A Quantitative Theory of Installment Loans

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Abstract

We develop a heterogeneous agent macro model with unsecured debts and risk of default applicable to the Indian context. The credit instrument is an installment (equivalently, EMI) loan. The model is calibrated to facts on the characteristics and performance of installment loans obtained from a large Indian non-bank financial company and to facts obtained from national surveys on the stochastic evolution of household incomes and household borrowing behavior. We find that Indian households do not engage in precautionary/buffer stock savings in response to income fluctuations, but save and borrow to meet occasional large expenditure needs. Indian households default rarely and do so because of severe income shortfalls. We find a rationale for the ubiquitous presence of prepayment penalties in the EMI loan market and we find that loans with flexible payment options would be welfare-enhancing for most households.

Keywords: EMI, installment loan, default risk, prepayment penalty

JEL Codes: D14, D15, E44, G51

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The installment plan was to consumer credit what the moving assembly line was to the automobile industry. Without it, today's trillion-dollar consumer credit industry would be inconceivable.

Lendol Calder, *Financing the American Dream*

1 Introduction

There is now a substantial macro literature on consumer debt and default (surveyed recently in Exler and Tertilt (2020)). At its core, this literature employs versions of heterogeneous agent macro models with uninsurable income risk (Imrohoroglu (1989), Hugget (1993), and Aiyagari (1994)) to analyze the implications of default on consumer debts. To date, this literature has focused almost entirely on the experiences of advanced economies, particularly the US. In this paper, we apply this framework to study unsecured consumer debts in the Indian context.

The application requires innovation along several dimensions. Most importantly, the credit instrument most commonly used for consumer loans in India is the installment loan. In the existing macro literature, however, the typical assumption is that a consumer borrows using a one-period term loan (Athreya (2002), Chatterjee, Corbae, Nakajima, and Rios-Rull (2007), Livshits, MacGee, and Tertilt (2007), Chatterjee, Corbae, Dempsey, and Ríos-Rull (2023), Chatterjee, Corbae, Dempsey, and Ríos-Rull (2025), among others) or a credit card (Raveendranathan (2020), Herkenhoff and Raveendranathan (2024), Chatterjee and Eyigungor (2025), among others). Since neither instrument is appropriate for India, we develop a competitive model of installment loans.

Second, quantification of the heterogeneous-agent macro framework requires information on the stochastic process governing household incomes. Following the procedure in Storesletten, Telmer, and Yaron (2004), we use the panel structure of the CMIE household survey to estimate a stochastic process for monthly household incomes for households residing in cities (Chatterjee and Mitra (2025)). The estimated process shares commonalities with the process estimated for the US, but also differs in important ways. The one distinguishing feature pertinent to the current study is that the incomes of urban Indian households appear to be substantially more persistent than those of their (primarily urban) US counterparts.

Third, quantification of the model also requires information on contract particulars and performance of installment loans. To the best of our knowledge, this type of detailed

information is not publicly available for India. To fill this gap, we utilize proprietary data from a large non-bank financial company (NBFC) on the characteristics and performance of over 18,000 randomly selected EMI loans. This data provides us with a micro glimpse into the workings of India's installment loans industry and offers key information for calibrating the model.

We report five findings. First, the quantification of the model is successful in that parameter values can be found that deliver model statistics close to targets. Success in this sense is not guaranteed because the twin assumptions of competitive risk-neutral lenders and rational households severely constrain the relationships between interest rates, default rates, and household leverage that we should expect to observe. Our quantification aligns reasonably closely with these statistics and also delivers a good match along several other dimensions related to the performance of installment loans.

Second, the quantification reveals behavior patterns that are strikingly different from those of US households. As a result of the persistence of income shocks and a relatively low deposit interest rate, urban Indian households do not engage in precautionary savings to buffer adverse income shocks (Deaton (1991), Carroll (1997)), and they seldom borrow to do so either. Thus, the quantification suggests that much of urban India's household savings is occurring for life-cycle reasons.

Third, while income fluctuations do not contribute to precautionary/buffer stock savings, Indian households both borrow and save to smooth through *expenditure* shocks. The model implies that more than 90 percent of borrowing episodes are in response to a consumption expenditure shock. We discuss survey evidence on reasons for borrowing that aligns reasonably well with this finding. In addition, our quantification implies that the primary reason Indian households default on their debts is due to adverse income shocks. Furthermore, households that do not have access to the credit market (because of a previous default) save to create a buffer stock of savings deposits to meet future expenditure shocks. Thus, precautionary savings in this sense are not zero; however, we estimate that the fraction of urban households in this situation of exclusion is small because the default rate is low, and exclusion from borrowing due to default is not permanent.

In the balance of the paper, we shift our focus from understanding how the model accounts for facts it is designed to match to properties of the installment loan contract, in particular, how contract interest rates vary with loan, income, and maturity. We also consider the contract and welfare implications of a ubiquitous feature of installment loans: penalties for prepayment, which discourage borrowers from paying down the loan faster

than the contractually agreed-upon schedule of EMI payments. Our fourth finding is that a prepayment penalty is welfare-improving for most borrowers: By discouraging good risks from leaving the pool early, the penalty mitigates *adverse retention* and allows lenders to offer lower interest rates on the contract. Furthermore, in a competitive loan market, prepayment penalties end up being transfers from households that get good income shocks (and therefore prepay their loan) and to those who don't get such shocks and stay in the contract. The transfer is affected through lower interest rates funded via prepayment fees.

Installment loans feature specific contractual obligations that last for the duration of the loan. In the spirit of financial innovations literature (Allen and Gale (1988), Allen and Gale (1994), Tufano (2003)), we investigate if a better contractual structure exists. One motivation is that the volume of personal consumer loans is growing rapidly in India. While installment loans currently occupy a preeminent position in the consumer loans industry, innovation may make the future look very different. Guided by the knowledge that default on an installment loan is triggered when making the contractual payments becomes too onerous, we consider a loan that imposes minimal contractual obligations. In this "flexi-loan," the borrower has complete discretion about how much to pay in any month, provided that the implied loan balance next month does not exceed the face value of the contract. Our fifth finding is that a competitive "flexi-loan" industry is welfare-improving for all non-indebted households who can borrow, except for households with very low incomes. Generally, these welfare gain results from lower interest rate on loans, because flexibility reduces default likelihoods. These findings are broadly consistent with evidence on the benefits of "relaxed" contract enforcement (Armendáriz and Morduch (2010) p. 202).

The paper is organized as follows. Section 2 describes the model environment. Section 3 discusses some computational details. Section 4 and presents the quantification of the model. Sections 5 discusses the borrowing, savings and default behavior implied by the model. Section 6 discuss the equilibrium contract structure and compares it to observed structure of EMI loans. Section 7 presents our findings on the desirability of prepayment penalties and Section 8 presents the welfare implications of flexible contract structure. Section 9 summarizes the paper and our ongoing research, and concludes.

2 Environment

A person's endowment y evolves according to a first-order Markov process $F(y'|y)$ with $y', y \in Y$. People are infinitely lived, with a discount factor of β and per-period preferences

$$u(c, \zeta)) = \frac{\zeta}{1-\gamma} c^{(1-\gamma)} \;\; \gamma > 0, \;\; \zeta \geq 1 \tag{1}$$

where ζ is a preference shock that follows a Markov process $G(\zeta'|\zeta)$ (it is understood that $u(c, \zeta)$ is $\zeta \ln(c)$ if $\gamma = 1$).

