The Aggregate Impact of Household Saving and Borrowing Constraints: Designing a Field Experiment in Uganda

By Joseph P. Kaboski, Molly Lipscomb, and Virgiliu Midrigan*

Broadly speaking, financial deepening and increased access to savings and credit are associated with macroeconomic development, and a vast theoretical and empirical literature has shown this to, at least in part, reflect a causal relationship.[1] Much less is known about how different types of financial access affect the the micro-behavior of households and the aggregate development of an economy.

We examine the impact of access to cash vs. asset-financed loans in the context of a micro-founded model where households face several different financial needs and constraints, typical of economic environments of many developing countries.[2] Specifically, households face income uncertainty and potentially high returns to entrepreneurial investments, which give motives to save and/or borrow. However, they also have low returns on savings and potentially limited self-control because of acute impatience (quasi-hyperbolic discounting).[3]

We map the model to key moments of microdata from Uganda, and evaluate the macroeconomic impacts of relaxing the borrowing constraints. Calibrated simulations show that cash loans lead to large increases in output, consumption, investment and entrepreneurship at the time they are made available, but the majority of this impact is only transitory. In the long run, the largest impacts of cash loans are an increase in indebtedness and a decline in net worth. These dynamics are driven largely by the interaction of low interest rates (so people desire to dissave) balanced by high income uncertainty which gives some demand for precautionary savings. In contrast, in the presence of high yield investments, asset-financed loans lead to smaller initial impacts on consumption and borrowing but larger increases in investment, and higher output, consumption, investment, net worth and entrepreneurship rates in the long run.

Long term access to credit is difficult to manipulate, but a short-term increase in access to the two types of credit also yields distinguishable patterns. A simulated short-term increase in access to the two types of credit motivates an experimental test of the model.[4] The former leads to large increases in consumption, while the latter leads to a decline in consumption, a much larger increase in investment, and a much smaller increase in borrowing. Using these results of the model for short-term access, we have designed a field experiment which we are currently conducting in

* Kaboski: University of Notre Dame & NBER, 717 Flanner Hall, Notre Dame, IN 46556, jkaboski@nd.edu. Lipscomb: University of Virginia, Garrett Hall, 235 McCormick Ave., Charlottesville, VA 22904, molly.lipscomb@virginia.edu. Midrigan: New York University and NBER, 19 W 4th St, New York, NY 10012, virgiliu.midrigan@nyu.edu. We thank Pascaline Dupas for comments, and Andres Blanco, Shoshana Griffith, and Grant Nelson for excellent research assistance, and we thank the Consortium on Financial Systems and Poverty and the National Institute of Health for funding for this project.

[1] A review of this literature is available in Levine (2005).

[2] Similar environments are examined in Francisco J. Buera, Joseph P. Kaboski and Yongseok Shin (2011), Francisco J. Buera, Joseph P. Kaboski and Yongseok Shin (2012), Marcel Fafchamps and John Pender (1997), Xavier Gine and Robert M. Townsend (2004), Joseph P. Kaboski and Robert M. Townsend (2011), and Virgiliu Midrigan and Daniel Yi Xu (2013).

[3] Constraints on savings is another, closely related, issue. See, for example, Pascaline Dupas and Jonathan Robinson (2013) and Nava Ashraf, Dean Karlan and Wesley Yin (2006)

[4] Kaboski and Townsend (2011) compare an actual cash loan policy in Thailand with a counterfactual simulation in which credit is contingent on investing. Marcel Fafchamps, David McKenzie, Simon R. Quinn and Christopher Woodruff (2011) compare differential responses of cash and in-kind grants on microentrepreneurs in Ghana.

Uganda.

I. Model

There is a continuum of households who are sophisticated quasi-hyperbolic discounters. A household's objective function is:

$$V_t = \frac{c_t^{1-\sigma}}{1-\sigma} + \beta E_t \sum_{\tau=1}^{\infty} \delta^t \frac{(c_{t+\tau})^{1-\sigma}}{1-\sigma}$$

where c_t is the household's consumption at date t. We assume $\beta < 1$ so that agents are relatively more impatient in the short-run (the discount factor between t and $t+1$ is $\beta\delta$), but relatively patient (with a discount rate of δ) thereafter.

Each period, a household operates one of two risky technologies: the traditional technology produce $y_t = e_t$, while the more productive modern technology yields $y_t = z_m e_t$, with $z_m > 1$. Risk is captured by e_t, which follows an AR(1) process.

