Choices by Poor Households When the Interest Rate for Deposits Differs From the Interest Rate for Loans

Mark Schreiner, Douglas H. Graham, and Mario Miranda

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Microfinance Risk Management
6070 Chippewa St. #1W, St. Louis, MO 63109-3060, U.S.A.
Telephone: (314) 481-9788, http://www.microfinance.com
and
Center for Social Development
Washington University in St. Louis
Campus Box 1196, One Brookings Drive, St. Louis, MO 63130-4899, U.S.A.

Abstract

Poor households try to save and to borrow to smooth consumption in the face of low and uncertain streams of income. They are constrained by credit limits and by the spread between the price paid for loans (borrowing) and the price earned for deposits (saving). Models of household choices that include all these facts are intractable. I use orthogonal polynomial projection methods to solve a Bellman equation of this model for a household with an infinite horizon and with rational expectations over uncertain future income. I use changes in the optimal choices of the household and in the long-run distribution of its consumption to suggest the effects of reduced costs of access to formal financial services. As the spread narrows, there is less disintermediation—households are more likely to borrow or to save. Still, sometimes the best choice is neither to save nor to borrow. This means that the long-run distribution of consumption has more than one mode. Simulations of the optimal decision rule suggest that favorable interest rates help poor households to increase and to smooth consumption. The model formalizes some of the ways in which access to formal financial services can improve the welfare of poor households.

Authors' Note

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1. Introduction

I use orthogonal polynomial projection to solve and to simulate a dynamic model of optimal choices by a poor household with an infinite horizon and with rational expectations over uncertain future income. The household faces a credit limit, and the interest rate on savings (deposits) differs from the interest rate for loans (borrowing). I compare two cases of interest rates. The effects on household decisions of a change in the spread suggest the effects of reduced costs of access to formal financial services.

I model five basic features of a poor household and its financial contracts. First, poor households both borrow and save. They borrow from formal or informal lenders, and households save in financial deposits or in real goods. Second, poor households face a credit limit. Third, financial contracts take place through time. Resources are lent in the present for the promise to repay in the future, so saving/borrowing choices in the present affect consumption in the future. Fourth, poor households earn less for saving than they pay for borrowing. Fifth, income for poor households is variable and uncertain (Besley, 1995).

The model also omits at least 10 basic features of the financial contracts used by poor households. First and most important, the possibility, prevention, and punishment of default affect financial contracts. Second, households smooth both consumption and income, so production and consumption choices depend on each other (Morduch, 1995). Third, the transaction costs of small loans or deposits swamp the interest earned or paid. I model changes in transaction costs as changes in the spread between the interest rates for deposits and loans. This makes transaction costs vary with the size of the loan or deposit. In reality, most transaction costs are fixed despite the size of the loan or deposit. Fourth, I model financial contracts as credit cards or passbook accounts. Financial contracts often involve multi-period commitments such as installment loans or certificates of deposit. Fifth, most loans require collateral. Sixth, both savings and borrowing may be non-zero at once. Seventh, households engage in non-financial saving and borrowing. Eighth, contracts may have non-divisibilities. Ninth, households may save not only for precautionary motives but also for investment, speculation, and convenience. Tenth and finally, interest rates and institutions are determined endogenously in general equilibrium.

Because of algebraic complexity, no single analytic model has captured more than a couple of these features (*e.g.*, Mendelson *et al.*, 1982; Helpman, 1981). Many models omit credit limits, but without explicit restrictions on the utility function, the optimal decision is then to play a Ponzi game. Few analytic models recognize the fact that borrowing costs more than saving pays.

My results extend those of Deaton (1991, 1992). Simulations suggest that more favorable interest rates increase the mean of consumption and decrease its variance. Thus, access to formal financial services and/or lower transaction costs for financial transactions can improve the welfare of poor households. This is necessary but not sufficient to justify interventions in financial markets designed to help households.

There are four more sections. Section II presents the model. Section III discusses the optimal decision rules. Section IV examines the long-run distribution of consumption. Section V concludes.

2. The Model

I formulate the decision problem of the poor household as a Bellman equation. Time is indexed by t. If the household lives 40 years and makes financial decisions weekly or monthly, then the horizon is effectively infinite. The household has rational expectations over labor income $\tilde{y}_t$. Labor income is an i.i.d. random variable realized at the start of each period. The per-period discount rate is δ. The time-separable, time-invariant, per-period utility function $U(\cdot)$ is defined over a single composite consumption good c_t whose price is unity. More consumption increases utility but at a decreasing rate, so the household is risk-averse.

