How Important are Investment Indivisibilities for Development? Experimental Evidence from Uganda

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Motivation

Theory: Investment indivisibilities can play an important role in development

- Micro development:
  - Explain entrepreneurship decisions and savings dynamics (e.g, Bassi et al., 2022; Buera, 2009; Midrigan & Xu, 2014)
  - Generate poverty traps (e.g, Balboni et al., 2021; Banerjee & Newman, 1993; Buera et al., 2014, Carter & Lybbert, 2012, Lybbert et al., 2004, Mckenzie & Woodruff, 2006)
  - Important for predicting impacts of financial interventions and poverty programs (e.g., Banerjee et al., 2019; Buera et al., 2021; Janes et al., 2021; Kaboski & Townsend, 2011)
- Macro development: Influence the quantitative importance of financial frictions for aggregate development, e.g., through output, productivity, and investment (Buera et al., 2014; Midrigan & Xu, 2014)
- Implies a demand for financing and risk

These issues are of particular interest in *peri-urban areas of LICs*, which are the margins for financial intermediation, growth

Research Questions

1. Are there investment non-convexities? For whom?
   - Empirical test: Offer a choice between a lottery with a low probability of a large grant and a lottery with a high probability of a small grant. *Importantly, low probability of large grant lottery is lower in expected value.*
     - Does anyone accept the lower expected value large grant lottery?
     - What types of people select into a riskier lottery?

2. What are the returns to investments made with the marginal dollar relative to investments made with the threshold k?
   - Empirical Test: How do investments made by those winning the riskier lottery differ from investments made by those winning the safer lottery? How do the returns to capital for those choosing the safe lottery differ from the risky lottery? (Note that this includes both the selection effect and the differential impact of the funds).

3. What do the investment choices imply for the general equilibrium effects of financial deepening?
   - Policy simulations: Calibrate model using baseline sample characteristics, including lottery choices $\implies$ simulate general equilibrium effects of financial interventions

Micro Findings

1. Substantial percentage chooses high-risk, larger grant (27 percent), especially among high-saving, male, investment-oriented households

2. Substantial levels of investment among lottery winners

   - Small lottery winners invest in agriculture and business, primarily in livestock and inventory in the short run, business durables in the long run.
   - Large lottery winners also invest in business durables, but largest investments are in land.
     - Growing literature on the importance of land market frictions and productivity (Foster and Rosenzweig, 2022; Bryan, de Quidt, Vargas, Wilkening and Yadav, wp; Acampora, Casaburi, Willis, wp)
   - Large lottery winners show some evidence of increased consumption at 18 months, and large income gains at 6 years. There are also potentially large returns due to capital gains on land.

3. Methods: Theory-implied cross-equation budget constraint useful

Macro Findings

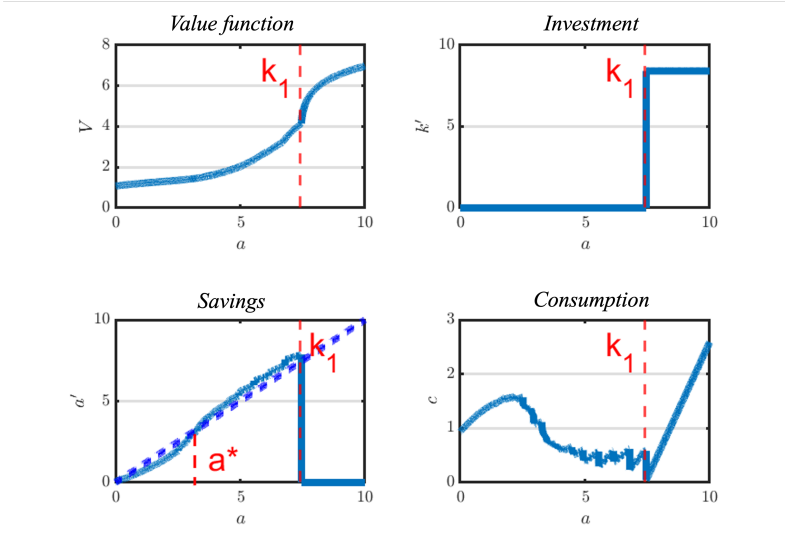
4. Aggregate impacts of credit, savings expansion depend on the elasticity of supply of the investment good

   - Elastic supply, e.g., durable business assets $\implies$ large aggregate impacts
   - Inelastic supply, e.g., land $\implies$ little impact, price simply adjusts
   - Empirical evidence of GE impacts on land price in peri-urban areas

