ONLINE APPENDIX

Demand and Supply of Infrequent Payments as a Commitment Device: Evidence from Kenya

Lorenzo Casaburi and Rocco Macchiavello

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Contents

A Theory Appendix

A.1 Proofs

Proof of Proposition 1.
To avoid a lengthy taxonomy of cases, the analysis focuses on interior solutions. This is without loss of generality as there always exists a rescaling of parameters D and Δ such that all assumptions are verified and an interior solution exists. We consider the three scenarios described in the main text. For notational simplicity, we also assume buyers pay a per period interest rate of $1/\delta$ when paying at the end of the month. This eliminates a trade credit motive and delivers a more transparent algebra without affecting any of the results.

A Liquid Saving Technology: Consider the case of a producer who, in a given month, must save on her own using the liquid saving technology. In $t = 2$, the producer decides to save δD and purchase the indivisible good in $t = 3$, rather than consuming, if $v+s_1-\delta D+\beta\delta\Delta \geq v+s_1$, where s_1 is the amount the producer saved in $t = 1$. The inequality holds if $\beta \geq \frac{D}{\Delta} \equiv \beta_1$. In addition, since $v/\delta < D$, self 1 must also save $s_1^P = \delta^2(D-v/\delta)$. She chooses to do so if $v-s_1^P+\beta\delta^2\Delta \geq v(1+\beta\delta)$, or $\beta \geq \frac{D}{\Delta} - \frac{v}{\delta\Delta} \equiv \tilde{\beta} < \beta_1$.

Infrequent Payments: Consider now the case in which the buyer pays a price per liter p at the end of the month ($t = 3$). Self 2 will save $s_2^* = \delta(D - px_1/\delta)$ for the indivisible good if $v - ((D - px_1)/\delta) + \beta\delta\Delta > v$ or $x_1 \geq \frac{\delta^2(D-\beta\Delta)}{p} \equiv x_1^*$. In turn, self 1 will be willing to provide this minimum amount of illiquid savings to self 2 if $(1 - x_1^*)v + \beta\delta((v - s_2^*) + \delta\Delta) \geq (1 + \beta\delta)v$, which holds if $p \geq v\frac{D-\beta\Delta}{\beta\Delta(1-\beta)} \equiv p_2$. The infrequent payment helps if the buyer can make non-negative profits, i.e., $p \leq v$. Setting $p = v$ yields $\beta \geq 1 - \sqrt{\frac{\Delta-D}{\Delta}} \equiv \beta_2$. Simple algebra shows that $\beta_2 < \beta_1$. When $\beta \in [\beta_2, \beta_1)$ producers can buy the indivisible good if the large buyer provides infrequent payments but not by saving on their own. Note that the threshold β_2 corresponds to the case in which producers sell at v and save in a commitment saving account with large withdraw fees before $t = 3$.

Infrequent Payments with a Relational Buyer: As discussed in the paper, a buyer who offers infrequent payments can further help producers save by threatening to punish them if they fail to sell (and thus to save) on a regular basis. We focus on the stationary relational contract that maximizes the buyer profits subject to incentive constraints for the producer. In the resulting relational contract the large buyer sets a price p for deliveries and requires the producer to sell x_1 and x_2 in period 1 and 2 respectively, such that $p(x_1/\delta^2 + x_2/\delta) = D$. If the producer ever deviates, the large buyer will never accept deliveries from that producer in the future.

Self 2 sells to the large buyer if $v(1-x_2^{**})+\beta\delta\left(\Delta + \delta V^{\Delta}\right) \geq v+\beta\delta\left(\delta V^0\right)$, where $x_2^{**} = \delta(\frac{D}{p}-\frac{x_1}{\delta^2})$, $V^{\Delta} = \frac{(1-x_1)v+\delta(1-x_2)v+\delta^2\Delta}{1-\delta^3}$ and $V^0 = \frac{1+\delta}{1-\delta^3}v$ are the continuation values when maintaining or leaving the relation, respectively. The inequality holds if $x_1 \geq \delta^2\frac{Dv(1-(1-\beta)\delta^3)-p\beta\Delta}{pv(1-\delta^3)} \equiv x_1^{**}$. Thus, x_1^{**} is the minimum level of (infrequent payment) sales that self 1 must make to the large buyer to induce self 2 to sell to the large buyer, too. Self 1 will chose to sell this amount if $p \geq Dv\frac{1+(1-\beta)^2\delta^3}{(2-\beta)\beta\Delta} \equiv p_3$.

