Who bears the welfare costs of monopoly? The case of the credit card industry*

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Abstract

How are the welfare costs from monopoly distributed across U.S. households? We answer this question for the U.S. credit card industry which is highly concentrated, charges interest rates that are 3.4 to 8.8 percentage points above competitive pricing, and has repeatedly lost antitrust lawsuits. We depart from existing competitive models by integrating oligopolistic lenders into a heterogeneous agent, defaultable debt framework. Our model accounts for half of the spreads and excess profits observed in the data. The welfare gain from competitive reform in the credit card industry is equivalent to a one-time transfer worth 3.4 percent of GDP. Along the transition path, all cohorts realize welfare gains from competitive reform. Poor households benefit the most from increased consumption smoothing, while rich households also benefit from higher general equilibrium saving interest rates.

Keywords: welfare costs of monopoly, consumer credit, competition, welfare

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1 Introduction

The long standing view that the dead weight losses from monopoly are small, e.g. Harberger (1954)'s study of American manufacturing in the 1920s, has been dispelled repeatedly (see a summary of arguments by Schmitz (2012)). Recent work by Schmitz (2016) has argued that across a number of industries, the costs of monopoly are large and disproportionately borne by low-income households. We contribute to this literature by integrating oligopolistic lenders into a Bewley-Huggett-Aiyagari framework and quantifying the distribution of welfare losses resulting from non-competitive behavior in the credit card industry. We find that both low-income households and high income households suffer significant welfare losses from the credit card monopoly.

The U.S. credit card industry is highly concentrated, generates excess profits, and charges interest rates that are 3.4 to 8.8 percentage points above competitive pricing. The Justice Department, Federal Trade Commission, and private parties have repeatedly won antitrust lawsuits against the U.S. credit card industry. To measure the welfare consequences of competitive reforms in the credit card industry, we depart from existing consumer credit models, which typically assume competitive, zero-profit lenders (e.g. Livshits, MacGee, and Tertilt (2007, 2010) and Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007)), and we develop a model with a finite number of credit card firms that imperfectly compete to issue non-exclusive credit lines. We estimate that the gains from competitive credit market conditions as opposed to 2016 credit market conditions are equivalent to a 2 percent increase in lifetime consumption or a one-time transfer worth 3.4 percent of GDP to U.S. consumers. During the transition from 2016 credit market competition to a competitive credit market, all current cohorts of consumers and newborn cohorts of consumers realize significant welfare gains. We find that the poorest U.S. households gain the most because they are better able to smooth consumption with more competitive credit markets. Moreover, the richest households gain from greater interest rates on savings due to general equilibrium effects.

We begin by documenting several features of the U.S. credit card industry. First, the credit card market is characterized by a large degree of market concentration. Nine credit card *issuers* (mainly banks such as Citigroup, JP Morgan, Capital One, and Bank of America) accounted for 86 percent of outstanding revolving credit in 2016. These issuers founded and jointly own (to varying degrees) the main *payment networks*, Visa and Mastercard. Visa and Mastercard control two-thirds of the payment network market as measured by credit card purchase volume. Second, even after adjusting for rewards programs and other credit card fees, credit card issuers charge interest rates that are on average 3.4 to 8.8 percentage points above an interest rate that would yield zero profits. A consequence of these large spreads is abnormal profits. Estimates from Ausubel (1991) and Grodzicki (2017) show that the average rate of return on assets for the largest 25 credit card banks are 5.0 to 7.3 percentage points higher than that of the whole banking industry.[1] Third, the credit card

[1]The average rate of return on assets refers to interest and non-interest income net of charge-offs nor-

industry has been the subject of numerous antitrust lawsuits since its inception. In 2005, the main credit card issuing banks and payment networks were sued for collusion; they lost the case in 2018 and were required to pay billions in penalties. The second half of the lawsuit (in progress) is mandating changes to the industry to promote competition. In 2017, new litigation alleges collusion between the main credit card issuing banks and payment networks to block entry.

