WORKING PAPER · NO. 2024-43

Access to Credit Reduces the Value of Insurance

Sonia Jaffe, Anup Malani, Julian Reif

MARCH 2024

THE UNIVERSITY OF CHICAGO
BECKER FRIEDMAN INSTITUTE
FOR ECONOMICS

5757 S. University Ave.
Chicago, IL 60637
Main: 773.702.5599
bfi.uchicago.edu

Access to Credit Reduces the Value of Insurance*

Sonia Jaffe, Anup Malani, Julian Reif†

March 2024

Abstract

We analyze the value of insurance when individuals have access to credit markets. Loans allow consumers to smooth financial shocks over time, decreasing the value of consumption smoothing from insurance. We derive formulas for the value of insurance that can be taken to data, and show how that value depends on individual characteristics and features of loans. We estimate that access to a five-year loan decreases the values of community- and experience-rated insurance for the average beneficiary by \$232–\$366 (58–61%). Even for the sickest decile, this loan access reduces the value of community-rated insurance by \$1,099 (17%).

JEL Codes: D1, I13

Keywords: insurance, credit markets

*We thank Bartek Woda for excellent research assistance. We are grateful to participants at the Becker Friedman Institute Health Economics Initiative Annual Conference, the University of Southern California, and the University of Chicago Law School for helpful comments and feedback.

†Sonia Jaffe: Microsoft (email: sonia.jaffe@microsoft.com); Anup Malani: University of Chicago Law School and NBER (email: amalani@uchicago.edu); Julian Reif: Gies College of Business, University of Illinois, and NBER (email: jreif@illinois.edu)

1 Introduction

A primary purpose of insurance is to help consumers smooth consumption over time in the presence of financial shocks. Many studies have combined insurance theory with medical spending data to estimate the risk-reduction value of health insurance (Feldstein and Gruber, 1995; Finkelstein and McKnight, 2008; Engelhardt and Gruber, 2011; Shigeoka, 2014; Barcellos and Jacobson, 2015; Limwattananon et al., 2015).[1] Insurance is not, however, the only financial technology for smoothing consumption. Consumers can also save and borrow. Yet prior studies generally do not account for alternative consumption-smoothing technologies, so they may overstate the value of insurance by comparing it to a counterfactual with no other smoothing technology.

This paper studies the value of insurance in a setting where consumers who face a generic financial shock can choose to smooth consumption with insurance or with borrowing. Our contribution has two parts. First, we develop a model where consumers choose whether to purchase insurance; if they decline insurance, they can take out a loan to cover an expenditure shock if it occurs. We provide analytic and approximation formulas for the value of insurance in the presence of credit markets. Second, we apply our formulas to health expenditures data from the Medical Expenditure Panel Survey (MEPS) to measure the drivers of value from health insurance.

Our analysis yields several policy-relevant insights. First, we show that insurance and loans act as substitutes; for example, health insurance becomes less valuable when consumers also have access to loans to cover medical expenditures, for both experience- and community-rated insurance. In a baseline case with actuarially-fair insurance, we calculate that the availability of a 5-year loan reduces a consumer's value of experience-rated insurance by \$232 (58%) and of community-rated insurance by \$366 (61%), relative to a setting with no loan markets. The value of insurance falls even under for cases where we expect the value of insurance to be greatest: for the sickest decile, access to a 5-year loan reduces the value of community-rated insurance by \$1,099 (17%). We obtain similar results after adding price markups to insurance and loans.

Increasing the ease of borrowing by increasing the length of the payback period or reducing interest rates reduces the value of insurance. The value of insurance decreases with the length of time for which an individual can borrow: access to a 2-year loan reduces the value of experience-rated insurance by \$159 (40%), access to a 5-year loan reduces the value by \$233 (58%), and access to a 10-year loan reduces the value by \$254 (64%). Likewise, a

[1] A similar willingness-to-pay calculation is used in valuation of disability insurance (e.g., Deshpande and Lockwood, 2022).

reduction in the interest rate markup on loans reduces the value of insurance: reducing the interest rate on a 5-year loan from 8.40% to 2.78% reduces the value of community-rated insurance by $107 (25%).

A second insight is that access to loans reduces the value of insurance more for low-income households than for high-income households. Intuitively, financial spending shocks are more costly for people with low income, so an additional consumption-smoothing technology is worth more to them. We calculate that actuarially-fair, experience-rated insurance is worth $1,265 to a household making $20,000–$30,000 per year, but only $110 to a household making $175,000–$200,000, when loans are unavailable. The introduction of a 5-year loan reduces the value of insurance by $851 (67%) for the lower-income household, but only by $54 (49%) and for the higher-income household.

Finally, our approximation formula, which can be taken to aggregate data on the mean and variance of medical expenditures, performs reasonably well as compared to our exact formula across different loan lengths.

The remainder of this paper has three parts. Section 2 reviews the literature on the value of insurance. Section 3 presents a model of consumer choice between insurance and loans to smooth financial shocks. Section 4 applies formulas implied by the model to MEPS data.

2 Literature review

This paper contributes to three strands of literature on insurance. The first strand measures the consumption-smoothing value of insurance. A canonical paper is Finkelstein, Hendren and Luttmer (2019), which values Medicaid using data from the Oregon Health Insurance Experiment. They offers two approaches to estimate the impact of insurance on consumption. The first equates out-of-pocket (OOP) payments with lost consumption. This approach can overestimate the value of insurance because it assumes that consumers have no access to credit markets. The second approach examines consumption with and without insurance, which will reflect the savings or borrowing consumers use to smooth consumption. However, this approach underestimates the value of insurance if the researcher lacks data on critical periods where health shocks significantly reduced consumption among those without insurance.

We contribute to this first strand of literature by developing a new method for valuing consumption smoothing. Our approach reallocates OOP payments over time using borrowing, and the length of loans can be greater than the periods of consumption observed. This means that concurrent consumption decreases by less than OOP. But consumption may fall by than the reduction directly observed by the investigator. Therefore, our approach yields a valuation of insurance in between the two approaches in the last paragraph.

A second strand of insurance literature includes studies that value insurance in a setting where consumers have access to credit. (These studies contrast with those cited in the introduction, which assume that consumers do not have access to saving and borrowing.) This strand examines a variety of insurance markets, from weather (de Nicola, 2015) to auto and property (Hansen, Jacobsen and Lau, 2016) to healthcare. Our analysis is most closely related to Handel, Hendel and Whinston (2015), who calculate the welfare value of one-year health insurance contracts under community- versus experience-rating. We, by contrast, estimate how the value of experience- and community-rated health insurance changes when consumers gain access to credit markets.

A third strand of insurance literature examines the interplay of health insurance and debt. One portion of this literature examines the effect of insurance on indebtedness (e.g. Mazumder and Miller, 2016; Barcellos and Jacobson, 2015; Hu et al., 2018; Caswell and Goddeeris, 2019; Goldsmith-Pinkham, Pinkovskiy and Wallace, 2021; Batty, Gibbs and Ippolito, 2022). However, these papers do not typically calculate the value of access to loans, which is our contribution. One paper that allows for credit markets is Brevoort, Grodzicki and Hackmann (2020), which calculates the value of health insurance allowing consumers to avoid the impact of unpaid bills on their credit scores and future access to credit. Our paper takes a simpler approach and assumes debt is directly repaid rather than indirectly redressed in the form of curtailed access to future credit.

Another portion of this third strand of literature suggests that protection against excess debt (e.g., access to bankruptcy) and health insurance are substitutes (Gross and Notowidigdo, 2011; Mahoney, 2015). But bankruptcy typically provides relief only from extreme financial events; these events are relatively rare, even among the uninsured (Dobkin et al., 2018; Malani, 2021). By contrast, our study examines how access to debt, rather than relief from debt, affects the value of health insurance. In this context, a reduction in loan interest rates benefits consumers, even if they are not facing bankruptcy, and thus reduces the value of insurance in many more states of the world.

3 Theory

This section presents a model of consumer choice between insurance and financial loans. We assume that people can only take out loans to cover expenditure that would otherwise have been covered by insurance (e.g., covered medical costs in the case of health insurance), and that they cannot otherwise use saving and borrowing to smooth consumption across time. Because we hobble credit markets in this manner, our model provides an upper bound on the value of insurance.

Previous studies have generally considered a single period with no credit markets (e.g., Engelhardt and Gruber, 2011; Finkelstein and McKnight, 2008; Deshpande and Lockwood, 2022). Because we allow borrowing, our model must include multiple periods. We focus the model on the choice of insurance or loans in a single period, and assume that the consumer has insurance in all other periods. Consequently, our empirical estimates can be interpreted as the annual value of insurance, similar to other studies.[2]

With a multi-period model, we cannot use the standard "certainty equivalent" approach to valuing insurance, which asks how much consumption a consumer is willing to sacrifice to smooth consumption across states, because the answer would depend on which period the individual is asked to sacrifice consumption. Instead, we calculate the difference in utility from consumption flow with and without an insurance contract, and then obtain a dollar amount by normalizing by the marginal utility of consumption. An incidental benefit of our approach is that it yields a closed-form solution for the value of insurance, which is not possible with the certainty equivalent approach to calculating WTP.

We first illustrate our main results using a simplified model where individuals face only one financial risk per period. We then extend the model to allow for multiple shocks, savings, and loan fees.

3.1 One-shock model

A consumer lives for T periods and earns income y in each period. Consumption, c, is equal to income net of financial shocks and any credit market transactions. We assume the period utility function, $u(c)$, is strictly increasing, concave, and continuously differentiable, and denote the consumer rate of time preference as β. In each period, the consumer faces a financial risk that, with probability π, reduces her income available for consumption by p. We allow the risk of this shock, but not its magnitude, to vary across consumers, and we assume shocks are serially uncorrelated. Thus, the only parameters that vary cross consumers are T, y, and π.

The consumer can smooth her consumption by purchasing insurance or by borrowing. We assume the consumer purchases insurance in periods $2, \ldots, T$, and focus our attention on the consumer's purchase decision in period 1. If she chooses not to purchase insurance, she has the option to borrow in case of a financial shock in that period.

If the consumer purchases insurance, she pays a premium at the beginning of the period equal to the actuarially-fair cost of insurance multiplied by a markup, m^I. The actuarially-

[2]This interpretation assumes that costs of health shocks are serially uncorrelated. See Kowalski (2015) for an analysis of how serial correlation increases the value of insurance.

fair premium depends on how insurance is priced. If insurance is community-rated, then the fair premium, $\pi^C p$, depends on the average risk of the people in the insurance pool, π^C. If insurance is experience-rated, then the fair premium, πp, depends on the consumer's own risk, π. To avoid the possibility of unraveling, we assume that insurance is either only community-rated with a single pool or is only experience-rated, and is priced the same in each period (Rothschild and Stiglitz, 1976).

We assume that there is only one insurance contract available and that it is complete, i.e., no co-pays, deductibles, or co-insurance. We also assume there is no adverse selection. The markup on the insurance premium, m^I, accounts for additional costs such as administrative fees and moral hazard. We assume that m^I is low enough that, absent loans, consumers will want to buy insurance, since we are not interested in how loans change the value of insurance if people were not buying it to begin with.[3]

If insurance is community-rated and the individual chooses to purchase insurance in period 1, her lifetime utility is:

$$V^I(\pi^C) = \frac{1-\beta^T}{1-\beta} u\left(y - m^I \pi^C p\right)$$

The individual must pay a premium each period, which reduces her consumption by $m^I \pi^C p$.

If the consumer chooses a loan instead of insurance, she must pay back p over n periods at an effective interest rate, r^e. This effective interest charged depends both on the interest rate r corresponding to the time preference (with $\beta = \frac{1}{1+r}$) and the interest rate markup r^m:

$$r^e = r + r^m$$

We require that $n \leq T$, so that people must fully pay back loans. There is no debt relief or bankruptcy. The repayment amount is αp per period during periods 1 through n, where:

$$\alpha(r^e) = \frac{1 - \frac{1}{1+r^e}}{1 - \left(\frac{1}{1+r^e}\right)^n}$$

Thus, α is increasing in the effective interest rate and decreasing in the length of the loan.

An alternative to using an interest rate markup $r^m \geq 0$ is to use a markup on principal,

[3] This requires that $m^I < 1/\pi^C$ or $m^I < 1/\pi^C$, depending on whether insurance is community- or experience-rated. For individuals to buy full insurance, the cap on m^I is even lower.