Under the assumption of perfect contract enforcement and no buyer default, the relational contract helps producers buy the indivisible good as long as the large buyer can make zero profit from the relationship, i.e., if $p \leq v$. Setting $p = v$ and rearranging terms yields $\beta \geq 1-\sqrt{\frac{\Delta-D}{\Delta-D\delta^3}} \equiv \beta_3$. Simple algebra establishes $\beta_3 < \beta_2$. When $\beta \in [\beta_3, \beta_2)$, the producer buys the indivisible good under the relational contract (which features both illiquid payment and punishment threat), but not with illiquid payments alone. Even a producer with access to an illiquid saving technology might not use it if the buyer provides illiquid payments with the additional threat of future punishment if the producer deviates from the plan.

Proof of Proposition 2. We now consider the case in which infrequent payments must be self-enforcing, i.e., buyers must be given incentives to honor their promises to pay at the end of the month. While, in principle, both the large and the small buyers can offer infrequent payments, we characterize an equilibrium in which the large buyer sets prices such that small buyers are *not* able to credibly promise infrequent payments. That is, we construct an equilibrium such as the one described in Proposition 3. We first check that in equilibrium there are no profitable unilateral deviations and then show that there are intermediate values of β that satisfy all the conditions.

Proposed Equilibrium: In the proposed equilibrium the large buyer first sets the price for infrequent payments.[1] The small traders decide whether to offer daily or infrequent payments and at which price. Finally producers either accept or reject the relational contract offered by the large buyer and make their sales and purchases decisions.

Large Buyer: The large buyer sets the price to maximize profits subject to three constraints: *i)* producers must be willing to sell; *ii)* no other trader can credibly offer infrequent payments; and *iii)* the large buyer must be credible. Generally, when such an equilibrium exists *iii)* cannot be binding.

Let us now consider the large buyer's possible deviations. Two cases must be distinguished: *case 1:)* the producer's participation constraint is binding; *case 2:)* the small traders' incentive constraint binds. In both cases the large buyer has no incentive to default on promised monthly payments, as she would lose the future rents. In both cases she also has no incentives to lower the price. If the producer's participation is binding that would lower the volumes bought; if the small trader's incentive constraint is binding traders would then become credible at a larger price and the buyer wouldn't make any profit. The large buyer has thus no incentives to deviate.

Producers: In *case 1* producers do not have incentives to deviate: they are indifferent between sticking to the plan versus deviating and never being able to buy the indivisible good in the future. In *case 2* they would be made strictly worse-off by such a deviation.

Small Traders: Small traders also have no incentives to deviate. In the proposed equilibrium they make zero profits. Given the price set by the large buyer they can't credibly offer infrequent payments. If they do so, they would still make zero profit.[2]

We have thus checked that the proposed strategy profile constitutes a subgame-perfect Nash equilibrium in which no player has a unilateral incentive to deviate. We now check that all the required conditions can indeed be verified for intermediate values of impatience β.

Existence: Consider a deviation in which a small buyer offers a producer infrequent payments at price p and denote with $\hat{x}_t^S$ the resulting quantity the trader buys in period $t = 1, 2$. If the producer accepts the small buyer's offer, she is punished by the large buyer who will refuse to purchase from her in the future. To attract the producer, then, the small buyer must offer a deal that allows the producer to purchase the indivisible good solely from his promised low frequency

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

[2] The assumption that buyers either offer monthly or daily payments, but not both, rules out a deviation in which small traders offer a contingent plan in which monthly payments are offered only to those producers that have defaulted on the large buyer. If they could do so (or if we consider asymmetric equilibria in which some small traders specialize in offering infrequent payments to defaulting producers) we need to distinguish the two cases. In *case 1* the producer wouldn't accept the offer: the producer constraint is binding at a monthly price that is larger than what traders could credibly offer. In *case 2*, instead, the defaulting producer would accept the deal. This contingent plan would thus change the value of defaulting on the large buyer for the producer. This would shrink the set of parameters for which a *case 2* equilibrium arises, without altering any of the other conclusions.