To measure the welfare gains and losses associated with a non-competitive credit card industry, we build on a small but innovative class of models that explicitly model credit card lenders' market power (e.g. Wasmer and Weil (2004), Drozd and Nosal (2008), Petrosky-Nadeau and Wasmer (2013), Galenianos and Nosal (2016), Herkenhoff (2017), Raveendranathan (2018)). These environments maintain the assumptions of atomistic lenders, free-entry, and zero ex-ante profits. We depart from these frameworks by developing a general equilibrium production economy in which a finite number of non-atomistic credit card firms strategically compete for customers. We build a dynamic model of Stackelberg oligopoly in which credit card lenders sequentially compete on the interest rates and limits of their credit lines. We estimate the model to match 1970 and 2016 credit market conditions. Our benchmark non-competitive model accounts for roughly half of the observed spreads, profits, and charge-off rates in the credit card industry in both 1970 and 2016.

To illustrate our benchmark model's mechanisms, we first measure the welfare gains of replacing the regional monopolies that prevailed in the absence of interstate banking during the 1950s, 1960s, and 1970s with oligopolies. In 1970, the gains to U.S. consumers of a transition from a credit card monopoly to a credit card duopoly are equivalent to a 1 percent increase in lifetime consumption. During the transition from monopolist to duopolist lenders, almost every consumer is weakly better off. General equilibrium effects generate gains that are larger along the transition path than when comparing steady states. The increase in the borrowing limit allows consumers to delay default, which implies that credit card firms' profits remain positive during the transition. The aggregate gains to contemporary cohorts are equivalent to a one-time transfer worth 1 percent of GDP. If we decompose the aggregate gains, then the gains to consumers in the lowest deciles of the earnings and wealth distributions are equivalent to a one time transfer worth 1.22 and 1.26 percent of GDP per capita, respectively. Low-income and low-wealth consumers benefit from the ability to borrow more at a cheaper rate. The gains to those in the highest deciles of the earnings and wealth distributions are equivalent to a one-time transfer worth 1.27 and 1.60 percent of GDP per capita, respectively. High-income and high-wealth consumers benefit from a higher savings interest in general equilibrium. The consumers in the middle deciles of the earnings and wealth distributions are also better off, but they do not benefit as much from the ability to borrow more at a cheaper rate or from the higher savings interest rate.

malized by total assets.

We then estimate the welfare gains from competitive reforms in an oligopolistic version of the model calibrated to 2016 credit market conditions. While credit markets have become more competitive over time (e.g. Grodzicki (2017)), our competition assumptions well approximate the current 2016 credit market. We consider less competitive calibrations with a lender duopoly or triopoly (approximating the fact that the top three credit card issuing banks control half of the market and have repeatedly colluded with the top three payment networks), as well as a more competitive oligopoly calibration with six lenders (an approximation to the fact that the top six credit card issuing banks control three-quarters of the market). Consumers have welfare gains worth 2 percent of lifetime consumption if we replace the oligopolists with competitive lenders. The aggregate gains to contemporary cohorts are equivalent to a one-time transfer worth 3.4 percent of GDP. The gains to consumers in the lowest deciles of the earnings and wealth distributions are equivalent to a one time transfer of 6.66 and 6.83 percent of GDP per capita, respectively. The gains to those in the highest deciles of the earnings and wealth distributions are equivalent to a one-time transfer of 5.23 and 7.06 percent of GDP per capita, respectively. Similar to the 1970s reform, low-income and low-wealth consumers benefit from the ability to borrow more at a cheaper rate, and savers now receive a higher interest rate because of general equilibrium effects. Because of the significant expansion of limits and lowering of borrowing rates, we find that this reform is Pareto improving both across steady states as well as along the transition path.

