Unintended Consequences of the Credit Card Act*

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Abstract

This paper asks first why consumers seek financing through credit cards. It then evaluates the impact on consumer welfare of the constraints on increasing interest rates present in the Credit Card Act. We model consumer financing in a setting where consumers do not commit to borrow from a given lender and where information asymmetry between a consumer and a lender arises over time. The existence of ex-post information asymmetry coupled with the lack of commitment leads to adverse selection of consumers which, in turn, prompts lenders to offer credit terms that are inefficient relative to a setting with perfect information. This inefficiency is alleviated if credit contracts have some of the features that we observe in credit cards, and we show that these features arise in the competitive equilibrium credit contract. Specifically, in a competitive equilibrium the issuer charges an up-front fee and commits to an interest rate before a loan is taken; the issuer retains an option to change the interest rate upon new information, and consumers have an option to repay the loan at any time. We also show that restrictions on increasing the interest rate, as in the Credit Card Act, are welfare decreasing for a large set of parameters. They lead to lower up-front fees, higher credit card interest rates for low credit-quality consumers, and lower credit limit for high credit-quality consumers. Our results are robust to consumers who have limited rationality and underestimate the risk of default and the risk that their credit-quality decreases. This paper contributes to the literature by providing a new model of credit cards, and offers predictions of relevance for policy makers.

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1 Introduction

In this article, we explore analytically the effects on consumer welfare of a salient feature of the restrictions imposed by the Credit Card Accountability, Responsibility, and Disclosure Act of 2009 (the "Card Act" or "Act").[1] Specifically, we analyze the effect of the restrictions on increasing interest rates on existing balances and requiring periodic re-evaluations of rate increases on future borrowings. To address this question we model credit cards as lines of credit in a competitive market environment with post-contract information asymmetry between an informed consumer and an uninformed credit card issuer.[2] A credit card issuer uses an up-front fee and interest rate to mitigate the inefficiencies that arise due to the information asymmetry. We find that constraints on the issuer's ability to increase the interest rate in response to relevant credit information can lead to higher interest rates and lower credit limits, and lower consumer welfare. In other words, our results show that the Card Act may have unintended negative consequences for welfare. Specifically, anticipating the restrictions on increasing future interest rates, issuers decrease the credit limit offered to consumers whose credit quality improves, and set higher interest rates to consumers whose credit quality deteriorates, making credit more expensive and harder to obtain. Consumer welfare is reduced. Reduced welfare can result even when the consumer is modeled as having biases making him "irrational" in a specific sense.

The financial crisis and events surrounding it culminated in a flurry of legislative activity. The Card Act was one of the notable pieces of legislation. Shortly following this legislation, the Consumer Financial Protection Bureau (CFPB) was created as part of the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (the "Dodd-Frank Act").[3] Among other provisions the Card Act restricts issuers' ability to change prices: issuers cannot in-

[1] Pub. L. No. 111-24, 123 Stat. 1734 (2009) (codified in scattered sections of the U.S.C.).

[2] In this paper we do not address moral hazard which can only exacerbate the effects of interest rate and other fee regulation. For example, knowing that issuers would be unable freely to increase interest rates commensurately with increased risk, consumers may engage in more profligate spending and lesser effort in generating income that can be used for repayments. The issue of moral hazard has been analyzed recently by Kaplan and Zinman (2009).

[3] Pub. L. No. 111-203, 124 Stat. 1376 (2010) (codified and scattered sections of the U.S.C.).

crease interest rates in the first year after opening the credit card account;– rate increases after the first year apply only to new charges, and not to existing balances, and then must be periodically re-evaluated.[4] The Card Act also imposes restrictions on magnitudes of late fees as well as on charging over-the-limit fees unless the consumer explicitly requests that the issuer allow transactions that take the consumer over the credit limit.[5]

In general, issuers set annual percentage rates (APR's) based on their initial assessment of the borrowers' risk. Subsequent information may reveal that the borrowers represent higher risks to the issuer. Such subsequent information includes macroeconomic and industry-wide publicized events such as impending recession, rising unemployment, changes in tax burdens, or adverse regulatory measures. Information may also be revealed about a particular borrower's ability to repay credit card loans. A consumer's own borrowing and repayment behavior under the contract may signal higher risk of defaulting on repayments. Late payments, over the limit charges, or other indicia of degraded ability to pay due to loss of job or other events are examples of borrower-specific information. Reacting to adverse signals in a world free of restrictive regulation issuers would charge consumers increased rates and additional fees, such as default interest rates and late fees.

We first analyze the credit card market under the conditions that prevailed before the enactment of the Card Act. We begin by focusing on a setting with competitive lenders and a rational consumer, and in which ex-post information asymmetry between the consumer and lenders arises over time. We then extend the analysis to consider consumers who are biased and underestimate the risk of change in their credit-quality or the risk of default. The main elements of the model are as follows: a consumer and lenders interact over three periods. A consumer wants to borrow at time 2 against his uncertain time 3 income. Lenders offer

[4]There are two exceptions to the prohibition of increasing the interest rate on existing balances. The Credit Card Act allows the issuers to increase the interest rates when issuers use a reference interest rate and this rate increases. The Act also allows an increase in the interest rate on existing balances if the consumer is more than 60 days late in making the minimum payment.

[5]See What You Need to Know: New Credit Card Rules Effective Aug. 22, Board Governors Fed. Res. Sys., http://www.federalreserve.gov/consumerinfo/wyntk_creditcardrules2.htm (last updated June 15, 2010); What You Need to Know: New Credit Card Rules Effective Feb. 22, Board Governors Fed. Res. Sys., http://www.federalreserve.gov/Consumerinfo/wyntk_creditcardrules.htm (last updated Mar. 11, 2010).

credit terms in time 1 or 2, including credit terms similar to those in credit cards. Credit cards are lines of credit that a consumer has the option to use at a pre-specified interest rate, and can repay at any moment. A credit card agreement specifies an interest rate, a credit limit, and an up-front fee, and gives the issuer the option of changing the credit terms upon new relevant information. Lenders offer credit terms to maximize their profits but, because of competition, they will make zero profits in equilibrium. The three-period- model can be interpreted as one credit cycle that is repeated indefinitely. In reality, this cycle can be seen as one year beginning with the credit card issuance (time 1), borrowings over the year that are collapsed into the time 2 in the model, and finally, payments over the year that are collapsed into time 3 in the model. Correspondingly, the upfront fee can be interpreted as an annual fee charged in the beginning of every year or cycle.

Credit cards offered at time 1 are valuable in our model because they help addressing an adverse selection problem that arises over time. To be specific, we assume that information is symmetric at time 1. The consumer and lenders have the same knowledge about the probabilities of the consumer's default risk. Between time 1 and 2 a consumer privately observes some information about his time 3 income, and information asymmetry arises. Since in most cases the privately observed information cannot be credibly disclosed or verified to the satisfaction of the lender, information asymmetry leads to an adverse selection of consumers: consumers whose credit quality improves find the same credit terms less attractive than consumers whose credit quality deteriorates, and end up borrowing less. To deal with the adverse selection lenders at time 2 offer menus of credit terms that induce consumers to self-select into different credit terms according to their credit quality.[6] This self-selection of consumers results in high credit-quality consumers obtaining a credit limit that is inefficiently low relative to a setting without private information. In addition, the menu of credit terms

[6]Credit cards do not usually offer outright menus of credit terms, but we can interpret over-the-limit credit and fees as part of the menu of different credit terms. That is, the card offers a menu of at least two credit terms: the standard credit terms with the explicit credit limit and interest rate, and the implicit credit terms with some implicit over-the-limit credit constraint and an explicitly higher cost of credit (same interest rate coupled with over-the-limit fees).

offered at time 2 when an issuer faces adverse selection are worse than what a consumer could obtain if he contracted on a credit line at time 1 before the information asymmetry arises.

Contracting on a credit line and committing to an interest rate at time 1 is optimal, as briefly explained below, but not free from inefficiencies. The consumer's option of not using the card and borrowing from alternative lenders coupled with the anticipated onset of information asymmetry, still leads to adverse selection of consumers. The contrast with time 2 is that at time 1 the issuer can charge an up-front fee that mitigates the effects of adverse selection. Specifically, a higher up-front fee allows the issuer to offer lower interest rates to low credit quality consumers and increase the credit limit to higher credit quality consumers, thus increasing consumption and welfare at time 2. However, charging an up-front fee and thus reducing consumption at time 1 to obtain better credit terms and higher consumption at time 2 is costly to a consumer because delaying consumption reduces his utility. Hence, when choosing the optimal up-front fee and menu of credit terms, a consumer trades-off the cost of lower consumption at time 1 with the benefit of higher ex-ante expected consumption at time 2.

We then examine how the introduction of restrictions on raising interest rates on new and existing balances changes the equilibrium that characterizes the pre-Card Act economic environment. To capture the effects of regulation we allow the consumer's private information to become public with some probability, both before and after a consumer decides to use the credit card. In this setting we show that the consumer's option to repay the loan and the issuer's option to change the interest rate upon new information are optimal. Having the option to change the interest rate makes the credit terms offered to high credit-quality consumers less attractive to low credit-quality consumers because the low interest they would benefit from may be increased to match their credit-quality. Self-selection of consumers into different contracts is thus better enabled in that low credit-quality consumers will not find it as advantageous to mimic the better quality consumers. Since self-selection is better enabled, a competitive lender can mitigate the distortion of the consumption of high credit-quality consumers by offering a higher credit limit. The consumer's option to repay the loan coupled with competition from other lenders disciplines the credit card issuer and ensures that the new interest rate is effectively contingent on the consumer's credit-quality and set at the competitive risk-based rate.[7] Except for a small set of parameters when the equilibrium before regulation is separating but the equilibrium after regulation is pooling, regulation that prevents the issuer from increasing the interest rate is welfare decreasing. It implies larger ex-post losses because the issuer cannot adjust the rate it charges to high risk consumers, and it makes self-selection more difficult to achieve. In response to regulation, credit card issuers would offer cards with a lower up-front fee , higher interest rates for high risk consumers, and lower credit limits for low risk consumers. Welfare would be reduced, especially for high credit-quality consumers who now have a lower credit limit. Welfare may be reduced even when consumers are biased as described above. These results, which essentially apply to credit terms of new accounts, are consistent with evidence in the recent CFPB Card Act Report (2013, "CFPB Report"). Interest rates on new accounts increased in an amount ranging from 31% for consumers with the highest FICO scores to 39% for consumers with the lowest FICO scores (see figure 39 on page 70 of the CFPB Report).[8]

Related Literature

To our knowledge Tam (2011) is the only other theoretical attempt at evaluating the welfare impact of the Credit Card Act. Tam sees the Card Act's rules as lengthening the credit

[7]In this paper the borrower can transfer his balance to a different lender without paying any transfer fee. We believe inferences would not be qualitatively affected if we were to include such a fee.

[8]In contrast, the increase in interest rates on existing accounts was smaller, and it ranges from 17% for consumers with the highest FICO scores to 4.7% for consumers with the lowest FICO scores. This smaller increase is partly due to the Card Act's restrictions on increasing interest rates.