payment. The deviating small buyer faces the maximum temptation in $t = 3$, once he has already purchased the output and needs to pay for deliveries $\hat{x}_1^S$ and $\hat{x}_2^S$. Let's consider a one-period deviation where the small buyer defaults for one month and then reverts to pay future sales with infrequent payments upon meeting in the outside market a producer willing to sell to him (which happens in each period with probability γ).[3]

The continuation value of such a relationship with a producer is given by $V^S = \sum_{s=0}^{\infty} \delta^{3s}(v - p)(\hat{x}_1^S + \delta\hat{x}_2^S)$. The small buyer's offer is credible if paying the promised amount and continuing the relationship gives a higher discounted value than defaulting and then searching for an uninformed producer in the outside market, that is: $-\frac{p}{\delta^2}(\hat{x}_1^S + \delta\hat{x}_2^S) + \delta V^S \geq \delta \sum_{m=0}^{\infty} \gamma(1-\gamma)^m \delta^{3m} V^S$. Simple algebra delivers: $p \leq \delta^3(1-\gamma)v \equiv p^S$. The empirical version of the trader IC constraint used in the calibration (Equation 1) is similarly derived. We consider a buyer who sources a constant amount of milk, x, and pays the same unit price, p, across the 30 days of the month (these assumptions are supported by the data). The incentive constraint is $-30px + \delta \sum_{s=0}^{\infty} \delta^{30s}((\sum_{t=0}^{29} \delta^t vx) - 30\delta^{29}px) \leq \delta \sum_{u=0}^{\infty} \delta^{30u}(1-\gamma)^u \sum_{s=0}^{\infty} \gamma\delta^{30s}((\sum_{t=0}^{29} \delta^t vx) - 30\delta^{29}px)$, which simplifies to $p > \frac{1}{30}\delta(1-\gamma)\frac{1-\delta^{30}}{1-\delta}v \equiv p^T_{empirical}$.

The large buyer sets the price to maximize profits subject to three constraints. First, he must pay a price higher than the highest price at which small buyers can credibly promise infrequent payments, $p \geq p^S$. Second, he must pay a price high enough to induce producers to sell for infrequent payments. This minimum price, which we denote as p^P, is equal to p_3 defined in the proof of Proposition 1. At this price, the large buyer must be credible, which is the case if $p^P \leq \delta^3 v$. Simple algebra shows that this is the case if $\beta \geq 1 - \sqrt{\frac{\Delta - \frac{D}{\delta^3}}{\Delta - D}} \equiv \beta_4 > \beta_3$. There always exists a set of parameters such that $\beta_4 < \beta_1$, and thus the producer can save through a relational contract with infrequent payments (and imperfect enforcement), but not on her own. The large buyer then sets $p^* = \max\{p^S, p^P\}$.

A.2 Extensions

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

[3]In the model, default on one farmer triggers punishment from farmers the trader tries to match in subsequent periods, but not from other farmers the buyer is currently buying from. Allowing for this collective punishment would imply that the optimal deviation for the trader would be defaulting on all the farmers he buys from. If the opportunity to find new uninformed farmers, γ, is invariant with size, the trader incentive constraint when allowing for collective punishment would be identical to our baseline framework. However, γ may be decreasing in the number of farmers the buyer deals with. In practice, most traders are small itinerant buyers with limited capacity. We therefore abstract from differences in size across traders and focus on the difference between the traders and the large credible buyer. The model generalizes to the case with heterogeneous costs of default: $\gamma_0 \leq \gamma_1 \leq \gamma_2 < ... < \gamma_N$.

Producer's Utility and Heterogeneity. The model assumes that producers have a linear utility function. Allowing a concave utility function and/or that producers also derive utility from consumption of the divisible good in $t = 3$ would make algebra more cumbersome without providing additional insights or altering the key results.

