# Digital Collateral

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# Motivation

*About 590 million Africans live off the grid. Most of them rely on flame-based lamps powered by fossil fuels like kerosene. The light from these lamps is dim and comes with significant health and financial costs. A kerosene lamp may cost less than $5, but fuel averages about $57 per year. Sub-Saharan Africans burn up about $10 billion annually on kerosene, and worldwide, kerosene costs people without electricity $36 billion.*

—Study by the International Finance Corporation (World Bank)

# The Problem

Low quality light, burns fossil fuel ($$$), fire hazard

# The Solution

A $30 solar lantern pays for itself in 8-10 weeks

# The (Product Adoption) Puzzle

In LMICs, household investment in many basic technologies has extremely high returns

- Yet adoption has been slow and is not widespread

There are a number of explanations for why

- Both on the supply and demand side
- Today will focus on credit market frictions

# Isn't microfinance the answer?

- Traditional microfinance
  - Expensive (and unsecured)
  - Inconvenient (high transaction costs)
  - Low uptake
  - Modest effects on the average borrower (Banerjee, 2015)

- Digital financial products are becoming increasingly popular. The growth has been facilitated by technology:
  - Access to mobile phones
  - Digital payments (mobile money)

What are the effects on households and firms? How best should they be utilized?

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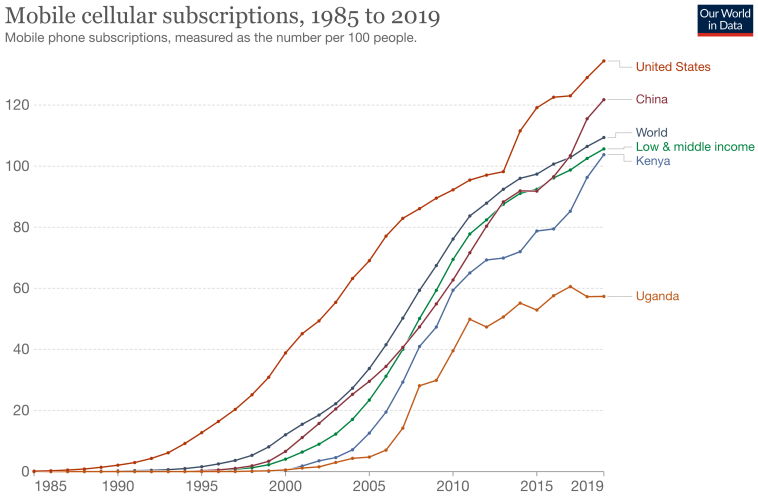
# Adoption has been Rapid



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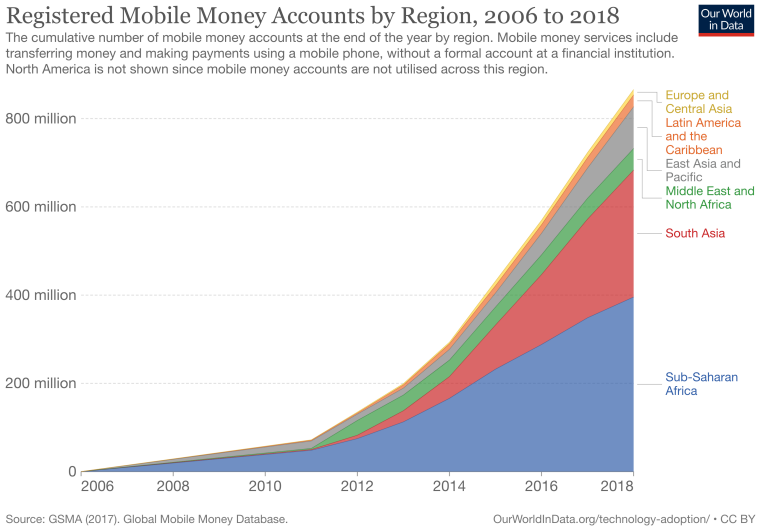

# What about secured lending?

Collateralized lending is the predominant source of credit for households in rich countries

- More than 80% of US household debt is secured

Why? Collateral alleviates credit market frictions.

