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**Abstract**

I develop and estimate a dynamic equilibrium model of risky entrepreneurs' borrowing and savings decisions incorporating both formal and local-informal credit markets. Households have access to an exogenous formal credit market and to an informal credit market in which the interest rate is endogenously determined by the local demand and supply of credit. I estimate the model via Simulated Maximum Likelihood using Thai village data during an episode of formal credit market expansion. My estimates suggest that a 49 percent reduction in fixed costs increased the proportion of households borrowing formally by 36 percent, and that a doubling of the collateralized borrowing limits lowered informal interest rates by 24 percent. I find that more productive households benefited from the policies that expanded borrowing access, but less productive households lost in terms of welfare due to diminished savings opportunities. Gains are overall smaller than would be predicted by models that do not consider the informal credit market.
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# 1 INTRODUCTION

It is well known that in village economies, local informal financial arrangements exist in the absence of external formal credit market options (Udry 1994; Townsend 1994). As formal borrowing and savings opportunities have expanded, informal credit markets have persisted. But dynamic models that study the effects of financial deepening on development do not explicitly consider informal financial options, and studies that test the fit of informal risk-sharing models to data generally do not consider formal options explicitly.[1] On the other hand, studies which explicitly analyze the interaction of formal and informal credit markets generally do so in non-dynamic settings.[2] It is difficult to fully analyze the effects of financial deepening which determines asset distributions, however, when these distributions are fixed. In this paper, I develop and estimate a dynamic equilibrium risky entrepreneur model that incorporates formal as well as informal borrowing and savings choices. In this model, households are infinitely-lived, risk-averse, and have varying productivity and wealth.

**Related Literature** The analysis in this paper contributes to several strands of the literature. First, there has been substantial research on the impacts of greater financial access on developing economies (Greenwood and Jovanovic 1990; Banerjee and Newman 1993; Lloyd-Ellis and Bernhardt 2000; Gine and Townsend 2004; Greenwood, Sanchez, and Wang 2010; Kaboski and Townsend 2011; Moll 2014; Buera, Kaboski, and Shin 2017; Dabla-Norris et al. 2018). Despite the importance of informal financial arrangements (Udry 1994; Townsend 1994), these dynamic models of financial deepening–formal credit market expansion–generally do not explicitly consider informal financial options.[3] Additionally, studies that test the fit of informal risk-sharing models to data do not model formal options explicitly (Alem and Townsend 2014; Karaivanov and Townsend 2014; Kinnan 2017). In this paper, I model risky entrepreneurs' choices over formal and informal credit market options in an exogenous incomplete markets setting.[4] Similar to Kaboski and Townsend (2011), I treat villages as small open economies where formal prices are exogenously determined, but I ex-

1. See Townsend (2010) and Buera, Kaboski, and Shin (2015) for reviews.

2. For example, Gine (2011) and Karaivanov and Kessler (2018) use the initial waves of the Townsend Thai village survey to study how household firms choose between formal and informal borrowing in two-period models. Gine (2011) distinguishes formal and informal borrowing by interest rates, fixed costs, and collateral constraints.

3. Banerjee et al. (2017) allow households to borrow from formal and informal sectors at exogenous rates to finance within period capital investments, and households can save across periods at an exogenous negative savings rate.

4. While there are different ways for rural households to transfer financial resources, Karaivanov and Townsend (2014) find that a model with exogenously incomplete borrowing and savings options fit consumption and investment data in rural Thai villages better than constrained efficient credit/insurance models. The model in effect augments equilibrium models of risky entrepreneurs (see review: Quadrini (2009)) with additional exogenous borrowing and savings options.

tend the framework to explicitly consider informal choices and equilibrium interest rates determined within each local informal credit market. My approach here focuses on the *micro-equilibrium* effects of formal credit market expansion on village credit markets. This is different from Buera, Kaboski, and Shin (2017) and Breza and Kinnan (2018), which study the macro equilibrium effects of large microfinance roll-outs on prices, including interest rates and wages, in the aggregate economy.