Similarly, it is also straightforward to extend the model to allow for producers heterogeneity in, e.g., the degree of time-inconsistency β or the valuation for the indivisible good Δ. Consider for instance the case in which Δ_i differs across producers and is distributed according to a strictly increasing and twice continuously differentiable cumulative function $G(\Delta_i)$ on support $\Delta_i \in [0, \infty)$. In this case the key result of the theory that the price paid by buyers offering monthly payments is lower than the daily price would still emerge in equilibrium. In addition, there would be a sorting of producers with heterogeneous Δ_i into different marketing channels.[4]

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

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

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

Furthermore, the presence of large buyers offering a saving tool undermines producers' credibility when borrowing from traders: in the event of a default against a trader, the producer can still buy desired lumpy goods in the future by selling to the large buyer. By offering this saving service, the large buyer prevents competition from traders offering credit without having to take on any default risk. In our context, producers have limited access to well-functioning formal credit markets, but they could borrow from either the large buyer, traders, or other informal sources to finance their lumpy consumption. Evidence from the survey reveals however that only 26% of

[4] These insights are robust to the case in which the large buyer can perfectly discriminate across producers. With multiple large buyers competing perfect discrimination would of course not be possible. In practice, the cooperative bylaws rule out price discrimination possibly due to prevailing norms and the concern that producers could perceive to be treated unfairly. We have also assumed that all buyers maximize profits. The framework can be extended to the case in which the large buyer (which is a coop) also cares about producers' welfare. Provided the assumption of limited contract enforcement is maintained the main results wouldn't change.

producers borrow from any source for their dairy business; and very few borrow from either traders or the coop.

Intra-Personal Plans. In the main text, we abstracted from producers' personal strategies across periods (see, e.g., Strotz, 1955; Laibson, 1997; Bernheim et al., 2015). These strategies could allow the producer to save the necessary amount to buy the indivisible good. The intuition is as follows. Consider a producer that decides to follow a plan in which she saves sufficient funds to purchase the indivisible good on her own. Should any of her selves ever deviate, all future selves consume all their endowment every period and the indivisible good is never purchased again. By relaxing the incentive constraint, infrequent payments would still help.

In our simple model with perfect monitoring the intra-personal rule perfectly mimics the relational contract with the buyer: if the producer can punish herself by committing to never buy the indivisible again she will achieve the same level of deterrence afforded by the relational contract with the buyer. In practice (and in more complicated models) we conjecture that the relational contract with the buyer could still help achieving saving targets even those producers that can implement inter-temporal saving strategies. For example, the producer might find it difficult to carry out the punishment because her future selves have a strong temptation to renegotiate. Such renegotiations might not be easily prevented since the producer also has strong incentive to forget what caused deviating from the plan in the past, as in Bénabou and Tirole (2004). The buyer has no incentive to renegotiate the punishment as such a renegotiation could lead other producers to reduce supplies and would have incentives to remind the producers about her past deviations. This would give the buyer a stronger ability to punish producers' deviating selves.

B Survey Evidence

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

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

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

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

Fourth, farmers report using money earned from the traders and from the coop for different purposes, as shown in Appendix Figure C.1. The monthly payment from the coop is predominantly (almost 40%) used to finance lumpy expenses in the dairy business, such as purchase of feed and equipment. The largest share of traders' daily payments is instead spent on current expenses, such as purchasing food (55%).[5] In sum, several additional pieces of survey evidence supports the

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

results from the demand experiments: farmers value the coop's infrequent payments as those help overcoming saving constraints.

B.2 Survey Evidence on Buyers

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

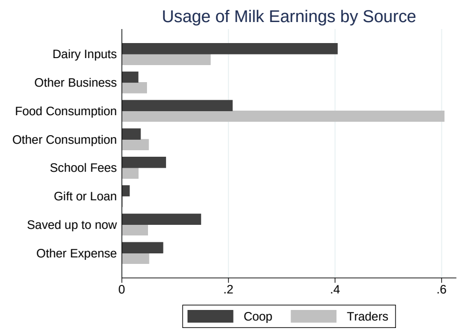
There are many reasons why farmers may be willing to accept a lower price from the coop. First, 75% of respondents report a sense of pride from selling to the coop. Second, farmers may take loans from the coop. However, survey data suggest only 7.5% do and "loans" mostly take the form of advances on milk *already* delivered.[6] The coop also sells inputs at some of its collection centers: This may reduce transaction costs, but 90% of farmers report being unsatisfied with the inputs' quality and prices. Third, while farmers report that most traders are available every day, the coop's demand may be more reliable in peak production season. However, since the coop does not condition present purchases on past deliveries, coop's purchase guarantee in the peak season cannot explain sales to the coop in other months. Fourth, about one-quarter of the farmers report they have attended a training organized by the coop over the last year. Fifth, there is essentially no quality testing done by either the coop or the large buyer, thus the difference in price cannot be driven by systematic differences in milk quality. Sixth, farmers may bear a higher transport cost when bringing milk to traders than to the coop collection center. However, average distance between the farmer and the sale point seems higher for the coop. Finally, we note the cooperative does not make second payments at the end of the year.