People have access to a risk-free savings vehicle with an interest rate of $r > 0$ and to unsecured EMI consumption loans. We assume that access to the consumption loan market is limited to people in good standing, i.e., to those who do not have a record of a past default. We assume that a person can have at most one EMI loan at a time for tractability.

A person who takes out a loan of B at an interest rate of R and chooses to repay the loan over T periods is obligated to make T periodic payments of I starting the next period. The periodic payments I is given by the "EMI formula"

$$I = \frac{B \cdot R \cdot (1+R)^T}{(1+R)^T - 1} = \frac{B \cdot R}{1 - (1+R)^{-T}}. \tag{2}$$

The formula indicates that for a given B and R, the EMI I depends negatively on T: I is lower for longer maturities. Since I is what is owed each period — and can be avoided by defaulting — we expect maturity T to influence default risk via its impact on I. Therefore, in this setup, we expect the interest rate menu offered by lenders to be conditional on the persistent income level y, loan size B, and maturity T.

We assume that debts B and maturity T belong to discrete sets $\mathcal{B}$ and $\mathcal{T}$, respectively. The set of persistent incomes $\mathcal{Y}$ and the set of preference shocks $\mathcal{Z}$ are also discrete. Let $\mathcal{K}$ denote the set $\mathcal{Y} \times \mathcal{Z} \times \mathcal{B} \times \mathcal{T}$ and let k index elements of $\mathcal{K}$. In what follows, we will use k to refer to the contract with characteristics (y_k, ζ_k, B_k, T_k). If R_k is the interest rate for contract k, (2) determines I_k as a function of R_k (and B_k and T_k). We recognize this dependence as $I_k(R_k)$ when needed.

2.1 Individual's Decision Problem

At any given time, the individual could be in one of three situations: she could be in a state of exclusion from credit markets following a default, which we call the exclusion status (X); she could be in good standing (i.e., not excluded from participating in the credit market) but not carrying any debt, which we call the non-indebted status (N); or she could be carrying an EMI loan, which we call the indebted status.

We now describe the Bellman equations for each of these situations.

Exclusion Status

In this situation, the person cannot have any debt and can only save. The interest rate on the asset is $r > 0$. She emerges from the exclusion state next period with some probability $\xi \in (0, 1)$.

$$v^X(A, y, \zeta) = \max_{A' \geq 0} u(c, \zeta) + \beta \mathbb{E}_{(y', \zeta')|(y,\zeta)}[\xi v^X(A', y', \zeta') + (1 - \xi) v^N(A', y', \zeta')] \tag{3}$$

s.t.

$$c = y + (1 + r)A - A'.$$

Non-indebted Status

In this situation, the person could choose to continue in the non-indebted state, i.e., not borrow. In this case,

$$v^N_N(A, y, \zeta) = \max_{A' \geq 0} u(c, \zeta) + \beta \mathbb{E}_{(y', \zeta')|(y,\zeta)} v^N(A', y', \zeta') \tag{4}$$

s.t.

$$c = y + (1 + r)A - A'$$

If she chooses to borrow, she must choose an EMI contract. Her choice set is $\mathcal{K}_{\{y,\zeta\}} \equiv \{k \in \mathcal{K} : y_k = y \text{ and } \zeta_k = \zeta\}$, i.e., the set of contracts that feature her current persistent income state and her current preference shock. For tractability, we assume that a borrower cannot carry positive assets. So,

$$v^N_E(A, y, \zeta) = \max_{k' \in \mathcal{K}_y} u(c, \zeta') + \beta \mathbb{E}_{(y', \zeta')|(y,\zeta)} v_{k'}(B_{k'}, y', \zeta') \tag{5}$$

s.t.

$$c = y + B_{k'} + (1 + r)A$$

Then,

$$v^N(A, y, \zeta) = \max\left\{v_N^N(A, y, \zeta), v_E^N(A, y.\zeta)\right\} \tag{6}$$

Indebted Status

A person who is carrying an EMI loan k has four distinct options: (i) She could continue to make the EMI payment I_k, (ii) she could pay more than the EMI payment, i.e., make a partial prepayment, (iii) she could refinance her loan, or (iv) she could default.

Sticking with the EMI

$$\begin{aligned} &v_k^S(B, y, \zeta) = u(c, \zeta) + \beta \mathbb{E}_{(y', \zeta')|(y,\zeta)} v_k(B', y', \zeta') \\ &\text{s.t.} \\ &c = y - \min\{I_k, (1 + R_k)B\} \\ &B' = \max\{0, B - (I_k - R_k B)\} \end{aligned} \tag{7}$$

If $(1 + R_k)B$ is less than I_k the loan balance inclusive of interest is less than the EMI. In this case, the "sticking" option amounts to paying off the loan balance. Note that if $(1 + R_k)B < I_k$ then $B - (I_k - RB_k) < 0$ and the individual exits the period with $B' = 0$.

Partial Prepayment

Under this option, the borrower makes a payment $P > 0$ to reduce her principal. The set of feasible P is $\mathcal{P}_k(B) = \{P > 0 : B - (I_k - R_k B) - P \in \mathcal{B}\}$.

$$\begin{aligned} &v_k^P(B, y, \zeta) = \max_{P \in \mathcal{P}_k(B)} u(c, \zeta) + \beta \mathbb{E}_{(y', \zeta')|(y,\zeta)} v_k(B', y', \zeta') \\ &\text{s.t.} \\ &c = y - I_k - (1 + \eta)P \\ &B' = B - (I_k - R_k B) - P \end{aligned} \tag{8}$$

If $P > 0$, the borrower is required to make a prepayment penalty $\eta \geq 0$. If the borrower chooses the maximum P, she closes her loan. We denote the partial prepayment decision rule by $P_k(B, y)$ (the amount prepaid).

Refinance

Under this option, the person pays down her existing loan fully with penalty and takes out a new EMI loan for a loan amount of $B_{k'}$. This option is available if $B \leq B_k/4$, i.e., if

the outstanding balance does not exceed 25 percent of the original loan amount.

$$v_k^R(B, y, m) = \max_{k' \in \mathcal{K}_y} u(c) + \beta \mathbb{E}_{y', m'|y} v_{k'}(B_{k'}, y', m')$$

s.t.

$$c = y + m + B_{k'} - B(1 + R_k)$$

Default

Under this option, the individual incurs a default cost of κ in utility terms and sheds her debt and cannot save in the period of default.[1] Next period, she is let back into the credit market with probability $1 - \xi$ or enters the exclusion state with probability ξ.

$$v^D(y, \zeta) = u(c, \zeta) - \kappa + \beta \mathbb{E}_{(y', \zeta')|(y, \zeta)} \left[\xi v^X(0, y', \zeta') + (1 - \xi) v^N(0, y', \zeta') \right] \tag{9}$$
$$c = y.$$

Then, the value of being in the indebted state with an EMI loan k is:

$$v_k(B, y, \zeta) = \begin{cases} \max \left\{ v_k^S(B, y, \zeta), v_k^P(B, y, \zeta), v_k^R(B, y, m), v^D(y, \zeta) \right\} & \text{if } B \leq B_k/4 \\ \max \left\{ v_k^S(B, y, \zeta), v_k^P(B, y, \zeta), v^D(y, \zeta) \right\} & \text{otherwise.} \end{cases} \tag{10}$$

