

Credit Lines *

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Abstract

This paper develops a new theory of long term unsecured credit contracts based on costly contracting that matches the data in a variety of dimensions. Credit lines are long term relations between banks and households that pre-specify a credit limit and interest rate in each period. Households can unilaterally default according to the Bankruptcy code, and can switch credit lines. Banks can set a new credit limit at any time, but must commit to the interest rate or not depending on the regulatory setting. We solve and characterize the set of lines that are traded under free entry competition and the distribution of households over interest rates, credit limits and wealth. We find that this model replicates the main properties of typical lending contracts. We use the theory to study the new regulatory rules in the U.S. credit card market which require a stronger commitment from banks not to raise interest rates discretionally. This results in tighter limits but lower interest rates, reduced indebtedness and lower default.

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1 Introduction

Lending contracts in the U.S. do not live in a vacuum but are shaped by a set of regulations of which bankruptcy provisions and Regulation Z are the central ingredients. They specify the conditions under which debt can be discharged and also the degree of commitment that lending institutions have to abide to. In this paper we take these regulations to heart, together with the notion that contracting is costly both to borrowers and lenders, and develop a theory of unsecured credit where borrowing contracts take the form of credit lines that specify credit limits and interest rates. The terms of a contract may be changed by the bank and households can switch lenders. Our theory reproduces the main features of the U.S. unsecured lending environment, including the pattern of switching, bankruptcy, interest rates, credit limits and debt levels across households.

We use the theory that we develop in a suitably calibrated model to study the effects of the new regulatory rules in the U.S. credit card market. The Federal Reserve has recently approved fundamental changes in the industry with the aim of curbing so called 'deceptive practices' on the part of issuers.¹ Prominent among these changes is the banning of interest rate hikes on existing credit card balances.² The Fed and consumer groups welcome this shift as they expect it to benefit consumers by protecting them against surprise and abusive changes in conditions. The banking industry have expressed concerns that this will hurt consumers by reducing competition and access to credit. How will consumers be affected in the end by the restrictions on pricing introduced?

The analytical framework that we develop extends the model of consumer idiosyncratic risk and incomplete markets used in much quantitative macroeconomics (e.g., İmrohoroğlu (1989), Huggett (1993), Aiyagari (1994)). The model introduces three fundamental assumptions. First, borrowing is not restricted to have to be conducted by means of one period debt contracts only, thus allowing for lasting credit lines. Second, within a given credit line, a lender can change the debt limit at any time but may or may not deviate from the interest rate initially signed depending on the regulatory setting. A form of partial commitment intends to capture the shift in the U.S. consumer protection law. Third, indebted households are not committed to honour their debts and can exercise the option to declare bankruptcy in a way that encompasses the main provisions of Chapter 7 of the U.S. bankruptcy code.

¹The Board voted the new regulation on December 18, 2008. It will not come into effect before July 2010. The Credit Cardholders' Bill of Rights, which contains most of the regulation's rules, passed in the full House of Representatives by a 312-112 margin on September 23, 2008, but did not pass the Senate and never became law. New York Rep. Carolyn Maloney is reintroducing the pro-consumer credit card bill for consideration by the new 111th Congress.

²Except under limited circumstances.

In the benchmark version of the model, there is no commitment and banks can alter the terms of the contract – both the interest rate and the limit – at the beginning of any period. In this setting, a household holding one credit card knows its associated current limit and interest rate, but can only make a (rational) guess about how these terms will evolve in subsequent periods. Switching to a different credit card is possible but costly for the household. Any of the credit lines available for a consumer to switch to specifies the consumer's current class type and – assuming initial full information – the size of the initial loan. Subsequently, the household can borrow any amount up to the debt limit set by the bank, switch to another line or declare default.³ Note that, given the switching cost, consumers may in general wish to hold on to the present credit card even if their personal circumstances change. Credit lines are issued by competitive financial intermediaries or banks, the second group of actors in the economy. A bank launching a line offers the initial terms of the contract. In any subsequent period, and as long as the line survives, the bank sets the credit limit and interest rate at will under incomplete information about the card holder's current earnings.

There is a large set of potential types of credit lines. The characteristics of the credit lines that are effectively traded must be determined in equilibrium by the requirements that the banks' rules for debt limit and interest rates are time-consistent and that there is no profitable entry of other types of contracts. This calls for studying the behavior of households and existing banks to deviations in the credit limit and interest rate. The stationary distribution of the model delivers profiles of consumption, wealth/debt, credit card limits and interest rates, default and switching across households.

We study first a quantitative version of this no-commitment benchmark economy. The parameters of the model are calibrated to match U.S. aggregate statistics for the distributions of wealth and earnings, the default and write-off rates on unsecured debt, and the credit limits and interest rates by income groups. Within this setting, banks do often raise interest rates after the initial period and credit limits respond to changes in the borrower's observable characteristics. High-income households enjoy disproportionately larger limits, borrow less frequently but, when they do, incur higher debts. Many households revolve credit repeatedly within a given contract, but about two thirds of borrowers are switching to a new contract, typically one with a looser limit but a higher interest rate.

In order to study the regulatory changes in the U.S., we also consider a version of the model where banks are not allowed to change the interest rate at their discretion. There is commitment to stick to the initially agreed price. In this case, compared to the no-commitment benchmark, there is even a larger

³Notice that the properties of the contracts of our model agree with the typical credit card contracts. The only issue is exclusivity, but this is implicit in the existing arrangements. Banks know the asset position of its customers every few months and rearrange the terms of the contract accordingly.

set of potential types of contracts. In an equilibrium with free-entry, there must be no profitable entry of other types of contracts. In the quantitative setting, the adoption of such price commitment causes changes in the credit market. Generally, banks tighten debt limits but charge lower interest rates. This changes is sharper among high-income households. In terms of aggregates, borrowing decreases and wealth increases, the risk of default and the frequency of contract switching both decline, and average consumption rises.