Model Implications

- Poverty traps arise due to the indivisible investment opportunity (under financial frictions)
- This leads to a preference for risk $\implies$ Risky investment opportunities (lotteries, in our context) may be chosen to help finance indivisible investments
- Those choosing the risky lottery are high productivity, i.e., their return to investing exceeds saving

Asset-Dependent Poverty Traps for High Capital-Productivity Household

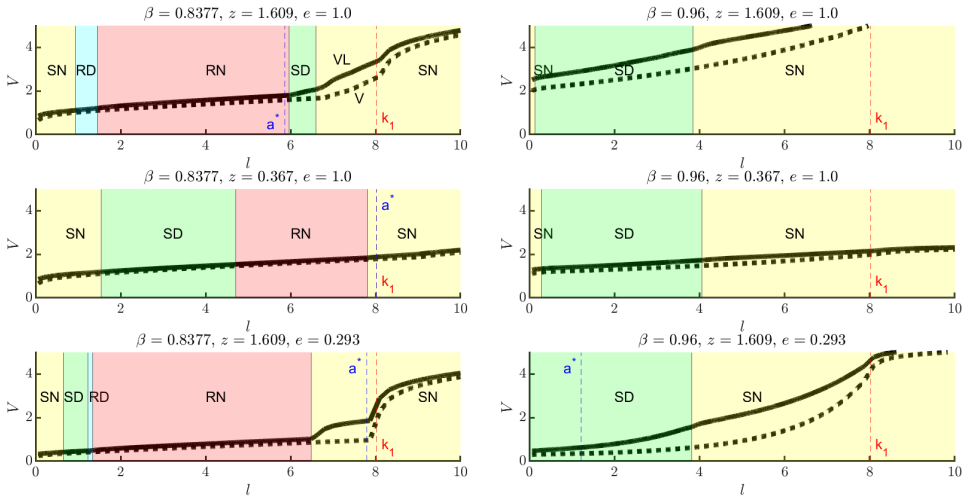


Lottery Setup

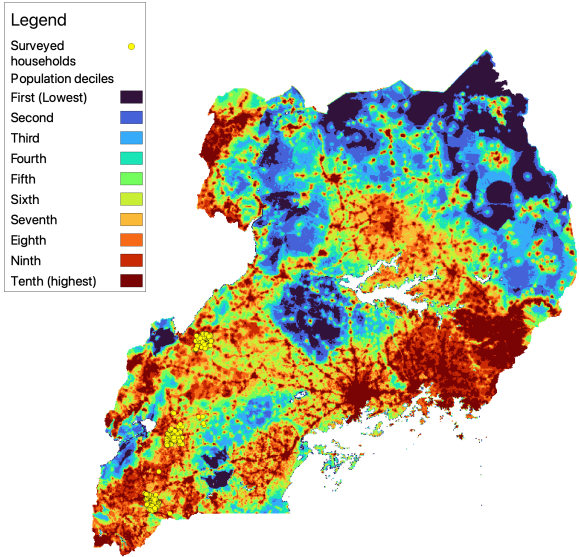
The convex region of the value function should lead to a preference for risk. We offer four lotteries to test model predictions:

1. Safe now (SN): Pays Δ^S with probability π^S immediately
2. Safe delay (SD): Pays $1.03\Delta^S$ next period with the same π^S probability
3. Risky now (RN): Pays $\Delta^R > \Delta^S$ with probability $\pi^R < \pi^S$ immediately
4. Risky delay (RD): Pays $1.03\Delta^R$ next period with the same π^R probability

Asset-Dependent Lottery Selections: At Varying Productivity Levels and Discount Rates



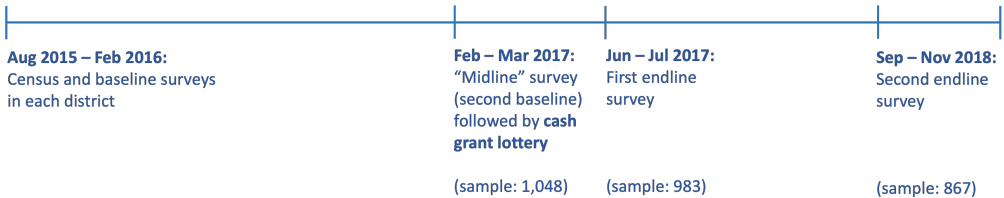
Experiment: Sample



Population Data Source: WorldPop,& Bondarenko,M.(2020). Individual Countries 1km UN Adjusted Population Density (2000-2020) [Data set].University of Southampton. https://doi.org/10.5258/SOTON/WP00675