The poor household chooses a level of net saving s_t. *Borrowing* is negative net saving. With formal financial contracts or with low transaction costs, deposits earn an interest rate of d_f and loans cost an interest rate of l_f. In contrast, the interest rates with informal contracts or with high transaction costs are d_i and l_i. Formal deposits earn more than informal savings, and formal loans cost less than informal loans:

$$\mathrm{r}\,(s_t) = \begin{cases} d \text{ if } s_t > 0 \\ l \text{ if } s_t \leq 0 \end{cases} \quad \text{where}$$

$$d = \begin{cases} d_f \text{ with formal savings or low transactions costs} \\ \\ d_i \text{ with informal savings or high transactions costs} \end{cases} \tag{1}$$

$$l = \begin{cases} l_f \text{ with formal loans or low transactions costs} \\ \\ l_i \text{ with informal loans or high transactions costs} \end{cases}$$

$$d_f > d_i,\ l_f < l_i,\ \text{and}\ d_k < l_k,\ k = i,\ f.$$

On the savings side, several forces make the rate of return to informal saving low and usually even negative: households usually lend informally to friends or relatives for low or no interest; stocks of grain or building materials depreciate; inflation erodes cash balances; and relatives seek gifts from liquid households (Binswanger *et al.*, 1986). In contrast, formal deposits hide wealth from relatives and provide safer, higher returns.

On the borrowing side, formal loans should be cheaper than informal ones. For example, moneylenders often charge astronomical rates. In addition, the reduced transaction costs implicit in loans from friends or relatives are more than overcome by the opportunity cost of maintaining the social ties required to get informal loans. The revealed preference of borrowers and savers in developed economies for formal financial contracts shows that, at least in deep financial markets, formal contracts offer more than informal contracts.

The household starts each period with wealth w_t, the sum of labor income, net saving from the past period, and any interest from net saving in the past period:

$$w_t = \tilde{y}_t + s_{t-1} \cdot [1 + r(s_{t-1})]. \tag{2}$$

The household allocates wealth between consumption and savings:

$$w_t = c_t + s_t. \tag{3}$$

New households have no savings. Borrowing is less than the credit limit k, and saving is less than wealth:

$$k \le s_t \le w_t. \tag{4}$$

The value function $\mathbf{V}(w_t)$ is the sum of current and discounted expected future utility, given current wealth and optimal decisions in all future periods. The Bellman equation for the maximization problem of the household is:

$$\mathrm{V}(w_t) = \max_{k \le s_t \le w_t} \mathrm{U}(w_t - s_t) + \left(\frac{1}{1+\delta}\right) \cdot \mathrm{E_t}\, \mathrm{V}\{\tilde{y}_{t+1} + s_t \cdot [1 + \mathrm{r}(s_t)]\}, \tag{5}$$

with $\mathbf{r}(s_t)$ defined as in (1).

Equation (5) is a functional equation in $\mathbf{V}(\cdot)$. Since w_t is continuous, the solution function $\mathbf{V}(\cdot)$ must make (5) hold at an infinite number of values of w_t. Savings is the function $\mathbf{f}(w_t)$ that maximizes (5). Given assets and savings, (3) gives consumption.

The parameterization of (5) follows Deaton (1992). Utility is CARA(2). This assumption has some empirical support (Hildreth and Knowles, 1982; Kydland and Prescott 1982; Friend and Blume, 1975; and Tobin and Dolde, 1971). What drives the results is not the exact number used but rather the fact that the poor household is risk-averse.

With favorable interest rates, deposits earn 5 percent and loans cost 25 percent. The spread is narrow at 20 percentage points. With unfavorable interest rates, savings earn -5 percent and loans cost 50 percent. The spread is wide at 45 percentage points. The credit limit is 10. Again, the results are driven not by the exact numbers but by the fact of the credit limit and by the fact of the spread.

Income is Normal with mean 100 and standard deviation 10. The discount rate δ is 10 percent. These choices match those of Deaton (1992) and Dercon (1992). I cannot defend these choices as empirical facts. I made these choices to ease comparisons between the simple model of Deaton (1992) and the same model with a credit limit and a spread between the interest rate on savings and loans.

Miranda (1994) and Judd (1991) show why numerical solutions of (5) by orthogonal polynomial projection are more accurate, elegant, and quick than the grid techniques of Deaton (1991, 1992). Numerical techniques represent the value function with a polynomial with nice approximation properties. Given an initial guess for $\mathbf{V}(\cdot)$ at a few well-chosen levels of wealth, I use the first-order conditions of (4) to solve for the level of savings that maximizes $\mathbf{V}(\cdot)$, taking the current approximation to $\mathbf{V}(\cdot)$ as given when evaluating the right-hand side of (5). I approximate the distribution of the income shock with Gaussian quadrature. This process iterates until $\mathbf{V}(\cdot)$ converges.

