Timing lumpy investments with bridge loans and clunky formal loans: Evidence from Thailand

ANIL K. JAIN, ROBERT M. TOWNSEND, FAN WANG*

Abstract. This paper studies how flexible local (informal) credit resolves the mismatch between rigid formal loans and lumpy investment. In Thai monthly panel data, formal loans are one-year bullet contracts, and about half of lumpy investments are bridge-financed: a short local loan repays a maturing formal loan, and a new formal loan repays the bridge. We model bridge financing with risky, long-gestation projects and costly state verification: short bullet maturities emerge as the formal lender's optimal contract when collateral depreciates quickly. Calibrated to the data, bridge financing raises welfare most for the largest investments, adding up to 4.5 percentage points of permanent wages beyond formal credit alone.

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Section 1. Introduction

Formal credit has expanded rapidly across developing countries, often with the aim of stimulating investment among rural households. Yet the contracts carrying that expansion are typically rigid. By contrast, many productive investments available to rural households are lumpy and slow to pay off, generating returns over horizons longer than a single loan cycle. Alongside formal credit, local lenders—neighbors, relatives, moneylenders—continue to lend on flexible terms at higher cost. This paper examines how households combine the two sectors to finance long-gestation lumpy investments, and why formal lenders keep their loans short in the first place.

The mechanism we document is that the two lending sectors are complements in maturity: households manufacture longer term project finance out of short-term loans, using expensive local credit to bridge the gaps between successive formal loans. These investments are large, infrequent, and highly productive. A typical household in the Thai villages we study makes one every seven to ten years, at a size worth about twice the productive assets it already owns, and our estimates put the return at roughly 19 percent a year, well above the formal borrowing rate. About half of these investments are financed by chains of loans, in which a short loan from a local lender repays a maturing formal loan and is itself repaid by a new formal loan shortly after. The two sectors also grow together: villages that received larger injections of formal credit went on to make more bridge-financed investments.

Motivated by the empirical facts, we develop an intertemporal model in which a risk-averse household chooses consumption, savings, and investment over time, and can borrow from two lenders that differ in one key respect—the local lender can verify whether a project has succeeded, and the formal lender cannot. That single asymmetry generates both the household's demand for the expensive bridge loan and the formal lender's choice of a short-term contract. We characterize the optimal joint savings, borrowing, and investment strategies, including those involving bridge financing, and analyze how changes in formal interest rates and access to local credit shift the timing of lumpy investment and household welfare.

The model highlights a simple but powerful mechanism: bridge loans allow households to transform a sequence of short-term formal loans into effective longer-term financing, enabling high-return investments that would otherwise be out of reach or reduce welfare by delaying investment. Calibrated to the Thai data, the model implies gains from bridge access that rise steeply with project size, reaching 4.5 percent of permanent wages for the largest investments we consider.

To fix ideas, consider a farmer with a high-return, risky indivisible project: farm equipment that costs \$100 and yields \$19 per year, with the returns starting—and success becoming known—only one year after installation. The formal lender offers one-year loans that must be fully repaid before a new loan is disbursed, so a loan taken to buy the equipment matures exactly when the project has yet to produce any income. A local lender who can observe how the project turned out resolves the mismatch. If the project succeeds, the local lender extends a short "bridge" loan that repays the maturing formal loan, and a new formal loan repays the bridge shortly after. Conditional on success, two one-year formal loans and a brief bridge become, in effect, a synthetic single two-year loan. The formal lender keeps the maturity short for a related reason: the project may fail, and without a way to verify the outcome the lender would be left recovering equipment with a lower salvage value at the end of a two-year loan than at the end of a one-year one. We formalize this choice below.

Our data come from the Townsend Thai Monthly Survey, a monthly panel covering roughly 650 rural households in 16 villages from 1999 to 2009, in which most households borrow from both the formal and informal sectors. Formal loans—from state development banks such as the BAAC and from the government's Village Fund—are almost uniformly one-year bullet contracts: maturities cluster tightly around twelve months, sizes come from a coarse standardized menu, and interest rates are low and homogeneous. Repayment behavior matches the contract: for over 90 percent of performing loans, the full principal is repaid in the month the loan falls due. Around 5 percent of loans fail to repay principal in full, and we calibrate the model's project-failure probability to that rate. Loans from local lenders are shorter, smaller, and carry higher and far more dispersed interest rates, while quasi-formal lenders such as agricultural cooperatives sit between the two poles on each dimension.

Investments in these villages are lumpy, infrequent, and productive. The average household makes a lumpy productive investment once every seven to ten years, and the median investment is worth roughly twice the household's existing productive assets. Linking the timing of investments to the timing of loans, we find that over 70 percent of investments are linked to loans originated shortly before them, and about half are financed through bridge structures. Among bridge-linked investments, the vast majority combine formal and local lenders, and a majority of those contain the formal–local–formal chain of the example above, with a short local loan spanning the gap between two one-year formal loans.

We quantify the magnitudes in three estimation exercises. First, household income rises with investment: the estimates imply a monthly return on investment of around 1.4 percent—roughly 19 percent annually, well above formal borrowing rates—for the households that select into investing. Second, consumption follows the financing cycle: it rises across the investment-loan window for about two thirds of investment episodes, and for the majority of investing households, it rises substantially after the debt has been fully repaid compared to when the debt was first originated. Finally, we exploit the Million Baht Village Fund program, which gave every village one million baht of lending capacity regardless of village size, generating larger per-household credit injections in smaller villages. Villages receiving larger injections saw more lumpy investment in the short run and persistently more bridge-financed investment: expanding formal credit increased, rather than displaced, the use of local bridge loans.

Motivated by these facts, we model an infinitely-lived, risk-averse farmer in continuous time who earns a constant wage, starts with zero liquid assets, and has access to a lumpy investment project. The project requires a large capital outlay and spends one year in gestation: capital installed at the investment date produces nothing until the one-year mark, when the project either succeeds—yielding a permanent flow return—or fails, leaving collateral whose salvage value depreciates with age. The farmer observes the outcome privately, can save in a technology earning less than the discount rate, and chooses when to invest, how much to consume, and how to finance the project.

The two lenders in the model differ in their ability to verify that outcome. The formal lender has deep funding but a prohibitive verification cost, so its contract cannot depend on how the project turns out. It offers a one-year bullet loan, capped at the break-even loan size, and on default it liquidates the collateral and confiscates the farmer's liquid assets. The local lender, embedded in the village, verifies the outcome at low cost and lends on state-contingent terms: verified successes receive a bridge loan priced at a zero-profit fee that amortizes the verification cost, and failures receive nothing. The second formal loan is safe for precisely the reason the first is risky—by the time it is disbursed, the local lender has certified the project's success.

For the farmer, the bridge does two things. It spreads the repayment of the first formal loan across two years of income rather than compressing it into the gestation year, when the wage is the only income; and it raises borrowing capacity, because the bridge is itself repaid out of the following year's wage and project income. For small projects the first role dominates: formal credit covers the cost outright, investment is immediate, and the bridge buys smoother repayment. For large projects both roles operate, and the added borrowing capacity shortens the years of saving that would otherwise precede investment.

The model also explains the rigidity that creates the demand for bridges. We let the formal lender choose between the one-year contract and a single two-year loan spanning the project's full horizon, and show that the choice is determined by how fast collateral depreciates. Under the one-year contract, a failed project defaults at the earliest date, so the lender recovers the higher one-year salvage value; under the two-year loan it recovers only the more depreciated collateral. When collateral decays quickly—as for farm equipment sold in distressed, illiquid local markets—the short bullet contract is the lender's profit-maximizing offer. Rigid formal lending and flexible local bridging thus emerge together, as an equilibrium division of credit sustained by the verification asymmetry.

Calibrated to the Thai data—a 19 percent annual return on investment, a 6 percent formal interest rate, and an implied local-lender fee of about 2 percent at the median loan size—the model quantifies the welfare gains from bridge financing across the observed distribution of investment sizes, measured as consumption-equivalent variation. The gains rise steeply with project scale. At the 25th percentile and the median of investment size, where formal credit covers the project cost and investment is immediate, access to a bridge adds 0.3 and 0.8 percentage points of permanent wages, respectively, beyond formal credit alone. At the 75th percentile—a project equivalent to 326 percent of annual income, beyond the largest feasible loan—the bridge brings investment forward by years, and increases welfare by 4.5 percentage points of permanent wages. Varying project risk while holding the expected return fixed leaves these rankings intact, so the gains reflect the value of credit access rather than a mechanical return effect.

The farmer in the model is forward-looking and time-consistent, so the expensive short-term borrowing at the center of the paper is a planned refinancing: it concentrates at formal-loan maturities, is sized to the maturing repayment, and is repaid by the new disbursement rather than rolled over—the pattern our data show. The same logic carries a measurement implication. Formal records in this market show a sequence of one-year loans repaid on time, while the household's effective credit exposure spans two years, so assessments of rural leverage built from formal-sector records alone will understate both the duration and the riskiness of household balance sheets.

Subsection 1.1. **Literature.** Our paper draws on and contributes to four literatures. It extends models of consumption, savings, and borrowing under incomplete markets by adding formal-loan rigidity as a friction on investment timing; it sharpens the theory of formal–informal coexistence, where our maturity-bridging mechanism is distinct from co-financing; its closest empirical relatives are the field experiments on repayment flexibility; and it connects to the household finance literature on flexible versus rigid credit, payday borrowing, and behavioral accounts of high-cost debt. The common thread is an expensive, flexible instrument—a local bridge loan—deployed to overcome the rigidity of cheap formal credit, so that a sequence of short formal loans can finance a lumpy, long-gestation investment.

Taking the rigidity of formal credit and the flexibility of local credit as features of the environment—documented in our data and in the microfinance literature reviewed below—we extend a model of consumption, savings, and borrowing with endogenously incomplete markets to study how loan rigidity shapes the household's investment-timing decision. To our knowledge, no existing model treats formal-loan rigidity as a friction on the timing of lumpy household investment, or gives flexible local credit a role in bridging the maturity of a rigid formal loan. Existing theories of formal–informal complementarity work on the cost margin—the local loan co-finances the project or funds installment obligations—whereas here it bridges time, as we discuss below.

The dynamic macro-development and village-economy models closest to ours treat credit as a single aggregate (Banerjee 2013; Kaboski and Townsend 2011; Buera, Kaboski, and Shin 2021; Karaivanov and Townsend 2014; Kinnan 2022), despite long-standing evidence that informal credit remains a large presence in these economies (Udry 1990; Siamwalla et al. 1990). The models that do separate formal from informal credit (Gine 2011; Karaivanov and Kessler 2018; Wang 2022) treat the choice between the two as a point-in-time decision, not the sequential use of local credit to bridge a formal loan's maturity. We build the split into the household's dynamic consumption–savings–investment problem, so that the timing of formal and local borrowing is a choice variable rather than something we impose. The mechanism also echoes the trade-credit literature, where flexible financing from non-financial firms bridges gaps left by rigid formal financing (Petersen and Rajan 1997; Giannetti, Burkart, and Ellingsen 2011)—the same logic of an expensive, flexible instrument filling a gap left by a cheaper, rigid one, here applied to household investment rather than firm financing.

A theoretical literature explains the coexistence of formal and informal credit as an equilibrium in which formal lenders lean on the informal sector's informational advantage. In Jain (1999) the formal sector finances only part of each project, forcing borrowers to raise the remainder from better-informed informal lenders; the informal loan is disbursed alongside the formal one and covers the financing gap. Jain and Mansuri (2003) develop a related mechanism: tightly scheduled installments push borrowers into the informal market before returns are realized, co-opting informal lenders' monitoring. Surendra (2024) documents the interconnection empirically in rural India, where moneylenders on-lend bank credit, so that formal supply expands rather than displaces informal lending. Closest to our empirical setting, Sripakdeevong and Townsend (2022), using the same Thai data, document credit-refinancing chains in which a short-term local bridge loan repays a maturing formal loan that a new formal loan then repays. They read these chains largely as consumption smoothing and deferment; we show the same structure financing large, lumpy investments.

Our mechanism shares that premise but operates on a different margin: the bridge loan spans *time* rather than a share of the project's *cost*. Co-financing certifies borrower types at origination; bridging certifies the project's realized outcome at refinancing, and the second formal disbursement rests on that certification. The two are complementary—

co-financing economizes on screening at entry, bridging synthesizes maturities the formal sector rations—and they are testable in loan timing: bridge episodes concentrate at formal-loan maturities and are sized to the maturing repayment, not at the investment date.

Our supply side follows Conning (1999): monitoring-intensive lending is hard to leverage with outside funds, so close-monitoring lenders stay small, costly, and largely self-funded. The two polar lenders sit at opposite ends—the local lender has cheap in-village verification but shallow pockets, the formal lender deep funding but an arm's-length technology that cannot condition on the project's realized state. Given that technology, our maturity-choice extension shows the one-year bullet form emerging as the lender's profit-maximizing offer: early liquidation recovers the higher one-year salvage value together with the borrower's undrawn liquid assets, so short maturities dominate when collateral depreciates quickly. The quasi-formal lenders in our data, pairing some local monitoring with greater capacity at visibly higher rates, sit between the poles.

The paper's closest empirical relatives are the microfinance experiments on repayment flexibility. Rigid, tightly prescribed repayment—whether weekly installments or annual terms—is a common feature of formal credit in developing economies, from development banks to the classic microcredit contract (Morduch 1999; Conning and Udry 2007; Banerjee, Karlan, and Zinman 2015; Karlan and Mullainathan 2010), and practitioners have long observed that poor households value borrowing and repaying on their own timing (Rutherford 2001). A wave of field experiments relaxing that schedule finds that flexibility can unlock investment: a grace period raises investment in illiquid assets and long-run profits at the cost of higher default (Field et al. 2013); an option to delay installments improves business outcomes and *lowers* default, operating as insurance (Battaglia, Gulesci, and Madestam 2024), though a similar option raised default among urban Colombian borrowers without improving business outcomes (Brune, Giné, and Karlan 2022); pricing flexibility screens the more disciplined borrowers (Barboni and Agarwal 2023); lean-season moratoria raise food consumption without raising default (Shonchoy and Kurosaki 2014); and performance-contingent repayment approaches equity (Cordaro et al. 2022).

The shared friction is the one our model formalizes: repayment falls due before the project pays out, so a rigid schedule deters high-return but illiquid investment. The experiments relax it by redesigning the formal contract; the households we study relax it across contracts—a bridge loan repays the maturing formal loan and a new formal loan repays the bridge, so two one-year contracts finance a project with a two-year payback period, at the price of the bridge fee. The mechanism does not depend on the bullet shape: under installment schedules the same mismatch surfaces as recurring shortfalls that informal borrowing fills (Jain and Mansuri 2003), and the bullet form merely concentrates it at a single date, which is what makes bridge episodes visible in our monthly panel. Why lenders do not simply sell flexibility parallels our supply side—Field et al. (2013) find a separately priced grace-period contract unravels under moral hazard and adverse selection, and Barboni and Agarwal (2023) that screening through price is what makes flexibility viable.

Our findings also speak to the household finance literature on borrowing in emerging economies, surveyed by Badarinza, Balasubramaniam, and Ramadorai (2019). Unsecured credit, much of it informal, is a large share of household liabilities there, at rates well above formal-sector rates, and a recurring concern is that high-cost informal debt can trap households in long rollover cycles. The informal-lending tradition traces those rates to the costs of screening, monitoring, and enforcement (Aleem 1990; Siamwalla et al. 1990), which is the local lender's village-level advantage in our model. Our contribution is a mechanism in which the expensive local loan is demanded briefly and at a predictable date—the maturity of a formal loan—so the same high-rate borrowing that elsewhere signals distress here marks a planned refinancing.

The same structure connects the paper to household finance in advanced economies (Gomes, Haliassos, and Ramadorai 2021, section 3.2), where balance sheets pair rigid long-term contracts—mortgages, car loans—with flexible but expensive short-term ones—credit cards, payday loans. Payday lending is the closest analogue to a bridge loan: a small, short, expensive loan taken against a known future inflow. Gomes, Haliassos, and Ramadorai (2021) read the evidence as payday takeup being "a response to persistently restricted access to cheap sources of very short-term liquidity" rather than irrationality, and Morse (2011) finds payday credit helps when it bridges a transitory shock. Our bridge loans share that structure but bridge to a new formal loan disbursed against a verified successful project—to support investment, not to smooth consumption—and are repaid quickly, avoiding the repeat borrowing that drives payday welfare concerns (Allcott et al. 2022).

A behavioral account of expensive short-term borrowing is time inconsistency: present-biased borrowers overuse fast credit (Laibson 1997; Meier and Sprenger 2010), with related evidence on under-provisioning for predictable seasonal needs (Fink, Jack, and Masiye 2020) and narrow framing of per-period fees (Bertrand and Morse 2011). These make the same headline prediction as our model, so the content lies in timing, sizing, and persistence. Our time-consistent model differentiates those details: present bias and planning fallacy predict borrowing at consumption peaks followed by rollovers and surprise at the repayment burden, whereas bridge financing concentrates at formal-loan maturities, is sized to the maturing repayment, and is repaid from the new disbursement—the pattern the data show. The welfare implications also differ: limiting repeat borrowing can help present-biased payday borrowers (Allcott et al. 2022), whereas restricting bridge credit delays profitable investment. The two can coexist; our claim is only about the loans timed to formal-loan maturities.

The remainder of the paper proceeds as follows. Section 2 describes the data and documents the loan-term and investment facts. Section 3 links investments to loans and measures the prevalence, duration, and size of bridge structures. Section 4 presents the estimation results on investment returns, consumption, and the Million Baht Village Fund. Section 5 develops the model, the calibrated welfare analysis, and the maturity-choice extension. Section 9 concludes.

Section 2. Data and Background

We analyze a panel dataset of village households in Thailand. The data provides key empirical facts that motivate our model, and we calibrate the model using this household-level evidence. Thailand offers an excellent setting for studying the interaction between formal and informal credit markets. Thai villages have traditionally supported vibrant informal credit networks (Siamwalla et al. 1990), while formal credit has been supplied by experienced state development banks, most notably the Bank for Agriculture and Agricultural Cooperatives (BAAC). The central government has actively financed the expansion of these development banks and subsidized their operations. As a result, BAAC, like other development banks globally, has historically offered below-market interest rates that are more uniform than those typically provided by commercial banks. In addition, BAAC has traditionally required full repayment of both interest and principal on its loans, as mandated by law (Maurer, Khadka, and Seibel 2000).

In recent years, the government made improving rural informal borrowing conditions a central priority and introduced a set of programs to achieve this goal. The most prominent initiative was the Million Baht Village Fund program (Boonperm, Haughton, and Khandker 2013), which provided every village in Thailand with one million baht in lending capacity. Loans from this program were generally uniform in size and carried identical interest rates. Funds were disbursed via accounts at the BAAC, which also provided logistical support for managing the loans. These loans are generally referred to as "village fund loans." Unlike traditional BAAC loans, Village Fund loans typically had weaker enforcement of repayment requirements and sometimes implicitly permitted loan rollovers. This is partly because loan administration was delegated to village committees rather than the BAAC (Phongpaichit and Baker 2004).

We use the 1999 to 2009 waves of the Townsend Thai Monthly Survey to study how informal choices help to complete the more rigid formal financial options available to households. This dataset is particularly well-suited for analyzing interactions between formal and informal borrowing, as it includes extensive household-level financial data for approximately 650 households across 16 villages in Thailand (Samphantharak and Townsend 2009).[1] Half of the villages are located in the wealthier Central region, while the other half are in the poorer Northeastern region. Households in the survey typically consist of multiple generations and operate a range of household businesses and farms. For each household, the dataset provides detailed monthly records of financial transactions throughout the survey period, including loan amounts and interest rates for both formal and informal borrowing.

Subsection 2.1. **Loan terms.** We find substantial differences between more rigid formal loans and more flexible informal loans in terms of loan duration, size, and interest rates. Formal loans are predominantly one-year contracts, tend to be larger and more uniform in size, and carry relatively homogeneous and low interest rates. In contrast, informal loans typically have shorter maturities, are smaller and more varied in size, and exhibit both higher average interest rates and greater rate dispersion. Aggregating across provinces and survey years, we present key empirical contrasts in Table 1 and Figures 1, 2, and 3, which compare the duration, size, and interest rates of formal, quasi-formal, and informal loans.[2]

In our analysis, we classify both BAAC and Village Fund loans as formal, reflecting their more rigid institutional structures. Loans from local moneylenders, neighbors, relatives, and other individual lenders are classified as informal, reflecting their more flexible terms. Loans from village agricultural cooperatives and production groups—locally based organizations with cross-regional ties—are classified as quasi-formal.

A striking feature of formal loans in our empirical setting is their uniform maturity structure: nearly all BAAC and Village Fund loans are due in approximately one year. As shown in column 2 of Table 1, the 20th to 95th percentiles of the formal loan maturity distribution range narrowly from 11 to 13 months. In contrast, informal loans have much shorter and more dispersed maturities, with a median term of just 3 months and only reaching 10 months at the 80th percentile. On average, formal loans are due in just under 13 months—more than twice the average maturity of informal loans, which is just under 6 months. Quasi-formal loans fall between these two extremes: roughly one-third are due in less than 11 months, while 45 percent mature between 11 and 13 months. The largely non-overlapping nature of these maturity distributions is illustrated in Figure 1.

1. There were 684 unique households in the 1999 wave. Of these, 606 households have complete credit market participation information for all survey years from 1999 to 2009. These households span 16 villages, with between 33 and 44 households observed over the 11-year period in each village. In total, 304 households are from two Northeastern provinces, while 302 households are from two Central provinces.

2. Appendix Figures C.7, C.8, and C.9 provide additional graphical detail, breaking out loan terms by lender category within our broader classifications.

Table 1. Duration, size, and interest rates of loans.

	Duration (months)			Size (baht)			Interest (monthly)		
Percentiles	Formal	Quasi-formal	Informal	Formal	Quasi-formal	Informal	Formal	Quasi-formal	Informal
Below median deciles									
5	3.0	3.0	0.0	5,000	1,000	630	0.23%	0.00%	0.00%
10	4.0	5.0	0.0	5,000	1,400	1,000	0.31%	0.00%	0.00%
20	11.0	7.0	1.0	10,000	2,000	1,800	0.46%	0.00%	0.00%
30	12.0	10.0	1.0	13,000	2,380	2,700	0.46%	0.00%	0.00%
40	12.0	12.0	2.0	16,000	3,000	5,000	0.50%	0.33%	0.00%
Quartiles									
25	12.0	8.0	1.0	11,000	2,000	2,000	0.46%	0.00%	0.00%
50	12.0	12.0	3.0	20,000	5,000	6,000	0.50%	0.45%	0.71%
75	13.0	13.0	8.0	30,000	15,000	20,000	0.67%	1.00%	3.00%
Above median deciles									
60	12.0	12.0	5.0	20,000	6,000	10,000	0.58%	0.69%	2.00%
70	13.0	13.0	7.0	20,000	10,000	15,000	0.62%	0.92%	2.62%
80	13.0	18.0	10.0	30,000	23,520	20,000	0.75%	1.00%	4.00%
90	13.0	26.0	13.0	50,000	50,000	45,000	1.00%	1.85%	6.25%
95	13.0	60.0	13.0	90,000	108,750	110,000	1.27%	3.00%	9.23%
Mean									
mean	12.8	15.5	5.8	31,876	27,271	22,628	0.80%	0.86%	2.36%

Note: The distribution of loan duration (in months), loan size (in baht), and loan interest rates (monthly) across lender types. Due to their rigidity, we classify BAAC and Village Fund loans as relatively formal loans. Due to their relative flexibility, we classify loans from local moneylenders, neighbors, relatives, and other local and individual lenders as informal loans. We classify loans from village agricultural coops and production cooperative groups, which are locally-based organizations with cross-region networks, as quasi-formal. There were 64 commercial loans observed in the sample (in contrast to 3396 BAAC loans), and they are excluded from the analysis. See discussions in Section 2.1.

Formal loans offer a relatively rigid menu of fixed loan sizes, in contrast to the smaller and more finely graduated sizes of informal loans. Village Fund loans, for instance, are highly discretized: approximately 90 percent fall between 5,000 and 30,000 baht, in increments of 5,000 baht. BAAC loans exhibit greater variation, but they too are generally issued in 5,000 baht intervals.[3] These institutional constraints are reflected in the distribution of loan sizes: the 5th, 6th, and 7th deciles of formal loan sizes are all exactly 20,000 baht, as shown in column 4 of Table 1.

While some informal loans are comparable in size to the largest BAAC loans, the vast majority are much smaller. Specifically, comparing columns 5 and 7 of Table 1, we find that at the 30th and 60th percentiles, formal loans are at least five times and twice as

3. The discretization of formal loan sizes is a common feature of development bank lending. From the perspective of managers at national branches, offering a standardized menu of loan options may reduce administrative complexity and lower operational costs relative to tailoring loans to individual borrowers.

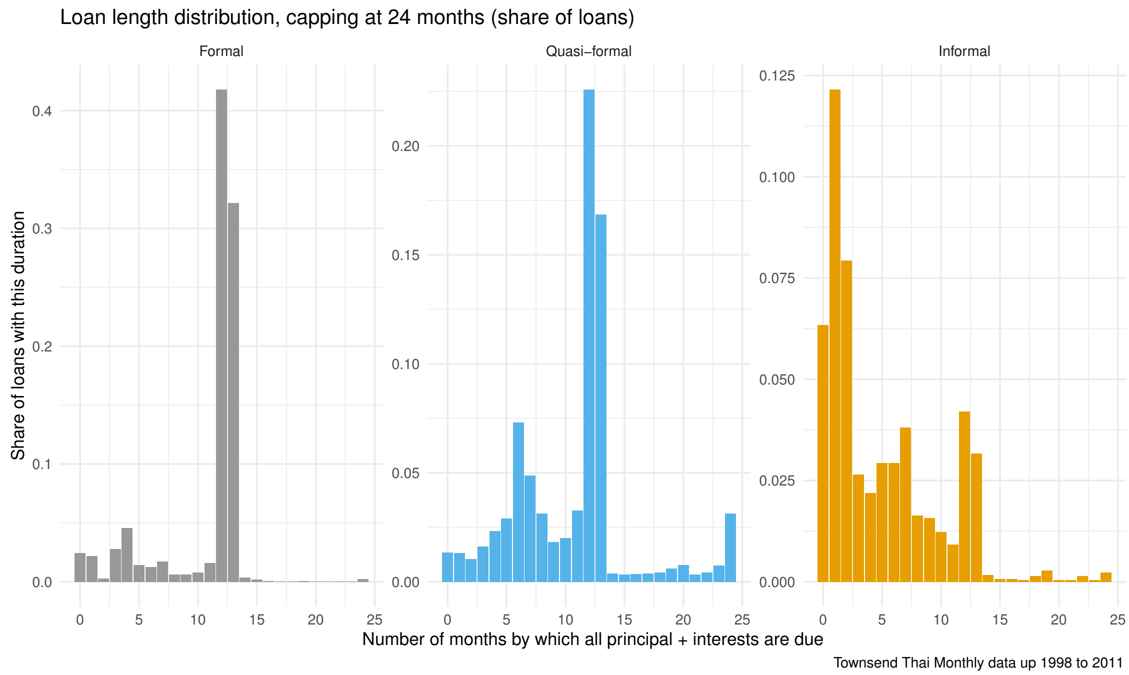

Fig. 1. Loan duration distribution

We show the loan duration (in months) distribution across formal, quasi-formal and informal loans. See discussions in Section 2.1.

large, respectively, as informal loans. The size distributions of formal and informal loans only converge above the 90th percentile. On average, informal loans are just 71 percent the size of formal loans and display no repeated values across deciles, reflecting their relatively more continuous and negotiable nature. In terms of size distribution, quasi-formal loans more closely resemble informal loans. These differences are further illustrated in Figure 2, which plots intersecting log loan size distributions across lender groups.

Interest rates on informal loans exhibit both a higher mean and wider dispersion compared to formal loans. Village Fund loans typically charge uniform interest rates within a given location and time period. For example, at the inception of the Village Fund program, nearly all such loans carried an annual interest rate of 6 percent, while BAAC loans charged 8 percent annually. Aggregating across time, column 8 of Table 1 shows that formal loans have a median monthly interest rate of 0.50%, a narrow interquartile range of 0.46% to 0.67%, and less than a one percentage point spread between the 5th and 95th percentiles.

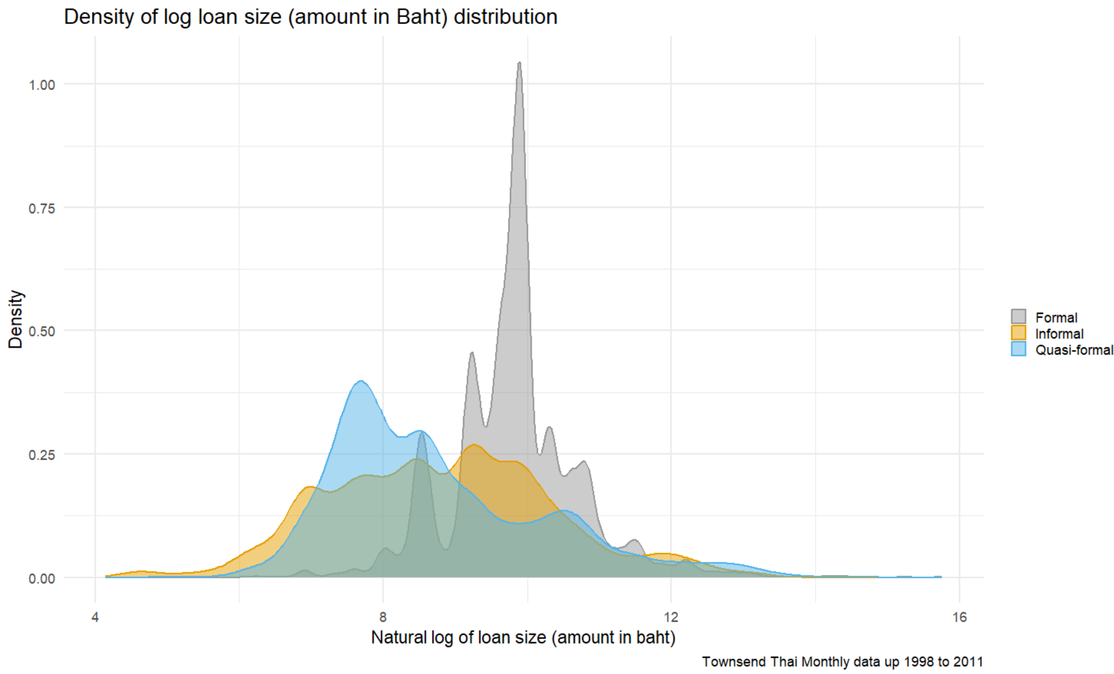

Fig. 2. Loan size distribution

We show the loan size (in log of baht) distribution across formal, quasi-formal and informal loans. See discussions in Section 2.1.

In contrast, as shown in column 9, informal loans display much greater heterogeneity. While 44% of informal loans report a zero percent interest rate,[4] the average monthly interest rate is 2.36%—substantially higher than the 0.80% average for formal loans. Above the median, the gap between informal and formal monthly interest rates widens from 1.5 percentage points to over 5 percentage points. Quasi-formal loans straddle the two categories: their interest rates resemble those of informal loans below the median and those of formal loans above the median. These broader patterns across lender types are mirrored within the eight main lender categories, whose interest rate distributions are shown in Figure 3.

In addition to loan duration, size, and interest rates, the monthly panel provides month by month loan repayment information which allows us to examine when loans are repaid and how much is repaid. Defining loan default as repaying less than the principal owed by the loan due date, we find that around 5% of all loans default and the share defaulting is at most 6.4% across all lender types. Pairing duration of loan information at origination with monthly repayment data, we find that for 92.5% of non-defaulting loans, the full principal is repaid in the month the loan is due. This shows the prevalence of

4. We use interest rates reported by households. Ostensibly zero-interest informal loans may require non-pecuniary compensation in the form of goods or services.

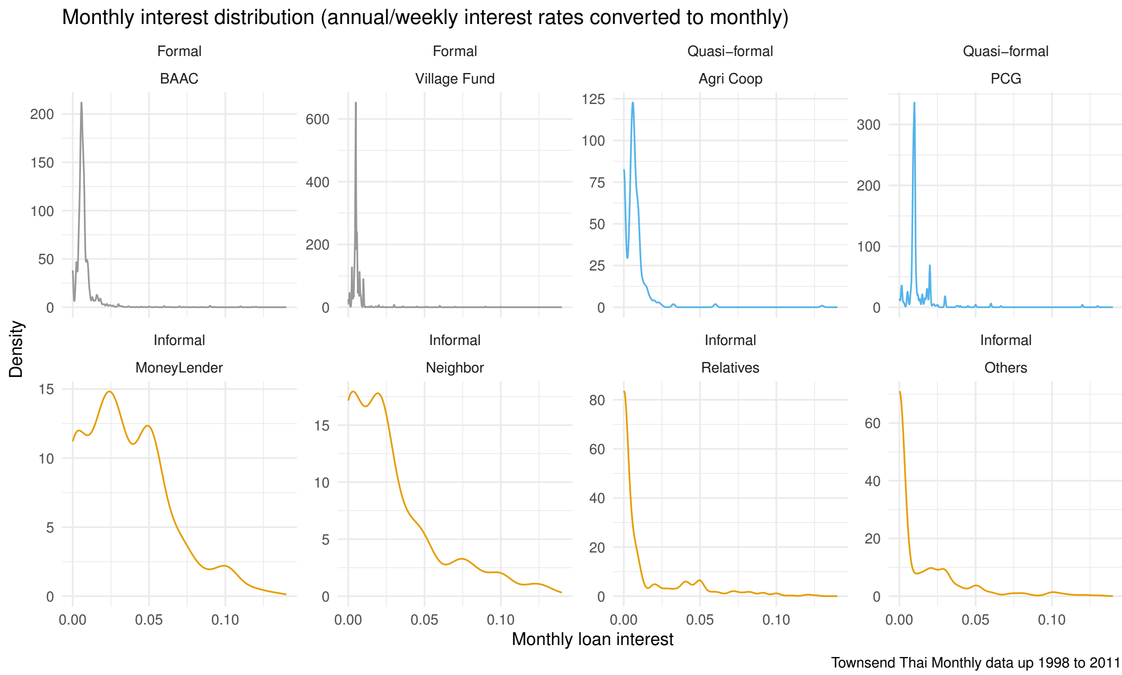

Fig. 3. Loan interest rate distribution

We show the loan interest rate (monthly) distribution across formal, quasi-formal and informal loans. See discussions in Section 2.1.

bullet loans in our data. We provide additional details on default and bullet payment in Appendix Sections C.1.1 and C.1.2.

We also consider aggregate loan term differences across villages. Comparing the eight villages with a relatively higher share of quasi-formal and also lower shares of informal loans to other villages, we find that monthly informal interest rates are lower in more-quasi-formal loan villages (0.89% vs 3.03%). Additionally, loan duration and size also tend to be longer and larger in more-quasi-formal villages across loan types. The presence of more quasi-formal borrowing opportunities, which combine features of formal and informal loans, might crowd out informal loans with worse terms and select informal loans that are larger, cheaper, and longer-duration. We provide additional details on village-level loan term differences in Appendix Section C.1.3.