$m^L \geq 1$, so that the per-period payment on a loan with principal of p would be $m^L\alpha(r)p$.[4] The loan markup, m^L, is easier to compare to the insurance markup, m^I, but less relevant to real-world settings that price loans using interest rates.

Just as a markup on insurance may cause a person to purchase incomplete insurance, a markup on interest rates may cause a person to not fully smooth consumption over time. In our simplified model, we assume that $r^m = 0$ (equivalently, $m^L = 1$) so that individuals choose to fully smooth consumption. This assumption also implies $\beta = 1/(1+r^e)$ and $\frac{1-\beta^n}{1-\beta} = \frac{1}{\alpha(r)}$, which simplifies our equations. To simplify notation, we drop the dependence of α on r until we consider interest rate markups in Section 3.4.

The consumer's utility when she declines to purchase community-rated insurance in period 1 is:

$$\begin{aligned} V^L(\pi^C) = (1-\pi)\left(u(y) + \frac{\beta - \beta^T}{1-\beta}u(y - m^I\pi^C p)\right) \\ + \pi\left(\frac{1}{\alpha}u\left(y - m^I\pi^C p - \alpha(1-m^I\pi^C)p\right) + \frac{\beta^n - \beta^T}{1-\beta}u(y - m^I\pi^C p)\right) \end{aligned}$$

With probability $(1-\pi)$ there is no shock and the individual loses no consumption in period 1, but she must pay premiums in periods 2 through T. With probability π there is a shock and the individual pays a part of the shock $(m^I\pi^C p)$ directly and borrows the remainder of the shock $((1-m^I\pi^C)p)$ to smooth consumption in the first n periods. In periods 2 through n, she pays the premium for that period and her per-period loan repayment. Thus, in periods 1 through n, the individual pays $m^I\pi^C p + \alpha p(1-m^I\pi^C)$. From period $n+1$ onward, the individual pays only her insurance premium.

The incremental utility from community-rated insurance over loans is:

$$\begin{aligned} V^{\Delta,L}(\pi^C) = V^I(\pi^C) - V^L(\pi^C) = (1-\pi)\left(u(y - m^I\pi^C p) - u(y)\right) \\ + \frac{\pi}{\alpha}\left(u(y - m^I\pi^C p) - u(y - m^I\pi^C p - \alpha p(1-m^I\pi^C))\right) \end{aligned} \tag{1}$$

If the individual takes out insurance and there is no shock, she loses the premium $m^I\pi^C p$ in period 1. However, if there is a shock, then the individual gains for the first n periods because she avoids having to repay $\alpha\left(1 - m^I\pi^C\right)p$ each period on a loan. In the special case where $n = 1$ (which implies $\alpha = 1$), this expression simplifies to the conventional value

[4] The two markups are related to each other by the formula:

$$m^L(r^e) = \frac{1 - \frac{1}{1+r+r^m}}{1 - \left(\frac{1}{1+r+r^m}\right)^n}\frac{1 - \left(\frac{1}{1+r}\right)^n}{1 - \frac{1}{1+r}}$$

of insurance, ignoring the possibility of taking out a loan.

3.1.1 Discussion

Our basic model yields several insights regarding the value of insurance.[5] First, we note that if insurance is actuarially fair ($m^I = 1$) and experience rated ($\pi^C = \pi$) then the incremental value of insurance is positive. In other words, it is always optimal to choose actuarially-fair, experience-rated insurance over loans.

Second, increasing access to credit reduces the incremental value of insurance. For example, consider an increase in the loan repayment period, n. We show in the Appendix that an increase in n must reduce the value of insurance in this setting. Intuitively, a consumer does not have to choose a longer repayment period unless she benefits from it, so the option value of larger n is always (weakly) positive. Likewise, lowering the interest rate markup r^e would also make credit markets more accommodating. However, we cannot show this just yet as we have assumed here that $r^m = 0$. We will show that rate markups lower the incremental value of insurance in Section 3.4, which explicitly permits loan markups.

Third, the effect of loan markets on the value of insurance is smaller for higher-income people. It's well known that the conventional value of insurance in a setting without loan markets declines with income: a financial shock reduces marginal utility less for a high-income person than a low-income person. Consequently, when consumers gain access to loan markets, the subsequent reduction in the value of insurance is smaller for higher-income people, because their initial valuation was already small.[6]

3.2 Multiple shocks

To make our model more realistic, we modify it to allow multiple financial shocks. All consumers face the same set of price shocks, but the probabilities of those shocks can differ across individuals. For a given consumer, let shock i occur with probability π_i and produce cost p_i. In keeping with our prior notation, let $\mathrm{E}^C[p]$ denote the community-rated fair premium, where pricing depends on the expected costs of all individuals in the risk pool.

[5] The Appendix reports other comparative statics, including the effect on utility of changes in markups or in the risk/magnitude of the price shock.

[6] Because higher-income households have lower marginal utility of consumption, converting incremental value to dollars inflates the value of insurance for higher-income households relative to lower-income households. Our empirical analysis shows that this countervailing effect does not dominate, however.

Extending Equation (1) to allow for multiple shocks yields:

$$V^{\Delta,L}(\mathrm{E}^C[p]) = \sum_{i:p_i<m^I\mathrm{E}^C[p]} \pi_i \left(u(y - m^I\mathrm{E}^C[p]) - u(y-p_i)\right) + \frac{1}{\alpha} \sum_{i:p_i>m^I\mathrm{E}^C[p]} \pi_i \left(u\left(y - m^I\mathrm{E}^C[p]\right) - u\left(y - \alpha p_i - (1-\alpha)m^I\mathrm{E}^C[p]\right)\right) \quad (2)$$

The individual must choose whether to insure all of her period 1 shocks or none of them. If an individual chooses not to purchase any insurance, she uses loans to smooth only the portion of her shocks that exceeds the insurance premium.[7] The first term in (2) captures cases where the financial shock, p_i, is smaller than the premium, $m^I\mathrm{E}^C[p]$. Here, an individual without insurance just pays directly out of present consumption; the incremental value of purchasing insurance is negative in this case since the premium exceeds the size of the shock. The second term in (2) captures the cases where the shock is larger than the insurance premium. Here, the incremental value of insurance is positive. If the individual had not purchased insurance, then she would pay an initial amount, $m^I\mathrm{E}^C[p]$, and then borrow the remaining amount, $p_i - m^I\mathrm{E}^C[p]$.

3.3 Savings and a Taylor approximation

Using Equation (2) to quantify the value of insurance requires data on financial shocks, which may not be available at the individual level. By taking a second-order Taylor approximation of Equation (2), the dollar value of insurance can alternatively be approximated using only data on the population mean and variance of shocks. Implementing this approximation directly would require conditioning the mean and variance on whether price is above or below the community-rated premium, which in turn requires either knowing the full distribution of shocks (thereby defeating the purpose of this exercise) or assuming a convenient functional form. We will therefore make the simplifying assumption that individuals can save for n periods as well as borrow over that duration.

A person who saves will change her behavior when she experiences a shock of $p_i < m^I E^C[p]$ in period 1: she will take the $m^I\mathrm{E}^C[p] - p_i$ she is not spending on insurance or medical expenditures in period 1 and spread it across n periods, producing the following

[7] Recall that by assumption the individual purchases insurance in periods $2, 3, ..., T$. Thus, an optimizing agent who wants to smooth consumption over time will not borrow against future consumption until the size of the first period shock equals the cost of future premiums. This issue was not relevant in Section 3.1 because of our assumption that $m^I < 1/\pi^C$, which guaranteed that the price shock was greater than the premium.

expression for the value of insurance:

$$V^{\Delta,LS}(\mathrm{E}^C[p]) = \frac{1}{\alpha}\sum_i \pi_i \left(u\left(y - m^I\mathrm{E}^C[p]\right) - u\left(y - m^I\mathrm{E}^C[p] - \alpha\left(p_i - m^I\mathrm{E}^C[p]\right)\right)\right) \tag{3}$$

Because the banking system now allows both borrowing and saving, the relative value of insurance falls, i.e., $V^{\Delta,LS} < V^{\Delta,L}$.

Taking a second-order Taylor approximation around $\tilde{y} = y - m^I\mathrm{E}^C[p]$ then yields:

$$V^{\Delta,LS}(\mathrm{E}^C[p]) \approx \frac{1}{\alpha}\sum_i \pi_i \left(u'(\tilde{y})\left[\alpha\left(p_i - m^I\mathrm{E}^C[p]\right)\right] - \frac{u''(\tilde{y})}{2}\left[\alpha\left(m^I\mathrm{E}^C[p] - p_i\right)\right]^2\right)$$

This weighted sum is an expectation from the perspective of an individual. If we then take the expectation across all individuals in the risk pool, regroup and divide by $u'(\tilde{y})$ we obtain:

$$\frac{V^{\Delta,LS}(\mathrm{E}^C[p])}{u'(\tilde{y})} \approx -(m^I - 1)\mathrm{E}^C[p] + \frac{1}{2}\frac{\gamma}{\tilde{y}}\alpha\left(\mathrm{Var}^C[p] + \left(m^I - 1\right)^2(\mathrm{E}^C[p])^2\right) \tag{4}$$

where γ is the coefficient of relative risk aversion and $\mathrm{Var}^C[p]$ is the variance of price. Intuitively, the dollar value of insurance is declining in the expected cost (because the markup m^I is multiplicative) and increasing in the variance of shocks and the relative risk aversion.

This approximation requires much less information to calculate than Equation (2). One only needs data on α, which can be calculated from r (or β) and the loan period, the markup m^I on insurance, the (community) mean and variance of medical spending shocks, the coefficient of relative risk aversion γ, and net-of-premium income $\tilde{y}$.[8]

3.4 Loan markups

Finally, we allow loans to have a markup, $r^m > 0$ (or $m^L > 1$). If a consumer borrows money, she must pay it back at an interest rate greater than her time preference, $r^e > r$, which increases the repayment rate: $\alpha(r^e) > \alpha(r)$. Introducing a loan markup complicates the analysis because the consumer will no longer perfectly smooth her consumption across periods. Rather than borrowing the entire portion of the shock that exceeds $pm^I\pi^C$, as in Equation (2), the consumer will borrow less.

Let $L^*(p_i)$ be the optimal loan amount for the individual when the shock is p_i and $r^e > r$.

[8] Note that for an apples-to-apples comparison of the incremental value of insurance using individual data and the approximation, one would convert the former into a measure of dollars by dividing by $u'(\tilde{y})$.

Generalizing Equation (2) yields:

$$
\begin{aligned}
V^{\Delta,L}(\mathrm{E}^C[p]) = & \sum_{i:p_i \leq p_{min}} \pi_i \left(u\left(y - m^I \mathrm{E}^C[p]\right) - u(y - p_i)\right) \\
& + \sum_{i:p_i > p_{min}} \pi_i \left[\frac{1}{\alpha(r)} u\left(y - m^I \mathrm{E}^C[p]\right)\right. \\
& \left. - \left(u\big(y - p_i + (1 - \alpha(r^e))L^*(p_i)\big) + \left(\frac{1}{\alpha(r)} - 1\right) u\left(y - m^I \mathrm{E}^C[p] - \alpha(r^e)L^*(p_i)\right)\right)\right]
\end{aligned} \tag{5}
$$

where $L^*(p_i) \geq 0$ satisfies the following first-order condition:

$$
(1 - \alpha(r^e))u'(y - p + (1 - \alpha(r^e))L^*(p_i)) = \alpha(r^e)\frac{\beta - \beta^n}{1 - \beta} u'\left(y - m^I \mathrm{E}^C[p] - \alpha(r^e)L^*(p_i)\right) \tag{6}
$$

and where p_{min} is defined implicitly as the price shock such that the individual doe not borrow, $L^*(p_{min}) = 0$. See the Appendix A.4 for details and for a derivation in the special case of CRRA utility, which we use in our quantitative analysis.

Adding an interest rate or loan markup to our model allows us to show analytically that those markups increase the value of insurance; the value of insurance is increasing in $\alpha(r^e)$, the repayment rate, which is itself increasing in the total interest rate paid, r^e.