Experiment: Sample and Timeline

1,048 underbanked peri-urban and rural households in the western Uganda districts of Ntungamo, Ibanda, and Kagadi:



Started with a census survey and then oversampled:

- Entrepreneurs
- Those lacking formal financial services, such as credit or a savings account
- Stratified over gender, household head status

Cash Grant Experiment

- At midline, participants were given a choice between:
  1. 50% chance of winning 350,000 UGX ($98, ~2 months of median income) either tomorrow or with 3% interest in 30 days
  2. 10% chance of winning 1,700,000 UGX ($476, ~10 months of median income) either tomorrow or with 3% interest in 30 days
- The small and large lottery correspond to the 25^{th} and 75^{th} percentile desired investment levels, as reported in the baseline survey
- Expected value in the risky lottery is slightly lower: $\$47.60 < \$49.00$
- Shown probabilities using visual "beads" and unlimited practice rounds of both lotteries on the enumerator's tablet, *before* choosing

Lottery Choices

	High-risk	Low-risk	Total
Patient	78	144	222
	(7%)	(14%)	(21%)
Impatient	204	622	826
	(20%)	(59%)	(79%)
Total	282	766	1,048
	(27%)	(73%)	(100%)

27% of participants sign up for the large lottery despite the fact that it is *lower* in expected value–participants would need to be risk seeking for this to be explained by risk preferences, and Holt and Laury (2002) show that risk aversion tends to increase in lottery size.

◂ balance: small lottery ◂ balance: large lottery

Determinants of Lottery Choice

The model predicts that those choosing the riskier lottery:

- Do so to finance investment
- May have higher savings as they increase wealth to self-finance investment
- Have high productivity
- May be either patient or impatient in lottery choice

Determinants of Lottery Choice

Significant predictors of selecting the larger lottery:
(model predictions in parentheses)

- Report that they want to use credit for business investment and want to invest >$100
  (do so to finance investment)
- Have higher wealth and larger growth in wealth from baseline to midline
  (may have higher savings)
- Have higher crop income and larger growth in total income from baseline to midline
  (have high productivity)
- Are more patient than average (28% among the risk-loving v. 22% in overall sample)
  (may be either patient or impatient)
- Demographically: Male, household heads, slightly older, with larger families

Income Predictors of Risk-Loving Wealth Predictors of Risk-Loving

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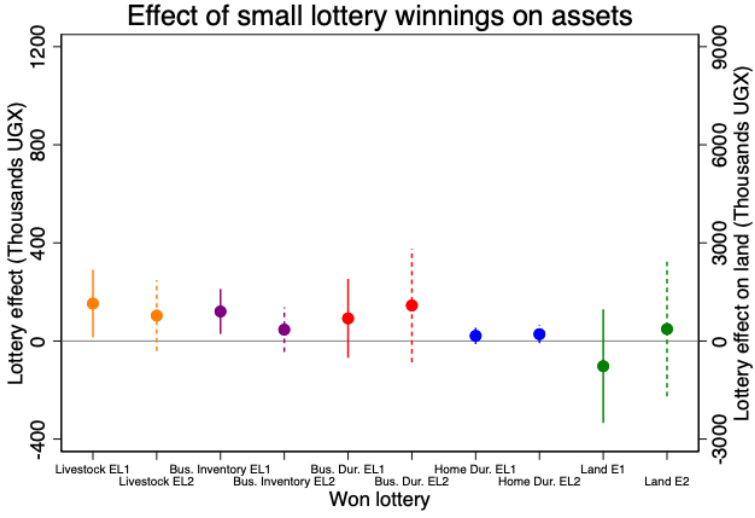
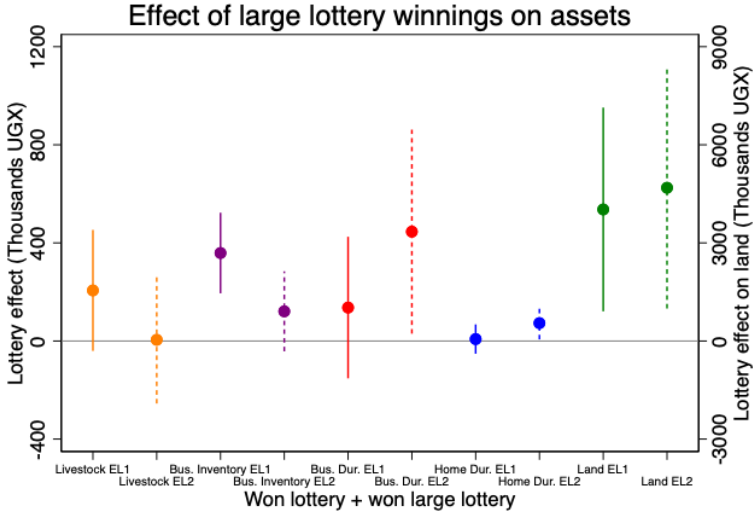
Impact of Small Lottery on Assets?