There is an emerging literature analyzing bankruptcy and credit in quantitative general equilibrium models. In Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) there is no switching cost and credit conditions adjust instantaneously. So it considers one-period contracts, where the interest adjusts with the size of the loan, and there is no room for pre-approved credit limits. Livshits, MacGee, and Tertilt (2007b) and Livshits, MacGee, and Tertilt (2007a) and Athreya and Simpson (2006) share similar features. In contrast, the present paper has the realistic feature that, due to the cost of switching, households can keep the same credit conditions for loans of varying size and over changing personal circumstances. Mateos-Planas (2007) studies the determination of an endogenous credit limit that is binding for some households in a model where banks confront an adverse selection problem since the information about the characteristics of individuals is limited. It has one-period contracts with credit limits where the interest does not depend on the amount borrowed but, for tractability reasons, constraints the range of contracts that can arise. It cannot be used to study variability in these conditions. The present paper instead delivers long-lasting contracts and a non-trivial distribution of credit limits and interest rates. A new strand of the literature (Chatterjee, Corbae, and Rios-Rull (2005)) attempts to provide a theory of credit without exogenous punishment. In independent work, Drozd and Nosal (2007) have posed a model with credit lines and default in an environment with search type frictions. They also have multiperiod contracts, but full commitment and constant conditions within any given contract. Notice that none of these existing models can be used to address changes that affect the level of commitment in the lenders' policies.

Section 2 puts forward the model that we use and analyzes the behavior of the agents. We move on to equilibrium in Section 3, and to computation and characterization in Section 4. We map the model to the data in Section 5 and study the inner workings of the model as well as its sensibility to parameter values in Section 6. Section 7 explores and evaluates quantitatively the effects of the proposed policy change while Section 8 concludes.

2 The model

We now turn to describe each of the elements of the model, starting with households in Section 2.1, and the problem that they solve which takes as given the set of available contracts. We then continue with the financial intermediaries in Section 2.2.

2.1 Households

There are many infinitely-lived households. Each period, households have a stochastic endowment of labor earnings ε in $\mathcal{E}$, a bounded set. The distribution of earnings is controlled by $F_e^\varepsilon(\varepsilon)$ where $e \in E$ is income class that follows a Markov chain with matrix $\Gamma_{e,e'}$. Households have a credit history flag that we denote with h . Such a flag can take the value of 0 or the value of 1. If $h = 0$ the household is free to engage in contracting, and if $h = 1$ it is banned from doing so.⁴ A household with $h = 0$ switches to $h = 1$ upon engaging in the process of filing for bankruptcy. Such an action entails a utility cost χ_d . Engaging in contracting (switching in our own jargon) also carries a utility cost, χ_s . Both utility costs are independent identically distributed random variables with continuous and bounded support and distribution $F^s(\chi_s)$ and $F^d(\chi_d)$.⁵ We sometimes write for compactness of notation $F_e(\varepsilon, \chi)$ to refer to the distribution of all idiosyncratic i.i.d. shocks. Both utility costs are privately observed. A household with $h = 1$ switches to $h = 0$ with constant probability δ . The utility costs, the impossibility of savings at the time of filing while the household is punished acts as a deterrent from filing for bankruptcy.

At the beginning of a period, then the household is characterized by the information needed to forecast future income e , its asset position, $y \in \mathcal{Y}$, its income ε , its credit history h , its credit line or contract $\omega \in \Omega$, and the utility costs for defaulting and switching $\chi = \{\chi_d, \chi_s\}$. The set Ω of available contracts is an equilibrium object to be determined below. We refer to $a = y + \varepsilon$, as the household's cash in hand of which only y is publicly known. Assets can be positive and they are held in the form of the aggregate risk free asset. They can also be negative. If so it is because it has been lent to the household by an intermediary with whom it has contractual relationship $\omega \in \Omega$. Having no relationship is denoted as $\omega = 0$. Such a contract specifies the initial terms of borrowing, the amount borrowed y_0^ω and (the inverse of) the interest rate q_0^ω as well as continuation values for the interest rate $q^\omega(e, y)$, and for the credit limit $b^\omega(e, y)$. We exclude from the arguments the credit history flag as it

⁴Again, see the discussion in Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) for a rationale of summarizing the credit scores this way.

⁵The reason for these costs is to provide continuity for the profit actions of the banks which is an important feature for many reasons.

is implicit that $h = 1$ prevents the existence of credit lines and that when savings are positive the rate of return is the same for everybody.

The household makes four types of interrelated choices. These are the bankruptcy (or default) decision $d \in \{0, 1\}$, whether to switch credit line $s \in \{0, 1\}$, the choice of credit line for current borrowing $\omega' \in \Omega$, and how much to borrow or save $y' \in \mathcal{Y}$, a compact set. The decision whether to default is available only if the household currently has a good credit record $h = 0$. Recall that defaulting $d = 1$ is implemented via a Chapter 7 type of bankruptcy filing, and it means that it changes the credit standing from good $h = 0$ to bad $h' = 1$, it rules out borrowing or saving in the filing period so $y' = 0$ (we are assuming the exemption level to be zero), and it forces the household to switch to the zero-credit line, $\omega' = 0$. A household with a bad credit record $h = 1$ cannot choose to switch credit line and must therefore be holding the zero-credit line $\omega = 0$. With probability $1 - \delta$ the status remains bad $h' = 1$, the zero-credit line is allocated $\omega' = 0$, and the household can save on the terms specified by this contract. For a household with a good status $h = 0$, the decision not to default $d = 0$ keeps the good standing $h' = 0$. A household with a bad credit record $h = 1$ regains a good status next period $h' = 0$ with probability δ . Carrying a good credit record into the next period $h' = 0$ allows the household to decide whether to switch credit line. If it decides not to switch $s = 0$, the available credit line remains the current one $\omega' = \omega$ and she can save or borrow on the terms specified by this type of contract for continuing customers. If she decides to switch $s = 1$, she can choose any new line type ω' from the available set Ω , and borrow or save on the terms specified by this type of contract for new customers. This set of available contracts Ω plays an important role and we will determine later its contents.

Summing up, the credit status evolves depending on the current status, the default decision, and nature according to

$$h' = \begin{cases} 0 & \text{if } h = 0, \text{ and } d = 0, \\ 0 & \text{if } h = 1, \text{ with probability } \delta \\ 1 & \text{if } h = 0, \text{ and } d = 1, \\ 1 & \text{if } h = 1, \text{ with probability } 1 - \delta, \end{cases} \quad (1)$$

and the credit line is governed by the new credit status and the decision to switch as

$$\omega' \begin{cases} = 0 & \text{if } h' = 1, \\ = \omega & \text{if } h' = 0 \text{ and } s = 0, \\ \in \Omega & \text{if } h' = 0 \text{ and } s = 1. \end{cases} \quad (2)$$

Regarding the asset position, it will be governed by the terms of the credit line in use by the household ω' . We thus turn to describe these contracts.