4 Quantitative Analysis

4.1 Data

We obtain individual-level data on medical spending from the 1996–2014 Medical Expenditure Panel Surveys. We end our sample period in 2014, the first year the ACA's major provisions came into force. Because members of a household co-insure each other's risk, we perform our main analysis at the household level. We focus on the value of private insurance, so we drop households with members over age 65, who are age-eligible for Medicare, and with household income below 138% of the federal poverty line, the income-eligibility threshold for many Medicaid programs. Finally, we drop households where the oldest member is under the age of 22. Our final sample includes 334,230 adults in 135,570 households.

To estimate the distribution of medical expenditures faced by each household, we first predict medical expenditures at the individual level using a flexible function of geography, age, sex, and pre-existing medical conditions (see Appendix B for details). We then aggregate these predictions to the household level and classify households into deciles of predicted medical expenditures, conditional on family size. Finally, we use the distribution of actual medical expenditures in each decile to approximate the distribution of potential shocks faced ex ante by each household in that decile (Abaluck and Gruber, 2011).[9] Consequently, households in lower deciles face less spending risk than households in higher deciles, reflecting the notion that people have some information about their expected medical spending.

We cap healthcare spending shocks at the household's federal poverty level. Since our sample only includes households with income above 138% of the federal poverty level, this cap ensures positive consumption.[10] This assumption is consistent with the fresh start principle in bankruptcy law, which protects a person's future income from past debts (Jackson, 1984).

We consider both experience- and community-rated policies. While US healthcare insurance is largely community-rated, in some pockets it is meaningfully experience-rated. For example, individual experience can affect premiums in the small group market if the pool suffers from adverse selection. Furthermore, even under the ACA, insurers can price discriminate to some extent on age, family size, and health behaviors such as smoking.[11]

We set experience-rated premiums equal to average spending, conditional on household size and predicting spending decile. Similar to the ACA, we set community-rated premiums equal to average spending, conditional on household size, age group, and Census region. Age groups are defined as under 35, 35–44, 45–54, and 55–64. Premiums for households of size 2 are shown in Figure A.1. Community-rated premiums increase with age, but their overall range is smaller than the range spanned by experience-rated premiums. The smaller range of the community-rated premiums reflects cross-subsidization: individuals with high expected spending pay the same premium as those with low expected spending (conditional on age group and region).

Table A.1 shows summary statistics for our sample. The average age is 32, and 49% are female. Median income is \$24,937 (2014 dollars) for individuals and \$66,671 for households. On average, individuals have 1.32 self-reported chronic conditions, as measured using Clinical Classification Software (see Appendix B for details). The median household has 2 people (including children).

[9] The domain of the distribution of actual expenditures for a decile is not restricted to the range defining a decile, meaning a household in a low decile may have very large shocks (though with a low probability). Only the predicted expenditures lie in the decile.

[10] We also use this top-coded distribution in calculating the expected costs for the insurance premiums. Limiting the right-tail risk in this way inevitably decreases the value of insurance. Alternatively, we could set a consumption floor. The disadvantage of this approach is that it causes the distribution of health shocks and community-rated premiums to become income dependent.

[11] Prior to the ACA, small group insurers could discriminate between prices of different small pools of employees. Even under the ACA, insurers can discriminate so long as the highest premium charged to a pool member is no more than 3 times the price of the lowest premium charged to a pool member.

4.2 Model parameterization

We estimate the incremental value of health insurance using Equation (5), which allows for multiple health shocks and loan markups. We assume that utility exhibits constant relative risk aversion:

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma} \tag{7}$$

While there is no consensus regarding the precise value of γ, the coefficient of relative risk aversion, its value is conventionally set below 2 (Chetty, 2009). To be conservative, our main specification sets $\gamma = 2$, which raises the value of insurance relative to lower values of γ. Appendix A.4 provides the solution for the optimal loan amount, L^*, when utility takes a CRRA form. We set the consumer rate of time preference, β, equal to 0.95 (implying $r = 5.26\%$).

Our preferred specification assumes a 5% markup on insurance ($m^I = 1.05$). On the one hand, the Affordable Care Act capped medical-loss ratios (MLR, or $1/m^I$) at 85% for large insurers and 80% for small ones. As of 2022, the MLR for large group, small group and individual markets was 88%, 86%, and 83% (Ortaliza, Amin and Cox, 2023), which corresponds to $m^I \approx 1.15$. On the other hand, tax laws allow deduction of insurance premiums when computing taxable income. That subsidy is roughly equal to the average tax rate, which was 13.63% in 2000 (York, 2023). Accounting for both the MLR regulations and the tax subsidy implies a markup of $m^I \approx 1$. Because the average tax rate is right skewed, with an average tax rate of 3.1% for below median income taxpayers, we opt for an intermediate insurance markup of 1.05. We compare this markup to a baseline of $m^I = 1$ in our main figures, and to $m^I = 1.1$ and 1.15 in the appendix (Table A.3).

Our baseline assumption is no interest rate markup on loans ($r^m = 0$). While there are certainly administrative expenses for loans, our main application is healthcare markets, where the Emergency Medical Treatment and Labor Act (EMTALA) requires hospitals practically to treat uninsured patients before they charge them, and those charges do not include interest on late payments. Moreover, uninsured patients often negotiated prices down to levels even lower than what insurers pay (Mahoney, 2015) because they have the alternative option of discharging much of their debt through bankruptcy. To assess the sensitivity of our estimates to the interest rate markup, we also consider alternative scenarios that vary r^m from –2.78% up to 8.40%. Finally, our preferred specification assumes that the loan payback period is 5 years[12] , although we also show alternative specifications with shorter or longer payback

[12]We choose 5 years because it is close to the midpoint of the typical range of 2-7 years for consumer loans (Safier, 2023).

lengths.

We report all estimates in units of dollars by dividing $V^{\Delta,L}(n)$ and $V^{\Delta,L}(n=1)$ by the marginal utility of income, $u'\left(y - m^I \mathrm{E}^j[p]\right)$, where $j \in \{E, C\}$ depending on how insurance is priced.

4.3 Results

The availability of loans reduces the value of insurance. Figure 1(a) reports the average dollar value of experience-rated insurance for households of size 2, by decile of health-expenditure risk. The blue line reports our benchmark: the conventional value of actuarially-fair ($m^I = 1$) insurance when credit markets are absent. This value increases with decile of predicted spending, a familiar result. The average value of insurance is \$399.[13] The dashed red line shows that the value decreases substantially when credit is available: access to an actuarially-fair ($r^m = 0\%$), five-year loan reduces the average value of insurance by \$232, to \$167 (58%). The effect is large, in absolute and relative terms, across all deciles of predicted spending.

Markups cause the incremental value of experience-rated insurance over loans to fall to zero at lower deciles and negative at higher deciles. As a baseline, the green line in Figure 1(a) shows the conventional value (absent loans) of insurance when it is priced with a 5% markup ($m^I = 1.05$). The markup causes the conventional value to fall from \$214 to \$131 (-39%) for consumers in the lowest-risk decile. This value gap rises for consumers facing higher spending risks because markups are multiplicative, rising with expenditures. For those in the highest-risk decile, the value of insurance is negative, indicating that a rational consumer in that decile would not choose to purchase insurance without a subsidy. When credit is introduced (dashed orange line), the value of insurance falls further, even when loans have a markup ($r^m = 2.78\%$). This decrease is substantial enough that insurance becomes unattractive to consumers across all spending-risk deciles.

Figure 1(b) shows that loans reduce the value of community-rated insurance by roughly the same absolute amount as for experience-rated insurance. However, this effect is small relative to the extensive cross-subsidization that occurs from individuals with low healthcare costs to those with high healthcare costs. On average, the introduction of credit reduces the value of fair insurance by \$366, from \$598 to \$232 (61%).

Because the value of loans decline with income, access to loans reduces the absolute value of insurance most for lower income households. Figure 2(a) shows the value of experience-rated insurance for 15 income bins, starting at \$20,000 and going up to \$300,000. The

[13] By way of comparison, Engelhardt and Gruber (2011) estimate that the average financial risk-reduction value of Medicare Part D insurance is \$455 (2007 dollars) for individuals between the ages of 60–70. While Part D only includes prescription drug coverage, the population it covers is older than our sample.

conventional value of insurance declines with income because of the usual result that higher-income households value the consumption-smoothing benefit of insurance less. Introducing loans reduces the value of insurance by \$851 (67%) for lowest-income bin, but only by \$28 (48%) for the highest-income group. Introducing markups make the conventional value of insurance negative for households with income above \$70,000. The introduction of loans when markups are present means that households with even \$50,000 of income do not gain from insurance. Panel (b) shows qualitatively similar dynamics for community-rated insurance.

Next, we investigate how the length of loans and the interest rate affects the value of insurance. Figure 3(a) illustrates the effects of actuarially-fair loans with repayment terms ranging from 2–10 years on experience-rated insurance. The dashed red line shows that allowing the consumer to smooth payment across just two years with an actuarially-fair loan reduces the average value of insurance by \$159 (40%). Longer loans, which allow for greater consumption smoothing, reduce the value of insurance further, although the effect is diminishing: a 5-year loan reduces the value by –\$233 (58%), and a 10-year by –\$254 (64%).

Figure 3(c) shows that loans substantially reduce the value of actuarially-fair, experience-rated insurance even when interest rates are substantially higher than the rate of time preference. Each line shows a different interest rate with a 5-year repayment term. For ease of interpretation, we measure the price of the loan in terms of an annual interest rate cost rather than a one-time markup at the time of purchase. The graph shows that cheaper loans cause greater reductions in the value of experience-rated insurance. Nevertheless, even when insurance markets are actuarially-fair, the availability of a loan with an annual interest rate markup as high as 8.40% still reduces the average value of insurance by \$97 (24%).

Panels (b) and (d) of Figure 3 show the corresponding values for community-rated insurance. In the lowest decile, loan markets reduce the value of insurance by up to \$123 (7%), depending on the loan terms; for the highest decile, they reduce the value by up to \$1,386 (21%).

Finally, Table 1 reports the *average* incremental value of insurance for different combinations of insurance markups, m^I, interest rate markups, r^m, and loan lengths, n. The fifth row reports that the availability of a five-year, actuarially-fair loan reduces the value of actuarially-fair, experience-rated insurance by 58.2% on average. The effect is slightly larger (61.2%) for community-rated insurance. In some cases the average reduction exceeds 100%, indicating that a substantial portion of the population would choose not to purchase insurance at all.

We gauge the accuracy of our Taylor approximation by comparing it to exact estimates calculated using the complete data. We focus on the approximation's ability to inform policy about how the value of health insurance changes after one accounts for access to credit markets, i.e., value of insurance with a loan with $n = 1$ minus the value of insurance with $n > 1$. Figure A.2 in the Appendix shows the approximated change and the exact change for loans of 2, 5, or 10 years. Depending on the loan length, the approximate value is 10–18% lower than the exact value.

5 Conclusion

The private value of health insurance as a method of financing medical care depends on how consumers would finance care in the absence of insurance. We show that greater access to credit reduces the incremental financial value of insurance. The impact is non-trivial: in a baseline case with no loads on insurance or administrative costs on loans, introducing credit markets with just 2-year loans reduces the incremental value of insurance by approximately 40% (Table 1).

We provide precise and approximate formulas for calculating the welfare value of insurance, not just its effect on out-of-pocket payments, which have no natural welfare interpretation. Our approximation requires few parameters to calculate: r or β, the loan period, the mark-up m^I on insurance (including moral hazard), the community-rated expectation $\mathrm{E}^C[p]$ and variance $\mathrm{Var}^C[p]$ of health expenditure shocks, and the coefficient of absolute risk aversion. Moreover, the approximation is reasonable across a range of loan lengths.

Our analysis has implications for policy, especially in healthcare markets. First, it suggests that some of the welfare gains of insurance can be obtained by improving access to credit. Extension of this analysis to debtor protections such as bankruptcy would have implications for those protections. Second, it affects cost-benefit analyses of public health insurance expansions. Insurance expansions are less valuable when credit markets are well-developed or when interest rates are low. Third, it shows how different health care policies can undermine each other. For example, EMTALA reduces uptake of insurance because it functionally offers low-interest health loans.

References

Abaluck, J. and J. Gruber (2011). Choice inconsistencies among the elderly: evidence from plan choice in the medicare part d program. *American Economic Review 101*(4), 1180–1210.

Barcellos, S. H. and M. Jacobson (2015). The effects of medicare on medical expenditure risk and financial strain. *American Economic Journal: Economic Policy 7*(4), 41–70.

Batty, M., C. Gibbs, and B. Ippolito (2022). Health insurance, medical debt, and financial well-being. *Health Economics 31*(5), 689–728. https://doi.org/10.1002/hec.4472.

