Journal of Law, Finance and Accounting, 2016, 1: 93–138

Unintended Consequences of the Credit Card Act

Tiago Pinheiro[1] and Joshua Ronen[2*]

[1] *Cass Business School, City University, UK*
[2] *Leonard N. Stern School of Business, New York University, 44 West Fourth Street 10-71, New York, NY10012, USA*

ABSTRACT

This article evaluates the impact on consumer welfare of the constraints on increasing interest rates present in the Credit Card Act. We develop a model of consumer financing in a setting where information asymmetry between a consumer and a lender arises over time and triggers adverse selection. We find the competitive equilibrium of this setting and show that restrictions on increasing the interest rate, as in the Credit Card Act, are welfare decreasing for a large set of parameters. The Card's restrictions lead to higher credit card interest rates for low credit-quality consumers and lower credit limit for high credit-quality consumers; these negative effects on welfare are only partially offset by lower up-front fees. We find similar results when we extend our analysis to settings in which consumers have limited rationality.

1 Introduction

The financial crisis and events surrounding it culminated in a flurry of legislative activity aiming to improve the working of financial markets. The Credit Card Accountability, Responsibility, and Disclosure Act of 2009 (henceforth, the

*We are grateful to seminar participants at the Federal Reserve Board in Washington D.C., at the Philadelphia Federal Reserve Bank, at the Norwegian School of Economics, at the 2014 IFABS, PFN, and FEBS conferences, and at the inaugural conference of the

ISSN 2380-5005; DOI 10.1561/108.00000006

"Act") was one of the notable pieces of legislation.[1] 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").[2] Both the Act and the CFPB have the objectives of protecting consumers and establishing fair and transparent practices in the credit card market. To this end, the Act regulates disclosures to consumers of contractual and related information and restricts the charging of credit card fees and the changing of interest rates.

Whether the provisions of the Act improve consumer welfare is an open question that we address in this article. In particular, we explore analytically the effects of the Act's interest rate adjustment restrictions: Issuers cannot increase interest rates on outstanding balances. In addition, issuers cannot increase interest rates on new charges in the first year of the credit card account. Interest rate increases after the first year must be periodically re-evaluated.

Our analysis shows that, by and large, these restrictions decrease consumer welfare. We show that the absence of an option to increase interest rates exacerbates the inefficiencies in the credit card market. Such inefficiencies arise from consumers acquiring private information that reveals an increase in their default risk, and then obtaining credit at an interest rate that does not yet reflect the additional risk. In the presence of restrictive regulation, issuers cannot disincentivize consumers from taking advantage of favorable credit terms by increasing interest rates if and when the consumer's private information becomes known to them. Such increase in interest rates would mitigate the information related inefficiencies in the credit card market.

To determine how restrictions on raising interest rates affect consumer welfare, we first analyze the credit card market under the conditions that prevailed prior to the Act. We then examine how the introduction of such restrictions affects the supply of credit cards and the equilibrium of this market. Our credit card market is a setting with competitive lenders and a rational consumer. We then extend the analysis to consider consumers who underestimate default, who understimate the change in their credit quality, or who are irrationally impatient.

In our model, lenders face an adverse selection of consumers that arises over time. We believe that this is a key characteristic of the credit card market, and one which drives its main features. To be specific, we assume that information is symmetric at the time a card is issued: the consumer and lenders have

Journal of Law, Finance, and Accounting for their comments and suggestions. We thank Geng Li for discussions and comments and for sharing summary statistics on corporate credit card offers. We grateful acknowledge financial support by Finans|Bergen. All errors are our own.

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

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

the same knowledge about the probabilities of the consumer's default risk.[3] Between the time of issuance and the time the consumer actually uses the card to borrow, he privately observes some information about the income that would enable him to repay his borrowing, 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. Those whose credit-quality improves ("high credit-quality consumers") find the same credit terms less attractive than those whose credit-quality deteriorates ("low credit-quality consumers"), and the former end up borrowing less.

To deal with the adverse selection, lenders offer menus of credit terms that induce consumers to self-select into different terms according to their credit-quality.[4] The 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.[5] To mitigate this inefficiency, lenders charge up-front fees that allow them to offer lower interest rates to low credit-quality consumers and increase the credit limit to those whose credit-quality improves. Charging an up-front fee is costly, though, as it reduces consumption at the time of issuance. In a competitive equilibrium, the up-front fee and menu of credit terms trade-off a consumer's cost of lower consumption at issuance for the benefit of higher *ex-ante* expected future consumption.

The competitive equilibrium credit terms and conditions include an option for the issuer to change the interest rate upon new information. This option is optimal because of the realistic possibility that the consumer's private information becomes public with some probability, either before or after a consumer decides to use the credit card. 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, once the private information of the latter is revealed, the low interest may be increased to match their credit quality. Self-selection of consumers into different contracts is thus better

[3]The assumption that information is symmetric at the time a card is issued is without loss of generality. The crucial feature of this assumption and the ones that follow is that information asymmetry increases over time.

[4]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.

[5]While this may at first glance seem counter-intuitive note that it is consistent with borrowers with higher credit scores being granted higher credit limits than those with lower credit scores. For any given (observable) credit score, there is information symmetry about credit quality. Yet, as time goes by, asymmetry arises and what our model shows is that those whose (unobservable) credit quality improves self select into lower credit limits as their desired borrowing is lower in equilibrium.

enabled in that low credit-quality consumers will not find it as advantageous to mimic the higher credit-quality consumers. Since self-selection is better enabled, a competitive lender can increase the consumption of high credit-quality consumers by offering a higher credit limit. Note that in the competitive equilibrium issuers do not use the option to increase interest rates to extract rents from consumers. The equilibrium credit contract includes an option for the consumer to repay the loan at any time. This option, coupled with competition from other lenders, restrains 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.[6]

We then examine how the introduction of restrictions on raising interest rates on new and existing balances changes the equilibrium that prevailed prior to the Act.[7] Except for a small set of parameters regulation that prevents the issuer from increasing the interest rate is welfare decreasing. The small set of parameters in which regulation is not welfare decreasing is such that the equilibrium is separating before regulation and pooling after regulation. An equilibrium is separating when consumers of different credit-quality choose different credit terms, and pooling otherwise. This regulation implies larger ex-post losses because the issuer cannot adjust the rate it charges to low credit quality consumers, and it makes self-selection more difficult to achieve. In response to regulation, credit card issuers offer cards with lower up-front fees, the benefits of which are more than offset by higher interest rates for low credit-quality consumers and lower credit limits for high credit-quality consumers. Consequently, welfare is reduced, especially for high credit-quality consumers who now have a lower credit limit. We find that welfare may also be reduced when we extend our analysis to settings in which consumers underestimate the risk of change in their credit-quality, the risk of default, or when they are irrationally impatient.