2.1.1 Contracts

To better understand contracts we first start from a newly chosen contract, ω . It specifies the amount that the household borrows in this period $y_0^\omega \leq 0$ and the interest rate at which it does so q_0^ω . It is indexed by the observable characteristics of the customer at the time of signing which reduces to the income class. This is important since the actual income, consumption or savings are irrelevant: the asset position at the end of the period y' , and the income class e (plus the credit history $h = 0$, obviously) are all that matters to forecast future behavior. We typically write q_0^ω , e_0^ω and y_0^ω to refer to the initial terms of a contract.

For existing customers, a line of type ω specifies a credit limit and an interest rate for every possible asset level and income class of the borrower, $b^\omega(e, y)$ and $q^\omega(e, y)$.

It is important to understand the reason why the beginning of period asset position matters. It has to do with the fact that different assets held affect the decision to default or to switch or even of how much to save. Under the existing regulation Z the actual borrowing cannot be used as an argument, so the lagged argument is the best that can be done.

Given this setting, and using the constraints for h' and ω' above, the evolution of the asset position for a household with current assets y , class e and contract type ω obeys the constraint

$$y' \begin{cases} = y_0^{\omega'} & \text{if } h' = 0, h = 0, \text{ and } s = 1, \\ = 0 & \text{if } h' = 1 \text{ and } h = 0, \\ \geq b^\omega(e, y) & \text{otherwise.} \end{cases} \quad (3)$$

The first row represents the case for new contracts that specify the initial loan size. The second row displays how filing for bankruptcy prevents from savings, while the third row represents the case of continuing customers who face the debt constraint prescribed by the contract held. Implicit in the last row are those households with a bad credit history which are restricted to have $\omega = 0$ that has the property that $b^0(e, y) = 0$. Note that the value of y only enters directly this expression via its effect on q^ω .

2.1.2 Budget constraint and preferences

With what we have said, and the fact that all saving can be done at the risk free rate of return q^* , we can write the budget constraint in a compact if cumbersome way as

$$c + \left\{ q^* 1_{y' \geq 0} + \left[s q_0^{\omega'} 1_{y' = y_0^{\omega'}} + (1 - s) q^\omega(y, e) \right] 1_{y' < 0} \right\} y' = (1 - d 1_{y < 0}) y + \varepsilon. \quad (4)$$

Households have standard preferences over streams of consumption, with per period utility function $u(c)$ and discount rate β . Consequently, we write the per period total felicity taking into account the possible utility costs associated with either defaults or switches as

$$u(c) - \chi_s s - \chi_d d. \quad (5)$$

2.1.3 The decision problem

To pose the decision making problem of the agent it is convenient to split it in three different stages. The first stage determines the credit status h' , the second stage determines the type of contract ω' , and the third stage determines the asset position y' . We proceed to solve for the value function, $v(e, y, \varepsilon, \chi_d, \chi_s, \omega, h)$ backwards.

In the third stage, the household's situation depends on choices and events of previous stages that determined a new credit record h' and credit line ω' . There are three possibilities in this stage. First, if it has chosen to default $d = 1$, its consumption will be its endowment, $c = \varepsilon$, and $h' = 1$, $\omega' = 0$, and $y' = 0$. Its corresponding value in stage 3, $v^{3,d}$, is a function only of the current endowment and income class and we write

$$v^{3,d}(e, \varepsilon, \chi_d) = u(\varepsilon) - \chi_d + \beta E \{v(e', 0, \varepsilon', \chi', 0, 1) | e\} \quad (6)$$

where the expectation is over the exogenous states ε' , e' and χ' although in this case χ' is actually irrelevant as neither switching nor defaulting will be available options the next period and those costs are iid. Second, if the household has not defaulted and had switched line it will repay all debts, keep the good credit record, and borrow as specified by the new contract for a new customer. Given that the endowment ε , is transitory, the stage 3 value for a switcher $v^{3,s}$ is a function of cash in hand, income

class, and the new type of contract

$$v^{3,s}(e, y + \varepsilon, \chi_s, \omega') = u(y + \varepsilon - q_0^{\omega'} y_0^{\omega'}) - \chi_s + \beta E \left\{ v(e', y'^{\omega'}, \varepsilon', \chi', \omega', 0) | e \right\}. \quad (7)$$

Third and last, if the household has not defaulted nor switched, then it can choose how much to borrow subject to the debt limit and keep the same line. The value for a non-switcher $v^{3,n}$ is then a function of the initial contract and the updated credit record:

$$v^{3,n}(e, y, \varepsilon, \omega, h') = \max_{y' \geq b^\omega(y, e)} \{ u(y + \varepsilon - [q^* 1_{y' \geq 0} + q^\omega(e, y) 1_{y' < 0}] y') + \beta E \{ v(e', y', \varepsilon', \chi', \omega, h') | e \} \}. \quad (8)$$

We write the solution as $y'^n(e, y, \varepsilon, \omega, h')$. This notation covers the circumstance of a household with an initial bad record that did not cleared $h = h' = 1$, in which case it is necessarily the case that they have the zero line $\omega = 0$.

In the second stage, the situation depends on the default choices (or nature for those with bad credit) that determined the credit record h' in the first stage. If the household has defaulted, then there is no choice to be made about the contract and the value is as in the third stage $v^{2,d}(e, \varepsilon, \chi_d) = v^{3,d}(e, \varepsilon, \chi_d)$. If the household did not default but maintains the bad record $h' = 1$, there is no access to credit lines $\omega' = 0$, so $v^{2,n}(e, y, \varepsilon, 1, 0) = v^{3,n}(e, y, \varepsilon, 1, 0)$. If the household has good credit $h' = 0$ it can decide whether and where to switch and its value is . Therefore, the value for a non-defaulter is

$$v^{2,n}(e, y, \varepsilon, \chi_s, \omega, 0) = \max_{s \in \{0,1\}} \left\{ s \max_{\omega' \in \Omega_e} v^{3,s}(e, y + \varepsilon, \chi_s, \omega') + (1 - s) v^{3,n}(e, y, \varepsilon, \omega, 0) \right\} \quad (9)$$

Where Ω_e denotes the set of contracts available to a type e household. The decisions whether to switch and which line to choose if switching that solve the problem are $s(e, y, \varepsilon, \chi_s, \omega)$ and $\omega'^s(e, y + \varepsilon)$ respectively (notice that the decision of where to switch to does not depend on the utility cost of switching).