For evidence on the up-front fees, we can look at annual fees. The CFPB Report shows that the incidence and dollar amount of annual fees have increased, albeit both the incidence and average fees remain relatively small in magnitude. This evidence is seemingly inconsistent with our model's predictions, but note that our model's predictions are applicable only to new accounts, and since the data on annual fees in the CFPB Report aggregates existing and new accounts, we are unable to isolate the effect of the Card Act on new accounts.

contracts and committing the lenders to the terms of the contract for a longer period. Using a model of optimal default Tam (2011) concludes that longer-term debt contracts tend to result in higher average interest rates, and hence lower levels of borrowing and fewer households borrowing. The higher borrowing rates degrade the ability of new consumers of all types to smooth consumption, hence reducing welfare. While our conclusion about the effects of regulation on welfare is similar, we take a different approach. First, we look explicitly at the effect of the regulation on interest rates, instead of assuming that the Card-Act lengthens credit contracts. Second, and unlike Tam, our model allows for information asymmetry, a feature that we believe to be inherent in this market, and that drives our conclusion regarding the effect of regulation on welfare. Despite these modeling differences Tam's conclusions are consistent with our results, and reinforce the implications of our model for the Card Act's impact on consumer welfare.

In a recent paper, Agarwal at al. (2013), based on a behavioral model of low fee salience and limited market competition, analyze a panel data set of credit card accounts focusing on the Card Act's regulatory limits on charging fees and on the effect of the requirement that credit card bills reveal the costs of paying off balances in 36 months. The authors conclude that limits on fees reduced borrowing costs and that the cost revelation requirement increased the number of borrowers paying off in 36 months. These issues are not the subject of our analysis.

Much of the other research on credit cards focused on pricing issues, such as whether credit card interest rates are "too high". Some of this literature's conclusions relate to our assumption of competitive credit card markets. An early paper by Ausubel (1991) shows evidence that interest rates are high and sticky, and suggests that credit markets are not competitive. Brito and Hartley (1995), however, argue that competition is not inconsistent with high and sticky interest rates. They show that the unpredictability of consumer credit and the cost of originating non-credit card loans justify significant spreads (between credit card rates and other loan rates) which can arise in equilibrium within a competitive market.

Later evidence in Calem and Mester (1995) also suggests that competition can coexist with high and sticky rates. They find that consumers face switching costs and these costs are linked to information barriers coupled with adverse selection. These information barriers, rather than lack of competition, may explain the high and sticky rates. Calem et al. (2005) confirm their earlier findings and find evidence that switching costs have decreased over time.

Our model shares similarities with the model in Park (2004). Like us, Park's analysis is based on the fact that credit cards are one-sided commitments, in that a consumer has an option but not an obligation to use the credit card. Unlike us, though, he assumes that there is ex-ante, rather than ex-post, information asymmetry: a borrower and a lender differ in their information before the contract is signed. Moreover, Park discusses different pricing mechanisms but does not solve for the optimal interest rate. Park shows that the combination of one-sided commitment with ex-ante information asymmetry leads to teaser-rates followed by interest rates above the zero-profit rate. In contrast with our paper, an up-front fee cannot be used in Park's (2009) model to mitigate the problem that the one-sided commitment generates because the information asymmetry exists ex-ante.

2 Model

Consider a three time model with a consumer and competitive credit card issuers. The consumer discounts the future at rate $\beta < 1$. In time 1 the consumer's utility is increasing and concave in consumption. In times 2 and 3 he has linear preferences over his per-period consumption up to a threshold $\bar{c}$ above which he obtains no further utility, i.e., $u(c) = \min(c, \bar{c})$. We choose linear preferences in time 2 and 3 to eliminate any role of credit cards in insuring consumers. We want to solely focus on the liquidity role of credit cards and derive the effects of regulation on this liquidity role. Because of discounting the consumer would prefer to consume all his wealth at time 2. The threshold $\bar{c}$ guarantees that he also finds it optimal to consume after time 2.

The consumer has income y_1 in time 1, and y_1 is such that $u_1'(y_1) = \beta$. This assumption implies that, in a setting without asymmetric information and in which the interest rate is equal to the opportunity cost of the lender, the consumer does not want to borrow or save at time 1. At time 2 the consumer has no income. At time 3 his income is uncertain, and he receives Y with probability $q \in \{q_l, q_h\}$ and nothing otherwise. Since the consumer discounts the future and receives no income at time 2, he would like to borrow up to $\bar{c}$ against his time 3 income. In a competitive market, a consumer's ability to borrow at time 2 depends on the probability q; we can think of q as the consumer's credit quality. We will assume that a consumer's credit quality and income Y are large enough that a competitive creditor is always willing to lend $\bar{c}$ at time 2, i.e., $q_l Y \geq \bar{c}$. The consumer has limited liability and, if he borrows, he cannot be forced to pay the issuer more than his income.

At time 1, the credit quality q is unknown to all agents and the likelihood of high credit quality is denoted by f_h. This assumption implies that there is no ex-ante information asymmetry. Overtime, both lenders and the consumer learn about the consumer's credit quality. In particular, at some point between time 1 and 2, the consumer observes q. This information is public with probability p_1, and private otherwise. If between time 1 and 2 the consumer's private information about his credit quality does not become public then it may still become public with probability p_2 at some point between time 2 and time 3. Private credit quality information cannot be credibly disclosed by the consumer. This importantly implies that the information about the consumer's credit quality q is not contractible. In the real world, information about credit quality is often soft and not easily verifiable. In addition, the hard information that may be relevant is likely too costly to specify with the all the necessary details in the contract. The assumption that credit quality q is not contractible is crucial in justifying the issuer's option to change interest rates.

A credit card contract $\{F, c, r\}$ specifies a fixed fee F, a credit limit c, and an interest rate r if no information arrives.[9] The issuer agrees to extend credit on demand to a consumer

[9]We assume that the lack or existence of news is contractible, but not the specific news.

at the pre-determined interest rate r, and up to the credit limit c. We assume that the issuer can commit, either implicitly or explicitly, to an interest rate r to be charged when there is no public information, and that the issuer reserves the option to change the interest rate if there is public information.[10] Let r_p denote the interest rate that the issuer chooses ex-post upon new information.[11] We further assume that the credit card agreement does not bind the consumer to borrow from the issuer. In particular, the consumer can obtain credit from alternative lenders. This assumption is natural since it would be too costly for an issuer to monitor the consumer's borrowing behavior. The possibility of obtaining credit on demand and borrowing from an alternative lender gives rise to the adverse selection that is crucial for the trade-off in our model. It is important to note that, under the conditions of our model, the issuer's provision of credit on demand is not optimal. In section 6 and Appendix B we extend our model and provide conditions that make this feature of credit cards optimal. Under the conditions in those sections, credit cards are the optimal financial contract between the issuer and consumer.

Since the consumer has no additional benefit from consuming more than $\bar{c}$ and since he has limited liability, it is without loss of generality that we require contracts to satisfy $c \leq \bar{c}$, and interest rates s.t. $rc \leq Y$, and $r_p c \leq Y$. Even though the issuer cannot offer a contract contingent on the consumer's credit quality q it can still offer a menu of non-contingent contracts. We are going to abuse notation and start using the set $\{F, c(q), r(q)\}$ to denote a menu of non-contingent contracts with as many contracts as the number of consumer types q. We will also refer to the credit card at time 1 as a menu of contracts $\left\{F, \left(c^h, r^h\right), \left(c^l, r^l\right)\right\}$

[10] Due to prohibitions against unfair and deceptive practices prior to the enactment of the CARD Act issuers would not, according to our information, raise interest rates charged on pre-existing credit balances in the absence of information showing a change in risk or other factors relating to the cost of providing credit; and, therefore, this is an assumption we make in our analysis.

[11] The implicit assumption is that a court of law can observe and verify whether relevant information has arrived once it arrives, but that writing a contract contingent on the content of that information, q is too costly. This assumption is in line with the typical credit card contract in which lenders usually reserve the right to change the interest rate conditional on new information. Alternatively, instead of reserving an option to change the interest rate, the issuer could also commit ex-ante to an interest r_p if there is relevant public information about the consumer's credit quality. We show below that committing to an interest rate r_p ex-ante or setting it ex-post is equivalent, and thus the latter is optimal.

from which the consumer chooses a bundle (c, r) at time 2, the time at which the credit need arises.

Credit card issuers and other lenders operate in a competitive market. Outside lenders are willing to offer a consumer the interest rate that allows them to break-even given the information available about the consumer's credit quality. The cost of funds of lenders is 1 and equals the gross rate of return on savings.

Figure 1 has the timeline of the model. At time 1 a credit card issuer and a consumer agree on a credit card contract. New information arises between times 1 and 2 which is private with probability $1 - p_1$. At time 2 the consumer borrows b either using his credit card or by resorting to an alternative lender. Any private information that the consumer could have obtained earlier may become public between time 2 and 3, and the consumer's credit may be repaid or refinanced. At time 3 the consumer's income is realized and he repays the lender or defaults.

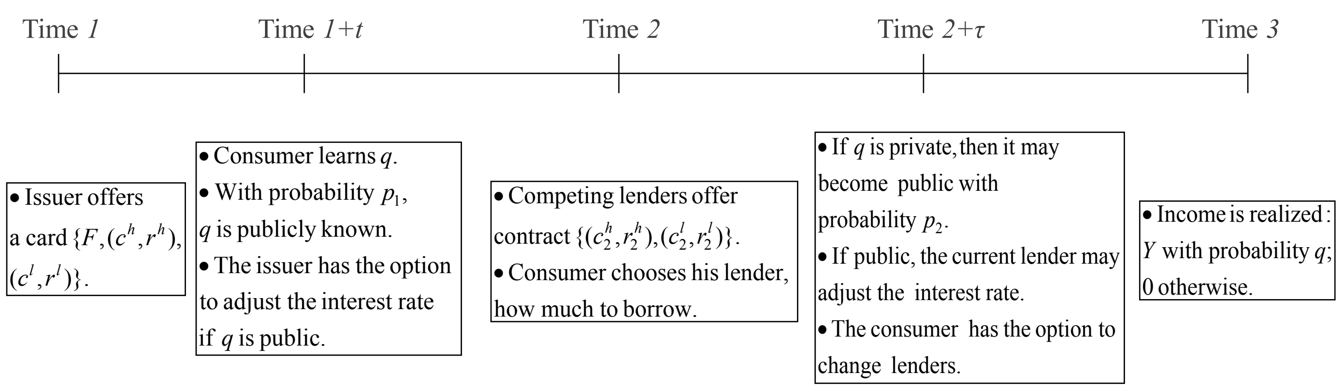

Figure 1: Timeline.

3 Analysis

We proceed with the analysis assuming that the issuer retains an option to change the interest rate when there is public information, and the consumer has an option to refinance the loan at any point. We will argue later that such options are optimal. Since the issuer has an option to change the interest rate upon public information, the rate $r_p(q)$ is chosen to maximize its ex-post profits. It is then straightforward to see that the issuer would like to set $r_p(q)$ as high as possible. But, as the consumer can always borrow at the competitive rate $\frac{1}{q}$ once information becomes public, the highest interest rate $r_p(q)$ the issuer can charge is the competitive rate, and thus $r_p(q) = \frac{1}{q}$.