The predictions of our model, which essentially apply to credit terms of new accounts, are consistent with evidence in a CFPB Report (2013) showing that 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.[8]

[6] In this article the borrower can transfer his balance to a different lender without paying any transfer fee. Inferences would not be qualitatively affected if we were to include such a fee.

[7] We restrict our analysis to the Act's restrictions on changing interest rates. The Card Act has other provisions, namely provisions on disclosure of information and limitations on the charging of fees, that we do not analyze.

[8] (Figure 39). In contrast, the increase in interest rates on existing accounts was smaller and range 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 Act's restrictions on increasing interest rates.

For evidence on the up-front fees, we can look at annual fees. The CFPB Report (2013) shows that the incidence and dollar amount of annual fees have increased, albeit both the

The remainder of the introduction has a brief overview of the literature that relates to this article. Section 2 presents the model and its main assumptions. The analysis is carried out in section 3. In section 4 we analyze the effects of the Act on consumer welfare, and in section 5 we extend our analysis to the cases of consumers with limited rationality. We explain why credit cards are optimally one-sided commitments in section 6. In section 7 we discuss the empirical evidence related to the predictions of our model. Section 8 concludes.

1.1 Related Literature

To our knowledge, Tam (2011) is the only other theoretical attempt at evaluating the welfare impact of the Credit Act. Tam sees the Act's rules as lengthening the credit 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 Act lengthens credit contracts. Second, and unlike Tam (2011), 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 (2011) conclusions are consistent with our results, and reinforce the implications of our model for the Act's impact on consumer welfare.

In a setting with time-inconsistent and biased consumers and with competitive lenders, Heidheus and Kőszegi (2010) find that welfare improves if lenders cannot impose large penalties on consumers for deferring payments. Since the Act imposes limits on late payment fees, it restricts the penalties for deferring payments and thus it should lead to higher welfare. This article differs from Heidheus and Kőszegi (2010) in two ways. First, we focus on the effects of regulation on interest rates rather than late payment fees. Second, in our setting, consumers are time-consistent and unbiased. Interestingly, and in contrast with Heidheus and Kőszegi (2010), even when we allow for consumers to be biased about their impatience, we show that regulation on interest rates as in the Act can be harmful for welfare.

In a recent article, Agarwal *et al.* (2014), based on a behavioral model of low fee salience and limited market competition, analyze a panel data set of

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. Since the data on annual fees in the CFPB Report (2013) aggregates existing and new accounts, we are unable to isolate the effect of the Card Act.

credit card accounts focusing on the 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 these conclusions relate to our assumption of competitive credit card markets. An early article 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 that 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.* (2006) 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 (2004) 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 (2004) discusses different pricing mechanisms, but does not solve for the optimal interest rate. Park (2004) 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 the current article, an up-front fee cannot be used in Park's (2004) model to mitigate the problem that the one-sided commitment generates because the information asymmetry exists ex-ante.

2 Model

2.1 Summary and Timeline

Consider a three time model with a consumer and competitive credit card issuers. At time 1, a credit card issuer and the consumer agree on a credit card contract. New information about the consumer's credit-quality arises between times 1 and 2. This information is private to the consumer with probability $1 - p_1$. At time 2, the consumer borrows b either by using his credit card or by resorting to an alternative lender. Between times 2 and 3, any private information that the consumer could have obtained earlier may become public and the consumer may repay or refinance his credit. At time 3, the consumer's income is realized and he repays the lender or defaults. Figure 1 has the timeline of the model.

This 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 time 2 in the model, and finally, payments over the year that are collapsed into time 3 in the model. In what follows, we introduce the key assumptions of the model and discuss them in turn.

2.2 Preferences

The consumer discounts the future at rate $\beta < 1$. In time 1, the consumer's utility $u(c)$ 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., $u(c) = \min(c, \bar{c})$. The threshold $\bar{c}$ guarantees that the consumer finds it optimal to consume after time 2. Otherwise, because of discounting, he would prefer to consume all his time 3 income at time 2.

The choice of a partly linear utility function at times 2 and 3 may seem ad hoc given the assumption of a concave utility function at time 1. We choose linear preferences in times 2 and 3 to eliminate any role of credit cards in insuring consumers against income shocks. We want to solely focus on the liquidity role of credit cards, i.e., we want to focus on credit demand driven by liquidity needs and derive the effects of regulation on this liquidity role. For robustness, we also develop the analysis when times 2 and 3 utility are concave and when time 1 utility is linear. This analysis is available in the online Appendix, and its main conclusion is that our results on the effect of regulation on welfare are unaffected if the utility function in times 2 and 3 is concave or if the time 1 utility function is linear.

2.3 Income

The consumer receives income y_1 in 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. We assume that the time 1 income y_1 is such that $u_1'(y_1) = \beta^2$. This assumption implies that, in a setting without asymmetric information and in which the interest rate is equal to the

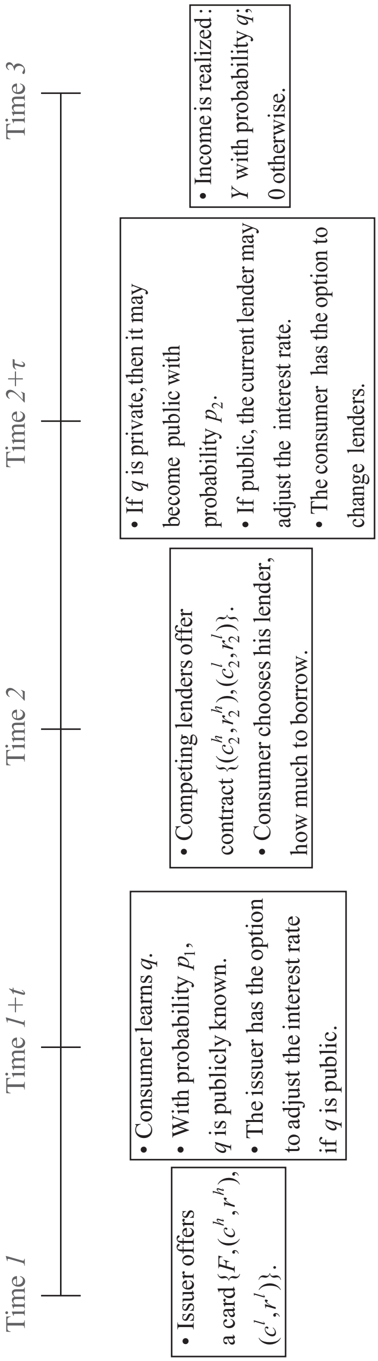

Figure 1: Timeline.

opportunity cost of the lender, the consumer does not want to borrow or save at time 1.

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., $q_l Y \geq \bar{c}$. Finally, we assume that the consumer has limited liability and, if he borrows, cannot be forced to pay the issuer more than his income.