Second, this paper contributes to works that study the interaction between formal and informal credit markets. Third, there is a significant and growing empirical literature that analyzes separate dimensions of credit market policies. Fourth, there is a literature that studies how the provision of formal insurance could crowd-out informal insurance (Attanasio and Rios-Rull 2000; Krueger and Perri 2011; Chandrasekhar, Kinnan, and Larreguy 2011).

The structure of the paper is as follows. Section **??** develops the model. Section **??** describes model mechanisms and demonstrates the equilibrium effects of shifting various dimensions of formal and informal credit market access costs. In Section **??**, I describe the data and background. Section **??** describes estimation results and counterfactuals. I offer the conclusion in Section **??**. Additional details for the solution and estimation methods are in Sections **??**.

# 2 Data

## 2.1 Data One

The survey also captures some aspects of the pecuniary fixed costs for acquiring each loan. There was a significant reduction in these costs after 2001 for formal borrowing. Most of the drop is due to the prevalence of the Million Baht Fund program. Loans from the Million Baht Fund had fees and transportation costs similar to borrowing informally, which is likely due to its localized and village-committee based administration.

Fees and transportation costs for the BAAC also went down over time. These might have been driven down by improvements in the BAAC itself or reductions in transportation and communication costs. Table **??** shows that costs at the BAAC, however, are still twice as large as the average costs reported for borrowing from relatives or moneylenders. Strikingly, the fees and transport costs on the few reported commercial bank loans are on average seven times larger than those for BAAC loans, and almost 35 times larger than the costs for Million Baht Fund loans or informal loans.

## 2.2 Data Two

In the literature on informal credit markets, repayment rates for informal borrowing have often been found to be high (Morduch 1999). Recently, evidence from a number of microfinance studies shows that repayment rates for formal borrowing have also been found to be high (Buera, Kaboski, and Shin 2017). Consistent with these findings, in the Townsend Thai Monthly Survey villages, both formal and informal repayments are high. These on-time repayment rates are directly calculated from the data: every month, new loans that households take out are recorded and the month in which repayment should be completed is also recorded; then every month, repayment amounts of each loan is tracked until full repayment.

Specifically, the eventual full repayment rate for formal loans is 97% and for informal loans is 95%. Interestingly, households that do not fully pay back their loans still pay a significant proportion of their debts, as shown in Table **??**. Taking partial repayments into consideration, I find that 98.2% of every Baht of principal lent is paid back for formal loans, and 96.5% of every Baht of principal lent is paid back for informal loans.

# 3 Model

## 3.1 Model One

Given $\mu_{R_{yv}}$, $\sigma_{R_{yv}}$, and price $p^N_{yv}$, each household solves the following maximization problem:

$$\max_{c,N} c + \rho \cdot c^2 + \left\{ \gamma \cdot H_{24} + \lambda \cdot \int_{R_{yv}} (H_{24} - R_{yv}) \, \mathbb{1}\{H_{24} \geqslant R_{yv}\} \, dF(R_{yv}) \right\} \tag{1}$$

where:

$$c = Y - p^N_{yv} \cdot N$$

$$H_{24}(N, X, \epsilon) = \exp(A + X \cdot \alpha + \epsilon) \cdot N^{\beta}$$

The realized household utility $u_{yv}$ is a function of parameters and $Y, p^N_{yv}, X, F(R_{yv}), \epsilon$. Households make choices given $\Omega = \left(Y, p^N_{yv}, X\right)$, the i.i.d. productivity shock $\epsilon$, and $F(R_{yv})$. At the birth of a child, a household chooses the optimal amount of nutrition for the child over the next 24 months given the joint relative distribution of the reference health outcome and their own child's helath given that child's productivity shock and nutritional intake. The parents choose knowing that more nutritional intake–at a decreasing rate of return–will increase the probability that their child will catch up to or exceed the reference health.