Brevoort, K., D. Grodzicki, and M. B. Hackmann (2020). The credit consequences of unpaid medical bills. *Journal of Public Economics 187*, 104203.

Caswell, K. J. and J. H. Goddeeris (2019). Does medicare reduce medical debt? *American Journal of Health Economics 6*(1), 72–103.

Chetty, R. (2009). Sufficient statistics for welfare analysis: A bridge between structural and reduced-form methods. *Annual Review of Economics 1*(1), 451–488.

de Nicola, F. (2015). The impact of weather insurance on consumption, investment, and welfare. *Quantitative Economics 6*(3), 637–661. https://doi.org/10.3982/QE300.

Deshpande, M. and L. M. Lockwood (2022). Beyond health: Nonhealth risk and the value of disability insurance. *Econometrica 90*(4), 1781–1810.

Dobkin, C., A. Finkelstein, R. Kluender, and M. J. Notowidigdo (2018). The economic consequences of hospital admissions. *American Economic Review 108*(2), 308–52.

Engelhardt, G. V. and J. Gruber (2011). Medicare part d and the financial protection of the elderly. *American Economic Journal: Economic Policy 3*(4), 77–102.

Feldstein, M. and J. Gruber (1995). A major risk approach to health insurance reform. *Tax Policy and the Economy 9*, 103–130. doi: 10.1086/tpe.9.20061828.

Finkelstein, A., N. Hendren, and E. F. Luttmer (2019). The value of medicaid: Interpreting results from the oregon health insurance experiment. *Journal of Political Economy 127*(6), 2836–2874.

Finkelstein, A. and R. McKnight (2008). What did medicare do? the initial impact of medicare on mortality and out of pocket medical spending. *Journal of Public Economics 92*(7), 1644–1668.

Goldsmith-Pinkham, P., M. Pinkovskiy, and J. Wallace (2021). The great equalizer: Medicare and the geography of consumer financial strain. *arXiv preprint arXiv:2102.02142*.

Gross, T. and M. J. Notowidigdo (2011). Health insurance and the consumer bankruptcy decision: Evidence from expansions of medicaid. *Journal of Public Economics 95*(7), 767–778.

Handel, B., I. Hendel, and M. D. Whinston (2015). Equilibria in health exchanges: Adverse selection versus reclassification risk. *Econometrica 83*(4), 1261–1313.

Hansen, J. V., R. H. Jacobsen, and M. I. Lau (2016). Willingness to pay for insurance in denmark. *Journal of Risk and Insurance 83*(1), 49–76.

Hu, L., R. Kaestner, B. Mazumder, S. Miller, and A. Wong (2018). The effect of the affordable care act medicaid expansions on financial wellbeing. *Journal of Public Economics 163*, 99–112.

Jackson, T. H. (1984). Fresh-start policy in bankruptcy law, the. *Harv. L. Rev. 98*, 1393.

Kowalski, A. E. (2015). What do longitudinal data on millions of hospital visits tell us about the value of public health insurance as a safety net for the young and privately insured? Technical report, National Bureau of Economic Research.

Limwattananon, S., S. Neelsen, O. O'Donnell, P. Prakongsai, V. Tangcharoensathien, E. van Doorslaer, and V. Vongmongkol (2015). Universal coverage with supply-side reform: The impact on medical expenditure risk and utilization in thailand. *Journal of Public Economics 121*, 79–94.

Mahoney, N. (2015). Bankruptcy as implicit health insurance. *American Economic Review 105*(2), 710–46.

Malani, A. (2021). Still in mortal peril? recent research suggests a new agenda for health care reform. *The Journal of Legal Studies 50*(S2), S239–S273. doi: 10.1086/708094.

Mazumder, B. and S. Miller (2016). The effects of the massachusetts health reform on household financial distress. *American Economic Journal: Economic Policy 8*(3), 284–313.

Ortaliza, J., K. Amin, and C. Cox (2023). 2023 medical loss ratio rebates.

Rothschild, M. and J. Stiglitz (1976). Equilibrium in competitive insurance markets: An essay on the economics of imperfect information. *The Quarterly Journal of Economics 90*(4), 629–649.

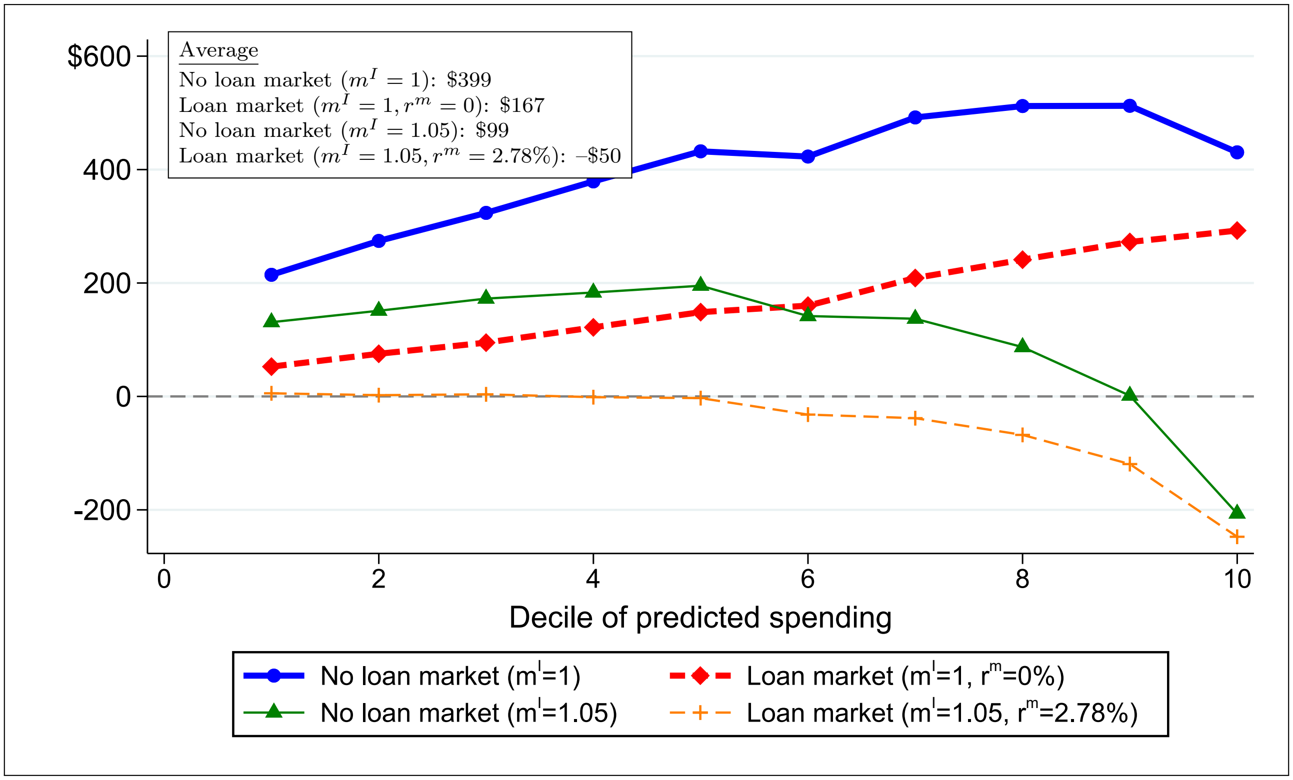
Safier, R. (2023, Jun). What personal loan term length should you choose? *Forbes*.

Shigeoka, H. (2014). The effect of patient cost sharing on utilization, health, and risk protection. *American Economic Review 104*(7), 2152–84.

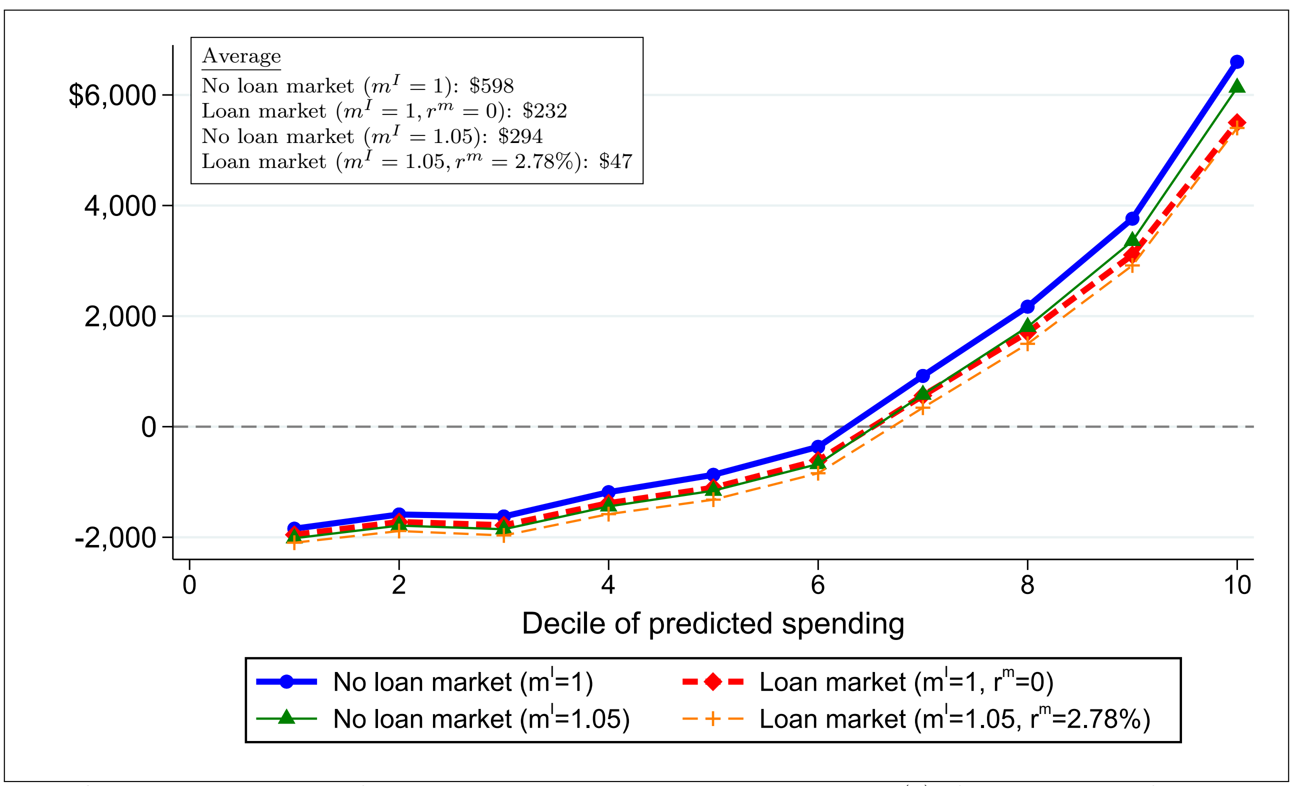
York, E. (2023). Summary of the latest federal income tax data, 2023 update.