Our assumptions on the income process are without loss of generality. They simplify our analysis while capturing a realistic sequence of contracting, buildup of a credit need, borrowing, and repayment. Taken together, the sequence of times 1 to 3 represent a credit cycle, such as one year, at the end of which the card is renewed.

In time 1, the consumer is issued a credit card and pays the up-front fee. He has sufficient income to pay the fee and consume. Whether or not he saves for future consumption would not have any qualitative effect on the inferences.[9]

Time 2 captures a time in which the consumer demands credit. The onset of the demand for credit can happen after any period following time 1. This period could be seconds or days after the issuance of the credit card, and corresponds to the first time the consumer's income is insufficient to satisfy a consumption need. As long as there is an imbalance between income and consumption, the particular way of modeling it does not affect the results. Our own assumption that income y_2 is 0 and the consumption need is $\bar{c}$ is thus without loss of generality.

Time 3 is when the consumer generates the stochastic income and pays the balance or defaults. Extending the model to a more general income structure at time 3 is straightforward and does not change the results. However, it does make the algebra a bit more complicated because the probability of default now depends on how much the consumer borrows at time 2. Provided that the distribution of income y_3 satisfies a couple of regularity conditions, results do not change.[10]

2.4 Information

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

---

[9] A complete analysis of the model under different assumptions about time 1 income can be found in the online Appendix to this article.

[10] The regularity conditions on the distribution of income ensure that i) low-types want to borrow up to $\bar{c}$ when the interest rate is less or equal than the competitive rate; and ii) that the benefit of consumption at time 2 relative to time 3 is higher for low-types than for high-types.

ex-ante information asymmetry. Over time, both lenders and the consumer learn about the consumer's credit quality. In particular, at some point between times 1 and 2, the consumer observes q. This information is public with probability p_1 and private otherwise. If the information between times 1 and 2 is private, then it may still become public with probability p_2 at some point between times 2 and 3.

When the information about credit-quality q is private, it cannot be credibly disclosed by the consumer. Hence, it is not contractible. The noncontractibility of the consumer's information is an important factor in justifying the optimality of the issuer's option to change interest rates. In the real world, information about credit quality is often soft and not easily verifiable. In addition, some of the hard information that may be relevant is likely too costly to specify with all the necessary details in the contract. Examples of soft nonverifiable information or information that is too costly to write in a contract include the risk of bankruptcy of the consumer's employer, the likelihood of unemployment, and other macroeconomic conditions of a certain region. This is the type of information that would lead issuers to change interest rates, a change that the Act now limits.

2.5 Credit Contracts

A credit card contract $\{F, c, r\}$ specifies an up-front fee F, a credit limit c, and an interest rate r if no information arrives. The issuer agrees to extend a credit line to a consumer at the predetermined interest rate r and up to the credit limit c.[11]

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. Let r_p denote the interest rate that the issuer chooses ex-post upon new information.

An issuer offers a menu of 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 $\left\{F, \left(c^h, r^h\right), \left(c^l, r^l\right)\right\}$ from which the consumer chooses a bundle (c, r) at time 2, the time at which the credit need arises.

Some comments about our contractual assumptions are in order. Under the conditions of our model, a credit line is not the optimal contract between a lender and a consumer. In section 6 and Appendix B, we extend our model and provide conditions that make this feature of credit cards optimal. Making

[11] The up-front fee can be interpreted as an annual fee charged at the beginning of every year or cycle.

the credit line an endogenous feature of credit cards is important because it generates the adverse selection problem faced by credit card issuers.

Our assumption that the issuer can commit to an interest rate r if there is no public information is not inconsistent with the issuer being unable to commit to an interest rate contingent on the consumers' type. In fact, our assumption is in line with the issuers' behavior. Due to prohibitions against unfair and deceptive practices prior to the enactment of the Act, issuers would not, according to our information, raise interest rates charged on preexisting credit balances in the absence of information showing a change in risk or in other factors relating to the cost of providing credit.

This assumption is also without loss of generality. If issuers do not commit to keeping the interest rate when no information arises, the equilibrium credit contract would be the same as described in the analysis below, but with the up-front fee F set to 0. Results about the effect of regulation do not change.

Finally, 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.

2.6 Market and Timeline

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.[12] The cost of funds of lenders is 1 and equals the gross rate of return on savings.

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 that the consumer has an option to refinance the loan at any point. We will argue later that such options are optimal. An issuer with an option to change the interest rate upon public information sets the rate $r_p(q)$ to maximize its ex-post profits, i.e., as high as possible. The highest interest rate $r_p(q)$ the issuer can charge

[12] Assuming that credit card issuers make zero expected prots is not unreasonable given the state of the credit card market. In a recent paper, Grodzicki (2014) establishes how the classical facts characterizing a failure of competition in credit card lending during the 1980s are largely reversed in the decades that follow. Specically, since 1990, lenders' markups decrease substantially, prices have become responsive to underlying costs, and prots have shrunk, all this despite increasing market concentration. The key to our results, though, is not that issuers make zero expected prots, but that they behave competitively. Allowing issuers to make positive prots would not change our results as long as they remain competitive.

is the competitive rate $\frac{1}{q}$, since a consumer can always borrow from another lender at such rate once information about his credit quality becomes public. Thus, $r_p(q) = \frac{1}{q}$.

We conduct the analysis ignoring the possibility that a consumer may save from time 1 to time 2. Ignoring such a possibility is without loss of generality, and we show in the Appendix that positive savings at time 1 are not optimal. 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 goal of this analysis is to characterize the competitive equilibrium at time 1. The time 1 competitive equilibrium depends on the equilibrium that arises at time 2. Thus, we first analyze the competitive credit market equilibrium at time 2 assuming that a consumer's credit quality is private information and that a consumer is not in possession of a credit card issued at time 1. We then develop the same analysis when the consumer does have a credit card from time 1. We briefly address what happens when a consumer's credit quality becomes public information between times 1 and 2. Using the results from these analyses, we derive the competitive equilibrium of time 1.

3.1 Time 2 Competitive Equilibrium

Adverse selection may arise at time 2; 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) (hereafter WMS). According to this definition, a competitive equilibrium of the credit card market is a menu of contracts such that there is no additional contract an issuer can offer that makes positive profits once competing issuers withdraw any loss-making contracts from the market. We also refer to an alternative definition of a competitive equilibrium offered by Rotschild and Stiglitz (1976) (hereafter RS). According to this definition, a competitive equilibrium is a menu of contracts such that there is no additional contract an issuer can offer that makes positive profits. The WMS 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

[13] For a more detailed explanation of these concepts, please refer to Rees and Wambach (2008). Also see Netzer and Scheuer (2014) for a game theoretical foundation of the WMS equilibrium concept.