2.2 Competitive Pricing of an EMI Loan

Let $Q_k(B, y, \zeta)$ denote the value to the lender of contract k with balance B, current persistent state y, and shock ζ. Assuming that the lender is not paid anything in default, this value satisfies the following recursion (for compactness, we write $\mathbb{E}$ for $\mathbb{E}_{(y', \zeta')|(y, \zeta)}$):

$$Q_k(B, y, \zeta) = (1 - D_k(B, y, \zeta)) \times \Big[-\delta B_k + \tag{11}$$
$$[\min\{I_k, (1 + R_k) \cdot B\} + \frac{\lambda}{1 + r)} \mathbb{E} Q_k(\max\{0, (B - (I_k - R_k B)\}, y', \zeta')] \mathbb{1}_{\left\{v_k(B,y,\zeta) = (v_k^S(B,y,\zeta)\right\}} +$$
$$[I_k + P_k(B, y, \zeta)((1 + \eta) + \frac{\lambda}{1 + r)} \mathbb{E} Q_k(B - (I_k - R_k B) - P_k(B, y), y', \zeta')] \mathbb{1}_{\left\{v_k(B,y,\zeta) = (v_k^P(B,y,\zeta)\right\}} +$$
$$[B_k(1 + R_k)(1 + \eta)] \mathbb{1}_{\left\{v_k(B,y,\zeta) = v_k^R(B,y,\zeta)\right\}} \Big].$$

If the current state is such that the borrower defaults, then the term $D_(B, y, \zeta) = 1$ and the current value of the contract is zero. In a nondefault state, the term in large square

[1]

brackets represents the lender's payoff. The first term, $-\delta B_k$, is the flow resource cost of maintaining a contract and is proportional to the contract's face value. The second term is the payoff if it is optimal for the borrower to stick with the installment loan payment. In this case, the lender receives a flow payoff and a continuation value, the latter being discounted by the risk-free rate and a factor $\lambda < 1$. The factor λ is a stand-in for flow costs borne by the lender from keeping a loan on its balance sheet. The third term is the payoff if it is optimal for the borrower to make a partial payment, and the final term is the payoff if the borrower refinances the loan.

The equilibrium contract interest rate R_k satisfies

$$B_k = \frac{1}{1+r}\mathbb{E}_{(y',\zeta')|(y_k,\zeta_k)} Q_k(B_k, y', \zeta'; R_k) \text{ for all } k \in \mathcal{K}, \tag{12}$$

where we recognize that $Q_k(B, y, \zeta)$ depends directly on R_k and indirectly on R_k via $I_k(R_k)$ and all value functions and decision rules. Equation (12) states that at the moment of origination, the face value of the loan must equal its market value.

3 Computation

A challenging aspect of computing unsecured debt models is solving the pricing equation for debt, specifically equations (11) and (12). The r.h.s. of the two equations are operators that take the function Q and R, respectively, as inputs and deliver "updated" Q and R functions as outputs (the l.h.s. of the two equations). Successful computation of the Q and R functions involves locating a joint fixed point of the two operators.

Continuity of the two operators is needed for the joint fixed point to exist; if this requirement is not satisfied, the computation may fail due to nonexistence. Since the household's choices are over a discrete set of options, the continuity of the r.h.s. operators is ensured if households choose *mixed* strategies. But our decision problem is formulated as choices over pure, not mixed, strategies. In this situation, a workaround that has become popular in the macro default literature (Chatterjee and Eyigungor (2015), Dvorkin, Sanchez, Sapriza, and Yurdagul (2021), among others) is to introduce a small amount of noise, making choices probabilistic, as would be the case with mixed strategies. We follow this approach. For our application, it is sufficient to introduce a minimal amount of noise in only two situations. For an indebted household, there is noise in the default decision and the choice of B'. For a non-indebted household, there is noise in the choice of contract.

4 Mapping the Model to Data

Quantification of the model requires information on the stochastic process for incomes. We follow Storesletten, Telmer, and Yaron (2004) and assume that monthly household income is given by $y(t)z(t)\alpha^i$, where y, the persistent component of earnings, is an AR1 process in logs, z, the transitory component, is i.i.d. with $\ln(z)$ having standard deviation σ_z, and α^i is a permanent household component with $\ln(\alpha)$ having standard deviation σ_α. We use the CMIE survey to estimate this process (see Chatterjee and Mitra (2025) for details). Table 1 gives the results of this estimation.

Table 1
Earnings Process Parameters

Parameter	Description	Value
ρ	Autocorrelation of log of persistent component	0.991
σ_ε	Std. of innovation to log of persistent component	0.041
σ_z	Std of log transitory shock	0.355
σ_α	Std of permanent component	0.633

Notes: All parameters are at monthly frequency.

At a monthly frequency, the persistent income level is close to a random walk, and the month-to-month random variation in this component is contained within ± 10 percent with more than 97 percent probability. We approximate this process (via Tauchen's method) by a 21-state first-order Markov chain. We treat the transitory shock as a measurement error and ignore it. In our model, given the homotheticity of the utility function, level differences in income translate into proportionate changes in consumption, debt, and savings levels, provided the utility cost of default changes proportionately with the permanent level of income. With this assumption, which we make for computational tractability, the calibration of the model does not require us to account for the scale effects of level differences in incomes; therefore, we also ignore the variation in permanent income levels.

We assume that ζ takes only two values $\{\bar{\zeta}, 1\}$, $\bar{\zeta} > 1$, and that probability of transitioning from $\bar{\zeta}$ to 1 is 1 and the probability of transitioning from 1 to $\bar{\zeta}$ is θ. Finally, we permit only five maturity lengths, corresponding to 1 through 5 years. Our EMI loan data motivates this choice, where we do not observe maturities exceeding 5 years.

With these parametrization, we must select values for β, γ, $\bar{\zeta}$, θ, ξ, κ on the household side and δ, λ and r on the lender side. We set γ to a conventional value of 2. We assumed that following a default, a person is excluded from borrowing for seven years, on average.

For our monthly model, this implies $\xi = 1/84$. We assumed an annual risk-free rate of 5.3 percent, which implies a monthly $r = 0.0043$, consistent with average deposit rates in India. These choices are summarized in the top panel of Table 2

For the remaining seven parameters, we targeted seven statistics. These are the average debt-to-income ratio measured in the AIDIS Survey which mainly pins down $\bar{\zeta}$; the fraction of households in debt as measured in the CMIE sample of Indian urban households, which mainly pins down θ; the average default frequency, as measured in the sample of EMI loans, which mainly pins down κ; the average tenure of loans and the average interest rate on loans are mainly pinned down by λ and δ; and the fraction of loans that are paid off before their maturity date and the average effective maturity as measured in the sample of EMI loans are mainly pinned down by η and β. The estimation is performed by minimizing the equally weighted sum of the squared percentage deviations of the model statistics from the data targets.

The parameter estimates, model moments, and data moments are reported in the bottom panel of Table 2. The model gets the EMI-to-income ratio, the fraction in debt, the default frequency, and the average interest rate about right; however, the model's average tenure, effective tenure, and preclosure rate are too high. We suspect that a better calibration, which the algorithm has not yet found, exists, in which β is higher (which would shorten the effective tenure because more patient people pay down their debts faster) and η is higher (which would reduce the preclosure rate).