We also assume that the consumer has the option to not borrow at time 2. The presence of this option makes the credit card the optimal financial contract in our model. In section 6 and in Appendix B we lay out conditions under which offering such option is optimal.

Finally, we assume that a consumer does not save from time 1 to time 2. This assumption is without loss of generality. While positive savings might be optimal in the presence of adverse selection, they do not change the optimality of charging an up-front fee or the effects of regulation on consumer's welfare since savings are not a perfect substitute for an up-front fee.[12] Note that since the consumer does not save from time 1 to time 2, any contract offered at time 2 cannot optimally have an up-front fee, and so we ignore it in our discussion.

The analysis starts at time 2 and then moves to time 1. We'll first analyze the competitive credit market equilibrium at time 2 assuming that a consumer's credit quality is private information and assuming that a consumer is not in possession of a credit card issued at time 1. We will then develop the same analysis when the consumer does have a credit card from time 1. We shall briefly address what happens when a consumer's credit quality becomes public information between time 1 and 2. Using the results from these analyses, we shall derive the competitive equilibrium of time 1.

3.1 Time 2 Competitive Equilibrium

Adverse selection may arise at time 2, and in the presence of adverse selection the definition of a competitive equilibrium is subtle. We follow the literature and use the definition of a competitive equilibrium proposed by Wilson (1977), Miyazaki (1977), and Spence (1978)

[12] Savings and an up-front fee have the same cost per unit to a consumer. They both decrease consumption today but, as it will become clear, the up-front fee yields a larger increase in future consumption.

(WMS). According to this definition, a competitive equilibrium of the credit card market is a menu of contracts such that here is no additional contract an issuer can offer that makes positive profits once competing issuers withdraw any loss-making contracts from the market. An alternative definition of a competitive equilibrium is offered by Rotschild-Stiglitz (1976) and we will also refer to their definition during our analysis. According to Rothschild-Stiglitz (RS), a competitive equilibrium is a menu of contracts such that there is no additional contract an issuer can offer that makes positive profits. The WSM and RS definitions differ in that the WMS definition considers the optimal reaction of issuers that end up with loss-making contracts after the addition of the new contract to the market. A standard result in the adverse selection literature is that the two definitions lead to the same equilibrium when the likelihood of a low credit quality consumer is sufficiently high.[13]

We restrict our attention to an equilibrium menu of contracts with at most two contracts: $\left\{\left(c_2^h, r^h\right), \left(c_2^l, r^l\right)\right\}$. This restriction is without loss of generality because a consumer can only be of two types. When the contracts are identical we call it a pooling equilibrium. When the contracts differ we call it a separating equilibrium. A separating equilibrium requires that consumers self-select into the contract targeted to their credit quality. To understand a consumer's contract selection consider the payoff of consumer q who chooses contract $\{c_2(\tilde{q}), r(\tilde{q})\}$:[14]

$$\begin{aligned} v(\tilde{q}; q) &= c_2(\tilde{q}) + \beta q \left(Y - p_2 \frac{1}{q} c_2(\tilde{q}) - (1-p_2) r(\tilde{q}) c_2(\tilde{q}) \right) \\ &= c_2(\tilde{q})(1-\beta) + \beta q Y + \beta(1-p_2)(1 - q r(\tilde{q})) c_2(\tilde{q}) \end{aligned} \tag{1}$$

Consumer q selects contract q if $v(q) \equiv v(q, q) \geq v(q, \tilde{q})$ for any $\tilde{q}$.

[13] For more on these equilibrium concepts please refer to Rees and Wambach (2008).

[14] We omit the interest rate r_p from the optimal contract because this is an ex-post choice of the issuer.

3.1.1 Time 2 Equilibrium without a Time 1 Contract

The time 2 credit card market is a conventional adverse selection problem when a consumer has no credit card from time 1. Wilson (1977) shows that a WSM competitive equilibrium is the menu of contracts that maximize the payoff of a high credit quality consumer subject to the issuer making zero profits and subject to consumers self-selecting into the contracts targeted to their credit quality. Formally, a time 2 competitive equilibrium solves:

$$\max_{\{c^h,c^l,r^h,r^l\}} v(q^h) = c_2^h + \beta q^h \left(p_2 \left(Y - \frac{1}{q^h} c_2^h \right) + (1-p_2) \left(Y - r^h c_2^h \right) \right) \tag{2}$$

subject to issuers making zero-profits:

$$\begin{aligned} f^h \left(q^h \left((1-p_2) r^h + p_2 \frac{1}{q^h} \right) - 1 \right) c_2^h + f^l \left(q^l \left((1-p_2) r^l + p_2 \frac{1}{q^l} \right) - 1 \right) c_2^l = 0 \\ \Leftrightarrow f^h \left(q^h r^h - 1 \right) c_2^h + f^l \left(q^l r^l - 1 \right) c_2^l = 0 \end{aligned} \tag{3}$$

the consumer's self-selection constraints:

$$v(q^h) \geq v(q^l; q^h) \tag{4}$$

$$v(q^l) \geq c_2^h(1-\beta) + \beta q^l Y + \beta(1-p_2)(1-q^l r^h) c_2^h \equiv v(q^h; q^l) \tag{5}$$

and the resource constraints:

$$c_2^i \leq \bar{c}, \; r^i c_2^i \leq Y, \; \frac{1}{q^i} c_2^i \leq Y$$

This problem is a linear maximization problem which has a corner solution. We leave it to the Appendix to show that in a competitive equilibrium the zero-profit constraint (3) and the low type truth-telling constraint (5) bind, and that $c_2^l = \bar{c}$. The next proposition characterizes the equilibrium menu of contracts.

Proposition 1. *There is a unique equilibrium at time 2. Consider the following condition:*

$$\frac{f^h}{1-f^h} > \frac{(1-\beta p_2)}{(1-\beta)}\left(1-\frac{q^l}{q^h}\right) \equiv \bar{f} \tag{6}$$

When condition (6) *does not hold the competitive equilibrium at time 2 is a Rothschild-Stiglitz separating equilibrium and it satisfies:*

$$\left(c_2^l, r^l\right) = \left(\bar{c}, \frac{1}{q^l}\right) \quad \left(c_2^h, r^h\right) = \left(\frac{1-\beta}{1-\beta+\beta(1-p_2)\left(1-q^l\frac{1}{q^h}\right)}\bar{c}, \frac{1}{q^h}\right) \tag{7}$$

When condition (6) *does hold, the competitive equilibrium at time 2 is pooling and it satisfies* $(c_2, r) = \left(\bar{c}, \frac{1}{E[q]}\right)$.

Proposition (1) establishes that a time 2 equilibrium is either pooling or separating depending on the likelihood f^h that a consumer has high credit-quality. When the likelihood of high credit-quality consumers is low, a separating equilibrium arises. The competitive contract menu is such that the low type consumer's credit limit is set at the efficient level $\bar{c}$, while the high type consumer's credit limit is distorted down. The interest rates are such that issuers exactly break-even on each consumer type, implying that there is no cross-subsidization across consumers. Relative to a frictionless setting without private information, low credit quality consumers borrow the same amount and pay the same interest rate. High credit quality consumers, on the other hand, pay the same interest rate but borrow less than in the absence of asymmetric information. The distortion in the credit limit of the high type consumer is expected. The value of present consumption relative to future consumption is smaller for the high type consumer than for the low type. To separate consumers a lender must offer higher consumption for the low type relative to the high type at time 2, and vice-versa at time 3. This result is akin to what one obtains in an insurance setting with adverse selection, in which consumers with low likelihood of an accident receive less than full insurance.

When the likelihood that a consumer has high credit-quality is high, a pooling equilibrium arises. In a pooling equilibrium both consumer types borrow the same amount as in a world without information asymmetry. Low credit quality consumers are charged an interest rate that is lower than a rate commensurate with their risk thus imposing a loss on a competitive issuer. This loss is compensated for with high credit quality consumers paying an interest rate higher than commensurate with their risk. Thus, in a pooling equilibrium, borrowing is socially efficient and maximizes social surplus. The surplus is distributed in such a way that high credit quality consumers subsidize low credit quality consumers.

The fact that the equilibrium depends on the probability f^h is intuitive. A pooling equilibrium arises when competing issuers cannot, by offering a separating contract, attract high credit-quality consumers and make positive profits. In light of what we just discussed, a separating and a pooling contract impose a trade-off on high credit-quality consumers, and the outcome of this trade-off depends on the probability f^h. While a pooling contract offers more credit at a higher interest rate, a separating contract offers lower interest rates but at the cost of credit-rationing. Since the interest rate of the pooling contract reflects average risk, it decreases with the probability f^h of the consumer having a high credit-quality. On the other hand, credit-rationing in a separating contract is solely determined by the self-selection constraint (5) and is independent of the probability f^h. Hence, as f^h increases, a pooling contract becomes relatively more attractive to high credit-quality consumers than a separating contract, and when f^h is sufficiently high there is no separating contract that, if offered, would attract high credit-quality consumers and make positive profits. A pooling contract is then optimal.

3.1.2 Time 2 Equilibrium with a Time 1 Credit Card

Recall that the time 1 credit card is a menu of contracts $\{F, c(q), r(q)\}$ that leaves to consumers the choice of a bundle (c, r) at the time at which a credit need arises, i.e., time 2. Two outcomes can then result when the consumer has a time 1 credit card: i) The time

1 credit card is the equilibrium menu of contracts or a bundle from the time 1 credit card is part of the equilibrium menu of contracts. ii) The time 1 credit card is not in the equilibrium menu of contracts. We will now discuss each outcome in turn.

Time 1 credit card is the competitive equilibrium at time 2 This outcome can only result if the time 1 credit card is a Rotschild-Stiglitz type equilibrium at time 2. To see this note that the credit card issuer at time 1 cannot withdraw the contracts offered at time 2 even if the contracts offered at time 1 make losses. When issuers cannot withdraw their offers from the market, a WMS competitive equilibrium is simply a menu of contracts such that there is no additional contract an issuer could offer that makes positive profits. This competitive equilibrium is exactly the definition of a Rothschild-Stiglitz equilibrium.

If a time 1 credit card is a Rothschild-Stiglitz equilibrium it will have most of the same characteristics of the Rothschild-Stiglitz contract of the previous section, but differs in a crucial point. Since the issuer can charge a positive fee F at time 1, it can now accommodate losses incurred on loans given to the low credit-quality consumers. The following proposition characterizes the time 1 credit card when it is a competitive equilibrium at time 2. The proof is left to the Appendix.

Proposition 2. *The time 1 credit card is a competitive equilibrium at time 2 only if it is a Rothschild-Stiglitz type equilibrium. If the time 1 contract is a competitive equilibrium or a bundle of the time 1 contract is part of a competitive equilibrium at time 2, the competitive equilibrium then satisfies:*

$$\left(c_2^l, r^l\right) = \left(\bar{c}, r^l\right) \quad \left(c_2^h, r^h\right) = \left(\frac{1+\beta\left(\left(1-p_2\right)\left(1-q^l r^l\right)-1\right)}{1+\beta\left(\left(1-p_2\right)\left(1-q^l \frac{1}{q^h}\right)-1\right)}\bar{c}, \frac{1}{q^h}\right) \tag{8}$$

with r^l solving the zero-profit condition $F = \left(1-p_1\right)\left(1-p_2\right) f^l \left(1-q^l r^l\right)\bar{c}$ for a given fee $F > 0$.

