Market Anomalies Under Saving Constraints: Evidence from the Kenya Dairy Industry *

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Abstract

When suppliers face saving constraints, buyers can compete by offering deferred payments. However, with limited enforcement, the ability to credibly promise deferred payments may vary across buyers. A simple model of a market with these features is developed and tested using multiple experimental designs and data sources from Kenyan dairy farming. The evidence unveils interlinkages between saving and product markets. A segmented market emerges in which buyers serve distinct purposes: small traders provide liquidity and pay a higher price; whereas a large buyer provides deferred payments that alleviate saving constraints. In this interlinked market structure, standard price incentives are ineffective in increasing deliveries.

Keywords: Interlinked Transactions, Saving Constraints, Reputation, Experiments.

JEL Codes: O12, Q13, L22, P13.

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1 Introduction

A prominent tradition in development economics explains a variety of (often puzzling) institutional arrangements through the lens of imperfect credit, labor, insurance, or land markets. A recent empirical literature has documented important failures in the market for saving products (see, e.g., Karlan et al. (2014), for a survey). This paper explores how saving constraints spillover into other markets. When producers have a demand for savings, buyers can offer deferred payments. This gives rise to a form of interlinked transactions between saving and product markets: a form of interlinkage that, to the best of our knowledge, had not been previously noted in the literature (Bardhan (1991)).

In addition, when contracts are not perfectly enforced, buyers might differ in their ability to credibly promise deferred payments. This induces a segmented market structure in which different buyers compete by offering radically different terms of payments. A producer sells the same product contemporaneously to different buyers as these serve different purposes: liquidity and saving devices. In this interlinked market structure, buyers’ standard pricing strategies, then, might fail to induce the anticipated responses.

We explore these mechanisms in the context of dairy farming in rural Kenya. Besides its intrinsic relevance, two features of the context enable a particularly transparent analysis of the mechanisms at work. First, dairy farming generates sales of milk every day. This induces a non-trivial cash-management problem and, potentially, a demand for deferred payments. Second, in the study region, a large buyer – a cooperative – competes with a large number of smaller buyers, with stark variation in observed terms of payments across buyers. Through a combination of administrative data from the cooperative, a rich survey of farmers in the region, and multiple experimental designs, we explore the extent to which demand for deferred payments and differences in credibility across the two types of buyers shape farmers’ sales.

\(^1\)Nowadays classical contributions in this literature are, e.g., explanations of sharecropping (Stiglitz (1974), Braverman and Stiglitz (1982)), rotating savings and credit associations (Besley et al. (1993), Anderson and Baland (2002)), joint liability lending (Ghatak and Guinnane (1999), Ghatak (2000)), labor tying (Bardhan (1983), Mukherjee and Ray (1995)) and risk-sharing networks (Coate and Ravallion (1993), Udry (1994)). De Janvry et al. (1991) discusses how specific market failures can induce *prima facie* puzzling farmer behaviors.

\(^2\)Prominent explanations for saving constraints are institutional barriers, transaction costs, pressure from close family, kinship members or friends, fear of theft and time-inconsistent preferences.

\(^3\)The dairy industry is the largest agricultural subsector in Kenya, contributing to 14% of agricultural GDP and 3.5% of total GPD.
patterns and buyers’ competition strategies.

After providing some background information on the study setting, we present three motivating facts. First, small traders pay 20-30% higher prices than the coop (both net or gross of transport costs). Second, small traders mostly pay farmers on a daily basis, while the cooperative pays all at once for milk deliveries at the end of the month. Third, a large share of farmers sells the same milk in the same day to both the coop and to traders.

We then present a stylized model to make sense of these facts. The model makes two key assumptions: farmers have a demand for deferred payments and traders cannot offer deferred payments⁴. Under these two assumptions, the model parsimoniously delivers all three motivating facts described above. In equilibrium farmers save by selling to the coop and obtain liquidity to meet daily consumption needs by selling to traders (and do not equalize the marginal returns from milk sold to the two types of buyers). The coop ‘charges’ farmers for saving services by paying a lower price for milk. The model also delivers a simple experimental test of the demand for deferred payments and additional testable predictions on the type of farmers that self-select into selling to the coop and on farmers’ response to changes in the paid by the coop - a key dimension of the coop’s sourcing strategy.

The empirical analysis closely follows the model. We begin by testing the first assumption: farmers have a demand for deferred payments. To isolate the benefits of deferred payments from other advantages the coop may have we design a first choice experiment. The cooperative offers farmers the option to switch to a daily payment system that mimics the one used by small traders. In addition, farmers are incentivized to switch with a 15% price increase. We show that the vast majority (85%) of farmers foregoes the price increase to stick with the monthly payment. Farmers have a substantial demand for deferred payments. The cooperative monthly payment satisfies this demand and contributes to the coop ability to source milk while paying a substantially lower price to farmers.

A second experimental design studies the underlying sources of farmers’ demand for deferred payments. We offer another sample of farmers the option to choose between retaining the current monthly payment scheme or switch to a flexible system in which farmers can chose every day whether to be paid in cash or at the end of the month. Again, a large

⁴In an extension of the model, we microfound the demand for deferred payments with time-inconsistent agents demanding commitment devices.
share of farmers, 93%, rejects the flexibility option.\footnote{The two shares are not comparable since in the second experiment farmers received a price increase regardless of their choice. Note the model required such a design in order for the flexibility option to be of any value to the farmers.} Farmers have a significant demand not just for deferred payments but, more precisely, for commitment. Additional survey evidence suggests that for a majority of farmers a demand for commitment arises from (sophisticated) time-inconsistent preferences while intra-household considerations play a role for a lesser, but still non-negligible, share of farmers.\footnote{Other inter-personal considerations (lack of trust in hired employees, pressure to share cash from (extended) family members, friends or neighbors) do not appear to play a role.}

We then provide direct evidence on the second assumption: traders cannot offer deferred payments. Survey data reveal that the overwhelming majority of farmers would not trust small traders to pay less frequently and express concerns that traders would run away with their money if they were to sell to them on credit. In contrast, we show that farmers discuss with each other about coop’s policies, thereby providing a rationale for the coop’s reputational advantage.

Finally, we turn to the additional model’s testable predictions. First, survey evidence confirms the sorting prediction that farmers who sell to the coop are more likely to set and reach saving goals. Second, we design two additional experiments to test the model’s predictions on farmers’ response to coop’s price increases.

A first intervention increases the price paid by the cooperative by a substantial amount, 30%. For the average farmer the price increase fully compensates for the price gap between the cooperative and the traders in the market. Since traders provide liquidity and buy at a higher price, the model predicts that such a large price increase has a very limited (in fact, ambiguous) impact on deliveries to the coop. Results confirm the prediction.

A second intervention adds to the substantial price increase a flexible payment option by which farmers can chose every day whether to be paid in cash or at the end of the month for that day deliveries. Since the intervention matches the price paid by traders and also provides liquidity to farmers the model predicts a stronger (and, in fact, large) response. We find evidence for a larger response, though the overall effect remains quite small. Based on evidence of time-inconsistent preferences, and building upon the literature on “soft-commitment”, we conjecture that the relatively small response to the second treatment could be due to a “rule of thumb”: sell to the coop in the morning to save, sell to traders in
the afternoon to get liquidity. Additional evidence from administrative data on deliveries to the coop lends support to the conjecture.

Related Literature

These results highlight that saving constraints can have profound implications for the way other markets are organized. In doing so, the paper is related to several strands of literature. First, it adds to the literature on market failures and institutions cited above and, in particular, to the literature on interlinked transactions. Bardhan (1980), Bardhan (1991) and Bell (1988) summarize this theoretical literature. More recently, Casaburi and Reed (2014), Casaburi and Willis (2015), Casaburi et al. (2014), Ghani and Reed (2014), Macchiavello and Morjaria (2014), and Macchiavello and Morjaria (2015), offer primarily empirical contributions. In particular, Casaburi and Willis (2015) find that bundling an agricultural insurance product within a contract farming scheme of a large firm in Kenya leads to significantly higher take-up rates. Although in a rather different set-up and with quite a different focus, their findings complements ours since insurance and saving markets both require small customers trusting larger service providers. Macchiavello and Morjaria (2014) provide evidence that competition reduces the use of interlinked transactions – including second payments – using coffee wet mills in Rwanda as a case study.

Second, although illustrated in the context of a dairy market, we believe the mechanisms highlighted in this paper are relevant to understand other important markets. For example, in the context of the labor market, Kaur et al. (2010) and Kaur et al. (2014) build on Clark (1994) and argue that modern factories reduce procrastination in effort provision. We argue that large factories ability to credibly promise regular monthly payments can also help to address self-control issues in spending habits. The literature on labor tying (see, e.g., Bardhan (1983), Mukherjee and Ray (1995)) explains the existence of segmented labor markets which shares similarities with the market we examine. The literature, however, has a distinctive advantage of focusing on the dairy market, however, is that milk is a highly homogenous good and, therefore, differences in terms of payment across buyers are unlikely to be driven by (unobserved) quality differences. In contrast, manufactured goods, services and - crucially - labor can be highly differentiated confounding the analysis.

focussed on workers' lack of access to credit/insurance markets and incentives to renege on implicit contracts. The mechanisms in this paper suggest that the ability of larger firms to offer deferred, regular, payments (e.g., in the form of access to lump sum credit or gifts) might be an additional determinant of labor tying.\footnote{A literature on taxi drivers' labor supply has highlighted how earning targets - possibly originating as a coping strategy against time-inconsistent preferences - induce anomalous responses to changes in returns. For instance, Dupas and Robinson (2014) provide evidence of use of heuristic as a source of soft-commitment among bicycle taxi drivers in Kenya.}

Third, our paper contributes to a growing body of evidence that studies the nature of saving constraints, the demand for and the impact of saving products in developing countries (see, e.g., Ashraf et al. (2006) and Dupas and Robinson (2013)). Karlan et al. (2014) provides an excellent summary of the literature. A substantial literature has documented a large demand for commitment products arising from time-inconsistent preferences and other behavioral biases (see, Bryan et al. (2010) for a review). The timing, frequency and mode of payments has been shown to be an effective saving tool in a variety of contexts (Bertrand et al. (2004)). Brune et al. (2014) and Brune and Kerwin (2014) provide experimental evidence in agricultural settings in low-income countries. Finally, a (mostly) theoretical literature explores competition and market structure when there are time inconsistent consumers/buyers - as opposed to producers/sellers (see, e.g., Vigna and Malmendier (2004), Heidhues and Köszegi (2010), Basu (2014)). Fischer and Ghatak (2010) and Basu (2011) explore theoretically the implications of time inconsistent preferences for microfinance borrowing and for the sustainability of Roscas respectively.

The rest of the paper proceeds as follow. Section 2 provides background information and descriptive evidence. Section 3 provides a simple model that guides the empirical analysis. Section 4 develops and then tests the hypothesis that farmers value the deferred payments offered by the coop and that this arises from a demand for commitment devices. Section 5 shows that reputation allows the cooperative to satisfy a demand for deferred payments but prevents other buyers from doing so. Section 6 explores the implications of these findings for farmers’ sale behavior and the coop’s competition strategy. Section 7 offers a few concluding remarks.

\footnote{Their review also remarks how the role of reputation in shaping constraints in saving markets remains an underexplored area. Dupas et al. (2014) report anecdotal evidence that low trust in banks limits usage of saving accounts in a sample of unbanked individuals in Western Kenya.}
2 Background and Motivating Facts

In this section, we briefly describe the study setting and the data sources. We then document three facts that motivate our hypothesis: (ii) relative to the coop, traders on average pay prices that are 25% higher and the gap is larger once accounting for transport costs; (ii) the coop pays once a month, while the traders pay more frequently, typically daily; (iii) coop deliveries are substantially smaller in the afternoon than in the morning, which we interpret as prima facie evidence that many farmers sell both to the coop (primarily, in the morning) and to traders (primarily, in the afternoon). This facts motivate our theoretical framework and the subsequent empirical analysis.

2.1 Background and Data Sources

The dairy industry is the largest agricultural sector in Kenya, contributing to approximately 14% of agricultural GDP and 3.5% of total GDP (Government of Kenya (2012)). Small-scale farmers, owning up to three cows, are responsible for about 80% of the production. Several studies have documented a gradual increase in productivity over the last decade (Wambugu et al. (2011)). The number of buyers in the industry has grown substantially since its liberalization, which occurred in 1992.