1. Moral hazard: incentives to repay
2. Adverse selection: screening device

Collateralized lending is much less common in poor countries.

- Supply side: Repossession costs
  - Contracts hard to enforce; property rights are difficult to establish
- Demand side: Income risk
  - Threat of repossession unattractive to households

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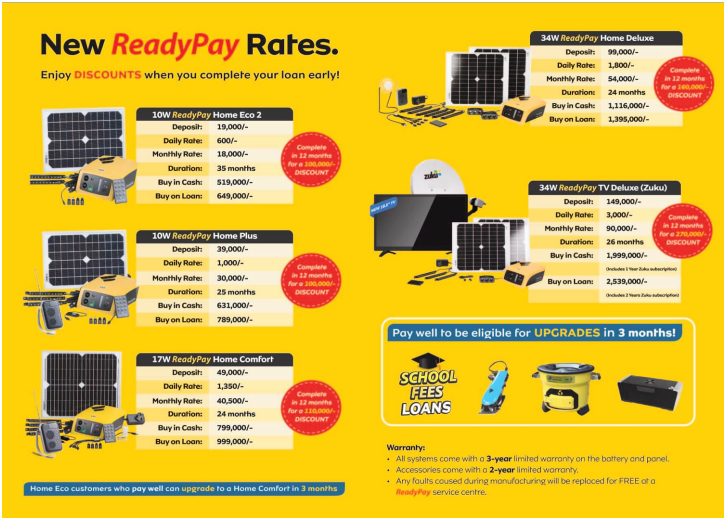
# Enter PAYGO financing and “Digital Collateral"

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GET A LOAN

# Research Questions

Experimental

- How valuable is securing loans with digital collateral to the lender?
  - Quantify the effect on repayment and profitability
- What is the channel?
  - Moral hazard vs adverse selection
- What are the impacts of the loans on households?

Theoretical

- What is the optimal way to utilize digital collateral?
  - Insurance vs incentives

# Summary of Experimental Results

1. Securing loans with DC significantly increases repayment and profitability
   - Default rates decrease by 19pp
   - Loan profitability (IRR) increases by 38pp
2. Decomposition
   - $\approx 2/3$ due to moral hazard
   - $\approx 1/3$ due to selection
3. Household outcomes appear promising
   - Reasonably high take-up
   - No evidence of a “debt trap"
   - More work to be done here
4. Securing loans with DC is not without cost
   - Production and installation costs of the technology
   - Median household is locked 25% of first 200 days
   - Flexible repayment: feature or bug? but potential room for improvement...

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# Field Experiment

- Partnership with Fenix International (recently acquired by Engie)
  - Largest SHS supplier in Uganda
    - Operations in Kenya, Zambia, Mozambique, Cote D'Ivoire and Nigeria
  - Range of SHS products, 10-34W
    - LED bulb $\approx$ 4-7W,
    - Refrigerator $\approx$ 500W
  - Third largest user of mobile money in Uganda

# Loan Product – School Fee Loans

In 2017, Fenix began offering "school fee" loans to existing SHS customers that were in good standing on their account

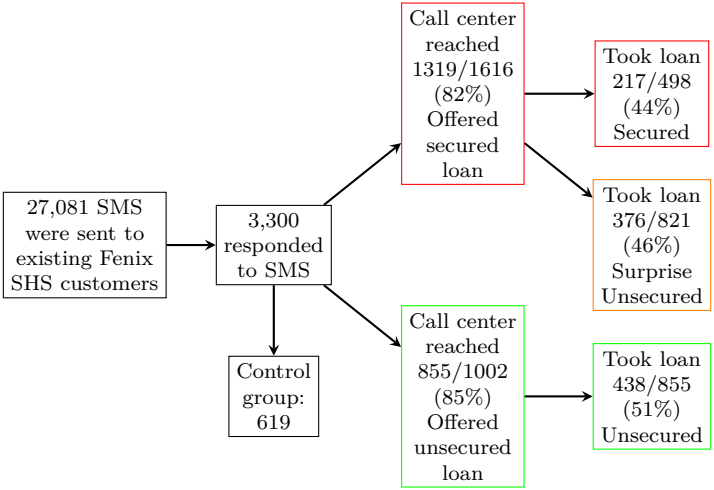
- Ranging from 100k-500k ($25-$125) loan size, 3x per year
- 100 day maturity, 15-20% deposit,
- PAYGO structure, e.g., on 300k loan
  - Make 50k deposit
  - Receive 300k a few days later
  - 3k per day, completed after 100 payments
  - If delinquent -> device locks
- Implied interest rate depends on repayment
  - 118% with 100% on time repayment
  - 64% with 50% repayment (1 out of every 2 days)