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

C Appendix Figures and Tables

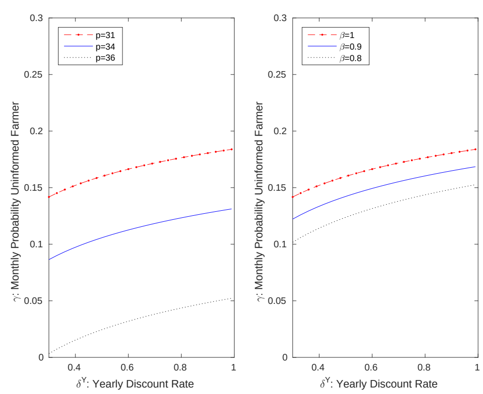
C.1 Appendix Figures

Figure C.1: Usage of Milk Earnings



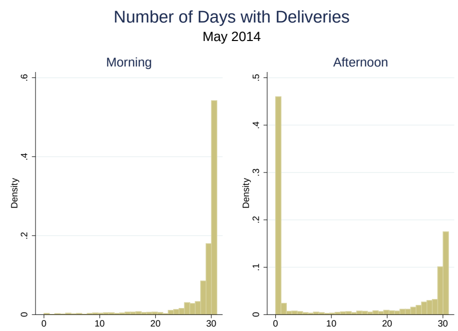
Notes: The figure describes how farmers in the baseline (N=595) use milk earnings from the coop and from other buyers, respectively. For each type of buyer, we compute the share of expenses on an item, relative to the total earned by the farmer from that buyer.

Figure C.2: Trader Incentive Constraint Calibration: Robustness



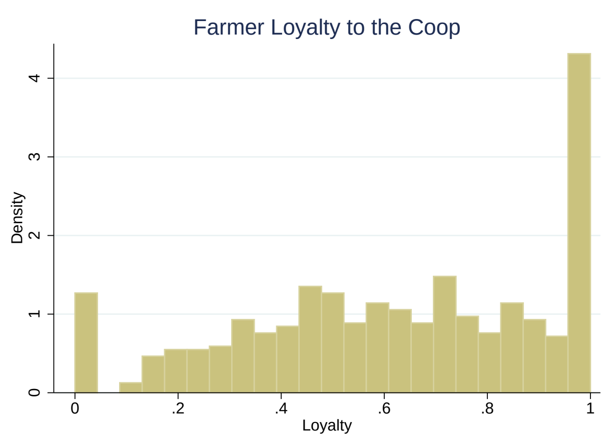
Notes: The figure presents robustness check to Figure 5. In the *left graph*, we vary the purchase price a trader would be able to offer when paying infrequently. If part of the observed price gap comes from other benefits the coop offers, the trader will have to offer a higher price. This reduces the γ threshold that makes the trader unable to commit. In the *right graph*, we allow the trader to be $\beta\delta$ and show to which extent an increase in time-inconsistency (i.e., lower β) reduces the threshold γ threshold.

Figure C.3: Number of Days with Deliveries to the Coop



Notes: The left (right) histograms present the distribution of the farmer-level number of days with positive deliveries to the coop in the morning (afternoon) in a month (measured in May 2014). The sample includes all the farmers making at least one sale to the coop (N=1,901) The figure shows that many farmers sell to the coop (almost) every day of the month and (almost) never in the afternoon.

Figure C.4: Farmers' Loyalty to the Coop



Notes: The *Loyalty* variable is defined as the ratio between sales to the coop and production available for sales among farmers in the baseline survey (N=595). Production available for sales is defined as the difference between production and home consumption (including feeding calves). Deliveries to the coop are obtained from cooperative records.