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 $\{c_2(\tilde{q}), r(\tilde{q})\}$

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

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

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 WMS 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 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

$$f^h (q^h r^h - 1) c_2^h + f^l (q^l r^l - 1) c_2^l = 0 \tag{3}$$

the consumer's self-selection constraints

$$v(q^l) \geq c_2^h (1 - \beta) + \beta q^l Y + \beta (1 - p_2)(1 - q^l r^h) c_2^h \equiv v(q^h; q^l) \tag{4}$$

$$v(q^h) \geq v(q^l; q^h) \tag{5}$$

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 is a linear maximization problem that has a corner solution. The Appendix shows that in a competitive equilibrium, the zero-profit constraint (3) and the low type truth-telling constraint (4) bind, and that $c_2^l = \bar{c}$. The next proposition characterizes the equilibrium menu of contracts.

Proposition 1. *There is a unique competitive (WMS) 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 coincides with the separating (RS) equilibrium and satisfies

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

When condition (6) does hold, the competitive equilibrium at time 2 is pooling and 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 break exactly 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 sufficiently 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.

Whether the competitive equilibrium is pooling or separating depends on the probability f^h; this dependence 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, separating and pooling contracts impose a trade off on high credit-quality consumers, the outcome of which 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 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 (4) 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

The time 1 credit card is a menu of contracts $\{F, c(q), r(q)\}$ that gives consumers the choice to borrow using one of the contract bundles (c, r) at time 2, when their credit needs arise. We can thus think of the time 1 contract as the consumer's outside option when, at time 2, he receives competing offers from other lenders. Two outcomes can result when the consumer has a time 1 credit card: i) The time 1 credit card is the equilibrium menu of contracts or a contract bundle from the time 1 credit card is part of the equilibrium menu of contracts, or 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 occurs when the time 1 credit card offers better terms than the time 2 competing lenders and if the time 1 credit card is similar to the RS time 2 equilibrium without a time 1 contract. To see this, note that the time 1 credit card cannot be withdrawn even if it makes losses. If the time 1 contract is part of the time 2 equilibrium, it must be that there is no other contract that attracts consumers and makes positive profits. This competitive equilibrium is the exact definition of a RS equilibrium.

A time 1 credit card then has most of the same characteristics of the RS contract of the previous section, but differs in a crucial point: An issuer can now charge a positive fee F at time 1 and 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 RS 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*

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

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. A positive up-front 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 to the high credit-quality consumer at time 2. This effect is the reason why an up-front fee is beneficial in our model as 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 times 1 and 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 times 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 consumers better-off.

To find the time 1 competitive equilibrium, we need first to determine the conditions under which a consumer wants 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

$$\begin{aligned} U_{1,c} \equiv u(y_1 - F) + \beta \left[p_1 \left(\bar{c}(1-\beta) + \beta E[q] Y \right) \right. \\ \left. + (1-p_1) \left(f^h v_c(q^h) + f^l v_c(q^l) \right) \right], \end{aligned} \tag{7}$$

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).

Consider also the consumer's utility when the credit card is not an equilibrium at time 2, and denote it by $U_{1,e}$. The expression for $U_{1,e}$ is analogous to $U_{1,c}$ in equation (7), with the time 2 expected utility $v_c(q)$ 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 propositions 1 and 2 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. There is no point in paying an up-front fee if the consumer is never using the credit card. 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

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

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* (8)*, with the up-front fee satisfying*

$$-u'(y_1 - F^*) + \beta^2 \left(1 + \frac{\frac{f^h}{f^l}(1-\beta)}{(1-\beta) + \beta(1-p_2)\left(1 - \frac{q^l}{q^h}\right)}\right) = 0. \quad (9)$$

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

It follows from equation (9) 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 does not 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, positive, or no effect on welfare. Regulation does not 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. Regulation improves welfare if a pooling contract becomes an equilibrium when the pre regulation equilibrium was separating. Note that the change from a separating to pooling equilibrium after regulation occurs in a relatively small set of parameters.

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 effects on welfare. We end this section with a discussion of how the regulation in the Card Act is restrictive in practice.

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

$$c_2^h = \frac{(1-\beta) + \beta\,(1-p_2^\epsilon)\left(1-q^l r^l\right)}{(1-\beta)+\beta(1-p_2^\epsilon)\left(1-\frac{q^l}{q^h}\right)}\bar{c} < \bar{c} \tag{10}$$

and

$$F + (1-p_1)\, f^l(1-p_2^\epsilon)\left(q^l r^l - 1\right)\bar{c} = 0. \tag{11}$$

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 (7) and after following the same steps as before, we find that the competitive time 1 contract maximizes $U_{1,c}$ subject to conditions (10) and (11). Differentiating the consumer's utility w.r.t. ϵ and using the envelope theorem yields

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

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

$$u'(y_1 - F) = \beta^2 \left(1 + \frac{\frac{f^h}{f^l}(1-\beta)}{(1-\beta) + \beta\,(1-p_2^\epsilon)\left(1 - \frac{q^l}{q^h}\right)}\right). \tag{12}$$

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 increased later 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 is thus optimal. 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*

$$\beta\left(1-\frac{q^l}{q^h}\right) - (1-\beta)\frac{q^l}{q^h}\frac{1}{1-p_2} < (>)0. \tag{13}$$

Condition (13) 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 (13) 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 thus the additional credit rationing that regulation induces in a separating contract at time 2 is 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 Act, which restricts the issuer's ability to adjust the interest rate, 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 (13) holds with a strictly less-than inequality.[14] Table 1 summarizes the effects of regulation on equilibrium and the welfare of consumers.

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 $1-\mu$ and let $p_1^\mu \equiv p_1\mu$. 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 does not observe that the consumer has a worse credit quality, and the zero-profit condition becomes

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

[14]Empirical evidence by Han *et al.* (2015) indirectly suggests that, if anything, pooling equilibria have moved into separating equilibria. Han *et al.* (2015) find that disparities in credit terms between bankruptcy filers and non filers appear to have deepened noticeably, particularly after the act became effective. Han *et al.* (2015) also shed light on the model's predicted increase in the difference in interest rates between high and low credit-quality consumers. For example, their Figure 5 shows that after the Act, bankrupt consumers receive fewer offers than non bankrupt consumers, and their offers have higher interest rates.

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

Table 1: The effects of regulation depending on parameters.

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 or 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 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.

4.3 How restrictive is regulation?

One may wonder how restrictive are the provisions of the Act in practice. Discussions with bankers indicate that changes in interest rates (mostly increases) before the Act using information other than what they collect from individual accounts were quite common. For example, changes in macroeconomic indicators such as economic downturns in areas where borrowers are clustered cause increases in interest rates irrespective of the particular payment history of individual borrowers.

One can look to indirect evidence on this. Han *et al.* (2015), for example, document that a one-percentage point increase in a state's unemployment rate reduces the likelihood of receiving a credit card offer by nearly 1 percentage point. A one standard deviation increase in house price growth is associated with a pronounced increase of 13.2 percentage points in the likelihood of receiving an offer, suggesting that housing price increases are correlated with increases in unsecured credit of consumers living in the same area. While this evidence is not directly related to changes in interest rates following macroeconomic events, it is consistent with bankers' assertions mentioned above.[15]

It should be noted that we evaluate the Act's restrictions by looking at the effects of a decrease in the probability that the issuers can increase interest rates. Our evaluation of the Act's restrictions still allows for cases in which issuers can increase interest rates, such as those that end up with a consumer being delinquent for more than 60 days.