It is worth remarking on the parameters δ and λ. These parameters relate to the resource costs of running a loan business. If we set $\lambda = 1$, so that there are no balance-sheet costs associated with keeping a loan on the books, the model's equilibrium has all borrowers choosing the longest maturity loan, namely, loans with a maturity of 5 years. This is because the longest maturity loans have the smallest contractual obligations (all else being equal) and therefore have the lowest default rates and the lowest interest rates. If λ is less than one, then long maturity loans become relatively more expensive (because more of their value is tied up in the continuation value) and the interest rates on those loans rise. This encourages borrowers to opt for shorter-term loans. However, this change also raises interest rates substantially, which is counterfactual. The model resolves this tension by assigning a slightly negative value to δ, which lowers average interest rates.

Table 2 Parameter Choices

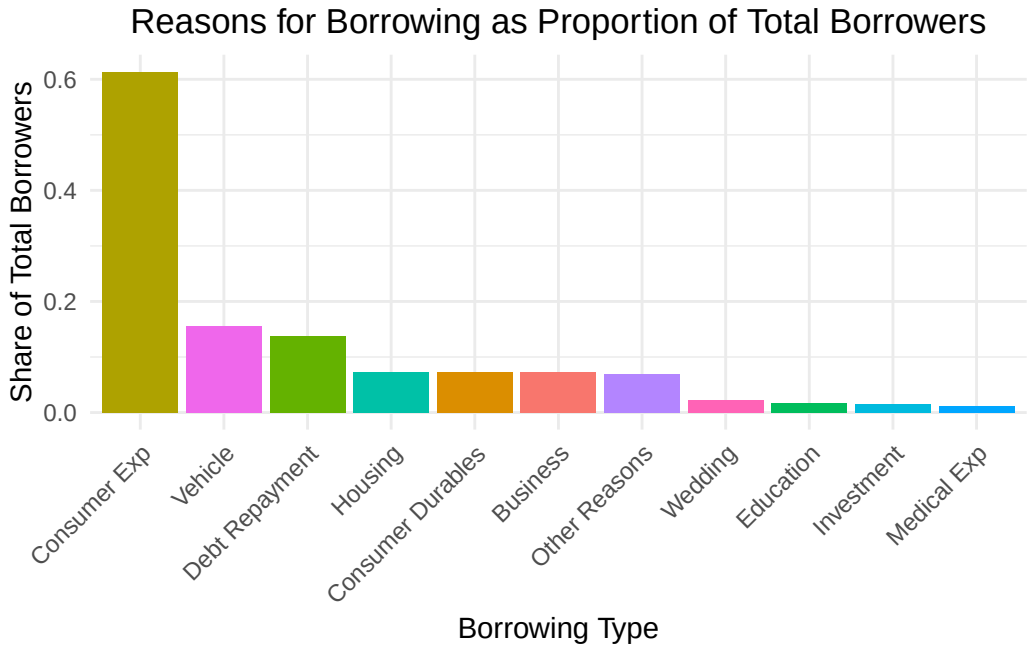
Description	Target	Data	Model	Parameter Value
		Parameters Set Independently		
Income process	Autocorrelation	0.991	0.991	$\rho = 0.991$
Income process	Std. Deviation	0.045	0.045	$\sigma = 0.045$
IES	Conventional	–	–	$\gamma = 2$
Risk-free rate	–	0.0043	0.0043	$r = 0.0043$
Exclusion duration	–	–	84	$\xi = 0.01$
		Parameters Set Jointly		
Utility shock	EMI-to-Income	7.1% (CMIE, 2014–2019)	6.36%	$\bar{\zeta} = 11.809$
Prob of U shock	Fraction in Debt	21.2% (AIDIS, 2019)	23.22%	$\theta = 0.010$
Cost of default	Default Frequency	0.7% (Loan Survey, 2013–2015)	0.68%	$\kappa = 1.886$
Balance sheet cost	Average tenure	52.16 mo. (Loan Survey, 2014–2015)	58.5 mo.	$\lambda = 0.988$
Operational Cost	Avg. Interest rate	15.26% (Loan Survey, 2014–2015)	16.48%	$\delta = -0.001$
Discount factor	Preclosure rate	57.4% (Loan Survey, 2014–2015)	69.3%	$\beta = 0.961$
Prepayment penalty	Effective tenure	32.4 mo. (Loan Survey, 2014–2015)	38.1 mo.	$\eta = 0.021$

5 Why Do Indian Households Borrow and Why Do They Default?

Figure 1 displays the frequencies of the respondents' reasons for borrowing as observed in the CMIE surveys. The main reason for borrowing is consumption, with a frequency of 60 percent. Debt taken on to support consumption could be due to shortfalls in income or unexpected expenditures. On the other hand, vehicles, consumer durables, weddings, and medical expenses are best considered as expenditure shocks. These categories together account for about 27 percent. If we attribute half of the 60 percent attributed to consumption to expenditure shocks, such shocks would be the dominant reason for consumer borrowing in India.

The incidence of borrowing in our model by (y, ζ) state is shown in Table 3. Borrowing due to an income shortfall alone is uncommon: Only 1.31 percent of all borrowings in the model occur when $\zeta = 1$, and all such borrowings occur for the third lowest and fourth lowest persistent income levels. No borrowings arise for the two other, even lower-income states because those states have no contracts available with interest rates below the 36 percent upper bound.

Figure 1
Reasons for Borrowing



In contrast, our model consistently shows positive borrowing in response to the ζ shock. Comparing the frequencies in the column for $\zeta > 1$ with the column for the long-run, or ergodic, distribution of y, we see that the frequencies are quite close, suggesting that anyone who is hit with an expenditure shock borrows, regardless of their income state. This is because people typically do not accumulate precautionary balances, so borrowing is often the only way to meet sudden expenditure demands (the incentives to save are discussed further below).

The incidence of default in the model is shown in Table 4. Here, the determinative factor is not ζ but the household's income state: 94 percent of defaults occur when the household is not facing an expenditure shock but is in one of the two lowest income states. Only in the third-lowest income state do people default when faced with an expenditure shock, but not otherwise, and this accounts for only 1.81 percent of defaults. The remaining defaults occur in cases where the household is in one of the lowest two income states, *and* is facing an expenditure shock. But such a household would default even if it were not facing an expenditure shock.

To summarize, then, the expenditure shock is the primary reason households borrow in the model, and adverse income shocks are the primary reason why they default. Survey

Table 3
Percentage of borrowing instances by (y, ζ) states

	$\zeta_1 = 11.80$	$\zeta_2 = 1$	**Ergodic** y
y_1	$\times$	$\times$	0.42
y_2	$\times$	$\times$	0.80
y_3	0.62	0.630	1.40
y_4	2.41	0.680	2.25
y_5	3.69	0	3.39
y_6	5.23	0	4.82
y_7	6.71	0	6.39
y_8	8.06	0	7.92
y_9	9.52	0	9.20
y_{10}	9.94	0	10.01
y_{11}	9.93	0	10.24
y_{12}	9.82	0	9.81
y_{13}	8.75	0	8.75
y_{14}	7.48	0	7.36
y_{15}	5.76	0	5.83
y_{16}	4.36	0	4.28
y_{17}	3.11	0	2.93
y_{18}	2.05	0	1.90
y_{19}	1.20	0	0.17
y_{20}	0.74	0	0.66
y_{21}	0.38	0	0.35

evidence is broadly consistent with the primacy of expenditure shocks in the decision to borrow. We suspect that adverse income shocks are the primary reason for the decision to default, which is consistent with anecdotal evidence on why households struggle to make their debt payments.