Given the similarities between quasi-formal and informal loans—both are locally based, and quasi-formal loans resemble informal loans especially in size, while falling between formal and informal on duration and rates—and given that both can observe borrowers at low cost within the village, from Section 3 onward we group them jointly as *local* lenders when contrasting them with arm's-length formal lenders. This grouping anticipates the model's distinction between local lenders, who can verify project success cheaply, and formal lenders, who cannot.

Subsection 2.2. **Investment.** We identify investments by tracking the capital holding of a household and identifying single or consecutive months in which there are jumps in asset holdings.[5] The data include four asset types: agricultural (including livestock), business, land, and household assets. We consider agricultural and business assets as the primary productive assets. Increases in land assets may generate additional production income, but can also be tied to durable consumption and speculation. Household assets are not considered productive. Investments are identified for each asset type individually and across three combined categories: the sum of (1) agricultural and business assets, of (2) agricultural, business, and land assets, and of (3) all four asset types, including household assets. The first two combined categories serve as our primary measures of assets and investments.

In Table 2, we present summary statistics which show that investments happen for most households, but at low frequency. Considering the asset time series that combines agricultural and business assets, we find that 93.2% of households had periods with positive assets during the 160 survey months. We find that 11.0% of households did not make any investments during the 160 months of the survey, 30.4% of households made one investment, 27.8% made two investments, 18.3% made three investments, and the remaining 12.5% made more than three investments. These results are shown in column 5 of Table 2. On average, across all households, 0.15 investments are made per year. In columns of Table 2, we consider alternative definitions of investments, and find more occurrences of agricultural investments compared to business investments. Overall, our findings here echo the results from Kaboski and Townsend (2011), which finds that 12 percent of households from the 64 villages in the Townsend Thai Annual Survey make lumpy farm and business assets investments each year.

In Table 3, we show that investments are generally large relative to existing asset and income levels. With investment as the unit of observation, we present the relative sizes of investments with respect to the levels of assets in the month preceding the investment as well as the income (revenue minus costs) of the household-firm from the 12 months preceding the month of investment. We first focus on agricultural and business investments. In column 4, we find that productive asset investments are substantial in relative size to existing asset levels. Specifically, the median investment is 209 percent of the household's

5. We present in Appendix Figure C.4 capital-asset time series and the identification of investment timing for two illustrative households. We compute deviation in assets month by month, and consider jumps as positive differences that exceed a high positive standard deviation threshold (2.33 times the standard deviation). We compute household- and asset-combination specific standard deviation based on monthly asset differences from the household panel.

Table 2. Number of investments made by households.

# of investments	Investments based on individual assets categories: Agricultural assets	Business assets	Land assets	Household assets	Investments based on combined assets categories: Agricultural and business assets	Agri., biz, and land assets	Agri., biz, land, and hh assets
Share of households with different number of investments							
0	13.6%	79.7%	24.5%	2.3%	11.0%	13.6%	5.0%
1	27.6%	14.0%	32.5%	22.6%	30.4%	29.7%	20.6%
2	29.4%	4.5%	17.5%	29.4%	27.8%	26.0%	23.4%
3	17.2%	1.0%	10.2%	23.9%	18.3%	14.4%	24.5%
4	8.6%	0.5%	5.2%	13.6%	8.0%	10.1%	15.6%
5	2.4%	0.2%	3.7%	5.2%	3.2%	4.1%	7.0%
6	1.1%	0.2%	2.6%	2.3%	1.3%	1.8%	2.4%
7	0.0%	0.0%	2.6%	0.6%	0.0%	0.2%	1.3%
8+	0.0%	0.0%	1.1%	0.2%	0.0%	0.2%	0.2%
Mean number of investments per year							
	0.14	0.02	0.14	0.19	0.15	0.15	0.20

Note: The table shows the distribution of the number of investments made by households during the 160 months of the panel sample period. There are four underlying asset types in the data, agricultural assets (including livestock), business assets, land assets, and household assets. We identify investments based on "jumps" in the asset time-series for each of the four asset types and summarize the results in columns 2 to 5. Additionally, we identify investments based on three combined asset definitions, considering respectively "jumps" in the sum of agricultural and business assets, the sum of agricultural, business and land assets, and the sum of agricultural, business, land, and household assets. Columns 6, 7, and 8 summarize results based on these aggregate asset definitions. See discussions in Section 2.2.

assets in the preceding month, and the interquartile range is between 62% and 1387%, meaning that about 75% of investments increased the combined agricultural and business assets level by more than half. In column 8, we summarize the productive investment to income ratio, considering self-employed productive income from agricultural (including cultivation, livestock, and shrimp and fish) and business sources, excluding income from labor and other sources. We find that the median investment to past 12 months total income ratio is about 66%, with the interquartile range between 21% and 327%. We also consider land. Land constitutes a large potential component of productive assets, but the acquisition of additional land might not be relevant for income generation. Column 5 shows that that even incorporating land, investment to asset ratio remains large with a median ratio of 10% and 3rd quartile ratio of 40%. Column 9 shows that considering land, the median investment to self-employed income ratio reaches 83%, with the interquartile range between 25% and 516%.

In this section, we pooled agricultural and business assets jointly as productive assets. In Appendix Section C.2.1, we find that the lumpiness of assets with respect

Table 3. Ratio of investment to prior month assets and prior 12 months income.

	Fraction of investment to existing assets				**Fraction of investment to prior year's income**			
Numerator: Investment definitions	Agricultural	Business	Agricultural and business	Agricultural, business, and land	Agricultural and business	Agricultural, business, and land	Agricultural and business	Agricultural, business, and land
Denominator: Assets or income	Agricultural and business assets			Agricultural, business, and land assets	All income		Self-employed income	
Bottom decile								
5	14.1%	3.1%	18.0%	0.3%	0.9%	1.3%	3.6%	4.6%
10	22.7%	4.9%	27.4%	0.7%	2.2%	2.7%	7.1%	8.7%
15	31.0%	9.5%	36.6%	1.1%	3.6%	4.3%	11.3%	13.0%
Quartiles								
25	52.9%	18.9%	62.2%	2.3%	7.4%	9.1%	20.5%	24.8%
50	180.6%	68.5%	209.2%	9.7%	24.6%	33.0%	66.2%	82.5%
75	1,088.4%	940.3%	1,386.6%	39.7%	66.1%	92.8%	326.8%	515.9%
Top decile								
85	6,801.1%	6,748.2%	10,380.3%	120.1%	120.5%	184.9%	12,500.0%	9,427.0%
90	Inf%	75,634.7%	Inf%	273.9%	194.2%	339.2%	Inf%	Inf%
95	Inf%	Inf%	Inf%	1,472.2%	626.8%	1,147.2%	Inf%	Inf%

Note: In this table, considering investments identified under alternative asset definitions, we present the relative sizes of investments with respect to the levels of capital in the month preceding the investment as well as the income (revenue minus costs) of the household-firm from the 12 months preceding the month of investment. Self-employed income in columns 6 and 7 considers income from agricultural (including cultivation, livestock, and shrimp and fish) and business sources. All income in columns 8 and 9 includes self-employed income and also income from labor and other sources. At the upper quantiles in columns 2, 3, 4, 8, and 9, the table shows positive infinity at the top quantiles. Infinities arise when an investment occurs in a household with zero levels of prior asset holding or prior income. Additionally, we set the investment to income ratio to positive infinity when income is negative (due to higher costs than revenue). See discussions in Section 2.2.

to earnings is similar across livestock assets, agricultural assets excluding livestock, and business assets, which are the three components of productive assets. Investments are lumpier when we consider livestock and non-livestock agricultural assets jointly, which indicates concurrency of investments within agricultural assets. Due to the lower frequency of business investments compared to agricultural investments, asset lumpiness does not increase significantly when we combine business and agricultural assets.

Section 3. Linking investments to loans

Subsection 3.1. **Time-linked investments with loans.** We use investment timing information jointly with the timing of the starting and ending dates of loans to identify all loans that are taken out in close proximity to the start of an investment month and repaid after the investment in assets has been made. Specifically, we identify all loans that are taken out between τ months before ($\tau = 6$ for the primary specification) and up to the month in which an investment was initiated; additionally, these loans must be due after the investment has been made.

We consider loans identified in this fashion as loans that could provide financing for the investment made within the τ window.[6] Specifically, let $\underset{\sim}{m}_{\text{inv}}$ and $\tilde{m}_{\text{inv}}$ be the starting and ending month of an investment made by a household. Let $\underset{\sim}{m}_a$ and $\tilde{m}_a$ be the month in which loan a made by the household originates and the month in which it is fully repaid, respectively. Let L be the total number of loans taken out by the household during the span of survey been considered, each investment by the household has a set of "investment-linked" loans L^A:

$$L^A(\tau) = \left\{ a \in \{1, \ldots, L\} \mid \underset{\sim}{m}_{\text{inv}} - \tau \le \underset{\sim}{m}_a \le \underset{\sim}{m}_{\text{inv}} \text{ and } \tilde{m}_{\text{inv}} < \tilde{m}_a \right\}. \tag{1}$$

L^A might contain the index for multiple loans, obtained from the same or multiple types of lenders. When that is the case, we interpret the household as jointly using multiple loan sources to support financing the initial investment, perhaps complementing loans from different sources given borrowing constraints on each, acting as top-up loans (Gine 2011). If L^A is empty, the investment is not loan-linked.

We take Eq. (1) to the panel data and link investments to loans. To allow for time before investment and after, we consider investments made between month 15 and month 145 within the 160 months panel. Additionally, given that households might also take loans for non-investment purposes, to reduce spurious linkages, we consider only investments that exceed 10,000 baht in drawing investment to loan linkages. For the rest of Section 3, we impose these restrictions on the investment sample. Given the sample, we consider the share of investments that are linked to loans within different τ-sized backward windows. Considering investments in agricultural and business assets, when $\tau = 0$, 36.7% of the investments are loan-linked. When $\tau = 3$, 61.5% of the investments are loan-linked. When $\tau = 6$, 72.1% of the investments are loan-linked. These shares significantly exceed those expected if investments occurred in random months.[7]

Subsection 3.2. **Time-link investments with loan hooks and bridges.** The features of rigid formal loans documented prior provide space for "bridge" loans. A borrower could

6. It is possible that these newly initiated loans are marked by households as servicing other needs besides financing new investments, but the new loan is a net addition to the cash-on-hand available that would enable investment.

7. In total, there were 15,880 household-months in which new loans were initiated out of a total of 114,318 household-months. If loans were randomly timed across household-months, there would be a 13.9% chance that loans are initiated in any household-month. Appendix Figure C.5 shows that the actual share of investments that are loan linked is significantly higher than the share that would be randomly linked across backward τ windows. As τ extends backward further, the chance that an investment is loan linked approaches 1 by construction.

ease their pending liquidity crunch by borrowing from a flexible bridge lender to help cover bullet debt obligations, and then borrow again from the same or an alternative bullet loan provider to repay the bridge debt and effectively achieve longer-term financing for a portion of the initial investment. To analyze these potential bridged investment to loan linkages, we define sets of loans that are "hooked" and "bridged" to the investment-linked set L^A loans.

For a household, loans a, b, and c form a set of investment-linked bridge loans, if loan a is linked to a particular investment, loans a and b as well as loans b and c are "hooked" together, and the end date of loan a is prior to the start date of loan c. Specifically, the start and end dates for loans a and b follow this sequence: $\underset{\sim}{m}_a < \underset{\sim}{m}_b \leq \tilde{m}_a \leq \tilde{m}_b$. Similarly, the start and end dates for loans b and c follow this sequence: $\underset{\sim}{m}_b \leq \underset{\sim}{m}_c \leq \tilde{m}_b < \tilde{m}_c$. The end date for loans a and start date for c follow this sequence: $\tilde{m}_a \leq \underset{\sim}{m}_c$. The inequalities in these orderings accommodate limited granularity in the temporal unit of observation—when data is observed monthly, we cannot distinguish loan timing sequences within the month. For the household, the set of bridge loans linked to a particular investment are:

$$\mathcal{B} = \left\{(a, b, c) \mid a \in L^A, b \in L^B(a) \text{ and } c \in L^C(a, b)\right\} . \tag{2}$$

$L^B(a)$ contains loans that are "hooked" to an investment via loan $a \in L^A$, and $L^C(a, b)$ contains loans that are "bridge-linked" to the investment via loans a and b.[8]

Building on the investment-loan linkages constructed following Eq. (1), we construct time-linked investment-loan bridges following Eq. (2). Table 4 presents the share of investments by different investment-loan linkage types. Results using the benchmark 6 months backward investment-loan window are shown.[9] Focusing on investments based on agricultural and business assets, we find that 27.9% of investments are "no-loan" investments, with $L^A = \varnothing$. 16.4% of investments are "initial loan set only" investments, with $L^B(a) = \varnothing$ for all $a \in L^A \neq \varnothing$. 6.8% of percent of investments are "hooked

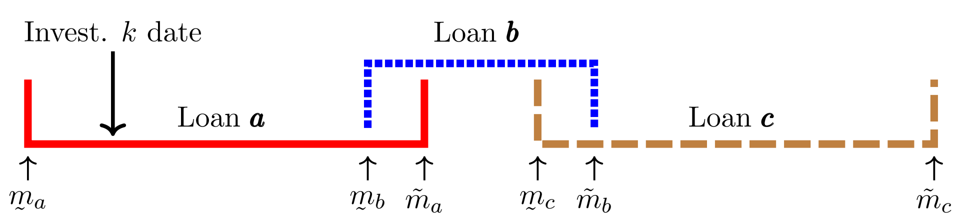

Fig. 4. Loan bridge illustration

8. In Appendix B, we define loan sets L^A, $L^B(a)$, and $L^C(a, b)$ formally and illustrate types of investment-linked bridge loans.

9. Results using a 3 month backward investment-loan window are similar and shown in Appendix Table C.5.

loans only" investments, with $L^C(a,b) = \varnothing$ for all (a,b) such that $a \in L^A \neq \varnothing$ and $b \in L^B(a) \neq \varnothing$. 48.6% of investments are "bridge-linked" investments, with non-empty $\mathcal{B}$, and these bridge-linked investments account for more than two thirds (68%) of all loan-linked investments.

Furthermore, focusing on the subset of bridge-linked agricultural and business investments, we find that 7.6% of bridge-linked investments have loan bridges with a single lender. In these cases, the triply-linked loans tend to be all from the Village Fund. Additionally, 8.0% of the bridge-linked investments have loan bridges involving both formal lenders (BAAC and Village Fund). The remaining 84.4% of bridge-linked investments contain loan bridges involving both formal and local (informal and quasi-formal) bridge components. Finally, among these investments with joint formal and local investment loan bridges, 57.3% contain loan bridges with formal–local–formal linkages—for a particular investment made by a household, there exists $(a, b, c) \in \mathcal{B}$ such that loans a and c are borrowed from the BAAC or Village Fund, and loan b comes from a local lender.[10]

Subsection 3.3. **Duration and size of investment-linked loan bridges.** In this section, we show the duration overlap across loan segments as well as the relative size of investments and loans within investment-loan bridges. For duration, we compare four time (months) segments summarized in Table 5. First, we compute *bridge-duration*, which is equal to the overall month gap between the start of the loan a and the end of loan c for each investment-linked loan-bridge. The median bridge-duration is 26 months. Second, we compute *start-end-duration*, which is equal to the sum of the month gap between the start of loan a to the start of loan b and the month gap between the end of loan b to the end of loan c. The median start-end-duration is 16 months. Third, we compute *overlap-duration*, which is equal to the sum of the number of months in which loan a overlaps with loan b and the number of months in which loan c overlaps with loan b. The median overlap-duration is 7 months. Fourth, we compute *gap-duration*, which is equal to the number of months between the end of loan a and the start of loan c. The median gap-duration is 3 months for all investment-loan bridges and 2 months for those with formal–local–formal linkages.

Jointly, we find that for the durations of the median investment-linked loan bridge, the bridging loan b originates around 3 months before annual loan a is due and is repaid around 3 months after annual loan c originates, and loan b provides bridging for about 2 to 3 months over the gap between loan a and loan c. There is substantial heterogeneity in loan bridge durations. At the first quartile of investment-linked loan bridge, the bridging is tightened with the overlap-duration falling to 3 to 4 months and the gap-duration falling

10. Decomposing the middle leg of these formal–local–formal bridges by lender category, 33.8 percent of the middle-leg loans ($n = 237$) come from informal lenders and 66.2 percent from quasi-formal lenders. Within the informal middle legs ($n = 78$), moneylenders account for 15.4 percent, neighbors for 29.5 percent, relatives for 30.8 percent, and other individual lenders for 24.4 percent.

TABLE 4. Number (#) and percent (%) of investments by credit arrangements.

	Alternative investment definitions					
	Agricultural and business assets investments		Agricultural, business, and land assets investments		Agricultural, business, land, and household assets investments	
	#	%	#	%	#	%
Investments *not* time-linked to loan bridges						
Invest. *not* time-linked any loans	205	27.9%	244	29.6%	426	29.7%
Invest. time-linked to *standalone* loans (set A loans only)	121	16.4%	132	16.0%	271	18.9%
Invest. time-linked to *"hooked"* loans (set A and B loans only)	50	6.8%	57	6.9%	111	7.7%
Investments time-linked to *only* formal *or only* local loan bridges						
Single lender type only investment-loan bridge	27	3.7%	26	3.2%	60	4.2%
Multiple formal lenders investment-loan bridge	29	3.9%	31	3.8%	41	2.9%
Multiple local lender types investment-loan bridge	2	0.0%	2	0.0%	6	0.0%
Investments time-linked to *joint* formal *and* local loan bridges						
Contains *formal—local—formal* loan bridges	173	23.5%	186	22.6%	293	20.4%
Do not contain formal—local—formal loan bridges, but includes *local links* in bridges	129	17.5%	145	17.6%	228	15.9%

Note: The number and share of investments linked to different types of loan structures, considering different investment definitions across columns, and using a 6-month investment-loan backward window ($\tau = 6$). See Appendix Table C.5 for results based on a 3-month backward window. To allow for time before and after investment, we consider investments made between month 15 and month 145 within the 160-month panel. Additionally, to reduce spurious linkages, we consider only investments that exceed 10,000 baht in drawing investment-to-loan linkages. See discussions in Section 3.2.

to 0 month. At the third quartile, the bridging widens with overlap-duration increasing to 11 months, gap-duration increasing to 6 to 7 months, and the overall bridge-duration widening to 34 months. Across quartiles, investment-loan bridges with formal–local–formal have slightly tighter bridging. Overall, the duration statistics on investment-linked loan bridges provide evidence that households use temporally inter-connected overlapping loans to extend the maturity of otherwise shorter-duration loans.

For size, we compare three relative investment and loan size statistics summarized in Table 6. First, we compute the *loan-a-to-investment ratio*, which is equal to the the

Table 5. The durations (months) of overlapping loan-bridge segments in time-linked investment-loan bridges.

	Loan bridges linked to agricultural and business assets investments				**Loan bridges linked to agricultural, business, and land assets investments**			
	Bridge duration	Start-end duration	Overlap duration	Gap duration	Bridge duration	Start-end duration	Overlap duration	Gap duration
	Start of loan a to end of loan c	*a + c dura. excluding b overlap*	*Loans a + c overlap with loan b*	*b dura. excluding a or c overlap*	*Start of loan a to end of loan c*	*a + c dura. excluding b overlap*	*Loans a + c overlap with loan b*	*b dura. excluding a or c overlap*
All investment-loan bridges								
Quartiles (number of months)								
25	23	12	3.5	0	23	12	3	0
50	26	16	7	3	26	16	7	3
75	34	21	11	6	34	21	11	7
Invest-loan bridges with formal-local-formal linkages								
Quartiles (number of months)								
25	23	12	4	0	23	12	3	0
50	26	16	7	2	26	16	7	2
75	34	21	11	6	34	22	11	6

Note: In the table, we consider investment-loan bridges in the top panel, and the subset of investment-loan bridges with formal–local–formal linkages in the bottom panel. In columns 2 and 6, we show *bridge-duration*, which is equal to the overall month gap between the start of the loan a and the end of loan c for each investment-linked loan-bridge. In columns 3 and 7, we show *start-end-duration*, which is equal to the sum of the month gap between the start of loan a and the start of loan b and the month gap between the end of loan b and the end of loan c. In columns 4 and 8, we show *overlap-duration*, which is equal to the sum of the number of months in which loan a overlaps with loan b and the number of months in which loan c overlaps with loan b. In columns 5 and 9, we compute *gap-duration*, which is equal to the number of months between the end of loan a and the start of loan c. In columns 2 to 5, we consider productive asset definitions without land. Results correspond to investment-linked loan bridges from the lower panels of columns 1 and 2 in Table 4. We include land in columns 6 to 9, and results correspond to investment-linked loan bridges from the lower panels of columns 3 and 4 in Table 4. See discussions in Section 3.3.

principal of a loans divided by the size of investment. Second, we compute the *loan-b-to-a ratio*, which is equal to the ratio of the principal of linked loan b to the principals of a loans. Third, we compute the *loan-c-to-a ratio*, which is equal to the ratio of the principal of linked loan c to the principals of a loans. Jointly, at the median, we find that sufficient loans originate near the start of investment to finance the majority (median loan-a-to-investment ratios exceed 50%) of the financial needs of the lumpy investments. Around one third (median loan-b-to-a ratios are around 30%) of the initial loans are covered with a bridge loan, and a loan of up to half of the initial loan (median loan-c-to-a ratios are around 50%) size is taken out after the bridge-loan facilitated repayment of initial loans.

There are substantial heterogeneities in the loan-a-to-investment ratio. At the first quartile, the ratios remain large at greater than 20%. At the third quartile, the ratios

TABLE 6. The distribution relative size of loans to investments and loans to loans in time-linked investment-loan bridges.

	Loan bridges linked to agricultural and business assets investments			Loan bridges linked to agricultural, business, and land assets investments			Loan bridges linked to agri., business, land, and household assets investments		
Numerator	a loans principals	b loan principals	c loan principals	a loans principals	b loan principals	c loan principals	a loans principals	b loan principals	c loan principals
Denominator	Investment size	a loans principals		Investment size	a loans principals		Investment size	a loans principals	
All investment-loan bridges									
Quartiles (fractions shown as percentages)									
25	29%	10%	16%	22%	11%	17%	19%	11%	14%
50	83%	30%	50%	66%	32%	50%	54%	29%	44%
75	173%	100%	100%	131%	100%	100%	103%	90%	100%
Invest-loan bridges with formal-local-formal linkages									
Quartiles (fractions shown as percentages)									
25	44%	8%	16%	32%	8%	16%	27%	8%	14%
50	95%	17%	40%	76%	20%	40%	66%	19%	40%
75	181%	55%	97%	144%	67%	97%	131%	59%	100%

Note: This table reports the relative sizes of investments and loans in investment-loan bridges. In the table, we consider investment-loan bridges in the top panel, and the subset of investment-loan bridges with formal–local–formal linkages in the bottom panel. In columns 2, 5, and 8, we show the *loan-a-to-investment ratio*, which is equal to the principals of a loans divided by the size of investment. In columns 3, 6, and 9, we show the *loan-b-to-a ratio*, which is equal to the ratio of the principal of linked loan b to the principals of a loans. In columns 3, 6, and 9, we compute the *loan-c-to-a ratio*, which is equal to the ratio of the principal of linked loan c to the principals of a loans, linked via loan b. In columns 2 to 4, we consider productive asset definitions without land. Results correspond to investment-linked loan bridges from the lower panels of columns 1 and 2 in Table 4. We include land in columns 5 to 7, and results correspond to investment-linked loan bridges from the lower panels of columns 3 and 4 in Table 4. We include land and household assets in columns 8 to 10, and results correspond to investment-linked loan bridges from the lower panels of columns 5 and 6 in Table 4. See discussions in Section 3.3.

exceed 100%. Total a loan principals can exceed investments because our time-based investment-loan linking strategy picks up all household loans. Given budget fungibility, the loans could be financing investments along with household expenditures for education, health, and other consumption items. Similarly, more expansive definitions of assets/investments across columns of Table 6 lead to a fall in the loan-a-to-investment ratio.

There are also substantial heterogeneities in the loan-b-to-a and loan-c-to-a ratios. At the first quartile, the loan-b-to-a ratios are around 10% and loan-c-to-a ratios are around 15%. The median and below results indicate that for the majority of investments, the timely repayment of loan a principals does not predominantly rely on bridging loans. Households are presumably using returns from investments to support most of the investment-loan repayments.

At the top panel of Table 6, at the third quartile, we find that the loan-b-to-c and loan-c-to-a ratios are both at around 100% among all investment-loan bridges. This shows that cross-lender evergreening is present as some households rollover loans of the same size across lenders. Interestingly, among bridges with formal–local–formal linkages in the lower panel of Table 6, at the third quartile, while the loan-b-to-a ratios are lower at around 60%, we still find 100% loan-c-to-a ratios. There could be excess loan c borrowing due to the clunkiness of formal loans: formal loans are chosen from a limited menu of sizes and repayment requires up-sizing.

Section 4. Empirical Estimation

We conduct three interlinked analyses to explore the linkages between the investment and earnings changes, the changes in consumption over the investment-loan window, and the impact of the Million Baht Village Fund program on village-level investment and investment-loan linkages. In each analysis, we exploit the monthly panel nature of our survey to construct pre- and post-forward and trailing windows around household-level investment and investment-loan dates as well as Village Fund program start dates. Focusing on households that have selected into making lumpy productive asset investments, the analyses provide key estimates on returns on investment, the change in consumption before investment and after bridged or non-bridged loan repayment, and the impacts of providing low-cost formal credit on investment and investment-bridging choices. The results provide empirical evidence on the availability of high return but risky lumpy capital investment opportunities that can lead to increases in consumption, and the importance of loan-bridging in facilitating additional investments when formal loan terms improve. The empirical findings also provide us with parameter estimates to feed into our structural equilibrium model as inputs as well as empirical moments to compare with model predictions.

Subsection 4.1. **Investments and changes in income.** We now compare two time-matched changes: the size of an investment and the change in income around it. Investment size is the difference in assets before and after the months in which an investment is made, as discussed in Section 2.2. Income change is the difference between average monthly income in the 12 months after and the 12 months before the months of investment. The positive association between the two measures the return on investment, a key parameter for the farmer's lumpy investment problem in Section 5.

Table 7 reports estimates using all sources of income or only self-employed productive income, and measuring assets without and jointly with land. Our within-household time differencing ensures that estimates are not driven by cross-sectional correlations in levels; survey month fixed effects difference out secular income growth; village fixed effects difference out village-level factors that affect both investment and income.

We find a strong positive relationship between investment size and household income changes. In column 3 of the top panel of Table 7, controlling for both village and survey month fixed effects, an additional baht of investment is associated with a 0.013 baht increase in average monthly income—a 1.3 percent monthly rate of return—in the 12 months after relative to the 12 months before the investment. Without the time and location fixed effects the estimate is larger, at 2.0 percent per month. When we use only self-employed productive income, rates of return are about 5 to 20 percent smaller. A possible explanation is that efficiency gains from investment free up household time for wage earning, which lifts the all-income estimates. Averaging across the six estimates in the top panel, we have an average monthly return of 1.4 percent per month.

In the lower panel of Table 7, we show that returns are about 5 to 40 percent smaller when land is included in assets, with the largest gaps when all sources of income are considered. A plausible explanation for these smaller estimates is that some land purchases serve consumption, storage, or speculation, which dilutes the return once land enters assets.

Every estimated rate of return excluding land exceeds 1.0 percent per month, the 90th percentile of BAAC and Village Fund interest rates, and every estimate in Table 7 is significantly above the 0.5 percent median monthly BAAC and Village Fund borrowing rate (see Table 1). As a placebo test, Appendix Table C.9 regresses income changes on changes in household (non-productive) assets and finds no significant effect. Additional estimation results are in the Appendix. Our findings are in line with the high returns to investment documented in village economies (Mel, McKenzie, and Woodruff 2008; Beaman et al. 2023).

Our estimates give the average return to investment for investing households. They are jointly determined by the increase in physical capital, concurrent changes in other inputs such as labor, and productivity shocks known to the household at the time of investment. They therefore measure the return to an investment episode rather than the capital elasticity of a production function.

Investing and non-investing households also differ in observables: investing households are wealthier and hold more productive assets. Wealth may reflect successful prior investments, and it may also enable new investment, since lumpy projects must be partly self-financed when loans have limited maturities, as we demonstrate in our model. Household heads in the two groups have similar educational attainment, while age of household head and household size differ by small but statistically significant amounts. These observable differences plausibly extend to unobservables such as entrepreneurial ability, so

Table 7. Changes in 12 months average monthly income before and after the investment month and the size of investment.

	Outcome: pre-post investment monthly income gap					
	All income			Self-employed income		
	(1)	(2)	(3)	(4)	(5)	(6)
Productive assets (business, agricultural, and livestock assets) investments						
Investment (pre-post asset difference)	0.0201	0.0120	0.0130	0.0161	0.0114	0.0119
	(0.0064)	(0.0072)	(0.0074)	(0.0061)	(0.0069)	(0.0071)
R^2	0.013	0.218	0.268	0.009	0.208	0.254
Observations	720	720	720	720	720	720
Productive assets including land investments						
Investment (pre-post asset difference)	0.0114	0.0090	0.0099	0.0134	0.0108	0.0110
	(0.0036)	(0.0040)	(0.0041)	(0.0027)	(0.0029)	(0.0030)
R^2	0.012	0.184	0.208	0.030	0.211	0.225
Observations	805	805	805	805	805	805
Survey-month FE	No	Yes	Yes	No	Yes	Yes
Village FE	No	No	Yes	No	No	Yes

Note: Standard errors in parentheses. The table reports the coefficient from regressing the difference in average monthly income (revenue minus costs) from the 12 months preceding and following the investment month on the size of investments. Investment size is the difference in assets before and after investment. In the upper panel, we show results using productive assets without land. In the lower panel, we include land. In columns (1) and (4), we regress changes in income on the size of investments without controls. We control for survey month fixed effects in columns (2) and (5), and both survey month and village fixed effects in columns (3) and (6). In columns (1) to (3) we consider all sources of income, and we consider only self-employed productive income from agricultural (including livestock, fish and shrimp) and business sources in columns (4) to (6). The sample here considers only investments that exceed 10,000 baht and that were made between month 15 and month 145 (providing sufficient months for forward and backward 12 month income windows). To avoid outlier contamination, we exclude the top 1 percentile of the investment changes from the estimation sample.

our estimates are best read as returns for households that invest. Appendix Section C.2.3 details the comparison.

As a companion analysis, Appendix Section C.3.1 reports descriptive statistics on the distribution of the ratio of the income change to the investment size. The ratio measures heterogeneity in the investment–earnings association directly from the raw data, free of parametric restrictions on the distribution of heterogeneity or functional form assumptions on the investment–earnings relationship; where earnings changes come only from investment, it is the household-level return. Most ratios are positive, and about 40 percent are negative, reflecting both losses on investment and ordinary fluctuation in earnings over time. The distribution has a long left tail and is left-skewed. Variability and skewness are lower for investments financed by bridged loans, suggesting selection into loan bridging among investments with lower downside risk.

We take the average return estimates from Table 7 directly into the model as the benchmark return on investment. The wedge between this return and the cost of loans determines the household's incentive to finance lumpy investment. The model also captures the riskiness of project returns through default risk, together with a joint risky-investment verification mechanism that induces selection into loan bridging by projects with lower default risk, and hence less left-skewed returns.

Subsection 4.2. **Investments and changes in consumption.** In this section, we explore the relationship between investment loans and consumption. We use the investment-loan linkages we constructed in Section 3.2 to construct consumption comparison windows. After a lumpy investment project successfully generates returns, a purely self-financed investment might allow for an immediate increase in consumption, but a loan- and bridge-loan-financed project might have delayed consumption increase until the repayment of loans. We construct an investment-loan window to account for these different financing scenarios. The start of the window is the investment start month. For investments without loans associated with them, the end of the window is the investment end month. For investments time-linked to standalone loans, the end of the window is the end month of the standalone loan (loan a). For investments time-linked to doubly-linked loans, it is the end month of the second loan (loan b); for investments time-linked to triply-linked (bridged) loans, it is the end month of the third loan (loan c).[11]

We compute the average consumption in the 12 months prior to the investment start month and in the 12 months after the relevant loan (or no loan) end month. Dividing these, we arrive at the percentage change in consumption before and after the investment-loan window. In the farmer's lumpy investment problem in Section 5, consumption stays near its pre-investment level while linked loans are outstanding and steps up once a successful project's returns are free of repayment obligations. The size and timing of that step depend on when the household invests, on the financing strategy, and on whether the project succeeds. The window comparison is designed to capture this before-and-after difference.

Consumption rises across the investment-loan window for most investments. About 65 percent of the 685 investment episodes show an increase, with a median rise of 15 percent; the mean increase of just under 34 percent reflects a long right tail, and the top quarter of episodes see increases above 50 percent (see Figure 5).

11. In cases where there are multiple loans in the same loan set, we use the first ending month of the loans in that set.

(a) Percentage change in consumption before and after the investment-loan window

(b) Within-household difference: inside-window growth minus outside-window growth

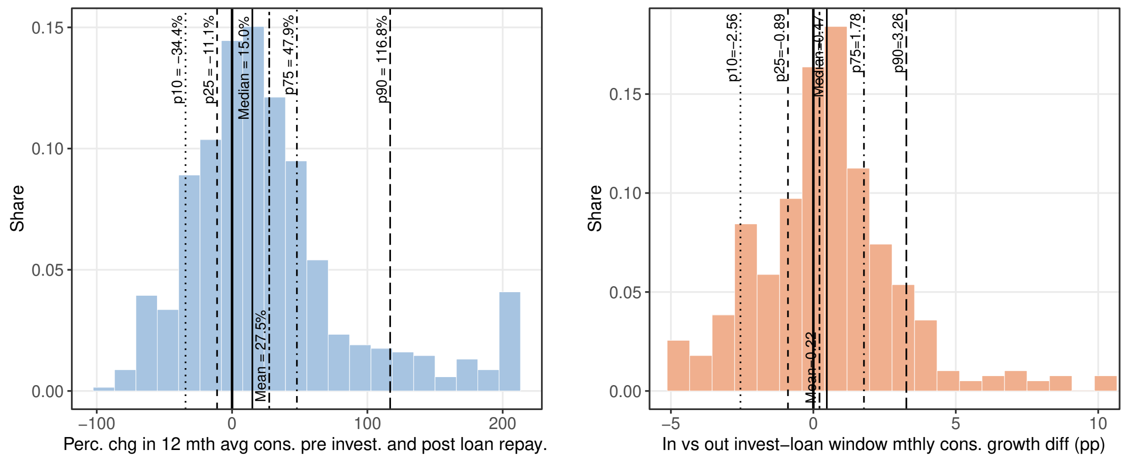

Fig. 5. Consumption growth in investment-loan window.