3. Optimal Decisions

Figure 1 shows optimal savings as a function of wealth. Consumption is wealth less savings. The solid line stands for choices with favorable interest rates, and the dashed line stands for choices with unfavorable interest rates. The wiggles reflect approximation error.

I glean four insights from Figure 1. First, low levels of wealth lead to borrowing. That is, net savings is negative. In fact, a household may borrow so much that the credit limit binds, as at wealth levels below 75 units for poor households in the favorable case. The cheaper the loan, the higher the level of wealth at which a household will start to borrow. In practice, more poverty means a hungry household waits longer before it will borrow.

Second, sometimes households consume all their assets and neither save nor borrow. That is, net saving is zero. This flat stretch of the net-savings function comes from the unequal interest rates for saving and borrowing. It disappears when the two rates are the same, as most analytical models assume and even as is assumed by some models solved with numerical techniques (*e.g.*, Deaton, 1992; Dercon, 1992).

This is how the flat stretch comes about. For some levels of wealth, one more unit of consumption in the present is worth more than the discounted expected value of one more unit plus interest in the next period, but less than the discounted expected value of not having to repay an extra unit plus interest in the next period. The range of disintermediation decreases as the spread between the interest rates for loans and deposits decreases.

This flat stretch in the net savings function may be part of the answer to the puzzle of why so many poor households have no deposits or loans at all (Hubbard, Skinner, and Zeldes, 1994). With a low reward for deposits and a high price for loans, a poor household might maximize utility by living hand-to-mouth.

Third, the household saves at high levels of wealth. Furthermore, the interest elasticity of saving increases as the return to saving increases. Not only does the household begin saving at lower levels of wealth, but the rate at which the household increases savings as wealth increases also increases. This matches the stylized fact that although rich and poor both save, the rich save a larger percentage of their income than the poor.

For this parameterization, increasing the return to savings increases savings more than decreasing the cost of borrowing decreases savings. This happens since cheaper loans reduce the need for a buffer of savings. In results not shown here, deposits decrease as loans get cheaper and the need to self-insure falls, all else constant.

Fourth, poor households will save even with negative returns and borrow even at exorbitant rates since they want very much to avoid episodes of low consumption. The desire to borrow when consumption is low helps explain the high rates charged by loan sharks and moneylenders (Adams and Fitchett, 1992).

Figure 1 shows decision rules. Given wealth on the horizontal axis, the vertical axis of Figure 1 depicts the level of net savings that maximizes the sum of current and discounted expected future utility over an infinite horizon. The decision rules alone do not reveal, however, the particular levels of savings and consumption of a poor household using the optimal decision rule through time. Nor do they reveal how interest rates affect how the household can smooth consumption.

4. The Long-run Distribution of Consumption

To approximate the long-run distribution of consumption for both the favorable and unfavorable scenarios, I simulated a poor household using the decision rules in Figure 1 for 100,000,000 periods (Figure 2). In the unfavorable case (dashed line), the mean of consumption is 99.88 with a standard deviation of 8.34. In the favorable case (solid line), the mean was 100.14 with a standard deviation was 6.02.

More favorable interest rates smooth consumption in two ways. First, cheaper loans help to avoid low consumption. The extreme left tail of the distribution of consumption is thinner with favorable rates than with unfavorable rates.

Second, more rewards for saving decreases episodes of high consumption. The extreme right tail of the distribution of consumption with favorable rates is inside the extreme right tail of the distribution with unfavorable rates. Increased savings and the higher interest earnings pad the buffer of the household against poor income draws.

Figure 2 highlights two other insights. First, savings and loans both buffer consumption but not in the same way. This skews consumption to the left. The credit limit means the poor household can avoid gluts easier than famines. In addition, loans cost more than savings earn.

Second, the distribution of consumption has three modes. Roughly speaking, this happens since the overall distribution is a mixture of the distributions of current assets conditional on the levels of net savings in the past period. Only the tail modes require explanation, and the modes in the left tail (91 units with favorable rates and 82 units with unfavorable rates) are the most interesting. These peaks happen since, when wealth is near the range where borrowing starts, a wide range of wealth maps into a narrow range of consumption. For example, consumption is almost the same when wealth is just below the point where nothing is saved or borrowed as when wealth is just above that point. The need to repay old debt and interest means that the conditional mean of wealth is lower if the household borrowed in the past period. This increases the likelihood of wealth being in the range where nothing is borrowed or saved or just in the range where something is borrowed. The same argument holds for deposits for the modes in the right tail (103 with favorable rates and 109 with unfavorable rates).

5. Conclusion

I solve and simulate a model of financial choices by a poor household with favorable and unfavorable interest rates. The model accounts for the uncertainty of income, the intertemporality of financial contracts, and the reality of credit limits and of different interest rates for loans and deposits.