Our project takes places in Kiambu district, in Central Kenya. Two main types of buyers coexist in the region. The first is a large coop with around 2,000 members, one of the oldest in the industry. The cooperative purchases about 18,000 liters per day from their farmers, for a total of approximately $2.5M per year. The cooperative is also the main partner in this research. Second, there is a large number of buyers purchasing smaller quantities of milk. These are primarily small informal buyers, such as local restaurants and itinerant traders delivering milk to the nearby town and to Nairobi (about one hour away). The statute of the cooperative states that members should only sell to the cooperative. However, many of them do sell to other traders, too. While obtaining exact estimates of this sale split is obviously difficult, below we present detailed evidence of this diversion.

Farmers deliver milk to the coop at collection centers. The coop has 24 collection centers (routes) which are open at fixed hours every day in the morning and in the afternoon. A clerk manages each of these centers, which are equipped with digital scales, aluminum milk
containers, and log books. These collection centers span an area of approximately 400 square kilometers around the main town in which the coop headquarters and processing plant are located. Historically the coop has been the main buyer of milk in this locality. In recent years, however, daily intake has decreased, possibly due to increased competition.

This paper combines two sources of data: administrative data from the coop and original survey data. The administrative data include all deliveries of milk from since June 2013 until September 2014. The dataset includes each member’s identification number as well as the collection center at which milk was delivered. Each collection center serves a number of different villages, which are small groups of households living along secondary roads in the proximity of the collection center. There are approximately 120 villages.

The original survey consists of various samples of farmers. We conducted a baseline survey of coop members as follows. We drew a random sample from the 1,030 members regularly delivering milk to the coop in the morning but not in the afternoon (after removing farmers in the bottom and top delivery deciles). The final sample included surveyed 654 farmers. The survey had a success rate of 88%, for a total of 576 surveyed farmers. The survey contains modules covering a variety of aspects related to household characteristics and dairy farming, including dairy practices, access to and use of financial services, attitudes towards the coop and other buyers as well as a time preference module. The survey was designed paying particular attention to elicit information on different types of buyers, their relationships with farmers and the benefits farmers receive by selling to each type. We complement the main survey with a smaller module targeting a random sample of 100 farmers among the remaining coop members that regularly sell to the coop both in the morning and in the afternoon.

In addition, we conduct a listing exercise of dairy farmers in six randomly selected villages in the catchment area of the coop. The database includes 479 farmers and 413 who sell at least a portion of their milk. The listing includes information on the number of cows owned, on whether the farmers sell to the coop and on their saving goal behavior.

Table 1 presents basic farmer descriptive statistics from the main survey sample. The survey targeted the household member in charge of managing milk production. 56% of the respondents are men, with an average age of 54. In 58% of the cases, the household head

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12 The rationale for this choice was to reduce dispersion in outcomes and thus increase power for the experiments described in Section 6.4.
manages dairy production. The average respondent has 1.4 active cows producing milk at the
time of survey. A handful of farmers have 10 or more cows. Average production is 7.2 liters
in the morning and 4.7 in the afternoon. 26% of the households hire at least one worker on
dairy farming. Dairy farming is just one of several income generating activities undertaken
by farmers in this rural area. About 50% of respondents reports crop farmers as their main
other source of income. Self-employment, casual laborer, and artisanal activities account for
the majority of the other occupations.

While dairy farming might not be the main source of income for the farmers, it never-
theless plays an important economic role. This can be seen by farmers’ response regarding
their main motivation to engage in dairy farming. First, it allows farmers to diversify their
income sources: 36% of farmers report that dairy farming is a profitable activity. Second,
it provides farmers with regular and secure source of income: almost 40% of farmers report
that dairy is a meagre, but secure source of income. In the sample, only 28% of respondents
have a regular income from other occupations. Finally, as emphasized by studies in other
contexts (e.g., Anagol et al., 2014), 12% of farmers report that dairy farming provides a way
of saving.\footnote{Home consumption is, of course, another important motivation for milk production.}

\section{2.2 Motivating Facts}

In this section we document three facts that guide the theoretical model in the Section
and the subsequent empirical analysis. For this purpose, we draw from the main baseline
survey and the coop administrative data.

\textbf{Fact 1: Traders pay higher prices (both gross and net of transport costs).}

Figure \ref{fig:prices} plots the distribution of the prices offered by the best trader in each village
in June 2014, as reported by the farmer, while the vertical red line shows the coop price.
The evidence, consistent with all the focus groups run prior to the survey, is that traders
unambiguously pay higher prices than the coop. The difference is stark: the price paid
by the coop is approximately 7 Kenya Shillings lower than the average price paid by the
traders. This corresponds to a 25\% price gap. In fact, as illustrated by the graph, the price
paid by the coop is essentially equal to the lowest price reported by farmers in the sample.
Unsurprisingly, almost 90% of farmers report traders pay better prices than the coop.\textsuperscript{14}

One potential explanation for these different prices could be differences in access to and/or transport costs between the traders and the coop. If the cooperative collection centers are open more often or regularly and/or more conveniently located, farmers might be willing to sacrifice higher prices paid by traders to incur lower transport costs. This hypothesis, however, is strongly rejected by the data. Around 82% of the farmers report the presence of at least another buyer in their village. On the extensive margin, almost 90% of farmers report that traders are available to purchase milk every day of the week.\textsuperscript{15}

Conditional on availability of traders, it could be the case that farmers incur higher transport costs when selling to the traders. However, this is also inconsistent with the data. The coop purchases milk at specific collection points while traders scout the villages for milk and are often reported to purchase milk at the farm gate. As a result, traders tend to be more conveniently located than the coop. Figure 2 plots the kernel density of the distance between the farmers and the two types of buyers: traders and the coop. The left panel measures distance in kilometers while the right panel uses the time it takes to walk to the buying point as a measure of distance. In both cases, traders buy nearer to the farmers. For example, approximately 54% of farmers report that it takes five or less minutes to bring their milk to the trader. The corresponding figure is less than 8% for the coop. We can assign an upper bound to the monetary value of the extra time it takes to bring milk to the coop using wages paid to casual workers in dairy farming. The median employed agricultural worker in our sample earns 4,250 Ksh per month. Workers are reported to be working six or seven days a week. Assuming 26 days of work per month leads a daily wage of around Ksh 160. At an average of 8 hours a day, the hourly wage equals 20 Ksh. With a median difference in

\textsuperscript{14}Focus groups revealed that farmers might be rather uncomfortable discussing their relationships with specific traders and, consequently, it was not possible to ask detailed questions about farmers’ relationships with specific traders. Farmers were asked to mention traders they were aware of that were active in their village, regardless of whether they sold to them or not. We asked farmers about the highest price paid by these traders. Asking about the highest price provides a more accurate description of a farmer’s outside option but might somewhat overstate the difference in prices between the traders and the coop. This bias is unlikely to qualitatively alter the significance of the descriptive figure: the price paid by the coop sits in the very left tail of the reported traders’ price distribution. Focusing on the highest price paid by traders in the village also allows for a much more accurate benchmarking of the incentive interventions in Section 6.

\textsuperscript{15}Since farmers may be reluctant to provide information on traders, these figures likely underestimate access to traders. Indeed, when indirectly asked to compare the coop with other buyers, a much higher proportion of farmers has an opinion about traders’ relative advantages and disadvantages.
distance between the coop and the trader of 15 minute walk one way and an average delivery of 3 liters, the difference in transport costs is about 3.5 Ksh per liter. This brings the average effective price gap between the cooperative and the traders to around 10 Ksh.\textsuperscript{10}

**Fact 2:** *Traders pay more frequently than the coop.*

The second motivating fact concerns the difference between the coop and the traders in the frequency of payments to the farmers. The cooperative pays farmers at once for the deliveries of any given month, typically in the first week of the subsequent month. In the baseline, we asked farmers how often traders in the village would pay. Figure 3 reports the share of traders that pay daily or weekly for the milk, as reported by the farmers. For the vast majority of the respondents, all traders pay more frequently than monthly (and, indeed, daily).

**Fact 3:** *In any given day, many farmers deliver milk to both traders and the coop.*

The third motivating fact concerns the patterns of deliveries to the cooperative. Milk is produced twice a day: in the morning and in the afternoon. Production in the morning is larger than in the afternoon. According to conversations with cooperative extension workers (later confirm with survey data), afternoon production is around two-thirds of morning one. Since farmers lack refrigerators, milk must be sold twice a day. Figure 4 shows that the aggregate volume of daily milk deliveries to the cooperative in 2014. Afternoon deliveries are about one third of the morning deliveries (13-15 thousands kilograms in the morning vs. 4-6 thousands in the afternoon), therefore much lower than implied by production. Figure 5 shows that an important margin for lower afternoon deliveries comes from the number of members delivering milk in the two parts of the day. The figure shows the distribution of the number of days with deliveries across members in May 2014 (conditional on more than 10 deliveries). Among these farmers, 80% sell to the coop in the morning at least 29 days. On the other hand, the afternoon distribution is quite bimodal: 45% of the members never delivered milk in the afternoon while 27% delivered at least 29 days. There is very little mass

\textsuperscript{10}Other possible confounding factors are unlikely to be a concern. Data from earlier months of 2014 show similar patterns and rule out substantial seasonality in price differences. Quality differentiation plays essentially no role in the market (with the coop being, if anything, more stringent than informal traders on quality requirements). Finally, the cooperative does not make second payments at the end of the year.
at intermediate values. To summarize, about half of the active members do not sell any milk to the coop in the afternoon. We interpret this as prima facie evidence that many farmers sell to other buyers in the afternoon. We use survey data to further document this pattern in Section 6.

In sum, the comparison between the traders and the coop reveals a striking pattern. When selling to traders, farmers receive a higher price, face lower transport costs, and are paid more frequently. Yet, many farmers who in any given day sell to traders, also sell to the coop. The rest of the paper explores a possible determinant of this behaviour. In the next section we lay out a simple theoretical model that posits farmers have a demand for deferred (i.e., monthly) payments. The theory then guides the empirical analysis in the rest of the paper.

3 Conceptual Framework

This section presents a heuristic model of the dairy market studied in the empirical analysis. Two key “reduced form” assumptions drive the results: A1) farmers have a demand for deferred payments; A2) traders cannot offer deferred payments. Under these two key assumptions, the model parsimoniously delivers all three motivating facts described in Section 2.2.

First, the model provides guidance on how to directly test the two key assumptions. It derives a simple experimental test of assumption A1 based on how farmers respond when the coop offers to switch to daily payments with higher prices. The prediction that farmers turn down this offer differentiates this model from alternative frameworks in which farmers value selling to the coop for reasons that are unrelated to the deferred payment. The baseline model derives a demand for deferred payments by assuming farmers lack access to a saving technology. Appendix B extends the model to allow access to a saving technology and (sophisticated) time-inconsistent farmers. The extension provides a microfoundation for assumption A1) and is also directly tested with an experimental design in the empirical analysis. The model also focuses survey questions on farmers’ trust towards traders to directly test assumption A2).
Second the model delivers additional testable predictions. First, the model yields implications on the type of farmers that self-select into selling to the coop. Correlation patterns in the survey data support these predictions. Second, the model can be used to predict farmers’ response to the price paid by the coop - a key aspect of the coop sourcing strategy. These additional predictions are tested (and broadly confirmed) with additional experimental designs.

3.1 Setup

Consider a continuum of mass one of heterogenous farmers (indexed by $i$), an infinite supply of small traders and a large buyer (the coop). Time is represented by three dates: $t = 1, 2, 3$. There is a common discount factor $\delta < 1$ across dates. The farmer derives utility $u(c)$ from consumption of a perfectly divisible good $c$ (whose price is normalized to one) in periods $t = 1, 2$. The utility function $u(\cdot)$ satisfies the usual properties, $u'(\cdot) > 0$, $u''(\cdot) < 0$, $u(0) = 0$ and $u'(0) = \infty$, and for simplicity only is assumed to be given by $u(c) = \frac{c^{\alpha} - 1}{\alpha}$, with $\alpha \in (0, 1)$.

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. The indivisible good costs $D$, and gives additional utility $\Delta_i$ to farmer $i$. The value of the indivisible good $\Delta_i$ is distributed according to a continuously differentiable cumulative function $F(\Delta)$ over the support $\Delta \in [\Delta, \infty)$. To avoid a taxonomy of cases, let us assume that the durable is desired by all farmers (i.e., a farmer with $\Delta_i = \Delta$ and access to a saving technology yielding returns $1/\delta$ would buy the durable).