### 3.2 Model Two

At the beginning of each period, for each household, the household productivity type $\mathcal{A}$, productivity shock $\epsilon$, and physical capital $k$, which is chosen previously by the household based on expected productivity, jointly determine the income of the household in the current period:[5]

$$y = \exp(\mathcal{A} + \epsilon) \cdot k^{\alpha} \tag{2}$$

## 4 Estimate

### 4.1 Estimation One

Besides the age at school closure, the impact of school closure on educational attainment may also differ by the number of years of exposure to the policy: short-run effects of closure on a child's educational attainment progression could be dampened or amplified over the medium and long run.[6] In order to identify both age and duration effects with our cross-sectional data, we exploit the variation in the year of school closure. Under the assumption that the impact of the policy is not specific to the calendar year of closure, we can estimate Equation 3 to obtain the impact of the policy as a function of both starting age and the length of exposure.

In Equation 3, we use similar notations as in Equation **??**, the difference is that the policy's effects are now captured by $\hat{\lambda_{zl}}$ that varies by age-at-closure variable $t_i$ and years-of-exposure variable $\tau_i$:

$$\begin{aligned} E_{pvia} &= \phi + \beta_v + \rho_{pa} \\ &\quad + \hat{\lambda_{zl}} \cdot \mathbb{1}\{(l_l \leqslant \tau_i \leqslant u_l) \cap (l_z \leqslant t_i \leqslant u_z)\} \cdot c_v \\ &\quad + X_i \cdot \gamma + \epsilon_i \end{aligned} \tag{3}$$

where, as before, $c_v$ is a binary variable indicating if individual $i$ is from a village $v$ with school consolidation (i.e. treatment village). As in Equation **??**, we group children in villages with school closure into $Z$ groups based on their age at closure, with lower and upper bounds for each group, $l_z$ and $u_z$. To capture duration effects, we further divide each of the $Z$ groups of children into $L$ groups based on the length of exposure $\tau_i$, defined as the gap between individual $i$'s age in 2011 and $i$'s age at year of school

5. The model focuses on financial (safe asset) and physical capital (risky asset) choices. Labor supply for the household firm is inelastic and captured by $\mathcal{A}$.

6. After an individual completes schooling, duration effects will become constant. In studies with cross-sectional data taken long after a policy has been implemented, Duflo (2001) for example, the duration effect is irrelevant because all educational attainment data is observed long after sample individuals have completed schooling. In our data, a significant proportion of individuals have not completed schooling, allowing us to have meaningful duration effects.

closure, $t_i$.[7] Each $l$ length of exposure group includes those with $\tau_i$ falling within lower and upper bounds, $l_l$ and $l_u$. The exposure groups allow us to separately estimate the short, medium and long run effects of the consolidation policy on educational attainment. There are $Z \cdot L$ groups of interest for this regression.[8]

## 4.2 Estimation Two

We include in the model measurement errors that allow us to estimate the parameters using maximum likelihood methods. As described previously, households observe $\Omega = (Y, p^N_{yv}, X)$, and the distributions of $R_{yv}$. In terms of choices and outcomes, the econometrician only observes $F^*$ and $N^*$, which differ from the true optimal nutritional choice $N$ by measurement error $\eta$ and true height outcome $h_{24}$ by $\iota$:

$$\log(N^*) = \log(N(Y, X, \epsilon; p^N_{yv}, \mu_{R_{yv}}, \sigma_{R_{yv}})) + \eta \tag{4}$$

$$\log(h^*_{24}) = \log(h_{24}(N(Y, X, \epsilon; p^N_{yv}, \mu_{R_{yv}}, \sigma_{R_{yv}}), X, \epsilon)) + \iota \tag{5}$$