In the first stage, finally, the decision whether to default is available only if the initial credit record is good, otherwise nature decides. The corresponding value is represented as:

$$v(e, y, \varepsilon, \chi_d, \chi_s, \omega, h) = \begin{cases} \max_{d \in \{0,1\}} \{ (1 - d) v^{2,n}(e, y, \varepsilon, \chi_s, \omega, 0) + d v_d^3(e, \varepsilon, \chi_d) \} \\ \delta v^{2,n}(e, y, \varepsilon, \chi_s, 0, 0) + (1 - \delta) v^{2,n}(e, y, \varepsilon, \chi_s, 0, 1) \end{cases} \quad (10)$$

With solution for the first row problem given by $d(e, y, \varepsilon, \chi, \omega)$. We refer to decision rules $\{y'^n, s, \omega'^s, d\}$ as *effective* decision rules because they operate along the equilibrium path.

To characterize equilibria, we have to understand deviations from equilibrium from various alternative agents. For this we have to understand how would the household behave in those circumstances. We analyze the behavior of the household under one period deviation of credit limits and interest rates in Section 2.1.4 and under the possible introduction of contracts that do not belong to the equilibrium set Ω in Section 2.1.5.

2.1.4 Deviations in debt limits and prices

The behavior of the household that we have describe is under stationary contracts. These contracts are available every period. This is not sufficient to characterize equilibrium. Lending institutions have to forecast what **would** households do if the terms of the contract where different this period. This can be thought of as the analysis of a one period deviation from the contract by the lender.⁶ Recall that the limits and interest rate are set at the beginning of the period, so the decision for the household also involves three stages.

The analysis requires the value function generated in the previous stage, v , that summarizes what the household gets after the deviation from the lender is over. The third stage decision for a non switching household that is offered an arbitrary pair of credit limit b and interest rate q is (where tildes denote the one period deviation objects)

$$\tilde{v}^{3,n}(e, y + \varepsilon, \omega, 0, b, q) = \max_{y' \geq b} \{u(y + \varepsilon - [q \mathbf{1}_{y' \geq 0} + q \mathbf{1}_{y' < 0}] y') + \beta E \{v(e', y', \varepsilon', \chi', \omega, 0) | e\}\} \quad (11)$$

with solution $\tilde{y}^n(e, y + \varepsilon, \omega, 0, b, q)$. Note that here we are making explicit the dependence on an arbitrary pair of credit limit and interest rate. Note also that the value for the household does not depend on the decomposition of its cash in hand.

⁶This type of analysis is typical in the analysis of policy without commitment. See for example, Klein, Krusell, and Ríos-Rull (2008).

In the second stage the default option remains unchanged while the value of non defaulting is

$$\begin{aligned} \tilde{v}^{2,n}(e, y + \varepsilon, \chi_s, \omega, 0, b, q) = \max_{s \in \{0,1\}} \\ \left\{ s \max_{\omega' \in \Omega_e} v^{3,s}(e, y + \varepsilon, \chi_s, \omega'), (1-s) \tilde{v}^{3,n}(e, y + \varepsilon, \omega, 0, b, q) \right\} \end{aligned} \quad (12)$$

with solution $\tilde{s}(e, y + \varepsilon, \chi_s, \omega, b, q)$ and $\tilde{\omega}^{ts}(e, y + \varepsilon)$.

In the first stage, the decision of whether to default or not comes from

$$\tilde{d}(e, y + \varepsilon, \chi, \omega, b, q) = \operatorname{argmax}_{d \in \{0,1\}} \left\{ (1-d) \tilde{v}^{2,n}(e, y + \varepsilon, 0, \chi_s, \omega, b, q) + d v_d^3(e, \varepsilon, \chi_d) \right\} \quad (13)$$

We refer to the tilde decision rules $\{\tilde{y}, \tilde{s}, \tilde{\omega}^{ts}, \tilde{d}\}$ as *within contract deviation decision rules*.

Characterizing the consumer behaviour given contracts amounts to solving functional equations (6-10) that solve the problem of the household as well as functional equations (11-13) that solve the household problem under deviations. Notice that the behaviour of the household as implied by equations (6-10) is the same as that in (11-13) when we impose that the credit limit and interest rate satisfy $b = b^\omega(y, e)$ and $q = q^\omega(y, e)$.

2.1.5 Deviation in contracts

In order to understand the free entry condition, we have to pose what would happen if an additional contract $\hat{\omega} \notin \Omega$ were offered one period only. This is what prospective entrants need to know to assess the rewards to entry.

The first thing to specify is what remains unchanged in this context. Because the newly offered contract is only available one period, if the agent has not switched to it, the value function as of the following period, v remains unchanged (other financial intermediaries do not need to know the existing distribution of households over contracts to determine what to pose). The same reasoning affects the objects determined as of the third stage: functions $v^{3,d}$, $v^{3,s}$, and $v^{3,n}$ determined in equations (6-8). To denote the new objects that arise under this thought experiment we use hats. To reduce the total number of functions to deal with we construct the problem of the household as we did in Section 2.1.4 by posing a possible one period deviation in interest rates and credit limits (this is the hat functions will be like the tilde functions)

After the only period that new contract $\widehat{\omega}$ was available to sign, the problem faced by holders of that contract in stage 3 is

$$\widehat{v}^{3,n}(e, y + \varepsilon, \widehat{\omega}, 0, b, q) = \max_{y' \geq b} \{u(y + \varepsilon - [q^* 1_{y' \geq 0} + q 1_{y' < 0}] y') + \beta E \{\widehat{v}(e', y', \varepsilon', \chi', \widehat{\omega}, 0)\}\}. \quad (14)$$

with policy rule $\widehat{y}^n(e, y + \varepsilon, \widehat{\omega}, 0, b, q)$ and with yet to be determined $\widehat{v}$. In the second stage such household faces

$$\widehat{v}^{2,n}(e, y + \varepsilon, \chi_s, \widehat{\omega}, 0, b, q) = \max \left\{ \widehat{v}^{3,n}(e, y + \varepsilon, \widehat{\omega}, 0, b, q), \max_{\omega' \in \Omega_e} v^{3,s}(e, y + \varepsilon, \chi_s, \omega') \right\} \quad (15)$$

with solution $\widehat{s}(e, y, \varepsilon, \chi_s, \widehat{\omega}, 0, b, q)$. In the first stage, the problem is

$$\widehat{d}(e, y + \varepsilon, \chi, \widehat{\omega}, 0, b, q) = \operatorname{argmax}_{d \in \{0,1\}} \{(1-d) \widehat{v}^{2,n}(e, y + \varepsilon, \chi_s, \widehat{\omega}, 0, b, q) + d v^{3,d}(\varepsilon, e, \chi_d)\}. \quad (16)$$