At dates $t = 1, 2$ farmers are endowed with $Q$ units of non-storable milk. Selling milk is a farmer’s sole source of income. Traders and the cooperative maximize profits by buying milk from farmers and selling it to consumers at (exogenous) price $v$. There are no intermediation costs. There is free entry of traders who compete à la Bertrand taking the price set by the cooperative as given. The cooperative cannot price discriminate across farmers and sets a price $p$ for deliveries at $t = 1, 2$ and decides whether to pay in each period or at $t = 3$. We make two key assumptions:

Assumptions
A1. Farmers have a demand for deferred payments.

A2. Traders cannot offer deferred payments.

Assumption A1 implicitly states that farmers lack access to a (sufficiently good) saving technology. Thus, deferred payments are the only tool to purchase the indivisible good at date \( t = 3 \). Lack of alternative saving devices could be due to either institutional constraints (e.g., bank branches are too far away), agency problems on the use of cash (e.g., fear of theft by neighbors, hired workers), or to lack of commitment in spending habits (e.g., due to pressure from family members, disagreement with spouse, or time-inconsistent preferences). Appendix B provides a microfoundation for Assumption A1 based on (sophisticated) time-inconsistent farmers. The extension, which is motivated by evidence further discussed below, shows that despite having access to a saving technology paying interest rate equal to \( 1/\delta \), farmers whose time inconsistency is above a certain threshold save only through the coop. In other words, time inconsistent preferences can provide a micro-foundation for assumption A1 in our environment.

Assumption A2 introduces an asymmetry in the contracts available to the traders and the cooperative. The cooperative can credibly promise to pay at \( t = 3 \) for deliveries at \( t = 1, 2 \), while traders cannot (i.e., they must pay at time \( t \) for deliveries in that period). This is a reduced form assumption for a world in which small, mostly itinerant, traders lack the ability to commit to future payments: upon defaulting on the payments due to a farmer, the trader can at no cost go to a different village and continue buying there unpunished. As a result of this, farmers do not trust traders and are unwilling to sell on credit to them. In the empirical section we provide direct evidence supporting this assumption using survey data.

\[ ^{17} \text{We assume that the cooperative pays interest rate } 1/\delta \text{ to farmers. Although this is not true in practice, the assumption is made to clarify that the cooperative's decision to pay at } t = 1 \text{ is not the result of the cooperative and the farmers having different time preferences. All the results carry through holding constant the cooperative nominal prices across periods (as is the case in practice).} \]

\[ ^{18} \text{Several other assumptions can be relaxed without affecting the results. For instance: a) farmers could have additional sources of income; b) there could be more than one firm offering deferred payments (provided they do not compete à la Bertrand, which would be inconsistent with lack of contract enforcement); c) in the baseline model farmers do not have a demand for credit and, therefore, we abstract from a credit market altogether. This last assumption can also be relaxed.} \]
3.2 Equilibrium and the Motivating Facts

For clarity, let us briefly consider the problem of the coop. If the coop decides to offer cash payments, free entry of traders and competition à la Bertrand drive the coop profit to zero. If, instead, the coop decides to offer deferred payments, the cooperative sets price $p$ to solve

$$
\max_p \sum_{t=1}^{2} \delta^{t-1} \left( \int_{\Delta} ((v - p) \times x_t(p, \Delta)) dF(\Delta) \right)
$$

(1)

where $x_t(p, \Delta) \geq 0$ denotes the quantity delivered to the coop at time $t$ by a farmer that values the indivisible good $\Delta$ when the coop pays a price $p$. Denote with $p^e$ the equilibrium price chosen by the cooperative. The equilibrium is described by the following proposition:

**Proposition 1:** In equilibrium:

P1.1 The cooperative pays a price strictly lower than traders, i.e., $p^e < v$.

P1.2 The cooperative always uses deferred payments.

P1.3 Farmers who sell to the cooperative also sell to traders in both periods.

The model, therefore, rationalizes all three motivating facts presented in the previous section as the logical consequence of the two core assumptions. We briefly discuss the intuition for these results. All the proofs are presented in Appendix A. The cooperative always exploits its advantage in satisfying farmers’ demand for deferred payments and pays a lower price than the one prevailing the market (P1.1 and P1.2). In equilibrium, farmers sell to the traders to satisfy their liquidity needs, and sell to the cooperative to accumulate the funds necessary to purchase the indivisible good (P1.3).

In addition, the model generates a prediction on which farmers self-select into selling to the coop:

**Proposition 1 (Continued):**

P1.4 Farmers selling to the cooperative are more likely to report setting saving targets.
Given the lower price paid by the coop, \( p^c < v \), accumulating the funds necessary to buy the indivisible good is costly and those farmers with relatively low \( \Delta \) might give up and simply sell to traders. Farmers with a higher \( \Delta \) (or higher \( \Delta/Q, \Delta/D \)) instead will set a saving target for themselves.\(^{19}\)

### 3.3 Direct Test of Assumption A1

In the model, the demand for deferred payments drives the gap in equilibrium prices. In practice, however, there might be many reasons why farmers might sell to the coop despite lower prices (e.g., sense of loyalty or affiliation with the cooperative, eligibility for other services, etc.). Empirically, it is therefore important to directly test for the validity of the two key assumptions A1 and A2. The next proposition delivers an experimental test to check whether the assumption of a demand for deferred payments is borne out in the data.

**Proposition 2:** All farmers who sell to the cooperative reject contract offers with daily payments and higher prices \( p' \), for all \( p' \in (p^c, v] \).

The proposition clarifies that if farmers have a demand for deferred payments they should be willing to give up even substantial price increases from the cooperatives in order to retain the ability to be paid at the end of the month. In the empirical Section we implement this test. This prediction differs starkly from alternative models where farmers value selling to the coop for other reasons and *in spite of* the fact the coop pays later. In these cases, farmers should always take-up the daily payment at a higher price (and, for farmer positive discount rates, at lower prices as well).

The second key assumption, A2, is harder to test experimentally as it would require collaborating with small informal traders. While an experimental approach is thus not feasible, we later present direct survey evidence that provides strong support for the assumption. Notice, however, that if assumption A2) is correct, a symmetric design in which traders offer farmers deferred payments would have not been a valid test for A1) since farmers would have

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\(^{19}\)The baseline framework does not feature farmers that sell only to the coop (while such farmers exist in the data, see Figure 3). A simple extension in which (some) farmers have access to alternative sources of income easily accommodates this feature and generates additional testable predictions.
turned down the offer because of lack of trust in the traders, regardless of whether they do have a demand for deferred payments or not.

### 3.4 Price Competition Strategies

Finally, the model can be used to generate additional testable implications. We focus on farmers’ deliveries to the coop in response to changes in coop’s price and mode of payments: two key dimensions of the coop’s sourcing strategy. In the equilibrium of the model, we show that even large changes in prices may be ineffective in increasing deliveries. The results are summarized by the following Proposition:

**Proposition 3:** *Consider a temporary (for \( t = 1 \)) large increase in the price paid by the coop from \( p^e \) to \( v \).*

**P3.1** The impact on deliveries to the cooperative at \( t = 1 \) is ambiguous.

**P3.2** If the option to be paid in cash is added to the price increase, deliveries at \( t = 1 \) increase by a larger amount (and equal production levels).

We provide a brief discussion of this results. Deliveries might increase or decrease. This happens because an increase in price paid for deliveries at \( t = 0 \) has two effects: a positive price effect (deliveries to the coop now are more valuable than deliveries later) and a negative income effect (the farmer can achieve the same desired saving with lower deliveries) (\( P3.1 \)).

Finally, if on top of the large price increase, farmers are also given the option to be paid in cash, they will simply switch all the deliveries to the cooperative and the standard price effects necessarily dominates (\( P3.2 \)). Note, however, that this effect only occurs if indeed the new price is above the price paid by the traders so that the liquidity option is valuable.

That is, while (\( P3.1 \)) also holds for a marginal temporary increase in the price paid by the cooperative, (\( P3.2 \)) does not.

In the empirical Section we test Proposition 3 through two experimental designs. As predicted, the empirical evidence confirms a stronger response in the treatment corresponding to

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\[20\] Moreover, note future deliveries decrease since the need to sell to the cooperative to achieve the target is reduced.
to \((P3.2)\) relative to the treatment implementing \((P3.1)\). The model, however, predicts a large response in \((P3.2)\) which we fail to detect in the empirical analysis. We postpone a discussion for this discrepancy to the empirical section.

To summarize, in this simple framework, we introduce two core assumptions and rationalize the motivating facts, we derive an experimental test for one of the two core assumptions as well as additional predictions on the impact of price changes on deliveries. In turn, these results guide the empirical analysis in the following sections.

4 Demand for Deferred Payments

This section explores the first hypothesis of our analysis: *farmers have demand for deferred payments*. We illustrate the results of a choice experiment with a random sample of members, which builds on Proposition 2 in Section 3. The experiment aims at identifying in a clean way the role played by the coop in satisfying members’ demand for deferred payments. A second choice experiment documents that this demand arises from a demand for commitment devices, consistent with the extended model presented in Appendix B. Finally, we discuss additional baseline survey evidence illustrating the role of the cooperative in helping farmers to reach their saving goals.

4.1 Demand for Deferred Payments

As mentioned in Section 3, there are certainly other reasons that might allow the cooperative to purchase milk from farmers at a significantly lower price. For instance, the cooperative is committed to purchase all the milk that the farmers deliver to its collection centers. This provides value, particularly in the rainy season, when the market has to absorb a higher supply of milk. Indeed, 75% of farmers report that the coop is better at ensuring demand during the rainy season. The cooperative also provides additional inputs and services. The collection centers, for instance, also sell dairy inputs, such as feed and supplements. Since farmers bring milk to the collection center, this might reduce procurement costs of buying
those inputs. More than 90% of farmers reports that traders do not offer any additional service and that the coop is better than the traders along these dimensions. Farmers may also derive a sense of pride in selling to the organization of which they are members. Indeed, around 75% of the respondents report they get pride in being a member and selling milk to the cooperative.

To assess the extent to which deferred payments are an important determinant of farmers’ willingness to sell to the coop, we would want to manipulate the timing of payments to farmers while holding constant the type of buyer and the other services (or lack of) provided. We implement such a test by offering farmers the possibility of switching to more frequent payments while retaining all others benefits they derive from selling to the coop. We offered to a representative sample of 102 farmers the option to be paid in cash on a daily basis for a month for deliveries to the coop. The offered payment method perfectly mimics the one used by traders. Farmers deciding to switch would be paid at the collection center, in cash, upon delivery. In addition to the standard price, farmers were offered 5 additional Kenyan Shilling per liter delivered if selected the daily payment option. The additional price associated with daily deliveries substantially reduces the gap between the average price paid by traders in the market and the price paid by the coop. In doing so, the choice experiment quantifies the share of farmers willing to forgive a large increase in price (16%) in order to retain the deferred payments on a monthly basis.

The experiment was completed for 96 of the 102 targeted members (94.1%). The first bar in Figure 6 summarizes the results. We find that only 14% of the farmers accept to switch to the daily payment option. A large majority of farmers (86%) is willing to forgive a very substantial increase in price in order to retain the monthly payment option. The evidence, therefore, is consistent with farmers having a high demand for deferred payments from the coop.

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21 The inputs sold by the coop are neither better or cheaper than those sold in the market. The coop also allows farmers to apply for small input loans. These, however, are based on amount milk already sold to the coop and quite highly priced. They are not used much.

22 As it will become clear below, the symmetric design in which traders offer farmers to be paid less frequently would have likely generated misleading results.

23 In practice, the farmer was told that the cooperative was piloting new payment systems. For the piloting phase, the farmer was offered the option to enter a lottery that would determine actual daily payments for the following month.
4.2 Demand for Commitment

So far, we have remained agnostic about what drives farmers’ willingness to pay a substantial price premium to receive payments for milk deliveries all at once, at the end of the month. While specifying the determinants of the demand for deferred payments is not necessary to understand the resulting market structure, understanding the effects of policy changes, including cooperative sourcing strategies, requires a fuller picture of the sources of the demand for deferred payments.

In the choice experiment described above, a large majority of farmers forego this substantial price increase to retain the monthly payment. When asked to state the main reasons for their choices, the vast majority of farmers reported as main reasons that they try to achieve saving targets (47%), that they do not trust themselves to handle the cash properly and is afraid of not saving enough (26%) and that the spouse wants to receive money on the coop account at the end of the month (14%). Interestingly, lack of trust in workers delivering milk, lack of proper saving technology and pressure to share income with network of family members, friends and neighbors were almost never cited as reason for sticking with the monthly payment.