5 Consumers with limited rationality

This section evaluates the effect of current regulation when (i) the consumer underestimates the likelihood of defaulting or (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.[16] In the last part of this section, we also discuss the effects of regulation if consumers make decisions as if they are more impatient than they are in actuality.

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.

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, the 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.

[15] If lenders respond to negative macroeconomic shocks by increasing interest rates and reducing credit, and this behavior is widespread, it has the potential to exacerbate macroeconomic shocks. Black *et al.* (2015) argue that a positive feedback lending of this sort can lead to a negative externality, in which case some form of regulation can be welfare improving.

[16] "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.

In the following subsections, we discuss 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.

5.1 Underestimating the Likelihood of Default

A consumer who underestimates the likelihood of default believes that at time 3, he is more likely to be in a state of the world in which he will have to make interest rate payments. From time 2 perspective, these interest payments are thus more costly.

5.1.1 Credit Terms

This effect of the underestimation of the likelihood of default is the key driver of the comparison between the biased and unbiased equilibria. The low interest rate offered to high credit-quality consumers becomes more attractive to low credit quality types. To induce self selection, credit to high credit-quality consumers has to be further rationed. To be specific, the optimal time 2 credit terms are now

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

and $r^i = \frac{1}{q^i}$. The credit limit c_2^h decreases with parameter $\delta \equiv \frac{q_b^i}{q^i}$, which is a measure of the extent of the bias.

However, the effect of this bias on the up-front fee and other credit terms at time 1 is ambiguous. The optimal fee F in a separating equilibrium satisfies $u'\left(y_1-F\right) = \beta^2 A\left(\delta\right)$ with $A\left(\delta\right)$ given by

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

The expression $A(\delta)$ moves ambiguously with the extent of the bias δ, and so the up-front fee F may be higher or lower when consumers are biased than when they are unbiased. The ambiguity of the effect of the bias δ on the up-front 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.

This ambiguity is driven by the following opposing forces. 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 up-front 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 possible to show that, depending on parameter values, the optimal fee can either increase or decrease with the extent of the bias.

5.1.2 Pooling vs Separating Equilibrium

Whether a pooling equilibrium arises in a smaller or larger set of parameters when consumers are biased is also ambiguous. A pooling equilibrium arises if the following condition holds:

$$-c_2^h(1-\beta\delta)+\bar{c}\left(1-\beta\delta\left(p_2^\epsilon+(1-p_2^\epsilon)\frac{q^h}{E[q]}\right)\right)\geq 0. \tag{14}$$

It is possible to show that more bias δ has an ambiguous effect on condition (14) 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 (14) stricter.

5.1.3 Consumer Welfare

Underestimating the likelihood of default 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

[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.

the purpose of welfare comparison, the consumer's utility is measured from an 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.

However, note that welfare may be higher when consumers are biased. This occurs when the competitive equilibrium is pooling with biased consumers, whereas it would have been separating had the consumers been unbiased.

5.1.4 Effects of Regulation

Regulation of 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 the credit limit c_2^h, hence bringing the competitive equilibrium closer to the unbiased optimum.

5.2 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.

5.2.1 Credit Terms

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 (7) after adjusting the probabilities f^h and f^l to reflect the bias of consumers, and subject to the same constraints (2) and (8). 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.

5.2.2 Regulation

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 even worse off with regulation.

5.3 Consumers Overestimate their Impatience

A regulator may also be concerned with consumers who significantly increase their debt for early consumption at the expense of later consumption. Such behavior arises if, for example, at the time of a consumer's borrowing decisions he is irrationally more impatient than what his preferences actually dictate. In other words, such behavior arises if a consumer overestimates his impatience. If consumers do overestimate their impatience, does regulation improve their welfare? To address this question, we consider that consumers either overestimate their discount factor β or their perceived consumption need $\bar{c}$.

If we model impatience as a bias in the consumer's discount factor, then the effects of regulation are the same as in the model without biases. To see this point note that the problem in our model is that consumers consume too little at time 2 rather than too much. Regardless of the effects of impatience, in a separating equilibrium, regulation leads to lower credit limits for high-types and higher interest rates for low-types, and hence decreases welfare. Regulation has no effect when the equilibrium is pooling.

If we model impatience as a bias in the perceived consumption need $\bar{c}$ being higher than the actual, then regulation may improve welfare. To see this point suppose that consumer's actual consumption need is $\bar{c}$ above, which he has no further utility from consuming at time 2. Suppose also that the consumer perceives his consumption need to be $\tilde{\bar{c}} > \bar{c}$. From the perspective of a benevolent social planner who is concerned with the unbiased welfare of the consumer, the optimal consumption at time 2 is $\bar{c}$. But, the credit card equilibrium is such that both consumer types may end up consuming more than $\bar{c}$. In this case, regulation on interest rates can be welfare increasing because it reduces the time 2 consumption of high credit-quality consumers and brings it closer to the optimum. However, when high credit-quality consumers are already consuming less than $\bar{c}$, regulation is again welfare decreasing. Further, note that a pooling equilibrium is no longer optimal because consumers are taking too much credit. If regulation makes a pooling equilibrium more likely, then it is also welfare decreasing. On the other hand, if it makes a separating equilibrium more likely, it can be welfare improving.[18]

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. Typically, credit cards also give the issuer an option to change the interest rate. Except for the one-sidedeness of issuer's commitment, the current model explains all of 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 change the interest rate in order to better address an adverse selection problem, and this option 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

[18] Heidhues and Kőszegi (2010) also model impatience of consumers. However, their model addresses the case of teaser rates when lenders offer cheap credit to be repaid quickly, but levy large penalties if the consumer falls behind the front-loaded schedule. Our model does not address this case.

card issuer. This one-sided commitment is a central feature of credit cards and a crucial driving force in our model. While the model does not 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 Empirical Evidence

To test the predictions of our ex-post adverse selection model we need to observe the following main measures: credit card interest rates, credit limits, and up-front fees. In what follows, we first discuss what we expect to observe for each of these measures following the predictions of our model and then refer to existing, but not necessarily fully applicable empirical evidence.

Two recent empirical papers on the effects of the Act are the works of Agrawal *et al.* (2014), and of Han *et al.* (2015). The first is based on a panel data set of account-level information on contract terms and utilization payments at the monthly level from January 2008 to December 2012, assembled by the Office of the Comptroller of the Currency. The second focuses on credit supply to consumers using Mintel Comperemedia's proprietary survey data set of credit card offers that is linked to survey participants' credit records, covering the 2007-2014 period.