C.2 Appendix Tables

Table C.1: Baseline Correlations

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

Notes: The table presents correlation between several measures of saving behavior and other farmer covariates, measured in the baseline survey for the *Price and Liquidity Experiment*, described in Section V-B. *Avg Daily Deliveries* are from coop administrative data. Both production and delivery variables are measured in kilograms. *Loyalty* variables are defined as ratios between sales to the coop and production available for sale (defined as the difference between production and home consumption, including feeding calves). A farmer is defined as *present biased* if she is more impatient when splitting KSh 200 between today and next week than between next week and the subsequent one. *Trust* for either the coop and the buyer is measured on an index from 1 to 4. Therefore, their difference can span -3 to 3. *Regular Income from Other Occupation* refers to permanent employee, civil servant, artisan, trader, and self-employed. For each of the covariates, the regression also includes a binary indicator for whether that covariate is missing (and missing values in the variables are replaced with an arbitrary negative value). Standard errors are robust to heteroskedasticity.

Table C.2: Farmer Saving Behavior and Sales to the Coop

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

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

Table C.3: Price and Liquidity Experiment: Balance Table

	Bonus [M]	Bonus+Flex [F]	Control [C]	P-value [M-F]	P-value [M-C]	P-value [F-C]	N
Male Respondent	.3706	.4765	.4123	.052	.825	.319	389
	(.4846)	(.5011)	(.4948)				
Respondent Age	58.39	54.96	56.12	.136	.323	.455	387
	(15.90)	(15.98)	(15.05)				
Household size	4.945	5.306	5.163	.133	.73	.425	395
	(2.185)	(1.928)	(2.064)				
Number of Cows	1.383	1.346	1.448	.849	.426	.28	394
	(.6874)	(.6754)	(.6904)				
Dairy Production (kg)	11.44	11.11	11.00	.894	.617	.803	389
	(7.026)	(4.948)	(5.450)				
Average Daily Deliveries in Sep 2014	3.963	4.051	4.216	.826	.199	.302	398
	(2.257)	(2.413)	(2.262)				
Loyalty	.6632	.6582	.6713	.597	.881	.618	376
	(.2476)	(.2516)	(.2529)				
Loyalty AM	.7814	.7669	.7611	.405	.659	.743	383
	(.2225)	(.2221)	(.2210)				
Loyalty PM	.4978	.5057	.5429	.552	.742	.213	378
	(.5004)	(.4997)	(.4943)				
Hire workers for dairy	.2229	.2516	.2551	.314	.625	.835	397
	(.4176)	(.4354)	(.4381)				
Any Other Village Trader	.8367	.8807	.7755	.25	.468	.079	396
	(.3708)	(.3251)	(.4193)				
Present Biased	.1313	.1103	.1086	.62	.538	.816	374
	(.3390)	(.3144)	(.3129)				
Difference Trust Coop-Trader	.7591	.9851	.9418	.158	.488	.523	358
	(1.121)	(1.126)	(1.109)				
Saves in Saving Groups	.6418	.7302	.7395	.121	.09	.831	396
	(.4810)	(.4452)	(.4411)				
Saves in Bank	.7260	.7105	.7938	.822	.274	.224	395
	(.4475)	(.4550)	(.4066)				
Regular Income from Other Occupation	.2094	.2105	.2142	.961	.572	.897	398
	(.4083)	(.4090)	(.4124)				
HH member manages money not cows	.2463	.2739	.3333	.694	.271	.146	377
	(.4324)	(.4475)	(.4739)				

Notes: The table reports summary statistics and balance tests for the *Price and Flexibility* randomized experiment described in Section V-B. Farmers in the *Bonus* group received an increase in milk price of 10 Kenyan shillings for afternoon deliveries. Farmers in the *Bonus+Flexibility* group received the same price increase and the option to be paid daily. *Avg Daily Deliveries* are from coop administrative data. Both production and delivery variables are measured in kilograms. *Loyalty* variables are defined as ratios between sales to the coop and production available for sale (defined as the difference between production and home consumption, including feeding calves). A farmer is defined as *present biased* if she is more impatient when splitting KSh 200 between today and next week than between next week and the subsequent one. *Trust* for either the coop and the buyer is measured on an index from 1 to 4. Therefore, their difference can span -3 to 3. *Regular Income from Other Occupation* refers to permanent employee, civil servant, artisan, trader, and self-employed. The randomization was stratified by farmer location (i.e., four zones) and baseline delivery levels (i.e., above/below median). We report p-values based on specifications that include stratum fixed effects.