We assess the relevance of time inconsistent preferences in generating a demand for deferred payment using an additional experiment, which targeted another random sample of 100 active members (and reached 95 of these). Farmers were offered the opportunity to choose every day whether they wanted to be paid in cash or at the end of the month for their deliveries. Farmers had to decide whether to accept this flexibility option or stay with the monthly payment option.24 If the farmer accepted the flexibility option, an operator would then call the farmer on a daily basis to ask their preferred payment mode for the day. The choice was offered to the respondent as follows. First, the farmer was contacted by phone to set up a meeting. The option was then explained to the farmer through a one-to-one meeting. Importantly, the farmer retains control everyday on whether to exercise the option to be paid daily or not.

A farmer whose only source of demand for deferred payment is lack of access to an adequate saving technology should always opt for the flexible payment scheme. The flexible

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24Regardless of the option chosen, farmers received an extra of Ksh 5 per liter of milk delivered for that month.
scheme can always replicate the cash flow profile of the monthly payment (the farmer simply has to never exercise the option to be paid in cash) and is strictly better if there are liquidity shocks. A farmer whose demand for deferred payment arises from a demand for commitment, instead, will demand to retain the monthly payment. The second bar in Figure 6 summarizes the results. An extremely high share of farmers, 93%, turns down the flexibility option. This is even higher than the share of those turning down the daily payment option (86%). We highlight that the results are not directly comparable since the relative price increase to incentivize switching was offered only in the first experiment.

The results of this second choice experiment show that farmers have a strong demand for commitment devices. This is consistent with a large body of literature (Ashraf, Karlan, and Yin, 2006; Bryan, Karlan and Nelson, 2010) and with further descriptive evidence presented below. Farmers’ responses when asked about the motivations for sticking to the monthly payment when offered the flexible arrangement are similar to the ones for the first choice experiment. Approximately 42% of those choosing the monthly option state that the main reason for doing so is that they want to reach a specific saving target they have in mind. Another 36% states that they don’t trust themselves to handle cash properly. Consistent with the design, the share reporting this as the main reason for their choice is higher in the second choice experiment than in the first one. Finally, 17% of the farmers mentions that the spouse wants to receive the money at the end of the month on the cooperative account. To summarize, time inconsistency (and sophistication) and, to a lesser extent, intra-household allocation concerns are likely candidates in inducing the large demand for commitment unveiled in the second choice experiment.

4.3 Survey Evidence

We complement the results from the two choice experiments presented above with evidence from the farmer baseline survey.

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Footnote: It is in principle possible that farmers dislike the flexibility option because they want to avoid a daily “cost of thinking” (see, e.g., [Dekel et al. 2001], [Ergin and Sarver 2010], [Ortoleva 2013]). However, if this were the only motivation driving our results, as opposed to a demand for deferred payment as commitment device, we should see farmers choosing the daily payment over the monthly option in the choice experiment presented in Section 4.1.
4.3.1 Coop Payments and Saving Goals

The baseline survey provides insights into farmers’ attitudes with regards to savings as well as the role the coop’s deferred payment plays in helping farmers reach their saving goals. Figure 7 summarizes this evidence. First, 82% of the farmers state that they set saving goals, and 87% of these state they reach these goals most of the times. Second, farmers perceive the coop as an important device to meet these goals. 71% of the farmers who state they set saving goals say that the coop’s deferred payments help reaching these goals. In addition, 79% say that they would reach these goals less often if the coop paid weekly (instead of monthly). Moreover, while 77% of farmers report that traders immediate payments provides them with the liquidity they need for daily purchases, 95% of farmers report that coop’s non-frequent payments allows them to save. To summarize, the survey evidence indicates that the monthly payment offers an additional service to the farmers. The coop in fact establishes an interlinkage between product and saving markets, a form not yet emphasized by the existing literature.

4.3.2 Demand for Commitment

The second choice experiment suggests that the demand for deferred payment could arise from sophisticated time-inconsistent farmers. Farmers might not trust themselves to handle cash properly and the deferred payment from the coop provides the necessary commitment. A large literature argues that, in the presence of time inconsistent preferences, simple heuristic might help decision makers resisting temptations and provide soft-commitment. In our environment, a simple heuristic would require farmers to sell to the coop to save and to traders for daily cash.

\[26\] Simple heuristics impose costs on decision makers. In particular, we would expect the farmer to be over saving in the morning relative to the afternoon implying a different willingness to trade-off future prices for immediate payment between the two times of the day. We designed an additional framed (and incentivized) choice experiment to elicit farmers’ willingness to trade-off deferred payment for cash in selling milk and randomly assigned farmers to be interviewed in the morning or in the afternoon to test for different discount rates across the two times of the day. Results show no difference between the two. The results confirm farmers are willing to forego a substantial premium to shift money at the end of the month. Few more than 10% of farmers accepted a price lower or equal than the coop baseline price. This figure is quantitatively consistent with the results from the first choice experiment. The majority of farmers required at least 35 Ksh. (31%) or 41 Ksh. (37%) to switch. However, we fail to detect any significant difference between answers elicited in the morning and in the afternoon.
The picture emerging from the choice experiment is corroborated by further evidence from the baseline survey. Table 3 documents correlations between several baseline variables with farmer saving behavior and demand for the coop deferred payments. Column (1) focuses on the likelihood that farmers set saving goals. This is higher for farmers who earn regular income from another occupation and for those who report saving in a bank. The most striking result is that present biasedness is positively correlated with this outcome, suggesting a certain degree of sophistication in our population. Column (2) also shows that farmers who report saving in a bank are more likely to reach these goals. We then turn to the relation between the coop and the saving goal outcomes. Focusing on column (3), we note that having another regular occupation reduces the likelihood that the farmer reports the coop helps reaching the saving goals. When looking at those farmers who claim they would reach the goals less frequently if the coop made weekly payments, a pattern of several interesting correlations emerges. First, larger milk producers, as measured by the number of cows, claim they would be less affected by this change. Second, regular income from another occupation lowers again the mean outcome. Third, the impact of the payment frequency on achieving the saving goals is particularly large for present biased farmers, consistent again with a degree of sophistication.

4.3.3 Other Sources of Demand for Deferred Payments

Finally, we consider other potential sources of the strong demand for deferred payments. First, perfectly rational farmers might have recurrent bulky expenditures, such as repayment of a loan or purchases of feed and other inputs, for which they set saving goals (Fafchamps et al. 2014). A farmer who does not have access to a cheap and/or secure saving technology saves on transaction costs by having the timing of her income profile matching the required disbursements. As described above, this hypothesis could be relevant since many farmers report to use the income from the cooperative for saving purposes and bulky purchases. On the other hand, a vast majority of farmers has access to bank accounts. Approximately 70%

\[^{27}\text{In the data, a farmer is defined as present biased in he is more impatient when splitting money between today and next week than when splitting money between next week and the subsequent one.}\]

\[^{28}\text{The sample in columns (2)-(4) is restricted to those respondents who say they do set saving goals.}\]

\[^{29}\text{The correlations among the four outcome variables presented in Table 3 are fairly low, spanning between -0.02 and 0.47, with an average of 0.10.}\]
of our respondents participate in saving groups (Chama) and/or an account with a bank on which they make an average of three deposits per month. Essentially all farmers are paid by the coop through direct deposit transfers on a bank account. This might increase saving balance if the direct deposits reduce deposit transactions costs more than withdraw costs. This would suggest that farmers have the ability to save if needed. Lack of access to alternative saving tools is unlikely to cause the demand for deferred payments from the coop.

Second, a demand for deferred payment could arise from agency problems within the dairy farm. In several cases, the owner of the cows is not the same person who operates the dairy business on a daily basis, the worker. For example, milking and feeding the cows, delivering milk to buyers and to the coop collection center, are examples of daily activities that are not necessarily performed by the owner of the cows. In an environment with low trust, the owner might prefer to be paid on an account and avoid the transaction costs associated with monitoring and providing incentives to the workers for honest behavior. Note that the owner and the worker can be related in very different ways. For instance, approximately 25% of the farmers in the sample report to hire additional labor to take care of the cows and deliver milk. In more than 90% of cases these workers are not part of the (extended) family or network of friends and neighbors of the farmers. In many other cases, approximately 40%, the owner and the workers are spouses: the husband typically owns the cows while the wife takes care of the day to day management. When this is the case, the wife might remain in charge of the cash money used for daily expenses while the husband expects to receive income at the end of the month to cover recurring input expenses for the business.

To summarize, both the choice experiment results and the evidence from the baseline are consistent with the hypothesis that the farmers value the coop’s deferred payments as it provides an effective tools for savings. In addition, the demand for the coop deferred milk payments comes from a demand for commitment devices.

\[^{30}\text{Blumenstock et al. (2014) provide evidence that direct deposits increase saving levels.}\]

\[^{31}\text{Requests of financial help from (extended) family members, friends and neighbors could also generate a demand for deferred, illiquid, payments (see, e.g., Anderson and Baland (2002)). These concerns, however, do not appear to be hugely important in our context. Approximately 30% of farmers had been approached by others for financial help within the three months preceding the survey. Of these requests, about 50% came from friends and neighbors. The timing of these requests for help is not correlated with the timing of payment of the coop.}\]
5 Deferred Payment and Buyer Reputation

This section shed lights on the heterogeneity across buyers in their ability to credibly offer deferred payments. We first document the large gap in reputation between the coop and the traders. Second, we argue that, while a formal financial sector is active in our study setting, transaction costs and lack of commitment saving accounts prevent traders from using the banks to mimic the deferred payments provided by the coop.

5.1 Why cannot traders provide deferred payment?

The evidence provided so far suggests that the deferred payments associated with the coop’s monthly payments are of substantial value to the farmers. Other traders do not provide these deferred payments in the current market equilibrium. As documented in Figure 3 essentially all traders (93%) pay more frequently than monthly. In fact, most traders pay daily. Why, then, don’t traders also provide deferred payments to farmers? The question is even more puzzling if one considers that small traders are likely to be liquidity constrained and would, therefore, presumably benefit from delaying payments to the farmers.\footnote{Similarly, it is possible that the coop’s prefers for trade credit contributes to the current equilibrium with monthly payments. However, farmers’ demand for deferred payments, documented in the previous section, differentiates this setting from a standard trade credit arrangement that arises only from the buyer’s demand for credit.}

We argue that, in the absence of enforceable contracts, a buyer’s reputation influences the extent to which she can credibly promise deferred payments. The survey modules were designed to provide direct evidence on these ingredients. Figure 8 documents them. First, traders in the market are small: 92% of the farmers report that none of the traders that purchased milk in their village is an agent (or buys on behalf) of another larger buyer. Traders are mostly small itinerant buyers who sell milk to either restaurants or bars in the local area or bring milk to Nairobi. Second, farmers do not want the traders to provide less frequent payments. We ask farmers whether they would feel comfortable with traders paying less often than they currently do. Only 18% of the farmers would like traders to pay less often. Moreover, when asked about the main reason for their preference with regard to trader payment frequency, 56% of the respondents (and 68% of those who said they did not want traders to pay less frequently) state that they are worried traders would default on the
contract ("escape") if left with holding too much money from the farmers. Finally, 53% of
the respondents were aware of some instances in which the traders flew with farmer money
in their village over the past two years. This is consistent with some traders paying weekly
or possibly holding farmers’ money for longer periods in specific cases.

These fairly negative perceptions of traders are reflected in direct comparisons with the
coop. Farmers trust much less traders than (members of) the coop. We asked farmers
several standard trust questions (based on the trust modules in the World Value Survey).
The respondent was asked to state how much she trusts members of various groups on a scale
between 1 (not at all) and 4 (completely). Trust in other coop members or in members of
the coop’s board averages at 2.4. In contrast, trust in traders averages at 1.6, significantly
lower. In total, 55% of the respondents reply that the cooperative is more trustworthy than
the traders (93% that is at least as trustworthy) and 80% report that it is more reliable in
payments than the traders.

The same reasons that induce farmers to demand deferred payments may prevent traders
from credibly offering them. They may face time inconsistency and thus be unable to save
the amount paid daily by the farmer if they cannot access appropriate commitment devices.
In addition, traders may particularly dislike making bulky payments instead of small daily
ones.\footnote{Similarly, the farmer’s temptation of strategic default may explain why the coop provides bulky payments
at the end of the month, as opposed to providing loans to the farmers worth the amount of the milk they
are expected to sell in the subsequent month.} On the other hand, the coop as an institution may not face the same challenges
arising from time inconsistency that the traders face. For instance, the coop internal financial
systems help ensure the timely disbursement of monthly payments to the farmers.