With a constant hazard rate of π_m, a household in the traditional technology has the opportunity to enter the modern sector, but this requires a one-time fixed irreversible investment κ. This irreversible investment suffers from "one hoss shay" depreciation with a depreciation with a constant hazard π of full loss of the investment κ in any given period, in which case the agent returns to the traditional technology next period.

We model long-term debt as a perpetuity contract (see Juan Carlos Hatchondo and Leonardo Martinez (2009), and Cristina Arellano and Ananth Ramanarayanan (2012) with coupon payments that decay geometrically at a rate γ . The contract specifies a price ω and a face value l_t, the latter of which is freely chosen by the borrower. Denoting borrowing at date t as $d_t = \omega l_t$, where the borrower receives d_t units of the good in period t and must repay $\gamma^{s-1} l_t$ units in all future periods $t+s$. Given past borrowing, the total amount that the household must repay at t is b_t/ω, where:

$$b_t = d_{t-1} + \gamma d_{t-2} + \gamma^2 d_{t-2} + ... = \sum_{j=1}^{t} \gamma^{j-1} d_{t-j}$$

is the total debt of the household. Given new borrowing at date t, the total debt of the household evolves over time according to $b_{t+1} = d_t + \gamma b_t$.

We assume a borrowing constraint of the form $b_{t+1} \leq \max(\gamma b_t, 0) + \lambda_t$. The parameter λ_t acts as a limit on the amount of new debt an agent can issue.[5] For an agent who invests, $\lambda = \lambda_1 + \lambda_2 \kappa$, while otherwise, $\lambda = \lambda_1$. We therefore view λ_1 as governing the availability of cash loans and λ_2 as governing any additional funds available for investment purposes (i.e., asset-financed loans).

The household budget constraint depends on whether an agent is investing or not, $I_t \in \{1, 0\}$, and whether the agent is producing in the modern sector or not $M_t \in \{1, 0\}$:

$$c_t + (1+r)\, b_t + \kappa I_t = M_t z_m e_t + (1 - M_t) e_t + b_{t+1}$$

The resulting policy functions have several important features. (The on-line appendix gives details of the recursive formulation, computation, policy functions, and comparative statics.) Ceteris paribus, wealthier and more productive households are more likely to join the modern sector. For marginal wealth households, the indivisible investment actually leads to a drop in consumption. Finally, households converge toward desired savings depending on their wealth and productivity. Poor agents save for precautionary reasons, and rich agents dissave because of their impatience, but the modern sector gives agents an additional self-financing motive for saving. In addition, low productivity agents who start out with a low level of assets face a poverty trap, where they will never save to enter the modern sector.

II. Results

A. Calibration

Choosing a period to be a quarter, we assign several standard values in the liter-

[5] The max operator captures the idea that lenders cannot force borrowers to repay existing debt obligations faster than what is specified by the perpetuity contract.

ature: the discount factor for future selves, δ, of 0.98; a risk aversion parameter, σ, of 2. Our δ of 0.75 implies a duration of loans of 4 quarters.

The remaining seven parameters are chosen endogenously to match specific features of a developing country context, in our case Uganda. These seven data moments are derived from a baseline pilot survey of 399 households in Fort Portal, Uganda. Our interest rate on savings of $r = 0$ and baseline borrowing constraints, $\lambda_1 = \lambda_2 = 0$, are consistent with very little formal savings and very low levels of household debt in the data. [6] Household responses to questions about the likelihood of various income realizations in the future imply an income variance equal to 0.25, which maps directly into our value of σ_ε.

The remaining six parameters are chosen to simultaneously match the following moments. Responses about the average desired investment imply an average investment size of about one quarter of average annual household income in the data.[7] The households we surveyed save very little: their level of liquid savings is equal to only about one-fourth of their quarterly income.[8] We target a fraction of agents in the modern sector of 0.36, equal to the fraction of households who own a business in the data, and a fraction of agents that enter the model sector of 1.9% per quarter, consistent with 7.6% of households having opened up their business in the previous year. Finally, the median consumption of those households that own a business (which we interpret in the model as having joined the modern sector) is about 37% larger than that of households that do not. Our last moment is taken from the work of Suresh de Mel, David McKenzie and Christopher Woodruff (2008) who estimate returns to capital in micro-enterprises in Sri Lanka and find these to be around 5% per month. Lacking Ugandan data, we use this additional target to pin down the productivity advantage of the modern sector, z_m.[9]

The remaining values jointly minimize the distance between the moments and the data, the results are as follows. A fairly low discount factor between periods t and $t+1$, $\beta = 0.55$, is necessary for the model to simultaneously match the low savings rates observed in the data and the high returns to investment. The probability that an agent exits the modern sector is π=0.054: the average duration of the modern technology is thus 18.5 quarters. The efficiency advantage of the modern sector is equal to $z_m = 1.17$. This number, together with our estimate of ρ of 0.75, is necessary to simultaneously match the returns to investment of 15% and the consumption gap between agents that own a business and those that do not. Finally, investment opportunities arrive fairly infrequently, with a probability of $\pi_m = 0.30$.