Figure 1: The value of health insurance, with and without a loan market

(a) Experience-rated insurance



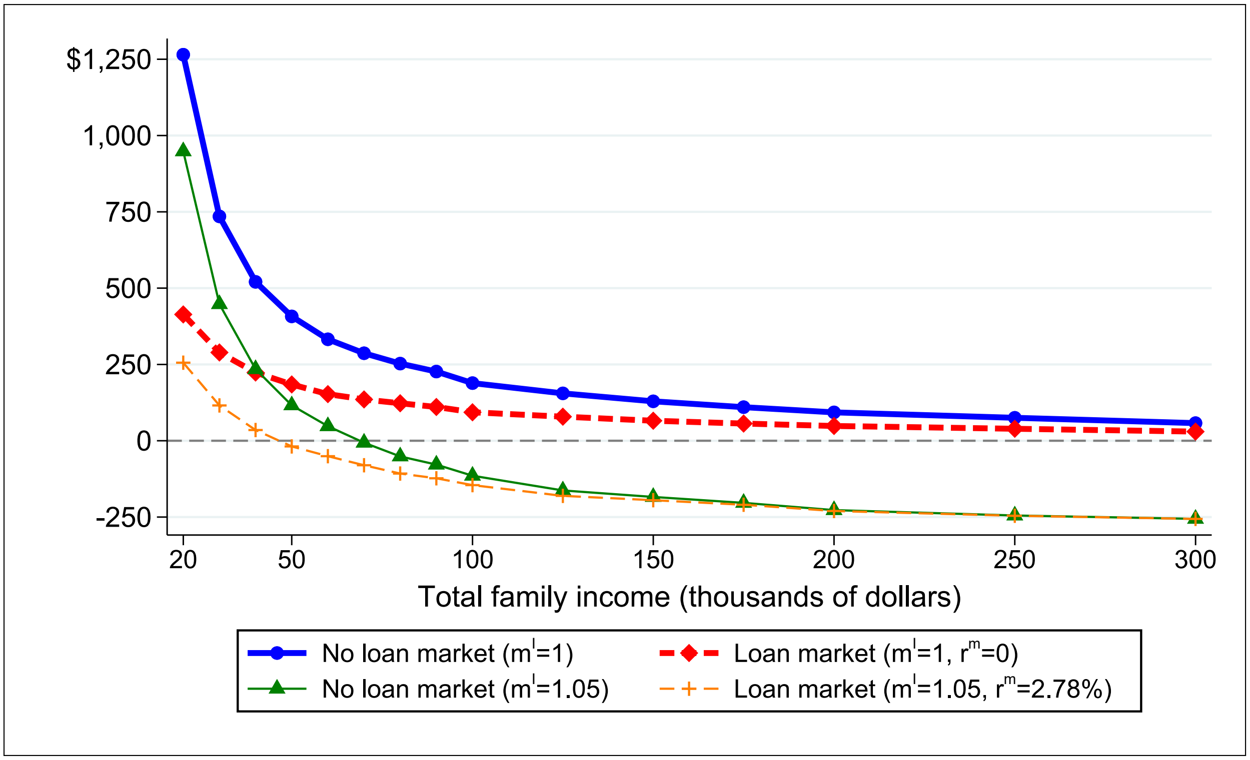
(b) Community-rated insurance



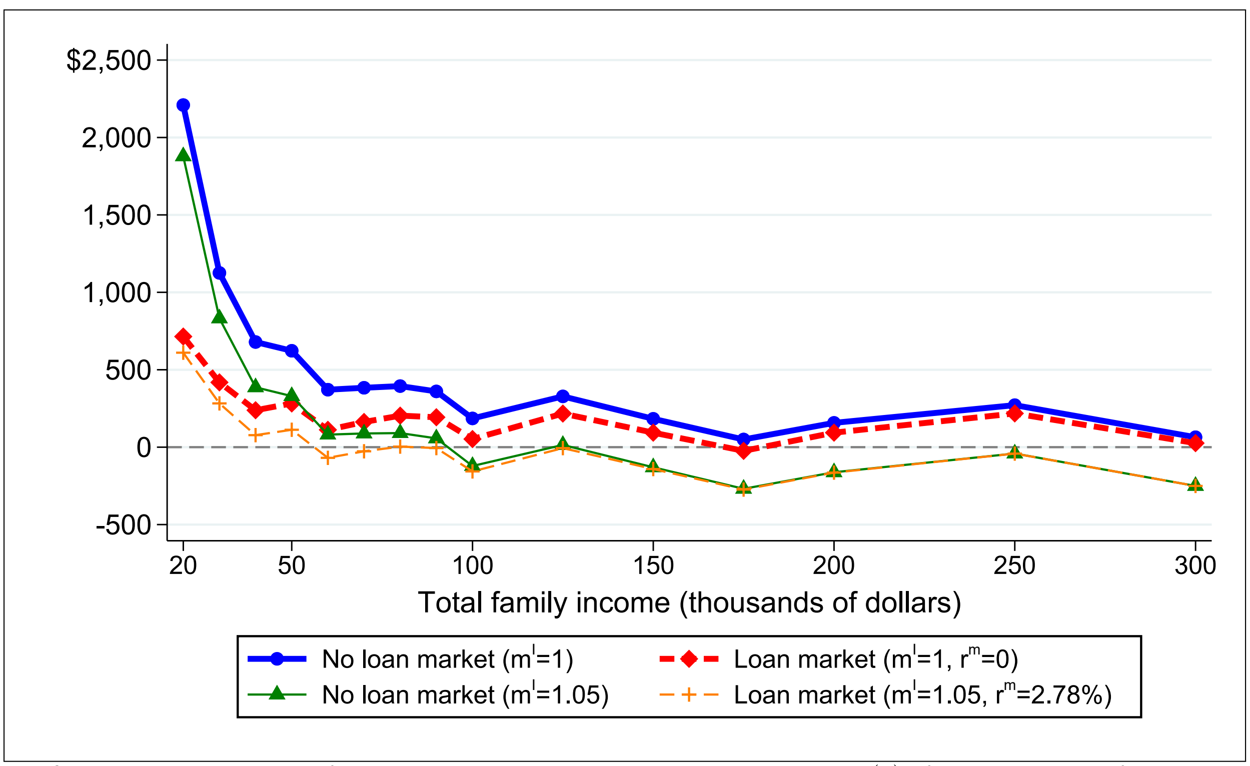
Notes: This figure plots the value of health insurance as calculated by Equation (5), for households of size 2. "No loan market ($m^I = 1$)" assumes only actuarially-fair health insurance is available. "Loan market ($m^I = 1, r^m = 0\%$)" introduces a loan market with actuarially-fair 5-year loans. "Loan market ($m^I = 1.05, r^m = 2.78\%$)" adds a 5% markup to the price of health insurance and a 2.78% annual interest rate markup to the loan cost (equivalent to a 5% loan markup). Experience-rated premiums are based on expected spending in a household's spending decile. Community-rated premiums are based on expected population expenditures for households of size 2, conditional on geographic region and age group.

Figure 2: The value of health insurance with and without a loan market, by household age and income

(a) Experience-rated insurance, by income



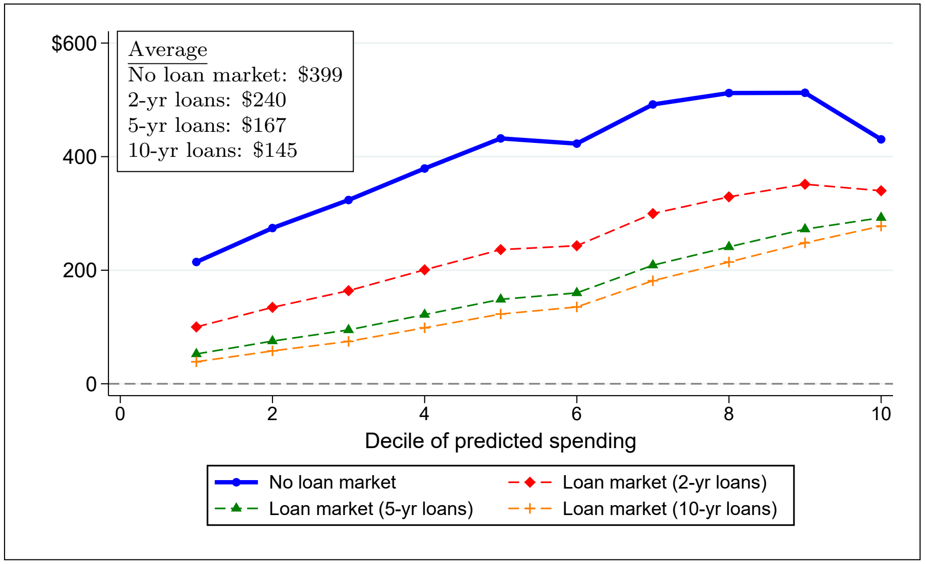
(b) Community-rated insurance, by income



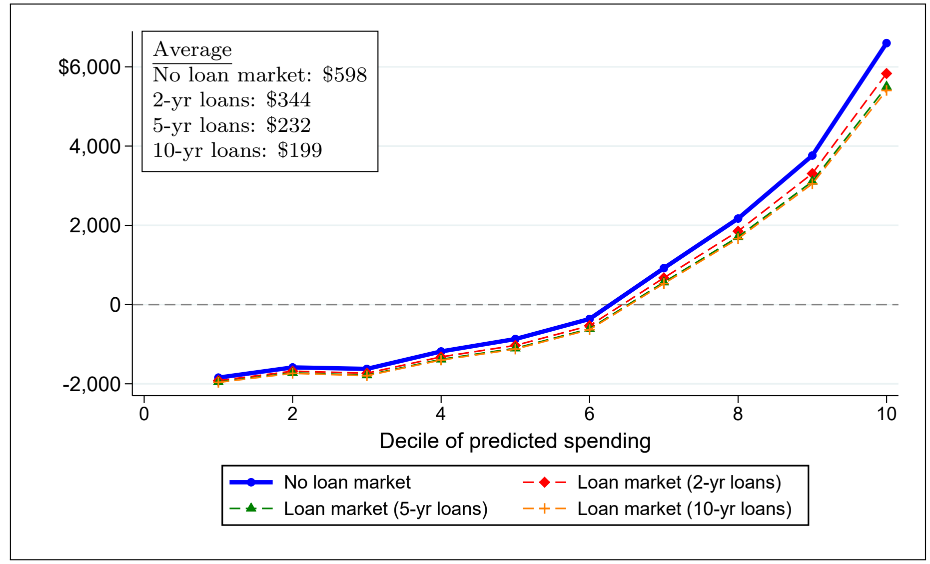
Notes: This figure plots the value of health insurance as calculated by Equation (5), for households of size 2. "No loan market ($m^I = 1$)" assumes only actuarially-fair health insurance is available. "Loan market ($m^I = 1, r^m = 0\%$)" introduces a loan market with actuarially-fair 5-year loans. "Loan market ($m^I = 1.05, r^m = 2.78\%$)" adds a 5% markup to the price of health insurance and a 2.78% annual interest rate markup to the loan cost (equivalent to a 5% loan markup). Premiums for experience rating are based on the expected spending in a household's spending decile. Experience-rated premiums are based on expected spending in a household's spending decile. Community-rated premiums are based on expected population expenditures for households of size 2, conditional on geographic region and age group.

Figure 3: The value of actuarially-fair insurance when loan markets are present, for different loan lengths and loan markups

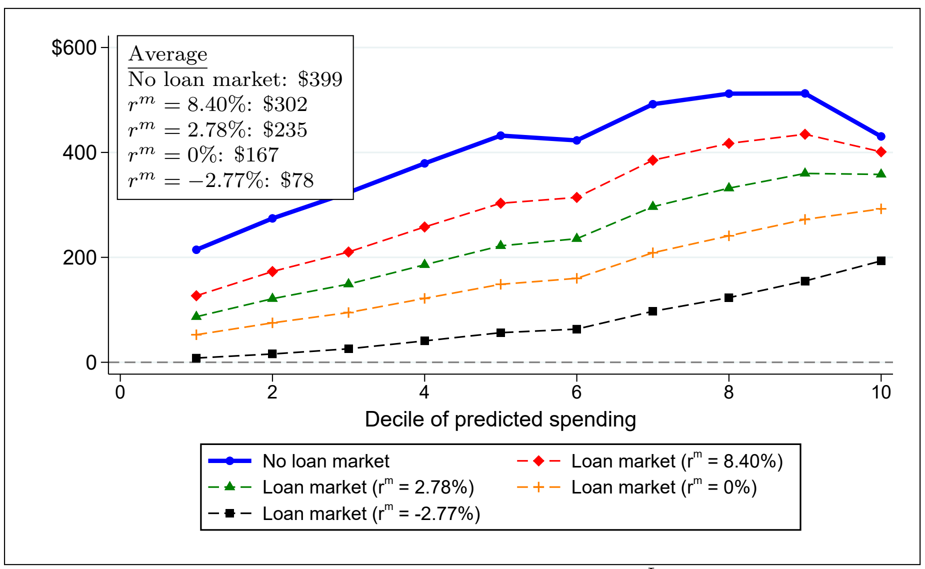
(a) Experience-rated insurance, different loan lengths