Table C.4: Price and Liquidity Experiment: Heterogeneous Treatment Effects

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

Notes: The table presents heterogeneous treatment effects for the *Price and Flexibility* randomized experiment described in Section V-B. Farmers in the *Bonus* group received an increase in milk price of 10 Kenyan shillings for afternoon deliveries. Farmers in the *Bonus+Flexibility* group received the same price increase and the option to be paid daily. We report results from the difference-in-differences model with farmer FE from Table 3, Column (3). The dependent variable is the kilograms of milk the farmer delivers to the coop in the afternoon. Refer to the notes of Table 3 for further details on the specification. *Avg Daily Deliveries* are from coop administrative data. Both production and delivery variables are measured in kilograms. *Loyalty* variables are defined as ratios between afternoon sales to the coop and afternoon production available for sale (defined as the difference between production and home consumption, including feeding calves). Standard errors are clustered at the farmer level.

D Experimental Instructions

This section presents sample instructions for the lab-in-the-field "*supply experiments*" presented in Section IV.

Introduction

Imagine that for the following month you have 3 litres per day to sell, for a total of 90 litres of milk in a month. I am going to ask you how you would like to sell this milk depending on various factors, including the price of milk, the mode of payment and the type of buyer.

We will ask you how you would sell your milk to a local trader who operates in your village [TRADER NAME]. In each question, you will be given two options, which may be different in price and the mode of payment.

Because you are going to earn money depending on how you chose to sell the milk, it is important you focus your attention and consider this as a real-life sale. To help you focusing on the choice, I will pour 3 liters of milk into 6 cups, of half liter each. I will put in front of you two buckets: one for each option. You will then decide how much to sell to each of the two options by simply pouring the milk into the corresponding bucket. So, if this is the bucket for option A and this is the bucket for option B, and you want to split the milk 50-50, youll pour 3 cups into each bucket. If, say, you want to sell most of it to option B, you can pour 5 or 6 cups in that bucket.

The choice that you make today will apply to each day for the next 30 days.

Remember, this is real milk and your choices will determine how much money you and the buyer earn. Specifically, for each litre of milk you sell to a buyer, we will transfer 60 Ksh to that buyer (as if we were then buying the milk from that buyer).

In each game, the buyers will offer you a price which will vary depending on specific rules of each game. We will provide details on the payment separately in each game.

In total, I am going to ask you SEVEN different questions. Think about each question carefully and separately, as if you were deciding how to sell your own milk to these different buyers.

At the end, you will draw from this bag a piece of paper. Each game appears at least on one piece of paper. The selected question will determine the question according to which you are going to be paid.

In addition to this payment, you will also get an appreciation fee of Ksh500 if you complete the sessions

OK. We are ready to start. Do you have any question?

Guaranteed Treatment

You have 3 liters of milk per day, for a total of 90 liters per month. We have poured your daily milk (3 liters) in 12 small cups. You can sell your milk to TRADER, who can pay you in different ways. The choice you make today will apply to the next 30 days.

Remember, we will give TRADER 60 Ksh per litre that you sell to him, minus any applicable deduction depending on your choice. We will pay TRADER the appropriate amount every day.

You have two options to sell your milk.

- You can sell part or all of your milk for a DAILY payment. For each litre you sell for DAILY payment, you will receive 40 Ksh per litre per day, paid every day over the next 30 days. To pay you, we will deduct 40 Ksh per litre per day from to the payment we make to TRADER and pay it to your MPESA account. Thus, you are guaranteed to be paid.

- You can sell part or all of your milk for a MONTHLY payment. For each litre you sell for MONTHLY payment, you will receive 50 Ksh per litre per day, paid all together in 30 days. To pay you, we will deduct 50 Ksh per litre per day from to the payment we make to TRADER and pay it to your MPESA account all together at the end of the month. Thus, you are guaranteed to be paid.

Did you understand the question? Do you need any clarification?

How much of the 3 litres of milk per day would you sell to TRADER for DAILY payment and how much for MONTHLY payment? Remember, each cup is worth half liter of milk per day. Pour the corresponding amount of milk you want to sell for DAILY payment in the right bucket and the amount you want to sell for MONTHLY payment in the left bucket.