Panel (a) shows the distribution of percentage changes in average 12-month consumption before and after the investment-loan window. For each investment, the window starts at the investment month and ends at the relevant repayment endpoint depending on investment-loan linkages. Consumption before and after is computed from 12-month averages before investment start and after the relevant window end. To help with visualization, we bunch percentage changes that exceed 200 percent; statistics are computed using the raw percentage changes. Panel (b) plots, for the same investing households, the household-specific difference between monthly consumption growth inside investment-loan windows and household-specific monthly growth outside these windows. Positive values indicate faster consumption growth during investment-loan episodes relative to the same household's outside-window benchmark. See Section 4.2 for discussions.

Consumption fluctuates for reasons unrelated to the investment, so both tails of this distribution are informative. The large increases in the upper quartile are indicative of the positive impact of successful lumpy investment on consumption. The magnitudes of the increases, however, could also be due to households no longer needed to save to finance their investment. The reductions in consumption in the lower quartile might be due to income losses and default when lumpy investments fail, and likely also capture the impacts of other consumption and income shocks that are unrelated to the particular investment-financing episode.

Consumption also grows faster inside the investment-loan window than outside it for the majority of investing households suggesting that investment is spurs larger consumption. To illustrate this result, we compute in- and out-window monthly consumption growth rates for investing households, and compare both to the growth rates of households that do not invest. [12] At and above the median, in-window monthly growth is roughly two to three and a half times the outside-window rate, against both benchmarks: the same households' months outside the window, and the months of households that do not invest.[13] Because the first comparison uses the same households' growth in their own other months, this pattern is consistent with a large positive impact of investment on household consumption rather than with a secular trend in consumption growth.

Below the median, in-window growth is negative, and in the bottom decile consumption falls faster inside the window than outside. This dispersion is consistent with project return heterogeneity and with the chance of project failure, which reduces income and consumption.

Subsection 4.3. **Million Baht Village Fund and investment and loan linkages.** In the prior sections, we analyzed the how investments relate to earnings and consumption by taking advantage of the monthly survey's high-frequency data to identify investment and investment-loan windows. In this section, we exploit a quasi-experimental variation in rural formal credit provision to study how the availability of low-cost formal credit affects the number of investments, and the financing arrangements for investments.

In September of 2011,[14] the Million Baht Village Fund program was introduced in Thailand by the government of Prime Minister Thaksin Shinawatra to make 1 million baht of low-cost loans available to each village in Thailand, irrespective of the number of households in the village (Kaboski and Townsend 2012). Given this policy feature, the inverse of the number of households in each village captures loan availability per household from the Village Fund program, and provides quasi-experimental variations in the intensity of the Village Fund treatment. The Village Fund loans required the repayment of principal and interest one year after issuance at generally 6 percent annual interests rate.[15]

12. We compute Monthly-equivalent cons. percent change $= \left(\left(\frac{\text{Cons. after}}{\text{Cons. before}}\right)^{\frac{1}{\text{Nr. of mths in window}}} - 1 \right) \cdot 100.$ The number of months in window is the difference between the loan end month and the investment start month, plus twelve to account of the forward and backward consumption windows. For month segments outside of the investment-loan window, we compute monthly-equivalent consumption percentage change for each month segment and then take the average across all (disconnected) segments for the average monthly-equivalent consumption percentage change outside of the investment-loan window.

13. We can also compute the individual-specific differences in in and out of the investment-loan window consumption growth rates. We find that at the median, 3rd quartile, and 9th decile, the in-window growth rates are 0.47, 1.78, and 3.27 percentage points higher, respectively. While this could account for individual-specific secular trends, given finite sample, this statistics is sensitive to mean reversion.

14. Starting in April of 2001, the monthly survey begins to pick up loans labeled as Village Fund loans. In April, May, June, July, and August, there were 5, 9, 4, 13, and 12 loans tagged as Village Fund loans across villages, respectively, accounting for 6.3 percent of the total number of loans extended across all monthly villages in these 5 months preceding the start of the program. In September of 2021, there were 105 Village Fund loans extended, accounting for 45 percent of loans extended across villages in that month.

15. which is below the average interest rate for formal loans of 14.8 percent and 13.0 percent in the surveyed villages in the northeastern and the central regions between 1999 and 2001, respectively (Wang 2022).

Kaboski and Townsend (2012) used the Townsend Thai annual survey with 64 villages and national village-level datasets to study the impact of Village Fund on investment and consumption via the inverse village household count mechanism. In this paper, we study the impact of the Village Fund on the number of lumpy investments and investment-loan linkages in the context of the 16 villages in the Townsend Thai monthly survey. In the 16 monthly survey villages, the total number of households per village ranges from 26 to 162 across villages, and the portion of households surveyed per village ranges from 30 to 92 percent.[16] Regressing the average amount of Village Fund loans per surveyed household on the number of households in each village, we find a significant negative relationship (see Appendix Figure C.6).

For each village and in each successive 12 months period (September to August) from 2 years before and up to 9 years after the start of the Village Fund program, we count the total number of investments, the number of investments linked to bridge loans (i.e., investments from the second and third panels of Table 4), and the number of investments linked to local-bridge loans (i.e., investments from the third panel of Table 4). Using village–year as the unit of observation, we regress the average number of investments per surveyed household on year fixed effects, village fixed effects, and the interaction of a post-Village Fund indicator with the inverse of the number of households in the village. The estimate of the interaction term captures the impact of expanding lower interest credit access on households. We consider different intervals of data after the introduction of the Village Fund to study the shorter- and longer-run persistent effects of the program on investments. We focus our analysis on results using an asset definition based on agricultural and business assets. In the appendix, we show that results are similar when we include land in the asset definition and when using additional post-Village Fund windows.

Considering data from 2 years before the introduction of Village Fund and 1 year after, our post-Village Fund and inverse village size interaction coefficient for the overall number of investments per village is 4.83. The coefficient is implicitly scaled by the one-million-baht-per-village normalization, and implies that an additional 10,000 baht of per-household Village Fund availability is associated with 0.048 additional investments per household. Since the Village Fund might be displacing existing funding sources that are more costly, the estimate does not imply that 10,000 baht is equivalent to 0.048 unit of an average investment, but captures the net increase in investment. Regressions where the outcomes are the number of bridge-linked and local-bridge-linked investments show similar magnitudes of results, with interaction coefficients of 4.76 and 4.61. The results indicate

16. In one village, the number of households is 26 and 24 households are surveyed. In all other villages, the number of households exceeds 50, and the number of surveyed households ranges between 43 and 53. See Appendix Table C.10.

that an increase in access to lower-cost credit leads to an increase in investment that is financed with joint formal–local loan bridges, and shows the importance of local-linked bridging in facilitating increases in lumpy investment when loans are "clunky".

Expanding our window to 6 years after the introduction of Village Fund, we find that the interaction coefficient for the overall number of investments per village per year is 0.80 and not statistically significant. This means that there is no persistent effect of the Village Fund on the overall number of investments per household in the longer run. The Village Fund might have quickened the pace of lumpy-investing without increasing the longer-run number of investment opportunities. In our model, we show that investment timing shortens with the availability of lower-cost formal credit when the repayment of loans with limited maturities is required.

Interestingly, the interaction coefficients when the outcomes are bridge-linked and local-bridge-linked investments remain positive and statistically significant at 1.80 and 1.68, respectively. Multiplying the results by 6 years, the estimates show that an additional 10,000 baht of per-household Village Fund availability is associated with approximately 0.11 additional local-bridge-linked investment per household over 6 years, doubling the one year immediate effect. The results suggest that as Village Fund loans are lent out, repaid, and re-lent, it continues to provide low-cost credit to support lumpy investments, possibly displacing other higher-cost funding sources. The persistence of the Village Fund and its rigid end-of-1-year-repayment contract structure can account for the increased number (portion) of bridge-linked and local-bridge-linked investments over time In our model, we explore the effect of reducing the interest rate on formal loans, and find that it could lead to a shift in the mode of financing investment from using only a non-bridged formal loan to using joint local-bridged loans.

In Figure 6, we plot the interaction coefficient for the overall number of investments, bridge-linked investments, and local-bridge-linked investments for 1 year and 6 years after the introduction of Village Fund. In Appendix Table C.11, we report additional results consistent with our main findings by showing additional time-windows and considering also land assets.

Section 5. Model

We model an infinitely-lived, risk-averse farmer in continuous time who has access to a productive lumpy investment project requiring I units of capital and yielding a risky return. The farmer discounts the future at rate $\rho > 0$, starts with zero liquid assets, and earns a constant wage flow. Our central question is how the credit environment shapes the farmer's choices: when to invest, how much to consume, and which lenders to borrow from.

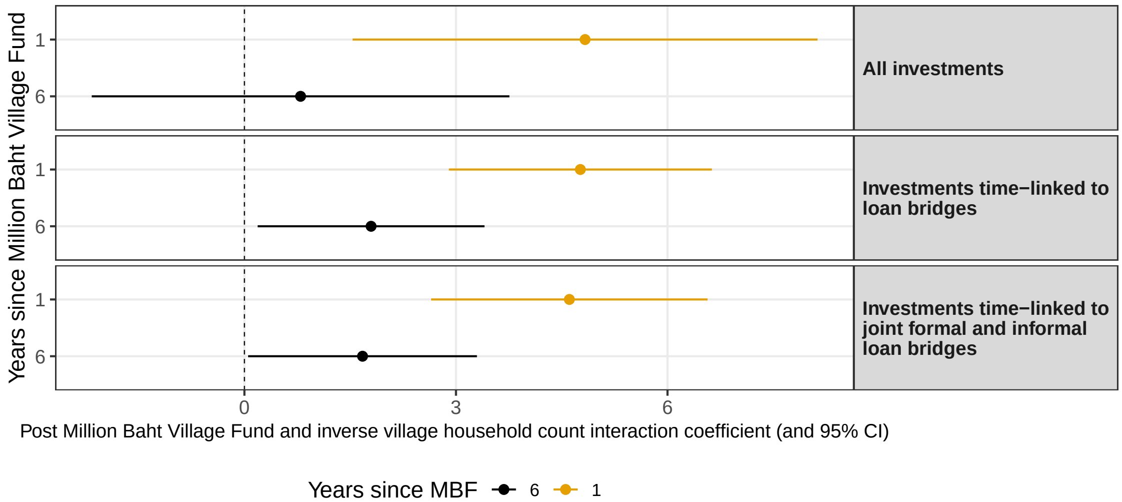

Fig. 6. Village Fund and investments

We estimate village–year regressions in which the outcome is the average number of investments by category per surveyed household, and we regress this on year fixed effects, village fixed effects, and the interaction of a post–Village Fund indicator with the inverse of the number of households in the village. We use robust standard errors. We interact post–Village Fund timing with the inverse of the village household count to identify the effect of increases in per-household Village Fund loan availability on the average number of investments, investment-to-loan bridges, and investments linked to joint formal and local loan bridges in each village. The plot shows the coefficient for these interaction terms along with 95% confidence intervals. The vertical axis includes results from regressions including 2 years before and 1 year after the introduction of the Village Fund, as well as results including 2 years before and 6 years after the Village Fund. Three panels distinguish three outcomes: average total investments, average investments time-linked to loan bridges, and average investments time-linked to joint formal and local loan bridges. We use agricultural and business assets as the asset definition. See Appendix Table C.11 for coefficient values, results for additional years after the Village Fund, and results for alternative asset definitions. See Section 4.3 for discussions.

We proceed as follows. Section 5.1 states the motivation and the two features that drive the analysis. Section 5.2 lays out the farmer's environment in the absence of borrowing: preferences, income, the investment project, savings, and the liquidity constraint. Section 5.3 introduces the two credit options—a formal lender with prohibitive verification cost and a local lender with low verification cost—and writes the law of motion for liquid assets that incorporates loan cashflows.

Section 6 then solves the farmer's problem: it characterizes the optimal investment date and consumption path, defines the equilibrium, calibrates the model to the Thai data, and presents comparative statics. Section 7 quantifies the welfare gain from bridge finance and shows how that gain varies with investment size. Section 8 endogenizes the formal lender's maturity choice and gives the conditions under which a one-year loan backed by a bridge dominates a single two-year loan.

Subsection 5.1. **Motivation.** Farmers choose whether to invest in the project, how to finance it, and when to invest. They can self-finance, but accumulating savings delays the investment date. They can also borrow from a formal lender. The formal contract is poorly matched to the project's timing, however: it is a one-year bullet loan requiring full repayment at maturity, before the project has generated enough return to cover it. Even with access to formal credit, then, farmers must build up substantial savings of their own to meet the repayment one year after investment.

Local lenders fill this gap. They offer short-term bridge loans that let farmers repay maturing formal debt on the due date, and are themselves repaid once the farmer—now in good standing—takes out a new formal loan. The bridge is what makes the two formal loans technically distinct: the first is fully repaid before the second is disbursed. This narrows the gap between the project's gestation and the formal loan's maturity, hastening the timing of investment and reducing the need for self-financing.

Figure 7 sets out the sequence that the model formalizes. Panel (a) traces the event structure: the farmer chooses when to borrow and invest, the project spends a year in gestation, and the state realizes at the one-year mark, after which the high- and low-return paths diverge. Panel (b) records who pays whom at each date along the successful path, from the first formal loan through the bridge and its refinancing to the final repayment at the two-year mark.

Two features generate this role for short-term local intermediation, alongside otherwise standard ingredients—CRRA utility, indivisible investment with hidden ex post returns, liquidation, and interest rate wedges. The first is the project's *one-period gestation lag*: capital installed at the farmer's chosen investment date (denoted T_I) produces no output until one year later, when the high- or low-return state ($s \in \{H, L\}$) is realized and privately observed by the borrower.

The second is an asymmetry in verification cost. The formal lender's verification technology is prohibitively expensive, so the formal contract cannot be conditioned on the realized state at maturity. A local lender embedded in the village—a family member, neighbor, or moneylender—can observe the realized state at low cost and therefore offer state-contingent refinancing. Low-return borrowers receive no bridge and default at the one-year mark, at which point the formal lender liquidates the project's collateral.

This lower verification cost for the local lender means the formal lender relies on the local lender's information: the second formal loan is disbursed only after local verification, and is risk-free for exactly that reason. The model therefore shares its central premise

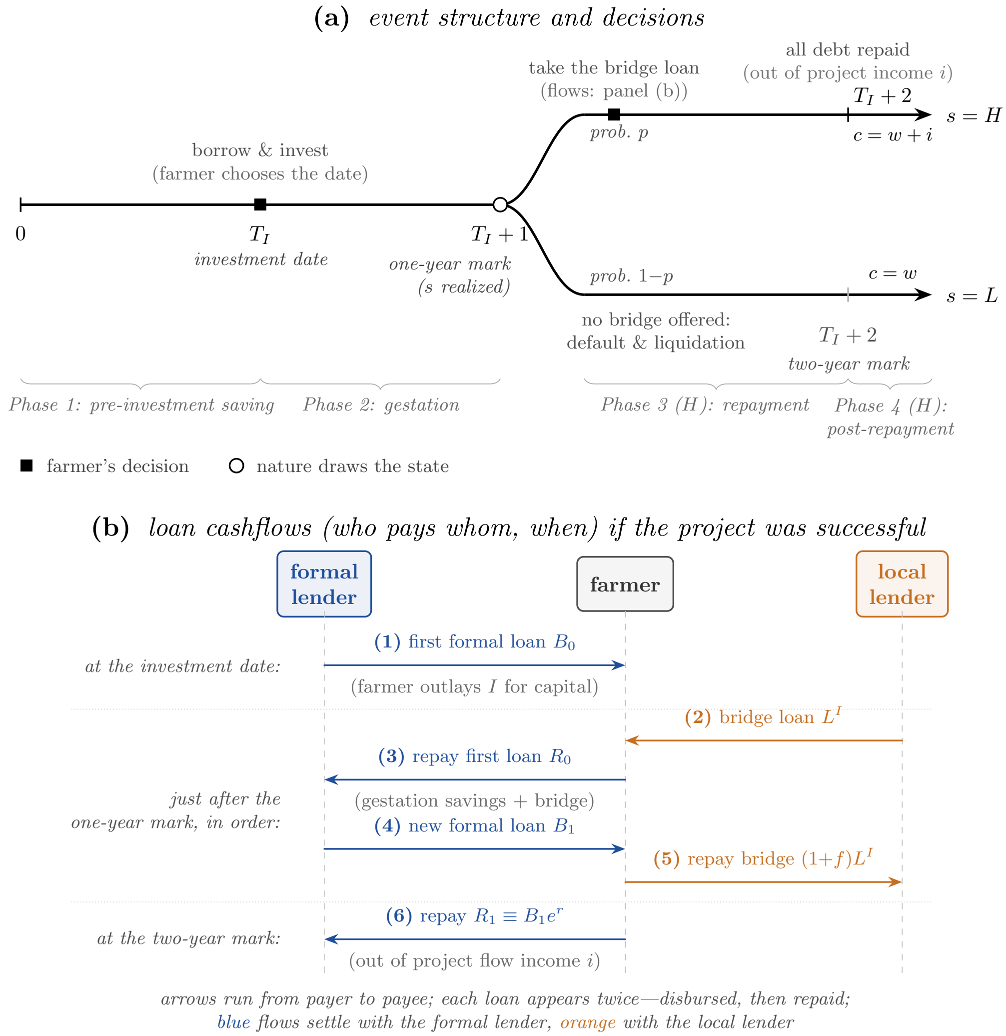

Fig. 7. Investment timeline and loan cashflows.

Panel **(a)** shows the event structure of the bridge-financing path. The farmer chooses the investment date, borrows a one-period formal loan, and invests; capital is in gestation during the first year after investment, and the state realizes at the one-year mark—high return with probability p, low return with probability $1 - p$. In the high-return state the farmer takes a bridge loan, and all debt is repaid at the two-year mark. In the low-return state no bridge is offered: the farmer defaults at the one-year mark, and the formal lender confiscates the depreciated capital (ℓ_1) together with any liquid assets accumulated during gestation, up to the amount owed. A farmer whose capital and liquid assets cover the repayment keeps the residual. Panel **(b)** shows the full loan ledger in the high-return state: time runs downward, and each loan appears twice, once disbursed and once repaid. The first formal loan funds the capital outlay (1). Just after the one-year mark the bridge loan arrives (2) and, combined with gestation savings, repays the maturing first loan (3); a new formal loan (4) immediately repays the bridge with its fee (5) and is itself repaid at the two-year mark out of project flow income (6).

with Jain (1999), in which the formal sector exploits the informal sector's informational advantage by financing only part of each project and letting better-informed informal lenders screen borrowers. The margin differs: in Jain (1999) the reliance is ex ante—informal lenders certify borrower *types* at origination—whereas here it is ex post—the local lender certifies the realized *state* at refinancing.

A natural alternative is a single *long-term* formal loan due two years after investment, which would remove the need for a bridge entirely. Section 8 endogenizes the formal lender's choice of maturity and shows that this alternative does not strictly dominate: because collateral depreciates with age, the early liquidation forced by short maturities preserves the lender's recovery value. Short maturity also lets the formal lender lean on the local lender's verification ability, learning a year earlier whether a project has succeeded. The model thus endogenizes both the *demand* for bridge finance (repaying a short formal loan against a longer-gestating project) and its *supply* (low-cost local verification, valuable precisely because collateral depreciates with age).

A final point concerns interpretation. The farmer here is fully forward-looking and time-consistent, so the bridge loan is a deliberate response to a maturity mismatch—the project's returns arrive later than the formal loan comes due—rather than a symptom of present bias (Laibson 1997; Meier and Sprenger 2010) or planning fallacy (Fink, Jack, and Masiye 2020). Because the borrowing is a deliberate response to the maturity mismatch, the bridge loan brings a profitable investment forward in time and is therefore welfare-improving, the opposite conclusion from behavioral accounts in which expensive short-term credit reflects over-borrowing against the household's own long-run interest (Allcott et al. 2022; see Gomes, Haliassos, and Ramadorai 2021, for a survey of the short-term borrowing literature). The contrast is visible in the shape of the borrowing: the bridge is short-lived and self-clearing, repaid by a new formal loan just after the one-year mark rather than rolled over repeatedly.

We take the formal interest rate as given—for example, an administrative rate set by headquarters or a development bank. We endogenize the fee charged by local lenders, who can verify project success, as a function of the verification cost and the project's chance of success. The size of formal loans is likewise endogenous, constrained by the formal lender's no-loss condition given the riskiness of the project. Both the local lender's fee and the formal loan size constraint vary with the farmer's project return and risk type.

Subsection 5.2. **Environment.** We populate the economy with a unit mass of farmers who differ in their investment opportunities. A farmer's type—the project's cost, flow return, and success probability $(I_\theta, i_\theta, p_\theta)$, defined formally in Section 5.2.2—is drawn from a distribution $G(\theta)$ and is publicly observable: both the formal and local lenders see the type and can condition their contracts on it. The only information not publicly observable is the realized state $s \in \{H, L\}$ one year after investment, which the farmer privately observes and which the local lender, but not the formal lender, can verify at cost c_v (Section 5.3).

Because types are observable and contractible, the credit market separates by type—each type is priced at its own break-even, with no cross-subsidization—and the equilibrium below holds type by type. We therefore describe the environment and solve the farmer's problem for a single type, suppressing θ in the notation, and aggregate over G only when computing market-level quantities and welfare (Section 7).

To build intuition, the remainder of this subsection describes the components of an individual farmer's environment in the absence of borrowing. Formal and local credit are introduced in Section 5.3.

5.2.1. *Preferences and income.* The farmer has CRRA preferences with coefficient of relative risk aversion $\sigma > 0$ and discount rate $\rho > 0$. Period utility is

$$u(c) \;=\; \frac{c^{1-\sigma}}{1-\sigma}, \qquad \sigma \neq 1, \qquad u(c) = \log c \text{ at } \sigma = 1.$$

Because the project return is risky, lifetime utility for a given policy is the expected discounted integral

$$\mathcal{V} \;=\; \mathbb{E}\left[\int_0^\infty e^{-\rho t}\, u\big(c(t,s)\big)\, dt\right], \tag{3}$$

where $s \in \{H, L\}$ indexes the (random) project state described in Section 5.2.2 and the expectation is taken over s. Although consumption is written as $c(t, s)$, the state realizes only one year after investment (Section 5.2.2), so the consumption paths for the two states coincide until that date. The farmer chooses a state-contingent consumption process $\{c(t, s)\}$, an investment date T_I (the time at which the project is installed), and loan contracts to maximize this objective. We reserve V for the maximized value of this objective, defined in the farmer's problem (20) below.

Turning to income, the farmer earns a constant wage flow $w > 0$ at every instant, regardless of investment status. If the farmer never invests and never borrows, consumption is pinned at $c(t) = w$ forever and lifetime utility takes the closed-form "autarky" value

$$V^{\text{autarky}} \;=\; \begin{cases} \dfrac{w^{1-\sigma}}{\rho\,(1-\sigma)}, & \sigma \neq 1, \\ \dfrac{\log w}{\rho}, & \sigma = 1. \end{cases} \tag{4}$$

We use V^{autarky} as the participation benchmark for both the investment decision and the credit-market equilibrium below: any allocation that delivers $\mathcal{V} \geq V^{\text{autarky}}$ is acceptable to the farmer, and a regime failing this bound is one in which the farmer prefers not to invest.

5.2.2. *Investment project.* The farmer can invest a single time in a project that requires I units of capital. The price of capital is normalized to one and capital does not depreciate in physical terms, so cumulative capital at time t is the path integral of the lumpy investment flow $k(t)$,

$$K(t) \;=\; \int_0^t k(\tau)\,d\tau \;=\; I \cdot \mathbb{1}_{\{t \geq T_I\}}, \tag{5}$$

where T_I is the (endogenous) investment date.

If investment of size I occurs at the investment date, the project unfolds in three stages:

- during the first year after investment the project is in gestation ($[T_I,\, T_I + 1)$) and produces zero output;[17]
- one year after investment, the state $s \in \{H, L\}$ is realized with high-return probability p and low-return probability $1 - p$. The realization is privately observed by the farmer; outsiders (that is, possible lenders) observe the state only by paying a verification cost (specified in Section 5.3)[18];
- from one year after investment onward, a successful project (state H) yields a constant flow return $i > 0$ per unit of time indefinitely, while a failed project (state L) yields zero flow return.[19]

All dates below are measured from the investment date, which the farmer chooses, so these anchors shift with that choice. We call the date one year after investment ($T_I + 1$) the *one-year mark*: the state realizes then, and the first formal loan matures then (Section 5.3). We call the date two years after investment ($T_I + 2$) the *two-year mark*, at which all debt is cleared along the successful path.

17. The zero-output assumption during the first year is a theoretical simplification. The mechanism requires only that the project's returns accrue over multiple years, so that the project's cash-flow horizon exceeds the maturity of the one-year formal loan.

18. Setting the date the state realizes equal to the maturity of the first formal loan is a normalization. What the mechanism requires is that the first formal loan mature at or after the state realizes, so that the local lender can verify the outcome at the moment the bridge loan is extended. Any timing that preserves this ordering delivers the same qualitative results.

19. The farmer retains the wage even after investing, so i should be interpreted as the *net additional* return from the project. The parameter i is the deterministic return conditional on project success; the realized project return is the random variable that equals i when the high state realizes and zero when the low state realizes.

The one-period gestation lag is the first of the two key features highlighted in Section 5.1; together with the verification asymmetry it creates the liquidity mismatch that bridge finance resolves. Because the farmer observes the state privately, a state-contingent formal contract would require verification, which is prohibitively costly for the formal lender (Section 5.3).

If the project fails, installed capital can be liquidated. The salvage value depreciates with the age of installed capital,

$$\ell(\tau) \;=\; \ell_0\, e^{-\delta\tau}, \qquad \delta > 0, \quad 0 < \ell_0 \le I, \tag{6}$$

where $\tau = t - T_I$ is the elapsed time since installation. Two values of the salvage function play a recurring role: the value one year after investment (the earliest verification date), $\ell_1 \equiv \ell_0 e^{-\delta}$, and the value two years after investment (when a two-year loan would mature and failure would first be verified), $\ell_2 \equiv \ell_0 e^{-2\delta} < \ell_1$. The gap between them, $\Delta_\ell \equiv \ell_1 - \ell_2 > 0$, is the per-failure recovery loss from delayed verification, and is the quantitative driver of the bridge-versus-long-term comparison in Section 8.

When a farmer finances investment through borrowing, a failed project triggers default and the lender liquidates the installed capital, recovering the depreciated salvage value. Under self-financing, a farmer whose project fails can likewise liquidate the installed capital and recover the same salvage value, which they then consume optimally over time using the savings technology. The liquidation option is thus available under either financing mode, and a failed project retains positive value through capital recovery.

5.2.3. *Savings and the liquidity constraint.* The farmer has access to a savings technology—"liquid assets"—that earns the deposit rate $\underline{r}$. We refer to this as a relatively poor savings technology because we assume it earns strictly less than the farmer's discount rate, so that pure consumption smoothing through saving is inefficient at the margin:

$$\underline{r} \;<\; \rho \;<\; r, \tag{7}$$

where r is the formal lending rate (introduced in Section 5.3.1). The *savings wedge* $\rho - \underline{r}$ governs the slope of the consumption path within any saving phase: the Euler equation under CRRA utility delivers

$$\frac{\dot{c}}{c} \;=\; \frac{\underline{r} - \rho}{\sigma} \;\equiv\; -m \;<\; 0,$$

so consumption declines at the constant decay rate m whenever the farmer is saving assets.[20]

Let $a(t,s) \geq 0$ denote the farmer's stock of liquid assets at time t in state s. In the absence of borrowing, the budget identity for the change in liquid assets is

(8)
$$\dot{a}(t,s) \;=\; \underbrace{w + i\,\mathbb{1}_{\{t \geq T_I+1,\, s=H\}} + \underline{r}\,a(t,s)}_{\text{income}} - \underbrace{c(t,s)}_{\text{consumption}} - \underbrace{k(t)}_{\text{investment}} + \underbrace{\ell_1\,\mathbb{1}_{\{t=T_I+1,\, s=L\}}}_{\text{liquidation recovery}}.$$

Equation (8) states that liquid asset accumulation equals the sum of the wage flow, plus the project return if the project has been installed and succeeds, plus the interest on existing savings, less consumption and capital investment, plus the salvage value recovered if the project fails and the capital is liquidated.[21] The indicator functions (each equal to 1 if the condition holds and 0 otherwise) encode the gestation lag and project risk (recall there is no return during the gestation period and in the low-return state) and, in the final term, the one-time liquidation at the failure date.

Equation (8) is the no-debt benchmark. The full law of motion that includes cashflows to and from both lenders is given as (18) in Section 5.3.3.

Finally, the farmer starts with zero liquid assets and is prohibited from holding negative balances:

$$a(0,s) = 0, \qquad a(t,s) \geq 0 \quad \forall\, t, s. \tag{9}$$

Zero initial liquid assets, combined with the fact that the wage arrives as a flow rather than as a stock, means the farmer holds nothing at time zero with which to buy capital. Investment therefore requires either credit disbursed at the investment date or savings accumulated before it. Which of the two the farmer relies on, and how long the accumulation takes, is the object of the analysis below.

Subsection 5.3. **Credit.** The liquidity constraint (9), combined with investment lumpiness, creates demand for external finance. We introduce two lender types. The formal lender represents an institution with deep funding capacity but a high verification cost—empirically, BAAC or the Village Fund in our Thai data. The local lender represents an in-village counterparty with limited capacity but low verification cost—a family member,

20. On any interval where the farmer is saving and the liquidity constraint is slack, shifting a unit of consumption to the next instant earns the deposit rate, so marginal utility must decline at the gap between the discount rate and the return on savings, $-\dot{u}'(c)/u'(c) = \rho - \underline{r}$. Under constant relative risk aversion marginal utility is $c^{-\sigma}$, so $\sigma\,\dot{c}/c = \underline{r} - \rho$. Step 2 of the proof in Appendix A applies this phase by phase and derives the dates at which the liquidity constraint binds instead, pinning consumption to current income.

21. The liquidation receipt arrives as a lump sum on a single date rather than as a flow. We write it inside the flow equation for simplicity.

neighbor, or small moneylender. The pairing of deep funding with expensive verification on one side, and cheap verification with shallow funding on the other, is not incidental: monitoring-intensive lending is difficult to fund with outside capital because outside financiers cannot verify the monitoring effort, so intermediaries with cheap local information tend to remain small and self-funded while deep-pocketed institutions lend at arm's length (Conning 1999).

The two lenders' contracts are not interchangeable. In equilibrium, we show that the formal contract is medium-term (one-period), and cannot be conditioned on the realized state s, while the local lender's contract is short-maturity, state-contingent, and offered only to verified high-return borrowers.

The two-lender structure is a modeling simplification. The empirical analysis also documents quasi-formal lenders that occupy an intermediate position between these two polar cases. They appear to have more local monitoring capacity than formal lenders and more lending capacity than purely local lenders, but they charge higher rates than formal lenders. We return to them in Section 8.5. For the baseline model, we focus on the two polar lender types because they isolate the central tradeoff: cheap but rigid formal credit versus flexible but costly locally monitored credit.

5.3.1. *Formal lender.* The formal lender has large resources and is willing to lend any amount up to an endogenous feasibility bound (Assumption 2 below) at the contracted rate r. We assume the interest rate is set externally; this is consistent with the data, which show little variation in formal interest rates, and with the Million Baht Village Fund, which set a single rate for all loans. The borrower chooses how much to borrow subject to an endogenous feasibility bound, but takes the maturity as given: the lender makes take-it-or-leave-it offers, so the borrower cannot negotiate for a preferred maturity.

Crucially, the formal lender's verification cost is prohibitive: it cannot cheaply observe the project state s at the loan's maturity date, and therefore cannot write a contract that pays differently in the high- and low-return states. We further restrict the formal contract to a maturity of one unit of time and a no-rollover requirement. Section 8 shows that these restrictions emerge endogenously from the verification-cost asymmetry between the two lender types.

We now introduce notation for the bullet loan contract. Let $D^F(t)$ denote the stock of formal debt outstanding at time t (the formal contract has a fixed one-period maturity, so we do not carry a separate maturity argument), and let $L^F(t)$ denote the net cashflow from lender to farmer at time t (positive for new disbursement, negative for repayment). Because formal loans are bullet, this cashflow is zero except on two dates: the farmer receives the principal at disbursement and pays principal plus interest at maturity.

The formal contract is governed by three restrictions. First, formal debt is always nonnegative (that is, the farmer cannot lend to the formal lender):

$$D^F(t) \geq 0 \quad \forall\, t. \tag{10}$$

Second, any loan disbursement at time t creates a contractual obligation to repay principal-plus-interest exactly one period later. With continuous compounding at rate r, a disbursement of $L^F(t)$ requires a repayment of size $L^F(t)\, e^r$ at $t+1$:

$$L^F(t) > 0 \implies L^F(t+1) \;=\; -L^F(t)\, e^r. \tag{11}$$

Note that (11) describes the contractual terms, not necessarily the realized outcome: in the low-return state the farmer defaults one year after investment and the lender recovers through liquidation rather than receiving the full contractual repayment.

Third, the contract forbids overlapping or rolling over formal loans. Any new disbursement requires zero formal debt:

$$L^F(t) > 0 \implies D^F(t^-) = 0 \tag{12}$$

where $D^F(t^-)$ denotes total formal debt outstanding in the instant before t. Throughout the paper, we use the convention that $x(t^-)$ denotes the left limit (the value in the instant before time t) and $x(t^+)$ denotes the right limit (the instant after t).

These three conditions characterize what we call a *one-period bullet* formal contract. This restriction is a scope condition rather than a claim about all microfinance contracts. It is meant to capture the agricultural and Village Fund contracts in the Thai panel, where scheduled principal repayment is concentrated around a one-year horizon. High-frequency installment contracts create a different version of rigidity: cash leaves the household throughout gestation instead of at a single due date. The bridge mechanism is therefore most directly applicable to bullet or weakly amortizing loans, and more broadly to investments whose cash-flow horizon is longer than the formal repayment horizon.

In the equilibrium analyzed below, the cashflows to- or from the formal lender are nonzero at only four instants: a disbursement at the investment date; a repayment just before the one-year mark; a new disbursement just after it (high-return state only); and a final repayment at the two-year mark (again, high-return state only). To simplify notation, we introduce four terms for formal loan disbursement and repayment:

$$B_0 \;\equiv\; L^F(T_I), \qquad B_1 \;\equiv\; L^F(T_I + 1^+), \tag{13}$$

$$R_0 \;\equiv\; B_0\, e^r \;=\; -L^F(T_I + 1^-), \qquad R_1 \;\equiv\; B_1\, e^r \;=\; -L^F(T_I + 2). \tag{14}$$

B_0, B_1 are positive disbursements (principals); R_0, R_1 are positive contractual repayments.

If the farmer fails to repay at maturity—which in equilibrium happens precisely when the project realizes the low return one year after investment—the formal lender exercises its default remedy. It liquidates the installed capital, recovering its current salvage value $\ell_1 = \ell_0 e^{-\delta}$, and confiscates any liquid assets that the farmer had accumulated during gestation (denoted $a(T_I + 1^-, L)$). Total recovery is

$$\min\bigl(\ell_1 + a(T_I + 1^-, L),\ R_0\bigr),$$

capped at the contractual repayment of the first formal loan (R_0). When the total value of capital and liquid assets exceeds the required payment, the excess is retained by the borrower, who consumes it optimally over time alongside wage income.