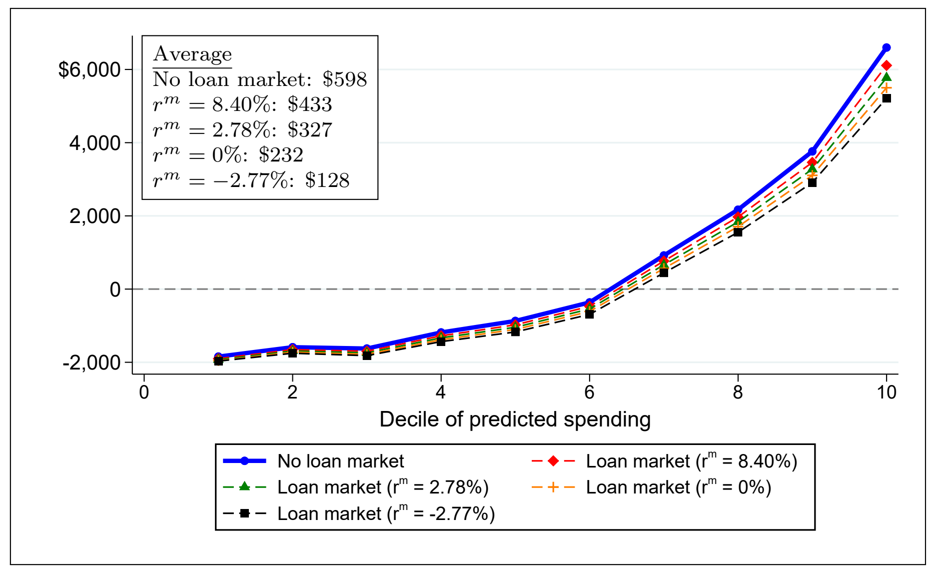
(b) Community-rated insurance, different loan lengths



(c) Experience-rated insurance, different loan markups



(d) Community-rated insurance, different loan markups



Notes: This figure plots the value of actuarially-fair ($m^I = 1$) health insurance for households of size 2, as calculated by Equation (5). "No loan market" assumes only actuarially-fair health insurance is available. In panels (a) and (b), insurance and loan markets are both actuarially fair ($m^I = 1, r^m = 0\%$), but we vary the length of the loan payback period. In panels (c) and (d), insurance markets are actuarially fair but the interest rate markup on the loan ranges from –2.78% (equivalent to 5% loan subsidy) to 8.40% (equivalent to 15% loan markup). Experience-rated premiums are based on expected spending in a household's spending decile. Community-rated premiums are based on expected population expenditures for households of size 2, conditional on geographic region and age group.

Table 1: The effect of accounting for loan markets on the value of health insurance

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Experience rated insurance			Community rated insurance		
Insurance markup (ratio)	Loan markup (ratio)	Loan interest rate markup (%)	Loan length (yrs)	Baseline value (dollars)	Reduction (dollars)	Reduction (%)	Baseline value (dollars)	Reduction (dollars)	Reduction (%)
1	0.95	–10.26	2	399.4	-256.1	64.1	597.7	-369.3	61.8
1	0.95	–2.77	5	399.4	-321.5	80.5	597.7	-469.3	78.5
1	0.95	–1.30	10	399.4	-341.1	85.4	597.7	-499.0	83.5
1	1	0	2	399.4	-159.4	39.9	597.7	-253.5	42.4
1	1	0	5	399.4	-232.6	58.2	597.7	-365.6	61.2
1	1	0	10	399.4	-254.4	63.7	597.7	-398.7	66.7
1	1.05	11.40	2	399.4	-93.3	23.4	597.7	-157.1	26.3
1	1.05	2.78	5	399.4	-164.6	41.2	597.7	-270.8	45.3
1	1.05	1.28	10	399.4	-186.7	46.7	597.7	-305.2	51.1
1	1.15	38.49	2	399.4	-41.3	10.3	597.7	-72.0	12.1
1	1.15	8.40	5	399.4	-97.0	24.3	597.7	-164.2	27.5
1	1.15	3.81	10	399.4	-115.8	29.0	597.7	-194.7	32.6
1.05	0.95	–10.26	2	99.3	-233.7	235.2	294.5	-342.4	116.3
1.05	0.95	–2.77	5	99.3	-293.0	295.0	294.5	-435.2	147.8
1.05	0.95	–1.30	10	99.3	-310.8	312.9	294.5	-462.8	157.2
1.05	1	0	2	99.3	-144.7	145.7	294.5	-234.3	79.6
1.05	1	0	5	99.3	-211.2	212.6	294.5	-338.3	114.9
1.05	1	0	10	99.3	-231.0	232.5	294.5	-369.0	125.3
1.05	1.05	11.40	2	99.3	-84.5	85.0	294.5	-142.7	48.5
1.05	1.05	2.78	5	99.3	-149.1	150.1	294.5	-247.7	84.1
1.05	1.05	1.28	10	99.3	-169.1	170.2	294.5	-279.6	95.0
1.05	1.15	38.49	2	99.3	-37.4	37.7	294.5	-63.2	21.5
1.05	1.15	8.40	5	99.3	-87.8	88.4	294.5	-147.5	50.1
1.05	1.15	3.81	10	99.3	-104.8	105.5	294.5	-175.3	59.5

Notes: This table reports the average value of health insurance, $V^{\Delta,L}$ for households of size 2 in 2014 dollars. Columns (1) and (2) report the parameter values for insurance and loan markups, m^I and m^L. Column (3) reports the loan annual interest rate markup, r^m, which is a function of the loan markup, m^L, and the consumer rate of time preference, β. Actuarially fair insurance corresponds to $m^I = 1$ and actuarially fair loans correspond to $r^m = 0\%$ (equivalently, $m^L = 1$). Column (4) reports the loan length, n, in years. Premiums for community rating are conditional on geographic region and age group.

Online Appendix

"Access to Credit Reduces the Value of Health Insurance"

Sonia Jaffe, Anup Malani, Julian Reif

A Model

We start by showing the comparative statics for the model discussed in the text. We then add multiple shocks per period and consider the possibility that consumers have loans in later periods rather than insurance. Lastly, we allow for more flexible markets to show the "lower bound" on the value of insurance.

A.1 Comparative statics

As shown in the text, in the case of a single potential shock, insurance in later periods, no markup on loans, and limited credit markets (so one can only borrow in the case of a shock), the value of insurance is:

$$V^{\Delta,L}(\pi^C) = (1-\pi)\ \left(u\left(y - m^I \pi^C p\right) - u\left(y\right)\right) - \frac{\pi}{\alpha}\left(u\left(y - m^I\pi^C p - m^L \alpha p\left(1 - m^I \pi^C\right)\right) - u\left(y - m^I \pi^C p\right)\right)$$

Risk. The effect of π in the case of community rating is simple:

$$\frac{\partial V^{\Delta,L}(\pi^C)}{\partial \pi} = u\left(y\right) - u\left(y - m^I \pi^C p\right) + \frac{1}{\alpha}\left(u\left(y - m^I \pi^C p\right) - u\left(y - m^I \pi^C p - m^L \alpha p\left(1 - m^I \pi^C\right)\right)\right) > 0$$

In the case of experience rating it is more complicated. If we think only about the effect of risk in the first period (separating π into π_1 and π_t for later periods), then the incremental value of insurance is:

$$\begin{aligned} V^{\Delta,L} = {} & (1-\pi_1)\left(u\left(y - m^I \pi_1 p\right) - u\left(y\right)\right) \\ & + \pi_1 \Big[\left(u(y - m^I \pi_1 p) - u\left(y - m^I \pi_t p - m^L \alpha p(1 - m^I \pi_t)\right)\right) \\ & + \left(\frac{1}{\alpha} - 1\right)\left(u(y - m^I \pi_t p) - u(y - m^I \pi_t p - m^L \alpha p(1 - m^I \pi_t))\right)\Big] \end{aligned}$$

The probability of the shock and period 1's premium are determined by π_1, but later period premiums and the amount one pays out of pocket (instead of borrowing) are determined by π_t. The effect of π_1 is:

$$\begin{aligned} \frac{\partial V^{\Delta,L}}{\partial \pi_1} = {} & \Big[u(y) - u(y - m^I \pi_t - m^L \alpha p(1 - m^I \pi_t)) \\ & + \left(\frac{1}{\alpha} - 1\right)\left(u\left(y - m^I \pi_t p\right) - u\left(y - m^I \pi_t p - m^L \alpha p\left(1 - m^I \pi_t\right)\right)\right)\Big] - p m^I u'(y - m^I \pi_1 p) \end{aligned}$$

The second derivative is:

$$\frac{\partial^2 V^{\Delta,L}}{\partial \pi_1^2} = (p m^I)^2 u''\left(y - m^I \pi p\right) < 0$$

Also note that $V^{\Delta,L}(\pi_1 = 0) = 0$. So if V equals zero for some $\pi > 0$ it must be that $\partial V^{\Delta,L}/\partial \pi < 0$ at that π. So if someone is indifferent between insurance and loans then on the margin, raising π_1 makes them prefer loans. Obviously, risks are correlated across periods, so if we are comparing across people then we need to think about both π_1 and π_t changing:

$$\frac{\partial V^{\Delta,L}}{\partial \pi} = \frac{\partial V^{\Delta,L}}{\partial \pi_1} - p m^I \pi\left(\left(\frac{1}{\alpha} - 1\right)u'\left(y - m^I \pi p\right) - \frac{1}{\alpha} u'\left(y - m^I \pi p - m^L \alpha p\left(1 - m^I \pi\right)\right)\left(1 - \alpha m^L\right)\right)$$

The increased premium payments in future periods raises the marginal utility of income in those periods, making it costlier to take out a loan in the first period, but this can be partially offset by borrowing less (hence the second term is multiplied by $1-\alpha m^L$). The net effect is ambiguous.

Risk is also reflected in the price of medical care. Again, think about separating the period 1 price p_1 and later period price p_t:

$$\begin{aligned} V^{\Delta,L}(\pi^C) = (1-\pi) & \left(u\left(y - m^I \pi^C p_1\right) - u\left(y\right)\right) \\ & + \pi \Bigg[\left(u\left(y - m^I \pi^C p_1\right) - u\left(y - m^I \pi^C p_t - m^L \alpha\left(p_1 - m^I \pi^C p_t\right)\right)\right) \\ & + \left(\frac{1}{\alpha} - 1\right)\left(u\left(y - m^I \pi^C p_t\right) - u\left(y - m^I \pi^C p_t - m^L \alpha\left(p_1 - m^I \pi^C p_t\right)\right)\right) \Bigg] \end{aligned}$$

$$\frac{\partial V^{\Delta,L}(\pi^C)}{\partial p_1} = -\pi^C m^I u'\left(y - m^I \pi^C p_1\right) + \frac{\pi}{\alpha} \alpha m^L u'\left(y - m^I \pi^C p_t - m^L \alpha\left(p_1 - m^I \pi^C p_t\right)\right)$$

The marginal utility of income is higher under loans, so if loans are "costlier" ($\pi m^L > \pi^C m^I$) then higher prices definitely push for insurance $\left(\frac{\partial V^{\Delta,L}(\pi^C)}{\partial p_1} > 0\right)$. If insurance is costlier, there are countervailing effects. The higher price makes the higher load on insurance costlier, but the additional dollars are more costly when the individual is making loan payments.

Obviously, a higher price this period makes us think that prices will be higher in the future:

$$\frac{\partial V^{\Delta,L}(\pi^C)}{\partial p} = \frac{\partial V^{\Delta,L}(\pi^C)}{\partial p_1} - \pi \pi^C m^I \left(u'\left(y - m^I \pi^C p\right)\left(\frac{1}{\alpha} - 1\right) - \frac{1}{\alpha}\left(1 - m^L \alpha\right) u'\left(y - m^I \pi^C p_t - m^L \alpha\left(p_1 - m^I \pi p_t\right)\right)\right)$$

Again, the increased premium payments in future periods raises the marginal utility of income in those periods, making it costlier to take out a loan in the first period, but this can be partially offset by borrowing less (hence the second term is multiplied by $1-\alpha m^L$). The net effect is ambiguous.

Effect of credit market access. Changing n affects α, which increases $V^{\Delta,L}(\pi^C)$. Again using $\tilde{y} = y - m^I \pi^C p$, we have:

$$\frac{\partial V^{\Delta,L}(\pi^C)}{\partial \alpha} = \frac{\pi}{\alpha^2}\left(-u\left(\tilde{y}\right) + u\left(\tilde{y} - \alpha m^L p\left(1 - m^I \pi^C\right)\right) + \alpha m^L p\left(1 - m^I \pi^C\right) u'\left(\tilde{y} - \alpha m^L p\left(1 - m^I \pi^C\right)\right)\right) > 0$$

which is positive since u is concave.