Overall, the fit is fairly good, owing to the fact that the model is exactly identified. We report several predictions for savings behavior in the model. Agents in the modern sector hold three times more financial savings than agents in the traditional sector, even though they produce only 30% more output on average. The reason these agents save more is that they face the risk of exiting the modern sector and thus a stronger precautionary-savings motive. Also note that a large fraction (70%) of households are borrowing constrained, an artifact of the very low rates of time preference.

Comparative static simulations with the model's key parameters underscore the identification in the model by illustrating how these parameters affect the moments we target. (See online appendix for more details.)

[6]The mean debt in our sample is 53,000 UGX or about 21 USD.

[7]The mode of the projected investment sizes of households we surveyed is equal to 500,000 UGX, or approximately 200 USD. Trimming the top and bottom 5% of the outliers, the mean projected investment size is 823,000 UGX. The per-capita quarterly income of agents in our sample is 600,000 UGX.

[8]The mean net financial assets are 177,000 UGX or 28 percent of quarterly income.

[9]By using direct estimates of the returns to capital, we are able to disentangle the extent to which differences in consumption across agents that own and do not own businesses is driven by selection vs. efficiency differences.

Table 1—: Steady State Comparisons: Cash vs. Investment Lines of Credit

	Hyperbolic			*Geometric*		
	Baseline	$\lambda_1 = 0.2$	$\lambda_2 = 0.5$	Baseline	$\lambda_1 = 0.2$	$\lambda_2 = 0.5$
Assets to income	0.25	-0.36	0.17	0.25	-0.46	0.21
Fraction:						
in modern	0.36	0.28	0.52	0.27	0.16	0.42
borrowers	0	0.86	0.22	0	0.89	0.09
constrained	0.70	0.11	0.77	0.39	0.08	0.44
Consumption	1.119	1.109	1.139	1.108	1.095	1.128
Output	1.143	1.127	1.173	1.126	1.105	1.156
Debt to output	0	0.49	0.03	0	0.52	0.02
Δ Welfare	-	1.9%	0.8%	-	6.9%	0.2%

B. *Aggregate Long Run Implications of Credit*

We emphasize the different long run implications of access to cash or investment loans for the aggregates in our economy by illustrating the impact of increases in λ_1 and λ_2, respectively, on the steady state values of consumption, investment, income and entrepreneurship rates in the population. These are illustrated in Table 1.

An increase in the cash credit limit, λ_1, from 0 to 0.20, implies the maximum amount of debt an agent can take on is given by $\lambda_1/(1-\delta) = 0.8$, thus about two-thirds of per-capita income. A large fraction, 86%, of agents indeed take up these loans: the debt to income ratio thus increases to about 50%. Since agents are now poorer (the asset to income ratio falls from 0.25 to -0.36), those that receive investment opportunities are less able to undertake them and the fraction of agents that operate the modern technology falls from 36% to 28%. Consequently consumption and output fall by 0.9% and 1.4%, respectively. Although steady state consumption falls, consumption-equivalent welfare increases by 0.09% because of higher consumption in the transition and increased consumption smoothing in the long run with access to cash lines of credit. (Only 11% of agents are borrowing-constrained in the long run, compared to 70% in our baseline model.)

Consider instead an increase in the investment credit limit, λ_2, from 0 to 0.50, which allows agents to finance up to 50% of the cost of their investment. In contrast to the cash line of credit, the investment line of credit leads to an increase in steady state consumption (by 1.8%) and welfare (2.6%). This is a result of the higher fraction of agents operating the modern technology compared to baseline (52% compared to 36% in the baseline). Although consumption is higher in the long run, the investment lines of credit lead to smaller welfare gains because the short-run increase in consumption is smaller and there is less consumption smoothing in the long run.