When the lender's recovery equals the full repayment ($\ell_1 + a(T_I + 1^-, L) \geq R_0$), the loan is fully collateralized and carries no default risk. The borrower keeps the residual left after the debt is settled and consumes it over time alongside wage income, following the same path as under self-financing. When recovery falls short ($\ell_1 + a(T_I + 1^-, L) < R_0$), the lender's loss is strictly positive and the borrower exits with zero liquid assets, consuming only wage income from one year after investment onward.[22] Section 5.3.3 records both cases as the settlement condition (19).

This early, higher-value recovery is the key respect in which the bullet contract differs from a long-term contract. Because the lender verifies failure at the earliest possible date, recovery is computed using the one-year salvage value rather than the more-depreciated two-year value, and it captures both the depreciated capital and the farmer's confiscated savings.

5.3.2. *Local lender.* The local lender represents the family members, neighbors, or village moneylenders whom we observe extending bridge loans in our Thai data. The local lender has limited financing capacity but low verification cost, c_v. This asymmetry follows naturally from the local lender's repeated and close interaction with the farmer—living in the same village, observing the harvest, talking to other farmers—which makes it cheap for the local lender to learn whether the project succeeded. Verification costs plausibly differ across local lenders: a relative or neighbor who works nearby and sees the harvest directly learns the outcome more cheaply than a moneylender lending at arm's length. Because the

22. The latter case is the empirically relevant region when collateral is scarce relative to the loan: the formal contract is genuinely risky and the lender prices this default risk into the feasibility constraint.

bridge loan is priced to cover the verification cost, this heterogeneity generates dispersion in bridge-loan rates of the kind we observe among local loans in our data.[23]

If a farmer requests a bridge loan one year after investment, the local lender pays the verification cost c_v to learn the realized state and then offers a state-contingent bridge loan:

- if the project succeeds (state H): a very short bridge of size L^I (the bridge loan amount) priced at proportional fee f per dollar borrowed, with total repayment $(1+f)L^I$ immediately afterward;
- if the project fails (state L): no bridge loan is extended; the farmer defaults on the maturing formal loan and the formal lender exercises its liquidation remedy.

The bridge is intentionally short-lived: it exists for an infinitesimal interval, just long enough to repay the first formal loan and be repaid itself by a new formal loan disbursement. Economically, the bridge converts two consecutive one-period formal loans into a synthetic two-period loan, conditional on success, at the cost of the bridge fee. For modeling convenience, the local lender extends at most one bridge loan per farmer.

Turning to the formal terms of the bridge, let $D^I(t,s)$ denote the stock of debt to the local lender and $L^I(t,s)$ the net cashflow at time t in state s.

The local lender's contract has three features. First, any bridge disbursement $L^I(t,s)$ is repaid in full—principal plus proportional fee f—immediately afterward:

$$L^I(t,s) > 0 \implies L^I(t^+,s) = -(1+f)L^I(t,s), \tag{15}$$

where $L^I(t^+,s)$ denotes the repayment cashflow immediately after t.

Second, the bridge is a once-ever contract. After a single disbursement, no further borrowing from the local lender is allowed:

$$L^I(t,s) > 0 \text{ for some } t \implies L^I(\tau,s) \le 0 \ \forall\, \tau > t. \tag{16}$$

Third, debt to the local lender is always nonnegative:

$$D^I(t,s) \ge 0. \tag{17}$$

23. Relationship lending may also carry motives outside the model, such as insurance or altruism within kin networks, so we read differences in verification cost as one source of the observed dispersion rather than the only one.

The bridge itself is risk-free for the local lender: by verifying the realized state before lending, the local lender extends the bridge only to farmers known to be high-return, who repay it from a new formal loan immediately afterward.[24]

5.3.3. *Asset accumulation with credit.* Combining the no-debt budget identity (8) with cashflows to and from both lenders, liquid assets evolve in state s according to

$$\begin{aligned}\dot{a}(t,s) = {} & \underbrace{w + i\,\mathbb{1}_{\{t \geq T_I+1,\, s=H\}} + \underline{r}\,a(t,s)}_{\text{income}} - \underbrace{c(t,s)}_{\text{consumption}} \\ & - \underbrace{k(t)}_{\text{investment}} + \underbrace{\ell_1\,\mathbb{1}_{\{t=T_I+1,\, s=L\}}}_{\text{liquidation recovery}} \\ & + \underbrace{L^F(t) + L^I(t,s)}_{\text{loan cash flows}}.\end{aligned} \tag{18}$$

Equation (18) extends (8) by adding the loan cashflow term. By (16) and the timing of the bridge contract, the cashflows to or from the local lender are nonzero only at the one-year mark and only in the high-return state, so during gestation only the cashflows to or from the formal lender can be nonzero.

Two things happen at the one-year mark in the low-return state: the project is liquidated and the first formal loan falls due. The lender is paid out of the salvage value of the capital (ℓ_1) together with the farmer's liquid assets, up to the amount owed (R_0), and the farmer carries forward whatever is left:

$$a(T_I + 1^+,\, L) \;=\; \max\big\{\, \ell_1 + a(T_I + 1^-,\, L) - R_0,\; 0 \,\big\}. \tag{19}$$

The same settlement applies whichever way the project was financed. A self-financing farmer owes nothing and keeps the entire salvage value. A borrower whose salvage value and savings exceed the repayment keeps the difference, while one whose resources fall short surrenders both and begins the following year with nothing.

At the time of investment, the farmer combines the accumulated savings with the formal loan disbursement to fund the project cost, leaving the farmer with zero liquid assets (since holding both liquid assets at the deposit rate and formal debt at the higher formal rate simultaneously is strictly dominated). After investment, in the high-return

24. The restriction that bridges go only to high-return borrowers is not formally modeled, but two forces support it. The first is repeated interaction. A local lender could in principle profit by bridging a low-return borrower—using the bridge to repay the first loan, secure a second, and repay itself—but the formal lender can infer from the subsequent default that the local lender bridged a failed project, and the threat of losing future business then sustains truthful bridging. The second is random auditing: if the formal lender occasionally verifies the state at the one-year mark before issuing the second loan and finds a low return, it refuses the disbursement, leaving the local lender unable to recover its bridge. Either force deters the bridging of failed projects.

state, the farmer uses the bridge sequence at the one-year mark and clears all debt by the two-year mark. In the low-return state, liquid assets and installed capital are applied to the debt at the one-year mark, and the farmer carries any residual forward as liquid assets. Figure 7 summarizes the timing, direction, and counterparty of every cashflow on the bridge-financing path.

Subsection 5.4. **Assumptions.** We maintain two parameter restrictions throughout. The first ensures the project has positive net present value; the second ensures the formal lender is willing to lend at the contracted rate. Because investment opportunities are observable, each restriction is imposed type by type, so the feasibility bound $\bar{B}$ defined below is specific to each observable type; as elsewhere, we suppress the type index in the notation.

Assumption 1 (Project profitability). *The project's expected discounted return at the investment date strictly exceeds its cost:*

$$\Big[\underbrace{\frac{p\,i}{\rho}}_{\textit{success: flow return}} + \underbrace{(1-p)\,\ell_1}_{\textit{failure: salvage}} \Big] e^{-\rho} \; > \; I.$$

Both terms are received one year after investment: the successful project pays its flow return from that date onward, and the failed project is liquidated for its one-year salvage value.

Assumption 2 (Formal-loan feasibility). *The formal lender will not lend a principal B at the contracted rate unless the expected gross repayment at maturity covers the lender's cost of funds, taken to be the deposit rate. Upon default, the lender confiscates installed capital (worth ℓ_1 one year after investment) and liquid assets held by the farmer, but recovers at most the required loan payment $B\,e^{r}$; any excess value is retained by the borrower. The feasibility condition is:*

$$p\,B\,e^{r} \; + \; (1-p)\,\min\!\big(\ell_1 + a(T_I + 1^{-}, L),\, B\,e^{r}\big) \; \geq \; B\,e^{\underline{r}}.$$

Let $\bar{B}$ denote the largest loan size satisfying this condition. When the expected repayment on an unsecured loan already covers the lender's cost of funds ($p\,e^{r} \geq e^{\underline{r}}$), the condition holds at every principal and the lender is willing to lend at any scale. Otherwise $\bar{B}$ is finite and solves the inequality with equality,

$$\bar{B} \; = \; \frac{(1-p)\big(\ell_1 + a(T_I + 1^{-}, L)\big)}{e^{\underline{r}} - p\,e^{r}}.$$

Liquid assets at the one-year mark themselves depend on the principal, since the loan shapes the consumption path during gestation and hence the savings held when the state *realizes. The expression therefore defines $\bar{B}$ as a fixed point, which we solve numerically along with the consumption path.*[25]

The bound applies to the first formal disbursement: $B_0 \leq \bar{B}$.[26]

Section 6. Optimal Strategy and Equilibrium

The farmer chooses an investment date T_I, a state-contingent consumption process $\{c(t,s)\}$, capital flow $\{k(t)\}$, and loan schedules $\{L^F(t),\, L^I(t,s)\}$ to maximize

$$
\begin{aligned}
V \;&=\; \max_{\{c(t,s),\, k(t),\, L^F(t),\, L^I(t,s)\},\, T_I} \mathcal{V}, \\
\text{where} \quad \mathcal{V} \;&=\; p\,\mathcal{V}(H) + (1-p)\,\mathcal{V}(L), \qquad (20)\\
\mathcal{V}(s) \;&=\; \int_0^{\infty} e^{-\rho t}\, u\big(c(t,s)\big)\, dt,
\end{aligned}
$$

subject to the capital accumulation constraint (5), the liquidity constraint (9), the formal loan contract (10)–(12), the formal-loan feasibility bound of Assumption 2 (the first formal loan satisfies $B_0 \leq \bar{B}$), the local loan contract (15)–(17), the asset accumulation law (18), and the non-anticipation restriction that consumption and contracts cannot be conditioned on s before the state is realized.

The non-anticipation restriction forces consumption to be identical across states from time zero to the one-year mark; the paths diverge only when the state realizes and the local lender verifies it.

Subsection 6.1. The farmer's optimal strategy. We characterize the farmer's optimal strategy. Throughout, we denote the consumption decay rate during saving phases by m, defined as

$$m \;\equiv\; \frac{\rho - r}{\sigma} \;>\; 0,$$

which is positive because the discount rate exceeds the return on savings. The decay rate comes from the Euler equation for the liquid asset; Step 2 of the proof in Appendix A derives it within each phase of the farmer's problem and identifies the phases in which the liquidity constraint binds instead, holding consumption at current income.

Proposition 6.1 (Farmer's optimal consumption path)**.** *Any solution to the farmer's problem can be represented in one of the following two forms:*

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25. At the calibrated parameters the resulting bound lies well above the loan sizes we consider, so the repayment-capacity margin discussed in Section 6 is the binding one; the break-even bound binds at lower success probabilities (Figure 13).

26. The second disbursement B_1 is risk-free in equilibrium (it is extended only when the local lender has already verified $s = H$) and is therefore not constrained by this assumption.

(1) No investment. $c(t,s) = w$, $k(t) = L^F(t) = L^I(t,s) = 0$, $\forall\, t$, $\forall\, s$.

(2) Investment at some date ($T_I \geq 0$). *There exist three saving-phase consumption levels $c_0, c_1, c_2 > 0$, a low-state consumption level $c_L \geq w$, loan principals, and a bridge size, all satisfying the budget and refinancing conditions of the farmer's problem, such that the optimal consumption path is*

$$c(t,s) \;=\; \begin{cases} c_0\, e^{-m\,t}, & 0 \leq t < T_I,\ \forall\, s, \\ \min\bigl\{c_1\, e^{-m\,(t-T_I)},\, w\bigr\}, & T_I \leq t < T_I + 1,\ \forall\, s, \\ \min\bigl\{c_2\, e^{-m\,(t-T_I-1)},\, w + i\bigr\}, & T_I + 1 \leq t < T_I + 2,\ s = H, \\ w + i, & t \geq T_I + 2,\ s = H, \\ \max\bigl\{c_L\, e^{-m\,(t-T_I-1)},\, w\bigr\}, & t \geq T_I + 1,\ s = L. \end{cases}$$

Before investing, the farmer saves towards the project. In the high-return state the farmer either repays the maturing formal loan directly or, when $L^I > 0$, bridges it with local credit and clears all debt two years after investment.

In the low-return state the farmer liquidates at the one-year mark and carries forward whatever the settlement (19) leaves, which depends on the size of the debt relative to the salvage value of capital and liquid assets. When collateral and liquid assets fall short of the required repayment, the farmer exits the default event with nothing and consumption equals the wage from that point onward ($c_L = w$). When they cover it—including the case of self-financing, where there is no debt at all—the farmer retains the residual and runs it down at the Euler rate, consuming above the wage until the residual is exhausted at a finite date and consuming the wage thereafter ($c_L > w$).

The proof is in the Appendix. The proposition is also what makes the model tractable. In the problem as stated in (20), the farmer chooses whole time paths of consumption, borrowing, and saving, together with the investment date. The proposition shows that any optimum has the exponential-and-corner shape above, so all that remains to choose is a short list of numbers: the consumption level at the start of each saving phase, the low-state consumption level, the investment date, and the loan sizes. Lemma A.1 collects the budget and refinancing conditions linking those numbers, and the optimum maximizes expected utility over the ones that satisfy them. This is a small constrained maximization, which is how we solve the model numerically.

Four features of the path warrant comment.

First, the minimum operators in the consumption formulas for phases 2 and 3 (spanning the investment date to the two-year mark) capture the cash-flow constraint that consumption cannot exceed income while debt is outstanding. At corner solutions—when the bridge loan is zero (no bridge) or the first formal loan is zero (no borrowing)—the farmer has no debt obligation in the corresponding phase, so consumption equals the full income flow and the minimum binds: the wage between the investment date and the one-year mark, or wage plus project income between the one-year and two-year marks.

Second, in each saving phase the farmer's marginal saving instrument is the liquid asset earning the savings return. The Euler equation under CRRA utility gives a constant growth rate of consumption ($\dot{c}/c = (\underline{r} - \rho)/\sigma = -m$), regardless of whether formal debt is outstanding.

Third, during gestation the state is unrealized and consumption is the same in both states. One year after investment, the state realizes and the path bifurcates. In the high-return state the farmer enters Phase 3, where returns flow and the bridge sequence executes.

In the low-return state the farmer liquidates, and what remains after the lender is paid governs the rest of the path. A farmer whose debt exceeds the value of capital and liquid assets surrenders everything and consumes the wage from that point onward. A farmer who is not underwater—most obviously the self-financing farmer, who owes nothing and keeps the whole salvage value—starts the failure phase with consumption above the wage and draws the residual down at the Euler rate until it runs out. The liquidation option is therefore available whichever way the project was financed, and failure yields positive value through capital recovery.

Fourth, the investment regime nests three financing sub-cases:

- *Mixed formal–local (the leading case):* both formal and local credit are used, and $0 < c_2 < w + i$.
- *Only formal loan with saving:* for example, if the verification cost is high enough that the equilibrium bridge fee would be prohibitive, the farmer optimally chooses zero borrowing from the local lender and zero second formal loan, with post-realization consumption equal to wage plus project income.[27]
- *Pure self-finance:* When the formal rate is very high or the salvage value is very low, the farmer borrows nothing from either source. With no debt to service, consumption in the high-return state equals wage plus project income in both post-investment phases; in the low-return state the farmer liquidates the installed capital, keeps the full salvage value, and draws it down while consuming above the wage.

27. The closed-form fee $f = c_v/(pL^I)$ is undefined as $L^I \to 0$; the interpretation is that the lender's break-even fee per unit of bridge grows without bound as the bridge shrinks (since fixed verification cost c_v is amortized over a vanishing principal), so any farmer who would choose a near-zero bridge optimally chooses zero bridge instead and accepts higher gestation savings to repay the first formal loan directly.

Whether the farmer saves toward the project first or instead invests immediately is a matter of project scale. The largest first formal loan the farmer can obtain and repay is limited by two margins: the lender's break-even bound of Assumption 2 ($B_0 \le \bar{B}$), and repayment capacity, since the contractual repayment $B_0\, e^{r}$ can be covered by at most one year of saved wages plus a bridge that is itself repaid out of at most one year of saved wage and project income.[28] The smaller of these constraints determines the maximum feasible first loan. When the maximum feasible loan falls short of the project cost, the farmer must accumulate savings before investing; when it covers the cost, investing immediately is feasible. Even then, the farmer may prefer a smaller loan in order to smooth expected consumption.

Turning to the bridge loan, it has two key roles. First, it spreads the repayment of the first formal loan across two years: absent a bridge, the whole repayment falls in the gestation year, when the wage is the farmer's only income, compressing consumption well below the wage for a full year. Second, it raises borrowing capacity, since the bridge is itself repaid out of the following year's wage and project income.

Large projects use both roles, because the added capacity shortens the years of saving that would otherwise precede investment. Small projects use only the first, since formal credit covers their cost outright and no saving phase remains to shorten. Section 7.2 demonstrates this trade-off: Figure 12 shows how the bridge loan and the investment date vary with project size.

Subsection 6.2. **Equilibrium.** We assume free entry of local lenders, so the bridge sector prices at zero expected profit. The formal lending rate is taken as given in the farmer's problem. Because investment opportunities are observable, the market separates by type: we state the equilibrium for a single observable type (the type index is suppressed below). An equilibrium for a type consists of an investment date, three initial consumption levels (one per saving phase), two formal-loan principals, a bridge-loan size, and a bridge fee, satisfying:

(1) *Farmer optimization.* Proposition 6.1 holds given the bridge fee and the formal rate.
(2) *Local-lender zero profit.* The local lender pays the verification cost per farmer to verify and earns the bridge fee only on the fraction p whose projects succeed:

$$p\, f\, L^{I} \;=\; c_v \;\Longrightarrow\; f \;=\; \frac{c_v}{p\, L^{I}}. \tag{21}$$

28. With savings compounding at the deposit rate, one year of saved wages is at most $w\, S$, where $S \equiv (e^{\underline{r}} - 1)/\underline{r}$, and one year of saved wage-plus-project income is at most $(w+i)\, S$, so the repayment-capacity bound is $e^{-r}\big[w\, S + e^{-r}(w+i)\, S - c_v/p\big]$. At the calibrated parameters of Table 8 the capacity margin is the one that binds at every project size we consider.

(3) *Formal-loan feasibility.* The first formal loan does not exceed the maximum break-even loan ($B_0 \leq \bar{B}$, with $\bar{B}$ as in Assumption 2).

Subsection 6.3. **The calibrated consumption path.** For intuition and for the welfare analysis, the paper uses a single calibration, disciplined to the Thai data and collected in Table 8. Every parameter is held fixed across households except the investment cost, which we evaluate at the 25th, 50th (median), and 75th percentiles of observed investment size. We take the 75th percentile as our baseline: it is the scale at which the bridge mechanism is most active and its welfare effects clearest. Each figure and table below names the percentile it uses; the long-term extension of Section 8 reuses this calibration with the parameter changes noted there.

We use a return on investment of 19 percent per year (consistent with the average monthly return estimate of 1.4 percent in our data), a formal interest rate of 6 percent (the median rate in our sample), and risk aversion of 1.2 (within the range of 0.8 to 1.5 commonly estimated for developing-country households). The depreciation rate is 50 percent per year with the initial salvage value at 50 percent of the investment cost.[29] The discount rate is 4 percent and the savings rate is 1 percent annually. The local lender's verification cost is 0.008, which corresponds to the empirically observed local-lender interest cost of around 2 percent.[30]

To build intuition for the consumption path, Figure 8 traces a representative consumption trajectory when the farmer finances the project with a bridge loan. In this example the investment takes place a little after four years, and all debt is repaid exactly two years later. We discuss the key consumption phases next:

Pre-investment (Phase 1). Consumption starts at around 59 percent of income and declines at a rate of 2.5 percent per year because the discount rate exceeds the return on savings. The farmer accumulates enough savings to combine with the first formal loan and fund the project (3.26 units of capital).

Gestation (Phase 2). During gestation the slope of consumption is unchanged—the farmer is still equating the marginal utility loss from saving with the return on liquid

29. Importantly, we consider much higher rates than accounting depreciation rates, both because of asset specificity (equipment fitted to particular crops or land) and because distressed sales occur when local buyers have limited liquidity, forcing fire-sale discounts (Shleifer and Vishny 1992). In Section 8, we consider alternative depreciation rates.

30. Specifically, the median local loan carries a monthly interest rate of 0.7 percent and lasts around three months. The verification cost is chosen so that the implied bridge fee at the *median* investment size matches this roughly 2 percent cost. Because the fee amortizes the fixed verification cost over the bridge principal ($f = c_v/(p\, L^I)$), the implied rate falls with loan size: at the 75th-percentile baseline the larger bridge implies a fee of about 0.8 percent, while at the 25th percentile the smaller bridge implies about 5.4 percent (Figure 12).

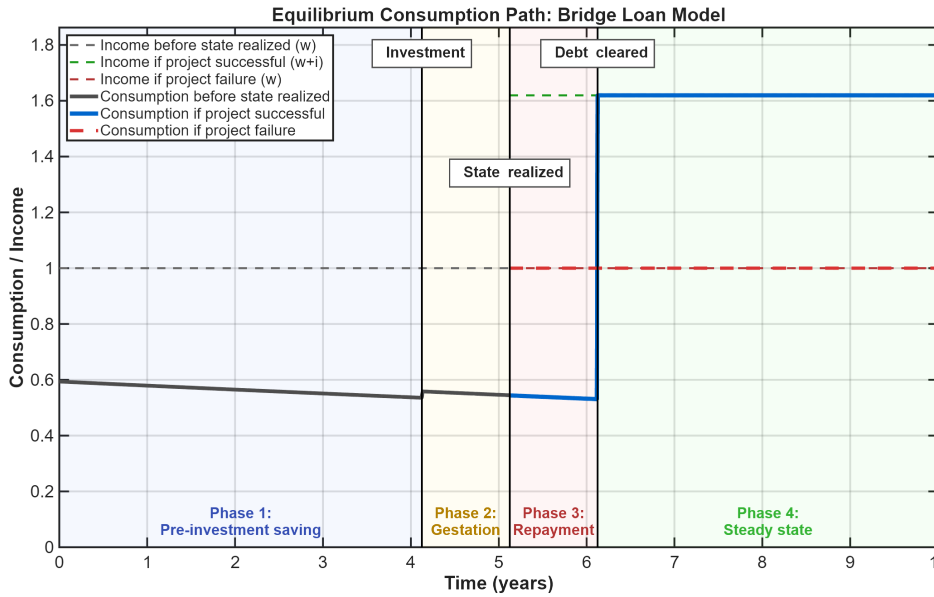

Fig. 8. Equilibrium consumption path. The figure shows the optimal consumption trajectory in both the high-return state (solid blue) and low-return state (dashed red). **Phase 1 (pre-investment)**: from time zero to the investment date (a little after four years), consumption starts at 59 percent of wage income and declines at the Euler rate ($m = 0.025$) as the farmer accumulates down-payment savings of 1.84. **Phase 2 (gestation)**: from the investment date to the one-year mark, the first formal loan (principal 1.42) is outstanding; consumption rises to 0.56 at the investment date and then declines at the Euler rate, while the farmer accumulates an additional 0.45 in gestation savings. **Phase 3 (repayment, high-return state)**: between the one-year and two-year marks, the maturing first loan (repayment 1.51) is repaid with gestation savings plus a bridge loan of 1.06 (at fee 0.8 percent), which is immediately refinanced by a second formal loan of 1.07. Consumption holds near 0.55—it does not yet rise with project income—as the farmer saves to repay the second loan (repayment 1.14). **Phase 4 (steady state, high-return state)**: from the two-year mark onward, all debt is repaid and consumption jumps to wage plus project income (1.62). In the low-return state (dashed red), the path coincides with the high state until the one-year mark, where default occurs. At the baseline calibration parameters, the total collateral and liquid assets fall short of the required loan repayment, so the formal lender confiscates all assets and the farmer consumes only the wage (1.0) from that point onward. When collateral and liquid assets exceed the required repayment (in parameter regions with lower loan sizes or higher salvage values), the farmer retains the excess and consumes it optimally over time alongside wage income. **Parameters**: see Table 8, with investment cost at the 75th percentile ($I = 3.26$).

TABLE 8. Baseline calibration, disciplined to the Thai data and underlying the welfare analysis of Section 7. Every parameter is common across households; only the investment cost I varies, taking its 25th-, 50th- (median), and 75th-percentile values in our sample (as a multiple of annual income). The **75th percentile is our baseline**. The project flow return scales with the investment cost at a fixed return-to-cost ratio of 0.19 per year, and initial salvage is 50 percent of the investment cost. The long-term extension of Section 8 reuses this calibration with the changes noted in its captions (δ varied and lending rates varied).

Parameter	Symbol	Value
Discount rate	ρ	0.04
Deposit rate	$\underline{r}$	0.01
Formal lending rate	r	0.06
Risk aversion	σ	1.2
Wage (normalized)	w	1
Project return-to-cost ratio	i/I	0.19/yr
Success probability	p	0.95
Initial salvage	ℓ_0	$0.5\,I$
Salvage decay	δ	0.5
Verification cost	c_v	0.008
Implied local lender fee (median investment size)	f	2%
Investment cost I (multiple of annual income):		
25th percentile		0.205
Median (50th percentile)		0.66
75th percentile (baseline)		**3.26**

assets.[31] The consumption path during this phase is identical in both states because the project outcome is not yet realized.

In the calibration shown, consumption jumps up to 0.56 at the investment date, as the first formal loan relaxes the budget, and then declines at the Euler rate through gestation; it nonetheless remains below its initial level (0.56 at the jump compared with 0.59 at time zero). The direction of the jump at the investment date is parameter-specific.

State realization and divergence. One year after investment, the project state is realized and the consumption paths diverge. In the low-return state, the farmer defaults. At this calibration the liquidated capital and confiscated liquid assets fall short of the required repayment, so the settlement leaves the farmer with nothing and consumption drops permanently to the wage (1.0); a farmer with a smaller loan or more durable collateral would instead retain a residual and consume above the wage while it lasted. In the high-return state, the farmer receives a bridge loan to repay the maturing first loan,

31. If early repayment were allowed (i.e., if the farmer could save in formal debt rather than liquid assets during gestation), the curve would tilt upward, reflecting the higher formal interest rate.

which is immediately refinanced by a second formal loan, and project income begins to flow.

Repayment of second loan (Phase 3, high-return state only). Consumption is close to 0.55 between the one-year and two-year marks: it does not yet rise with project income, because the farmer is saving to repay the relatively large second loan (repayment 1.14). In parameter regions where the second loan is smaller or project returns are higher relative to the loan, consumption may instead jump up as project income arrives.[32]

Post-repayment (Phase 4, high-return state only). Once all debt is cleared, two years after investment, consumption jumps to the full income stream—162 percent of initial income, equal to wage plus project income. The farmer consumes the entire flow rather than smoothing further because the discount rate exceeds the savings return (making additional saving dominated) and the formal rate exceeds the discount rate (making additional borrowing dominated).

Subsection 6.4. **Comparative statics.** Figure 9 maps the equilibrium financing regime and investment timing across the two key price parameters: the formal lending rate (horizontal axis) and the verification cost (vertical axis). A lower formal rate moves the farmer toward more intensive use of credit, and which boundary is crossed depends on the verification cost: where verification is cheap, the farmer moves directly from pure savings into bridge financing, while at higher verification costs formal credit alone is the intermediate regime. The bridge complements formal credit rather than substituting for it—its value comes from linking two formal loans into two-year finance, so cheaper formal credit raises the return to bridging.

Figure 10 examines the equilibrium loan sizes in more detail. Panel (a) shows the first formal loan as a share of investment cost across the parameter space. When formal rates are low and verification costs are moderate, the farmer borrows a substantial fraction of the investment cost from the formal lender. As the formal rate rises, the cost of debt service increases and the farmer relies more on savings, causing the loan-to-investment ratio to decline.

Panel (b) plots the absolute sizes of both formal loans at a fixed verification cost (0.05). At low formal rates, both loans are large. As the formal rate increases, both loans decline. In this range, the second formal loan exceeds the first because interest accumulation on the first loan exceeds the gestation savings that partially offset the bridge. At very high formal rates, both loans approach zero as the farmer switches to pure savings.

32. The second loan is effectively more expensive than the first, since it carries both the formal interest rate and the bridge fee (0.8 percent in this calibration); the farmer nonetheless prefers it to the alternative of saving enough during gestation to repay the first loan outright, which would force an even sharper consumption cut during gestation.

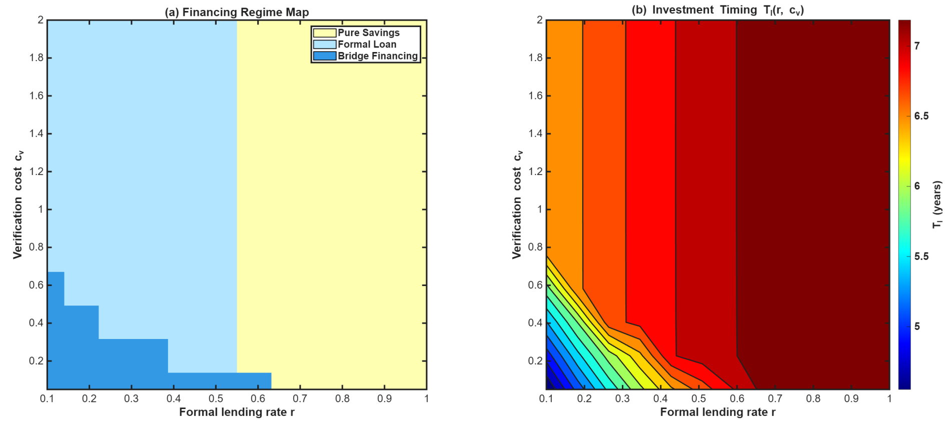

Fig. 9. Equilibrium financing regimes and investment timing. Panel (a) maps the farmer's preferred financing strategy across the formal lending rate (horizontal axis) and the verification cost (vertical axis). Each colored region marks the strategy that maximizes household welfare. **Bridge Financing (dark blue)**: When both costs are moderate, the farmer uses two consecutive one-year formal loans with a bridge loan covering the interim rollover. **Formal Loan (light blue)**: As verification cost rises, the bridge becomes unattractive and the farmer relies solely on formal credit. **Pure Savings (light yellow)**: At sufficiently high formal rates, borrowing becomes prohibitive and the farmer self-funds through savings. Two patterns emerge: first, higher verification costs discourage bridge use; second, higher formal rates push farmers away from all borrowing. Panel (b) shows the investment date in years as a function of the same two price parameters. When financing is cheap (bottom-left), the farmer invests almost immediately. As either cost rises, investment is delayed. Once borrowing costs exceed a threshold, the farmer drops bridge financing and eventually all formal credit; investment timing then stabilizes around the pure-savings threshold. Baseline calibration (Table 8), with the investment cost at the 75th percentile.

Section 7. Welfare Analysis

Choosing among financing contracts is ultimately about *when* and *how much* households consume. Static comparisons therefore miss the utility cost of sharp consumption swings. We translate differences in each contract's entire path into a single, cardinal metric measured in units of consumption-equivalent variation (CEV). We take autarky as the common benchmark and define the consumption-equivalent variation of a financing contract as the permanent proportional increase in the farmer's wage that would leave the farmer, in autarky, exactly indifferent to giving up that contract.[33]

33. Formally, let lifetime utility under autarky with wage stream scaled by a factor $1 + \Delta$ be denoted $V^A\big((1+\Delta)\,w\big)$, and let V^C denote lifetime utility under financing contract C evaluated at the baseline wage. The consumption-equivalent variation of contract C is the value Δ_C solving

$$V^A\big((1+\Delta_C)\,w\big) \;=\; V^C. \tag{22}$$

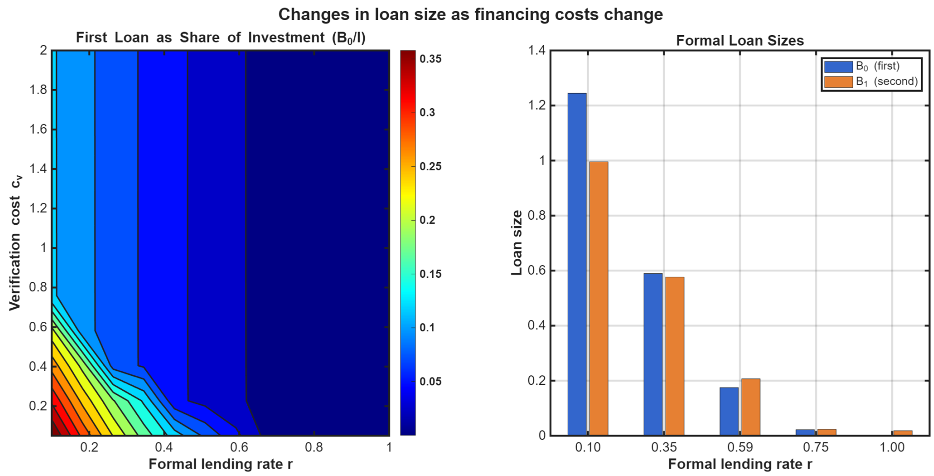

Fig. 10. Comparative statics: Formal loan sizes. Panel (a) shows the first formal loan as a share of investment cost across the formal lending rate (horizontal axis) and verification cost (vertical axis). The contour plot reveals that higher formal rates reduce the loan-to-investment ratio as borrowing becomes more expensive. Panel (b) plots the absolute sizes of the first formal loan (blue) and second formal loan (orange) at a verification cost of 0.05 for different formal rates. Both loans decline as the formal rate rises. In this parameter range, the second formal loan exceeds the first because interest accumulation on the first loan dominates gestation savings. The second loan must refinance the bridge loan plus the verification cost: its principal equals the bridge size plus the verification cost scaled by the inverse success probability ($B_1 = L^I + c_v/p$). At very high rates, both loans approach zero as the farmer self-funds. Baseline calibration (Table 8), with the investment cost at the 75th percentile.

Subsection 7.1. **Baseline calibration.** Our baseline investment cost is the 75th percentile of observed investment size, 326 percent of annual income (Table 8). It is the one project size in our sample large enough that formal credit and a bridge together cannot cover the cost outright, so it is the case in which the farmer must save before investing. We trace the full gradient across investment sizes below.

The project cost at which this switches over is worth reporting explicitly, since it separates the two cases of Section 6. At the calibrated parameters the repayment-capacity margin is the binding one, and setting it equal to the project cost puts the cutoff at about 220 percent of annual income. Above that scale, no combination of a first formal loan and a bridge can cover the cost at the investment date, so the farmer must save first and the investment date is necessarily positive.

Equivalently, a farmer denied the contract would require a wage raised by Δ_C in every period to be as well off as one with access to it; a value of 8 percent, for instance, corresponds to such a compensating wage increase of 8 percent. Because the metric is expressed as a percentage of permanent wages, it can be averaged across heterogeneous borrowers and used directly in policy analysis.