Finally, we hypothesize that in our context, buyer’s size is one of the factors driving
the reputational competitive advantage of the coop. To the extent that market participants
share information on (and possibly coordinate punishments against) defaulting players, a
larger player who interacts with more players has more to lose when defaulting against a
given subset of players and is, therefore, more credible.\footnote{This observation has been made in a variety of theoretical frameworks

First, as explained above, traders are “small” they cannot enjoy the economies of scale
associated with reputation. In particular, imagine a farmer were to replicate the same pay-
ment profile she has with the coop with a small trader. The farmer would deliver milk to the
trader every day and wait to be paid all at once at the end of the month. By the end of the month, the amount owned by the trader to the farmer would be substantial, at least relative to the business size of the trader. What would be the cost of the trader to renege on the loan? Presumably, quite little, unless most potential farmers the trader could source from share information about the default. The fact that traders are mobile and there are many small farmers, suggests that, although farmers might share information about defaulting traders, the ability to punish is limited. When a trader defaults on a farmer, she can easily find an alternative farmer that is not aware of this default. Consistent with this observation, when asking about names of traders operating in a village we find relatively little concordance across respondents. This suggests relatively little community enforcement available to coordinate punishment against defaulting traders.

Second, the coop is “large”. By this, we mean that enough farmers would share information and punish the coop if the coop were to renege on payments to some farmers. As a result, the gains from the coop’s perspective of defaulting on the payments to one farmer are likely to be smaller than the costs of not being able to source from enough farmers in, say, the village or collection center. The fact that transactions with the coop happen at a fixed collection center probably also helps community monitoring of the coop. The economies of scale implied by reputational forces suggest that there are substantial barriers to enter the market with a scale that allows competing with the coop.

The survey provides some direct evidence supporting the idea that the coop’s higher credibility stems from community enforcement. We have asked respondents about their social networks inside the village. In particular, we have focused on whether they know other members, whether they talk to them about dairy practices and/or about the cooperative policies and pricing schemes. Although the average amount of interactions appears to be relatively low, the average respondent reports to discuss issues related to coop pricing policies and management with 2.3 other members from the village. This is significantly higher than members’ interaction about dairy practices, which averages at 1.16.

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

5.2 Can traders buy reputation?

The cooperative is not the only institution providing saving in the area in which the study is conducted. Approximately 70% of our respondents participate in saving groups (Chama) and/or have an account with a bank on which they make an average of three deposits per month. Indeed, for most farmers, the coop payment occurs via a transfer to a bank account. The trust farmers have in the coop allows them to receive deferred payments, i.e., deposit, at extremely low transaction costs. Traders could potentially solve the reputation problem by transferring farmers’ daily payment to an account. Why doesn’t this happen?

Without trust, the traders and the farmers would have to incur substantial transaction costs to replicate the deferred payments achieved by the coop even if trustworthy banks were available. Farmers would have to be able to verify traders’ payments on a frequent basis, since they wouldn’t trust the trader to make the transfer. Traders would have to incur transaction costs too. Besides the fact that banks might not be offering appropriate commitment accounts, high transaction costs incurred by traders to transfer money to the bank and by farmers to verify the daily transfers prevent small traders from offering credible deferred payments.

In addition, since farmers’ demand for deferred payments arises (also) from a demand for commitment, the account on which the trader would deposits the money should have additional features that allow the farmer to commit. Otherwise, farmers might withdraw money as soon as it becomes available and thus fail to reach their saving goals. To the best of our knowledge, local banks do not offer accounts featuring these commitment options.

To summarize, the evidence presented in this section points at a substantial demand for

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Casaburi and Macchiavello (2015) study the impact of this policy on coop deliveries.
deferred payments among the survey population. Payment frequency becomes an important tool of non-price competition. Relative to traditional, itinerant buyers, the cooperative has a competitive advantage in satisfying this demand. Reputational concerns are a primary driver of the terms of transactions. Unlike smaller traders, the cooperative, a relatively large player, can commit to hold farmer revenues for a month. The next section explores the consequences of these observations for the equilibrium farmer sales behavior and for coop competition strategies.

6 Farmer Sales and Firm Competition: Implications

This section explores additional implications of the asymmetric ability between the co-operative and the traders to provide deferred payments in the market. We focus on both implications for the market structure as well as on implications for coop competitive strategies.

We first provide cross-sectional evidence consistent with the sorting derived in Proposition 1.4 in Section 3: farmers selling to the cooperative are more likely to set saving goals (and to reach them). Second, we provide additional evidence that many farmers selling to the coop also sell to other buyers. Third, we document that the traders and the coop coexist by serving farmers with different needs: farmers use traders as a source of liquidity and the coop as a device for saving. We use additional survey evidence to corroborate this claim. Finally, we provide an experimental test of Proposition 3 and study how coop deliveries respond to a (temporary) large increase in price.

6.1 Producer Sorting Across Buyers

Proposition 1.4 states that, in equilibrium, farmers sell to the cooperative if their saving goal (\(\Delta\)) is above a certain threshold. The listing exercise described in Section 2, which targeted a random sample of dairy farmers in six villages regardless of their coop sale status, allows us to test whether this relation holds in the sample.

We focus on the 413 farmers who sell at least part of their milk (86% of the total). Around forty percent of these sell to the coop, with shares between 11% and 72% across the six villages. The unconditional correlations in Table 2, Columns (1) show that farmers who
sell to the coop are more likely to report they set saving goals (86% vs. 66% ). Column (4) focuses on how often farmers reach these goals, conditional on setting them: the outcome variable is defined on a scale 1 (never reach the goals) to 6 (always reach them). The average score is 3.55 for those selling to the coop and 3.2 for those who do not.

We then look at conditional correlations. For the saving goal setting outcome, the results are robust when controlling for the number of cows owned by the farmers and then for village fixed effects (Columns (2) and (3)). On the other hand, in the regression where the dependent variable is the frequency at which farmers reach their saving goal, the coefficient on the coop sale dummy shrinks when adding these controls (and it becomes non-significant when village fixed effects are included). To summarize, while the cross sectional nature of the listing data poses an obvious caveat to a causal interpretation of these results, this evidence is consistent with the theory result predicting an extensive margin sorting (i.e. sorting across farmers) between the coop and the traders on the basis of the farmer saving goals.

6.2 Coexistence of Coop and Traders

We now focus on the intensive margin sorting: to which extent do farmers who sell to the coop also sell part of their milk to other buyers? First, we ask farmers about their sales to traders at different places in the survey. When asked directly, approximately 40% of farmers report to sell to traders. On average, farmers derive 16% of their dairy farming income from sales to traders. Conditional on selling to traders, the share of dairy income from traders jumps to 40%. When asked about sales to traders by other coop members in their village, respondents suggest that on average at least 50% of farmers sell to other traders. This evidence suggests that self-reported measures might underestimate the extent to which farmers sell to traders.

Second, we can construct measures of “loyalty” to the coop, defined as the ratio between sales to the coop and the production available for sales as reported in the survey. Production available for sales is the difference between total production and home consumption (including feeding calves), as reported by farmers in the survey. We can combine self-reported measures of total production and home consumption with self-reported measures of sales to the coop.

Farmers might hide sales to traders from other members. This also would lead to an underestimate even using reports about other members’ sales.
as well as with administrative data on deliveries to the coop. This allows us to construct two measures of loyalty: an administratively matched one and a self-reported one. Figure 9 illustrates the distribution of the two measures of loyalty. The left panel focuses on the administratively matched measure. As expected, this measures points at significantly higher sales to traders both on the intensive and on the extensive margin. We find that about 85% of the farmers in the sample sell at least some milk to other buyers. Conditional on selling to other traders, the average sold to other buyers is around 45% of the available milk. The right panel illustrates the distribution of the self-reported measure of loyalty. In this case, we find that approximately 40% of the farmers sells to other traders and, in this group, the amount sold to traders is around 40% of the available milk.

The segmentation pattern between morning and afternoon sales, documented in Figure 4, is even starker when we consider the above measures of loyalty to the coop. Farmers report to sell approximately 94% of their milk to the coop in the morning. The corresponding figure computed from administrative data is 63%. In contrast, farmers report to sell approximately 30% of their afternoon milk to the coop. The corresponding figure computed from administrative data is 4%. While the amount of sales to other buyers estimated from self-reported figures and from administrative data is quite different, both measures confirm that farmers predominantly sell to other buyers in the afternoon. Fixed costs, driven by the time required to transport the milk (Figure 2, are a likely explanation for this pattern. As a result of these travel costs, it is efficient for most farmers to travel to the coop only once a day. The desired amount to be deferred is large enough to imply that farmers prefer sell to the cooperative in the morning and to other traders in the afternoon.

6.3 Earning Source and Expenditure Patterns

In addition to paying higher prices, traders provide an additional service relative to the farmers: liquidity. While farmers can, by visiting the bank branch or the coop headquarters, obtain advances on their payments due at the end of the month, this form of liquidity is rarely used. Approximately 78% of respondents reports that traders are a better source of liquidity. There is some evidence that, in equilibrium, traders’ availability responds accordingly and is skewed towards the afternoon. Farmers report that approximately 50% of the traders are available for purchase both in the morning and in the afternoon. The remaining 50% of traders are relatively more likely to be available only in the afternoon (approximately 30% instead of 20%).
Therefore, farmers must sell to both types of buyers in order to achieve their desired cash flow profile.

This view is strongly supported by the different ways farmers use the money earned from cash from the traders the coop. The survey asked how farmers utilized the income generated by sales to the traders and to the coop in May 2014. Figure [10] illustrates the results. Deferred income paid by the coop is predominantly (almost 40%) used to finance bulky expenses in the dairy business, such as purchase of feed and equipment. The corresponding figure for sales to the traders is much lower, around 16%. Similarly, significantly larger shares of deferred income obtained from the coop are used for savings, 15%, or to pay for school fees, 10%, against 6% and 5% respectively for income derived traders.

On the other hand, the largest share of the income derived from traders is spent on current expenses, such as purchasing food (55%). The corresponding share for the coop is much lower, at 21%. We can also compare how income from sales to the coop is spent by farmers that do sell to traders versus those who do not. A similar pattern emerges. Farmers selling to traders use a much lower share of income from the coop for food consumption (14% instead of 24%) and, consequently, use a higher share to save (18% instead of 13%) and pay school fees (11% instead of 7%).

6.4 Increasing Deliveries to the Coop: Prices Incentives and Liquidity

The final part of the paper studies the effectiveness of standard price competition strategies when buyers compete on the provision of interlinked saving services as well as on the output market. Specifically, as the coop would like to increase afternoon supply from farmers to increase capacity utilization, we designed an experiment to test the impact of price incentives on afternoon deliveries. The design follows closely the comparative statics described in Proposition 3 in Section 3.

We selected 398 farmers among the ones surveyed at baseline. Farmers were randomly assigned to three groups: two treatment groups (around 150 in each) and one control group.

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38 Consistent with the point that intra-household frictions may be one of the drivers of the demand for deferred payments (Section 4.2), income from traders is also relatively more likely to be under the control of the spouse (33%) than of the household head relative to income from the coop (22%).
In the first treatment, farmers were informed that for the subsequent three days they will receive a bonus of Ksh 10 (an increase of approximately 30% relative to the baseline price) for their afternoon deliveries. Given the distribution of prices presented in Figure 1, this difference more than compensates for the average gap between the prices paid by the coop and the best price paid by other buyers in the village. The 30% increase improves on the price paid by the best buyers for more than 75% of the farmers. 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 payment in cash on the spot for the deliveries in that day or to retain the standard monthly payment. The farmers were given the opportunity to be paid in cash for morning and/or afternoon deliveries for the three days according to their choice.

We stratified on farmer location (zone) and baseline delivery levels. Table 4 confirms that the randomization worked overall. However, the proportion of male respondents differs across the two treatment groups (significant 5%) and the proportion of farmers reporting access to traders differs across the flexibility and the control group (significant at 10%). All the results presented below are robust to the inclusion of these covariates. Around 6% of the treatment farmers could not be reached before the intervention. The success rate in reaching target members was similar across the two groups. Delivery data are available on the whole sample.

The empirical analysis is based on the following Intention-to-Treat difference-in-differences specification:

\[
y_{it} = \eta_i + \beta Post_{it} + \gamma Bonus_i \times Post_{it} + \delta (Bonus + Flexibility)_i \times Post_{it} + \epsilon_{it} \tag{2}
\]

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

Figure 11 summarizes the findings. The graph suggests that the bonus treatment (the large price increase) has only a minor impact on the afternoon deliveries. The treatment group \(bonus + flexibility\) group induces a larger change, though this is still small in absolute
value. Table 5 confirms the results. We first focus on kilograms delivered to the coop in the afternoon. Column (1) presents an OLS using only observations from the three days of the experiment. Column (2) shows results from a difference-in-differences model. Column (3) reports the estimation of the model presented in Equation 2. Columns (4)-(6) and (7)-(9) present a similar analysis for a binary indicator equal to one if the farmer delivered any afternoon milk and for morning deliveries, respectively.