Note that when the issuer charges no up-front fee ($F = 0$), the time 1 credit card is the same menu of contracts as in the previous section. It is easy to show that a positive up-front fee F lowers the interest rate r^l below the competitive rate $\frac{1}{q^l}$ which in turn leads to a higher credit limit and consumption c_2^h to the high credit-quality consumer. Intuitively, a higher fee allows the issuer to make losses on the loans to the low credit-quality consumers by charging an interest rate that is lower than the competitive rate. Facing an interest rate lower than the competitive rate, a low credit-quality consumer has stronger incentives to choose the contract targeted to his risk profile. These stronger incentives for self-selection allow the issuer to increase the credit limit offered to the high credit-quality consumer. Thus, the up-front fee ultimately enables more lending at time 2 to the high credit-quality consumer. This effect is the reason why an up-front fee is beneficial in our model, since it brings the competitive equilibrium closer to the socially efficient solution that results when the consumer's credit-quality is observable.

No time 1 contract bundle is part of the competitive equilibrium at time 2 This outcome is equivalent to the consumer having no time 1 contract, so that the competitive equilibrium at time 2 would be the same as in section (3.1.1).

3.2 Credit quality publicly known before time 2

If the consumer's credit quality becomes public information between time 1 and time 2, competition between lenders ensures that each consumer type is able to borrow $\bar{c}$ at the competitive interest rate for their credit quality, $\frac{1}{q}$. The argument is the same as the one used for when credit-quality becomes public between time 2 and 3.

3.3 Time 1 Competitive Equilibrium

The time 1 setting differs from the time 2 setting in three dimensions: first a credit card issuer can charge an up-front fee F. As we have discussed in section (3.1.2), an up-front fee can ultimately improve a consumer's time 2 utility, and thus it might be optimally charged in a competitive equilibrium. Second, when offering a contract, credit card issuers take into consideration the fact that, instead of using the credit card, a consumer can borrow from another lender at time 2. Specifically, credit card issuers (and consumers) anticipate the competitive equilibrium that unfolds at time 2. Third, at time 1 an issuer faces no adverse selection since information is symmetric. Consumers behave symmetrically and self-selection at time 1 is not an issuer's concern. At time 1 a competitive equilibrium is a credit card contract $\{F, c(q), r(q)\}$ such that no other contract can be offered that yields positive profits and leaves the consumers better-off.

To find the time 1 competitive equilibrium we need first to determine under what conditions does a consumer want a credit card that is an equilibrium at time 2. Consider then the consumer's expected payoff from a credit card contract $\{F, c(q), r(q)\}$ when this contract is an equilibrium at time 2:

$$U_{1,c} \equiv u(y_1 - F) + \beta \left[p_1 \left(\bar{c}(1-\beta) + \beta E[q] Y \right) + (1 - p_1) \left(f^h v_c(q^h) + f^l v_c(q^l) \right) \right] \tag{9}$$

where $v_c(q)$ represents the consumer's time 2 expected utility from using the credit card contract and is as defined in expression (1). Similarly, let $U_{1,e}$ denote the consumer's utility when the credit card is not an equilibrium at time 2. The expression for $U_{1,e}$ is analogous to $U_{1,c}$ in equation (9) with the consumer's time 2 expected utility modified to reflect the contract terms that, as specified in section (3.1.1), would then arise at time 2. Let $v_e(q)$ denote that expected utility.

Comparing the contracts in (7) and (8), and the expressions for $U_{1,c}$ and $U_{1,e}$ two results follow immediately. First, a consumer would never accept a credit card with a positive up-front fee at time 1 if such contract is not an equilibrium at time 2. Second, the separating equilibrium that could arise at time 2 in the absence of a credit card can always be replicated by a time 1 credit card by setting the up-front fee to zero and offering terms identical to the time 2 separating equilibrium. This result implies that if the time 2 equilibrium in the absence of a credit card is a separating equilibrium, then a consumer will be at least as well off by accepting the credit card. Competition among credit card issuers then ensures that the optimal contracting terms maximize the consumer's utility $U_{1,c}$ subject to making zero profits:

$$\pi \equiv F + (1 - p_1) \left[f^h \left(q^h r^h - 1 \right) c_2^h + f^l \left(q^l r^l - 1 \right) c_2^l \right] = 0 \tag{10}$$

The next proposition summarizes this discussion.

Proposition 3. *If condition* (6) *does not hold then a consumer chooses a credit card that is an equilibrium at time 2. The equilibrium credit card solves the problem* $\max_F U_{1,c}$ *subject to* (10)*, with the up-front fee satisfying:*

$$-u'\left(y_1 - F^*\right) + \beta^2 \left(1 + \frac{\frac{f^h}{f^l}(1-\beta)}{(1-\beta) + \beta(1-p_2)\left(1 - \frac{q^l}{q^h}\right)} \right) = 0 \tag{11}$$

The credit limits and interest rates are as in proposition (2)*.*

It follows from equation (11) that the equilibrium up-front fee optimally trades-off lower consumption at time 1 with higher consumption at time 3 for a low credit-quality consumer and higher consumption at time 2 for a higher credit-quality consumer.

It remains to determine the time 1 competitive equilibrium when, in the absence of a credit card, the time 2 equilibrium is pooling. It is easy to show that a time 1 credit card yields strictly lower utility than a pooling time 2 equilibrium. A pooling equilibrium is efficient in that it induces the same borrowing and lending that would arise in the absence of information asymmetry. The only difference between the pooling equilibrium and a full information setting is the distribution of welfare, since the pooling equilibrium yields higher utility to a low credit-quality consumer at the expense of the utility of a high credit-quality consumer. From the perspective of a time 1 consumer who doesn't yet know his credit-quality, the distribution of the time 2 welfare is irrelevant, and the only key consideration is whether the time 2 pooling equilibrium is efficient, i.e., it maximizes social surplus. This argument then implies that when the time 2 equilibrium is pooling, a consumer will optimally choose not to obtain a credit card at time 1 or will choose a credit card that is not a competitive equilibrium at time 2, thus effectively obtaining new credit terms at time 2. The next proposition summarizes this result.

Proposition 4. *If condition*(6) *holds then a consumer opts for no credit card at time 1 or a credit card that is not a competitive equilibrium at time 2. The equilibrium credit terms are only determined at time 2 as in proposition* (1)*, and a pooling equilibrium arises.*

4 Effects of Regulation

As shall be discussed below regulation can have a negative, a positive or no effect on welfare. Regulation doesn't affect welfare when pooling is the time 2 competitive equilibrium both before and after regulation. Regulation reduces welfare when a separating contract is the time 2 competitive equilibrium. By preventing the issuer from increasing interest rates upon new information, regulation makes it more tempting for a low credit quality consumer to choose the contract targeted to a high credit-quality consumer. This additional temptation aggravates the adverse selection problem and leads to more credit rationing of the high credit-quality consumer. Regulation improves welfare if a pooling contract becomes an equilibrium when the pre-regulation equilibrium was separating.

We proceed to analyze the effects of regulation when pooling is not the time 2 competitive equilibrium.We focus the analysis of the effects of regulation on the case in which the time 1 credit card is a competitive equilibrium at time 2. We then discuss the effects of regulation when pooling is the time 2 competitive equilibrium. Finally, we determine how regulation affects the type of equilibrium that arises, and conclude discussing its effect on welfare.

4.1 Increasing interest rates on existing balances

4.1.1 Separating competitive equilibrium at time 2

Suppose that the interest rate r can only be increased with probability ε on arrival of new information so that the probability at time 2 that the interest rate increases is $p_2^\epsilon \equiv p_2\epsilon$. This constraint is only binding for the low credit-quality consumer, and it changes his truth-telling constraint and the zero-profit condition. These conditions now become:

$$v_c^\epsilon\left(q^l\right) \equiv \bar{c} + \beta q^l \left(Y - p_2^\epsilon \frac{1}{q^l}\bar{c} - \left(1 - p_2^\epsilon\right) r^l \bar{c}\right) = c_2^h + \beta q^l \left(Y - \left(p_2^\epsilon \frac{1}{q^l} + (1 - p_2^\epsilon) \frac{1}{q^h}\right) c_2^h\right)$$

$$\Leftrightarrow c_2^h = \frac{(1-\beta) + \beta\left(1 - p_2^\epsilon\right)\left(1 - q^l r^l\right)}{(1-\beta) + \beta(1 - p_2^\epsilon)\left(1 - \frac{q^l}{q^h}\right)}\bar{c} < \bar{c} \tag{12}$$

and:

$$F + \left(1 - p_1\right) f^l (1 - p_2^\epsilon)\left(q^l r^l - 1\right)\bar{c} = 0 \tag{13}$$

After replacing expression $v_c\left(q^l\right)$ with $v_c^\epsilon\left(q^l\right)$ in the consumer's expected utility $U_{1,c}$ in equation (9) and after following the same steps as before, we find that the competitive time 1 contract maximizes $U_{1,c}$ subject to conditions (12) and (13). Differentiating the consumer's utility w.r.t. ϵ and using the envelope theorem yields:

$$\frac{dU_1}{d\varepsilon} = \beta\left(1 - p_1\right) f^h (1-\beta) c_2^h \frac{\beta p_2 \left(1 - \frac{q^l}{q^h}\right)}{(1-\beta) + \beta\left(1 - p_2^\epsilon\right)\left(1 - \frac{q^l}{q^h}\right)} > 0$$

Consumer's welfare increases with the probability of being able to increase the interest rate. This is expected: a higher probability of increasing the interest rate makes it less attractive for low credit-quality consumers to choose the credit terms designed for high credit-quality consumers,thus alleviating the adverse selection problem and the inefficiencies associated with it. Regulation that limits the credit card issuer's ability to increase the interest rate leads to lower welfare.

To obtain the effects of regulation on the credit terms c_1^h and r_l^1 and the fee F we need first to find the optimal fee, which now satisfies:

$$u'(y_1 - F) = \beta^2 \left(1 + \frac{\frac{f^h}{f^l}(1-\beta)}{(1-\beta) + \beta\,(1 - p_2^{\epsilon})\left(1 - \frac{q^l}{q^h}\right)} \right) \tag{14}$$

Using the implicit function theorem, it is possible to show that $\frac{\partial F^*}{\partial \varepsilon} > 0$, and thus the optimal fee increases with the probability of the issuer being able to change the interest rate. The intuition for this result is as follows. When the issuer can change r_1^l it becomes less costly in terms of profits to offer a low interest rate since this rate can be later increased to reflect the consumer's credit quality. Thus, on the margin, decreasing the rate r_1^l requires a smaller increase in the up-front fee F. Conversely, a marginal increase in the up-front fee F now yields a larger reduction in rate r_1^l, and thus it is optimal to increase it. One can also show that $\frac{\partial c^{h*}}{\partial \varepsilon} > 0$ and $\frac{\partial r^{l*}}{\partial \varepsilon} < 0$, i.e., the high type credit limit increases and the low type interest rate decreases with the probability of the issuer being able to adjust the interest rate. Thus, if a separating equilibrium arises after regulation, consumer welfare is reduced. The next lemma summarizes these results.