We assume that $\eta$ and $\iota$ are normally distributed, and that $\epsilon$, $\eta$ and $\iota$ are independent. The standard deviation of $\eta$ is $\sigma_\eta$ and the mean is $\mu_\eta = -\frac{\sigma^2_\eta}{2}$. The standard deviation for $\iota$ is $\sigma_\iota$ with mean $\mu_\iota = -\frac{\sigma^2_\iota}{2}$. The log likelihood is based on the difference between model optimal nutritional choices and observed nutritional choices, as well as the model height outcome and observed heights at 24 months of age:

$$\max_{\theta \in \Theta} \sum_{y=1970}^{1975} \sum_{v} \left\{ \sum_{i=1}^{n_{yv}} \log \left( \int_\epsilon \phi_\iota\left( \ln h^*_{24,i} - \ln h_{24}(_{\theta, \mu_{R_{yv}}, \sigma_{R_{yv}}}^{Y_i, X_i, \epsilon_i;}) \right) \cdot \phi_\eta\left( \ln N^*_i - \ln N(_{\theta, \mu_{R_{yv}}, \sigma_{R_{yv}}}^{Y_i, X_i, \epsilon_i;}) \right) dF(\epsilon_i) \right) \right\} \tag{6}$$

where

$$\theta = \{ \underbrace{\rho, \gamma, \lambda}_{\text{Preference}}, \overbrace{\delta}^{\substack{\text{Atole} \\ \text{disc.}}}, \underbrace{A, \alpha, \beta, \sigma_\epsilon}_{\substack{\text{Production} \\ \text{Function}}}, \sigma_\eta, \sigma_\iota \} \tag{7}$$

Equation 6 is determined by $\theta$ as well as a set of $(\mu_{R_{yv}}, \sigma_{R_{yv}})$ that are village- and time-specific. This means that in estimating the model, we do not impose assumptions about where the current height distribution is with respect to the stationary height distribution. We solve for optimal choices given the observed individual specific $\Omega_i$ and the observed $\mu_{R_{yv}}, \sigma_{R_{yv}}$ for each year $y$ in village $v$.

7. $\tau_i = \min(a_i, a_i - t_i)$: $\tau_i$ is the gap between age in 2011 and $t_i$ if individual $i$ was borne before the year of closure, and it is the age of the child in 2011 if the child was borne after school closure.

8. Ideally, we would estimate the policy effects for each $t_i$ and $\tau_i$ combination separately, but we have constructed the $Z$ and $L$ groups due to limited sample size.

# 5 CONCLUSION

In recent decades, formal financial services have expanded significantly in developing countries. This paper evaluates the impacts of improving access to the formal credit market on rural households, taking into consideration the impacts of changing formal credit market conditions on the informal credit market.

I built a risky entrepreneur model assuming that villages are small open economies with respect to formal credit market options, but households can also borrow and save in an equilibrium local credit market. I showed that formal credit market expansions through interest rates subsidies, access fixed costs reductions, and collateral constraint relaxations have heterogeneous and non-separable effects on households. These effects differ depending on informal credit market conditions. In the Thai case, villages already had extensive informal borrowing and savings activities, and the effects of formal credit market expansions on household welfare were hence limited.

# REFERENCES


Alem, Mauro, and Robert M. Townsend. 2014. "An Evaluation of Financial Institutions: Impact on Consumption and Investment Using Panel Data and the Theory of Risk-Bearing." *Journal of Econometrics* 183, no. 1 (November): 91–103.

Attanasio, Orazio, and Jose-Victor Rios-Rull. 2000. "Consumption smoothing in island economies: Can public insurance reduce welfare?" *European Economic Review* 44, no. 7 (June): 1225–1258.

Banerjee, Abhijit V., and Andrew F. Newman. 1993. "Occupational Choice and the Process of Development." *Journal of Political Economy* 101, no. 2 (April 1): 274–298.

Banerjee, Abhijit V., Emily Breza, Esther Duflo, and Cynthia Kinnan. 2017. *Do Credit Constraints Limit Entrepreneurship? Heterogeneity in the Returns to Microfinance* ID 3126359. SSRN, September 1.