We conclude the discussion of default by presenting Figure 2, which plots the default regions for a loan with a maturity of 5 years and a moderate level of debt (3.8). The black line demarcates the default region (in yellow) from the repayment region (in light and dark green) when the ζ shock is 1, and the red line demarcates it when $\zeta > 1$. In either situation, the default set has a threshold property: the default occurs for income levels below the red or black line. Notice that there are no repayment states for debt levels above 3.8, but this is because this region does not apply to this example: borrowers cannot increase the face value of their loan without refinancing, and so the only relevant debt levels are those at or below 3.8.

Table 4
Percentage of default instances by (y, ζ) states

	$\zeta_1 = 11.80$	$\zeta_2 = 1$	**Ergodic** y
y_1	0.45	51.74	0.42
y_2	3.64	42.33	0.80
y_3	1.82	0	1.40
y_4	0	0	2.25
y_5	0	0	3.39
y_6	0	0	4.82
y_7	0	0	6.39
y_8	0	0	7.92
y_9	0	0	9.20
y_{10}	0	0	10.01
y_{11}	0	0	10.24
y_{12}	0	0	9.81
y_{13}	0	0	8.75
y_{14}	0	0	7.36
y_{15}	0	0	5.83
y_{16}	0	0	4.28
y_{17}	0	0	2.93
y_{18}	0	0	1.90
y_{19}	0	0	0.17
y_{20}	0	0	0.66
y_{21}	0	0	0.35

We now address the incentives for precautionary savings with respect to income fluctuations. In this economy, earnings shocks are volatile but extremely persistent. The persistence makes the value of precautionary savings as a buffer against income shocks low. In addition, the monthly interest rate on deposits (0.43 percent) is an order of magnitude lower than the monthly discount rate (4.06 percent), making it very costly to precautionary save. However, in this economy, there is also another important shock: the expenditure shock. Interestingly, households that are excluded from the credit market because of a previous default, *do* build a buffer stock of savings because they have no other way to meet this expenditure shock. This is shown in Figure 3. The figure plots the savings policy function for two different income levels for a household that is excluded from borrowing. Observe that both policy functions intersect the 45° line from above, indicating that there is target level of savings for these households (0.5 for the mean income household and 1.5 for the high-income households).

Figure 2
Default Regions

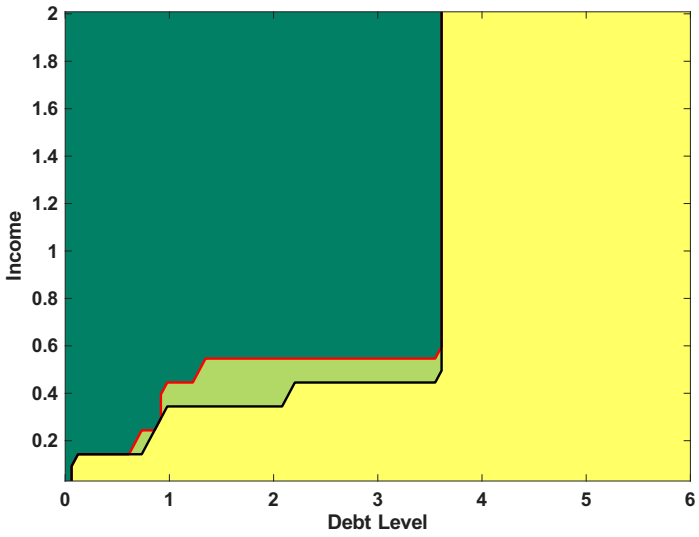
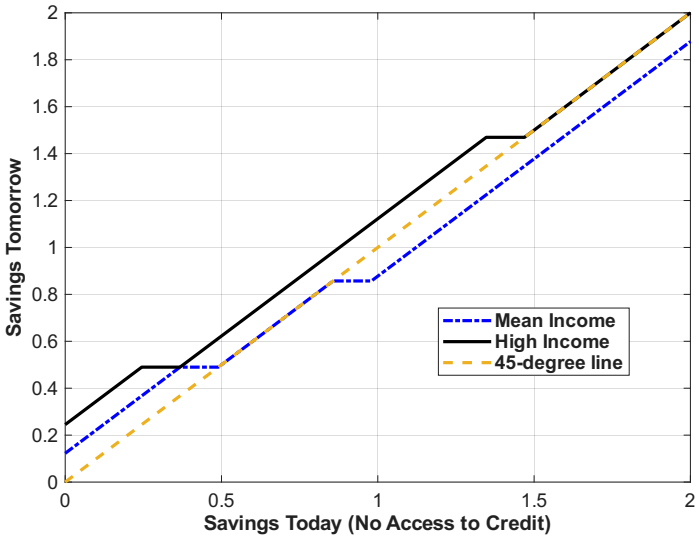


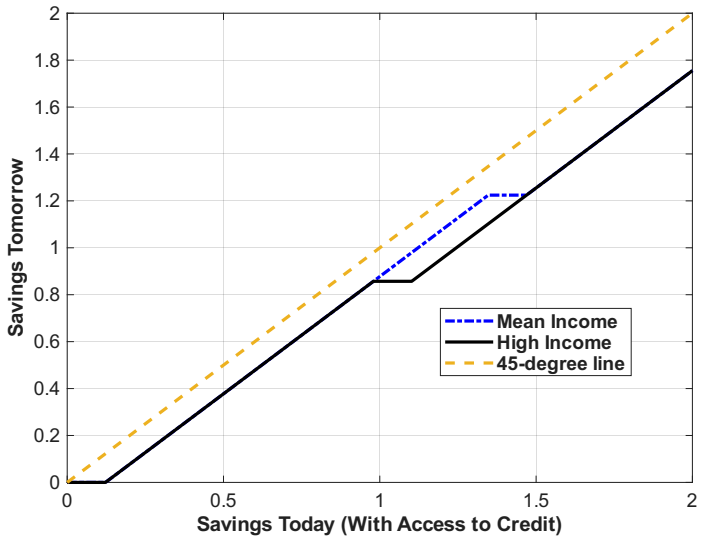
Figure 3
Savings Policy Function in Exclusion



In contrast, households that have access to the credit market have a target savings level of zero. This is shown in Figure 4. Observe that the two policy functions for the mean and high-income households lie completely below the 45° line, which means that any positive savings would be depleted to zero. These households do not accumulate

any savings because they know they plan to borrow to smooth through the expenditure shock.