All coefficients plotted on left axis except land

Impact of Large Lottery on Assets?



All coefficients plotted on left axis except land

Measuring Grant Impact on Households

For each i household in district d:

$$Y_{id} = \beta_0 + \beta_1 Win_i + \beta_2 Win_i * D_i^m + \beta_3 D_i^m + \rho_1 Y_i^b + \rho_2 Y_i^m + \gamma X_i^m + \lambda_d + \varepsilon_{id}$$

(m denotes midline and b denotes baseline, both pre-intervention)

- Outcome Y_{id}: Consumption, savings, investment, income, borrowing
- Win_i: Whether the household won a lottery (small or large)
- $Win_i * D_i^m$: Additional effect of winning the risky lottery ("won large lottery")
- D_i^m: Household's lottery decision, risk loving or not
- X_i^m: Vector of household-level demographic controls, including patience
- λ_d: District fixed effects

Appreciation in Land Values

Land values appreciated by 41% between midline and second endline! Why?

- Urbanization and government expansion of infrastructure network.
- Measurement error
- Land investment may be substantial, but take time to increase income (for example, buildings take time to construct and use).
- Expansion of the oil industry in Western Uganda
- Appreciation created by increased land demand from grant experiment–approximately 20% of total appreciation of land values.

Note that this appreciation in land values means that to beat land as an investment, returns to capital in business have to be extremely large.

Land

While retrospective values are noisy, clear evidence that large lottery winners differentially purchased land:

	(1) land purch bw mid & e3=1	(2) land purch $value_{e3}$	(3) land invest bw mid & e3=1	(4) land invest $value_{e3}$	(5) land sales bw mid & e3=1	(6) land sales $value_{e3}$
won lottery (0/1)	.011	230,043	.032	505,127	-.021	-5,656
	(.038)	(385,160)	(.039)	(501,342)	(.031)	(109,364)
won large lottery (0/1)	.15**	340,997	-.026	336,124	-.04	-210,823
	(.078)	(833,419)	(.081)	(1,174,079)	(.065)	(212,927)
risk loving (0/1)	-.033	119,034	.045	255,712	.039	22,753
	(.047)	(479,676)	(.048)	(654,657)	(.04)	(131,481)
district fe's	Yes	Yes	Yes	Yes	Yes	Yes
demographic controls	Yes	Yes	Yes	Yes	Yes	Yes
$\beta_1 + \beta_2$	.16	571,041	.0057	841,251	-.061	-216,479
P-value: $\beta_1 + \beta_2 = 0$	.017	.44	.94	.43	.29	.24
Control mean if risk loving = 0	.37	3,408,823	.36	4,204,332	.18	549,500
Control mean if risk loving = 1	.33	3,672,605	.41	4,834,988	.22	611,871
R^2	.08	.16	.043	.19	.031	.039
Observations	838	838	838	838	838	838

Heteroskedasticity-robust standard errors in parentheses. * $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Long-Term (6-year) Results: OLS

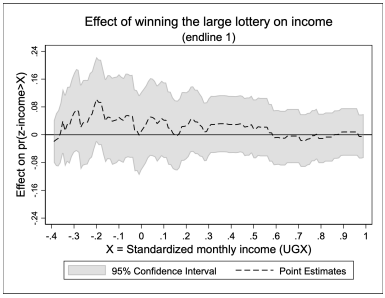
Income increases substantially in the long term:

	(1) weekly consumption	(2) home durables	(3) savings	(4) div. investment	(5) indiv. investment*	(6) mthly income
won lottery (0/1)	-818	-2,455	19,243	15,687	570,089	-15,468
	(4,387)	(113,772)	(54,942)	(117,392)	(1,080,048)	(28,595)
won large lottery (0/1)	13,470	-80,403	32,624	16,592	-563,232	129,367**
	(9,130)	(224,349)	(138,951)	(257,404)	(2,357,928)	(62,467)
risk loving (0/1)	4,318	14,317	175,644**	95,343	2,127,393	-34,305
	(5,536)	(141,031)	(76,641)	(147,478)	(1,391,724)	(32,407)
$\beta_1 + \beta_2$	12,652	-82,858	51,867	32,280	6,857	113,900
P-value: $\beta_1 + \beta_2 = 0$	.12	.67	.69	.89	1	.042
Control mean if risk loving = 0	74,243	1,176,056	452,420	1,064,878	14,388,904	388,771
Control mean if risk loving = 1	81,032	1,304,103	633,123	1,258,952	18,360,600	355,319
R^2	.13	.18	.12	.18	.33	.18
Observations	838	838	838	838	838	838

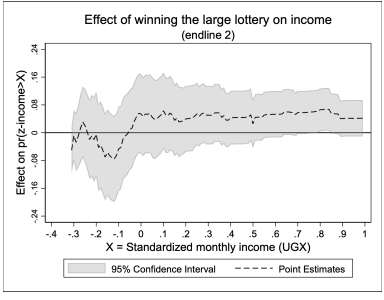
All quantities in UGX; Outliers winsorized to 95th/5th percentile; Heteroskedasticity-robust standard errors in parantheses

*Total indivisible investment includes real land values, adjusted down to exclude appreciation in land values over time

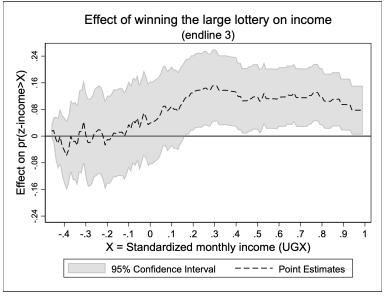
OLS Results



Endline 1



Endline 2



Endline 3

Empirical Summary

- Winning the small lottery leads to initially divisible investments, primarily in inventory and livestock, with any effects decreasing over time.
- Winning the larger lottery leads to higher indivisible investment in land and business durables through the medium run. Large lottery winners differentially purchase land.
- We measure large income gains in the long run, 6 years after grant allocation.

What does the tendency to invest in land mean for the expansion of financial services?

Policy Simulations

1. Use baseline data and lottery choices to calibrate model to state of financial autarky ($\theta = 0$, $r = 0$)

2. Evaluate model fit with simulated data and regressions

3. Simulate expansion of financial services in partial equilibrium and general equilibrium:

   - Credit expansion

   - Access to interest-bearing savings

Calibration Model Fit

Counterfactual Impacts of Credit Expansion (25% of collateral)

When capital is elastic, large capital and income increases and decrease in poverty. When capital is fixed, no impact on aggregate income or poverty. The price of capital adjusts.

	No Credit, No Interest-Bearing Savings ($\theta = 0, r = 0$)	**Policy Alternative 1: Expansion of Credit** ($\theta = 0.25$)	
		Capital is elastic "PE"	Capital is fixed "GE"
Agg. Income (=Consumption)	1.00	1.53	1.00
Agg. Net Savings	1.00	0.91	0.38
Agg. Capital	1.00	2.30	*1.00*
Price of Capital	1.00	*1.00*	1.33
Fraction Poor	1.00	0.68	1.00
Prob. Staying Poor	1.00	1.00	1.00

Counterfactual Impacts of Interest-Bearing Savings (r=0.05)

Smaller, but still large increases in income and capital when capital is elastic. When capital is fixed, aggregate impacts tempered but maintain modest gains in income and reduction in poverty.

	No Credit, No Interest-Bearing Savings ($\theta = 0, r = 0$)	**Policy Alternative 2: Interest-Bearing Savings** ($r = 0.03$)	
		Capital is elastic "PE"	Capital is fixed "GE"
Agg. Income (=Consumption)	1.00	1.22	1.04
Agg. Net Savings	1.00	1.76	1.37
Agg. Capital	1.00	1.39	*1.00*
Price of Capital	1.00	*1.00*	1.11
Fraction Poor	1.00	0.70	0.77
Prob. Staying Poor	1.00	0.86	0.86

Conclusions

1. Evidence consistent with investment indivisibilities: 27% choose lower expected value, low probability large grant lottery.

2. Land appears to be a primary indivisible investment in peri-urban Uganda.

3. Large lottery winners realize large income gains in the long run. Land investment is also associated with large capital gains.

4. Quantitative impacts of financial interventions: Large when the investment good is elastically supplied, but not when fixed supply (land).

5. Policy: Improving access to interest-bearing savings appears more helpful for inducing business investment than credit when the lumpy investment good is inelastically supplied.