Consistent with Proposition 3.1, which predicts an ambiguous impact of a price increase due to the opposite effect of income and substitution effects, the large bonus treatment has a small impact on afternoon deliveries (0.12 kg per day). In the flexibility treatment, around 30% of the farmers choose the flexibility option for the afternoon. In turn, the flexibility group displays an increase in afternoon deliveries of 0.25 kg per day and an increase in the likelihood that farmers deliver any afternoon milk of 6.8 percentage points, compared to a baseline level of zero. While, as per the prediction in Proposition 3.2, the point estimate on this treatment is larger than the one on the bonus treatment, the difference in coefficients is not significant at conventional levels and the overall impact is still quite small in absolute level.

We now consider several deviations from our stylized model that could help explain the limited response to the flexibility treatment. First, for some farmers, the very large price increase may still not be large enough to match the trader net prices, inclusive of transport costs. Second, some farmers may not have enough milk to sell, once accounting for consumption and other domestic usages. However, at least 45% of the farmers sell milk in the afternoon to the traders and this estimate is likely to be a lower bound because of under-reporting. Third, if farmers sell to traders with whom they have relationships, the farmer might be unwilling to jeopardize the relationship with the trader to earn a substantial price increase from the coop for a limited amount of time. However, this hypothesis is at odds with the evidence discussed above. While we do not have direct information on whether the farmer always sells to the same trader, 90% of the farmers report that the traders do not provide any additional service, which we would expect if relationships where important.

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39 In addition, farmers that do not sell to traders should equate the marginal utility of milk consumed at home with the marginal value of cash paid at the end of the month. A substantial increase in the price for milk paid by the coop should be expected to lead to a certain degree of substitution. 40 On the other hand, precisely because the incentive is available for few days the farmer might not significantly compromise the relationship with the trader by suspending sales for such a short period.
Consistent with some of the above explanations, Table 6 shows suggestive evidence that the impact of the Bonus + Flexibility treatment is stronger for larger farmers (Columns 2 and 3), for those who report access to another trader (Column 4) and who are less loyal to the coop (Column 5, though this is not significant at conventional levels). Interestingly, farmers that mention another trader show i) a weaker impact of of the bonus alone, consistent with the hypothesis that access to a source of liquidity limits the impact of the price incentive when the coop pays the extra amount only at the end of the month, and ii) a stronger impact of the combined bonus and flexibility intervention, consistent with the fact that they have more milk to reallocate to the coop if the coop outpays the traders.

A final possibility for the limited responsiveness of both treatments is that farmers use a simple rule of thumb that our basic model fails to capture: they sell to the coop in the morning as a saving tool and to traders in the afternoon for liquidity. The behavioral literature has emphasized how simple rules can be used to provide “soft-commitment” (see, e.g., Bénabou and Tirole (2004) for a theoretical discussion and Dupas and Robinson (2014) for empirical evidence). The use of such a rule of thumb could originate from farmers’ demand for deferred payments originating from sophisticated time-inconsistent farmers, which we documented in Section 4.2.

Cooperative administrative data highlight the existence of such rule of thumb. If farmers responded to incentives, they would change the amount delivered to the coop based on the time gap between the delivery date and the payment date, which occurs at the end of the month (or, more precisely, early the subsequent month). An impatient farmer may sell more to the coop toward the end of the month, as this time gap between delivery and payment is smaller. A farmer who values the commitment device that the coop’s deferred payment provide may actually sell more to the coop early in the month, as the implicit saving period is longer. The data, however, feature a completely flat profile across days of the month. Figure 12 shows the average coop deliveries per day 2014 in both morning and afternoon. In addition, as mentioned in Section 2.2, the distribution of the number of afternoon deliveries per month is bimodal: most farmers either sell every day or never. We also observe that very few farmers deliver amounts of milk that systematically differ between the beginning and the

\[ \text{Results are similar when we remove year and month fixed effects before computing daily averages to control for different month length.} \]
end of the month. Overall, this evidence confirms that few farmers optimize their delivery behavior depending on the day of the month.

In addition to documenting a pattern consistent with a simple rule of thumb, this evidence also alleviates concerns that specific experimental features, such as the short duration, may have driven the little responsiveness we found in the experiment. The limited incentive responsiveness we observed in the experiment is also present in the long-term administrative data. Furthermore, focus groups clearly point at the fact that those farmers who sell both to the coop and the traders set aside a fixed amount of money – the morning production – for coop delivery. An implication of this rule of thumb hypothesis is that it would be a potentially risky decision for the coop to extend the availability of flexible payment to farmers. Providing more flexible payment might lead farmers to change their perception of the coop as provider of deferred payments. This might be one of the main sources of competitive advantage for the coop.

To summarize, this section documented a market equilibrium where the coop competes by providing deferred payments and other buyers compete by offering higher prices, lower transport costs and, crucially, liquidity. In this setting, the ability of the cooperative to use monetary incentives to increase deliveries is limited: competition through the deferred payments undermines effectiveness of standard price competition strategies. Additional evidence suggests that introducing an option that gives farmers the desired amount of liquidity only induces a small response. While fixed transport costs might explain some of this lack of response, we conjecture and provide evidence that behavioral biases – in particular the adoption of simple rule of thumbs by sophisticated time-inconsistent agents – may also drive this result.

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

This paper documents how imperfections in the saving markets spillover onto other markets. Focusing on the Kenya dairy industry, we study a context in which farmers have demand for deferred payments and, due to limited enforcement, buyers are asymmetric in their ability to provide these services. A simple model based on these assumptions matches several features of the market under study, including some pieces of (possibly) puzzling evidence.

Administrative data, surveys, and multiple experimental designs document the existence of an interlinked saving-product market, featuring a high degree of segmentation. Small buyers compete primarily through prices and liquidity provision. A coop – the largest buyer in the study setting – provides deferred payments. Finally, we show that, in this interlinked equilibrium, standard competition strategies, such as price incentives, have limited impact on supplier sale behaviors.

While these findings are drawn from a specific setting, we believe they are of interest for a broad class of markets. First, several agricultural value chains feature similar deferred payments arrangements. Second, employers often provide deferred compensation. While the primary goal may be to retain workers for a longer period (Sivasankaran, 2013), it is quite likely that workers value this option and that more credible employers can use the deferred payment as a competitive tool. Third, many value chains feature small suppliers providing trade credit to large buyers (Klapper, Laeven, and Rajan, 2011). While buyer market power has been proposed as leading candidate for this pattern, it is possible that, particularly in developing countries, suppliers may benefit from the shift in the timing of payments. We hope future research will assess the importance of the mechanisms unveiled in our paper in these and other settings.

43A leading example concerns smallholder tea producers within a contract farming scheme (UNCTAD, 2009). Consistent with our argument, it is again the presence of a modern organizational form, such as contract farming, and of credible large buyers that induces the emergence of interlinked saving services.
References


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Appendix A: Proofs

Proof of Proposition 1

Proposition 1 characterizes the equilibrium. We begin by deriving deliveries from a farmer’s point of view taking as given the price set by the coop. We show that the cooperative always sets price \( p^e < v \) and pays at the end of \( t = 3 \) (Proposition 1).

Bertrand competition implies that traders buy at price \( v \). If the cooperative pays everyday, it must pay at least \( v \) to guarantee any supply of milk. Profits are, therefore, at most zero. To prove the result we simply need to show that the cooperative can attract positive milk deliveries offering deferred payments at a price \( p < v \).

For future reference, it is useful to denote price \( p_t \) as the price paid by the cooperative for deliveries at time \( t \). Denote with \( I_{\{D=1\}} \) the choice of the farmer to buy the indivisible good at \( t = 3 \). Given the price set by the cooperative, the farmer choses deliveries of milk to the cooperative \( x_t \) at date \( t = 1, 2 \) to solve the following problem

\[
\max_{x_1, x_2, I_{\{D=1\}}} u(c_1) + \delta u(c_2) + \delta^2 \Delta \times I_{\{D=1\}} \quad \text{s.t.}
\]

\[
c_1 = (Q - x_1) v \\
c_2 = Qv - I_{\{D=1\}} \times \left( \frac{v}{p_2} \left( D - \frac{x_1p_1}{\delta} \right) \right) + (1 - I_{\{D=1\}}) \times \left( \frac{x_1p_1}{\delta} \right).
\]

First, note that if \( I_{\{D=1\}} = 0 \) the farmer sets \( x_t = 0 \) for \( t = 1, 2 \) and obtains utility \( (1 + \delta) \times u(Qv) \). If, instead, \( I_{\{D=1\}} = 1 \), the farmer sets

\[
x_1 = \frac{\delta}{1 + \delta} \left( \frac{D + Q(p_1 - p_2)}{p_1} \right) \quad \text{and} \quad x_2 = \frac{\delta}{1 + \delta} \left( \frac{D - Q(p_1 - p_2) / \delta}{p_2} \right).
\]

Setting \( p_1 = p_2 = p \) this gives \( x_1 = x_2 = \frac{\delta}{1 + \delta} \frac{D}{p} \) with corresponding utility \( (1 + \delta) u(Qv - \frac{\delta}{1 + \delta} \frac{D}{p}) + \delta^2 \Delta \). This expression is increasing in \( p \). By assumption, \( (1 + \delta) u(Qv - \frac{\delta}{1 + \delta} \frac{D}{v}) + \delta^2 \Delta \geq (1 + \delta) \times u(Qv) \). This implies that prices \( p < v \) attract positive deliveries and, therefore, yield positive profits to the coop. This proves both \( P1.1 \) and \( P1.2 \). The solution is feasible if \( \frac{\delta}{1 + \delta} \frac{D}{v} \geq Q \). Conditionally on selling to the coop (and omitting the knife-edge case \( \frac{\delta}{1 + \delta} \frac{D}{v} = Q \)), then, \( x_t < Q \), i.e., farmers also sell to traders in both periods. This proves \( P1.3 \). Finally, notice that in an interior equilibrium in which some farmers do not sell to the coop, there is a \( \Delta^e > \Delta \) such that those farmers have \( \Delta \in [\Delta, \Delta^e) \). This proves \( P1.4 \).
Proof of Proposition 2

Given equilibrium price \( p^e < v \), define \( \Delta^e \) as the lowest valuation for which farmers sell to the coop, i.e., \((1 + \delta) u(Qv - \frac{\delta D}{1+\delta p^e}) + \delta^2 \Delta^e = (1 + \delta) \times u(Qv)\). Proposition 2 simply follows from the definition of \( \tilde{p} \in (p^e, v] \).

Proof of Proposition 3

The first part of the proposition follows from comparison of \( x_0(Q, p^e, p^e) \) and \( x_0(Q, v, p^e) \). Simple algebra proves the result. The second part of the proposition comes from the fact that at \( t = 1 \) the farmer can sell all her quantity to the coop choosing to be paid for an amount equal to \((Q - x_0(Q, v, p^e))\) in cash and for the rest at the end of the month.
Appendix B: Time-Inconsistent Farmers

The purpose of this section is to show that (sophisticated) time inconsistent preferences offer a microfoundation for the assumption that farmers use the (illiquid) coop payment to save even though they might have access to a saving technology paying appropriate returns. The extension is motivated by abundant empirical evidence (including in our context) that farmers do have a demand for commitment. In writing a behavioural extension we do not rule out other explanations (such as intra-household and intra-farm agency problems) that could account for the demand for commitment.

Setup

To keep things as simple as possible, we modify the model as follows. First, we assume $\Delta$ is large enough so that the farmer wants to purchase the indivisible good at $t = 1$ (henceforth $St$, with $t = 1, 2, 3$, denotes the farmer “self” at period $t$). Second, as is well-known in this class of models, we need to add an additional consumption period, $t = 3$ (with consumption of the indivisible postponed of one extra period). For simplicity, we assume there is no milk production in this third period. Third, we assume the farmer can save cash earned by selling to the trader from one period to the next earning interest rate $(1 + r) = 1/(\delta + \epsilon)$, with $\epsilon \to 0$. Fourth, to simplify the algebra, we assume that the farmer’s utility from consuming the divisible good is linear. These last two assumptions imply that the farmer always prefers to consume in earlier periods. Note that the main results do not depend on these last two assumptions, but the algebra becomes significantly more tedious if we relax them.