Finally we obtain the hat function by using the contract continuation values

$$\widehat{v}(e, y, \varepsilon, \chi, \widehat{\omega}, 0) = \left\{ [1 - \widehat{d}(e, y + \varepsilon, \chi, \widehat{\omega}, 0, b^{\widehat{\omega}}(e, y), q^{\widehat{\omega}}(e, y))] \widehat{v}^{2,n}(e, y + \varepsilon, \chi_s, \widehat{\omega}, 0, b^{\widehat{\omega}}(e, y), q^{\widehat{\omega}}(e, y)) + \widehat{d}(e, y + \varepsilon, \chi, \widehat{\omega}, 0, b^{\widehat{\omega}}(e, y), q^{\widehat{\omega}}(e, y)) v^{3,d}(\varepsilon, e, \chi_d) \right\}. \quad (17)$$

Equations (14- 17) yield the value of holding a new contract $\widehat{\omega}$ the periods after it has been introduced. We now turn to its value the period is newly offered. It is given by

$$\widehat{\widehat{v}}^{3,s}(e, y + \varepsilon, \chi_s, \widehat{\omega}) = u(y + \varepsilon - q_0^{\widehat{\omega}} y_0^{\widehat{\omega}}) - \chi_s + \beta E \{\widehat{v}(e', y'^{\widehat{\omega}}, \varepsilon', \chi', \widehat{\omega}, 0) | e\}. \quad (18)$$

where we are using the double hat to indicate that this function only applies the period the new contract $\widehat{\omega}$ is available. In the second stage the problem is

$$\widehat{\widehat{v}}^{2,n}(e, y, \varepsilon, \chi_s, \omega, 0, \widehat{\omega}) = \max \left\{ v^{3,n}(e, y, \varepsilon, \omega, h'), \max_{\omega' \in \Omega_e} v^{3,s}(e, y + \varepsilon, \chi_s, \omega'), \widehat{\widehat{v}}^{3,s}(e, y + \varepsilon, \chi_s, \widehat{\omega}) \right\}. \quad (19)$$

Let $\widehat{\widehat{s}}^{\widehat{\omega}}(e, y, \varepsilon, \chi_s, \omega, 0) = 1$ denote whether a type $(e, y, \varepsilon, \chi_s, \omega, 0)$ would switch to contract $\widehat{\omega}$. In the

first stage we have

$$\widehat{v}(e, y, \varepsilon, \chi, \omega, 0, \widehat{\omega}) = \max_{d \in \{0,1\}} \left\{ (1-d) \widehat{v}^{2,n}(e, y, \varepsilon, \chi_s, \omega, 0, \widehat{\omega}) + d v^{3,d}(\varepsilon, e, \chi_d) \right\}. \quad (20)$$

when the solution to this problem $\widehat{d}^{\widehat{\omega}}(e, y, \varepsilon, \chi_d, \chi_s, \omega, 0) = 1$, it indicates that the type $(e, y, \varepsilon, \chi_d, \chi_s, \omega, 0)$ would choose to default if it had contract $\widehat{\omega}$. We refer to the hat decision rules $\{\widehat{y}^n, \widehat{s}, \widehat{\omega}^{ts}, \widehat{d}, \widehat{s}^{\widehat{\omega}}, \widehat{d}^{\widehat{\omega}}\}$ as *alternative contract deviation decision rules*.

2.2 Intermediaries

Financial intermediaries, or banks, issue credit lines to households at a fixed initial cost π . The set of lines ω available for a bank to extend span all the potential combinations of initial conditions –class e_0^ω and loan $y_0'^\omega$ – and prices q_0^ω , and credit-limit and price rules b^ω and q^ω . The space of all potential available contracts Ω^P in general is thus the set:

$$\{\omega : [e_0^\omega, y_0'^\omega, q_0^\omega, b^\omega(e, y), q^\omega(e, y)] \in E \times \mathcal{Y}^- \times [0, 1] \times \mathcal{C}_b \times \mathcal{C}_q\} \quad (21)$$

where $\mathcal{C}_b$ and $\mathcal{C}_q$ are the class of mappings $E \times \mathcal{Y} \rightarrow \mathcal{Y}^-$, and $E \times \mathcal{Y} \rightarrow [0, 1]$, (sets of possible values for credit limits and interest rates, respectively). This is in principle a very large set and we will discuss below how to restrict it.

Recall the structure of a contract. Upon issuing a contract ω the bank gives a type e_0^ω household an amount $q'^\omega y_0'^\omega$ in exchange for a promise to receive amount $y_0'^\omega$ (if no bankruptcy) and a continuation of the possibility of lending in the future up to $b^\omega(e, y)$ at interest $q^\omega(e, y)$ for as long as the consumer wants to maintain the contract if it has not filed for bankruptcy. In order to fund these loans, financial intermediaries sell liabilities to households in the form of one-period deposits at the risk-free discount price q^* . We start describing the values for the bank assuming that there is full commitment and therefore, there is nothing to choose, in Section 2.2.1. We then turn to look at the problem in the absence of commitment to more than one period ahead interest rates and credit limits in Section 2.2.2. It is at this stage that we the features of Regulation Z, that the bank can change the interest rates for the following period as well as the credit limit for the following period provided it is not smaller than the current level of debt. We then go on to describe commitment to a rate of return but not to the credit limit, a position that we are considering as a plausible alternative to the current legal environment in Section 2.2.3.

2.2.1 The value of a contract under commitment

To value a contract ω for a bank, we start defining the cash flow m for a bank of a household of whom the bank only observes type $\{e, y\}$. Depending on the household's draw of the earnings, ε , and utility costs, χ , shocks, it can either default or not, and then it can switch or borrow different amounts. To avoid cumbersome notation we write $g(e, y, \varepsilon, \chi, \omega) = [1 - d(e, y, \varepsilon, \chi, \omega)] [1 - s(e, y, \varepsilon, \chi, \omega)]$ to denote whether the contract goes on $g = 1$ or does not go on $g = 0$ because the household defaults or switches. Consequently, the value for the bank is (taking into account the household's decision rules)

$$\begin{aligned} \Psi(e, y, \omega) = & -y \mathbf{1}_{y < 0} \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) [1 - d(e, y, \varepsilon, \chi, \omega)] + \\ & \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) g(e, y, \varepsilon, \chi, \omega) q^\omega(e, y) y'^m(e, y, \varepsilon, w, 0) \mathbf{1}_{y'^m(e, y, \varepsilon, w, 0) < 0} \\ & + q^* \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) g(e, y, \varepsilon, \chi, \omega) \sum_{e'} \Gamma_{e, e'} \Psi(e', y'^m(e, y, \varepsilon, w, 0), \omega) \end{aligned} \quad (22)$$

where the first term is the expected payment of the loan, which takes into account that the household may default, the second term is the additional borrowing that the household may engage that requires the contract to go on (neither to default nor to switch) and the third term is the continuation value of the contract discounted at the risk free rate of return.