Our paper is related to competitive consumer credit models (Livshits et al. (2007, 2010) and Chatterjee et al. (2007)) as well as recent models that generate lender market power via search and bargaining (e.g. Wasmer and Weil (2004), Drozd and Nosal (2008), Petrosky-Nadeau and Wasmer (2013), Galenianos and Nosal (2016), Herkenhoff (2017), Raveendranathan (2018)). What makes the search models of the credit market tractable are the assumptions of atomistic lenders, free entry, and a small open economy. An exception is an innovative and contemporaneous paper by Galenianos and Gavazza (2018) who estimate a static search model that features a distribution of entry costs, generating positive ex-ante profits among lenders. There is also a relatively new and innovative literature in Industrial organization that generates monopoly power among credit card lenders using extreme value shocks (Grodzicki (2015) and Nelson (2018)). What makes Grodzicki (2015) and Nelson (2018) tractable is the partial equilibrium nature of the models and exogenous default. We contribute to both of these literatures by developing a general equilibrium model of credit market oligopoly.

Another class of models relates improvements in screening technology to greater credit access and greater competition in the credit market (e.g. Livshits et al. (2016), Sánchez (2018), and Grodzicki (2017)). While early contributions such as Ausubel (1991) document a lack of competition in the credit market throughout the 1970s and 1980s, Grodzicki (2017) makes a strong empirical argument that there has been an increase in competition in the credit market recently (Drozd and Nosal (2008) and Galenianos and Nosal (2016) also argue that reductions in entry costs –and thus increased competition– are quantita-

tively consistent with the rise in debt and defaults from the 1980s to the 1990s). In our framework, as additional oligopolists enter the credit market (i.e. moving from monopoly and duopoly in the 1970s to oligopoly in the 2000s), our competitive structure endogenously generates increases in pass-through rates, credit limits, and credit access that likely complemented screening technology improvements. We contribute to this literature by developing a quantitative model of credit market oligopoly and showing that the welfare gains from competitive reforms in both the 1970s and 2000s are significant despite more competition.

Our paper relates to theoretic and quantitative models of credit lines (Drozd and Nosal (2008), Mateos-Planas and Seccia (2006), Mateos-Planas and Seccia (2013), Drozd and Serrano-Padial (2013), Drozd and Serrano-Padial (2017), and Braxton et al. (2018)). Both Drozd and Nosal (2008) and Braxton et al. (2018) have incorporated long-term credit lines into models with imperfect competition (via search and bargaining) in the credit market. Others, including Hatchondo and Martinez (2018), have modeled multiple credit lines. Bizer and DeMarzo (1992) consider one lender borrowing from a potential continuum of banks, sequentially, without commitment in a 2-period economy. They find that in general interest rates, default rates, and promised repayments (face value of the debt) are higher with multiple lenders and no commitment. Hatchondo and Martinez (2018) argue that in general equilibrium infinite horizon economies, these predictions do not hold, and individuals actually borrow more with commitment. Our contribution to this literature is to incorporate non-exclusive credit lines into a dynamic oligopoly model of the credit market.

Our model is also related to the quantitative banking literature (e.g. Corbae et al. (2011) and Corbae and D'Erasmo (2019)). Of particular note, Corbae and D'Erasmo (2019) consider a Stackelberg Cournot bank that faces a competitive fringe, building on the earlier work of Allen and Gale (2004) and Boyd and De Nicolo (2005) who consider Cournot competition. We contribute to this literature by modeling defaultable debt on the household side and considering N-bank oligopolistic competition for credit lines.

2 Competition in the U.S. credit card industry

We briefly discuss a narrative history of competition in the early credit card industry largely based on Evans and Schmalensee (2005) and Wildfang and Marth (2005), and then we turn to contemporary indicators of competition in the credit card industry.