At the baseline calibration, bridge financing lifts lifetime welfare by roughly 23.7 percent of wages relative to autarky; a single formal loan alone achieves about 19.3 percent, while self-financing yields about 18.2 percent. The incremental gain from adding a bridge rollover to formal borrowing—the bridge premium—is therefore around 4.5 percentage points of permanent wages.

Subsection 7.2. **Heterogeneity across investment sizes.** The baseline above fixes the project at the 75th percentile of our sample. There is substantial heterogeneity in project size. To understand how the welfare gains from bridge financing differ across this distribution, we calibrate the model separately at the 25th, 50th, and 75th percentiles of observed investment size.

The three calibrated project sizes straddle the 220 percent cutoff of Section 7.1. The 75th-percentile project, at 326 percent of annual income, sits above it: the maximum feasible first loan is about 238 percent of annual income, well short of the cost, and the farmer must accumulate the difference. The 25th-percentile project (20.5 percent) and the median (66 percent) sit below it, and for both the maximum feasible first loan exceeds the project cost several times over, so immediate financing is available to them.

Figure 11 quantifies this pattern. For small projects (25th percentile), self-financing alone delivers modest gains of around 2.5 percent of permanent wages relative to autarky, with minimal additional benefit from formal or local credit access (the bridge premium is only 0.3 percentage points). At the median investment size, the total welfare gain rises to approximately 8 percent, with bridge financing adding roughly 0.8 percentage points beyond what formal credit alone achieves. For large projects (75th percentile), the total gain reaches about 23.7 percent of permanent wages, and the bridge premium grows to 4.5 percentage points. This heterogeneity reflects both the absolute returns to larger investments and the increasing value of overcoming liquidity constraints when project scale is substantial.

A striking feature of Figure 11 is that the bridge premium relative to a single formal loan (blue) is substantially larger than the formal-loan premium relative to self-financing (orange). The reason is timing: project income begins only one year after investment, so a borrower with a single formal loan must repay it out of saved wage income alone, which severely limits how much that loan can help.

Figure 12 unpacks the mechanisms behind these differential gains by showing how bridge financing characteristics vary with investment size. The left panels reveal that larger projects require substantially more formal credit (the first formal loan size rises from about 0.20 at the 25th percentile to about 1.42 at the 75th percentile) and correspondingly larger bridge loans (increasing from about 0.15 to about 1.06). The top-right panel shows that the implicit cost of local funds varies widely: at the 25th percentile the implied annual rate is around 5.4 percent; at the median it is around 2.0 percent, consistent with the observed local-lender fees in our data; and at the 75th percentile it falls to roughly 0.8 percent, indicating that for very large projects the verification cost becomes small relative to the loan size.[34]

The bottom-left panel shows where that cutoff bites. Households with small and median-sized projects invest immediately—at date zero at the 25th percentile and about three weeks in at the median—because formal credit covers their project cost outright and there is nothing to save toward. Households at the 75th percentile wait over four years, since the largest loan they can obtain and repay falls well short of what their project costs. This changes how the two smaller types should be read: they borrow close to the full project cost from the formal lender rather than saving toward it, so their gains over autarky come from investing years earlier than a saver could rather than from being helped past a financing constraint.

Even the two smaller types take a bridge loan, of 0.15 at the 25th percentile and 0.42 at the median. Immediate financing removes the need to save *before* investing; the mismatch between a one-year loan and a project that pays only after gestation remains. The maturing loan at the median is 70 percent of annual income, and repaying it out of the gestation year alone would leave the farmer consuming under a third of the wage for twelve months. The bridge spreads that repayment into the following year instead.

This is the sense in which bridge financing matters most for the largest investments. The bridge is taken up at every project size, so the gradient in the premium comes from what the bridge buys: smoother repayment at small scale, and years of earlier investment at large scale, where formal credit alone would leave the farmer saving for far longer.

Subsection 7.3. **Risk variation with constant expected returns.** A natural concern is whether the welfare gains documented above reflect genuine risk mitigation or merely the mechanical effect of higher expected returns. We address this by varying the success probability while holding the project's expected return constant at 18 percent of the investment cost. Figure 13 reports the results.

Panel (a) shows that bridge financing delivers substantial welfare gains relative to autarky, ranging from about 18 percent of permanent wages at low success probabilities to about 24 percent at high success probabilities. The gap between bridge financing and self-financing—the value of credit access—is around 6 to 6.5 percentage points throughout, and is somewhat larger at lower success probabilities. Formal credit only (without bridge financing) falls between these two, offering welfare gains intermediate between self-financing

34. We use a common verification cost across the three percentiles (the verification cost, c_v, is 0.008 units of capital) and then solve for the corresponding local lender interest rate. For larger loans, this fixed fee is a smaller portion of the total loan size.

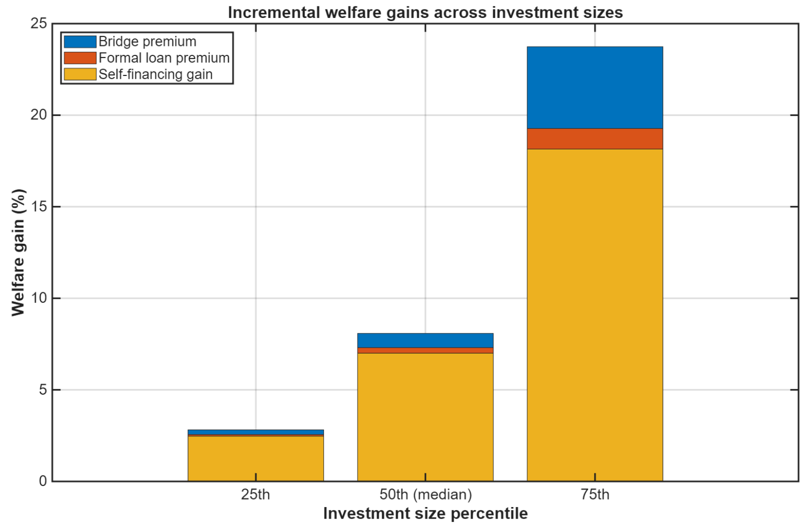

Fig. 11. Incremental welfare gains across investment sizes. The figure shows the welfare gains (measured in consumption-equivalent variation as a percentage of permanent wages) decomposed into three components: the self-financing gain relative to autarky (yellow), the formal loan premium beyond self-financing (orange), and the bridge premium beyond formal-only financing (blue). Investment sizes correspond to the 25th, 50th (median), and 75th percentiles in our sample. The bridge premium increases substantially with project scale, rising from 0.3 percentage points at the 25th percentile to 4.5 percentage points at the 75th percentile, while the total welfare gain rises from 2.8 percent to 23.7 percent of permanent wages. Baseline calibration (Table 8).

and bridge financing across all success probabilities. Two forces drive this pattern. First, higher success probability mechanically reduces income variance and raises welfare under all strategies. Second, at lower success probability, the bridging facility provides insurance through the limited liability contract, which induces the farmer to invest earlier for riskier projects. The sustained gap confirms that the welfare ranking from the baseline calibration is robust to large variation in risk when expected returns are held fixed.

Panel (b) shows that investment timing under bridge financing generally falls with higher success probability, from about 5.3 years at low success probabilities to about 4 years at high success probabilities. Self-financing requires substantially longer delays—8 years at low success probabilities declining to 7.4 years at high success probabilities—because it relies entirely on accumulated savings. In general, the farmer prefers to invest earlier as projects become safer because the value of the safer future cashflows is higher due to the farmer's risk aversion. However, investing earlier may not be possible due to the lending contract. Higher risk, with a fixed lending rate and limited liability, can make the loan size constraint bind. For instance, below success probabilities of around 85 percent with the bridge financing contract, the formal lender's non-negative profit condition binds,

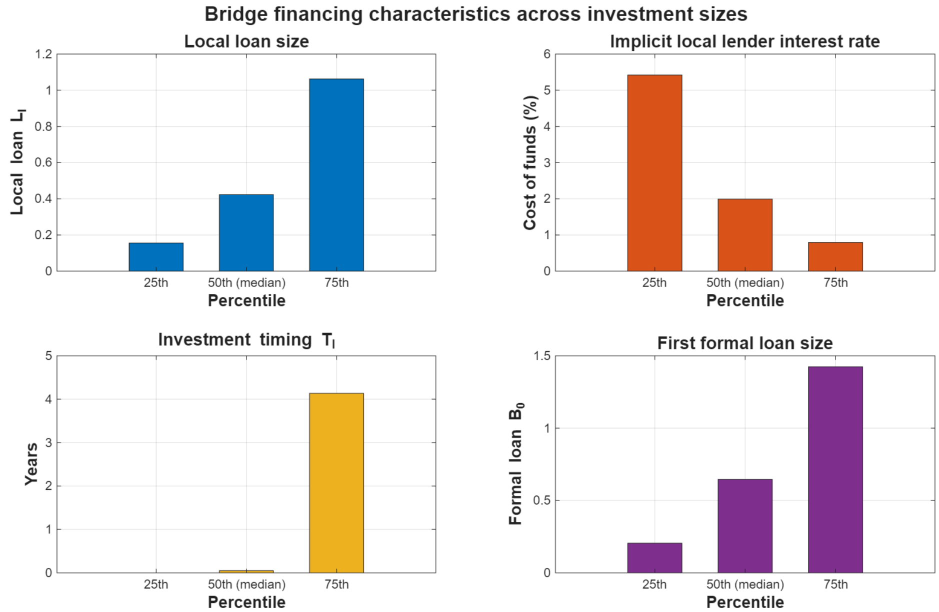

Fig. 12. Bridge financing characteristics across investment sizes. The figure displays four key variables across the 25th, 50th (median), and 75th percentiles of investment size: local loan size (top left), implicit annual local-lender interest rate (top right), investment timing in years (bottom left), and first formal loan size (bottom right). Larger projects require substantially more formal credit and larger bridge loans, but benefit from lower implicit local-lender interest rates as the fixed verification cost is spread over larger loan amounts. A bridge loan is taken at all three project sizes. Investment timing is what changes sharply with scale: investment is immediate at the 25th percentile and about three weeks in at the median, where formal credit covers the project cost outright, and is delayed over four years at the 75th percentile, where the largest feasible first loan falls well short of the cost. Baseline calibration (Table 8).

limiting the size of the possible loan and requiring the farmer to contribute more from savings as the probability of success declines.[35]

Together, the two panels show that the welfare gains from bridge financing are not a byproduct of higher expected returns; holding expected returns fixed, the gains remain large and robust, confirming the value of credit access for large-scale productive investments.

Subsection 7.4. **Caveats to our estimates.** These welfare calculations abstract from several real-world factors that could affect the net gains. First, the project technology is

35. At very high success probabilities, the project's flow return falls toward the borrowing rate, making formal credit expensive relative to the project's profitability. The farmer optimally responds by borrowing less and delaying investment slightly to self-finance a larger share, even though the lender's participation constraint is slack.

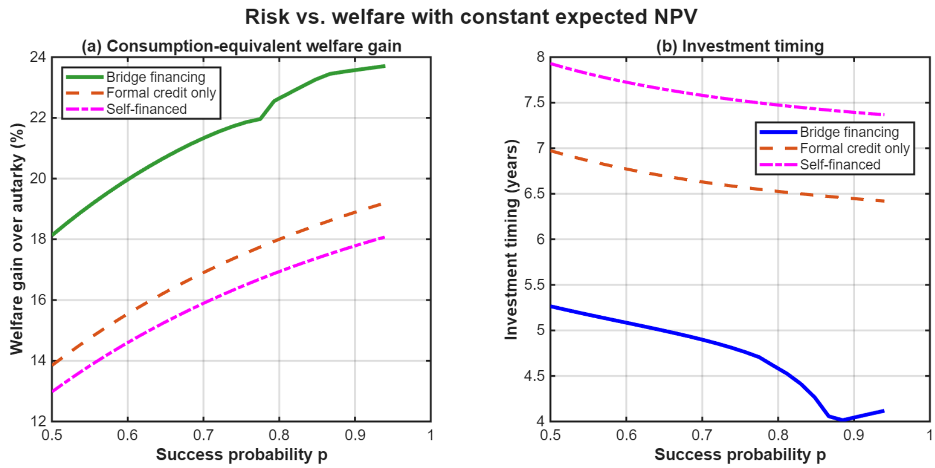

Fig. 13. Risk versus welfare with constant expected NPV. The figure varies the success probability while holding the expected return constant at 18 percent of the investment cost. Panel (a) shows consumption-equivalent welfare gains (as a percentage of permanent wages) relative to autarky for bridge financing, self-financing, and formal credit only. Panel (b) shows investment timing (years until investment) under all three financing strategies. Baseline calibration (Table 8), with the investment cost at the 75th percentile (326 percent of annual income) and the expected project return held fixed at 18 percent of cost.

binary: the model captures the risk of outright failure, but not dispersion in the payoff conditional on success, and every household faces the same failure probability.

Second, default is modeled only through liquidation and confiscation; we do not add deadweight enforcement costs, reputational costs, lender balance-sheet externalities, the risk of over-indebtedness while formal and local debt are simultaneously outstanding, or exposure to income shocks during the bridge period. Incorporating these factors would yield more conservative welfare estimates.

Third, the constant expected NPV exercise is most relevant for investments where the maturity mismatch between project returns and loan duration is substantial—different investment types (e.g., livestock versus equipment) may exhibit varying degrees of benefit from bridge financing depending on their return profiles and gestation periods.

Fourth, these welfare gains are, if anything, conservative with respect to the specification of preferences. Our baseline uses constant relative risk aversion, under which the farmer can smooth consumption fairly freely through saving. Introducing a minimum consumption threshold—as in Stone-Geary preferences—would limit that smoothing near the subsistence floor and raise the marginal value of credit that brings investment forward, so the welfare gains from bridge financing would plausibly be larger still. We retain the constant-relative-risk-aversion baseline for transparency and leave a full quantitative treatment of subsistence preferences to future work.[36]

Section 8. Long-Term Loans and Maturity Choice

In our baseline model, formal lenders offer only one-year loans, requiring farmers to bridge the gap between loan maturity and project completion through borrowing from the local lender at the one-year mark. The baseline analysis takes this maturity restriction as given. But why do lenders impose it? A natural alternative—a single two-year loan covering the full project horizon—would eliminate the bridge and its verification cost. This section characterizes that alternative and asks which contract the lender would choose to offer.

We assume the lender chooses which maturity to offer; the borrower can only accept or reject, and never selects maturity directly. The lender's choice depends on how fast collateral depreciates. Bridge financing lets the lender liquidate a failed project early, recovering the higher one-year salvage value together with the borrower's not-yet-consumed savings, up to the amount owed; when collateral decays fast and is modest relative to the loan, this recovery advantage is large and the lender offers short maturities.

This comparison also clarifies how to interpret the quasi-formal lenders documented in the data. A quasi-formal lender can be viewed as an institution that partially relaxes the baseline model's separation between monitoring capacity and lending capacity. When such credit is available at acceptable terms, it can provide longer maturity directly; when it is unavailable or too expensive, borrowers instead assemble maturity synthetically through the formal-local-formal bridge sequence. Section 8.5 returns to this interpretation after the formal comparison.

Subsection 8.1. **The long-term contract.** The long-term contract is a loan disbursed at the investment date with principal B^{LT} and a single repayment two years later of $R^{LT} = B^{LT}e^{2r}$. Three features define it. *First*, timing: one disbursement, one repayment, no intermediate settlement. *Second*, information: no payment is due at the one-year mark and no verification occurs there, so the lender learns the project outcome only at maturity. *Third*, recovery: at maturity the lender collects the contractual repayment from successful borrowers; a borrower who does not repay is in default, and the lender liquidates the installed capital—by then worth the two-year salvage value, $\ell_2 = \ell_0 e^{-2\delta}$—and seizes any

36. Concretely, the standard CRRA utility function would be modified to $U(c(t)) = \frac{(c(t)-\bar{c})^{1-\sigma}}{1-\sigma}$ for consumption above the floor ($c(t) > \bar{c}$).

liquid assets the borrower holds at that date.[37] The installed capital is pledged and cannot be sold by the borrower before maturity; otherwise a failed borrower would liquidate it at the one-year mark, when it is still worth the higher one-year salvage value, and consume the proceeds along with their savings.

Subsection 8.2. **Recovery and the lender's participation constraint.** The absence of interim verification has a sharp consequence for default recovery. A borrower whose project has failed keeps their accumulated savings for the full year between the outcome realization and loan maturity, and decides only at maturity whether to repay. Repaying means handing over the full amount owed and keeping the installed capital, which by then is worth only its two-year salvage value. When the amount owed exceeds that salvage value, repaying costs more than the capital it retains, so the borrower defaults. The lender then seizes any liquid assets still held at maturity, which is why the borrower consumes those savings over the final year instead.

Lemma 8.1 (Asset run-down before delayed liquidation)**.** *Consider a borrower in the low-return state under the long-term contract, whose repayment due at maturity exceeds the depreciated collateral ($R^{LT} > \ell_2$). Such a borrower defaults at maturity and optimally consumes all accumulated liquid assets during the year between the outcome realization and loan maturity: liquid assets reach zero at or before maturity and remain there, so the lender's default recovery is the depreciated collateral alone, ℓ_2.*

The run-down path is smooth, with consumption above the wage and declining at the Euler decay rate until liquid assets are exhausted—exactly at maturity when gestation savings are large enough, as in our calibration, and strictly earlier otherwise, with consumption at the wage from that point on. The derivation is in the Appendix.

The lemma assumes the amount owed exceeds the depreciated collateral, which holds throughout the region we compare. When the collateral instead covers the amount owed, repaying costs less than the capital it retains, so the borrower repays. The lender's recovery is therefore the smaller of the depreciated collateral and the amount owed, which is the form the participation constraint below takes.

Recovery under the long-term contract—depreciated collateral alone, with the borrower's savings consumed before maturity—stands in sharp contrast to bridge financing, under which the lender liquidates at the one-year mark, seizing the higher one-year salvage value ($\ell_1 = \ell_0 e^{-\delta}$) and the borrower's accumulated gestation savings, up to the amount owed. The difference in recovery drives the lender's contract choice: liquidating a year

37. Repayment in a successful state is incentive compatible: default would surrender capital whose value in the high state exceeds the repayment due, so the farmer is better off repaying and retaining the invested capital. Lemma 8.1 applies the same comparison in the low state, where it reverses because the failed project's capital is worth only its salvage value.

earlier recovers higher valued collateral and reaches savings that the long-term borrower would by then have consumed. Section 8.4 quantifies this advantage and shows how it narrows, and eventually reverses, as collateral becomes more durable.

This recovery also sets how much the lender is willing to advance. The lender participates if expected repayment covers the two-period cost of funds. By Lemma 8.1, the default recovery under the long-term contract is the depreciated collateral whenever the borrower is underwater, and the amount owed otherwise, so the participation constraint is

$$p\, R^{LT} \;+\; (1-p)\,\min(\ell_2,\, R^{LT}) \;\geq\; B^{LT} e^{2\underline{r}}. \tag{23}$$

Where this constraint binds, the recovery sets the cap on the principal. The long-term lender collects only the depreciated collateral in default, so the cap is tighter than under bridge financing, where recovery would also include the borrower's seized savings.

Subsection 8.3. **The borrower's optimal contract.** Given the lending rate and the lender's participation constraint, the borrower chooses the principal, the investment date, and a consumption plan to maximize expected utility. The plan has the same shape as the baseline path of Proposition 6.1: consumption declines at the Euler decay rate within each phase, and the pre-realization phases are common across states because the outcome is still unknown. Two differences matter for the comparison below. First, there is no settlement at the one-year mark, so consumption passes smoothly through that date without the jump the bridge repayment induces. Second, in the low-return state the borrower is not liquidated at the one-year mark; instead, by Lemma 8.1, the borrower runs their savings down smoothly over the final year, consuming above the wage until liquid assets are exhausted at maturity.

The absence of an interim payment carries a cost. Gestation savings now earn the deposit rate for a full year while the principal accrues at the higher lending rate.

The delayed liquidation is the contract's distinctive advantage for the borrower. Under bridge financing the lender liquidates at the one-year mark and seizes the farmer's accumulated savings together with the collateral, up to the amount owed; under the long-term contract the farmer instead consumes those savings over the final year, before the lender can reach them. Because they are consumed in the failure state—when the project has collapsed and only the wage remains—these resources arrive exactly when marginal utility is highest. The long-term contract thus extends limited liability further than the bridge does: it shields not only the borrower's future income but the liquid assets accumulated before the project failed, which is valuable insurance for a risk-averse farmer.

Subsection 8.4. **Comparison with bridge financing.** Because the lender makes the offer, we ask which contract it chooses. Throughout we hold the lending rate fixed and compare otherwise identical projects.

The lender's profit from the long-term contract, valued at the disbursement date and discounted at the cost of funds, is

$$S^{LT} \;=\; e^{-2r}\big[p\, B^{LT} e^{2r} \;+\; (1-p)\, \min(\ell_2,\, B^{LT} e^{2r})\big] \;-\; B^{LT}, \tag{24}$$

where by Lemma 8.1 the default recovery is the collateral alone. Profit is zero where the borrower exhausts a binding cap (by construction, the break-even scale) and strictly positive otherwise. At the median lending rate used in the tables below, the participation constraint of Section 8.2 is slack and profit is strictly positive.

Under bridge financing the lender instead makes two one-year loans—one at the investment date and one at the refinancing date just after the one-year mark—and, in default, liquidates at the one-year mark. The lender's contract choice depends on how quickly collateral depreciates. Table 9 shows that when collateral decays rapidly (the baseline calibration, with depreciation rate 0.50), bridge financing earns higher profit: early liquidation preserves collateral value and lets the lender seize the borrower's accumulated savings. As collateral becomes more durable, the recovery advantage shrinks and eventually reverses. At depreciation rates below approximately 0.20, the long-term contract becomes more profitable for the lender despite recovering no savings, because the well-preserved collateral alone covers default losses.

The recovery advantage has two components: higher valued collateral—worth more the faster salvage depreciates—and the seized savings that the long-term borrower instead consumes. At the baseline calibration (depreciation rate 0.50, initial collateral value 1.63), bridge financing recovers 1.44 in default compared with 0.60 under the long-term contract. With slower depreciation (rate 0.15), recovery values converge (1.51 versus 1.21) and the long-term contract becomes more profitable: as collateral becomes more durable, default recovery approaches full repayment under either maturity and the lender's preference weakens toward indifference.

The bridge fee plays no role in this ranking: it compensates the local lender for verification and never reaches the formal lender. Short maturities are thus the lender's profit-maximizing response when collateral is scarce and decays quickly; where collateral is ample or durable, the lender has little reason to insist on them.

In the region where short maturities prevail—cheap local monitoring and rapidly depreciating collateral, the village setting of our calibration—the equilibrium formalizes the conjecture that contractual rigidity can be an optimal response to information asymmetry (Jain 1999; Conning 1999). The formal lender offers short, non-contingent contracts

Table 9. Lender Contract Preference and Collateral Depreciation

Depreciation Rate (δ)	Default Recovery BF	LT	Lender Profit BF	LT	Preferred Contract
0.50 (baseline)	1.44	0.60	0.121	0.097	BF
0.30 (slower)	1.51	0.89	0.124	0.111	BF
0.15 (slow)	1.51	1.21	0.124	0.127	LT
0.05 (durable)	1.51	1.47	0.124	0.140	LT

Note: The table shows how the formal lender's preferred contract depends on the collateral depreciation rate. All calculations use the median lending rate ($r = 0.06$) and baseline parameters from Table 8 with 75th percentile investment size ($I = 3.26$, initial collateral $\ell_0 = 1.63$). Recovery values show what the lender recovers in the default state: under bridge financing (BF), collateral is liquidated one year after investment ($\ell_1 = \ell_0 e^{-\delta}$) plus seized savings ($a_1 \approx 0.45$ at baseline), capped at the contractual repayment ($R_0 \approx 1.51$, the cap binding at the slower depreciation rates); under the long-term contract (LT), collateral is liquidated two years after investment ($\ell_2 = \ell_0 e^{-2\delta}$) with no savings seized. Lender profit is the formal lender's expected profit over the two-year horizon, discounted to the investment date at the deposit rate (the lender's cost of funds, $\underline{r} = 0.01$). For BF this includes both the pre-investment loan and the gestation loan; the bridge fee paid by high-state borrowers goes to the local lender and does not enter formal lender profit. When collateral depreciates rapidly (high δ), the lender prefers bridge financing because early liquidation preserves collateral value and the lender seizes accumulated savings. When collateral is durable (low δ), the lender prefers the long-term contract because collateral retains sufficient value even after two years, making the timing advantage of bridge financing less important.

and relies on the local lender's verification to certify which borrowers merit refinancing, so the second loan it extends carries no default risk.

One measurement implication follows. The formal loan records show a sequence of one-year loans, repaid and renewed. The household's effective credit exposure, however, spans two years: the initial loan plus the bridge loan that refinances it. Effective maturity exceeds stated maturity, and assessments of household leverage or credit risk built from formal-sector records alone will misstate both the duration and the riskiness of rural balance sheets. The ubiquitous bridge loans in our data are the equilibrium means by which this market assembles two-year project finance when formal lenders ration maturity, rather than evidence of fragility.

Subsection 8.5. **Quasi-formal lenders.** In the empirical section, we show that quasi-formal lenders—village agricultural cooperatives and production credit groups (Section 2.1)—are more likely than formal lenders to offer longer-maturity contracts: in Table 1, the 90th and 95th percentiles of quasi-formal loan duration are 26 and 60 months, compared with 13 months at both percentiles for formal BAAC and Village Fund loans (see also Appendix Section C.1.3). These longer contracts come at higher interest rates in the upper half of the distribution. Mean monthly rates are 0.86 percent for quasi-formal loans versus 0.80 percent for formal loans, and the gap widens above the median (1.00 percent versus 0.67 percent at the 75th percentile; Table 1). We do not model quasi-formal lenders as a separate lender type, but their behavior is naturally interpreted within the same tradeoff. Because these intermediaries combine features of both lender types, it is natural to view them as having some of the local lender's monitoring capacity together with greater lending capacity, albeit at a higher cost of funds than formal lenders. The combination comes at a price consistent with the evidence in Conning (1999), who finds that intermediaries that monitor their borrowers closely have higher costs per dollar lent and less access to outside funds, and accordingly charge higher rates and operate at smaller scale.

Quasi-formal loans therefore provide a direct, but not necessarily cheaper, alternative to the synthetic long-term contract created by the formal-local-formal bridge sequence. When quasi-formal credit is available at acceptable terms, farmers may obtain longer maturity directly from a lender that has both monitoring capacity and lending capacity. When such credit is unavailable, too small, or too expensive, farmers can assemble similar maturity indirectly by combining a short formal loan with local bridge refinancing. In this sense, quasi-formal lending is another institutional way to obtain longer-maturity financing, while the bridge sequence is the market's workaround when that direct option is absent or unattractive.

Section 9. Conclusion

Over the past few decades, formal financial services have expanded rapidly in developing countries. Yet for rural households, the structure of formal credit—particularly the widespread use of short-term bullet loans—remains poorly aligned with the financing needs of high-return but lumpy investments. This paper evaluates how such rigid loan structures interact with flexible local credit, and the welfare and investment implications of these interactions.

Empirically, we use detailed panel data from Thai villages to document the coexistence of formal and local loans and the prevalence of bridging. Linking investments and loans through timing overlaps, we find that over 70 percent of investments are linked to loans originated shortly before them, and about half are financed through a bridge. The most common pattern, close to half of all bridge-financed investments, is a three-loan sequence: a formal loan, then a short loan from a local lender that repays it at maturity, then a new formal loan that repays the local lender. The formal legs run about a year each, the bridge is far shorter, and the bridging covers a substantial share of the repayment on the initial loan.

Three estimation exercises quantify what is at stake. Household income rises with investment, at an implied monthly return of about 1.4 percent for the households that select into investing. Consumption rises across the investment-loan window for about two thirds of episodes, with dispersion consistent with return heterogeneity and the chance of project failure. Using the Million Baht Village Fund as a quasi-experiment, villages receiving larger per-household credit injections invested more in the short run and financed persistently more investment through bridges: expanding rigid formal credit increased, rather than displaced, bridge borrowing.

Motivated by these facts, we develop a continuous-time model of consumption, saving, and investment under liquidity constraints and rigid formal borrowing terms. The two lenders differ in their ability to verify project outcomes: the formal lender has deep funding but costly verification, while the local lender verifies outcomes at low cost and lends on state-contingent terms. Short bridge loans therefore roll over the formal bullet loan that partially finances a risky lumpy investment, effectively extending repayment duration. An extension makes the maturity itself the lender's choice, and the one-year bullet contract is preferred when collateral depreciates quickly, because default then surfaces early and the collateral is liquidated while it still holds value. Rigid formal lending and flexible local bridging emerge together as an equilibrium division of labor sustained by the verification asymmetry.

Calibrating the model to the Thai data, bridge loans complement rigid formal credit by enabling earlier investment and smoother repayment. The headline number is for the largest projects we consider: at the 75th percentile of investment size, the welfare gain attributable to the bridge loan reaches 4.5 percentage points of permanent wages relative to relying solely on one-year bullet loans. The gain is much smaller at the median investment size, at 0.8 percentage points, because formal credit covers a median-sized project outright, so there the bridge buys smoother repayment rather than years of earlier investment. The ranking of financing arrangements is stable when project risk varies at a fixed expected return.

These estimates come with limits that the paper sets out explicitly. Returns are measured among households that select into investing; those households hold more productive assets and draw less of their income from wage labor than households that do not invest, so the gains describe the investing type rather than the average household. The wage is constant by construction, which keeps the consumption path tractable but leaves out the income risk that would raise precautionary saving ahead of investment. Default operates only through liquidation and confiscation, so deadweight enforcement costs, reputational costs, and lender balance-sheet externalities sit outside the calculation, and adding them would make the welfare estimates more conservative.

Beyond our sample, recent policy discussions in Thailand find that rural borrowing is still broad-based and dominated by BAAC, the Village Fund, local lenders, and cooperatives, with household debt burdens remaining high. The rigid maturity structure persists as well: most BAAC loans are still due yearly, and about one quarter of interviewed households report borrowing to repay existing loans (Chantarat et al. 2023; Vannavanit et al. 2026). Recent policy has centered on debt relief rather than on the maturity of new lending, so it addresses distressed debt after the fact rather than the terms under which new investment is financed (Ratanavararak and Chantarat 2023).

The policy implication is that expanding formal credit requires attention to repayment structure, and not only to volumes or interest rates. Our Million Baht Village Fund estimates make the point directly: cheaper credit at unchanged maturity raised investment, but it arrived packaged with bridging rather than displacing it, and the model reproduces this pattern, since lowering the formal rate while holding maturity fixed moves households toward joint formal–local arrangements. The maturity extension then shows why lengthening maturity is harder than a mandate: the formal lender prefers the one-year contract because early liquidation raises what it recovers when a project fails. Lengthening maturity therefore has to compensate the lender for that lost recovery—through collateral that holds its value, or through the price of the loan—rather than simply requiring longer terms.

The binding friction in our model is ex post outcome verification. Recent advances in digital payments and consolidated credit bureau data improve who receives credit (World Bank 2020; Vannavanit et al. 2026), but verifying whether a particular harvest succeeded remains costly for arm's-length lenders—the local informational advantage that sustains the observed division of labor between lender types (Conning 1999; Surendra 2024). In our model, this verification cost is what rules out state-contingent formal lending. Bridging may matter beyond rural lending, since Thai listed firms also finance long horizons by rolling over short-term debt (Saengchote 2025). Policies that accelerate outcome observability, such as crop monitoring and integrated farm registries (Khandker and Yamano 2025), could help complement credit expansion, since they would let formal lenders supply directly the flexibility that bridging now assembles across contracts.

References

Aleem, Irfan. 1990. "Imperfect information, screening, and the costs of informal lending: a study of a rural credit market in Pakistan." *The World Bank Economic Review* 4 (3): 329–349.

Allcott, Hunt, Joshua J. Kim, Dmitry Taubinsky, and Jonathan Zinman. 2022. "Are High-Interest Loans Predatory? Theory and Evidence from Payday Lending." *The Review of Economic Studies* 89, no. 3 (May): 1041–1084. https://doi.org/10.1093/restud/rdab066.

Badarinza, Cristian, Vimal Balasubramaniam, and Tarun Ramadorai. 2019. "The Household Finance Landscape in Emerging Economies." *Annual Review of Financial Economics* 11 (December): 109–129. https://doi.org/10.1146/annurev-financial-110118-123106.

Banerjee, Abhijit, Dean Karlan, and Jonathan Zinman. 2015. "Six Randomized Evaluations of Microcredit: Introduction and Further Steps." *American Economic Journal: Applied Economics* 7, no. 1 (January): 1–21. https://doi.org/10.1257/app.20140287.

Banerjee, Abhijit Vinayak. 2013. "Microcredit Under the Microscope: What Have We Learned in the Past Two Decades, and What Do We Need to Know?" *Annual Review of Economics* 5 (1): 487–519. https://doi.org/10.1146/annurev-economics-082912-110220.

Barboni, Giorgia, and Parul Agarwal. 2023. "How Do Flexible Microfinance Contracts Improve Repayment Rates and Business Outcomes? Experimental Evidence from India."

Battaglia, Marianna, Selim Gulesci, and Andreas Madestam. 2024. "Repayment Flexibility and Risk Taking: Experimental Evidence from Credit Contracts." *The Review of Economic Studies* 91 (5): 2635–2675.

Beaman, Lori, Dean Karlan, Bram Thuysbaert, and Christopher Udry. 2023. "Selection Into Credit Markets: Evidence From Agriculture in Mali." *Econometrica* 91 (5): 1595–1627. https://doi.org/10.3982/ECTA18916.

Bertrand, Marianne, and Adair Morse. 2011. "Information Disclosure, Cognitive Biases, and Payday Borrowing." *The Journal of Finance* 66, no. 6 (December): 1865–1893. https://doi.org/10.1111/j.1540-6261.2011.01698.x.

Boonperm, Jirawan, Jonathan Haughton, and Shahidur R. Khandker. 2013. "Does the Village Fund Matter in Thailand? Evaluating the Impact on Incomes and Spending." *Journal of Asian Economics* 25 (April): 3–16. https://doi.org/10.1016/j.asieco.2013.01.001.

Brune, Lasse, Xavier Giné, and Dean Karlan. 2022. *Give Me a Pass: Flexible Credit for Entrepreneurs in Colombia.* Working Paper 30634. National Bureau of Economic Research, November. https://doi.org/10.3386/w30634.

Buera, Francisco J, Joseph P Kaboski, and Yongseok Shin. 2021. "The Macroeconomics of Microfinance." *The Review of Economic Studies* 88, no. 1 (January 1, 2021): 126–161. https://doi.org/10.1093/restud/rdaa047.

Chantarat, Sommarat, Chayanee Chawanote, Lathaporn Ratanavararak, Chonnakan Rittinon, Boontida Sa-ngimnet, and Narongrit Adultananusak. 2023. *Financial Lives and* *the Vicious Cycle of Debt among Thai Agricultural Households.* Discussion Paper 204. Bangkok: Puey Ungphakorn Institute for Economic Research, March 31, 2023.

Conning, Jonathan. 1999. "Outreach, Sustainability and Leverage in Monitored and Peer-Monitored Lending." *Journal of Development Economics* 60 (1): 51–77.