At the time of issuing the contract its value, denoted by $\Psi_0(\omega)$, is

$$\Psi_0(\omega) = q_0^\omega y_0'^\omega + q^* \sum_{e'} \Gamma_{e^\omega, e'} \Psi(e', y_0'^\omega, \omega) \quad (23)$$

The absence of commitment implies that a bank is free to choose certain things each period regardless of what the contract specifies and we turn now to consider the problem of the bank under such circumstances. As with households, we refer to functions Ψ and Ψ_0 as *effective* contract values. As the reader may suspect, the lack of commitment prevents non-time consistent contracts from being offered.

2.2.2 Lack of Commitment to interest rates and credit limits

Recall that we are interpreting Regulation Z as an environment where the Bank can specify the continuing terms of a loan each period before the household makes its decisions regarding default, switch and borrowing but it commits to the terms it sets until the following period. The choices of the bank, can therefore be made only contingent in the observables of the households as the beginning of the period.

As we said, this entails the income class e , the asset position y and, of course the credit history h . Recall also that we derived functions $\tilde{y}^n(e, y + \varepsilon, \omega, 0, b, q)$, $\tilde{s}(e, y + \varepsilon, \omega, \chi_s, 0, b, q)$, and $\tilde{d}(e, y + \varepsilon, \chi, \omega, 0, b, q)$ as the savings, switching and defaulting decisions that a household with type $(e, y, \varepsilon, \chi, \omega, 0)$ would make if for this period only the interest rate and credit limit it were facing were $\{b, q\}$.

A bank at the beginning of a period sees a costumer of type $\{e, y, \omega\}$ and is considering which credit limit and interest rate to set. It has to both forecast what the consumer would do for each possible pair of credit limit and interest rate and it also has to forecast what future banks would do. The former is an out of equilibrium deviation that we have already analyzed in Section 2.1.4. From the household's problem in that Section, the bank obtains the tilde functions that will use in its decision making. Its problem is now

$$\begin{aligned} \tilde{\Psi}(e, y, \omega, b, q) = & -y \mathbf{1}_{y < 0} \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) [1 - \tilde{d}(e, y, \varepsilon, \chi, \omega, b, q)] + \\ & \sum_{\varepsilon} F_e(\varepsilon, \chi) \tilde{g}(e, y, \varepsilon, \chi, \omega, b, q) q \tilde{y}^n(e, y, \varepsilon, \omega, 0, b, q) \mathbf{1}_{\tilde{y}^n(e, y, \varepsilon, \omega, 0, b, q) < 0} \\ & + q^* \sum_{\varepsilon} F_e(\varepsilon, \chi) \tilde{g}(e, y, \varepsilon, \chi, \omega, b, q) \sum_{e'} \Gamma_{e, e'} \Psi(e', \tilde{y}^n(e, y, \varepsilon, \omega, 0, b, q), \omega) \end{aligned} \quad (24)$$

Alternative credit conditions for this period as described by the pair (b, q) affects all margins. The first line incorporates the default choice which is affected by future interest rates and the imposed credit limit. The second line shows how not only that the policy of the banks affects the possible amounts borrowed by the household, but also contracts that survive as described by function g (contracts that go on, that is where there was neither default nor switch). Finally, the third row incorporates the fact that the continuation value of the contract is again affected by the banks choices. Note that the nature of the one period deviation on the part of the bank is incorporated by having tildes only in the current function, but not in the function that shows the continuation values.

The bank faces several trade-offs in this problem. Choosing terms that are too stringent (low limit, high interest rate) may induce some borrowers to default since the remaining within the contract may not be so attractive, other households may choose to switch to better terms, while others may stay paying more interest but perhaps on smaller loans. Choosing terms that are too loose may reduce current default but attract more borrowing that may prove costly in the future when households have an opportunity to default on them. It is a careful assessment of all this margin what determines the choice of banks.

A bank that is subject to no commitment, except to not restrict the existing debt, will solve at the

beginning of each period

$$\operatorname{argmax}_{q, b \geq y} \tilde{\Psi}(e, y, \omega, b, q). \quad (25)$$

A solution to this problem is a pair of functions $\tilde{b}(e, y, \omega)$ and $\tilde{q}(e, y, \omega)$ both of which are computed taking into account the continuation values for credit limits and interest rates specified by contract ω , objects that we have denoted $b^\omega(e, y)$ and $q^\omega(e, y)$. Clearly, a time consistent contract ω is one where

$$\tilde{b}(e, y, \omega) = b^\omega(e, y) \quad \text{and} \quad \tilde{q}(e, y, \omega) = q^\omega(e, y, \omega). \quad (26)$$

Only time consistent contracts can be equilibrium contracts as it will be formalized below. So we restrict our attention to them.

Responses to off-equilibrium contracts offerings In the same fashion that we characterized the problem of households if other contracts were offered in Section 2.1.5, we also explore what would be the interest rate and credit limit responses of a bank that offers equilibrium contract $\omega \in \Omega$ when there is an off-equilibrium contract $\hat{\omega} \notin \Omega$ offered. First, note that the behavior of a bank is not affected after $\hat{\omega}$ is introduced. The reason is that such contract is no longer available so none of its customers will take it into consideration. Consequently, we only have to derive the response of interest rates and credit limits in the period that the new (off-equilibrium) contract is introduced. The extent to which existing banks respond to the possible entry of contracts depends crucially on timing issues. If a new contract enters after the banks have set their interest rates and credit limits policies for the period, the banks have no capacity to respond. If, however, new contracts are offered at the same time that existing banks set their period policies then they can respond to the entrant. Such a response can be written as functions as $\hat{b}, \hat{q}$ with arguments $(e, y, \omega, \hat{\omega})$ that result from solving problem (24) under alternative circumstances where we use functions $\{\hat{d}^{\hat{\omega}}, \hat{g}^{\hat{\omega}}\}$. We write such problems compactly (ignoring arguments of functions) as

$$\hat{b}, \hat{q} \in \operatorname{Argmax}_{b, q} \sum_{\varepsilon, \chi} F_e(\varepsilon, \chi) \left[-y \left(1 - \hat{d}^{\hat{\omega}} \right) + q \tilde{y}^n \hat{g}^{\hat{\omega}} \right] 1_{-y > 0} + q^* \mathbb{E} \{ \Psi \} \quad (27)$$

We now turn to the problem faced by potential intermediaries that could offer contracts that are different from the existing ones.