Breza, Emily, and Cynthia Kinnan. 2018. *Measuring the Equilibrium Impacts of Credit: Evidence from the Indian Microfinance Crisis.* Working Paper 24329. NBER.

Buera, Francisco J., Joseph P. Kaboski, and Yongseok Shin. 2015. "Entrepreneurship and Financial Frictions: A Macrodevelopment Perspective." *Annual Review of Economics* 7 (1): 409–436.

———. 2017. *The Macroeconomics of Microfinance.* Working Paper 17905. NBER, March.

Chandrasekhar, Arun G., Cynthia Kinnan, and Horacio Larreguy. 2011. "Information, Networks and Informal Insurance: Evidence from a Lab Experiment in the Field."

Dabla-Norris, Era, Yan Ji, Robert M Townsend, and D. Filiz Unsal. 2018. *Distinguishing Constraints on Financial Inclusion and Their Impact on GDP, TFP, and Inequality.* Working Paper, Working Paper Series 20821. NBER.

Duflo, Esther. 2001. "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment." *American Economic Review* 91, no. 4 (September): 795–813.

Gine, Xavier. 2011. "Access to Capital in Rural Thailand: An Estimated Model of Formal vs. Informal Credit." *Journal of Development Economics* 96, no. 1 (September).

Gine, Xavier, and Robert M. Townsend. 2004. "Evaluation of Financial Liberalization: A General Equilibrium Model with Constrained Occupation Choice." *Journal of Development Economics* 74, no. 2 (August): 269–307.

Greenwood, Jeremy, and Boyan Jovanovic. 1990. "Financial Development, Growth, and the Distribution of Income." *Journal of Political Economy* 98, no. 5 (October): 1076–1107.

Greenwood, Jeremy, Juan M. Sanchez, and Cheng Wang. 2010. "Financing Development: The Role of Information Costs." *American Economic Review* 100, no. 4 (September): 1875–1891.

Kaboski, Joseph P., and Robert M. Townsend. 2011. "A Structural Evaluation of a Large-Scale Quasi-Experimental Microfinance Initiative." *Econometrica* 79, no. 5 (September 1): 1357–1406.

Karaivanov, Alexander, and Anke Kessler. 2018. "(Dis)advantages of informal loans – Theory and evidence." *European Economic Review* 102:100 –128.

Karaivanov, Alexander, and Robert M. Townsend. 2014. "Dynamic Financial Constraints: Distinguishing Mechanism Design From Exogenously Incomplete Regimes." *Econometrica* 82, no. 3 (May): 887–959.

Kinnan, Cynthia. 2017. *Distinguishing Barriers to Insurance in Thai Villages.* Technical report.

Krueger, Dirk, and Fabrizio Perri. 2011. "Public versus private risk sharing." *Journal of Economic Theory,* Incompleteness and Uncertainty in Economics, 146, no. 3 (May).

Lloyd-Ellis, Huw, and Dan Bernhardt. 2000. "Enterprise, Inequality and Economic Development." *The Review of Economic Studies* 67, no. 1 (January): 147–168.

Moll, Benjamin. 2014. "Productivity Losses from Financial Frictions: Can Self-Financing Undo Capital Misallocation?" *American Economic Review* 104, no. 10 (October): 3186–3221.

Morduch, Jonathan. 1999. "The Microfinance Promise." *Journal of Economic Literature* 37, no. 4 (December): 1569–1614.

Quadrini, Vincenzo. 2009. "Entrepreneurship in Macroeconomics." *Annals of Finance* 5, no. 3 (June): 295–311.

Townsend, Robert. 2010. "Financial Structure and Economic Welfare: Applied General Equilibrium Development Economics." *Annual Review of Economics* 2 (1): 507–546.

Townsend, Robert M. 1994. "Risk and Insurance in Village India." *Econometrica* 62, no. 3 (May): 539–591.

Udry, Christopher. 1994. "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria." *The Review of Economic Studies* 61, no. 3 (July): 495–526.