Incorporating the features often missed by analytic models makes a difference. In particular, the spread between the interest rates for deposits and loans means that it is sometimes optimal neither to save nor to borrow. This disintermediation creates extra modes in the long-run distribution of consumption.

Simulations suggest favorable interest rates help the household increase mean consumption and decrease its variability. These results strengthen the idea that formal finance and/or decreased transactions costs can improve the welfare of poor households. They do not, however, justify interventions in financial markets. All I find is that benefits could be positive. I do not measure the level of benefits, nor do I measure costs.

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Figure 1

Optimal Decisions With Different Interest-Rate Spreads

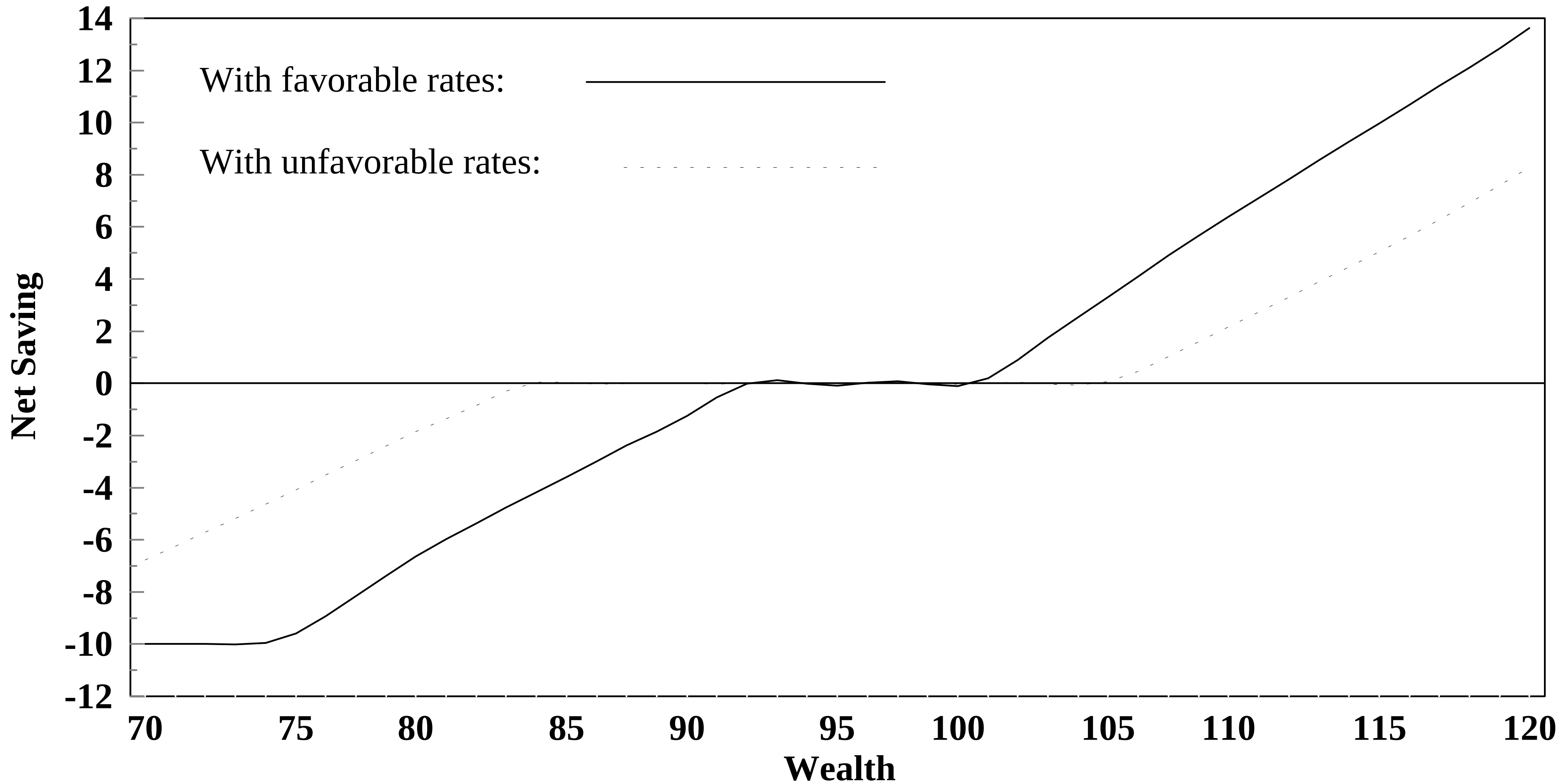

Figure 2

Long-Run Distribution of Consumption With Different Interest Rates