2.1 Historical background

During its inception in the late 1950s and early 1960s, the credit card industry was characterized by regional monopolies. While systematic evidence on interest rate dispersion and pricing is not available, scholars who have studied the beginning of the credit card industry describe a highly non-competitive (and very 'cooperative') environment. In particular, Evans and Schmalensee (2005) document that the early years of the credit card industry

were characterized by limited competition. Visa's predecessor, National BankAmericard Inc (NBI), was founded in California and only began franchising the program to other banks in 1966. Part of the franchise was the restriction that banks could only issue Visa cards, which severely limited competition and prompted several antitrust suits in the early 1970s (see below). American Express, which to that point was only a travel and entertainment card, began its own credit card program via franchising (it would later exit the credit card market and only return 20 years later). The predecessor to Mastercard was a 'cooperative' of banks which began expanding around the same time period. Nonetheless, the programs were highly regionally concentrated: American express was concentrated in New York, New England, New Jersey, and Pennsylvania (Evans and Schmalensee (2005), p. 62), whereas BankAmericard was concentrated in the West. The Interbank Card Association, which is the predecessor to Mastercard, included banks primarily in the Midwest (Evans and Schmalensee (2005), p. 63). The lack of competition among these groups of banks, and the lack of distinction between payment networks and banks, resulted in several high profile antitrust lawsuits that we discuss below.

2.1.1 Monopoly and Collusion in the 1970s and 1980s

There are several important court cases and academic studies which have argued that the credit card market was non-competitive throughout the 1970s and 1980s. We discuss evidence regarding (i) lack of competition of networks across regions and inability of banks to issue competing network cards, (ii) network rules preventing competitive new-entrant credit cards from being issued, (iii) evidence of interest rate collusion amongst issuing banks. In the early 1970s and 1980s, issuing banks wholly owned the networks, and the network rules, which were determined 'on-the-fly' by the banks that owned the networks, severely impeded competition amongst banks.

We first discuss the 'Worthen' and 'MountainWest' cases based on analysis by Wildfang and Marth (2005). The Worthen case establishes that credit card networks effectively blocked entry and banned issuance of competing cards. In 1970 Worthen Bank was a member of Visa (previously the National BankAmericard, Inc (NBI) network). Worthen wanted to issue Mastercard (previously the Interbank Card Association network) credit cards. Visa rules prohibited Worthen from doing so. Worthen sued over this 'exclusivity' rule (the prohibition of issuing both networks cards), arguing that banning the bank from issuing other credit cards was the strongest form of anti-competitive behavior described in the Sherman Act (*per se illegality*). The federal district court agreed with Worthen. After an appeal and review by the Department of Justice, Visa abandoned 'exclusivity' rules and there were no barriers to banks dually issuing Visa and Mastercard credit cards by 1976.

The second important case is the 'MountainWest' case. In the 1980s, Sears attempted to enter the credit card market. They wanted to issue an aggressive 'Prime Option' card on the Visa network that would have no annual fee (thus a lower implicit interest rate) and would

have offered other attractive features. Despite the fact that Sears owned MountainWest Financial, a Visa Member bank, Visa prohibited Sears from issuing the card. Visa adopted a new rule banning Visa memebership to any institution that was "deemed competitive." As Wildfang and Marth (2005) summarize, "Sears claimed the rule was designed to, and did, exclude an aggressive price-discounting new entrant, which would have benefited consumers" (p. 682). Sears was initially affirmed in court, but then reversed on appeal by the Tenth Circuit. As Wildfang and Marth (2005) describe, legal scholars believe that the reversal was largely based on a misunderstanding of the facts by the jury. At the time of the trial several news outlets interviewed Visa spokespeople, who acknowledged that allowing Sears to offer lower fee cards would benefit consumers. New York Times News Service (1991) report, "David Brancoli, a spokesman for Visa, based in San Mateo, Calif., said the bank association opposed the new Sears card. He said that though competition among Visa issuers would benefit consumers, consumers would benefit even more from competition among different brands of cards..." New York Times News Service (1991) further quote Allen R. DeCottiis as saying, "Visa banks are extremely concerned. They paid to build the Visa infrastructure, and now others are allowed access."