# Experimental Design

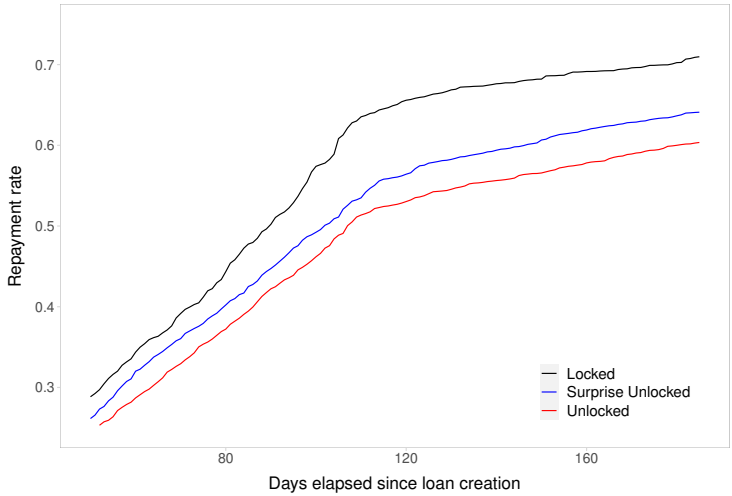
- Sample randomly divided into 4 groups
  1. Secured: Offered a loan secured by digital collateral (their SHS)
  2. Unsecured: Offered an unsecured loan
  3. Surprise Unsecured: Offered secured loan, if they accepted, we “surprised" them (ala Karlan and Zinman, 2009)
  4. Control: No offer

- Difference in repayment between Secured and Unsecured captures MH + AS
  - Secured - Surprise Unsecured: same offer $\implies$ only MH
  - Surprise Unsecured - Unsecured: different offer $\implies$ only AS

# Sample Sizes and Take-up



# Loan Repayment



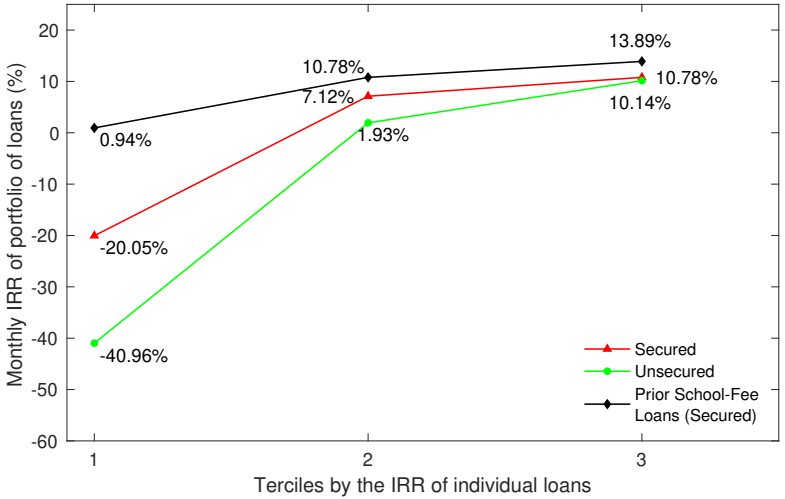
# Loan Repayment

| Loan day | Mean Unsecured | Secured | Adverse Selection | Moral Hazard |
|---|---|---|---|---|
| 100 | 0.46 | 0.13*** | 0.04 | 0.09** |
| | | (0.04) | (0.03) | (0.04) |
| 150 | 0.57 | 0.13*** | 0.05 | 0.09** |
| | | (0.04) | (0.03) | (0.04) |
| 200 | 0.62 | 0.11*** | 0.04 | 0.07* |
| | | (0.04) | (0.03) | (0.04) |
| $n$ | | 655 | 814 | 593 |