Conning, Jonathan, and Christopher Udry. 2007. "Chapter 56 Rural Financial Markets in Developing Countries." In *Handbook of Agricultural Economics,* vol. Volume 3, 2857–2908. Elsevier.

Cordaro, Francesco, Marcel Fafchamps, Colin Mayer, Muhammad Meki, Simon Quinn, and Kate Roll. 2022. *Microequity and Mutuality: Experimental Evidence on Credit with Performance-Contingent Repayment.* Working Paper 30411. Cambridge, MA: National Bureau of Economic Research, September.

Field, Erica, Rohini Pande, John Papp, and Natalia Rigol. 2013. "Does the classic microfinance model discourage entrepreneurship among the poor? Experimental evidence from India." *American Economic Review* 103 (6): 2196–2226.

Fink, Günther, B. Kelsey Jack, and Felix Masiye. 2020. "Seasonal Liquidity, Rural Labor Markets, and Agricultural Production." *American Economic Review* 110, no. 11 (November): 3351–3392. https://doi.org/10.1257/aer.20180607.

Giannetti, Mariassunta, Mike Burkart, and Tore Ellingsen. 2011. "What You Sell Is What You Lend? Explaining Trade Credit Contracts." *The Review of Financial Studies* 24, no. 4 (April 1, 2011): 1261–1298. https://doi.org/10.1093/rfs/hhn096.

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). https://doi.org/10.1016/j.jdeveco.2010.07.001.

Gomes, Francisco, Michael Haliassos, and Tarun Ramadorai. 2021. "Household Finance." *Journal of Economic Literature* 59, no. 3 (September): 919–1000. https://doi.org/10.1257/jel.20201461.

Jain, Sanjay. 1999. "Symbiosis vs. crowding-out: the interaction of formal and informal credit markets in developing countries." *Journal of Development Economics* 59, no. 2 (August): 419–444. https://doi.org/10.1016/S0304-3878(99)00019-X.

Jain, Sanjay, and Ghazala Mansuri. 2003. "A little at a time: the use of regularly scheduled repayments in microfinance programs." *Journal of Development Economics* 72, no. 1 (October): 253–279. https://doi.org/10.1016/S0304-3878(03)00076-2.

Kaboski, Joseph P., and Robert M. Townsend. 2011. "A Structural Evaluation of a Large-Scale Quasi-Experimental Microfinance Initiative." *Econometrica* 79 (5): 1357–1406. https://doi.org/10.3982/ECTA7079.

———. 2012. "The Impact of Credit on Village Economies." *American Economic Journal: Applied Economics* 4, no. 2 (April): 98–133. https://doi.org/10.1257/app.4.2.98.

Karaivanov, Alexander, and Anke Kessler. 2018. "(Dis)advantages of informal loans – Theory and evidence." *European Economic Review* 102:100–128. https://doi.org/https://doi.org/10.1016/j.euroecorev.2017.12.005.

Karaivanov, Alexander, and Robert M. Townsend. 2014. "Dynamic Financial Constraints: Distinguishing Mechanism Design From Exogenously Incomplete Regimes." *Econometrica* 82, no. 3 (May): 887–959. https://doi.org/10.3982/ECTA9126.

Karlan, Dean, and Sendhil Mullainathan. 2010. “Rigidity in Microfinancing: Can One Size Fit All?” In *QFinance: The Ultimate Resource.* Bloomsbury.

Khandker, Shahidur R., and Takashi Yamano, eds. 2025. *Agricultural Finance in Developing Countries: Challenges and Opportunities.* Manila and Tokyo: Asian Development Bank / Asian Development Bank Institute. https://doi.org/10.22617/TCS250075-2.

Kinnan, Cynthia. 2022. “Distinguishing Barriers to Insurance in Thai Villages.” *Journal of Human Resources* 57, no. 1 (January 1, 2022): 44–78. https://doi.org/10.3368/jhr.57.1.0219-10067R1.

Laibson, David. 1997. “Golden Eggs and Hyperbolic Discounting.” *Quarterly Journal of Economics* 112 (2): 443–477.

Maurer, Klaus, Shyam Khadka, and Hans Dieter Seibel. 2000. *Agricultural Development Bank Reform: The Case of The Bank for Agriculture and Agricultural Cooperatives (BAAC), Thailand.* 2000,3. University of Cologne, Development Research Center.

Meier, Stephan, and Charles Sprenger. 2010. “Present-Biased Preferences and Credit Card Borrowing.” *American Economic Journal: Applied Economics* 2 (1): 193–210.

Mel, Suresh de, David McKenzie, and Christopher Woodruff. 2008. “Returns to Capital in Microenterprises: Evidence from a Field Experiment.” *The Quarterly Journal of Economics* 123, no. 4 (November 1, 2008): 1329–1372. https://doi.org/10.1162/qjec.2008.123.4.1329.

Morduch, Jonathan. 1999. “The Microfinance Promise.” *Journal of Economic Literature* 37, no. 4 (December 1, 1999): 1569–1614.

Morse, Adair. 2011. “Payday Lenders: Heroes or Villains?” *Journal of Financial Economics* 102 (1): 28–44.

Petersen, Mitchell A., and Raghuram G. Rajan. 1997. “Trade Credit: Theories and Evidence.” *The Review of Financial Studies* 10, no. 3 (July 1, 1997): 661–691. https://doi.org/10.1093/rfs/10.3.661.

Phongpaichit, Pasuk, and Christopher John Baker. 2004. *Thaksin: The Business of Politics in Thailand.* NIAS Press.

Ratanavararak, Lathaporn, and Sommarat Chantarat. 2023. *Do Agricultural Debt Moratoriums Help or Hurt? The Heterogeneous Impacts on Rural Households in Thailand.* Discussion Paper 195. Bangkok: Puey Ungphakorn Institute for Economic Research, July 3, 2023.

Rutherford, Stuart. 2001. *The Poor and Their Money (Oxford India Paperbacks).* {Oxford University Press, USA}, August 1, 2001.

Saengchote, Kanis. 2025. *Debt Composition, Institutional Demand, and Corporate Investment: Evidence from Thailand.* Discussion Paper 242. Bangkok: Puey Ungphakorn Institute for Economic Research.

Samphantharak, Krislert, and Robert M. Townsend. 2009. *Households as Corporate Firms: An Analysis of Household Finance Using Integrated Household Surveys and Corporate Financial Accounting.* Cambridge University Press. https://doi.org/10.1017/CBO9780511808210.

Shleifer, Andrei, and Robert W. Vishny. 1992. “Liquidation Values and Debt Capacity: A Market Equilibrium Approach.” *The Journal of Finance* 47, no. 4 (September): 1343–1366. https://doi.org/10.1111/j.1540-6261.1992.tb04661.x.

Shonchoy, Abu S., and Takashi Kurosaki. 2014. *Impact of Seasonality-Adjusted Flexible Microcredit on Repayment and Food Consumption: Experimental Evidence from Rural Bangladesh.* IDE Discussion Paper 460. Institute of Developing Economies, JETRO.

Siamwalla, Ammar, Chirmsak Pinthong, Nipon Poapongsakorn, Ploenpit Satsanguan, Prayong Nettayarak, Wanrak Mingmaneenakin, and Yuavares Tubpun. 1990. "The Thai Rural Credit System: Public Subsidies, Private Information, and Segmented Markets." *The World Bank Economic Review* 4, no. 3 (September): 271–295.

Sripakdeevong, Parit, and Robert M. Townsend. 2022. "The Village Money Market Revealed: Financial Access and Credit Chain Links Between Formal and Informal Sectors." *Annual Review of Financial Economics* 14 (Volume 14, 2022 2022): 1–20. https://doi.org/10.1146/annurev-financial-012820-034126.

Surendra, Vaishnavi. 2024. "The Moneylender as Middleman: Formal Credit Supply and Informal Loans in Rural India."

Udry, Christopher. 1990. "Credit markets in Northern Nigeria: Credit as insurance in a rural economy." *The World Bank Economic Review* 4 (3): 251–269.

Vannavanit, Worarit, Sommarat Chantarat, Lathaporn Ratanavararak, and Kazushi Takahashi. 2026. *Flexible Debt Relief and Credit Behavior: Evidence from Loan-Level Data.* Discussion Paper 253. Bangkok: Puey Ungphakorn Institute for Economic Research, May 29, 2026.

Wang, Fan. 2022. "An empirical equilibrium model of formal and informal credit markets in developing countries." *Review of Economic Dynamics* 46 (October 1, 2022): 224–243. https://doi.org/10.1016/j.red.2021.09.001.

World Bank. 2020. *Thailand PromptPay.* World Bank Fast Payments Toolkit, Case Study.

ONLINE APPENDIX

Timing lumpy investments with bridge loans and clunky formal loans: Evidence from Thailand

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Appendix A. Proofs

Proof of Proposition 6.1.

Proof. The proof has three steps. First, we rule out cash-flow patterns outside the two forms stated in the proposition. Second, conditional on the remaining cash-flow skeleton, we derive the consumption path from the Euler equation and the liquidity constraint. Third, we reduce the remaining choice to a finite-dimensional maximization over the investment date and loan sizes.

Step 1: admissible loan timing. Consider any allocation in which the farmer invests at date T_I. Note that taking a formal loan strictly before the proceeds are needed is dominated by delaying the same loan disbursement until the date of investment because the interest rate on debt (r) is strictly above the savings interest rate ($\underline{r} < r$), and all future feasibility constraints are weakly relaxed. Similarly, formal borrowing used only to raise consumption before investment or after all project debt has been cleared is dominated by avoiding the loan, since the borrowing rate exceeds both the discount rate and the savings rate ($r > \rho > \underline{r}$). Hence any positive first formal loan disbursement must be originated at the investment date and used to help finance the project cost.

The bullet-contract restriction then fixes the first contractual repayment at the one-year mark. Before that date the project state is still unknown, so feasibility and the information constraint require the same consumption and asset path in both states. The state is learned at the one-year mark, and the two states diverge from there.

In the low state with borrowing ($B_0 > 0$), the local lender declines to lend, so the farmer defaults and the formal lender liquidates collateral and confiscates accumulated liquid assets, up to the required repayment. Under self-financing ($B_0 = 0$) there is no debt to settle, so the farmer liquidates the installed capital and keeps the full salvage value. Either way the settlement is (19) and the continuation is the low-state path of Proposition 6.1.

In the high state, the farmer repays the maturing formal loan using gestation savings alone whenever those savings suffice. Otherwise, if continuation is optimal, the farmer closes the repayment gap with a bridge loan of size $L^I = R_0 - a(T_I + 1^-)$. The no-overlap restriction rules out a second formal loan before the first is repaid, so once the bridge loan has repaid the first loan, any positive second formal disbursement must occur immediately and is used to repay the bridge loan with fee. Extra formal borrowing after that point is again pure consumption borrowing at rate $r > \rho$ and is dominated. Thus an investment allocation has exactly the cash-flow dates summarized in Lemma A.1, allowing the corner cases $B_0 = 0$, $L^I = 0$, or $B_1 = 0$.

Step 2: consumption within each phase. Conditional on this cash-flow skeleton, the problem decomposes into deterministic intervals separated by the investment date, the one-year realization date, and the two-year debt-clearance date. On any interval where the farmer is saving liquid assets and the liquidity constraint is slack, loan cashflows are fixed by the discrete contract dates. A small transfer of consumption from time t to time $t + dt$ earns the deposit return, so the standard Euler equation is

$$\frac{\dot{c}(t,s)}{c(t,s)} = \frac{\underline{r} - \rho}{\sigma} = -m,$$

which gives an exponentially declining consumption path within every slack saving phase. This proves the exponential form in the pre-investment phase, in gestation, in the high-return repayment phase, and—while the residual left by liquidation remains positive—in the low-return phase after failure.

The liquidity constraint accounts for the minimum operators. At the investment date, all liquid assets are used to reduce the first formal loan, since holding liquid assets while borrowing formally is strictly dominated. Thus liquid assets are zero immediately after investment. During gestation, current income is only the wage. If the unconstrained Euler path lies above the wage while liquid assets are zero, consuming it would violate $a(t,s) \geq 0$, so the constraint binds and consumption equals the wage. Once the Euler path falls below the wage, the farmer saves the difference toward the first repayment. Hence

$$c(t,s) = \min\{c_1 e^{-m(t-T_I)}, w\}$$

between the investment date and the one-year mark.

The same logic applies in the high-return state between the one-year and two-year marks, except that current income is wage plus project income, giving

$$c(t,H) = \min\{c_2 e^{-m(t-T_I-1)}, w + i\}.$$

Once the high-return borrower repays the second formal loan at the two-year mark, no debt remains. Carrying positive liquid assets is dominated because $\underline{r} < \rho$, and borrowing to consume above income is dominated because $r > \rho$. Consumption therefore equals the permanent income flow $w+i$ from the two-year mark onward. In the low state, the settlement (19) at the one-year mark determines the continuation. When capital and liquid assets fall short of the required repayment, the borrower is left with zero liquid assets and no project income, so the same argument gives consumption equal to the wage from that date onward. When they cover it, the borrower retains the residual (A.6) and holds it as liquid assets.

This last case carries a maximum operator rather than a minimum, and the reason is the mirror image of the argument above. In the earlier phases the farmer holds no liquid assets and current income caps consumption from above, so the constraint binds when the Euler path lies above income. Here the farmer starts the phase holding positive liquid assets and no debt, so consumption is unconstrained from above and the Euler path declines from a level above the wage. Liquid assets are drawn down while it does. Once the declining path reaches the wage, running assets below zero is infeasible and saving is dominated because the deposit rate falls short of the discount rate, so consumption stays at the wage.

Hence $c(t,L) = \max\{c_L e^{-m(t-T_I-1)}, w\}$, with the low-state consumption level and the exhaustion horizon jointly determined by (A.7): consumption declines at the decay rate until the residual is exhausted at a finite date, and equals the wage thereafter. Self-financing is the case with no debt to settle, so the residual is the full salvage value and the same path applies.

Consumption in the pre-investment phase is determined differently, because the length of that phase is itself chosen by the farmer. Conditional on investment being chosen, any initial interval in which the liquidity constraint binds and consumption equals the wage is strictly dominated. The original path is a discounted average of wage consumption during that initial interval and the continuation value of the same saving-and-investment plan. Since the no-investment case is handled separately, an investing optimum must deliver a continuation value at least as high as wage consumption forever, which is what makes investing worthwhile in the first place. Starting the same continuation earlier therefore weakly improves value. Thus any investing optimum can be represented with no wage-bound initial segment, so the Phase-1 consumption path is the exponential $c_0 e^{-mt}$ with no minimum operator.[A.38]

Step 3: investment versus no investment. If the farmer never invests, borrowing is unused and the only feasible asset is liquid saving at rate $\underline{r}$. Starting from zero liquid assets, with a constant wage and $\underline{r} < \rho$, any positive saving postpones consumption into a technology whose return is below the discount rate. Thus the liquidity constraint binds

A.38. Equivalently, this condition can be written as $c_0 \leq w$.

at zero and the no-investment allocation is $c(t,s) = w$ with no capital investment and no loans.

If the farmer invests, the investment date is weakly positive, and two cases arise. When the maximum feasible first formal loan falls short of the project cost, the farmer cannot fund the project at time zero, since they hold no liquid assets then. The investment date is then strictly positive and the pre-investment saving phase is nondegenerate. When the maximum feasible loan covers the project cost, investing at time zero is feasible: the pre-investment interval is empty, the Phase-1 budget condition (A.1) holds with zero pre-investment savings and a first loan equal to the project cost, and the phases from the investment date onward are unchanged.

The argument that follows fixes the investment date and reasons about the subsequent phases, so it covers both cases. Consider any fixed feasible tuple $(T_I, c_0, c_1, c_2, B_0, B_1, L^I)$ satisfying the budget and refinancing conditions in Lemma A.1, which also pin down the low-state consumption level c_L through the settlement and the low-state budget. The path constructed above satisfies the Kuhn–Tucker conditions for the continuous-time consumption problem on each phase; because utility is strictly concave and the budget and liquidity constraints are linear, these conditions are sufficient.[A.39] The remaining choice is therefore the finite-dimensional maximization over that tuple, compared with the no-investment value. Consequently any optimum is either the no-investment allocation or an investment allocation with the stated form. □

Lemma A.1 (Budget conditions and finite-dimensional choice)**.** *On any feasible investment path of the form in Proposition 6.1, the eight objects—three initial consumption levels (one per saving phase), the low-state consumption level, the investment date, two formal-loan principals, and the bridge size—satisfy the budget and refinancing conditions below. Imposing those conditions leaves a finite-dimensional feasible set, over which the optimal investment path maximizes expected utility.*[A.40]

(1) Phase-1 budget. *Pre-investment savings:*

$$a(T_I^-) \;=\; \int_0^{T_I} \left[w - c_0\, e^{-m\,\tau}\right] e^{\underline{r}(T_I-\tau)}\, d\tau, \qquad a(T_I^-) + B_0 \;=\; I. \tag{A.1}$$

A.39. The settlement (19) is linear in the choice variables on each side of the coverage threshold, but kinked at it, so the argument applies region by region: once the tuple is restricted to either the shortfall region or the coverage region, the constraint set is convex and the first-order conditions are sufficient there. The optimum is the better of the two regional optima, which is how the numerical solution is computed.

A.40. Pre-investment savings and gestation savings are not separate unknowns: they are determined by the Phase-1 and Phase-2 consumption levels (together with the investment date) via the integrals below, and we display them explicitly only for readability. Similarly, the contractual repayments are deterministic functions of the formal-loan principals from the bullet contract (11).

(2) Phase-2 budget (gestation). *Savings accumulated during gestation:*

$$a(T_I + 1^-) \;=\; \int_{T_I}^{T_I+1} \big[w - c(\tau, s)\big]\, e^{\underline{r}(T_I+1-\tau)}\, d\tau. \tag{A.2}$$

(3) Bridge-and-refinance condition (high-return state). *One year after investment, the maturing first formal loan is repaid using gestation savings plus the bridge:*

$$R_0 \;=\; a(T_I + 1^-) + L^I, \tag{A.3}$$

where the contractual repayment of the first formal loan is $R_0 \equiv B_0\, e^r$. If $L^I > 0$, the local lender's zero-profit condition (21) determines the bridge fee, and a second formal loan is immediately disbursed to repay the bridge with fee:

$$B_1 \;=\; (1+f)\, L^I \;=\; L^I + \frac{c_v}{p}. \tag{A.4}$$

If $L^I = 0$, no verification cost is incurred, the fee is irrelevant, and $B_1 = 0$.

The second formal loan is repaid two years after investment out of income saved between the one-year and two-year marks. The farmer owes $R_1 \equiv B_1\, e^r$. Feasibility requires the two to coincide:

$$R_1 \;=\; \int_{T_I+1}^{T_I+2} \big[w + i - c(\tau, H)\big]\, e^{\underline{r}(T_I+2-\tau)}\, d\tau. \tag{A.5}$$

(4) Low-state budget (failure). *One year after investment, the settlement (19) leaves the farmer with residual liquid assets*

$$A_L \;\equiv\; \max\!\big\{\, \ell_1 + a(T_I + 1^-) - R_0,\ 0\,\big\}, \tag{A.6}$$

where gestation savings are common across states by non-anticipation. If the residual is zero, the farmer consumes the wage from that date onward ($c_L = w$). If it is positive, the low-state consumption level exceeds the wage and is pinned down by the requirement that the residual finance the excess of consumption over the wage until the declining path reaches the wage:

$$A_L \;=\; \int_0^{T_L} \big[c_L\, e^{-m\,\tau} - w\big]\, e^{-\underline{r}\tau}\, d\tau, \qquad T_L \;=\; \frac{1}{m}\, \ln\!\Big(\frac{c_L}{w}\Big), \tag{A.7}$$

where the exhaustion horizon T_L is measured from the one-year mark. The right-hand side of (A.7) is strictly increasing in the low-state consumption level, so the pair (c_L, T_L) is unique. Under self-financing there is no first formal loan, so the residual is the full salvage value ($A_L = \ell_1$).

(5) Finite-dimensional choice. *Among tuples satisfying these conditions, the formal-loan feasibility constraint, and the liquidity constraint, the optimal investment path is the tuple that maximizes expected utility, compared with the no-investment value.*

Proof. Equations (A.1) and (A.2) are obtained by integrating the asset accumulation law forward over the pre-investment and gestation phases, with liquid assets earning the deposit rate. At the investment date, liquid assets are exhausted to minimize the first formal principal, giving $a(T_I^-) + B_0 = I$. At the one-year mark, the contractual first repayment is $R_0 = B_0 e^r$; in the high state it must be covered by gestation savings plus the bridge loan, which gives (A.3).

If the bridge loan is used, the local lender's zero-profit condition gives $f = c_v/(pL^I)$, so the second formal principal needed to repay the bridge loan with fee is $B_1 = (1+f)L^I = L^I + c_v/p$, which is (A.4). When gestation savings cover the repayment on their own, the farmer skips the bridge loan, pays no verification cost, and needs no second formal disbursement, so $B_1 = 0$. Integrating the high-state asset law over the second repayment phase yields (A.5).

In the low state, the settlement (19) applied at the one-year mark gives the residual (A.6). If the residual is zero the liquidity constraint binds and consumption equals the wage, since saving out of wage income is dominated when the deposit rate falls below the discount rate. If the residual is positive, the farmer holds it as liquid assets and faces a cake-eating problem with wage income: the Euler equation gives consumption declining at the decay rate while liquid assets are positive, and the liquidity constraint fixes consumption at the wage once they are exhausted. Integrating the low-state asset law from the one-year mark to the exhaustion date, with liquid assets earning the deposit rate, yields the budget condition (A.7).

The final item is the remaining finite-dimensional maximization, once the within-phase consumption paths and cash-flow conditions have been imposed. □

Proof of Lemma 8.1 (Asset run-down). *Step 1: default is optimal.* At the moment the low state is realized, one year after investment, the borrower holds gestation savings ($a_1^{LT} > 0$) and chooses a consumption plan for the final year together with a settlement decision at maturity. Because the loan is a bullet contract and liquid assets are seized in default, only two outcomes are available at maturity. Either the borrower delivers the full repayment due—equivalently, carries to maturity at least the shortfall between that repayment and the depreciated collateral—and retains the installed capital, worth its two-year salvage value in the low state. Or the borrower defaults, surrendering the capital along with any liquid assets held, which are absorbed by the shortfall.

The first outcome is strictly dominated. Relative to defaulting and consuming the savings, repaying hands over the full amount owed and returns capital worth only the two-year salvage value, so it leaves the borrower with strictly fewer lifetime resources—short by the difference between the two, which is positive by the premise of the lemma. It also delays those resources by up to a year, which the borrower dislikes because the discount rate exceeds the deposit rate ($\rho > \underline{r}$). Default is therefore optimal, whether or not the full repayment could have been financed out of savings and a further year of wage income. This is the low-state counterpart of the high-state comparison in Section 8.1, which runs the other way because a successful project's capital is worth more than the repayment due.

Step 2: the run-down path. Given default, every unit of liquid assets carried to maturity is absorbed by the shortfall and seized, so the shadow value of terminal liquid assets is zero. The borrower's continuation problem on the interval between realization and maturity is then a standard cake-eating problem with wage income, return on savings at the deposit rate, and a terminal condition that liquid assets are worthless at maturity. The optimal path exhausts them no later than maturity, and the Euler equation at the deposit rate applies while they remain positive. The run-down path is therefore

$$c(\tau, L) \;=\; \max\bigl\{c_d\, e^{-m(\tau - T_I - 1)},\, w\bigr\}, \qquad \tau \in [T_I + 1,\, T_I + 2),$$

the mirror image of the minimum operators in Proposition 6.1: there the liquidity constraint caps consumption at income while debt is outstanding; here the run-down keeps consumption above income while seizable assets remain.

In the interior case, liquid assets are exhausted exactly at maturity and the initial consumption level c_d solves

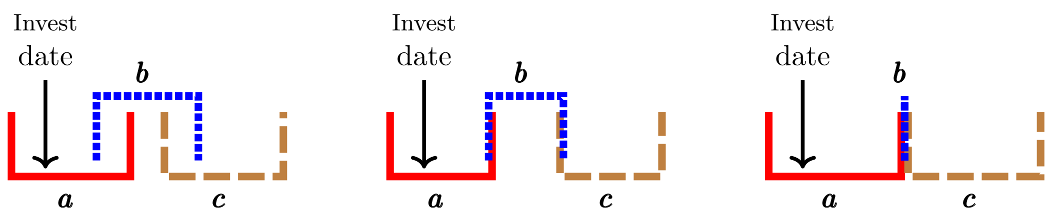
$$\int_{T_I+1}^{T_I+2} \left[c_d\, e^{-m(\tau - T_I - 1)} - w\right] e^{\underline{r}(T_I + 2 - \tau)}\, d\tau \;=\; a_1^{LT}\, e^{\underline{r}},$$

where the savings a_1^{LT} are accumulated during gestation at the deposit rate, as under the high-return path. This case applies provided the implied path stays above the wage through maturity ($c_d\, e^{-m} \geq w$), which holds whenever gestation savings are large enough, as in our calibration.

When gestation savings are smaller, liquid assets run out at the earlier date where the declining path reaches the wage, and consumption equals the wage from that date onward. The exhaustion date and the initial consumption level are then jointly determined by two conditions: the budget integral taken up to that date, and the smooth-pasting condition that consumption equals the wage there. In either case liquid assets are zero at maturity, so the lender's recovery is the depreciated collateral ℓ_2 alone, and consumption from maturity onward equals the wage. $\square$

Appendix B. Additional Data Definition and Construction (online)

Subsection B.1. **Defining investment-linked loan hooks and bridges.** Building on the discussions in Section 3.2 of the main text, here we define loan sets $L^{A}_{j,k}(\tau)$, $L^{B}_{j,k}(a)$, and $L^{C}_{j,k}(a,b)$ and illustrate types of investment-k-linked bridge loans. For added precision, in this section, we redefine L^{A} from Eq. (1) and $\mathcal{B}_{j,k}(\tau)$ from Eq. (2) with additional notations for household j, investment k, and investment-loan windows τ.



(a) Loans a and b as well as loans b and c are "loosely-hooked" to each other—bridge loan b originates before a is due and b is due after c originates.

(b) The loans are "tightly–hooked"—bridge loan b originates when a is due and b is repaid when c originates.

(c) The "bridge" is lengthless—the bridge loan b originates and is repaid in the same unit of time that a is repaid and c originates.

Fig. B.1. We illustrate in three panels the origination and repayment timelines for three types of investment-linked bridge loans allowed by Eq. (B.5). Investment-linked loan a is shown in solid-red, bridge-loan b is shown in dotted-blue, and third loan c is shown in dashed-brown. The left and right vertical bounding edges for each loan illustrates origination and due dates (months) for each loan, and the horizontal span for each loan illustrates loan duration. A black arrow points to the date when the investment is made, which is within τ-window of loan a as defined in Equation (1).

Let $m^{\mathrm{I},s}_{j,k}$ and $m^{\mathrm{I},e}_{j,k}$ be the starting and ending month of the kth investment made by household j; superscript I denotes investments. Let $m^{\mathrm{L},s}_{j,a}$ and $m^{\mathrm{L},e}_{j,a}$ be the month in which loan a made by household j was first initiated and the month in which it is fully repaid, respectively; superscript L denotes loans. Let L_j be the total number of loans taken out by household j during the span of survey been considered, each investment k by household j has a set of "investment-linked" loans $L^{A}_{j,k}(\tau)$:

$$L^{A}_{j,k}(\tau) = \Big\{ a \in \{1,\ldots,L_j\} \;\Big|\; m^{\mathrm{I},s}_{j,k} - \tau \leq m^{\mathrm{L},s}_{j,a} \leq m^{\mathrm{I},s}_{j,k} \text{ and } m^{\mathrm{I},e}_{j,k} < m^{\mathrm{L},e}_{j,a} \Big\}. \tag{B.1}$$

Loan set $L^{B}_{j,k}(a)$ loans that are "hooked" to investment k via loan a from loan $L^{A}_{j,k}(\tau)$. Specifically, loan $b \in L^{B}_{j,k}(a)$ is taken out by household j after loan a has *originated* and before or in the month in which loan a is *due*, and loan b is repaid after or in the month in which loan a is *due*:

$$\text{(B.2)} \quad L^B_{j,k}(a) = \left\{ b \in \{1,\dots,L_j\} \setminus L^A_{j,k}(\tau) \;\middle|\; \begin{array}{c} m^{\mathrm{L},s}_{j,a} < m^{\mathrm{L},s}_{j,b} \le m^{\mathrm{L},e}_{j,a} \\ \text{and } m^{\mathrm{L},e}_{j,a} \le m^{\mathrm{L},e}_{j,b} \end{array} \right\} \text{ for } a \in L^A_{j,k}(\tau) \;.$$

For household j, the set of investment-k-linked hooked loans are:

$$\text{(B.3)} \quad \mathrm{HOOK}_{j,k}(\tau) = \left\{ (a,b) \mid a \in L^A_{j,k}(\tau) \text{ and } b \in L^B_{j,k}(a) \right\} \;.$$

We define loan set $L^C_{j,k}(a,b)$ as containing loans that are "bridge-linked" to investment k via sets $L^B_{j,k}(a)$ and $L^A_{j,k}(\tau)$ loans. Specifically, the origination date of loan $c \in L^C_{j,k}(a,b)$ satisfies three conditions: Loan c originates after or in the same month that loan a is *due*, after or in the same month that loan b *originates*, and before or in the same month that loan b is *due*. Additionally, the due month for loan c must come after the *due* date of loan b:

$$\text{(B.4)} \quad \begin{gathered} L^C_{j,k}(a,b) = \left\{ c \in \{1,\dots,L_j\} \setminus \left(L^A_{j,k}(\tau) \cup L^B_{j,k}(a)\right) \;\middle|\; \begin{array}{c} m^{\mathrm{L},e}_{j,a} \le m^{\mathrm{L},s}_{j,c} \;, \\ m^{\mathrm{L},s}_{j,b} \le m^{\mathrm{L},s}_{j,c} \le m^{\mathrm{L},e}_{j,b} \;, \\ \text{and } m^{\mathrm{L},e}_{j,b} < m^{\mathrm{L},e}_{j,c} \end{array} \right\} \\ \text{for } b \in L^B_{j,k}(a) \text{ and } a \in L^A_{j,k}(\tau) \;. \end{gathered}$$

For household j, the set of investment-k-linked bridge loans are:

$$\text{(B.5)} \quad \mathcal{B}_{j,k}(\tau) = \left\{ (a,b,c) \mid a \in L^A_{j,k}(\tau), b \in L^B_{j,k}(a) \text{ and } c \in L^C_{j,k}(a,b) \right\} \;.$$

Eq. (B.5) allows for three types of "bridges" as visualized in Figure B.1. In Panel (a), the loans are "loosely-hooked"—the bridging loan is taken out before the due date of the first loan and repaid after the origination date of the third loan. Conforming to Eqs. (B.1), (B.2) and (B.4), the investment, loan origination, and loan due dates are such that: $m^{\mathrm{L},s}_{j,a} < m^{\mathrm{I},s}_{j,k} < m^{\mathrm{L},s}_{j,b} < m^{\mathrm{L},e}_{j,a} < m^{\mathrm{L},s}_{j,c} < m^{\mathrm{L},e}_{j,b} < m^{\mathrm{L},e}_{j,c}$. In Panel (b), the loans are "tightly-hooks"—the bridging loan is taken out in the same month the first loan is due and repaid in the same month that the third loan originates, with $m^{\mathrm{L},s}_{j,a} < m^{\mathrm{I},s}_{j,k} < m^{\mathrm{L},s}_{j,b} = m^{\mathrm{L},e}_{j,a} < m^{\mathrm{L},s}_{j,c} = m^{\mathrm{L},e}_{j,b} < m^{\mathrm{L},e}_{j,c}$. In Panel (c), the "bridge" is length-less—the bridge loan originates and is repaid in the same month, with $m^{\mathrm{L},s}_{j,a} < m^{\mathrm{I},s}_{j,k} < m^{\mathrm{L},s}_{j,b} = m^{\mathrm{L},e}_{j,a} = m^{\mathrm{L},s}_{j,c} = m^{\mathrm{L},e}_{j,b} < m^{\mathrm{L},e}_{j,c}$.

Presumably, to function as parts of a loan-bridge, loan b is taken out at a time prior to when loan a is due, and loan c is taken out before loan b is repaid. But temporal unit of observation in surveys, which is month in our empirical data, is unlikely allow allow for sufficiently fine temporal granularity to distinguish the orders of these events.

Subsection B.2. **Inter-loan gaps and loan hooks and bridges definition.**

B.2.1. *Loan hooks.* we identify all within-individual loans that have overlaps, and create a file where the unit of observation is each binary combination of overlapping loans for each household. loans that overlap are "hooked", with a loan that is in the upper hook position, and the paired loan in the bottom hook position.

for each within household paired loan we compute the three gaps:

- 'gl': top left - bottom left - 'gm': bottom left - top right - 'gr': top right - bottom right

where "top left" refers to the start date of the first loan, and "bottom right" refers to the end date of the second loan. consideration all possible combinations of loan pairings, two loans are hooked only when all three gaps are positive or non-zero:

- $gl > 0$: the bottom loan is taken out after the top loan. - $gm \geq 0$: the top loan is not due yet or just due when the bottom loan is taken out. - $gr > 0$: the bottom loan is due after the top loan is due.

during this process, we also identify loan pairs that have identical timing, these are loan pairs where $gl = gr = 0$. for these loans, $gm + 1 > 0$ is the length (including start and end) of both loans. if $gm = 0$, we have two paired loans that both start and end in the same month. furthermore, we check on whether the hooked loans are provided by the same lender. we document the same of loan hooks that are:

- top and bottom hook from the same lender. - top and bottom hook have duplicative start and end times: $gl = gr = 0$ - top and bottom hook both start and end in one month: $gm = gl = gr = 0$

B.2.2. *Loan bridges.* A loan bridge consists of three components, left-bank loan (loan A), bridge loan (loan B), and right-bank loan (loan C).

We compute three sets of three gaps.

1. Gaps between left-bank and bridge loans: - 'G12L': start of B - start of A - 'G12M': end of A - start of B - 'G12R': end of B - end of A 2. Gaps between left-bank and bridge loans: - 'G23L': start of C - start of B - 'G23M': end of B - start of C - 'G23R': end of C - end of B 3. Within-loan gap, duration of each lona: - 'GW1': loan A gap - 'GW2': loan B gap - 'GW3': loan C gap

In addition, we compute river, abutment and approach widths. Jointly there are 12 bridge related widths statistics for each loan ridge.

1. River width ('GRV') = 'G12R' - 'G23M' = 'G23L' - 'G12M' 2. Abutment width ('GAB') = 'G12M' + 'G23M' - Left-abutment width = 'G12M' - Right-abutment width = 'G23M' 3. Approach width ('GAP') = 'G12L' + 'G23R' - Left-approach width = 'G12L' - Right-approach width = 'G23R'

Having computed these statistics, two most basic requirements are:

1. Must be positive: $GRV > 0$, which means brige A must end in a month prior to the start of bridge C. 2. Middle loan must not be longer than loans A and B: $\min(GW1, GW3) > GW2$, note that $GW2 > GRV$. 3. we define typical bridge as satisfying additionally these conditions: $\min(GW1, GW3) \geq 11 > GW2$

Appendix C. Additional Empirical Results (online)

Subsection C.1. Additional details on loans.