In the late 1980s, accusations of interest rate collusion amongst issuing banks were widespread. Wells Fargo and First Interstate Bank of California were sued for interest rate fixing on millions of credit cards by the California state Attorney General (White (1992)). Wells Fargo and First Interstate Bank of California ultimately settled the case for 55 millions dollars, fearing potentially large losses in court. While the case did not go to court, academic research by Knittel and Stango (2003) provides strong evidence for interest rate collusion in the early 1980s. Knittel and Stango (2003) show that the average spread between credit card interest rates and the cost of funds was higher in states where firms where firms faced relatively tight interest ceilings and lower in states with no ceilings. They argue that firms colluded at non-binding interest rate ceilings up until the late 1980s.

While there is a lack of publicly available data on interest rates in the 1970s and 1980s, Knittel and Stango (2003) obtained disaggregated interest rate data from historical editions of the *Quarterly Report of Rates of Selected Direct Consumer Installment Loans* which is collected by the Federal Reserve Board. Over and above their tests for collusion, Knittel and Stango (2003) observe extreme price stickiness in an environment with large fluctuations in the risk free rate: "The most striking aspect of credit card pricing during the 1980's is the extent of clustering at certain interest rates... A corollary of this clustering is rate stickiness. For example, in our sample the average spell during which a given issuer's credit card rate remains unchanged is more than five years. These two factors... seem to defy conventional notions of pricing in competitive markets" (p. 1708).

The combination of (i) lawsuits establishing non-competitive behavior, including the blocking of competitive new entrant credit cards, and (ii) academic and legal cases arguing that there was widespread price collusion, motivate our modeling assumption of the early 1970s as a monopoly.

2.2 Indicators of competitiveness in the 2000s

We document the following features of the modern credit card industry in the 2000s: (i) it is highly concentrated, (ii) even after adjusting for rewards programs and other credit card fees, credit card issuers charge interest rates that exceed zero-profit interest rates, (iii) credit card issuing banks have excess returns, and (iv) the credit card industry has been sued repeatedly for antitrust violations from inception until present.

The first defining feature of the credit card industry is the large degree of market concentration. We measure market concentration of both credit card issuers (e.g. banks such as Citigroup, JP Morgan, Capital One, Bank of America) and credit card payment networks (e.g. Visa, Mastercard, and American Express). Table 1 shows that three credit card issuers accounted for roughly half of outstanding revolving credit in 2016, and nine credit card issuers accounted for 86 percent of outstanding revolving credit in 2016. Table 2 shows that three payment networks (Visa, American Express, Master Card) accounted for 96 percent of credit card purchase volume in 2016. The issuing banks founded and still jointly own (to varying degrees) the main payment networks, Visa and Mastercard, whereas American Express is a vertically integrated issuer and payment network. Since issuers own significant portions of the payment networks, and, as we will discuss below, the payment networks and issuers have been repeatedly sued for colluding, it is difficult to draw the line between these institutions. Whether the effective number of competitors in the credit card market is nine issuing banks or three collusive issuer-payment networks is not clear. We will consider both cases in our quantitative analysis.

Table 1: Revolving credit share by issuer, 2016 (source: SEC filings and ValuePenguin)

Company	**Cumulative share**
1. Citigroup	18
2. JP Morgan	34
3. Capital One	46
4. Bank of America	58
5. Discover	66
6. Synchrony	73
7. American Express	78
8. Wells Fargo	83
9. Barclays	86
10. Other	100

The second defining feature of the credit card industry is high interest rate spreads. To measure how far the credit card industry is from competitive pricing, we will focus on what we call *excess spreads*. We compute excess spreads as the difference between the *actual spread* and the *zero-profit spread*. The *actual spread* (τ_{actual}) is the difference between the (cross-sectional) average credit card interest rate and the Moody's Aaa rate. The *zero-profit spread* is defined as the spread that credit card firms should charge on interest income to