In addition to the evidence in these papers, we cite summary statistics on the supply of corporate credit cards that were provided to us by Geng Li. As corporate cards were not subject to the Act, we can consider them a control group for the treatment group of consumer cards affected by the same economic factors impinging on the supply of cards to consumers.

7.1 Separating or Pooling?

Our model has different predictions about the above measures depending on whether the credit card contract is separating or pooling before and after the Act. As a first step to test our model, we need to be able to empirically identify pooling and separating contracts.

Our interpretation of the model's separating contract is a credit card that provides the option of borrowing over the credit limit for a fee. The fee effectively increases the interest rate charged on credit balances. In contrast, a pooling contract does not include the possibility of extending credit over the specified limit. Thus, a simple way of identifying a pooling contract is to check whether it offers the possibility of over-the-limit credit.

To identify a pooling contract after the Act, we can take advantage of the Act's provision that bars the issuer from charging an over-the-limit fee unless the borrower opts into borrowing over-the-limit for a specified charge. Thus, a pooling contract is simply one in which the consumer does not opt-in to borrow over-the-limit. Before the Act, no formal opting into an over-the-limit option exists. To distinguish between separating and pooling contracts, we need to observe whether consumers attempt to borrow over the limit, as well as whether they are successful. Consumers who are successful likely have a separating contract, while those who do not borrow over the limit likely have a pooling contract.

In what follows, we focus on the predictions of our model when the optimal contract is separating both before and after the Act, as we believe this is the dominant case. At the end of this section, we consider other cases. The related evidence we cite does not distinguish between pooling and separating contracts and so, for the purposes of testing our model, inferences drawn from the data are limited.

7.1.1 Interest Rates

In a separating contract, our model suggests that after the Act, the interest rate would increase for consumers whose credit quality decreases during a credit cycle of borrowing and repayment. However, for consumers whose credit quality improves during a credit cycle, the interest rate should not change. Our interpretation of the model further suggests that the interest rates offered at the time of credit card issuance would also not change.

To empirically operationalize the construct of increasing or decreasing risk of default during a credit cycle, one can track the evolution of FICO scores over time. Although the observed scores may not fully reflect the risk of default (as they do not quantify intangibles such as changing probability of employment or generating income due to an impending recession), they can be used as ex-post proxies for the ex-ante private information possessed by the consumer about his own credit risk.

The empirical evidence that currently exists does not shed light on the effective interest charges paid by consumers whose credit quality changes during a credit cycle. The only evidence available is on the interest rates at the time of the card issuance; this evidence is partly consistent with the prediction of our model. Figure 4 of Han *et al.* (2015) and the similar data provided by Geng Li for corporate credit cards show that after the Act, and for those consumers in the two lowest quartiles of FICO scores, interest rate spreads increased by roughly as much as those offered in corporate cards. Since corporate cards were not affected by the Act, this evidence suggests that the Act had little effect on the interest rates spread of consumer cards. On the other hand, for those consumers in the two highest quartiles of FICO scores, interest rates of consumer cards decreased relative to those of corporate cards.

Additionally, Agrawal *et al.* (2014) work reports a decrease in the cost of credit. Their work suggests that interest rates increase after the Act, but that the increase is insufficient to offset the decline in the fees that the Act mandates. However, this evidence is unrelated to our predictions as it does not distinguish between consumers whose credit quality improves or decreases over a credit cycle, nor does it distinguish between new and old accounts.

7.1.2 Credit Limit

Our analysis and interpretation of a separating equilibrium leads us to predict a decrease in the credit limit of new credit cards. However, consumers whose credit quality deteriorates during a credit cycle are expected to borrow the same as before the Act by going over-the-limit.

This prediction suggests a decrease in the observed credit limit of new accounts and no change in the total borrowings of consumers whose FICO scores deteriorate. The extant empirical evidence is mute on the latter prediction. On the decrease of the credit limit of new accounts, Figure 5 in Han *et al.* (2015) and the summary statistics provided by Geng Li show evidence that is partly consistent with our prediction.

Consistent with the implications of our model, the credit limit offered to consumers with low FICO scores decreases after the Act once we control for other factors. Specifically, in the lowest quartile of credit quality, the credit limit of consumer cards increases, but by less than the credit limit of corporate cards. Conversely, a similar comparison for the other quartiles of FICO scores suggests that the credit limit offered to consumers in the second and third quartile did not change after the Act while the credit limit offered to consumers with high FICO scores increased.

Similarly, Agrawal *et al.* (2014) work reports a nonstatistically significant increase in the credit limits of credit cards, but without distinguishing between old and new accounts (the latter being the focus of our model). Note that the data on corporate credit cards is particularly noisy, which limits the strength of our inferences.

7.1.3 Up-front Fee

Our model predicts a decrease in the up-front fee of contracts that were separating before the Act. To test this prediction, we can track the behavior of a credit card's annual fee, which is. the closest empirical construct to the up-front fee. Our model's prediction then suggests a decrease in annual fees after the Act.

The existing empirical evidence is consistent with this prediction. Figure 5 in Han *et al.* (2015) shows that after the implementation of the Act, the incidence of the annual fee for low credit-quality consumers decreases. This result is clearer and applies to consumers of any FICO score once we control for the incidence of the annual fee in corporate credit cards. Also, Table 3 in Agarwal *et al.* (2014) shows evidence that fees excluding the over-the-limit and late payment fees have not increased after the Act.

Ideally, when testing this prediction, we would also consider the rewards that credit cards often offer to their users. The value of these rewards can be thought of as a negative implicit fee which should be combined with any explicit fee. Figure 5 in Han *et al.* (2015) indicates that the incidence of offers of such rewards increased in the post-Act period, at least for consumers with lower scores.

What if the credit card contract is not separating?

If a credit card contract is not separating before and after the Act, it can then be pooling before and after, pooling before and separating after the Act, or separating before and pooling after. To our knowledge, there are currently no studies that distinguish between pooling and separating contracts. Nonetheless, we summarize below the main implications related to contracts that are not separating before and after the Act.

Interest rate When pooling contracts continue to be pooling after the Act, we should observe no change in the specified interest rate. When a pooling contract becomes separating after the Act, we should observe a decrease in the specified rate but an increase in the effective rate (i.e., including the over-the-limit fee) of those consumers whose risk deteriorates over a credit-cycle. Finally, when a separating contract before the Act becomes a pooling contract after, we should observe an interest rate that is higher for those whose risk declines over a credit cycle, but lower for those whose risk increases over a credit cycle.

Credit Limit As for the credit limit, it should not change if the credit contract is pooling before and after the Act. The credit limit should increase if the contract is separating before the Act and becomes pooling after. Conversely, if the contract is pooling before and becomes separating after, the credit limit should decrease.