C.1.1. *Default.* In this section, we document loan repayment and default. For each loan, the monthly survey reports the principal and interest repaid in each month after origination. We compute cumulative principal and interest repaid by the loan's due date and divide by the principal owed to obtain a repayment ratio. We use principal owed alone as the denominator to improve comparability across loans, whose interest is quoted at monthly, weekly, and annual frequencies over differing durations.

A ratio below one means that part of the principal remains unpaid at the due date. A ratio above one means that repayments cover the principal and some or all of the interest. Because the panel ends at survey month 160, some loans have yet to mature when it closes. We therefore keep only loans whose expected due month falls at or before month 160.

We find that the overall mean repayment ratio is 1.063. Severe under-repayment is uncommon: 1.3% of loans have a repayment ratio of zero, and 2.5% repay less than half the principal. Defining default as a repayment ratio below one, 5.1% of loans default. Under a more forgiving benchmark that counts a loan as in default only when the ratio falls below 0.95, the rate is 4.6%.

Under the ratio-below-one definition, default rates are broadly similar across lender types, with Village Fund a clear exception at the low end. For the formal lenders, BAAC and Village Fund, the default rate is 5.3% and 1.1%, respectively. For the quasi-formal lenders, Agri Coop and PCG, the rate is 3.9% and 5.6%. For the informal lenders, the rate is 3.8% for MoneyLender, 3.6% for Neighbor, 4.1% for Relatives, and 6.4% for Others. Figure C.1 presents the distribution of the repayment ratio across the eight lender types.

Given these empirical facts, in our model we explicitly incorporate risk into the investment decision. We calibrate the probability of the low-return state, in which the farmer defaults and repays less than the full amount owed, to 5%.

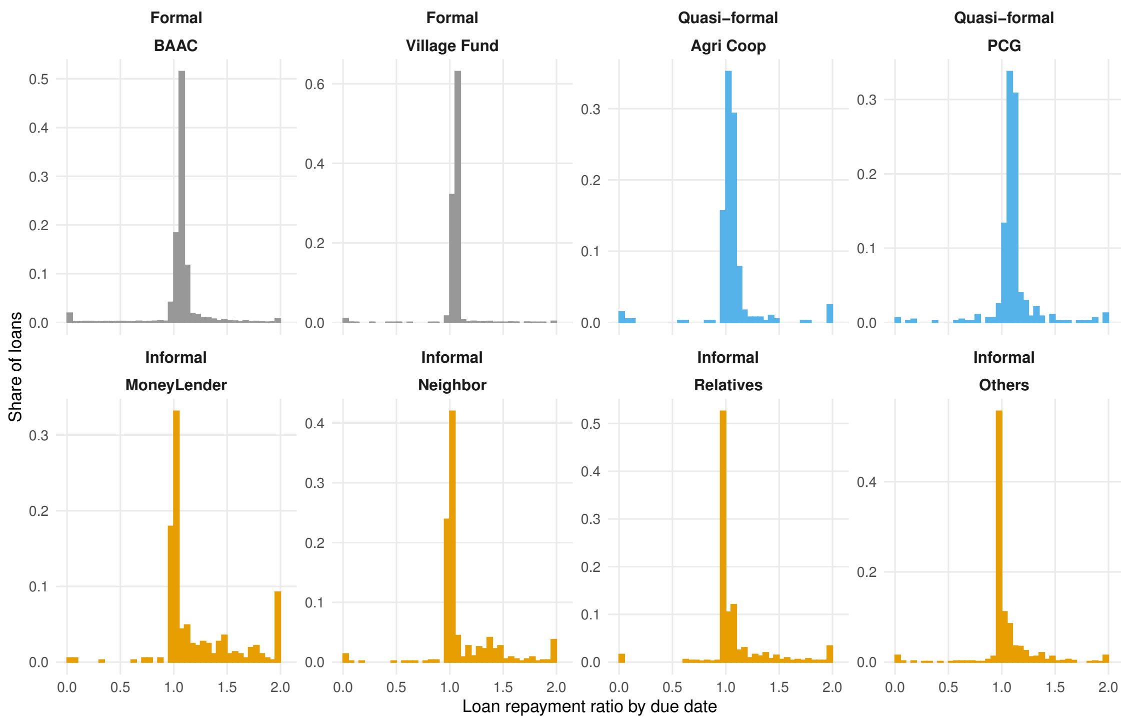


Fig. C.1. Repayment ratio distribution by eight lender types

The figure shows the share of loans by repayment-ratio bin for eight lender types nested within Formal, Quasi-formal, and Informal categories. For each loan, we compute cumulative principal and interest repaid by the loan's due date and divide by the principal owed to obtain a repayment ratio. A ratio below one means that part of the principal remains unpaid at the due date. A ratio above one means that repayments cover the principal and some or all of the interest. We consider only loans whose expected due month is at most 160. See Sec C.1.1 for discussions.

C.1.2. *Bullet repayment.* In this section, we document the prevalence of bullet repayment. For each loan, the monthly survey reports principal repaid after origination in each month. We take the final observed panel month for each loan and divide principal repaid in that month by total loan size to obtain a last-month-of-loan principal repayment ratio. If the last-month repayment ratio is one, then the entire loan principal obligation is paid in that last month, which means that the loan had a bullet repayment structure. We refer to a last-month repayment ratio that is equal to or greater than 1 as a full bullet loan. A ratio below one means that some principal was repaid in earlier months.

As in our discussion in Section C.1.1 on default, we restrict attention to loans that have reached their expected due month by the end of the panel, and we also focus on principal repayment because of the complexity of interest repayment accounting given differential compounding frequencies. Additionally, as we document in the default discussion, around 5% of loans can be classified as in default based on missing principal repayment by the contractual due month. A loan in default would not be repaying 100 percent of its principal in the last month, even if it had a bullet repayment structure. So we further restrict attention to loans that are not in default, using the definition that cumulative principal repaid by the last observed month is at least 95 percent of loan size.

Conditional on this non-default sample, the overall mean across all loans for last-month principal repayment share is 95.2%. We find that 92.5% of loans are full bullet loans. Relaxing the threshold, across all loans, we have that 92.7% of loans have last-month repayment ratio of at least 0.90, 93.0% at least 0.80, and 95.3% at least 0.50.

Across loan types, bullet repayment remains especially common for formal lenders. 93.3% and 99.5% of BAAC and Village Fund loans are full bullet loans, respectively. Given that Village Fund loans also have a 1.1% default rate (see Section C.1.1), this means that Village Fund loans are nearly universally fully repaid on the due month. For the quasi-formal lenders, the full bullet ratio is lower but remains predominant, indicating more repayment flexibility. For Agricultural Coop and PCG loans, the full bullet shares are 95.7% and 73.6%, respectively. For informal lenders, the full bullet share is similar to the level of BAAC loans across informal lender types: the full bullet share is 93.9% for MoneyLender, 95.5% for Neighbor, 94.2% for Relatives, and 93.3% for Others. In Figure C.2, we present the distribution of the last-month principal share across eight lender types in this non-default sample.

Given these empirical facts, in our model we explicitly incorporate formal loans as bullet-payment contracts.

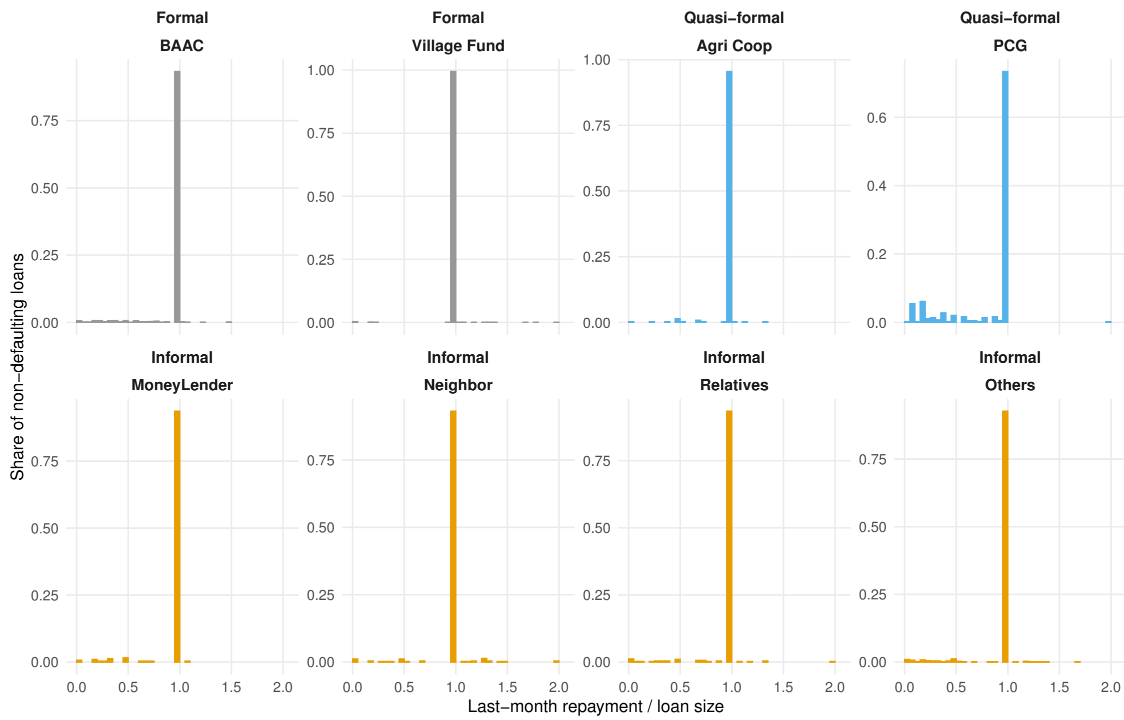


Fig. C.2. Bullet repayment: last-month principal share by eight lender types

The unit of observation is the loan. The last-month principal ratio equals principal repaid in the last month of the loan panel divided by loan principal. A ratio of one is the full bullet repayment. We report the share of loans by last-month principal ratio bin for eight lender types nested within formal, quasi-formal, and informal categories. We restrict to the non-default sample (cumulative repaid ≥ 0.95) and to loans not due yet by survey-month 160. See Table C.1 for full bullet repayment loan shares. See Section C.1.2 for discussions.

Table C.1. Last-month principal share key statistics by lender type (non-default sample)

	Formal		Quasi-formal		Informal			
Statistic	BAAC	Village Fund	Agri Coop	PCG	Money-lender	Neighbor	Relatives	Others
Share ratio $\geq$ 1.00	93.3%	99.5%	95.7%	73.6%	93.9%	95.5%	94.2%	93.3%
Share ratio $\geq$ 0.95	93.5%	99.6%	96.2%	73.6%	93.9%	96.2%	94.4%	93.7%
Share ratio $\geq$ 0.90	93.5%	99.6%	96.5%	75.4%	93.9%	96.2%	94.4%	93.7%
Share ratio $\geq$ 0.80	94.0%	99.6%	96.5%	77.0%	93.9%	96.2%	94.7%	94.0%
Share ratio $\geq$ 0.50	95.9%	99.6%	99.2%	81.5%	96.5%	97.7%	97.1%	95.5%

Note: The unit of observation is the loan. The last-month principal ratio equals principal repaid in the last month of the loan panel divided by loan principal. A ratio of one is the full bullet repayment. Columns are eight lender types, grouped as Formal (BAAC, Village Fund), Quasi-formal (Agri Coop, PCG), and Informal (Moneylender, Neighbor, Relatives, Others). Rows are shares of loans with last-month repayment ratio of at least 1.00, 0.95, 0.90, 0.80, and 0.50. We restrict to the non-default sample (cumulative repaid ≥ 0.95) and to loans not due yet by survey-month 160. See Figure C.2 for full last-month principal repayment ratio distributions. See Section C.1.2 for discussions.

C.1.3. *Village with more quasi-formal loans.* We show in Table 1 that the 90th percentile of the quasi-formal loan-duration distribution exceeds 2 years and the 95th percentile reaches 60 months. This indicates that the presence of quasi-formal loans may affect the usefulness of the investment-loan-bridging mechanism. To address this question, in this section we compare credit markets (villages) with more or less quasi-formal loan share, and contrast their loan terms and investment-loan relationships.

We compute village-level loan shares across formal, quasi-formal, and informal lender types. For each of the 16 villages, using all survey months, we count the number of formal, quasi-formal, and informal loans. Village-specific loan shares are the count in each category divided by the village total loan count. Formal loan shares are relatively stable across villages and generally between 40 and 50 percent (with one village having a 73 percent share), whereas quasi-formal shares vary between 11% and 48% and informal shares vary between 7% and 49%. Across villages, places with a higher quasi-formal share tend to have a lower informal share, with a village-level correlation of -0.655. We show cross-village correlations in quasi-formal, formal, and informal loan shares in Figure C.3.

We assign the eight villages with higher quasi-formal shares to the relatively higher quasi-formal-loan-share village group. Among them, six villages also rank in the bottom half of the informal loan share distribution. Additionally, six of the eight more-quasi-formal villages are in the wealthier Central provinces closer to Bangkok, and six of the

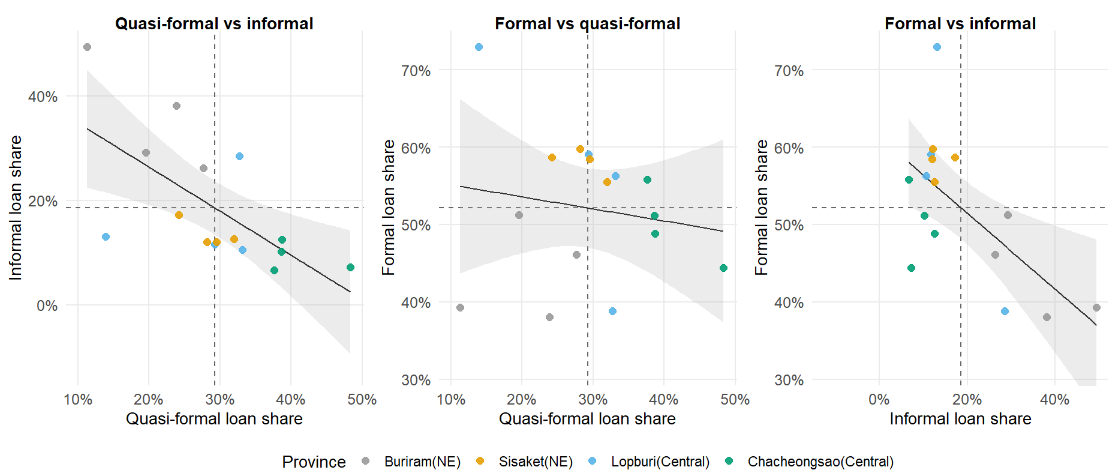


Fig. C.3. Village-level loan-type share scatter plots.

Each point is one of the 16 villages. Left: quasi-formal share (horizontal) vs informal share (vertical). Middle: quasi-formal vs formal. Right: informal vs formal. Solid line is an OLS fit with shaded 95% CI; dashed lines mark the sample mean of each axis. Colours distinguish the four provinces (Buriram, Sisaket, Lopburi, Chacheongsao). The quasi-formal–informal correlation is -0.655. See discussion in Section C.1.3.

eight less-quasi-formal villages are in the poorer Northeast provinces that border Cambodia. Unsurprisingly, households in more-quasi-formal villages are on average at the 55th percentile of the within-sample net wealth distribution (computed at survey-month 24 as in Section C.2.3); in contrast, households in less-quasi-formal villages are on average at the 45th percentile.

Monthly interest rates are lower in more-quasi-formal villages for quasi-formal loans (0.76% vs 0.95%) and especially for informal loans (0.89% vs 3.03%). Formal rates, which are largely centrally determined, are statistically indifferent between more or less quasi-formal villages. Additionally, across loan types, villages with more quasi-formal loans also have loans that are about 1 month longer in duration and have higher average loan sizes. In terms of loan duration distribution, in villages with more quasi-formal loans, the median loan duration is 12 months, the 90th percentile is 36 months, and the 95th percentile is 60 months. The corresponding quantiles are 12, 25, and 34 months for the other villages. We present the statistics in Panel A of Appendix Table C.2.

We are not able to disentangle whether loan term differences are driven by the demand for credit from higher-wealth households or the local availability of quasi-formal lenders. However, a possible interpretation of the patterns is that quasi-formal lenders create local competition for informal credit, leading to substantially lower informal interest rates in villages with more quasi-formal loans. Additionally, the presence of larger, cheaper, and longer-duration quasi-formal loans crowds out informal loans with worse terms and selects informal loans that are larger, cheaper, and longer-duration.

In terms of investment and investment-loan linkages, we find that the investment sizes are twice as large (110 thousand baht versus 58 thousand baht) in more-quasi-formal villages, although the frequency of investment per household-year is slightly lower (0.08 vs 0.10). Additionally, in more-quasi-formal villages, the fraction of investments financed by any loan is lower (0.66 vs 0.77), financed by bridge loans is lower (0.43 vs 0.52), and financed by local-bridge-linked loans (local includes informal and quasi-formal) is lower (0.36 vs 0.44).[C.41] We present the investment and loan statistics in Panel B and C of Appendix Table C.2.

The investment-loan patterns suggest that in villages with more quasi-formal loans, which are wealthier and have improved loan terms, households are able to make larger investments both through self-financing and through borrowing without relying on multi-loan bridging structures. This is consistent with quasi-formal loans having longer duration and being able to support investments without the need for bridging. However, even in higher quasi-formal loan share villages, bridging and local-bridge-linked loans still support

C.41. As in Section C.2.3, we focus on investments in agriculture and business assets between survey-month 15 and 145 that are larger than 10,000 baht.

TABLE C.2. Group mean comparisons for loan terms and investment shares by quasi-formal village groups

Panel A: Loan terms	Group means		Number of loans		
Lender type	More quasi-formal	Less quasi-formal	More quasi-formal	Less quasi-formal	Mean-diff p-value
Length (months)					
Formal	13.3	12.5	4,045	6,706	0.0045
Quasi-formal	16.7	14.4	2,416	2,880	0.0000
Informal	6.3	5.6	717	1,729	0.0478
Amount (baht)					
Formal	42,459	25,424	4,116	6,750	0.0000
Quasi-formal	35,096	20,017	2,757	2,974	0.0000
Informal	51,684	12,963	1,081	3,250	0.0000
Interest (monthly)					
Formal	0.79%	0.81%	3,897	6,581	0.9215
Quasi-formal	0.76%	0.95%	2,399	2,827	0.0151
Informal	0.89%	3.03%	680	1,490	0.0000
Panel B: Average number of investments					
	Group means		Numer of household-years		
Investments per household-year	0.0824	0.1023	3,727	4,045	0.0040
Panel C: Average investment size, shares of investments					
	Group statistics		Number of investments		
Average investment size (baht)	110,547	57,753	307	414	0.0041
Any-loan-linked fraction of investments	0.658	0.773	307	414	0.0009
Bridge-linked fraction of investments	0.433	0.517	307	414	0.0317
Informal-bridge-linked fraction of investments	0.358	0.440	307	414	0.0338

Note: Panel A reports lender-type loan-term comparisons across village groups with more versus less quasi-formal borrowing, including Welch two-sample t-test p-values. Panel B reports average shares of investments that are any-loan-linked, bridge-linked, and local-bridge-linked across the same village groups, also with Welch two-sample t-test p-values. See discussion in Section C.1.3.

43% of investments. This is not surprising given that the majority of quasi-formal loans are 1 year or less in duration. The quasi-formal loans, depending on their terms, could displace the need for investment-loan-bridging, or could act as the main loan or the bridging loan in the formal–local bridging structure. In our model section, we discuss quasi-formal loans and lenders as having low monitoring costs similar to informal and local lenders and having greater sources of funds for loans, allowing them to compete and crowd out other loan types.

Subsection C.2. **Additional details on investments and investment-loan linkages.**

C.2.1. *Investment to income ratio of agricultural and business investments and loan-bridging types.* In our main analysis, we pooled agricultural and business assets jointly as productive assets. We analyzed investments based on this pooled asset classification, as well as a wider classification that also includes land, in Sections 2.2 and 3. In this section, across components of our productive asset aggregate, we analyze the relative lumpiness of investment to income and variations in investment–loan–bridge credit arrangements. Specifically, we consider separately the three components of our agricultural and business asset composite: livestock assets, agricultural assets excluding livestock (e.g., cultivation-related assets, machinery, etc.), and business assets. We also consider agricultural assets combining livestock and non-livestock agricultural assets. These asset components could have different degrees of investment lumpiness, and that could impact the relevance of the loan-bridging mechanism for financing investments across these sub-classifications of productive assets. We find broadly similar magnitudes of investment lumpiness across these sub-classifications and similar importance of loan-bridging.

Table C.3 reports the ratio of investment size to household earnings over the 12 months preceding the investment month, for the 25th, 50th, and 75th percentiles. We show results for livestock assets, agricultural assets excluding livestock, agricultural assets including livestock, and business assets in each column. Earnings are defined as earnings excluding labor and other non-self-employed sources. Investments are large relative to

Table C.3. Ratio of investment size to previous 12 months earnings, by agri/biz asset subtype

	$\frac{\text{Investment size}}{\text{Previous 12 months earnings}}$			
	Earnings			
Percentiles	Livestock	Agri (excl. livestock)	Agri (incl. livestock)	Business
25	12.2%	10.6%	18.4%	8.2%
50	44.9%	34.7%	61.8%	31.1%
75	243.2%	173.8%	317.8%	213.2%

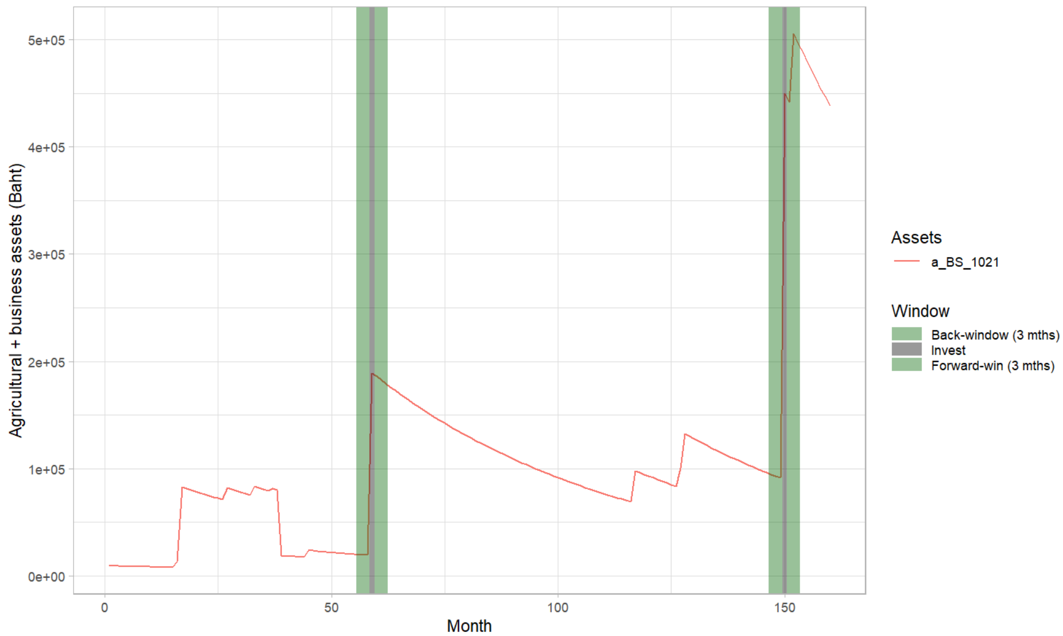
Note: The unit of observation is an investment under each asset-class definition. Columns report Livestock, Agri excl. livestock, Agri incl. livestock, and Business. Cells are percentiles of the ratio of investment size to household earnings over the 12 months preceding the investment month. Earnings are earnings excluding labor and other non-self-employed sources, as in the corresponding earnings columns of Table 3. Sample restrictions match the main investment tables: investments between survey months 15 and 145 with size at least 10,000 baht. This table is a subtype extension of Table 3.

prior earnings under all four definitions, with differing magnitudes. The lumpiness of assets is similar across the three components of productive assets. At the median, the investment-to-earnings ratio is 44.9% for livestock, 34.7% for agricultural assets excluding livestock, and 31.1% for business assets. At the 75th percentile, investment under all three asset definitions is between 1.7 and 2.4 times larger than prior year earnings. The combined agricultural asset definition including livestock is lumpier, with a median investment-to-earnings ratio of 61.8% and a 75th percentile ratio of 317.8%. These results break down the investment-size-to-earnings ratio in column 7 of Tables 3, where we find that combining all agricultural and business assets, the median investment-to-earnings ratio is 66.2% and the 75th percentile ratio is 326.8%.

Changes in investment lumpiness as we aggregate assets provide information on the concurrency, relative lumpiness, and frequency of investments in component assets. As discussed in Section 2.2, we identify investments by tracking the asset holdings of a household and identifying single or consecutive months in which there are jumps in asset holdings (see Appendix Figure C.4 for illustration). Specifically, we compute deviations in assets month by month, and consider jumps as positive differences that exceed 2.33 times the standard deviation of monthly asset fluctuations. In households where livestock investments are relatively much smaller in size than non-livestock agricultural investments, the lumpiness of their combined agricultural asset investments would be similar to their non-livestock agricultural investments. This is not the case in our data, since we find similar lumpiness in livestock and non-livestock agricultural investments. For households where investments in livestock assets and investments in non-livestock agricultural assets occur in the same or neighboring months, the combined asset jump would show up as a lumpier investment (with respect to the same level of prior income) in the combined agricultural asset definition. In our data, the increase in asset lumpiness for the overall agricultural assets provides evidence of concurrency of investments within agricultural assets. Additionally, combining data from across households, even if business investments are relatively similar in lumpiness as agricultural assets, if business investments appear relatively less frequently (see the next paragraph), then the combined asset definition will have similar lumpiness as agricultural assets. This is the case for us as well given the similarity in column 7 of Table 3 and with column 3 of Table C.3.

Table C.4 repeats the investment–loan–bridge classification of Table 4 for our four agricultural and business asset definitions, and we find similar patterns of investment–loan–bridge arrangements across the four definitions. As for Table 4, we use the benchmark six-month backward investment–loan window ($\tau = 6$), consider investments between survey-months 15 and 145, and include investments that are larger than 10,000 baht. Sample sizes are 410 livestock investments, 418 agricultural (excl. livestock), 692 agricultural (incl. livestock), and 99 business investments. The share of investments not time-linked

(a) Illustrative household example 1



(b) Illustrative household example 2

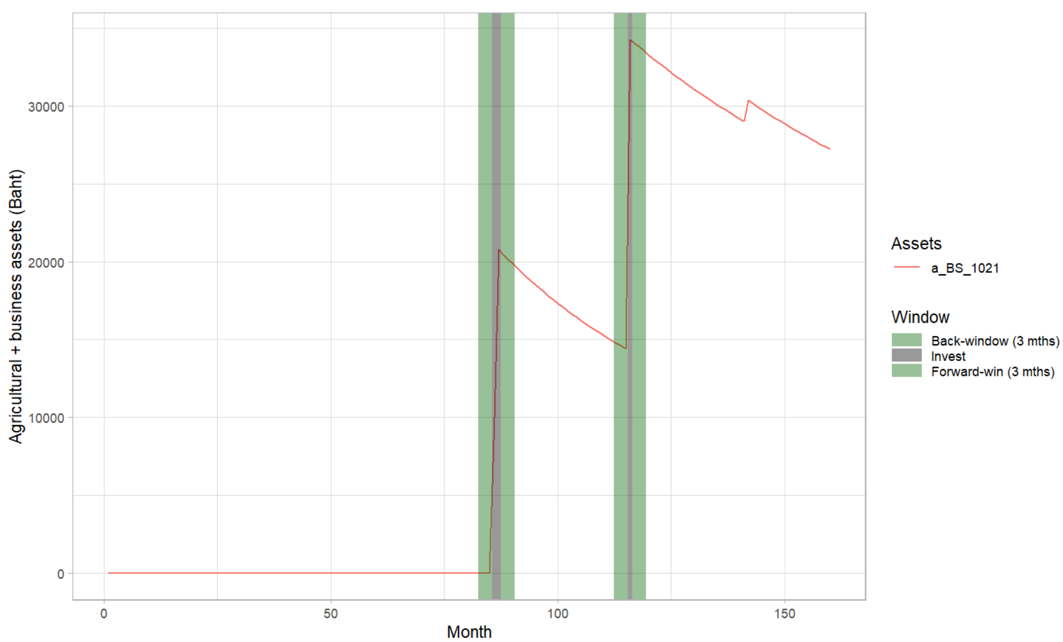


Fig. C.4. Identifying investments (shifts in capital-assets).

TABLE C.4. Number (#) and percent (%) of investments by credit arrangements, by agri/biz asset subtype

	Asset-class investment definitions							
	Livestock assets investments		Agricultural (excl. livestock) assets investments		Agricultural and livestock assets investments		Business assets investments	
	#	%	#	%	#	%	#	%
Investments *not* time-linked to loan bridges								
Invest. *not* time-linked any loans	105	25.6%	112	26.8%	191	27.6%	27	27.3%
Invest. time-linked to *standalone* loans (set A loans only)	52	12.7%	75	17.9%	104	15.0%	21	21.2%
Invest. time-linked to *"hooked"* loans (set A and B loans only)	29	7.1%	31	7.4%	48	6.9%	6	6.1%
Investments time-linked to *only* formal *or only* local loan bridges								
Single lender type only investment-loan bridge	15	3.7%	11	2.6%	19	2.8%	11	11.1%
Multiple formal lenders investment-loan bridge	14	3.4%	19	4.5%	27	3.9%	3	3.0%
Multiple local lender types investment-loan bridge	0	0.0%	1	0.2%	1	0.1%	1	1.0%
Investments time-linked to *joint* formal *and* local investment-loan bridges								
Contains *formal—local—formal* loan bridges	114	27.8%	83	19.9%	169	24.4%	17	17.2%
Do not contain formal—local—formal loan bridges, but includes *local links* in bridges	81	19.8%	86	20.6%	133	19.2%	13	13.1%

Note: The number and share of investments linked to different types of loan structures, considering Livestock, Agri (excl. livestock), Agri (incl. livestock), and Business investment definitions across columns, and using a 6-month investment–loan backward window ($\tau = 6$). Row groups match Table 4: investments not time-linked to loan bridges (no loan; standalone set-A loans; hooked set-A/B loans); bridges with only formal or only local lender types (single-lender; multiple formal; multiple local); and bridges with joint formal and local components (formal–local–formal; other local links). To allow time before and after investment, we keep investments between months 15 and 145 within the 160-month panel and require investment size above 10,000 baht. Column sample sizes are $N = 410$ (Livestock), $N = 418$ (Agri excl. livestock), $N = 692$ (Agri incl. livestock), and $N = 99$ (Business). This table is a subtype extension of Table 4.

to any loan is similar across columns—25.6%, 26.8%, 27.6%, and 27.3% respectively—so that roughly one quarter of investments under each definition are not linked to loans in the window. Bridging is common for all four types: the combined share of investments time-linked to loan bridges is 54.6% for livestock, 47.9% for agri excl. livestock, 50.4% for agri incl. livestock, and 45.5% for business.

Supported by our empirical evidence, in our model, we do not consider sub-types of agricultural and business assets separately, but rather we consider a single productive asset type. However, our model allows for asset heterogeneity in size (relative to income) and risk. To the extent that investments across asset types could be modeled as having different joint distributions of size and risk, our model allows for heterogeneity in asset types.

C.2.2. *Additional results on investment-linked loan hooks and bridges.* Table 4 in the main text presents the share of investments by different investment-loan linkage types for 6 months backward investment-loan window. In Appendix Table C.5, we present results for 3 months backward investment-loan window. Across the columns of Table C.5, we consider different definitions of assets-investments.

In Table C.5, we find that "no-loan" investments increases to 38.5 percent of all investments, which is larger than the 27.9 percent from Table 4. For proportions of types of loans among investment-linked loans, Table C.5 shows that 67 percent of loan-linked investments having bridge-loans and 82 percent of bridge-linked investments having both formal and local components. These statistics are similar to results from Table 4.

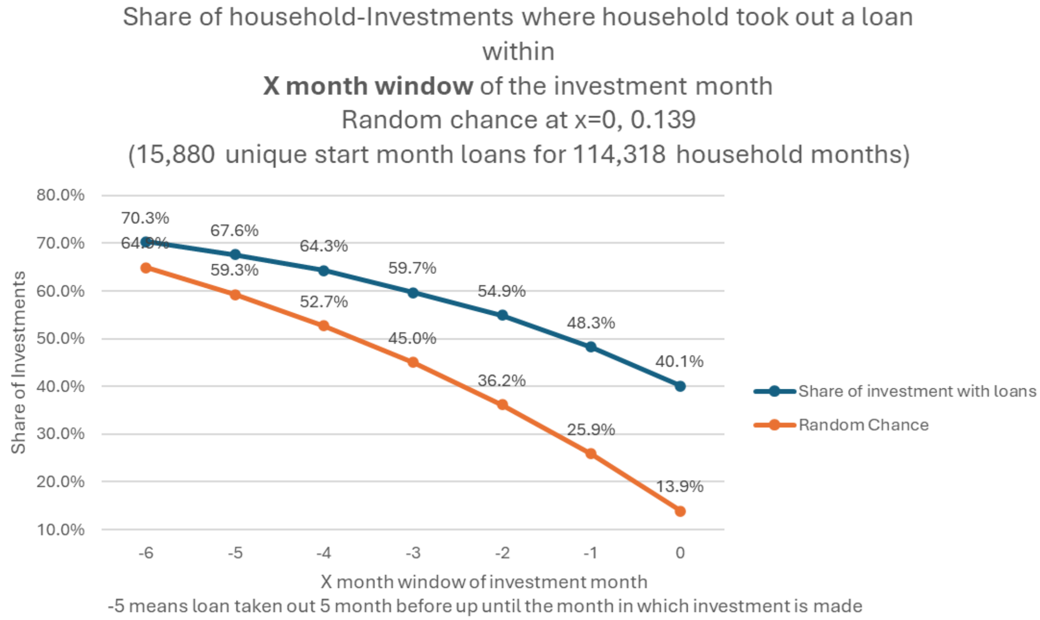
Additionally, Panel (B) of Appendix Figure C.5 shows that when we further contract the backward investment-loan window to $\tau = 0$, bridge-linked investments remains dominant, accounting for 59% of all loan-linked investments.

TABLE C.5. Number (#) and percent (%) of investments by credit arrangements (3 month investment-loan backward window).