Figure 4
Savings Policy Function with Access to Credit



6 Contract Mechanics

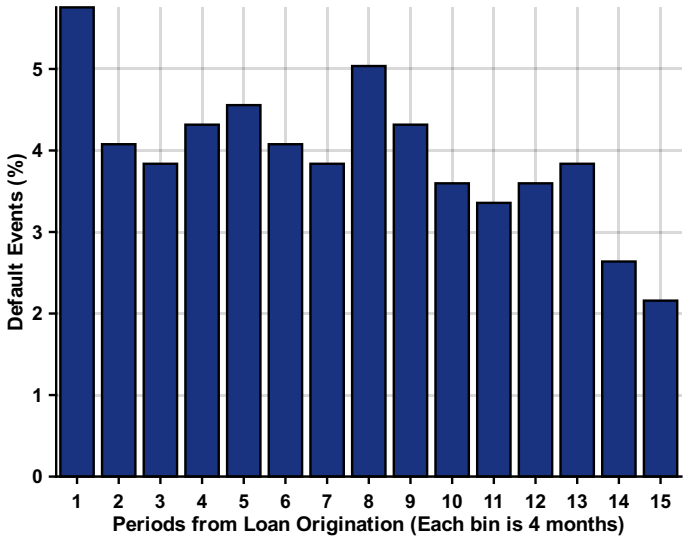
The borrowing behavior of households depends on the interest rate menu households face, which, in turn, depends on a borrower's default incentives.

Default Incentives:

The value in the indebted state, $v^k(B, y, \zeta)$, decreases in B. The logic for this is as follows. Imagine a second individual with contract k and state y, ζ but with a debt level of $B - \Delta$, where Δ is a small positive number. It is feasible for this individual to take the same action each period as the individual with debt B. When the B individual pays her debt off, the $B - \Delta$ individual will also pay her debt off (because she has been following the decisions of the B individual up to that time), and she will experience a higher consumption level because she would have arrived in that period with less debt. Hence, the $B - \Delta$ individual has a feasible policy rule that, along paths involving paying off the debt at some point, yields her more utility than the B individual. Therefore $v^k(B - \Delta, y, \zeta) > v^k(B, y, \zeta)$ for any $\Delta > 0$.

Since the payoff from default is independent of B, viz (9), the property that $v^k(B, y, \zeta)$ is decreasing in B implies that if it is optimal to default on a debt level of B, it must be optimal to default on a higher debt level. In other words, for each y, ζ and k, there is a threshold debt level $\bar{B}_k(y, \zeta)$ such that there is a default if and only if $B > \bar{B}_k(y, \zeta)$. Since the outstanding debt level declines over the lifetime of a loan, the threshold property implies that the probability of default on a loan falls over time. This is because the set of (y, ζ) states for which repayment is optimal expands over time as the level of indebtedness declines. In other words, the default hazard on an EMI loan decreases as the loan approaches maturity. Figure 5 plots the default hazard for all loan contracts originated in our economy. Therefore, contracts vary in terms of income, debt levels and maturity. Still, we observe that the probability of default decreases over time from the point of origination.

Figure 5
Default Hazard Rate

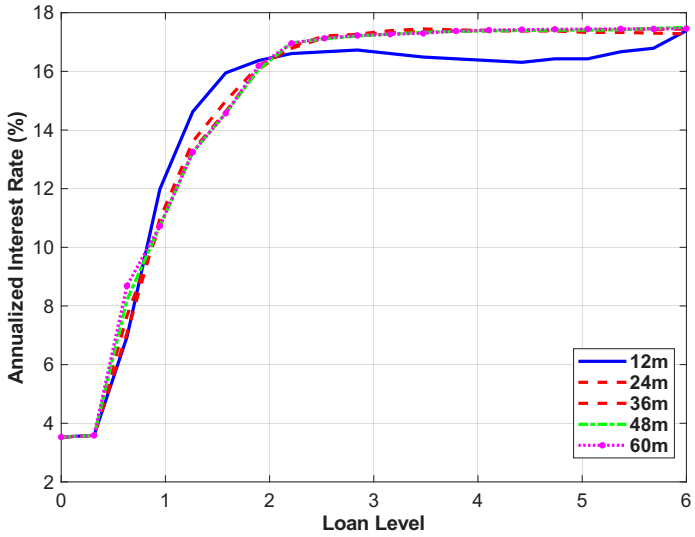


The quantity I does not appear explicitly as an argument in $v^k(B, y, \zeta)$ because it enters implicitly through the contract indicator k — which determines T_k and hence I_k — and does not change as the contract progresses through time. Nevertheless, we can consider a change in I_k holding fixed B, y, ζ, and R. All else being equal, an increase in I_k lowers current utility since consumption is lower for all payment choices — see the budget constraint equations in (7) and (8). However, a higher I_k also means that for all payment choices, the loan will amortize *faster*, i.e., B' will be lower, meaning the continuation value will be higher. The current utility effect is a force that increases default probability, while

the continuation value effect is a force that decreases default probability. Thus, the overall impact of a higher I_k is ambiguous.

The impact of y on default incentives is also ambiguous. An increase in y will raise $v^k(B, y, \zeta)$ since the decision rule for a lower level of y remains feasible at a higher level of y and affords strictly greater consumption. However, the value in default, $v^D(y, \zeta)$, also increases in y, so we cannot be sure how default incentives are affected. However, the assumption that the cost of default rises with y attenuates the increase in $v^D(y, \zeta)$ with y, ensuring, in our computations, that individuals repay at high y levels and default at low y levels. In other words, there is a default threshold $\bar{y}_k(B, \zeta)$ such that default occurs if and only if $y < \bar{y}_k(B, \zeta)$.

Figure 6
Interest Rate, Loan Size and Maturity



Interest Rate Menu w.r.t. Loan Size:

Figure 6 plots the interest rate against loan size for all the maturities available in our model. The income level for which these schedules are drawn is the median income level of 1. Except for very small loans, which are offered at (essentially) the risk-free rate, the curves are upward-sloping for all maturities. The reason for this is that holding fixed maturity and interest rate, a bigger loan lowers the value of indebtedness (as discussed previously) and, therefore, increases the set of (y, ζ) combinations for which default is optimal. Hence, equilibrium interest rates must rise with the level of debt. However, another channel is at work. As interest rates rise, the EMI formula (2) implies that I_k also

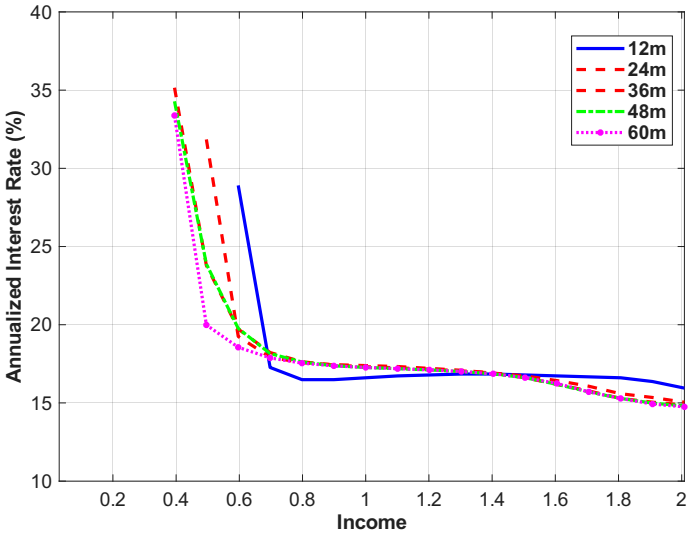
rises. Additionally, as previously discussed, this effect lowers the $\bar{B}_k(y, \zeta)$ schedules and further increases default probabilities.

Interest Rate Menu w.r.t. to Persistent Income Level:

Figure 7 plots the interest rate schedule for different levels of y. These schedules are drawn for a debt level of 1.05?, i.e., for a debt level approximately equal to the median B. There are no interest rates for persistent income below approximately 0.60 per month. This is because no contract can be offered at an interest rate less than the maximum interest rate allowed in the model (a monthly interest rate of 10 percent). As income rises, the first contract to become available is for a maturity length of 5 years, the most extended maturity available in our model, and, therefore, the lowest I_k. For higher incomes, successively lower maturities with successively higher I_k become available.