Lemma 1. *In a separating equilibrium contract decreasing ϵ lowers the up-front fee, the credit limit of high credit quality consumers, and increases interest rates for low credit quality consumers. Welfare in a separating equilibrium contract is reduced.*

4.1.2 Pooling competitive equilibrium at time 2

In a pooling equilibrium contract, decreasing ϵ does not change the credit limit, and leads to a higher interest rate since the issuer is making larger losses on low credit-quality consumers. The higher interest rate implies that there is more cross-subsidization from high to low credit-quality consumers. Since this is just a wealth transfer, consumer welfare as measured from time 1 perspective, does not change.

4.1.3 Pooling or separating equilibrium?

The threshold $\bar{f}^{\epsilon} = \frac{1-\beta p_2}{1-\beta}\left(1-\frac{q^l}{q^h}\right)+\frac{p_2(1-\epsilon)}{1-\beta}\left[\beta\left(1-\frac{q^l}{q^h}\right)-\frac{1-\beta}{1-p_2}\frac{q^l}{q^h}\right]$ that determines whether a pooling or separating contract is an equilibrium may decrease or increase with regulation, $\frac{\partial \bar{f}^{\epsilon}}{\partial \epsilon} \gtrless 0$. Regulation makes a separating contract less beneficial to a high credit-quality consumer since it leads to more credit rationing. Likewise, a pooling contract after regulation is also less beneficial to high credit-quality consumers due to the pooling interest rate being higher. Whether a separating contract becomes relatively more attractive than a pooling contract depends on the consumer's discount factor β, on the likelihood p_2 of the consumer's credit-quality becoming publicly available, and on the ratio of the low and high type consumer's credit quality q^l/q^h. If $\beta\left(1-\frac{q^l}{q^h}\right) > (1-\beta)\frac{q^l}{q^h}\frac{1}{1-p_2}$, the threshold $\bar{f}^{\epsilon}$ increases with regulation, and a pooling contract is the equilibrium in a smaller set of parameters. The opposite is true when $\beta\left(1-\frac{q^l}{q^h}\right) < (1-\beta)\frac{q^l}{q^h}\frac{1}{1-p_2}$.

Lemma 2. *The threshold$\bar{f}^{\epsilon}$ increases(decreases) with ϵ if:*

$$\beta\left(1-\frac{q^l}{q^h}\right)-(1-\beta)\frac{q^l}{q^h}\frac{1}{1-p_2} < (>) 0 \tag{15}$$

Condition (15) is more likely to be positive and regulation will reduce the set of parameters in which a pooling contract is the equilibrium when the consumer's discount factor β is higher, when the likelihood of observing new information p_2 is lower, and when the ratio of income probabilities $\frac{q^l}{q^h}$ is lower. To understand the effect of β on condition (15) note that when the consumer cares more about the future (higher β), his benefit from shifting consumption from time 3 to time 2 is smaller and the additional credit-rationing that regulation induces in a separating contract at time 2 is thus less costly. At the same time, the higher interest rate in time 3 induced by regulation in a pooling contract is more costly to a consumer, hence the result.

Turning now to the likelihood p_2 of observing new information, note that regulation is only relevant when new information arises. Hence, the lower the likelihood p_2 the smaller the effect of regulation in a separating and in a pooling contract. The decrease in the effect of regulation is stronger in a separating contract, and hence the result.

Finally, a lower ratio of income probabilities $\frac{q^l}{q^h}$ exacerbates the effect of regulation in a separating and a pooling contract. In a separating equilibrium a low credit-quality consumer who mimics the high credit quality consumer earns a rent of $\left(1 - \frac{q^l}{q^h}\right)$ if new information does not arise or if the issuer cannot, because of regulation, change interest rates. This rent is behind the adverse selection problem and determines the extent of credit-rationing. A lower $\frac{q^l}{q^h}$ increases this rent and enhances the effect of regulation, thus leading to more credit-rationing. Similarly, in a pooling contract, the expected interest$q^h r^\epsilon$ paid by a high credit-quality consumer increases more with regulation the lower the ratio $\frac{q^l}{q^h}$. It turns out that the exacerbation of the effect of regulation is larger in a pooling contract making it relatively worse than the separating contract, and hence the result.

4.1.4 Welfare Effects

Regulation as in the Card Act which restricts the issuer's ability to adjust the interest rate then leads to lower welfare, lower up-front fees, lower credit limit for better borrowers and higher interest rates for low quality borrowers. Regulation reduces consumer welfare if a separating contract is the equilibrium contract after regulation. Regulation increases interest rates but has no effect on credit limits and welfare if a pooling contract is the equilibrium contract before and after regulation. Finally, regulation has a positive effect on consumer welfare if it induces a pooling equilibrium when before there was a separating equilibrium. The latter can only happen when condition (15) holds with a strictly less-than inequality. Table 1 summarizes the effects of regulation on equilibrium and on the welfare of consumers.

Parameters	**Equilibrium**		**Consumer Welfare**	
	PRE-REGULATION	POST-REGULATION	TIME 1	TIME 2
$\frac{f^h}{1-f^h} < \min\left(\bar{f},\ \bar{f}^{\epsilon}\right)$	Separating $r^h = \frac{1}{q^h},\ r^l < \frac{1}{q^l}$ $F > 0,\ c^h < \bar{c} = c^l$	Separating $F \searrow,\ c^h \searrow,\ r^l \nearrow$	$U_c \searrow$	**h**: $\searrow$ **l**: $\nearrow$
$\frac{f^h}{1-f^h} > \max\left(\bar{f},\ \bar{f}^{\epsilon}\right)$	Pooling $F = 0,\ r = \frac{1}{E[q]}$ $c^h = c^l = \bar{c}$	Pooling $r \nearrow$	$U_c \longrightarrow$	**h**: $\searrow$ **l**: $\nearrow$
$\bar{f} < \frac{f^h}{1-f^h} < \bar{f}^{\epsilon}$	Pooling (contract as above)	Separating $F \nearrow,\ c^h \searrow$ $r^l \nearrow,\ r^h \searrow$	$U_c \searrow$	**h**: $\searrow$ **l**: $\searrow$
$\bar{f}^{\epsilon} < \frac{f^h}{1-f^h} < \bar{f}$	Separating (contract as above)	Pooling $F \searrow,\ c^h \nearrow$ $r^l \searrow,\ r^h \nearrow$	$U_c \nearrow$	**h**: $\searrow$ **l**: $\nearrow$

Table 1: The effects of regulation depending on parameters.

4.2 Increasing interest rates on new balances

Since in our model the time 1 credit card is a menu of contracts we will assume that regulation that prevents increasing interest rates on new balances applies to all interest rates in the menu of contracts. Accordingly, suppose an issuer cannot raise the interest rates on new balances with probability $1 - \mu$, let $p_1^{\mu} \equiv p_1\mu$, and consider first the case when a pooling contract is the equilibrium. Since consumers do not obtain credit at time 1, regulation is of no relevance.

Now suppose a separating contract is the equilibrium contract. Then regulation has an effect equivalent to the consumer's private information becoming public between times 1 and 2 with lower probability. To see this note that a consumer whose credit quality improves and becomes publicly known will always obtain credit at the interest rate $r^h = \frac{1}{q^h}$. On the other hand, a consumer whose credit-quality worsens and becomes publicly known will use the time 1 credit card. The issuer suffers the same losses as when it doesn't observe that the consumer has a worse credit-quality, and the zero-profit condition becomes:

$$F + (1 - p_1^{\mu}) f^l (1 - p_2) \left(q^l r^l - 1\right) \bar{c} = 0$$

Note finally that when the consumer's credit quality is not observed, the self-selection constraint is unchanged. The optimal fee now satisfies:

$$u'(y_1 - F) = \beta^2 \left[\frac{\frac{f^h}{f^l} \frac{1-p_1}{1-p_1^{\mu}} (1-\beta)}{(1-\beta) + \beta (1-p_2) \left(1 - \frac{q^l}{q^h}\right)} + 1 \right]$$

Straightforward application of the implicit function theorem yields that $\frac{\partial F}{\partial \mu} > 0$, $\frac{\partial r^l}{\partial \mu} < 0$, and $\frac{\partial c_2^h}{\partial \mu} < 0$. Since the self-selection and zero-profit condition at time 2 remain unchanged, regulation on new balances does not change the set of parameters for which pooling is an equilibrium. Results are summarized in the following lemma:

Lemma 3. *In a separating equilibrium, decreasing μ leads to a lower up-front fee F, higher interest rate r^l for low credit-quality consumers, and a lower credit limit c_2^h for high credit-quality consumers. In a pooling equilibrium decreasing μ has no effect in equilibrium. Also, the threshold determining whether a pooling equilibrium arises remains unchanged.*

The intuition behind this result is as follows. An issuer that cannot act on public information about the consumer's credit-quality and increase interest rates on new balances is in the same conditions as an issuer that has not observed any information and is subject to adverse selection. Thus, regulation as in the Credit Card Act that makes it more costly to increase interest rates on new balances leads to the existence of an adverse selection problem when before regulation there was none. It follows that the up-front fee optimally decreases, interest rates for low credit-quality consumers are higher, and there is less credit available for high credit-quality consumers.

5 Biased Consumer

This section evaluates the effect of current regulation when (i) the consumer underestimates the likelihood of defaulting, or when (ii) the consumer underestimates the likelihood of his credit quality decreasing . We focus on these particular consumer biases because they seem to correspond to the biases of concern to the regulator.[15]

We capture bias (i) by assuming that the consumer believes his likelihood of default is given by $1-q_b^i < 1-q^i$. To capture bias (ii) we assume that at time 1 the consumer believes that he will have low credit quality with probability $f_b^l < f^l$.

We maintain the assumption that issuers are competitive and have no biases.

Analysis

As in the benchmark model, competition among issuers leads them to break-even while offering the credit card that maximizes the consumer's utility. Unlike the benchmark model, consumer's utility when solving the issuer's problem is computed under the consumer's perspective, thus including the consumer's biases. Note, however, that when we later discuss the effect of biases and regulation on consumer welfare, we compute the consumer's utility without the biases.

In the following subsections we analyze each bias in turn. In each subsection we will first compare the unbiased with the biased competitive equilibrium and then discuss the effect of regulation.

Underestimating the Likelihood of Default

To proceed with the analysis let $1-q_b$ denote a biased estimate of the likelihood of defaulting used by a representative consumer. The expected utility at time 2 of a consumer with credit

[15] "Consumer financial products are often complex – even experienced consumers may have difficulty evaluating the likelihood of certain fees and charges, ..." and "...consumers unfamiliar with consumer financial products may not fully consider the probabilities associated with poor outcomes..." in *Understanding the Effects of Certain Deposit Regulations on Financial Institutions' Operations*, CFPB, November 2013.

quality q_b who claims to have credit quality $\tilde{q}_b$ is given by:

$$v_b(\tilde{q}_b; q_b) = c(\tilde{q}_b) + \beta q_b \left(Y - p_2 \frac{1}{q} c(\tilde{q}_b) - (1-p_2) r(\tilde{q}_b) c(\tilde{q}_b) \right) \tag{16}$$

As before let $v_b(q) \equiv v_b(q; q)$.[16]

It follows from (16) that a consumer who underestimates the likelihood of default at time 3 believes that he is more likely to be in a state of the world in which the marginal utility of net income is highest This belief leads him to attach higher utility to time 3 consumption and makes interest rate payments more costly. As we shall see, this effect of the bias is the key driver of the comparison between the biased and unbiased equilibria. Note that this bias is akin to the consumer having a higher discount factor β for his time 3 consumpion. Sometimes we will use this relation to provide intuition.