2.2.3 Potential Intermediaries offering new contracts

Some possible off-equilibrium contracts will not be taken up by households and hence we do not have to worry about them, but others would be taken if available. So in addition to characterizing the problem of existing contracts in the presence of off-equilibrium contracts, we also have to characterize the properties of off-equilibrium contracts themselves. Again, the functions $\{\hat{d}, \hat{g}, \hat{y}^n\}$ and $\{\hat{\tilde{d}}, \hat{\tilde{g}}\}$ that characterize the response of households to such offerings are crucial. For any possible alternative contract $\hat{\omega}$ we just need to worry about two things, first to verify whether it is time consistent which amounts to verify (26), this is whether $\tilde{b}(e, y, \hat{\omega}) = b^{\hat{\omega}}(e, y)$ and $\tilde{q}(e, y, \hat{\omega}) = q^{\hat{\omega}}(e, y)$, and second to compute its value, this is to compute $\Phi_0(\hat{\omega})$. Both calculations are identical to those described in Sections 2.2.1 and 2.2.2 and we avoid repeating the derivation.

Lack of commitment only to credit limits Besides the policy allowed under Regulation Z, we are interested in a policy that involves commitment to an interest rate, but not to the credit limit. The specification of this environment is quite easy and we will only describe it briefly. The objects with tilde derived in Section 2.1.4 would only consider deviations in the credit limit b but not in q . The same thing will go with the objects in Sections 2.2.2 2.2.3.

3 Equilibrium

The definition of equilibrium in this economy is a little bit more contrived than in other more standard environments. In addition to the conditions of agents optimizing and market clearing, we have to characterize the set of equilibrium contracts Ω that emerges as the result of free entry in banking.

We have already defined in the set of potential contracts Ω^P as all possible combinations of initial class, initial loan, price and debt-limit rule. This set is very large. We have referred to Ω as the set of contracts available for the households to choose from. We start by defining equilibrium formally and then we discuss the conditions involved.

Definition 1. *An equilibrium consists of a set of available contracts $\Omega \in \Omega^P$, decision rules for households, $\{y^n, s, \omega'^s, d\}$, and contract values for banks Ψ_0 , and Ψ . In addition, within contract deviation functions, $\{\tilde{y}^n, \tilde{s}, \tilde{\omega}'^s, \tilde{d}\}$, and alternative contract deviation functions $\{\hat{y}^n, \hat{s}, \hat{\omega}'^s, \hat{d}, \hat{\tilde{s}}, \hat{\tilde{d}}\}$ for households as well as responses to $\{\hat{b}^{\hat{\omega}}, \hat{q}^{\hat{\omega}}\}$ and values of alternative contracts $\Phi_0(\hat{\omega})$ for intermediaries such that:*

1. Household decision rules solve their problem as defined in (6 -20).
2. Zero profits: Ψ_0 satisfies $\Psi_0(\omega) - \pi = 0$, $\forall \omega \in \Omega$.
3. Contracts are time consistent. For all $\omega \in \Omega$, $\{b^\omega(e, y), q^\omega(e, y)\}$ satisfy (26).
4. Unprofitable opening of other contracts. For all $\hat{\omega} \in \Omega^P$, $\hat{\omega} \notin \Omega$, at least one of the following conditions is not satisfied:
 - (a) Time consistency. That $\{b^{\hat{\omega}}(e, y), q^{\hat{\omega}}(e, y)\}$ satisfy (26) given the alternative contract deviation decision rules.
 - (b) Entry possibilities: $\hat{\Psi}_0(\hat{\omega}) - \pi \geq 0$.
 - (c) Some households choose it: $\hat{s}(e, y, \varepsilon, \omega, \hat{\omega}) = 1$ for some $(e, y, \varepsilon, \omega)$.

Remark 1. This definition uses a very loose definition of equilibrium contract set Ω . In the sense that it allows for contracts that are available but not used. So this set can be quite large. However, this is not a problem, define $\Omega^E \subset \Omega$ the set of effectively used contracts as those such that *i*) are time consistent, *ii*), yield zero profits, and *iii*) some households choose it. It is clear that if Ω decision rules and values is an equilibrium so is Ω^E with the same decision rules and values. Alternatively, for some equilibrium where $\Omega^E = \Omega$ is an equilibrium, we could enlarge Ω to include time consistent contracts that would give zero profits if somebody would take them, but nobody does. The type of contracts that we would enlarge Ω^E with include contracts that offer all possible levels of debt y'_0 for all types of households (e) . The interest rate q_0 that this contract would offer could be very unattractive. This insight is very useful to find equilibria.

Remark 2. This definition allows for banks to respond immediately to the entry of new contracts. This feature may give banks a certain ability to keep higher profit margins as they can respond immediately to new contracts. Had we made the alternative assumption of lagged response of banks they would have to be more concerned about preempting entrance.

Remark 3. The issue of credit limit is easy to deal with. Note that we have defined the asset set as a compact set. In economies of this type $\beta < q^*$ guarantees the existence of an upper bound to asset holdings. So the upper bound is not a problem. The lower bound of assets is not a problem either. There is a maximum amount of debt that can be paid for with positive probability. This means that more debt than that is only consistent with $q = 0$. So we could use such a bound. Typically, though it is sufficient to pose a level of debt for which the rate of return is high but not infinity and that it prevents households from borrowing.

Remark 4. Note that we have not impose any condition on the distribution of agents. This is because the environment is essentially a small open economy (or storage economy) and the risk free rate is given. To complete characterize the economy, we need an initial condition, this is a measure of households over states, that we denote x and a Markovian process on the states to construct an updating operator for the distribution of agents. Moreover, in this economy standard conditions about the persistence properties for income classes Γ guarantee that there is a unique stationary distribution x^* and that such distribution is the limit of any initial one. These are all standard operations for our environment and we spare the reader the details. See Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) for example for details.

Equilibrium with lack of commitment only to credit limits Equilibrium in an environment with lack of commitment only to credit limits is perfectly analogous, and we again spare the reader the details.