Interest rates generally decline with income. Higher incomes mean a lower burden of installment payments and so a lower likelihood of default. The only exception to this pattern is for the shortest maturity, which has a rising segment between the incomes of 0.8 and 1.2. Interest rates are tightly clustered for any given income level.

Figure 7
Interest Rate, Income and Maturity



7 Why Prepayment Penalties?

Prepayment penalties are common in installment loan contracts, although we are not aware of an explanation for this ubiquitous contract feature. Our model gives an answer based on risk sharing and adverse retention.

To illustrate the adverse retention part, consider a 5-year contract (of some size) accepted by borrowers with an income of 1.7. We consider two cases. In one case, there is no prepayment penalty, and in the other, the prepayment penalty is 5 percent. Figure 8 shows that the quality of the borrower pool in terms of the average income of surviving borrowers through the entire tenure of the contract. Intuitively, borrowers with a higher realization of y in any period after the loan's inception are more likely to either pay off the loan in full (because of prepayment or refinance) before the tenure ends. This is true for both contracts and is reflected in the downward slope of the two lines. However, the prepayment penalty deters some borrowers from prepaying who would otherwise have done so, causing the average income of surviving borrowers to be higher, especially for longer tenures.

Figure 8
Borrower Quality

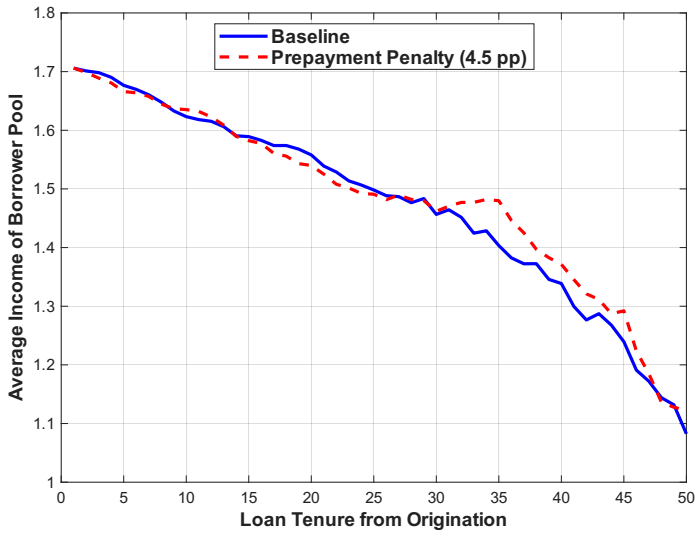


Figure 9 plots the interest rate associated with median income and a 5-year contract for all levels of debt. The figure shows that interest rates are lower in a model with a prepayment penalty. There are two reasons for this. First, the borrower pool deteriorates more slowly with a prepayment penalty (as noted above), making the pool less risky ex-

ante. Second, the revenue from prepayments that do happen is passed on to borrowers as a lower interest rate.

Figure 9
Interest Rates with Penalty

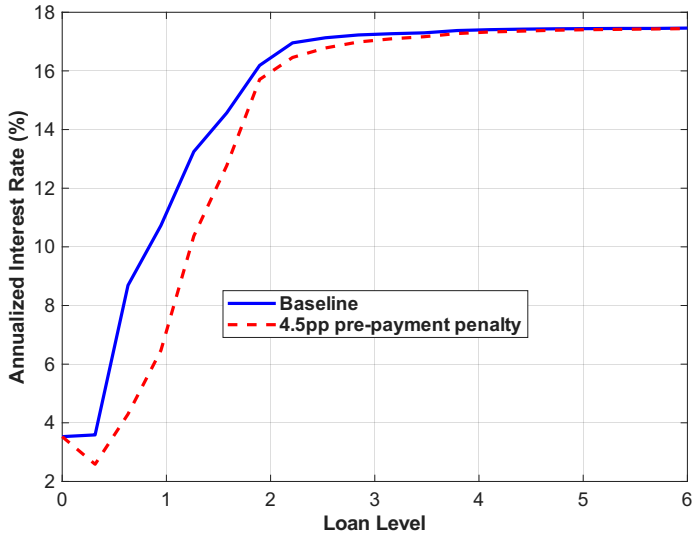
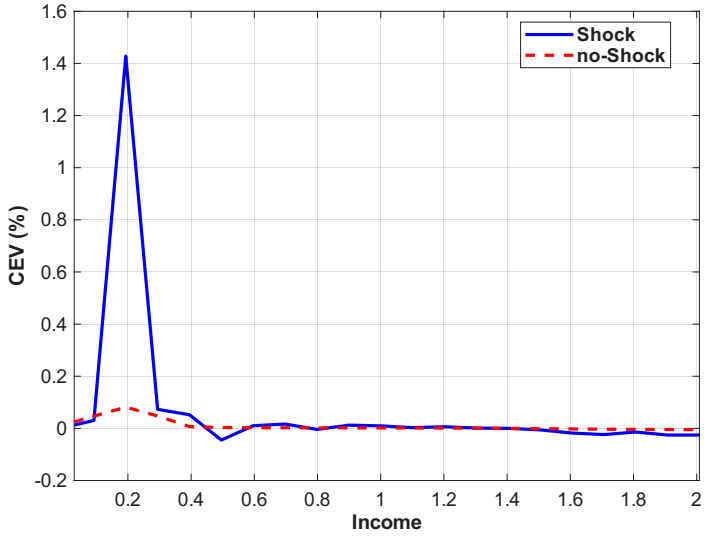


Figure 10
Welfare gains due to prepayment penalty



The effect of such penalties on welfare is, however, ambiguous. While a small penalty creates incentives for the high-income borrower to stay in the pool, it also exposes them to

default risk due to the extension of the loan's life. On the positive side, the revenue from the penalty is reflected in the lower interest rates. If the penalty imposed is prohibitively high, no borrower will prepay, and no additional revenue will accrue to the lender. This situation results in higher default risk and higher associated interest rates. This non-monotonicity alludes to the existence of an optimal rate of pre-payment penalty.

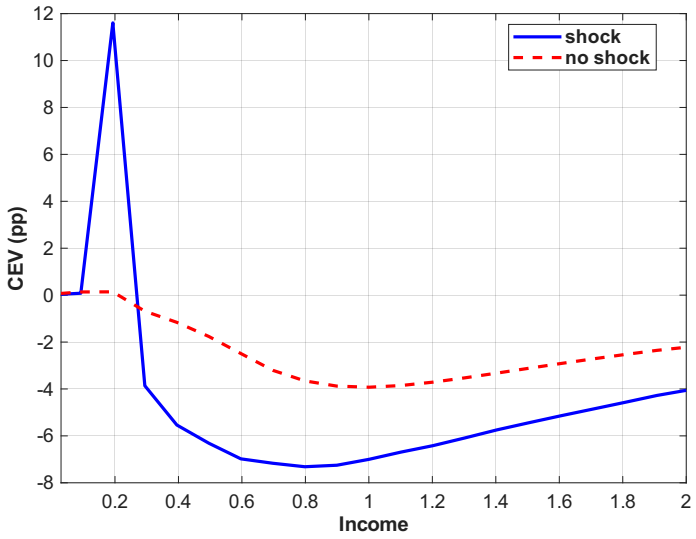
Figure 10 plots consumption equivalent variation (CEV): percentage of consumption required to be transferred to a borrower in the baseline model with a 2.1 percent pre-payment penalty to make him/her indifferent to a world with a 5 percent prepayment penalty. The figure reports the CEV in a state with no debt and plots it against the income. The blue (solid) line represents a high borrowing shock ($\zeta > 1$) state, and the dashed (red) line represents the state for a low borrowing shock ($zeta = 1$). The CEV is greater than zero at very low income levels. For higher levels of income, there are higher chances of the prepayment penalty reducing welfare. The ζ shock raises the CEV for low income levels. This is because $\zeta > 1$ induces more borrowing, which makes the world with prepayment penalties more valuable.