The remainder of the analysis is analogous to the case in which the consumer is unbiased. At time 2 competitive firms offer contracts that maximize the expected welfare of a high credit-quality consumer subject to making zero-profits. After making the necessary adjustments in a consumer's utility, the optimal credit limits c_2^i and interest rates r^i in a separating equilibrium solve the same problem as in (2). The optimal credit terms satisfy:

$$c_2^h = \frac{1-\beta\delta}{1-\beta\delta+\beta\delta\left(1-p_2^{\epsilon}\right)\left(1-\frac{q^l}{q^h}\right)} \text{ } \textit{and} \text{ } c_2^l = \bar{c}$$

and $r^i = {}^1/_{q^i}$. The parameter $\delta \equiv \frac{q_b^i}{q^i}$ denotes the extent of the bias, and the extent of the bias is assumed to be identical across consumer types. It is possible to show that the time 2 consumption decreases with the extent of the bias δ. This result is expected. Due to the bias, interest rate payments at time 3 income are more costly to consumers, making the credit

[16] In expression (16) note that consumers anticipate that issuers may raise their interest rate to $\frac{1}{q}$ even though they believe their probability of default is q_b. We are implicitly assuming that consumers and issuers agree to disagree with respect to the likelihood of default. This simply reflects the fact that issuers are not biased when interpreting public information about credit quality while consumers interpret the information with a bias.

terms with low interest rates offered to high credit-quality consumers more attractive to low credit-quality consumers. To induce self-selection of consumers, credit to high credit-quality has to be further rationed.

A pooling equilibrium arises if the following condition holds:

$$-c_2^h (1 - \beta\delta) + \bar{c} \left(1 - \beta\delta \left(p_2^\epsilon + (1 - p_2^\epsilon) \frac{q^h}{E[q]}\right)\right) \geq 0 \tag{17}$$

It is possible to show that more bias δ has an ambiguous effect on condition (17), and a pooling equilibrium may arise in a smaller or larger set of parameters when consumers become more biased. To understand this ambiguous result recall that whether the competitive equilibrium is pooling or separating depends on which yields the highest expected utility to high credit-quality consumers. In a separating equilibrium more bias δ leads to more credit rationing of high credit-quality consumers, thus yielding lower utility to these consumers. On the other hand, more bias reduces the benefit of shifting consumption from time 3 to time 2, thus making a pooling equilibrium relatively less attractive. In addition, in a pooling equilibrium, more bias δ leads to lower utility to high credit-quality consumers: Since a consumer attaches higher value to his time 3 income, it becomes more costly to pay the interest rate that reflects average risk. Depending on which of these effects is stronger more bias δ may relax or make condition (17) stricter.

At time 1 credit card issuers set up-front fees and credit terms competitively. As before, the optimal fee and credit card terms maximize (9) subject to (12) and (13) after adjusting the consumer's utility functions in expressions (9) and (12). The optimal fee F in a separating equilibrium satisfies:

$$u'\left(y_1 - F\right) = \beta^2 A\left(\delta\right) \equiv \beta^2 \left[\underbrace{\frac{f^h/f^l \delta}{1 - \beta\delta + \beta\delta\left(1 - p_2^{\epsilon}\right)\left(1 - \frac{q^l}{q^h}\right)}}_{\frac{\partial c_2^h}{\partial F}} \underbrace{\left(1 - \beta\delta\right)}_{Shifting\, consumption\, benefit} + \underbrace{\delta}_{Returning\, fee\, benefit} \right]$$

It is possible to show that $A\left(\delta\right)$ moves ambiguously with the extent of the bias δ, and so the upfront fee F may be higher or lower when consumers are biased. The ambiguity of the effect of the bias δ on the upfront fee extends to the effect of the bias on the credit limit c_2^h and interest rate r^l because these directly depend on the fee F. The following opposing forces are at play: For a biased consumer, shifting consumption from time 3 to time 2 is less valuable . Since the purpose of the fee is to shift consumption between these two periods, its benefit becomes smaller, and this effect should lead to a lower upfront fee. On the other hand, with a biased consumer it becomes less costly to charge the fee F since he attaches more value to time 3 income and the fee is returned (in expectation) to the consumer at that time. In addition, the credit limit c_2^h becomes more sensitive to the fee F, increasing the benefit of the latter. These last two effects should then lead to a higher fee. Combining all three effects, it is then possible to show that, depending on parameter values, the optimal fee can either increase or decrease with the extent of the bias.

Bias leads to an unambiguous decrease in consumer welfare in a separating equilibrium. To understand this point note that the credit card in a competitive equilibrium with biased consumers is also feasible in a setting with unbiased consumers.[17] Note further that, for the purpose of welfare comparison, the consumer's utility is measured from an unbiased

[17] With biased consumers the break-even condition remains unchanged, and the truth-telling constraint becomes tighter. A credit card that satisfies both these conditions will also satisfy them when consumers are unbiased.

perspective, just like in the unbiased case, and thus any contract that is not maximizing the unbiased consumer utility is not optimal. It then follows that the competitive separating equilibrium when consumers are biased yields lower welfare than when consumers are not biased.

Welfare may be higher when consumers are biased. This occurs when the competitive equilibrium is pooling whereas it would have been separating had the consumers been unbiased.

Effects of Regulation

Regulation on interest rates on existing and new balances have similar effects on the competitive equilibrium as in the case with fully rational consumers. Regulation leads to lower fees F, higher interest rates r^l, and lower credit limit c_2^h in a separating equilibrium.

Consider now the effect of regulation on welfare when consumers are biased. As before, the threshold determining whether the equilibrium is separating may increase or decrease with regulation, and so it is possible that regulation improves consumer welfare by inducing a pooling equilibrium when a separating equilibrium would arise without regulation. However, with biased consumers, it is now possible that regulation improves welfare even if the equilibrium is separating both before and after regulation. This occurs if the equilibrium credit limit c_2^h with biased consumers without regulation is higher than when consumers are rational. Regulation is then beneficial because it decreases c_2^h, hence bringing the competitive equilibrium closer to the unbiased optimum.

Underestimating the Likelihood of a Credit-Quality Change

Suppose consumers underestimate the likelihood that their credit-quality will become low and denote this likelihood by f_b^l. Let $\delta = 1 - \frac{f_b^l}{f^l}$ denote the extent of the consumer's underestimation, with larger δ meaning more underestimation.

As before we start the analysis with the time 2 equilibrium. Since at time 2 consumers know their type, this kind of bias has no effect on the credit terms that arise in a separating or pooling equilibrium at time 2 or on whether the equilibrium is separating or pooling.

At time 1 consumers decide whether to obtain a credit card or wait until time 2. When making their decision consumers anticipate the time 2 equilibrium keeping in mind that their beliefs and the beliefs of credit providers differ. That is, we maintain the assumption that consumers and credit providers agree to disagree. Issuers then offer credit terms to maximize (9) after adjusting the probabilities f^h and f^l to reflect the bias of consumers, and subject to the same constraints (8) and (10). The optimal fee now satisfies:

$$u'(y_1 - F) = \beta^2 \left[\left(1 + \delta \frac{f^l}{f^h}\right) \frac{\frac{f^h}{f^l}(1-\beta)}{1-\beta+\beta(1-p_2^\epsilon)\left(1-\frac{q^l}{q^h}\right)} + 1 - \delta \right]$$

Bias has two opposing effects on the optimal fee. A biased– consumer believes that there is a lower likelihood of his credit quality deteriorating and thus a lower likelihood of him benefiting from the low interest rates at time 3 that the fee affords. This belief increases the consumer's cost of the fee. On the other hand, a biased consumer also believes that there is a higher likelihood that his credit quality improves, thus increasing the benefit of a higher credit limit c_2^h. The net effect of the bias on the fee is negative, and the more biased a consumer the lower the fee. As a consequence of the lower fee, the optimal credit limit is also lower and the optimal interest rate is higher. Consumer welfare, measured from the perspective of an unbiased consumer, is also lower.

The effects of regulation are the same as in a setting with unbiased consumers. The interesting point to note is that in a separating equilibrium regulation moves the optimal contract further away from the optimum. Biased consumers who, without regulation, obtain suboptimal contracts, are made worse off with regulation.

6 The credit line

Credit cards are essentially credit lines– a one-sided commitment of the issuer to extend credit upon request – with an option to repay the loan at any time. Credit cards also typically give the issuer an option to change the interest rate. Except for the one-sidedeness of issuer's commitment, the current model explains all these features. Specifically, in the optimal competitive contract the issuer commits at time 1 to extend credit at time 2 with an interest rate lower than what it would charge if it only contracted with the consumer at time 2. It keeps an option to the change interest rate in order to better address an adverse selection problem, and this option to change the interest rate leads to the inclusion of the option of the consumer to repay an outstanding balance at anytime.. Thus, our model embodies the view that an interest rate commitment together with an up-front fee saves on adverse selection costs, providing credit to consumers in an efficient way.

Our model does not explain why the issuer's commitment is one-sided, i.e., why the consumer retains the option of not borrowing from the credit card issuer. This one-sided commitment is a central feature of credit cards and a crucial driving force in our model. While the model doesn't provide a justification, we argue that having an option to not borrow is optimal if it is likely that the consumer may not need the loan, and if borrowing imposes some cost to the consumer above and beyond the interest rate cost that compensates for his risk. Examples of such a cost are bankruptcy costs and opportunity costs. Our model can be easily extended to include these features and thus endogeneize the one-sided commitment of the issuer. We do this exercise in Appendix (B).

7 Conclusion

The Credit Card Act restricts a credit card issuer's ability to increase interest rates on new and existing balances. What are the welfare consequences? To address this question we model credit cards as lines of credit in an environment with post-contract information asymmetry. We find that restrictions on the issuer's ability to increase the interest rate upon relevant credit information leads, under a large set of parameters, to a higher interest rate to low credit quality consumers, lower credit limit to high credit quality consumers, lower up-front fees, and reduced welfare. Thus, our results show that the Card Act creates unintended negative consequences for consumer welfare.

In our modeling we have deliberately ignored the value of credit cards as a method of payment. We believe this is without loss of generality since the provision of credit and the provision of a method of payment are two different goods that can be easily unbundled, and examples of this unbundling abound (e.g. debit cards). A more complete analysis, though, would consider both functions of credit cards, and would evaluate whether restrictions on interest rates changes have an effect on the value of credit cards as a method of payment.