Denoting with $s_t$ the amount saved by the farmer from selling to traders and with $x_t$ the amount sold to the coop in period $t = 1, 2$, the farmer’s utility at $t = 1$ is given by

$$U_1 = c_1 + \beta \delta (c_2 + \delta c_3 + \delta^2 \Delta),$$

(3)

where $c_1 = v(1 - x_1) - s_1$ and $c_2 = v(1 - x_2) - s_2 + \frac{s_1}{\delta}$ and, as usual, $\beta < 1$.

The utility of “self” $t = 1$ when she does not purchase the indivisible is $U_1^c \equiv v(1 + \beta \delta)$. Since the coop pays a price $p < v$, the farmer optimally sets $x_1 = x_2 = s_1 = s_2 = 0$ if the doesn’t plan to buy the indivisible good.
Equilibrium Saving Behavior

Since selling to the traders gives a higher price and the coop pays the same interest as the saving technology, $S_1$ would always prefer to sell to traders and save rather than saving through the coop. However, if she does so, she risks leaving liquid savings in the hands of $S_3$, which might decide to consume it rather than resist the temptation and buy the indivisible good. The associated incentive constraint is given by:

$$\left(x_1p_1 + x_2p_2 + \frac{s_2}{\delta^2} - D\right) + \beta \delta \Delta \geq \frac{s_2}{\delta} \quad (4)$$

Note that the constraint puts a maximum to the amount that $S_2$ can save by selling to traders, $s_2$. Moving one step backward, $S_2$ chooses $x_2, s_2$ so that $c_3 = 0$ when $S_3$ purchases the indivisible good. Therefore the first term on the left hand side in (4) is equal to zero. Thus, in order to satisfy the inequality, we must have $s_2 \leq \beta \delta^2 \Delta \equiv \hat{s}_2$. If $S_2$ left $s_2 > \hat{s}_2$, $S_3$ would prefer to consume $s_2$ rather than resist the temptation and purchase the indivisible good. We need to distinguish two cases, depending on whether how severe time inconsistency is.

**Case 1:**

If $\beta \geq \frac{D}{\Delta} \equiv \hat{\beta}$ (i.e., $\hat{s}_2/\delta^2 \geq D$) then the constraint (4) is not binding. $S_2$ induces $S_3$ to purchase the indivisible at no cost and sets $x_2 = 0$. $S_2$ constraint is given by

$$v + \frac{s_1}{\delta} - x_2v - \hat{s}_2 + \beta \delta^2 \Delta \geq v + \frac{s_1}{\delta}. \quad (5)$$

Moving one step back, $S_1$’s utility when $S_2$ purchases the indivisible and sets $s_2 = \delta^2 p_D \leq \hat{s}_2$ and $x_2 = 0$ is

$$U^s_1 \equiv v + \beta \delta(v + \delta^2(\Delta - D)) \quad (6)$$

We note that $U^s_1 > U^c_1$ if $\Delta > D$ (which we assume it’s always the case).

**Case 2:**

If $\beta < \hat{\beta}$, instead, the constraint (4) is binding and thus $S_2$ cannot purchase the indivisible good by simply saving $s_2$ but rather needs to save through the coop. In this case, $s_2 = 0$, then $x_2 = (p_D - x_1p_1)/p_2 \equiv \hat{x}_2$. Moving one step backward, the value of $x_1$ is chosen by $S_1$
taking into account the incentive constraint of $S2$, given by
\[
\frac{S_1}{\delta} + (1 - \hat{x}_2)v + \beta \delta^2 \Delta \geq \frac{S_1}{\delta} + v. \tag{7}
\]
Since $S1$ always wants to anticipate consumption as much as possible (subject to implementing a saving plan that induces $S2$ and $S3$ to buy the indivisible) the constraint must be binding, i.e., $x_1^* = \frac{v p_d - p_2 \beta \delta^2 \Delta}{p_1 v}$ and $x_2^* = \frac{\beta \delta^2 \Delta}{v}$.

The utility of $S1$ when she purchases the indivisible good by setting $x_1 = x_1^*$, $x_2 = x_2^*$ and $s_1 = s_2 = 0$ is given by
\[
U_{x_1}^z \equiv v - x_1^* v + \beta \delta (v - x_2^* v + \delta^2 \Delta) = U_1^s - v (x_1^* + \beta \delta x_2^*) < U_1^s. \tag{8}
\]

We note that $U_{x_1}^z > U_1^c$ if $\Delta > \frac{v p_d}{\beta \delta^2 (p_1 (1 - \beta) \delta + p_2)} \equiv \hat{\Delta}$ if this condition holds, $S1$ prefers to save through the coop and to purchase the indivisible rather than consuming all of her cash.

We summarize the equilibrium of the model with the following proposition:

**Proposition B:**

**B1** If $\beta \geq \hat{\beta}$, the farmer saves through the trader, she sets $s_2 = \delta^2 p_D$, $s_1 = x_1 = x_2 = 0$ and achieves $U_1^s$.

**B2** If $\beta < \hat{\beta}$ and $\Delta \geq \hat{\Delta}$, the farmer saves through the coop, she sets $x_1 = x_1^*, x_2 = x_2^*$, $s_1 = s_2 = 0$ and she achieves $U_{x_1}^z < U_1^s$.

**B3** If $\beta < \hat{\beta}$ and $\Delta < \hat{\Delta}$, the farmer does not save at all ($s_1 = s_2 = x_1 = x_2 = 0$) and she achieves $U_1^c$.

\[44\text{There exist parameters configurations such that conditions } \beta < \hat{\beta} \text{ and } \Delta > \hat{\Delta} \text{ can both be satisfied if } \frac{v}{\delta^2 (p_1 (1 - \beta) \delta + p_2)}. \text{ We assume this condition holds throughout.}\]
**Figures**

**Figure 1: Prices**

![Figure 1: Prices](image1)

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

**Figure 2: Distances**

![Figure 2: Distances](image2)

*Notes:* The figure presents kernel densities of the distance between the farmer and the buyer, as reported by the farmer 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 3: Payment Frequencies

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

Figure 4: Daily Coop Milk deliveries in AM and PM: Aggregate

Notes: The figure presents aggregate morning and afternoon milk deliveries to the coop in 2014.
Figure 5: Number of Days with Deliveries

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

Figure 6: Choice Experiments

Notes: The figure presents results from the choice experiments reported in the paper. The first bar focuses on the first choice experiment. It reports the share of the 100 farmers targeted by the experiment who said they would prefer monthly payments to daily payments with a bonus of KSh 5, from a baseline of 31. The second bar focuses on the second choice experiment. It reports the share of the 100 farmers targeted by the experiment who said they prefer the monthly payment to the “flexibility” option, which would allow them to choose every day whether to be paid daily or monthly.
**Figure 7: Savings and the Coop**

![Bar chart for Farmer Savings and the Coop](chart)

*Notes:* The figure presents summary statistics on farmer savings behavior and on the role of the coop in helping savings. For the first variable *Set saving goals*, we use the entire baseline sample. For the other variables, we limit the sample to those farmers answering “Yes” in the first column.

**Figure 8: Traders**

![Bar chart for Traders and Deferred Payments](chart)

*Notes:* The figure presents summary statistics on paying behavior of the buyers and on the reason they cannot offer deferred payments. *Trust coops more than traders* and *Coop more reliable than traders in payments* take value one if the trust score and the payment reliability score are strictly larger for the coop than for other buyers, respectively.
Notes: Loyalty variables are computed as the ratio between sales to the coop and production available for sales. Production available for sales is defined as the difference between production and home consumption (including feeding calves). In the left panel (“Administrative Data”), the numerator is obtained from the cooperative records. In the right panel (“Self Reported”), the numerator is obtained from farmers’ answers in the baseline survey.

Figure 10: Usage of Milk Earnings

Notes: The figure describes how farmers use milk earnings from the coop and from other buyers, respectively. For each farmer-buyer, we compute the share of expenses on a certain item relatively to the total earned by the farmer from that buyer.
Figure 11: Bonus Experiment Afternoon Deliveries

![Bonus Experiment: Afternoon Deliveries](image)

*Notes:* The figure presents mean afternoon deliveries for the bonus experiment. Days -3 to -1 refer to the month before the experiment. Days 1 to 3 refer to the days of the experiment.

Figure 12: Average Coop Delivery by Day of the Month

![Average Coop Delivery by Day of the Month](image)

*Notes:* The figure shows average coop delivery in 2014 by day of the month (1st to 31st) for both morning and afternoon deliveries.
Tables

Table 1: Summary Statistics

<table>
<thead>
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<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
<th>N</th>
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<td>Respondent Age</td>
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<td>6.594</td>
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<td>543</td>
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<tr>
<td>Hire workers for dairy</td>
<td>0.261</td>
<td>0.44</td>
<td>0</td>
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<td>574</td>
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<tr>
<td>Loyalty (Admin Sales)</td>
<td>0.617</td>
<td>0.291</td>
<td>0</td>
<td>1</td>
<td>529</td>
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<tr>
<td>Loyalty (Self Reported Sales)</td>
<td>0.852</td>
<td>0.24</td>
<td>0</td>
<td>1</td>
<td>526</td>
</tr>
<tr>
<td>Loyalty AM (Admin Sales)</td>
<td>0.712</td>
<td>0.282</td>
<td>0</td>
<td>1</td>
<td>542</td>
</tr>
<tr>
<td>Loyalty PM (Admin Sales)</td>
<td>0.495</td>
<td>0.492</td>
<td>0</td>
<td>1</td>
<td>533</td>
</tr>
<tr>
<td>Respondent Mentions Any Trader</td>
<td>0.821</td>
<td>0.384</td>
<td>0</td>
<td>1</td>
<td>576</td>
</tr>
<tr>
<td>Present Biased</td>
<td>0.125</td>
<td>0.331</td>
<td>0</td>
<td>1</td>
<td>553</td>
</tr>
<tr>
<td>Difference Trust Coop-Trader</td>
<td>0.863</td>
<td>1.138</td>
<td>-2</td>
<td>3</td>
<td>526</td>
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<tr>
<td>Saves in Bank</td>
<td>0.738</td>
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<td>0</td>
<td>1</td>
<td>572</td>
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<tr>
<td>Regular Income from Other Occupation</td>
<td>0.203</td>
<td>0.403</td>
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<td>1</td>
<td>576</td>
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<td>HH member manages money not cows</td>
<td>0.3</td>
<td>0.459</td>
<td>0</td>
<td>1</td>
<td>533</td>
</tr>
</tbody>
</table>

Notes: The table presents summary statistics from the farmers targeted in the baseline survey. Production is measured in the survey and refers to June 2014. Mean Daily Deliveries are from coop administrative data and refer to September 2014. Both production and delivery variables are measured in kilograms. Loyalty variables are defined as ratios between sales to the coop, either from administrative data or from the survey, and the difference between production and other usages. Trust for either the coop and the buyer is measured as an index from 1 to 4. Therefore, their difference can span -3 to 3. Regular Income from Other Occupation refers permanent employee, civil servant, artisan, trader, and self-employed.
Table 2: Farmer Saving Behavior and Sales to the Coop

<table>
<thead>
<tr>
<th></th>
<th>Set Saving Goals</th>
<th>Reach Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Sells to Coop</td>
<td>0.206***</td>
<td>0.184***</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.042)</td>
</tr>
<tr>
<td>Avg Y No-Coop</td>
<td>0.664</td>
<td>0.664</td>
</tr>
<tr>
<td>N.Cows</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Village FE</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Observations</td>
<td>408</td>
<td>408</td>
</tr>
</tbody>
</table>

Notes: The analysis uses data from the dairy farmer listing exercise, which targeted 479 dairy farmers, of which 413 sold some portion of their milk. The binary variable “Set saving goals” is not missing for 408 of these farmers. The binary variable “Reach Goals” is defined only for those farmers who state that they set saving goals. Standard errors are robust to heteroskedasticity. *p<0.1, **p<0.05, ***p<0.01.
Table 3: Baseline Correlations