Effect of markup on insurance. The effect of increasing the load on insurance load is complicated because it affects not just current period premium payments, but also future premium payments:

$$\frac{\partial V^{\Delta,L}(\pi^C)}{\partial m^I} = -\pi^C p \left(\left(1 - \pi + \frac{\pi}{\alpha}\right) u'\left(\tilde{y}\right) - \frac{\pi}{\alpha} u'\left(\tilde{y} - m^L \alpha p\left(1 - m^I \pi^C\right)\right)\left(1 - \alpha m^L\right)\right)$$

Raising current period m^I decreases $V^{\Delta,L}$ by $\pi^C p \ (1-\pi) u'(\tilde{y})$, but raising the future m^I decreases the value of loans (increases $V^{\Delta,L}$) by $\pi^C p \ \frac{\pi}{\alpha}\left(u'\left(\tilde{y} - m^L \alpha p\left(1 - m^I \pi^C\right)\right)\left(1 - \alpha m^L\right) - u'\left(\tilde{y}\right)\right)$.

A.2 Saving and loans

Returning to the case of a single shock, we modify the model so that consumers can both borrow *and* save, so credit markets are more valuable and the incremental value of insurance is smaller. When there is no health shock in period 1, consumers without insurance will want to distribute the $m^I \pi^C p$ that they aren't spending on insurance in period 1 across the n periods they would be paying off a loan if they had a shock. So their consumption in each of those n periods is $y - (1-\alpha)\left(m^I \pi^C p\right)$, and the utility when using a combination of saving and a loan is

$$\begin{aligned}V^{LS} &= (1-\pi)\left(\frac{1}{\alpha}u(y-(1-\alpha)\left(m^I\pi^C p\right)) + \frac{\beta^n-\beta^T}{1-\beta}u(y-m^I\pi^C p)\right)\\ &\quad+\pi\left(\frac{1}{\alpha}u\left(y-m^I\pi^C p-\alpha(1-m^I\pi^C)p\right)+\frac{\beta^n-\beta^T}{1-\beta}u(y-m^I\pi^C p)\right)\end{aligned}$$

Subtracting this value from the value of insurance gives the incremental value of insurance:

$$V^{\Delta,LS} = \frac{1}{\alpha}\left(u\left(y-m^I\pi^C p\right)-\pi u\left(y-m^I\pi^C p-\alpha p\left(1-m^I\pi^C\right)\right)-(1-\pi)\,u\left(y-(1-\alpha)\left(m^I\pi^C p\right)\right)\right)$$

The value is increasing in α:

$$\begin{aligned}\frac{\partial V^{\Delta,LS}}{\partial\alpha} &= \frac{1}{\alpha^2}\big[-u\left(\tilde{y}\right)+\pi u\left(\tilde{y}-\alpha p\left(1-m^I\pi^C\right)\right)+(1-\pi)\,u\left(\tilde{y}+\alpha p\; m^I\pi^C\right)\\ &\quad+\alpha\left(\pi p\left(1-m^I\pi^C\right)u'\left(\tilde{y}-\alpha p\left(1-m^I\pi^C\right)\right)-(1-\pi)\,u'\left(\tilde{y}+\alpha p m^I\pi^C\right)p m^I\pi^C\right)\big]\\ &= \frac{1}{\alpha^2}\big[\pi\left(u\left(\tilde{y}-\alpha p\left(1-m^I\pi^C\right)\right)-u\left(\tilde{y}\right)+\alpha p\left(1-m^I\pi^C\right)u'\left(\tilde{y}-\alpha p\left(1-m^I\pi^C\right)\right)\right)\\ &\quad+(1-\pi)\left(u\left(\tilde{y}+\alpha p m^I\pi^C\right)-u\left(\tilde{y}\right)-u'\left(\tilde{y}+\alpha p m^I\pi^C\right)p m^I\pi^C\right)\big]\\ &> 0.\end{aligned}$$

As in the model without savings, there is both a direct effect of the insurance markup in the first period of making insurance less valuable and an indirect effect of a more expensive insurance in subsequent periods making loans costlier.

A.3 Income shocks

If health expenditure shocks are accompanied by (negative) income shocks (ϵ_y), that reduces the relative value of loans. If the shock is only in one period, the value of insurance is:

$$\begin{aligned}V^{\Delta,L} &= (1-\pi)\left(u\left(y-m^I\pi^C p_1\right)-u\left(y\right)\right)\\ &\quad+\pi\Bigg[\left(u\left(y-m^I\pi^C p_1-\epsilon_y\right)-u\left(y-m^I\pi^C p_t-\alpha\left(p_1+\epsilon_y-m^I\pi^C p_t\right)\right)\right)\\ &\quad+\left(\frac{1}{\alpha}-1\right)\left(u(y-m^I\pi^C p_t)-u\left(y-m^I\pi^C p_t-\alpha\left(p_1+\Delta y-m^I\pi^C p_t\right)\right)\right)\Bigg]\end{aligned}$$

So income shocks make insurance more valuable:

$$\begin{aligned}\frac{\partial V^{\Delta,L}}{\partial\epsilon_y} &= \pi\Bigg(-u'\left(y-m^I\pi^C p_1-\epsilon_y\right)+\alpha u'\left(y-m^I\pi^C p_t-\alpha\left(p_1+\epsilon_y-m^I\pi^C p_t\right)\right)\\ &\quad+\alpha\left(\frac{1}{\alpha}-1\right)u'\left(y-m^I\pi^C p_t-\alpha\left(p_1+\epsilon_y-m^I\pi^C p_t\right)\right)\Bigg)\end{aligned}$$

$$\frac{\partial V^{\Delta,L}}{\partial\epsilon_y} = \pi\Big(-u'\left(y-m^I\pi^C p_1-\epsilon_y\right)+u'\left(y-m^I\pi^C p_t-\alpha\left(p_1+\epsilon_y-m^I\pi^C p_t\right)\right)\Big) > 0$$

If the shock occurs in later periods (for convenience same number as loan length, but general idea holds):

$$\begin{aligned} V^{\Delta,L} &= (1-\pi)\ \left(u\left(y - m^I\pi^C p_1\right) - u(y)\right) \\ &+ \frac{\pi}{\alpha}\left(\left(u\left(y - m^I\pi^C p_1 - \epsilon_y\right) - u\left(y - m^I\pi^C p_t - \epsilon_y - \alpha\left(p_1 - m^I\pi^C p_t\right)\right)\right)\right) \end{aligned}$$

Again, the shocks increase the incremental value of insurance relative to loans:

$$\frac{\partial V^{\Delta,L}}{\partial \epsilon_y} = \pi\left(-u'\left(y - m^I\pi^C p_1 - \epsilon_y\right) + u'\left(y - m^I\pi^C p_t - \epsilon_y - \alpha\left(p_1 - m^I\pi^C p_t\right)\right)\right) > 0$$

A.4 Optimal borrowing amount

Consider the multiple shock model with loans but no savings. If we permit $m^L > 1$, it is not optimal for the individual to fully smooth consumption across periods. The individual chooses a loan amount L that solves

$$\max_L u(y - p + L - \alpha(r^e)L) + \sum_{t=1}^{n-1} \beta^t u\left(y - m^I E[p] - \alpha(r^e)L\right).$$

This gives a first order condition

$$(1-\alpha(r^e))u'(y - p + L - \alpha m^L L) = \alpha(r^e)\frac{\beta - \beta^n}{1-\beta}u'\left(y - m^I E[p] - \alpha(r^e)L\right). \tag{8}$$

Note that since $\frac{\beta-\beta^n}{1-\beta} = \frac{1}{\alpha(r)} - 1$.

We can get a closed-form solution if we use CRRA. With CRRA, we have

$$\begin{aligned} \frac{(1-\alpha(r^e))}{(y - p + L - \alpha(r^e)L)^\gamma} &= \frac{\alpha(r^e)(1/\alpha(r) - 1)}{(y - m^I E[p] - \alpha(r^e)L)^\gamma} \\ \frac{(1-\alpha(r^e))}{\alpha(r^e)(1/\alpha(r) - 1)} &= \frac{(y - p + L - \alpha(r^e)L)^\gamma}{(y - m^I E[p] - \alpha(r^e)L)^\gamma} \\ \left(\frac{(1-\alpha(r^e))}{\alpha(r^e)(1/\alpha(r) - 1)}\right)^{1/\gamma} &= \frac{(y - p + L(1-\alpha(r^e)))}{(y - m^I E[p] - \alpha(r^e)L)} \end{aligned}$$

Defining $z = \left(\frac{(1-\alpha(r^e))}{\alpha(r^e)(1/\alpha(r)-1)}\right)^{1/\gamma}$, the first-order condition becomes

$$L\left(1 - \alpha(r^e) + \alpha(r^e)z\right) = p - m^I E[p]z - y(1-z)$$

If $r^m = 0$ then $\alpha(r^e) = \alpha(r)$ so $z = 1$ and this condition implies $L = p - m^I E[p]$, i.e., the consumer takes a loan out that completely smooths consumption across periods.

To see how the loan size responds to $\alpha(r^e)$, try CRRA with $\gamma = 2$. For $n = 5$, $\beta = .95$, and $r^m = .05$,[1] we get $\alpha(r) \approx .221$ and $\alpha(r^e) \approx .241$ so $z \approx .946$ and $L = \frac{1}{.987}\left(p - m^I E[p] * .946 - .054y\right)$.

B Data

We obtain data on annual medical expenditures from the 1996–2014 Medical Expenditure Panel Survey (MEPS), a nationally representative survey of U.S. households. We define expenditures as all direct payments, including out-of-pocket payments and payments made by private and public health insurers. Each survey has a two-year overlapping panel design, with each

[1]If we want to think of the markup as multiplicative instead of increasing the interest rate, note that $m^L = \frac{\alpha(r^e)}{\alpha(r)}$, which in this case is about 1.09.

panel consisting of five rounds of interviews that take place over two full calendar years. The medical expenditure data are measured at the end of each calendar year, resulting in two measures per individual. We report the medical expenditure data in 2014 dollars using the "Medical care services" consumer price index (CPI). (Income is adjusted using the standard "all-items" index.)

The MEPS also provides us with information on chronic conditions, which are measured using self-reported data from respondents about their health status during each interview round. These self reports are recorded by the interview and then translated into ICD-9-CM codes by professional medical coders. These are then aggregated into 260 mutually exclusive clinical classification categories, which group together similar conditions.[2] For year 1, we define pre-existing conditions as those reported in the round 1 interview. For year 2, we use conditions reported in round 3.

The MEPS clinical classification codes for mental disorders and for alcohol and substance abuse disorders were revised in 2004 and 2007. We therefore group some of these codes together to make them comparable. After this grouping, we are left with 244 distinct clinical classification codes.