# Loan Completion

| Loan day | Mean Unsecured | Secured | Adverse Selection | Moral Hazard |
|---|---|---|---|---|
| 110 | 0.31 | 0.10** | 0.01 | 0.09* |
| | | (0.05) | (0.04) | (0.05) |
| 150 | 0.41 | 0.17*** | 0.05 | 0.12** |
| | | (0.05) | (0.04) | (0.05) |
| 200 | 0.47 | 0.19*** | 0.05 | 0.13** |
| | | (0.05) | (0.04) | (0.05) |
| $n$ | | 655 | 814 | 593 |

# Profitability



# Educational Outcomes

| | Enrollment | | Days absent | | Log school expenditures | |
|---|---|---|---|---|---|---|
| Secured | 0.11*** | | -2.39*** | | 0.47*** | |
| | (0.03) | | (0.77) | | (0.16) | |
| Surprise Unsecured | 0.08*** | | -1.31* | | 0.32** | |
| | (0.03) | | (0.74) | | (0.15) | |
| Unsecured | 0.10*** | | -2.00*** | | 0.37** | |
| | (0.03) | | (0.74) | | (0.15) | |
| Pooled | | 0.09*** | | -1.83** | | 0.37** |
| | | (0.03) | | (0.72) | | (0.15) |
| Pooled × Children | -0.02*** | -0.02*** | 0.37** | 0.38** | -0.05 | -0.05 |
| | (0.01) | (0.01) | (0.19) | (0.19) | (0.04) | (0.04) |
| Outcome control mean | 0.88 | 0.88 | 2.77 | 2.77 | 81 | 81 |
| $n$ | 1683 | 1683 | 1683 | 1683 | 1683 | 1683 |

# Effect on Household Balance Sheet

| | Asset purchases | | Asset sales | | Money borrowed | | Net difference | |
|---|---|---|---|---|---|---|---|---|
| Secured ($\beta_1$) | 15 | | -10 | | 23 | | 2 | |
| | (44) | | (20) | | (47) | | (62) | |
| Surprise Unsecured ($\beta_2$) | -23 | | -4 | | 28 | | -47 | |
| | (39) | | (18) | | (42) | | (55) | |
| Unsecured ($\beta_3$) | 33 | | 14 | | 17 | | 2 | |
| | (39) | | (18) | | (42) | | (55) | |
| Pooled ($\beta$) | | 8 | | 2 | | 23 | | -17 |
| | | (34) | | (16) | | (37) | | (48) |
| Outcome control mean | 236 | 236 | 96 | 96 | 283 | 283 | -143 | -143 |
| $n$ | 1877 | 1877 | 1877 | 1877 | 1877 | 1877 | 1877 | 1877 |

- No significant impact on household finances.

# What is the real innovation?

Two possibilities:

1. Better technology for repossession
   - Provides repayment incentives without incurring repossession costs
   - Plausible (even likely)...but straightforward

2. Facilitates a richer space of contracts (e.g., “temporary" repossession) by lowering the cost of dynamically controlling household’s consumption of the good.
   - Question: is this actually valuable?
   - Answer: Yes! (Green and Sraer, 2022)

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   - Answer: Yes! (Green and Sraer, 2022)

# Conclusion

- Firms: Securing loans with DC significantly increases repayment and profitability
- Households: Relatively high demand for credit secured by DC
  - Access to credit increases school enrollment and expenditures
- But not without cost: median HH locked 25% of first 200 days
  - Room for improvement? Overall welfare effect on households?
- Temporary repossession (as in PAYGO) can be optimal

# Current and Future Directions

Contract Design

- Is it possible to reduce locking without sacrificing incentives for repayment?
  - Arrears vs Paygo
  - Implementation of optimal contract with loyalty program/virtual currency

Quantify the Welfare Effects

- Estimate a model of households and firms
  - Employs data from a randomized pricing experiment of smartphone contracts
- Counterfactual: no lockout, perfectly competitive pricing
- Current estimates
  - Current pricing: Household welfare ↑ 10-15% income for customers with 60% take up