Non-Guaranteed Treatment

You have 3 liters of milk per day, for a total of 90 liters per month. We have poured your daily milk (3 liters) in 12 small cups. You can sell your milk to TRADER, who can pay you in different ways. The choice you make today will apply to the next 30 days.

Remember, we will give TRADER 60 Ksh per litre that you sell to him, minus any applicable deduction depending on your choice. We will pay TRADER the appropriate amount every day.

You have two options to sell your milk.

- You can sell part or all of your milk for a DAILY payment. For each litre you sell for DAILY payment, you will receive 40 Ksh per litre per day, paid every day over the next 30 days. To pay you, we will deduct 40 Ksh per litre per day from to the payment we make to TRADER and pay it to your MPESA account. Thus, you are guaranteed to be paid.
- You can sell part or all of your milk for a MONTHLY payment. For each litre you sell for MONTHLY payment, you will receive 50 Ksh per litre per day, paid all together in 30 days. Specifically, TRADER will be responsible for making you the payment at the end of the month. You will receive whatever money she decides to return on your MPESA account. If TRADER does not make any payment, you will not receive any money.

Did you understand the question? Do you need any clarification?

How much of the 3 litres of milk per day would you sell to TRADER for DAILY payment and how much for MONTHLY payment? Remember, each cup is worth half liter of milk per day. Pour the corresponding amount of milk you want to sell for DAILY payment in the right bucket and the amount you want to sell for MONTHLY payment in the left bucket.

No Trader's Saving Constraints Non-Guaranteed Treatment

You have 3 liters of milk per day, for a total of 90 liters per month. We have poured your daily milk (3 liters) in 12 small cups. You can sell your milk to TRADER, who can pay you in different ways. The choice you make today will apply to the next 30 days.

Remember, we will give TRADER 60 Ksh per litre that you sell to him, minus any applicable deduction depending on your choice. We will pay TRADER the entire due amount IN 30 DAYS.

You have two options to sell your milk.

- You can sell part or all of your milk for a DAILY payment. For each litre you sell for DAILY payment, you will receive 40 Ksh per litre per day, paid every day over the next 30 days. To pay you, we will deduct 40 Ksh per litre per day from to the payment we make to TRADER and pay it to your MPESA account. Thus, you are guaranteed to be paid.
- You can sell part or all of your milk for a MONTHLY payment. For each litre you sell for MONTHLY payment, you will receive 50 Ksh per litre per day, paid all together in 30 days.

> Specifically, TRADER will be responsible for making you the payment at the end of the month. You will receive whatever money she decides to return on your MPESA account. If TRADER does not make any payment, you will not receive any money.

Did you understand the question? Do you need any clarification?

How much of the 3 litres of milk per day would you sell to TRADER for DAILY payment and how much for MONTHLY payment? Remember, each cup is worth half liter of milk per day. Pour the corresponding amount of milk you want to sell for DAILY payment in the right bucket and the amount you want to sell for MONTHLY payment in the left bucket.

References

Abreu, Dilip. 1988. "On the theory of infinitely repeated games with discounting." *Econometrica: Journal of the Econometric Society* 383–396.

Banerjee, Abhijit, and Sendhil Mullainathan. 2010. "The shape of temptation: Implications for the economic lives of the poor."

Bénabou, Roland, and Jean Tirole. 2004. "Willpower and personal rules." *Journal of Political Economy*, 112(4): 848–886.

Bernheim, B Douglas, Debraj Ray, and Şevin Yeltekin. 2015. "Poverty and Self-Control." *Econometrica*, 83(5): 1877–1911.

Haushofer, Johannes, and Jeremy Shapiro. 2016. "The short-term impact of unconditional cash transfers to the poor: Experimental Evidence from Kenya." *The Quarterly Journal of Economics*, 131(4): 1973–2042.

Jack, William, Michael Kremer, Joost De Laat, and Tavneet Suri. 2016. "Borrowing Requirements, Credit Access, and Adverse Selection: Evidence from Kenya."Technical report, National Bureau of Economic Research.

Laibson, David. 1997. "Golden eggs and hyperbolic discounting." *The Quarterly Journal of Economics* 443–477.

Strotz, Robert Henry. 1955. "Myopia and inconsistency in dynamic utility maximization." *The Review of Economic Studies* 165–180.