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A Competitive Equilibrium

A.1 Proof of Proposition 1

The usual WSM equilibrium is either a pooling equilibrium, the Rothschild-Stiglitz pair of contracts, or a cross-subsidization pair of contracts which are a convex combination of the Rothschild-Stiglitz pair of contracts and the pooling contract.[18] In our case, the maximization problem in (2) is linear, which implies that the competitive equilibrium is a corner solution, i.e., it is either the pooling equilibrium or the Rothschild-Stiglitz pair of contracts.[19] In the next steps in the analysis we first find the optimal pooling contract and the high credit-quality consumer payoff. We then determine the Rothschild-Stiglitz equilibrium and find under what conditions the Rothschild-Stiglitz equilibrium yields higher utility to the high credit-quality consumer than the pooling equilibrium.

A.1.1 Pooling Contract Payoffs

In a pooling contract a competitive lender charges the zero-profit interest rate $r = \frac{1}{E[q]}$ and offers the credit limit $\bar{c}$ which, given this interest rate, maximizes the utility of the high credit quality consumer. The consumer's utility from these credit terms is then: $v_p\left(q^h\right) = \bar{c}\left(1-\beta\left(p_2\frac{q^h}{q^h}+(1-p_2)\frac{q^h}{E[q]}\right)\right)+\beta q^h Y$. The pooling contract is the competitive equilibrium if it yields the highest utility to the high credit-quality consumer.

A.1.2 Rothschild-Stiglitz Equilibrium

Low type obtains higher credit limit and interest rate than high type. In equilibrium the credit limit of the low type consumer is higher than the credit limit of a high type consumer $c_2^l > c_2^h$. Conversely, the interest rate of a high type consumer is lower than the interest rate of a low type consumer $r_2^l > r_2^h$. Intuitively, the relative value of present

[18] Technically speaking, a pooling contract is also a cross-subsidization contract.

[19] Cross-subsidization contracts (other than the pooling contract) could arise in a knife-edge case in which the Rotschild-Stiglitz contract and the pooling contract yield the same payoff to the high credit-quality consumer.

consumption for the high type consumer is smaller than for the low type. To separate consumers a lender must offer higher consumption for the low type relative to the high type at time 2, and induce higher consumption for the high type through lower interest rates at time 3. Formally, subtract (4) from (5) to obtain:

$$\beta \left(q^l - q^h\right) \left(Y - (1-p_2) r_2^l c_2^l\right) \geq \beta \left(q^l - q^h\right) \left(Y - (1-p_2) r_2^h c_2^h\right)$$

and note that since $q^l < q^h$, it must be that $r_2^l c_2^l \geq r_2^h c_2^h$. That is, the low type consumer must have a larger debt payment. Using this result in (5) we have that $c_2^l \geq c_2^h$. In a non-pooling equilibrium it must be that $c_2^h \neq c_2^l$ and $r_2^h \neq r_2^l$, and so $c_2^l > c_2^h$. Finally, using the high type truth-telling constraint (4) it is easy to argue that $r_2^l > r_2^h$.

Zero-profit condition binds. It is straightforward to see that the zero-profit condition binds. If the lender is making strictly positive profits, there is another contract with lower interest rate r^h or higher consumption c_2^h that yields higher utility to the high credit-quality consumer..

The truth-telling constraint of the low type binds. If the truth-telling constraint of the low type consumer did not bind in an optimal contract, one could always increase the consumption of the high type consumer and interest payments s.t. profits are unchanged, and the consumer's expected utility strictly increases.

Formally, and by contradiction, suppose that equation (5) does not bind. Then consider a new contract in which we increase c_2^h by δ and change r_2^h by ε to keep profits equal to 0:

$$(c_2^h + \delta)(q^h(r_2^h + \varepsilon) - 1) = c_2^h(q^h r_2^h - 1)$$

The consumer's expected utility then increases by:

$$\Delta U = f^h(c_2^h+\delta)(1-\beta+\beta(1-p_2)(1-q^h(r_2^h+\varepsilon))) - f^h c_2^h(1-\beta+\beta(1-p_2)(1-q^h r_2^h))$$
$$= f^h(c_2^h+\delta)(1-\beta) - f^h c_2^h(1-\beta) = f^h\delta(1-\beta) > 0$$

These changes in c_2^h and $r_2^h c_2^h$ are feasible because c_2^h and $r_2^h c_2^h$ are interior, and because they lead to an increase in the utility of the high type consumersuch that the high type truth-telling and participation constraints and the feasibility constraints are satisfied. The new contract satisfies all the constraints and increases the consumer's utility, a contradiction with the original contract being optimal. The constraint (5) binds. As a corollary, the constraint (4) cannot bind. Subtract again (4) from (5) and realize that the inequality is strict.

The optimal low-type consumption is $c_2^l = \bar{c}$ By contradiction, suppose $c_2^l < \bar{c}$. Suppose also that a competitive issuer is making a profit with the low credit-quality consumer, i.e., $q^l r^l > 1$. It follows that increasing c_2^l introduces slack in the truth-telling constraint of the low credit-quality consumer and in the non-negative profits constraint. Similarly, suppose that the issuer is making a loss on the low credit-quality consumer, $q^l r^l < 1$. It is then possible to increase the interest rate r^l and increase c_2^l s.t. the issuer's profits with the low type, $c_2^l\left(q^l r^l - 1\right)$, are kept constant and the truth-telling constraint of the low credit-quality consumer is now slack:

$$v\left(q^l\right) = c_2^l + \beta q^l\left(Y - p_2\frac{1}{q^l}c_2^l - (1-p_2)\, r^l c_2^l\right) =$$
$$(1-p_2)\left[-\underbrace{c_2^l\left(q^l r^l - 1\right)}_{kept\,constant} + \underbrace{q^l r^l\,(1-\beta)\,c_2^l}_{increases} + \beta q^l Y\right] + p_2\left[c_2^l\,(1-\beta) + \beta q^l Y\right]$$

An issuer can then use this additional slack to increase c_2^h or decrease r^h, thus increasing the utility of the high credit quality consumer, a contradiction with $c_2^l < \bar{c}$ being optimal.

The issuer breaks-even on each bundle By contradiction, suppose an issuer has profits on the bundle targeted to the high credit quality consumers. Then, a competing issuer time 2 issuer could offer a credit contract with a lower interest rate r^h and higher consumption c_2^h such that the truth-telling constraint (5) is satisfied. Such a contract will only attract the high credit quality consumers and will still allow the competing issuer to earn non-negative profits, resultimg in a contradiction with the initial contract being the Rothschild-Stiglitz equilibrium. A similar argument applies when the issuer has profits on the bundle targeted to the low credit quality consumer.

Consumer's payoff under the Rothschild-Stiglitz Equilibrium Using the previous results and the truth-telling constraint (5) of the low-credit quality consumer, one can find the consumption of the high-credit quality consumer:

$$c^h = \frac{1-\beta}{1-\beta+\beta(1-p_2)\left(1-q^l\frac{1}{q^h}\right)}\bar{c}$$

The high credit-quality consumer's utility is $v_{RS}\left(q^h\right) = c^h\left(1-\beta\right)+\beta q^h Y$.

A.1.3 Pooling vs Rothschild-Stiglitz

A pooling equilibrium solves problem (2)if $v_p\left(q^h\right) > v_{RS}\left(q^h\right)$. Simplifying this inequality yields:

$$(1-\beta)\left(1-\frac{q^l}{q^h}+1-\frac{q^h}{E[q]}\right)+\beta\left(1-p_2\right)\left(1-\frac{q^l}{q^h}\right)\left(1-\frac{q^h}{E[q]}\right)>0$$

which can be re-written as:

$$\frac{f^h}{1-f^h} \geq \frac{(1-\beta p_2)}{\beta\left(1-p_2\right)}\left(\frac{\beta\left(1-p_2\right)q^l - q^h\left(1-\beta p_2\right)}{\left(\beta-1\right)q^h}-1\right) = \frac{(1-\beta p_2)}{(1-\beta)}\left(1-\frac{q^l}{q^h}\right) = \bar{f}$$

A.2 Proof of Proposition (2)

When the competitive equilibrium is a Rothschild-Stiglitz equilibrium it must then satisfy the conditions laid out in the proof of proposition (2) with a couple of adjustments to account for the up-front fee. First the issuer's zero-profit condition is as in equation (10) .Second, the issuer does not break-even on the low credit-quality consumers, and their interest rate is obtained from the zero-profit condition. Standard algebra yields the contract in (8)

A.3 Proof of Lemma (1)

The proof follows directly from the application of the implicit function theorem to equation (14):

$$\frac{\partial F}{\partial \epsilon} = \frac{\beta p_2 \left(1 - \frac{q^l}{q^h}\right)}{-u'' \left(y_1 - F\right)} \frac{\beta^2 \frac{f^h}{f^l} (1-\beta)}{\left[(1-\beta) + \beta \left(1 - p_2^\epsilon\right) \left(1 - \frac{q^l}{q^h}\right)\right]^2} > 0$$

Also, differentiating with respect to ϵ the consumption c_2^h and the interest rate r^l as determined in equations (12) and (13) yields:

$$\frac{\partial c_2^h}{\partial \epsilon} = \frac{\beta p_2 \left(1 - \frac{q^l}{q^h}\right) \left[(1-\beta)\bar{c} + \beta \frac{F}{(1-p_1) f^l}\right] + \left[(1-\beta) + \beta \left(1 - p_2^\epsilon\right) \left(1 - \frac{q^l}{q^h}\right)\right] \beta \frac{\frac{\partial F}{\partial \epsilon}}{(1-p_1) f^l}}{\left[(1-\beta) + \beta \left(1 - p_2^\epsilon\right) \left(1 - \frac{q^l}{q^h}\right)\right]^2} > 0$$

and:

$$\frac{\partial r^l}{\partial \epsilon} = -\frac{\frac{\partial F}{\partial \epsilon} + p_2 \left(1 - p_1\right) f^l \left(1 - q^l r^l\right) \bar{c}}{\left(1 - p_1\right) f^l (1 - p_2^\epsilon) q^l \bar{c}} < 0$$

where the inequality follows because $1 \geq q^l r^l$ in a separating equilibrium.

A.4 Proof of Lemma (2)

Following the same steps as before we can find the payoff of a high credit-quality consumer in a time 2 separating equilibrium:

$$v_S^\epsilon(q^h) = c_2^{h,\epsilon} \left(1 - \beta\right) + \beta q^h Y$$

with $c_2^{h,\epsilon} = \frac{\bar{c}(1-\beta)}{1-\beta+\beta\left(1-p_2^{\epsilon}\right)\left(1-\frac{q^l}{q^h}\right)} < c_2^h$. When the issuer cannot increase interest rates, it becomes more tempting for the low credit-quality consumer to mimic the high type. To ensure separation, the high type must be more credit rationed. Regulation increases the cost of a separation contract.