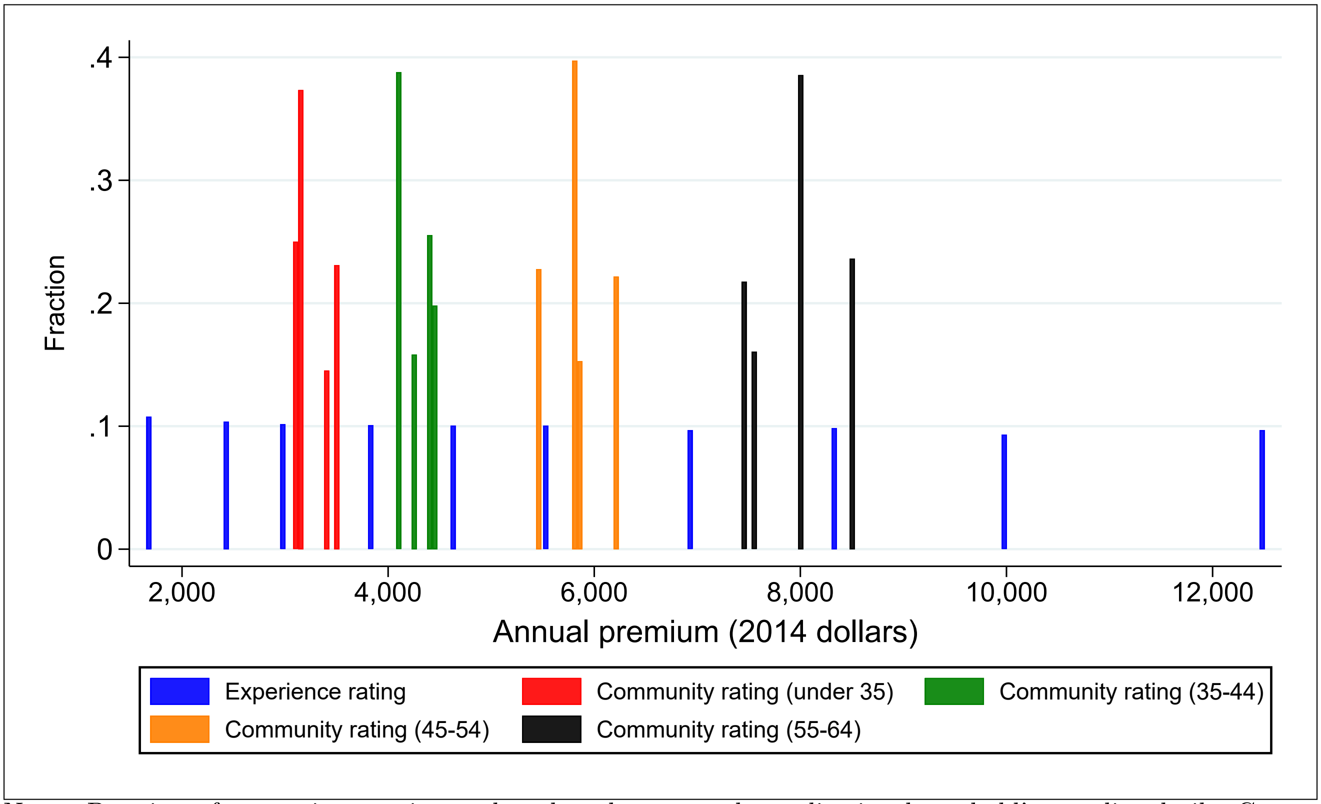
We predict medical expenditures at the individual level by estimating the following regression:

$$Y_{it} = f_1(\text{Age}_{it}, \text{Sex}_{it}) + f_2(\text{Region}_{it}) + f_3(\text{Conditions}_{it}) + \epsilon_{it}$$

where Y_{it} is total medical expenditures for individual i in year t. The regression includes indicators for single years of age, an indicator for sex, and all pairwise interactions between sex and age. We also include indicators for four different Census regions. Finally, we include indicators and counts for up to 244 different clinical conditions. The regression is weighted using the MEPS-provided person-level weights. Goodness of fit measures are reported in Table A.2.

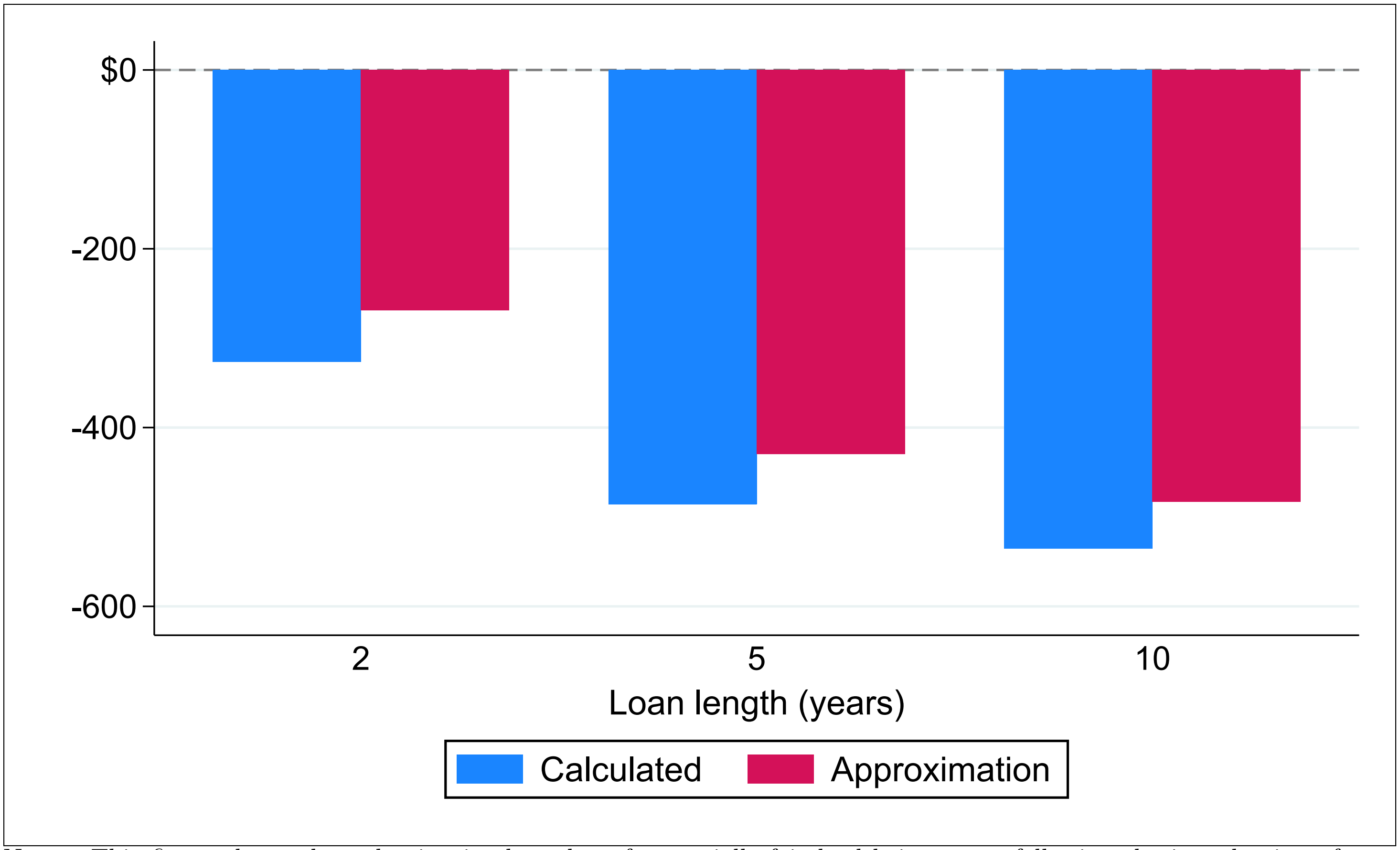
[2]There are 260 categories in the pre-2004 surveys, but this number increases slightly in later years.

Figure A.1: Experience- and community-rated premiums, households of size 2



Notes: Premiums for experience rating are based on the expected spending in a household's spending decile. Community-rated premiums are based on age group and Census region.

Figure A.2: The effect of introducing loan markets on the value of insurance, exact and approximate calculations



Notes: This figure shows the reduction in the value of actuarially-fair health insurance following the introduction of an actuarially-fair loan market with 2-year, 5-year, or 10-year loans. The blue bars ("Calculated") shows the exact value of the reduction, which is calculated by applying Equation (3) to individual-level data from the Medical Expenditure Panel Survey (MEPS), converting the result into dollars by dividing by the marginal utility of income, and then taking the average across all survey respondents. The red bars ("Approximation") show the Taylor approximation from Equation (4). The Taylor approximation is estimated using only aggregate statistics on the mean and variance of spending in the MEPS sample.

Table A.1: MEPS summary statistics, 1996–2014

	(1)	(2)	(3)	(4)	(5)	(6)
Variable	Median	Mean	Std dev	Min	Max	Count
A. Individuals						
Age	33.00	31.88	17.88	0.00	64.00	334,534
Female	0.00	0.49	0.50	0.00	1.00	334,534
Income	24,937	33,933	39,881	–120,108	799,712	334,534
Number of conditions	1.00	1.32	1.68	0.00	27.00	334,534
B. Households						
Family size	2.00	2.46	1.44	1.00	14.00	135,703
Income	66,671	82,301	58,200	15,652	904,973	135,703
Income per person	31,672	39,991	30,074	6,499	799,712	135,703
Medical expenditures	3,206	5,729	6,345	0	50,572	135,703
Medical expenditures per person	1,431	2,511	2,776	0	11,950	135,703

Notes: This table reports summary statistics for individuals in the Medical Expenditure Panel Survey (MEPS). Incomes and expenditures are in 2014 dollars. Both the individual and the household samples include children. All statistics are weighted except for the count.

Table A.2: Predicting medical expenditures

	(1)	(2)	(3)	(4)
Predictors	Num regressors	Sample size	R^2	Adjusted R^2
Region	4	334,534	0.0006	0.0006
Region, Age	68	334,534	0.0264	0.0262
Region, Age, Sex	69	334,534	0.0281	0.0279
Region, Age $\times$ Sex	133	334,534	0.0300	0.0296
Region, Age $\times$ Sex, CC	376	334,534	0.1644	0.1635
Region, Age $\times$ Sex, CC, count CC	562	334,534	0.1803	0.1789

Note: This table reports goodness of fit measures for six different regressions that predict individual-level annual medical expenditures using the 1996–2014 MEPS datasets. Region predictors include indicators for four different Census regions. Age predictors include indicators for single years of age. "Age×Sex" includes all pairwise interactions between the age and sex indicators. "Age×Sex and CC" adds indicators for the presence of up to 244 different pre-existing chronic conditions. "Age×Sex, CC, and count CC" adds count measures for each chronic condition. Column (1) reports the number of non-collinear regressors in the regression, including the constant term. All regressions employ person-level survey weights.

Table A.3: The effect of accounting for loan markets on the value of health insurance, for alternative insurance markup values

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				Experience rated insurance			Community rated insurance		
Insurance markup (ratio)	Loan markup (ratio)	Loan interest rate markup (%)	Loan length (yrs)	Baseline value (dollars)	Reduction (dollars)	Reduction (%)	Baseline value (dollars)	Reduction (dollars)	Reduction (%)
1.1	0.95	–10.26	2	-195.8	-213.3	-	-5.1	-316.9	-
1.1	0.95	–2.77	5	-195.8	-267.3	-	-5.1	-402.9	-
1.1	0.95	–1.30	10	-195.8	-283.5	-	-5.1	-428.5	-
1.1	1	0	2	-195.8	-131.7	-	-5.1	-216.1	-
1.1	1	0	5	-195.8	-192.1	-	-5.1	-312.4	-
1.1	1	0	10	-195.8	-210.1	-	-5.1	-340.9	-
1.1	1.05	11.40	2	-195.8	-76.8	-	-5.1	-128.2	-
1.1	1.05	2.78	5	-195.8	-135.5	-	-5.1	-224.6	-
1.1	1.05	1.28	10	-195.8	-153.7	-	-5.1	-254.2	-
1.1	1.15	38.49	2	-195.8	-34.1	-	-5.1	-54.4	-
1.1	1.15	8.40	5	-195.8	-79.9	-	-5.1	-130.7	-
1.1	1.15	3.81	10	-195.8	-95.4	-	-5.1	-156.0	-
1.15	0.95	–10.26	2	-486.1	-194.9	-	-301.1	-292.6	-
1.15	0.95	–2.77	5	-486.1	-244.1	-	-301.1	-372.0	-
1.15	0.95	–1.30	10	-486.1	-258.9	-	-301.1	-395.7	-
1.15	1	0	2	-486.1	-120.2	-	-301.1	-198.7	-
1.15	1	0	5	-486.1	-175.3	-	-301.1	-287.7	-
1.15	1	0	10	-486.1	-191.7	-	-301.1	-314.1	-
1.15	1.05	11.40	2	-486.1	-70.2	-	-301.1	-113.2	-
1.15	1.05	2.78	5	-486.1	-123.8	-	-301.1	-200.8	-
1.15	1.05	1.28	10	-486.1	-140.3	-	-301.1	-227.9	-
1.15	1.15	38.49	2	-486.1	-31.3	-	-301.1	-44.6	-
1.15	1.15	8.40	5	-486.1	-73.1	-	-301.1	-111.7	-
1.15	1.15	3.81	10	-486.1	-87.3	-	-301.1	-134.6	-

Notes: This table reports the average value of health insurance, $V^{\Delta,L}$ for households of size 2 in 2014 dollars. Columns (1) and (2) report the parameter values for insurance and loan markups, m^I and m^L. Column (3) reports the loan annual interest rate markup, r^m, which is a function of the loan markup, m^L, and the consumer rate of time preference, β. Actuarially fair insurance corresponds to $m^I = 1$ and actuarially fair loans correspond to $r^m = 0\%$ (equivalently, $m^L = 1$). Column (4) reports the loan length, n, in years. Premiums for community rating are conditional on geographic region and age group.