Annual Fee Finally, the annual fees should increase if a contract that is pooling before the Act becomes separating after. Conversely, the annual fees should decrease if a contract that is separating before the Act becomes pooling after. When the contract is pooling before and after the Act, there should be no change in annual fees.

8 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 and lower credit limit to high credit-quality consumers; these negative effects are only partially offset by a lower up-front fee, ultimately resulting in reduced welfare. Thus, our results show that the 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 rate changes have an effect on the value of credit cards as a method of payment.

We have also assumed that information about the consumer's credit quality is not contractible. This is not always the case. For example, the lender's own experience with the borrower is contractible. But, even when information is contractible, regulations that prevent the issuers from using such information should lead to the same welfare consequences as predicted. In cases in which the Act's regulation still allows the issuer to increase interest rates, such as when a consumer is more than 60 days delinquent, then regulation should have no impact on welfare.[19]

By having consumers with linear utility at times 2 and 3, we have eliminated the role of credit cards in insuring consumers; a more complete analysis would also consider this feature of credit cards. We develop such analysis in the online Appendix under the condition that the utility function satisfies $u''' > 0$. We show that while the contract features of the credit card may be different from the ones we obtain, the effects of regulation remain the same.

[19]This would be the case when a consumer is more than 60 days delinquent unless, under the Act, the issuer would need to re-evaluate the interest rate increase and with some probability restore it to its lower level.

We also ignored the existence of switching costs between credit card issuers. This assumption, however, is without loss of generality. In fact, our results are even stronger in the presence of switching costs. Contrary to conventional wisdom, switching costs improve consumer welfare in our model because they enhance separation of consumers. In addition, switching costs only play a role when information about the consumer's risk becomes public and issuers want to change interest rates. Since regulation as in the Act prevents issuers from changing interest rates, the benefits of switching costs are curbed by regulation. A detailed analysis is available in the online Appendix.

Finally, we restrict our analysis to the Act's restrictions on changing interest rates. We believe these to be the restrictions with larger effects on welfare. It would be interesting, though, to evaluate the welfare effects of the Act's other provisions. We leave this for future work.

A Appendix: 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.[20] 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.[21] In the forthcoming steps of 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.

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

[21] 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.

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 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 (5) from (4) 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 (4), we have that $c_2^l \geq c_2^h$. In a nonpooling 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 (5), it is easy to argue that $r_2^l > r_2^h$.

Zero-profit condition binds

It is clear 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 (4) 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

$$\begin{aligned}\Delta U &= f^h(c_2^h + \delta)(1 - \beta + \beta(1-p_2)(1 - q^h(r_2^h + \varepsilon))) \\ &\quad - f^h c_2^h(1 - \beta + \beta(1-p_2)(1 - q^h r_2^h)) \\ &= f^h(c_2^h + \delta)(1-\beta) - f^h c_2^h(1-\beta) = f^h\delta(1-\beta) > 0.\end{aligned}$$

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 consumer such 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 (4) binds. As a corollary, the constraint (5) cannot bind. Subtract again (5) from (4) 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, $c_2^l(q^l r^l - 1)$, are kept constant and the truth-telling constraint of the low credit-quality consumer is now slack

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

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 (4) 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, resulting 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 (4) 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 $v_{RS}\left(q^h\right) = c^h(1-\beta)+\beta q^h Y$.

A.1.3 Pooling vs Rothschild-Stiglitz

A pooling equilibrium solves problem (2) if $v_p(q^h) > v_{RS}(q^h)$. 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

$$\begin{aligned}\frac{f^h}{1-f^h} &\geq \frac{(1-\beta p_2)}{\beta\left(1-p_2\right)}\left(\frac{\beta\left(1-p_2\right)q^l-q^h\left(1-\beta p_2\right)}{(\beta-1)\,q^h}-1\right)\\ &= \frac{(1-\beta p_2)}{(1-\beta)}\left(1-\frac{q^l}{q^h}\right)=\bar{f}.\end{aligned}$$

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 (8). 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 (2).

A.3 Proof of Lemma 1

The proof follows directly from the application of the implicit function theorem to equation (12)

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

Also, differentiating with respect to ϵ the consumption c_2^h and the interest rate r^l as determined in equations (10) and (11) 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

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

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 does not 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

$$\begin{aligned} \max_F U_1 &= u(y_1 - F) \\ &\quad + \beta \left[f^h (1-p_1)(1-\beta) c_2^h + f^l (1 - p_1^{\mu}) \left((1-\beta) \bar{c} + \beta \frac{F}{(1-p_1^{\mu}) f^l} \right) \right] \\ &\quad + \beta (1-\beta) \bar{c} \left(p_1 \mu + f^h p_1 (1-\mu) \right) \quad s.t. \\ c_2^h &= \frac{(1-\beta)\bar{c} + \beta (1-p_2) \left(q^l r^l - 1 \right) \bar{c}}{(1-\beta) + \beta (1-p_2) \left(1 - \frac{q^l}{q^h} \right)} \end{aligned}$$

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

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

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 $\frac{\partial c_2^h}{\partial \mu} = \frac{\beta\frac{1}{f^l}}{(1-\beta)+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)}\frac{\partial}{\partial \mu}\left(\frac{F}{1-p_1^\mu}\right) > 0$.

A.6 Savings at Time 1 are Not Optimal

This section is based on the assumption that consumers can consume their savings at time 3 even if they default. To analyze whether savings are optimal at time 1, we need to understand the consumer's decisions at times 2 and 3 when they have time 1 savings. Consider a consumer at time 2 that has savings from time 1. If this consumer chooses the high-type contract, he uses his time 1 savings to increase the consumption at time 2 until consumption hits the threshold $\bar{c}$. To see this point, just compare the consumer's utility if he consumes his savings at time 2 and if he saves them further to time 3

$$b^h + 1 + \beta q\left[y_3 - E\left[r\right]b^h\right] - \left(b^h + \beta q\left[y_3 - E\left[r\right]b^h\right] + \beta\right) = 1-\beta > 0.$$

On the other hand, if the consumer chooses the low-type contract, he borrows $\bar{c}$ and consumes his time 1 savings only at time 3

$$(\bar{c}-1)+1+\beta q^l\left[y_3 - r^l\left(\bar{c}-1\right)\right] - \left(\bar{c} + \beta q^l\left[y_3 - r^l\bar{c}\right] + \beta\right) = \beta\left(q^l r^l - 1\right) \leq 0.$$