	Alternative investment definitions					
	Agricultural and business assets investments		Agricultural, business, and land assets investments		Agricultural, business, land, and household assets investments	
	#	%	#	%	#	%
Investments *not* time-linked to loan bridges						
Invest. *not* time-linked any loans	283	38.5%	333	40.5%	578	40.3%
Invest. time-linked to *standalone* loans (set A loans only)	108	14.7%	133	16.2%	262	18.2%
Invest. time-linked to *"hooked"* loans (set A and B loans only)	42	5.7%	47	5.7%	88	6.1%
Investments time-linked to *only* formal *or* *only* local loan bridges						
Single lender type only investment-loan bridge	28	3.8%	25	3.0%	49	3.4%
Multiple formal lenders investment-loan bridge	25	3.4%	22	2.7%	30	2.1%
Multiple local lender types investment-loan bridge	2	0.0%	1	0.0%	5	0.0%
Investments time-linked to *joint* formal *and* local investment-loan bridges						
Contains *formal—local—formal* loan bridges	136	18.5%	131	15.9%	205	14.3%
Do not contain formal—local—formal loan bridges, but includes *local links* in bridges	112	15.2%	131	15.9%	219	15.3%

Note: The number and share of investments linked to different types of loan structures, considering different investment definitions across columns, and using a 3-month investment-loan backward window ($\tau = 3$). See Table 4 for results based on a 6-month backward window. To allow for time before and after investment, we consider investments made between month 15 and month 145 within the 160-month panel. Additionally, to reduce spurious linkages, we consider only investments that exceed 10,000 baht in drawing investment-to-loan linkages. See discussions in Section 3.2 and Appendix Section C.2.2.

(a) Share of investments with loans



(b) Share of bridged-loans among investments with loans

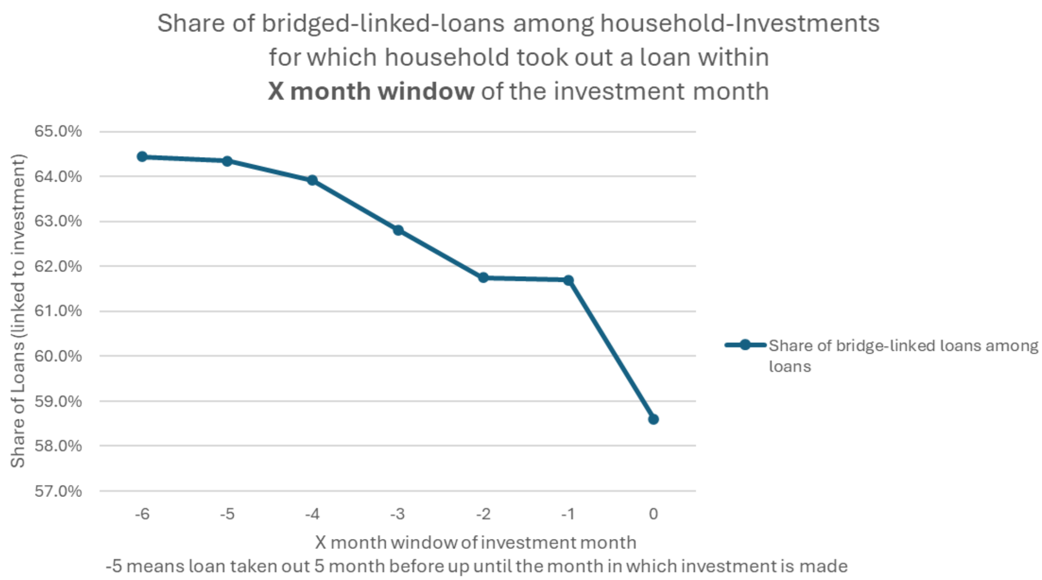


Fig. C.5. Loan and bridge-loan linkages to investments considering investments based on all assets including land and household assets.

C.2.3. *Attributes of investing households.* In this section, we analyze selection into investment. We compare the attributes of households that invest in physical capital versus those that do not invest. Among those investing, we compare households that invest with bridge-linked loans against those that invest without bridge-linked loans. Furthermore, we compare households that invest with local-bridge-linked loans against those that invest with bridge-linked loans without local linkages. We focus on investments in productive assets, that is, jointly considering agricultural (including livestock) and business assets.

We consider three sets of household characteristics. First, we consider households' relative asset and wealth positions, measured as within-sample household percentiles (scaled between 0 and 1) of net wealth and of the investment-asset stock. Given the dynamic nature of these variables, we measure these one year before the start of the Village Fund program in September 2000. Second, we consider households' income sources. Income could come from cultivation, livestock, fish/shrimp, business, labor, and other sources. We measure the share of total revenue accounted for by each of these sources during the year before the Village Fund program. Negative component incomes are set to zero before forming shares so that shares lie in $[0, 1]$. Third, using information from the household roster, we consider household demographics, including the number of individuals in the household, the household head's age, and the household head's years of schooling. For comparability, we also measure these one year before the start of the Village Fund.

For investment outcomes, we use the same criteria as our returns estimation in Section 4.1 and consider investments that are larger than 10,000 baht and that are between months 15 and 145 of the survey. We classify a household as investing if it made any investment or any investments with bridge or local-bridge linkages that meet our criteria. This also means that non-investing households might be investing, just not in the window of our analysis.

Overall, among the 690 households with non-missing balance-sheet information in September 2000, 379 (55%) households made a business or agricultural asset investment that meets our criteria. Among the investing households, 235 (62%) households invested with bridge-linked loans. Among the investors with bridge-linked loans, 206 (88%) invested with local-bridge-linked loans. This shows that investing is common but not universal among households, and that bridging and local-bridge-linked investing supports the majority of investments. These complement our discussions in Section 3.2 and our results in Table 4, which show similar prevalence of bridging and local-bridge-linking when considering investments as units of observation (rather than considering borrowing characteristics of households).

We find that households that invest are wealthier and have more investment assets than those that do not invest. The average net-wealth percentile among investing households is the 56th percentile (in September of 2000), and the 42nd percentile among non-investing households. The presence of limited loan maturity increases the need for self-financing, because the loan size is constrained by the cash-flow available to repay the loan. Households that are wealthier could provide the self-financing that combines with debt to finance investment projects. It is also possible that households with higher entrepreneurial ability have invested successfully and accumulated wealth. Additionally, we find that households that invest already have higher levels of assets, with an average investment-asset percentile (in September of 2000) at the 61st percentile among investing households and the 36th percentile among non-investing households. This indicates asset reinforcement, as households with already more productive assets invest to sustain and increase their productive capital.

Households that invest have a similar share of their household income coming from business income sources (12.3% vs 11.0%) and a substantially lower share coming from labor income sources (24% vs 47%), and the labor-share difference is statistically significant. Households that invest have household heads who are younger (51.4 years vs 54.3 years) and have larger households (5.4 people vs 4.9 people), both differences are small but statistically significant. It is possible that younger household heads have a longer time horizon to earn returns from investments and that larger households have more units of household labor to complement higher investments and assets. The difference in educational attainment between investing and non-investing household heads is not significant, and both are around 4.5 years of schooling.

When we control for household attributes jointly, we continue to find significant positive associations between investing and investment-asset percentiles and household size, a significant negative association with labor income share and household head age, while the wealth percentile remains positive but is no longer statistically significant once assets, income shares, and demographics are controlled jointly. We document group means and the significance of the mean differences in Panel A of Table C.6, and we show the conditional correlational results from regressing investment on the household attributes jointly in the first column of Appendix Table C.7.

In Panel B of Table C.6, we compare among investing households and find that households with investments connected to bridge loans have a lower average net wealth percentile than investing households who do not use bridge loans (54 percentile vs 60 percentile), but both are substantially above the average net wealth percentile of 42 percent among non-investing households. Wealthier households might be able to self-finance a greater portion of their investment, and are able to repay the debt with project earnings

Table C.6. Household characteristics and investments

Panel A: Invest vs not invest					
Attribute (unit)	Invest		Not invest		p-value
	Mean	N	Mean	N	(diff.)
Net wealth percentile (0 to 1)	0.56	379	0.42	311	0.000
Asset percentile (0 to 1)	0.61	379	0.37	311	0.000
Business income fraction of revenue	0.12	376	0.11	280	0.528
Labor income fraction of revenue	0.24	376	0.47	280	0.000
Household head education (years)	4.58	362	4.53	299	0.806
Household head age (years)	51.42	362	54.32	300	0.008
Household size (people)	5.44	362	4.86	300	0.001
Panel B: Invest with bridge vs invest without bridge					
Attribute (unit)	Invest with bridge		Invest without bridge		p-value
	Mean	N	Mean	N	(diff.)
Net wealth percentile (0 to 1)	0.54	234	0.60	145	0.086
Asset percentile (0 to 1)	0.62	235	0.60	144	0.475
Business income fraction of revenue	0.12	234	0.14	142	0.502
Labor income fraction of revenue	0.24	234	0.24	142	0.839
Household head education (years)	4.65	221	4.48	141	0.552
Household head age (years)	49.95	221	53.74	141	0.008
Household size (people)	5.32	221	5.62	141	0.223

Note: We consider agricultural and business asset-based investments that are larger than 10,000 baht and that are between months 15 and 145 of the survey. We classify a household as investing if it made any investment or any investments with bridge or local-bridge linkages that meet our criteria. The unit of observation is the household. The table reports three sets of pre–Village Fund household characteristics: relative balance-sheet positions, income composition, and demographics, measured one year before the Village Fund (September 2000). p-values are from two-sample t-tests. We regress binary investment classifications on household characteristics jointly in Appendix Table C.7. See discussions in Section C.2.3.

Table C.7. Characteristics of households with and without agricultural and business investments, conditional analysis

Attribute (unit)	Invest vs not invest	Invest with bridge vs without	Invest with local-bridge vs formal-only
Constant	0.544 (0.107)	0.916 (0.153)	0.944 (0.136)
Net wealth percentile (0 to 1)	0.115 (0.073)	-0.232 (0.108)	-0.229 (0.096)
Asset percentile (0 to 1)	0.442 (0.079)	0.188 (0.117)	0.130 (0.106)
Business income fraction of revenue	-0.126 (0.069)	-0.099 (0.098)	-0.102 (0.091)
Labor income fraction of revenue	-0.282 (0.062)	-0.027 (0.102)	-0.067 (0.095)
Household head education (years)	-0.008 (0.006)	-0.000 (0.010)	-0.002 (0.009)
Household head age (years)	-0.005 (0.001)	-0.004 (0.002)	0.000 (0.002)
Household size (people)	0.024 (0.008)	-0.008 (0.012)	0.001 (0.011)
N	630	359	220
R-squared	0.204	0.040	0.032

Note: OLS linear probability models of whether a household invests, with standard errors in parentheses. Columns add covariates sequentially: (1) net wealth percentile and asset percentile; (2) business and labor income fractions of revenue; and (3) household head education, household head age, and household size. Net wealth and asset covariates are within-sample percentiles scaled from 0 to 1 and measured one year before the Village Fund (September 2000). Income-fraction covariates are measured over the year before the Village Fund. Demographic covariates come from the household roster at the same pre–Village Fund reference date. The unit of observation is the household, and each column uses the complete-case sample for included regressors. See discussions in Section C.2.3.

over a shorter duration. Loan-bridging investing households are also younger than other investing households (50.0 vs 53.7 years). These significant differences remain conditional on all household characteristics jointly, which we show in column two of Appendix Table C.7. Among other dimensions, investing households that use bridge loans and those who do not are not statistically different.

Finally, conditional on bridging, wealthier households are less likely to use local-component bridges. Given that 88 percent of investing households with bridge-linked loans use local-bridge-linked loans, mean differences on most other attributes are small.

Overall, our finding here is that the observable characteristics between investing and non-investing households differ. The results indicate that existing productive assets and income composition (in particular labor versus other sources), as well as demographics, play an important role in selection into investment, while wealth differences are strong unconditionally and matter for bridging margins. We do not have clear interpretations for the mechanisms for why household demographics differ across household investing groups, but the fact that observable non-wealth characteristics differ is indicative that unobservable characteristics, such as entrepreneurial ability, risk tolerance, and social networks, might also differ across investing and non-investing households. Given these patterns, households who are investing might have a different and higher distribution of returns than the potential returns to investing for those who do not invest. In our model, we explicitly incorporate heterogeneities in risk and return among household firms. Households who have projects that are less risky and that have returns are more likely to invest more quickly, and would be more likely to be captured as investing when examined over any finite survey window. Among the financing options, we find in the model that households with less risky projects are more likely to use joint local-bridged loans.

Subsection C.3. **Additional results on investments and changes in incomes.**

C.3.1. *Return distribution by investment and loan-bridge type.* We examine the distribution of investment returns under different loan-bridge financing regimes. In Section 4.1 and Table 7, we presented regression results in which we regressed the change in income in the 12 months after, compared to the 12 months before, the date of the investment on the size of the investment. Measuring income as the change in self-employed earnings (excluding labor and other income) and investment as the change in agricultural and business assets (from column 4 in the top panel in Table 7), we find a return on investment of 1.6 percent in average monthly income. We use this return as the mean return in our model.

Using these definitions of income and investment, we now analyze the distribution of the earnings (change) to investment ratio, which we define as the change in self-employed income divided by the size of the investment. Following our classifications in Section 3.2 and Table 4, we divide investments into three categories: Investments that are not linked to loans, investments that are linked to loans but not bridged loans, and investments that are linked to bridged loans. We compare and describe the moments of the earnings to investment ratio distributions across these three investment-financing categories. If all earnings changes are due to investment, these ratios would provide the distribution of realized returns on investment across investment episodes. However, in practice, the ratios are contaminated by fluctuations in individual and aggregate economic conditions unrelated to the specific investments. The shapes of these distributions provide descriptive evidence on the potential heterogeneities in investment riskiness by financing regime.

Appendix Table C.8 reports mean, median, standard deviation, and skewness of the earnings to investment ratios by the three investment classifications. In contrast to

Table C.8. Moments of the investment return distribution by loan-bridge type

	Loan-bridge type		
Statistic	(1) No loans	(2) Loans, not bridged	(3) Bridged-loans
Mean	-0.038	0.030	0.017
Median	0.009	0.007	0.009
Std	0.532	0.491	0.269
Skewness	-6.322	-5.022	-1.569

Note: The unit of observation is an investment episode in the Townsend Thai Monthly Survey, restricted to investments between survey months 15 and 145 with size at least 10,000 baht. The outcome is the ratio of the change in self-employed income to the change in productive assets excluding land. Columns are loan-bridge types: (1) no time-linked loan; (2) time-linked standalone or hooked loans without bridging; (3) time-linked bridged loans. Std is the population standard deviation; skewness is the third standardized moment. Unlike the returns regressions, this table does not drop capital-invest outliers. See discussions in Section C.3.1.

the results from Table 7, we do not exclude the top 1 percentile of the investment changes from the estimation sample.

We find that median earnings to investment return ratios are similar across the three categories (0.009, 0.007, and 0.009, respectively). As a reflection of income volatility for village households, we find that up to 40 percent of the investments are associated with reductions in income. Despite fluctuations, given the positive medians, the majority of investments are associated with increases in income, indicating that capital investments tend to increase income.

The earnings to investment ratios are highly dispersed, left-skewed, and differ across the investment financing arrangements. The standard deviation of the ratios is highest for investments without loans (0.53), which is close to the value for investments with non-bridged loans (0.49), and substantially larger than for investments linked to bridged loans (0.27). The skewness of the earnings to investment ratios is strongly negative in all three groups, but the left skew is the most extreme for no-loan investments (-6.32), also large for investments with non-bridged loans (-5.02), and closest to zero for investment with bridged loans (-1.57). Despite the left-skewness, we find that the average earnings to investment ratios are positive and more than 2 times larger than the median for investments with non-bridged and bridged loans (0.030 and 0.017, respectively). This indicates the presence of outlier negative ratios, combined with a mass of relatively high positive ratios, without outlier positive ratios. In contrast, the average earnings to investment ratio is negative for investments without loans (-0.038) and lower than the median; this indicates an overall left-skewness of the return distribution for investments without loans.

The overall left-skewness of the earnings to investment ratios might be due to failed investments reducing pre-existing level of income for the household-firm. The relatively reduced variability and reduced skewness of investments financed by bridged loans indicates that there could be selection into loan-bridging among investments with lower downside risk. In our model, we capture this empirical pattern with a joint risky-investment and verification mechanism that induces selection into loan-bridging for projects with lower risk of default.

C.3.2. *Additional regressions for investments and changes in incomes.* In the main text, we present Table 7 and discuss the relationship between investments and changes in income by comparing changes in average monthly incomes in the 12 months after and before the months of investment.

In contrast to Table 7, which uses investments based on productive assets, Appendix Table C.9 uses investments computed based on changes in household assets, as a placebo test. While all estimates for rates of return are positive, they are significantly smaller in magnitudes than estimates in Table 7 and not significant except in the lower panel for column 4. The positive direction of all estimates indicate that a subset of household asset purchases, plausibly those that improve information acquisition and reduce transportation costs, might be partially productivity enhancing.

Table C.9. Placebo: Changes in 12 months average monthly income before and after investment month and the size of investment, considering household assets.

	Outcome: pre-post investment monthly income gap					
	All income			Self-employed income		
	(1)	(2)	(3)	(4)	(5)	(6)
Household assets investments						
Investment (pre-post asset difference)	0.0038	0.0050	0.0058	0.0001	0.0023	0.0033
	(0.0044)	(0.0048)	(0.0049)	(0.0040)	(0.0044)	(0.0045)
R^2	0.001	0.096	0.104	0.000	0.094	0.103
Observations	1216	1216	1216	1216	1216	1216
All assets (productive assets, land, and household assets) investments						
Investment (pre-post asset difference)	0.0043	0.0035	0.0041	0.0049	0.0032	0.0032
	(0.0027)	(0.0029)	(0.0030)	(0.0021)	(0.0022)	(0.0023)
R^2	0.002	0.088	0.110	0.004	0.098	0.116
Observations	1406	1406	1406	1406	1406	1406
Survey-month FE	No	Yes	Yes	No	Yes	Yes
Village FE	No	No	Yes	No	No	Yes

Note: Standard errors in parentheses. The table reports the coefficient from regressing the difference in average monthly income from the 12 months preceding and following the investment month on the size of investments. We compute investments for each asset definition separately. Investment size is the difference in assets before and after investment. In columns 2 and 5, we control for all survey month fixed effects; in columns 4 and 6, we control for survey month and village fixed effects. In contrast to Table 7, which uses investments based on productive assets, the results here use investments computed based on changes in household assets, which are not productivity enhancing, as a placebo test. See discussions in Section 4.1 and Appendix Section C.3.2.

Subsection C.4. **Million Baht Village Fund.** In this section, we document the relationship between the Million Baht Village Fund program and the number of households in each village.

From the baseline structure census of the monthly survey, we find the number of unique households residing in each village, which ranges from a minimum of 26 to a maximum of 162 households.

Additionally, we consider the number of surveyed households in each village in each year, which ranges from a minimum of 24 to a maximum of 52 households per village and per year.

Table C.10. Village census and surveyed household counts

Villages	Total households	Sampled households	Coverage (%)
1	95	45	47.4
2	53	45	84.9
3	53	43	81.1
4	57	43	75.4
5	66	47	71.2
6	104	53	51.0
7	135	47	34.8
8	112	47	42.0
9	157	48	30.6
10	162	48	29.6
11	82	46	56.1
12	73	47	64.4
13	70	49	70.0
14	97	45	46.4
15	65	47	72.3
16	26	24	92.3

Note: **Total households** is the village census household count (16 villages in provinces 7, 27, 49, 53). **Sampled HH** counts distinct anonymized household IDs in the Townsend monthly survey with non-missing household presence during baseline months 25–48, cross-walked to village. **Coverage** is 100× Sampled HH / Total HH. Near-100% coverage (e.g. province 53, village 10) indicates almost complete village enumeration; low coverage in large villages (e.g. province 49, village 3: 29.6%) means village-year outcome denominators use a subset of households. See discussion in Section 4.3.

We use September of 2021 (month 36 of the survey) as the month in which the Village Fund program was introduced.[C.42] And we compute the total amount in of Village Fund loans extented in each village between September of 2021 and 6 months, 12 months, and 18 months after.

We divide the total amount of Village Fund loans extended by the total number of unique surveyed households in the 6 months, 12 months, and 18 months after the start of the program to obtain an estimate of the average amount of Village Fund loans per household.

We regress the average amount of Village Fund loans per household on the number of households in each village to assess the relationship between village size and Village Fund borrowing intensity. We find that the relationship is negative, with larger villages having smaller average Village Fund loans per household, and the relationship is statistically significant at the 10 percent level for all three time horizons (6 months, 12 months, and 18 months after the start of the program). The scatter plot shows that the pattern is consistent within each of the four surveyed provinces.

At the 12 months window, we find that each additional household in the village reduces the average amount of Village Fund loans per household by 430 baht.

Appendix Table C.11 reports the interaction coefficients for additional post–Village Fund windows and for the alternative asset definition that includes land, corresponding to the main results in Section 4.3.

C.42. Starting in April of 2021, the monthly survey begins to pick up loans labeled as Village Fund loans, in April, May, June, July, and August, there were 5, 9, 4, 13, and 12 loans tagged as Village Fund loans across villages, respectively, account for 6.3 percent of the total number of loans extended across all monthly villages in these 5 months preceding the start of the program. In September of 2021, there were 105 Village Fund loans extended, accounting for 45 percent of loans extended across villages in that month.

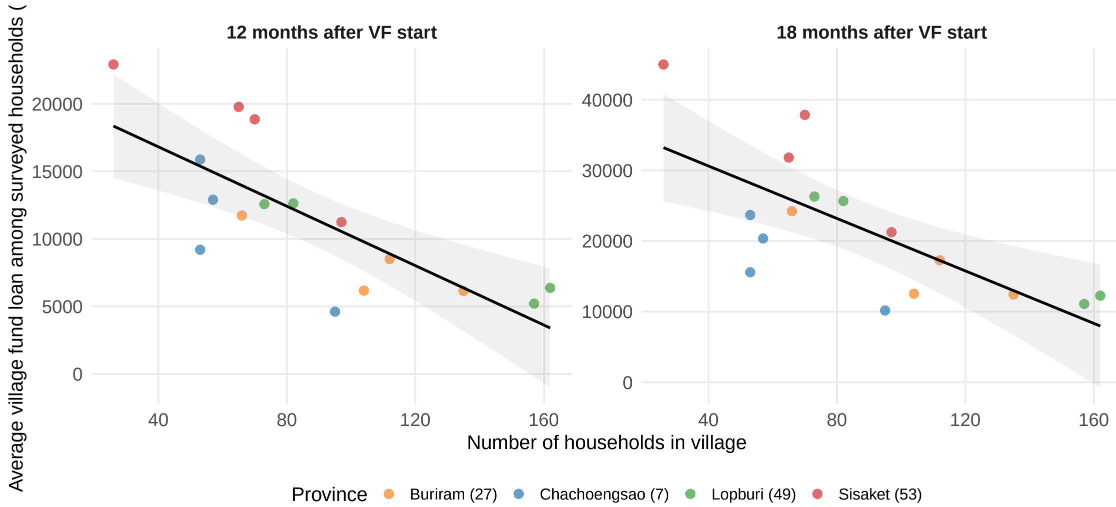


Fig. C.6. Million Baht Village Fund loan amount per surveyed household vs. village population

We compute the total amount of Village Fund loans extended in each village to sampled households in the 12 and 18 months after the start of September 2021. Regressing the average amount of Village Fund loans per surveyed household on the number of households in each village, we find that every additional villager decreases the average amount of Village Fund loans per surveyed household by 110 baht (SE=25). P-values are below 1 percent. The figure presents the scatter plot and regression line for results based on the 12-month (left) and 18-month (right) windows. The scatter plots show that the pattern is consistent within each of the four surveyed provinces. See discussion in Section 4.3.

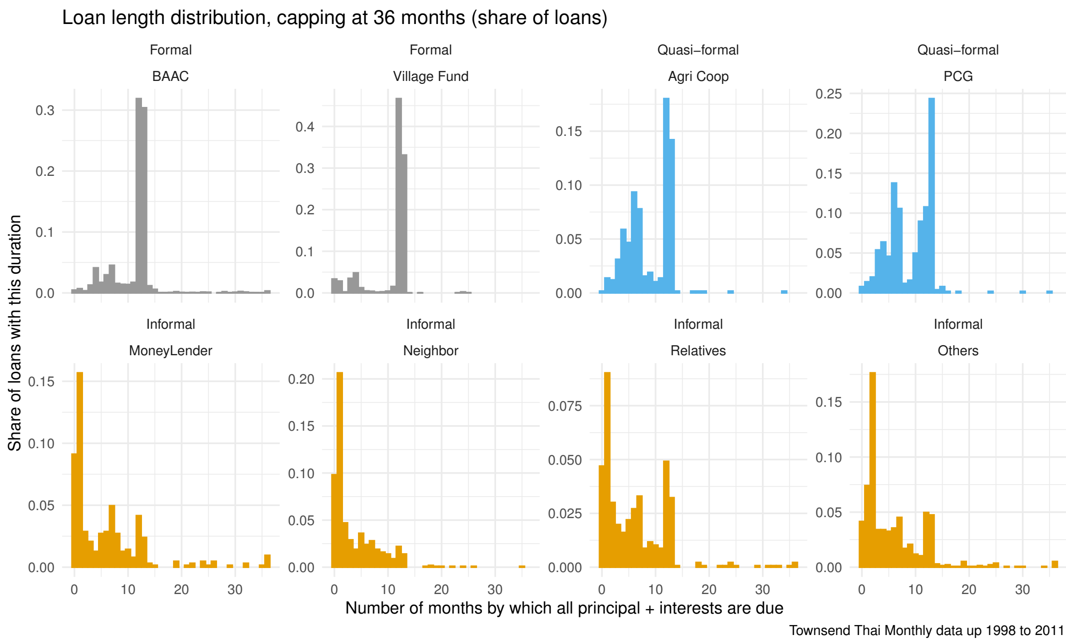
Table C.11. Village Fund and investments

Bridge outcome	Investment definition	Years since Village Fund introduction: 1	3	6	9
Investments	Agricultural and business assets	4.831	2.820	0.797	0.843
		(1.682)	(1.562)	(1.511)	(1.292)
	Agricultural, business, and land assets	5.171	2.839	1.190	1.683
		(1.382)	(1.344)	(1.406)	(1.131)
Investments time-linked to loan bridges	Agricultural and business assets	4.764	2.761	1.796	1.487
		(0.951)	(1.123)	(0.821)	(0.695)
	Agricultural, business, and land assets	4.131	2.593	1.769	1.630
		(1.281)	(0.823)	(0.687)	(0.598)
Investments time-linked to joint formal and local loan bridges	Agricultural and business assets	4.608	2.390	1.675	1.524
		(1.000)	(1.388)	(0.828)	(0.624)
	Agricultural, business, and land assets	3.689	1.967	1.500	1.407
		(1.114)	(1.046)	(0.696)	(0.583)

Note: For outcome y_{jt} (average investment per surveyed household per village–year), we estimate $y_{jt} = \alpha + \beta_1 \,\mathrm{PostVF}_t + \beta_2 \,\mathrm{PostVF}_t \times \frac{1}{N_j^{\mathrm{census}}} + \psi_t + \zeta_j + \varepsilon_{jt}$, where j indexes villages and t indexes years (August to September), PostVF_t equals 1 after the introduction of the Village Fund (September 2001), N_j^{census} is the village census household count, ψ_t denotes year fixed effects, and ζ_j are village fixed effects. We consider different post–Village Fund sample cutoff years since Village Fund introduction, namely 1, 3, 6, and 9 years after the Village Fund. Each cell reports the estimated coefficient $\hat{\beta}_2$, with robust standard errors in parentheses. Columns give the post–Village Fund sample cutoff years since Village Fund introduction. Row groups represent different outcomes: investments, investments time-linked to loan bridges, and investments time-linked to joint formal and local loan bridges. Within each row group, we consider two definitions of investments: agricultural and business assets, and agricultural, business, and land assets. Results for the 1 and 6 year window and agricultural and business assets definition are discussed in Section 4.3 and visualized in Figure 6.

Subsection C.5. **Additional Figures and Tables.**

(a) Shares



(b) Number of Loans

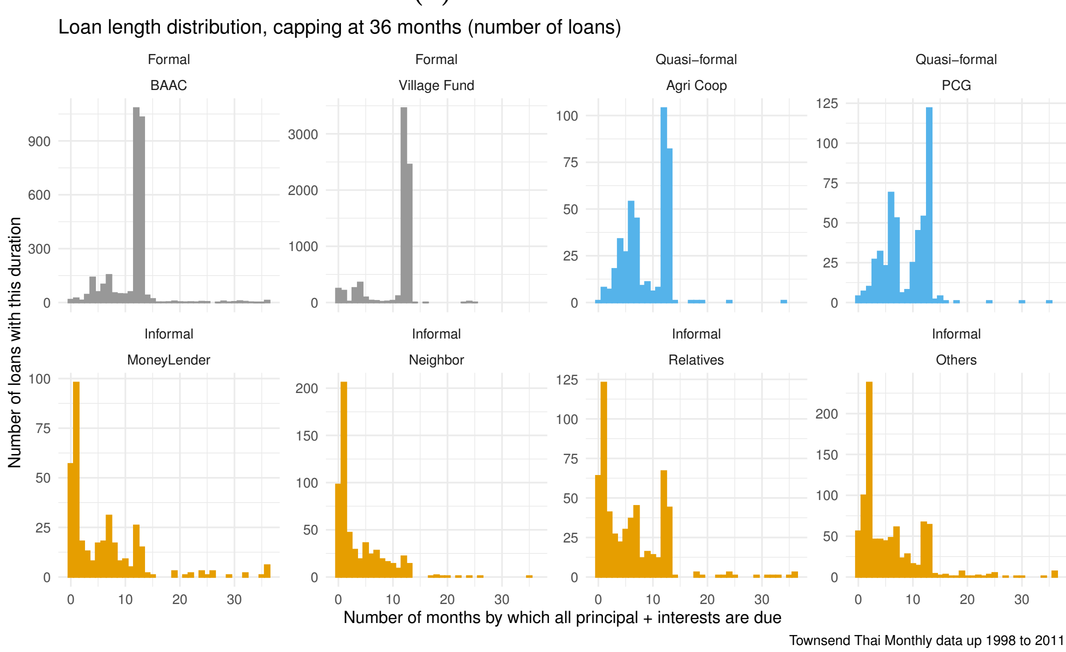


Fig. C.7. Length of loan distribution, across eight key lender types.

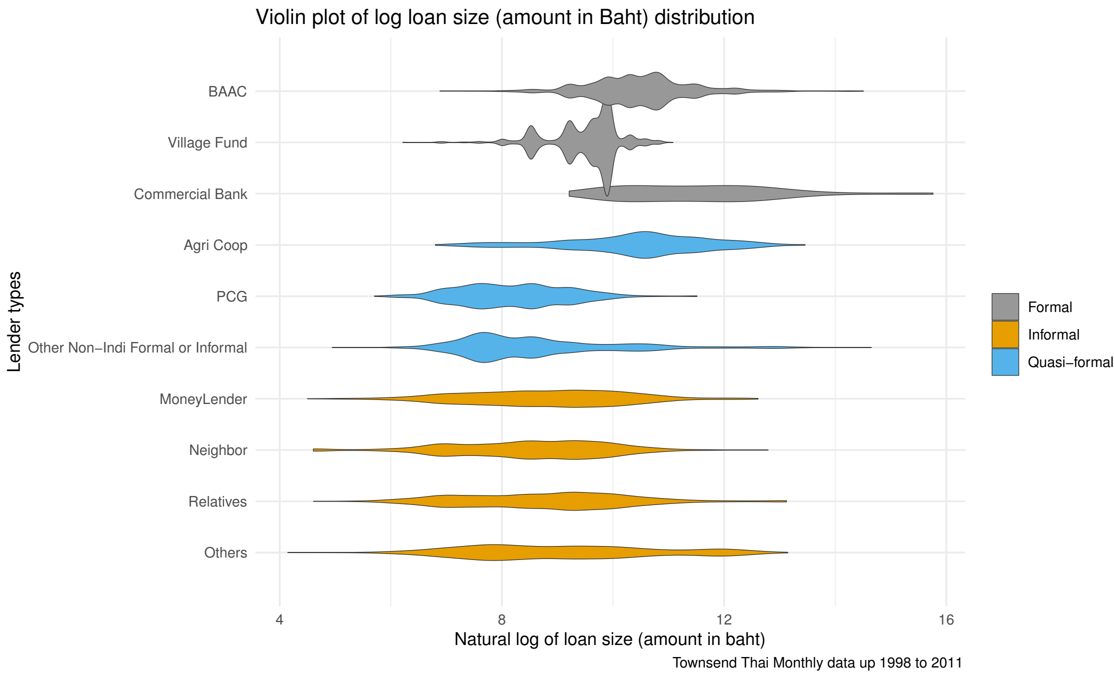


Fig. C.8. Loan size distribution across all lender types

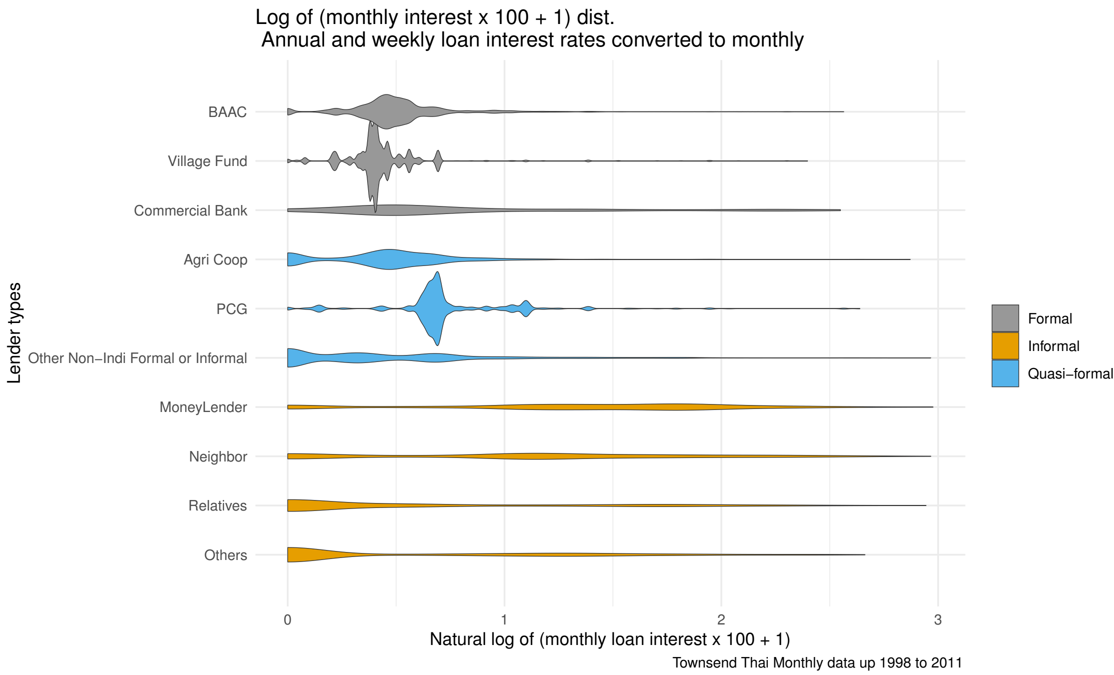


Fig. C.9. Loan interest rates distribution across all lender types