In a time 2 pooling equilibrium the high credit-quality obtains:

$$v_P^{\epsilon}\left(q^h\right) = \bar{c}\left(1-\beta\right) + \bar{c}\beta\left(1-p_2\right)\left(1-q^h r^{\epsilon}\right) + \beta q^h Y$$

with r solving the zero-profit condition after regulation:

$$-1 + f^h q^h\left(p_2\frac{1}{q^h} + \left(1-p_2\right)r^{\epsilon}\right) + f^l q^l\left(p_2^{\epsilon}\frac{1}{q^l} + \left(1-p_2^{\epsilon}\right)r^{\epsilon}\right) = 0$$

$$\frac{1-p_2+f^l p_2\left(1-\epsilon\right)}{\left(1-p_2\right)E[q] + f^l q^l p_2\left(1-\epsilon\right)} = r^{\epsilon} > r^{\epsilon=1}$$

Regulation leads to a higher interest rate in a pooling equilibrium since the issuer cannot increase this rate upon observing a low credit-quality consumer. Hence, regulation increases the cost of a pooling contract for a high credit-quality consumer.

A pooling contract is preferred to a separating contract if:

$$v_P^{\epsilon}\left(q^h\right) \geq v_S^{\epsilon}(q^h)$$

$$\Rightarrow \frac{f^h}{f^l} \geq 1 + \frac{1}{1-\beta}\left(1-p_2^{\epsilon}\right)\left[\beta\left(1-\frac{q^l}{q^h}\right) - \left(1-\beta\right)\frac{q^l}{q^h}\frac{1}{1-p_2}\right] \equiv \bar{f}^{\epsilon}$$

which is just a generalization of the threshold without regulation. Differentiating with respect to ϵ:

$$\frac{\partial\bar{f}^{\epsilon}}{\partial\epsilon} = -\frac{1}{1-\beta}p_2\left[\beta\left(1-\frac{q^l}{q^h}\right) - \left(1-\beta\right)\frac{q^l}{q^h}\frac{1}{1-p_2}\right]$$

The sign of $\frac{\partial\bar{f}^{\epsilon}}{\partial\epsilon}$ is ambiguous. Regulation can increase or decrease the set of parameters for which a pooling equilibrium arises.

A.5 Proof of Lemma (3)

Consider first the case when a pooling contract is the equilibrium. Since consumers do not obtain credit at time 1, regulation is mute. Now suppose a separating contract is the equilibrium contract. Then regulation has an effect equivalent to the consumer's private information becoming public between times 1 and 2 with lower probability. To see this note that a consumer whose credit quality improves and becomes publicly known will always obtain credit at the interest rate $r^h = \frac{1}{q^h}$. On the other hand, a consumer whose credit-quality worsens and becomes publicly known will use the time 1 credit card. The issuer makes the same losses as when it doesn't observe that the consumer has a worse credit-quality, and the zero-profit condition becomes:

$$F + (1 - p_1^{\mu}) f^l (1 - p_2) \left(q^l r^l - 1\right) \bar{c} = 0$$

Note finally that when the consumer's credit quality is not observed, the self-selection constraint is unchanged. Following the same steps as before the competitive time 1 contract solves:

$$\max_F U_1 = u(y_1 - F) + \beta \left[f^h (1 - p_1)(1 - \beta) c_2^h + f^l (1 - p_1^{\mu}) \left((1 - \beta) \bar{c} + \beta \frac{F}{(1 - p_1^{\mu}) f^l} \right) \right]$$
$$+ \beta(1 - \beta)\bar{c} \left(p_1 \mu + f^h p_1 (1 - \mu)\right) \ \ s.t.$$

$$c_2^h = \frac{(1 - \beta)\bar{c} + \beta(1 - p_2)\left(q^l r^l - 1\right)\bar{c}}{(1 - \beta) + \beta(1 - p_2)\left(1 - \frac{q^l}{q^h}\right)}$$

and the optimal fee satisfies:

$$u'(y_1 - F) = \beta^2 \left[\frac{\frac{f^h}{f^l} \frac{1 - p_1}{1 - p_1^{\mu}} (1 - \beta)}{(1 - \beta) + \beta(1 - p_2)\left(1 - \frac{q^l}{q^h}\right)} + 1 \right]$$

Using the implicit function theorem:

$$\frac{\partial F}{\partial \mu} = \frac{\frac{p_1}{\left(1-p_1^{\mu}\right)^2}}{-u''} \frac{\beta^2 \frac{f^h}{f^l}\left(1-p_1\right)\left(1-\beta\right)}{\left(1-\beta\right)+\beta\left(1-p_2\right)\left(1-\frac{q^l}{q^h}\right)} > 0$$

It then follows that $\frac{\partial r^l}{\partial \mu} = -\frac{\frac{\partial F}{\partial \mu}+p_1 f^l (1-p_2)\left(1-q^l r^l\right)\bar{c}}{q^l\left(1-p_1^{\mu}\right)f^l(1-p_2)\bar{c}} < 0$ and that $\frac{\partial c_2^h}{\partial \mu} = \frac{\beta \frac{1}{f^l}}{(1-\beta)+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)} \frac{\partial}{\partial \mu}\left(\frac{F}{1-p_1^{\mu}}\right) > 0$.

B One-Sided Commitment (Option to Not Borrow)

In this section we briefly extend our model to explain why the issuer's commitment is one-sided. Our explanation rests on consumers not always needing credit at time 2, and on credit providers facing a positive cost of funds which is reflected in the cost of lending. These two conditions make it costly to have consumers committing to borrow at time 2. The cost of this commitment is balanced against its benefit in eliminating the adverse selection costs. When the cost of the consumers' commitment is sufficiently large, the issuer's one-sided commitment becomes optimal.

To capture this trade-off in the model, assume that the gross opportunity cost of funds of a credit provider is $\iota > 1$. Assume also that the consumer may have a credit need at time 2 with probability m. We model the consumer's credit need through his preferences. If the consumer has a credit need, his utility from consumption at times 2 and 3 is $u^C(c_2, c_3) = min(c_2, \bar{c}) + \beta c_3$. On the other hand, if the consumer has no credit need his utility from consumption c_2 and c_3 is:

$$u^{NC}(c_2, c_3) = \beta c_3$$

When there is "no credit need" the consumer has no utility from consuming at time $t = 2$. As before the consumer may default at time 3 in which case all his savings go to the lender.

Consumer has no option to not borrow The analysis starts with the equilibrium when the consumer is require to borrow at time 2, i.e., when the consumer does not have the option to not borrow. We first determine consumer welfare for a given loan $\hat{c}$ that the consumer is required to borrow. We obtain the competitive equilibrium and then compare it with the case in which the consumer has the option to not borrow.

A consumer without a credit need at time 2 borrows and saves $\hat{c}$ until time 3 and derives the following expected utility$E\left[u_{NO}^{NC}(c_2, c_3)\right] = 0 + E[q]\beta c_3$. The subscript NO means "no option to not borrow". If the consumer has a credit need he borrows and consumes $\hat{c}$ and his expected utility is given by $E\left[u_{NO}^{C}(c_2, c_3)\right] = min(\hat{c}, \bar{c}) + \beta E[q] max\left(Y - r\hat{c}, 0\right)$. Combining these two case yields the time 1 utility:

$$U_1^{NO} = u(y_1) + \beta\left(mE\left[u_{NO}^{C}(c_2, c_3)\right] + (1-m)E\left[u_{NO}^{NC}(c_2, c_3)\right]\right)$$

A competitive card issuer offers a contract $(\hat{c}, r^{be})$ to maximize U_1^{NO} s.t. the break-even condition:

$$mE[q]r^{be}\hat{c} + (1-m)\left(E[q]\left(r^{be} - 1\right)\hat{c} + \hat{c}\right) = m\iota\hat{c} + (1-m)\left[(\iota - 1)\hat{c} + \hat{c}\right]$$

Solving the break-even condition yields $r^{be} = \frac{1}{E[q]}\left[\iota - (1-m)\left(1 - E[q]\right)\right]$. Using r^{be} in the expression for U_1^{NO} one obtains a linear function in $\hat{c}$. The optimal required borrowing level is thus $\bar{c}$ if:

$$\frac{\partial U_1^{NO}}{\partial \hat{c}} = \beta\left(m - \beta\left(m\iota + (1-m)(\iota - 1)\right)\right) \geq 0$$

Otherwise, if $\frac{\partial U_1^{NO}}{\partial \hat{c}} < 0$, lending is not optimal and $\hat{c}^* = 0$. From now on we will assume that $\frac{\partial U_1^{NO}}{\partial \hat{c}} \geq 0$ so that lending is optimal when the consumer has no option to not borrow. Consumer welfare is then:

$$U_1^{NO} = u(y_1) + \beta\left(m\left[\bar{c} + \beta E[q]\left(Y - \iota\bar{c}\right)\right] + (1-m)\left[\beta E[q]\left(Y - \bar{c}(\iota - 1)\right)\right]\right)$$

Consumer has the option to not borrow If a consumer does not have a "credit need" then he does not borrow and consumes $c_3 = Y$ with probability q and $c_3 = 0$ with probability $1-q$. Consumption at $t=2$ is $c_2 = 0$. His payoff is then $E\left[u_O^{NC}(c_2, c_3)\right] = 0 + \beta E[q]Y$ which is higher than the consumer's payoff when he is required to borrow and has no "credit need".

If a consumer has a "credit need" his payoff is the same as previously analyzed in the baseline model. The lender's 0 profit condition is now:

$$F + m(1-p_1)(1-p_2)\left(f^h\left(q^h r^h - \iota\right) + f^l(q^l r^l - \iota)\right) = 0$$

and from the analysis in the baseline model we obtain the optimal credit terms (F, c^l, r^l, c^h, r^h). Consumer welfare is then given by:

$$\begin{aligned} U_1^O &= u(y_1 - F) + m\left[\beta f^l \bar{c} + \beta^2\left(E[q]Y - \left(\iota - (1-p_2)(\iota - q^l r^l)\right) f^l \bar{c}\right)\right] \\ &\quad + (1-m)\beta^2 E[q]Y \end{aligned}$$

Comparing consumer welfare with and without the option to borrow Comparing U_1^O with U_1^{NO} amounts to comparing the benefit of the option to not borrow with the benefit of not having that option. Having the option to not borrow saves on opportunity costs when the consumer has no credit need. On the other hand, not having this option eliminates any adverse selection problem and allows for efficient lending when the consumer has a credit need. Whether the option to not borrow is optimal depends on the balance of these costs and benefits.

This balance depends on m. For m large enough (high likelihood of a "credit need"), not having the option to not borrow is optimal. For m small enough (low likelihood of a "credit need"), having the option to not borrow is optimal. There is a threshold $\bar{m}$ above which not having the option to not borrow is optimal, and below which having the option to not borrow is optimal. To see that there is a threshold $\bar{m}$ differentiate w.r.t. m the difference

$U_1^O - U_1^{NO}$:

$$\frac{\partial \left(U_1^O - U_1^{NO}\right)}{\partial m} = -\frac{F}{m}u'(y_1 - F) + \left(E\left[u_O^C(c_2, c_3)\right] - E\left[u_{NO}^C(c_2, c_3)\right]\right) \\ - \left(E\left[u_O^{NC}(c_2, c_3)\right] - E\left[u_{NO}^{NC}(c_2, c_3)\right]\right) < 0$$

Further it is possible to show that $U_1^O < U_1^{NO}$ for $m = 1$, and that $U_1^O > U_1^{NO}$ for $m = 0$. Thus, the difference $U_1^O - U_1^{NO}$ crosses 0 only once.