8 Flexible Contracts and Borrower Welfare

The goal of this section is to examine the implications of contract flexibility. We approach this by considering a borrowing arrangement that imposes minimal contractual obligations on the borrower. An individual who borrows is obligated to repay the loan, but the amount paid each period is at the borrower's discretion. The borrower can skip making a payment without triggering default or can partially or fully prepay the loan without any penalty. The only restriction on payments is that the borrower's obligation at the start of any period cannot exceed the face value of the contract, i.e., $B'(1+R) \leq B_k$, where R is the contractual interest rate agreed to at the inception of the loan, B_k is contract loan size at inception, and B' is the borrowers loan balance excluding interest at the start of the next period.

Figure 11 plots how much people with zero savings and in good standing with different y and ζ (persistent income and expenditure shock levels, respectively) living in our calibrated EMI world would need to be paid to switch to a world with flexible contracts. Focusing first on the dotted red line, which corresponds to $\zeta = 1$ (no expenditure shock), we see that, except for very low levels of income, everyone would pay negative amounts. This means they would *prefer* to live in a flexible contract world than in the EMI world. For people facing expenditure shock, the situation is similar, except that the welfare gain

Figure 11
CEV, Flexible vs EMI



and loss are magnified. This is intuitive because people facing the shock would like to borrow immediately.

Why is the Flex-Loan world better? To understand this, Figure 12 plots the interest rate for the flex contract for different income levels for a small loan size. For comparison, the interest rate for the corresponding EMI contract with a 5-year maturity is also plotted. Note that interest rates offered to low-income individuals are significantly higher for the flex contract than for the EMI contract, whereas for higher income levels, the opposite is true. Interest rates reflect the expected default probability. At low income levels, the flexibility of the contract encourages people to pay only the interest on the loan, allowing indebtedness to decrease more slowly over time. Consequently, the person is more exposed to defaulting due to a bad income shock (or an expenditure shock). In contrast, people with higher incomes are encouraged to pay down the loan since there are no prepayment penalties, and default probabilities decline more rapidly with duration. These changes in default probabilities are reflected in interest rates.

Figure 13 presents a similar graph but for a larger loan size. The adverse impact on the low-income borrowers is magnified as their default probability rises even more. Interestingly, the interest rate for the very high-income borrowers is higher with the Flex contract. The reason is that high-income households also take advantage of the flexibility of the loan and carry larger balances for longer. We suspect this is because the fixed utility cost of default matters less to rich people since their utility level is generally high and

they are more willing to risk default. Regardless, their welfare is higher under the Flex loan than the EMI.

It is noteworthy that aggregate default frequency in this Flex-Loan world is 0.3 percent, less than 1/2 of the aggregate default frequency in th EMI world.

Figure 12
Interest Rates on a Small Loan, Flex vs EMI

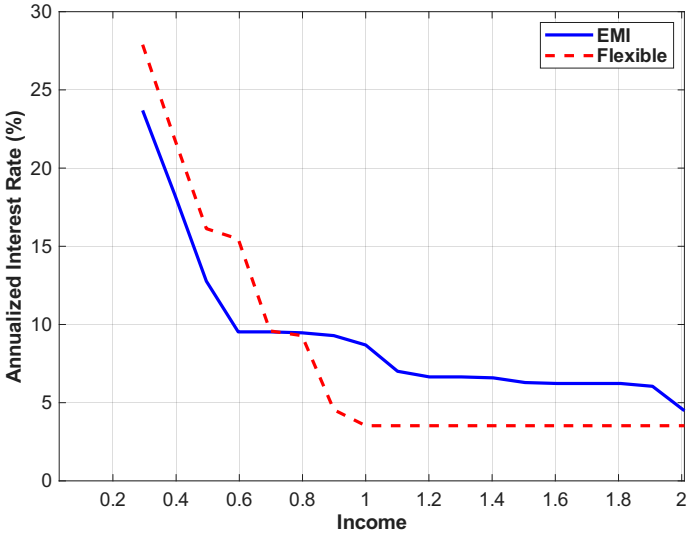
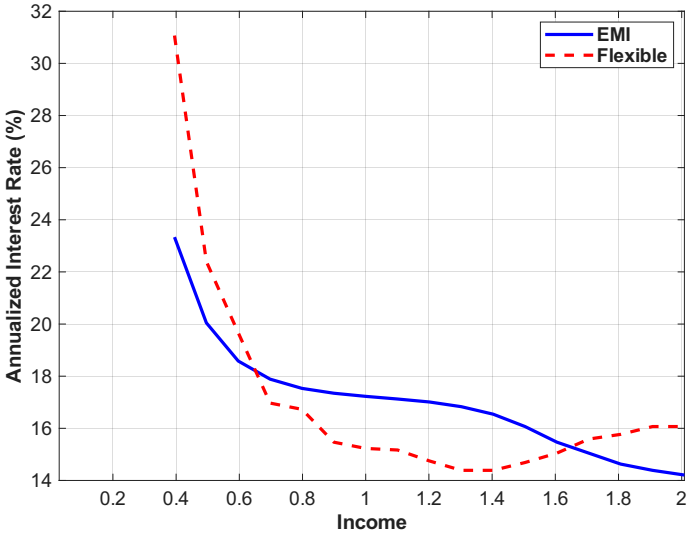


Figure 13
Interest Rates on a Large Loan, Flex vs EMI



9 Summary

This paper builds and analyzes a model of consumer debt with EMI loans as the sole form of borrowing. The borrower chooses a contract from an offered menu. Each contract comprises an amount and a tenure, and the lender determines the interest rate. These three objects determine the installment payment due every month over the chosen tenure. This contract structure is different from the vast literature on consumer debt and defaults which mostly assumes one-period loans, and the literature on sovereign debt because here the lenders commit not to reprice the loans as new income information is revealed for each borrower. Competitive lenders take this commitment into account and set the interest rates accordingly.

The model quantified with data on the income and borrowing behavior of urban Indian households and on EMI loan performance data from a large NBFC. The quantification of the model is largely successful and generates insights into why Indian households borrow and why they default. Households borrow to finance large expenditure needs and default in response to bad income shocks.

The model sheds light on the value of contract features such as prepayment penalties and on prospects of innovation in India's consumer loan industry. We found that default frequency is substantially lowered and welfare is generally higher for most people for contract structures that permit flexibility in payments. Flexibility allow households to delay payments when hit with adverse income shocks. While this may temporarily raise household indebtedness, in the long run there a fewer defaults.

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