What role does hyperbolic discounting play in these results? In terms of the positive predictions, a comparably calibrated geometric-discounting model shows very similar steady state predictions (and even dynamics), but the welfare implications differ considerably. The welfare gains of access to cash lines of credit are much higher for geometric discounters (6.9% vs. 1.9%). After the initial period, hyperbolic discounters put less weight on the transitory consumption increases that come from cash loans. However, the welfare gains for investment lines of credit are higher for hyperbolic discounters (0.8% vs. 0.2%), since they value the commitment that comes from investment. Consequently, hyperbolic discounters have a much more similar valuation of the two types of credit.

III. Designing a Field Experiment

We have emphasized that the aggregate implications of permanent access to cash and investment loans are quite different in the long run, and may have very different welfare implications. Lacking the ability to run long run experiments, we now use the model to design a logistically feasible short-term experiment that leads to observable predictions that can help assess the relevance of the model. Such an assessment will help determine how seriously we should take the long run predictions. The experiment uses the differential responses to temporary increases in cash and investment loans to distinguish hyperbolic from geometric responses. Feasibility is key, since we are implementing this model-designed experiment in continuing research based on actual field experiment in Uganda.

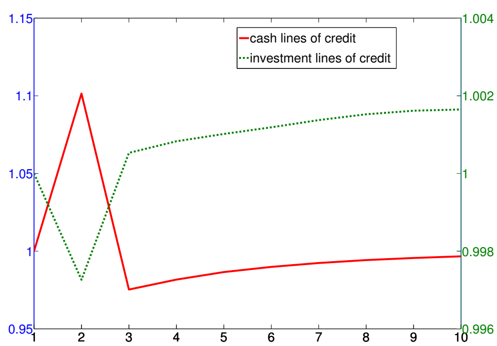

Figure 1. : Consumption Impact of Experiment

A. *Simulated Experiment*

We consider a short-term experiment where households are given access to credit for one period. The impacts of cash loans differ considerably from those of asset-financing loans. Figure 1 shows the impact on consumption relative to baseline, which is perhaps most striking: consumption increases by 10% under cash loans, but actually declines slightly under investment loans. The drop in consumption is driven by the fact that investment goes up by five times as much (250% vs. 50%) under asset-financing loans, and debt increases by only about one-fifth as much (12.5% vs. 2.5%). The increase in the modern sector is over three times as high with asset-financing loans (8.5% vs. 2.5%). These differences in readily measured outcomes should show up in the real world, if the mechanisms and predictions of model are relevant.

B. *Implementing the Field Experiment: Current and Next Steps*

Toward this end, we are currently implementing a field experiment approximating the simulated experiment as a pilot in Fort Portal, Uganda. The earlier referenced baseline survey involved a sample of 399 randomly selected households across the municipality of Fort Portal, Uganda. We collected data on household composition and demographics, consumption, savings, investment, income from various sources including business, desired investments, perceived income risk, and time and risk preferences. At baseline, all households were offered free savings accounts in the institution. Realized take-up of savings accounts was low, however: 203 households stated that they would like to open the savings accounts at the time they were offered, but only 40 households had opened an account as of 2 months later.

After two months, credit offers were extended to participants. Eleven percent of the least creditworthy participant households were eliminated from the participant pool as subjects to which the partner NGO, Pride, did not want to extend credit. One-third of the remaining households are being notified and given an open offer of a credit line for a cash loan available for a 3-month period, one-third are being given an open offer of a credit line for an asset-financed loan available for a 3-month period, and one-third are being kept as a control. Of those being offered a cash loan, half are asked to pledge collateral if they take the loans and half are not asked for collateral. We are surveying the households at the time they are notified that they are eligible for the credit, and at the end of the 3-month period to assess take up and household debt, as well as consumption, investment and income responses.

Together the pilot and model will assist in the development of the design for a planned larger scale and longer term experiment across the regional capitals of Uganda. Access and use of formal savings accounts and credit is rare outside of Kampala, so the treatment represents an important change in the access of households to financial tools. In designing the experiment, we use the model to generate predictions on the key variables that we identified in the experiment. Simulations across various levels of income uncertainty and risk aversion, and various entrepreneurial productivities, use parameters identified in our experiments. Moreover, these simulations give us a way of better predicting the sample sizes needed to get tight estimates. Finally, we conjecture that variation in loan terms and savings accounts in our field experiment will allow us to identify the hyperbolic discounting parameter. Such evidence, gained in a model where credit constraints are present, will help us assess the usefulness of standard questions designed to elicit such preferences. This is important given the relevance to normative evaluation.

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