4 Computation and Characterization of Equilibria

Computation of equilibrium that is the actual finding of the equilibrium allocations is more than a mere numerical exercise. Our computational strategy has, not only to be able to find zero profit conditions and household optimization, but also to characterize the equilibrium contract set.

To simplify matters, we discretize the set of possible asset holdings. We do it for two important reasons. One is that the nonconvexity of the household problems prevents us from taking advantage of the FOC to characterize the solutions. Discreteness of the asset and choice set makes all maximization problems finite. Moreover, the equilibrium objects are functions of assets which means that we are also making finite the set of prices (interest rates and the like) that we have to find. Obviously, interest rates themselves are not discretized. Here is where the utility costs shocks play an important role by making profit functions continuous in interest rates.

An important step in the computation of equilibrium is to restrict the set of possible contracts to a manageable size, but not too much as to leave out contracts that may exist in equilibrium. We proceed by a guess and verify type strategy. A suitable candidate for the set of available contracts is to have one per each type of income class and loan size (e, y') . Lets denote the set of such pairs Θ with generic element θ . For each θ , we need to compute the initial q_0^θ , and continuation interest rate functions $q^\theta(e, y)$ and credit limits $b^\theta(e, y)$. We look for values that guarantee that households maximize, that lenders maximize and that yield zero profits. We call such an object a Θ -equilibrium, and it satisfies all equilibrium conditions except the last one, that all other possible contracts are unprofitable. Not all contracts in the Θ -equilibrium will be taken up by households, but if they were the would yield zero

profits.

Finding a Θ -equilibrium is a large but manageable problem (if there are N_y asset positions and N_e income classes this amounts to $N_e^2 \times N_y^2 + N_e \times N_y$ interest rates and $N_e^2 \times N_y^2$ credit limits which is a fixed point problem that we have solved by backward iterations relatively easy. Appendix ?? describes our computational procedures to find a Θ -equilibrium in detail. Conditions for existence can be tricky in the sense that the fixed point in updating rules may not exist (there can be some sort of cycles). It can be proved (*we conjecture*) that an equilibrium exists for any finite economy. In all cases we have found a Θ -equilibrium without problem which amounts to a prove for an open set of economies.

Still a Θ -equilibrium is not an equilibrium until we verify the inexistence of alternative profitable contracts. Due to the extreme lack of commitment, once the contracts have started nothing remains from the initial conditions. Consequently, the possible contracts have to be specify different continuation policies. Such a possibility would include something like a contract with a tighter credit limit and a lower interest rate. The existence or not of these contracts is trivial to verify. They *never exist*. For each type of customer that a bank is attached to, the bank can choose a pair of interest rate and credit limits to maximize profits. There is (generically) a unique optimal interest rate per credit limit, and given this there will be a unique credit limit that maximizes profits. Once continuation policies are set there is a unique initial interest rate, essentially because of the law of one price.

For the environment where there is commitment to the interest rate but not to the credit limit, two things have to be verified to ensure that a Θ -equilibrium is indeed an equilibrium. First, whether for the interest rate in the Θ -equilibrium there could be alternative credit line policies that could be time consistent optimal contracts for the bank. It is easy to verify that they are not. Second, whether for different interest rates, and different continuation credit line time consistent policies that yield non-negative profits there are consumers that are takers. This is also straightforward to verify via the construction of a fine grid of interest rates after the computation of a Θ -equilibrium. In all cases we found none.

5 Mapping the model to the data

We first describe the targets in Section 5.1.

5.1 Targets for the model economy

We start by posing as targets the 75 percent poorest households. The gains in computational time (and this is a serious constraint as reported in Section 4) are substantial and we are only interested in those households that are ever likely to be in a negative financial asset position. In this model economy we have two income classes of equal measure where the average persistence in each income class is 10 years and where the high class has a mean that is 63% larger than that of the poorer class and where the median is almost double. The standard deviations are the same inducing a lower class that is substantially more volatile than our high class, or better expressed, the middle class, since we are missing the top quartile.

With this said, we build a model economy with the following aggregate targets

Variable	Target	Value in Model
Wealth to Income ratio	.9	87%
Coeff of Variation of Earnings		0.53
Coeff of Variation of Wealth		0.70
Debt to Income Ratio		.58%
Fraction of the Population in Debt		3.2%
Fraction of the Population Filing for Bankruptcy		.38%

Table 1: Targets of the Model Economy based on data

In such an economy, risk aversion is good, the average duration of the punishment is 10 years, and the utility costs of both search and default are **XXXX in terms of consumption**, while for the banks, the cost of creating a contract is about .8% of yearly output.

On a technical level we consider 12 possible loan sizes, 100 earnings levels and 900 possible asset positions. The minimum loan size is one half of the minimum earnings endowments and about 5% of average earnings. We have found no differences using thinner grids. Recall also that we constructed smooth shocks around the households and banks shocks to make the demand functions continuous.

5.2 Duties: Matching the targets

5.3 Accomplishments: Features of equilibrium contracts

Within the calibrated setting, banks do often raise interest rates after the initial period and credit limits respond to changes in the borrower's observable characteristics. High-income households enjoy disproportionately larger limits, borrow less frequently but, when they do, incur higher debts. Many households revolve credit repeatedly within a given contract, but about two thirds of borrowers are switching to a new contract, typically one with a looser limit but a higher interest rate.

6 Sensitivity Analysis and Comparative Statics

7 The Policy Change

In order to study the regulatory changes in the U.S., we also consider a version of the model where banks are not allowed to change the interest rate at their discretion. There is commitment to stick to the initially agreed price. In the quantitative setting, the adoption of such price commitment causes changes in the credit market compared to the no-commitment benchmark. Generally, banks tighten debt limits but charge lower interest rates. These changes are sharper among high-income households. In terms of aggregates, borrowing decreases and wealth increases, the risk of default and the frequency of contract switching both decline, and average consumption rises.

	Pre-reform (no commitment)	Post-reform (price commitment)
Mass in debt	0.03221	0.03080
Mass of defaulters	0.00383	0.00315
Mass switchers	0.02433	0.02095
Write-off rate	0.26980	0.23279
Wealth	1.1852	1.2105
Debt	0.00658	0.00582
Loan size (initial)	0.2262	0.2199
Loan price (initial)	0.8031	0.7935
Debt limit (initial)	0.2262	0.2199
Loan size (continuing)	0.1430	0.1298
Loan price (continuing)	0.8543	0.9000
Debt limit (continuing)	0.2224	0.1790
Aver. Consumption	1.37246	1.37736

8 Conclusions

TO BE COMPLETED

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