<table>
<thead>
<tr>
<th></th>
<th>Set Saving Goals</th>
<th>Reach Goals</th>
<th>Coop Helps Goals</th>
<th>Reach Less if Weekly Pyt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Dairy Production AM (kg)</td>
<td>0.009 (0.009)</td>
<td>0.005 (0.006)</td>
<td>-0.017 (0.011)</td>
<td>-0.009 (0.010)</td>
</tr>
<tr>
<td>Dairy Production PM (kg)</td>
<td>-0.016 (0.015)</td>
<td>-0.011 (0.012)</td>
<td>0.003 (0.016)</td>
<td>0.009 (0.015)</td>
</tr>
<tr>
<td>Mean Daily Deliveries</td>
<td>-0.001 (0.002)</td>
<td>0.004** (0.002)</td>
<td>0.006 (0.005)</td>
<td>0.002 (0.002)</td>
</tr>
<tr>
<td>Loyalty PM (Admin Sales)</td>
<td>-0.018 (0.037)</td>
<td>0.016 (0.033)</td>
<td>-0.088* (0.047)</td>
<td>-0.048 (0.043)</td>
</tr>
<tr>
<td>Respondent Mentions Any Trader</td>
<td>0.011 (0.044)</td>
<td>-0.037 (0.037)</td>
<td>0.062 (0.057)</td>
<td>0.078 (0.055)</td>
</tr>
<tr>
<td>Present Biased</td>
<td>0.109*** (0.041)</td>
<td>0.017 (0.040)</td>
<td>0.002 (0.062)</td>
<td>0.114** (0.045)</td>
</tr>
<tr>
<td>Difference Trust Coop-Trader</td>
<td>0.031** (0.015)</td>
<td>-0.004 (0.012)</td>
<td>0.004 (0.019)</td>
<td>0.040** (0.016)</td>
</tr>
<tr>
<td>Saves in Bank</td>
<td>0.073* (0.040)</td>
<td>0.092** (0.041)</td>
<td>-0.007 (0.050)</td>
<td>-0.106*** (0.040)</td>
</tr>
<tr>
<td>Regular Income from Other Occupation</td>
<td>0.012 (0.040)</td>
<td>-0.013 (0.036)</td>
<td>-0.091* (0.055)</td>
<td>-0.088* (0.050)</td>
</tr>
<tr>
<td>HH Head manages coop money not cows</td>
<td>0.068* (0.039)</td>
<td>0.015 (0.036)</td>
<td>0.002 (0.053)</td>
<td>0.014 (0.048)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.045</td>
<td>0.047</td>
<td>0.046</td>
<td>0.079</td>
</tr>
<tr>
<td>Dependent Variable Mean</td>
<td>0.821</td>
<td>0.882</td>
<td>0.712</td>
<td>0.791</td>
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<tr>
<td>Observations</td>
<td>575</td>
<td>482</td>
<td>483</td>
<td>484</td>
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</tbody>
</table>

Notes: The table presents correlation between several measures of saving behavior, as measured in the baseline survey, and other farmer covariates. Refer to Table [1] for a description of the covariates. For each of the covariates, the regression also includes a binary indicator for whether that covariate is missing (and missing values in the variables are replaced with an arbitrary negative value). Standard errors are robust to heteroskedasticity. *p<0.1, **p<0.05, ***p<0.01.
## Table 4: Balance table for bonus experiment (with stratum FE)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Respondent</td>
<td>.3732</td>
<td>.4794</td>
<td>.4</td>
<td>.048**</td>
<td>.941</td>
<td>.215</td>
<td>383</td>
</tr>
<tr>
<td>( .4853)</td>
<td>( .5012)</td>
<td>( .4924)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Respondent Age</td>
<td>58.32</td>
<td>54.73</td>
<td>55.89</td>
<td>.107</td>
<td>.384</td>
<td>.404</td>
<td>380</td>
</tr>
<tr>
<td>(16.00)</td>
<td>(15.93)</td>
<td>(15.08)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Household size</td>
<td>4.958</td>
<td>5.285</td>
<td>5.145</td>
<td>.172</td>
<td>.823</td>
<td>.429</td>
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<td>(2.082)</td>
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<tr>
<td>Number of Cows</td>
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<td>1.340</td>
<td>1.427</td>
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<td>.504</td>
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<td>387</td>
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<td>( .6773)</td>
<td>( .6765)</td>
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</tr>
<tr>
<td>(4.042)</td>
<td>(3.106)</td>
<td>(3.382)</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Dairy Production PM (kg)</td>
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<td>4.321</td>
<td>4.236</td>
<td>.741</td>
<td>.428</td>
<td>.992</td>
<td>382</td>
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<td>(3.058)</td>
<td>(2.013)</td>
<td>(2.278)</td>
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<tr>
<td>Mean Daily Deliveries</td>
<td>7.181</td>
<td>6.187</td>
<td>6.881</td>
<td>.224</td>
<td>.681</td>
<td>.221</td>
<td>375</td>
</tr>
<tr>
<td>(8.070)</td>
<td>(3.570)</td>
<td>(4.681)</td>
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</tr>
<tr>
<td>Hire workers for dairy</td>
<td>.2260</td>
<td>.2432</td>
<td>.2395</td>
<td>.377</td>
<td>.855</td>
<td>.85</td>
<td>390</td>
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<tr>
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<td>( .4034)</td>
<td>( .4290)</td>
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</tr>
<tr>
<td>Loyalty (Admin Sales)</td>
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<td>.6576</td>
<td>.6676</td>
<td>.577</td>
<td>.835</td>
<td>.612</td>
<td>370</td>
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<td>( .2483)</td>
<td>( .2515)</td>
<td>( .2542)</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Loyalty (Self Reported Sales)</td>
<td>.8678</td>
<td>.8468</td>
<td>.8780</td>
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<td>( .1803)</td>
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<td>( .1902)</td>
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<tr>
<td>Loyalty AM (Admin Sales)</td>
<td>.7816</td>
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<td>.7594</td>
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<td>( .2233)</td>
<td>( .2217)</td>
<td>( .2228)</td>
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<td></td>
</tr>
<tr>
<td>Loyalty PM (Admin Sales)</td>
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<td>.5093</td>
<td>.5330</td>
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<td>.827</td>
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<td>( .4950)</td>
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<tr>
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<td>.8424</td>
<td>.8791</td>
<td>.7812</td>
<td>.323</td>
<td>.514</td>
<td>.083*</td>
<td>391</td>
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<td>( .3655)</td>
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<td>( .4155)</td>
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<td></td>
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<td>Present Biased</td>
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<td>.1118</td>
<td>.1098</td>
<td>.664</td>
<td>.538</td>
<td>.821</td>
<td>370</td>
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<td>( .3401)</td>
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<tr>
<td>Difference Trust Coop-Trader</td>
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<td>.9294</td>
<td>.159</td>
<td>.554</td>
<td>.512</td>
<td>354</td>
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<td>(1.125)</td>
<td>(1.131)</td>
<td>(1.110)</td>
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<td></td>
</tr>
<tr>
<td>Saves in Bank</td>
<td>.7222</td>
<td>.7046</td>
<td>.7916</td>
<td>.828</td>
<td>.267</td>
<td>.235</td>
<td>389</td>
</tr>
<tr>
<td>( .4494)</td>
<td>( .4577)</td>
<td>( .4082)</td>
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<td></td>
</tr>
<tr>
<td>Regular Income from Other Occupation</td>
<td>.2054</td>
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<td>.2083</td>
<td>.865</td>
<td>.591</td>
<td>.854</td>
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<td>( .4082)</td>
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<td></td>
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<tr>
<td>HH member manages money not cows</td>
<td>.25</td>
<td>.2777</td>
<td>.3309</td>
<td>.707</td>
<td>.283</td>
<td>.155</td>
<td>372</td>
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<td>( .4346)</td>
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<td>( .4752)</td>
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<td></td>
</tr>
</tbody>
</table>

**Notes:** P-values are based on specifications which include stratum fixed effects. *p<0.1, **p<0.05, ***p<0.01.
Table 5: Bonus Experiment

<table>
<thead>
<tr>
<th></th>
<th>Kg PM</th>
<th>Kg PM (dummy)</th>
<th>Kg AM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Post*Bonus (γ)</td>
<td>0.128**</td>
<td>0.128**</td>
<td>0.043***</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.050)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Post*(Bonus+Flexibility) (δ)</td>
<td>0.247**</td>
<td>0.247**</td>
<td>0.068***</td>
</tr>
<tr>
<td></td>
<td>(0.099)</td>
<td>(0.099)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>Post</td>
<td>0.014</td>
<td>0.014</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.003)</td>
</tr>
<tr>
<td>Bonus</td>
<td>0.153**</td>
<td>0.000</td>
<td>0.047***</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(.)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Bonus+Flexibility</td>
<td>0.287***</td>
<td>0.029</td>
<td>0.075***</td>
</tr>
<tr>
<td></td>
<td>(0.106)</td>
<td>(0.029)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>R²</td>
<td>0.186</td>
<td>0.028</td>
<td>0.038</td>
</tr>
<tr>
<td>p-value γ = δ</td>
<td>0.210</td>
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<td>0.282</td>
</tr>
<tr>
<td>Control Group Mean (Post Period)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Farmer FE</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Farmers</td>
<td>397</td>
<td>398</td>
<td>398</td>
</tr>
<tr>
<td>Observations</td>
<td>1191</td>
<td>2385</td>
<td>2385</td>
</tr>
</tbody>
</table>

Notes: The table presents the results of the bonus experiment. 398 farmers are split in a control group; a group that receives an increase in price for the afternoon deliveries; a group that receives the bonus plus the option to receive the payment on the same day (as opposed to the end of the month). The analysis focuses on three measures of daily deliveries: kilograms delivered in the afternoon, a dummy for whether the farmer delivers any milk in the afternoon, and kilograms delivered in the morning. For each farmer, the regression includes a maximum of six observations. Three observations come from the experiment days (Post = 1) and three from the same calendar days in the previous month (Post = 0). For each outcome, the first model (Columns (1), (4), (7)) is an OLS run only on the three Post observations, controlling for the average level of the outcome in the three baseline observations. The second model (Columns (2), (5), (8)) is a difference-in-differences. The third model (Columns (3), (6), (9)) adds farmer fixed effects to the difference-in-differences. Standard errors are clustered at the farmer level. In Columns (1), (4), and (7), p-value γ = δ comes from testing that the coefficients on Bonus and Bonus+Flexibility are equal. In the other columns, from testing that the coefficients on Post*Bonus and Post*(Bonus+Flexibility) are equal. *p<0.1, **p<0.05, ***p<0.01.
Table 6: Bonus Experiment: Heterogeneity for kg PM

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post*Bonus ($\gamma$)</td>
<td>0.128**</td>
<td>0.147*</td>
<td>-0.009</td>
<td>0.060</td>
<td>0.503*</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.079)</td>
<td>(0.066)</td>
<td>(0.036)</td>
<td>(0.260)</td>
</tr>
<tr>
<td>Post*(Bonus+Flexibility) ($\delta$)</td>
<td>0.247**</td>
<td>-0.427</td>
<td>-0.271</td>
<td>0.431**</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>(0.099)</td>
<td>(0.530)</td>
<td>(0.223)</td>
<td>(0.206)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Post<em>Bonus</em>Dairy Production PM (kg)</td>
<td>-0.010</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.010)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post*(Bonus+Flex)*Dairy Production PM (kg)</td>
<td>0.159</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.139)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Post<em>Bonus</em>Average Daily Deliveries in Sep 2014</td>
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<td>0.034</td>
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<tr>
<td></td>
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<td>(0.023)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Post*(Bonus+Flex)*Average Daily Deliveries in Sep 2014</td>
<td></td>
<td>0.128*</td>
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<tr>
<td></td>
<td></td>
<td>(0.074)</td>
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</tr>
<tr>
<td>Post<em>Bonus</em>Loyalty PM (Admin Sales)</td>
<td></td>
<td>0.092</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.087)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post*(Bonus+Flex)*Loyalty PM (Admin Sales)</td>
<td></td>
<td>-0.331</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.213)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post<em>Bonus</em>Respondent Mentions Any Trader</td>
<td></td>
<td>-0.443*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.262)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post*(Bonus+Flex)*Respondent Mentions Any Trader</td>
<td></td>
<td>0.234*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.123)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.038</td>
<td>0.090</td>
<td>0.087</td>
<td>0.053</td>
<td>0.053</td>
</tr>
<tr>
<td>Dependent Variable Mean</td>
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<td>0.079</td>
<td>0.082</td>
<td>0.081</td>
<td>0.083</td>
</tr>
<tr>
<td>Farmer FE</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Farmers</td>
<td>398</td>
<td>382</td>
<td>398</td>
<td>372</td>
<td>391</td>
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<tr>
<td>Observations</td>
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<td>2289</td>
<td>2385</td>
<td>2229</td>
<td>2343</td>
</tr>
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</table>

Notes: The table presents heterogeneous treatment effects for the bonus experiment. The dependent variable is the kilograms delivered in the afternoon. We report results from the difference-in-differences model with farmer FE described in the notes of Table 5. Refer to Table 1 for a description of the covariates. Standard errors are clustered at the farmer level. *p<0.1, **p<0.05, ***p<0.01.