***p<0.01.