This result implies that regardless of consumer savings, the optimal contract offers a credit limit of $\bar{c}$ to low-type consumers. The credit-limit of high types now satisfies

$$\bar{c} + \beta q^l\left(y_3 - r^l\bar{c}\right) + \beta s_1 = s_1 + b^h + \beta q^l\left(y_3 - p_2\frac{1}{q^l}b^h - \left(1-p_2\right)\frac{1}{q^h}b^h\right)$$

if $s_1 + b^h < \bar{c}$ and the optimal credit limit is given by $b^h\left(s_1\right) = b^h\left(0\right) - \frac{s_1(1-\beta)}{(1-\beta)+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)}$. Time 2 consumption of a high type increases by $\Delta c_2 = s_1\frac{\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)}{(1-\beta)+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)}$. If savings from time 1 are such that $s_1 + b^h\left(s_1\right) > \bar{c}$ (this can only happen if $s_1 \geq \bar{c}$), then high types borrow nothing and save $s_1 - \bar{c}$ to time 3. The time 2 utility of a high-type is given by

$$U_{2,s}^h\left(s_1\right) = \begin{cases} b^h\left(s_1\right) + \beta q^h\left(y_3 - \frac{1}{q^h}b^h\left(s_1\right)\right) & \\ \qquad = U_{2,s}^h\left(0\right) + \beta\left[\frac{1-\beta+(1-p_2)\left(1-\frac{q^l}{q^h}\right)}{1-\beta+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)}\right]s_1 & if\ s_1 < \bar{c} \\ \bar{c} + \beta q^h y_3 + \beta\left(s_1 - \bar{c}\right) & if\ s_1 \geq \bar{c} \end{cases}.$$

If facing a pooling contract, the high-type consumes his savings at time 2 to reduce his interest-rate payment. His time 2 consumption stays constant at $\bar{c}$ while his time 3 utility increases by $\Delta u_3 = \frac{q^h}{E[q]} s_1$ if $s_1 < \bar{c}$ or $\Delta u_3 = \frac{q^h}{E[q]} \bar{c} + (s_1 - \bar{c})$ if $s_1 \geq \bar{c}$. The pooling contract has a credit limit of $b_p = \bar{c} - s_1$ and an interest rate of $r_p = \frac{1}{E[q]}$. The time 2 utility of a high-type is such that

$$U^h_{2,p}(s_1) = \begin{cases} \bar{c} + \beta q^h \left(y_3 - p_2 \frac{1}{q^h} (\bar{c} - s_1) - (1 - p_2) \frac{1}{E[q]} (\bar{c} - s_1) \right) & if \ s_1 < \bar{c} \\ \bar{c} + \beta q^h y_3 + \beta (s_1 - \bar{c}) & if \ s_1 \geq \bar{c} \end{cases}$$

$$= \begin{cases} U^h_{2,p}(0) + \beta \left(p_2 + (1 - p_2) \frac{q^h}{E[q]} \right) s_1 & if \ s_1 < \bar{c} \\ \bar{c} + \beta q^h y_3 + \beta (s_1 - \bar{c}) & if \ s_1 \geq \bar{c} \end{cases}.$$

A pooling equilibrium is as likely with and without savings if $s_1 < \bar{c}$. That is, a pooling equilibrium arises if $U^h_{2,p}(s_1) > U^h_{2,s}(s_1)$, which after simplification becomes

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

This condition is the same as the one that arises without savings and does not depend on s_1.

To summarize, in a separating equilibrium savings increase the high-type consumer's payoff by $\beta^2 \left[\frac{1-\beta+(1-p_2)\left(1-\frac{q^l}{q^h}\right)}{1-\beta+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)} \right] s_1$ and the low-type's utility by $\beta^2 s_1$. From time 1 perspective, \$1 of savings increases the consumer's payoff in $\beta^2 \left[1 + f^h \frac{(1-\beta)(1-p_2)\left(1-\frac{q^l}{q^h}\right)}{1-\beta+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)} \right]$. In contrast, \$1 spent in the up-front increases the consumer's future payoff by $\beta^2 \left(1 + \frac{\frac{f^h}{f^l}(1-\beta)}{(1-\beta)+\beta(1-p_2)\left(1-\frac{q^l}{q^h}\right)} \right)$. Thus, the up-front fee is more effective than savings in transferring income across time.

In a pooling equilibrium, savings increase the high-type's payoff by $\beta^2 \left(p_2 + (1 - p_2) \frac{q^h}{E[q]} \right) s_1$ and the low-types payoff by $\beta^2 s_1$. From time 1 perspective, savings increase the consumer's payoff in $\beta^2 \left[1 + (1 - p_2) \left(\frac{q^h}{E[q]} - 1 \right) \right] s_1$. Finally, savings do not affect the set of parameters for which the equilibrium is separating.

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 $t = 2$. Again, 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 required 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

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

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

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

Comparing consumer welfare with and without the option to not 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 $U_1^O - U_1^{NO}$

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

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.

References

Agarwal, S., S. Chomsisengphet, N. Mahoney, and J. Stroebel. 2014. "Regulating Consumer Financial Products: Evidence from Credit Cards". *The Quarterly Journal of Economics*. DOI: 10.1093/qje/qju037.

Ausubel, L. M. 1991. "The failure of competition in the credit card market". *The American Economic Review*: 50–81.

Black, B., C. K. Whitehead, and J. M. Coupland. 2015. "The Nonprime Mortgage Crisis and Positive Feedback Lending". Working Paper, SSRN.

Brito, D. L. and P. R. Hartley. 1995. "Consumer rationality and credit cards". *Journal of Political Economy*: 400–433.

Calem, P. S., M. B. Gordy, and L. J. Mester. 2006. "Switching costs and adverse selection in the market for credit cards: New evidence". *Journal of Banking & Finance*. 30(6): 1653–1685.

Calem, P. S. and L. J. Mester. 1995. "Consumer behavior and the stickiness of credit-card interest rates". *The American Economic Review*. 85(5): 1327–1336.

Consumer Financial Protection Bureau (CFPB). 2013. "CARD Act Report, A Review of the Impact of the CARD Act on the Consumer Credit Card Market". *Tech. rep.* CFPB.

Han, S., B. J. Keys, and G. Li. 2015. "Information, Contract Design, and Unsecured Credit Supply: Evidence from Credit Card Mailings". Working Paper.

Heidhues, P. and B. Kőszegi. 2010. "Exploiting naivete about self-control in the credit market". *The American Economic Review*: 2279–2303.

Miyazaki, H. 1977. "The rat race and internal labor markets". *The Bell Journal of Economics*: 394–418.

Netzer, N. and F. Scheuer. 2014. "A game theoretic foundation of competitive equilibria with adverse selection". *International Economic Review*. 55(2): 399–422.

Park, S. 2004. "Consumer rationality and credit card pricing: An explanation based on the option value of credit lines". *Managerial and Decision Economics*. 25(5): 243–254.

Rees, R. and A. Wambach. 2008. *The microeconomics of insurance*. Now Publishers Inc.

Spence, M. 1978. "Product differentiation and performance in insurance markets". *Journal of Public Economics*. 10(3): 427–447.

Tam, X. S. 2011. "Long-Term Contracts in Unsecured Credit Markets". *manuscript, University of Cambridge*.

Wilson, C. 1977. "A model of insurance markets with incomplete information". *Journal of Economic Theory*. 16(2): 167–207.