Table 2: Credit card purchase volume by payment network, 2016 (source: SEC filings and ValuePenguin)

Company	**Cumulative share**
1. Visa	51
2. American Express	74
3. Master Card	96
4. Discover	100

break-even. It is computed as follows: let τ_{zero} denote zero-profit spread, D charge-off rate, B outstanding revolving credit, r Moody's Aaa rate, and τ_o transition cost net of non-interest income. τ_o is computed as (operational cost + rewards and fraud - fees income - interchange income)/outstanding revolving credit. Operational cost and rewards and fraud refer to total cost and fees income and interchange income refer to non-interest income.[2] Given D, B, r, and τ_o, the zero-profit spread is estimated from the following break-even equation:

$$(1 - D)B(1 + r + \tau_{zero}) = B(1 + r + \tau_o) \tag{1}$$

The left hand side of (1) is total interest income net of charge-offs and the right hand side is total cost net of non-interest income. Table 3 presents the average excess spreads (1974-2016) for the case without transaction costs net of non-interest income ($\tau_o = 0$) and for the case with transactions costs net of non-interest income. For the latter, we use $\tau_o = -0.052$, which is an estimate from Agarwal et al. (2015). The negative τ_o implies that the credit card industry makes profits even if we ignore interest income. Table 3 shows that the average spread on credit cards is 3.42 percentage points above break-even if we ignore transaction cost net of non-interest income and 8.84 percentage points above break-even if we include transaction cost net of non-interest income. This implies a markup of 44-115 percent on the Moody's Aaa rate.

The large spreads imply *excess profits*, which is the third defining feature of the credit card industry. To measure profits, we use a common measure from the literature: average rate of return. Following Grodzicki (2017), the average rate of return for a bank is computed as interest and non-interest income net of charge-offs normalized by assets.[4] That is, suppose

[2]Visa and Mastercard control two-thirds of the payment network market as measured by credit card purchase volume, and they earn profits from *network fees* (also called *credit association fees*) that are typically 0.5 percent of transaction volume. Visa and Mastercard also set a separate fee called an *interchange fee*. Interchange fees are directly paid to the issuer banks and are typically equal to 1.5 to 3.0 percent of the transaction price.[3] These interchange fees are tied to the generosity of the rewards program that the issuing banks choose. Cards that provide greater rewards can charge higher interchange fees. Since banks that choose to offer rewards can charge more interchange fees (which are borne by *merchants* who sell goods and accept credit card payments), reward cards do not yield lower profits to issuer banks (merchants are typically not allowed to price discriminate by card, although recent legal changes have relaxed these rules). Hence, by construction of the interchange fees, rewards do not lower the excess profits and excess spreads of issuers.

[4]See Appendix B for ROA details.

Table 3: Credit Card Industry Excess spreads (source: author's calculations, see text)

Excess spread	**Average, 1974-2016 (percentage points)**
Without transaction	3.42
With other transactions	8.84

that for bank i, assets are given by A_i, interest and non-interest income by $(r+\tau_i)A_i$ where r is the cost of funds and τ_i is the average spread on the cost of funds, and charge-offs by D_iA_i where D_i is the fraction of banks assets (consumer debt) written-off. Then bank $i's$ return on assets is $\frac{(r+\tau_i)A_i - D_iA_i}{A_i} = r + \tau_i - D_i$. Excess profits are computed as the difference between the average (asset weighted) return on assets for the 25 large credit card banks and the average (asset weighted) return on assets for all banks. In Table 4, we report estimates from the literature. It shows the average rate of return on assets for the largest 25 credit card banks are 5.0-7.3 percentage points higher than that of the banking industry. Figure 1 plots an updated time series of return on assets for the largest 25 credit card banks. The return on assets is positive in every year from 1990 through 2018, and the average ROA of credit card banks is 6.74% higher than the banking sector over this time period.

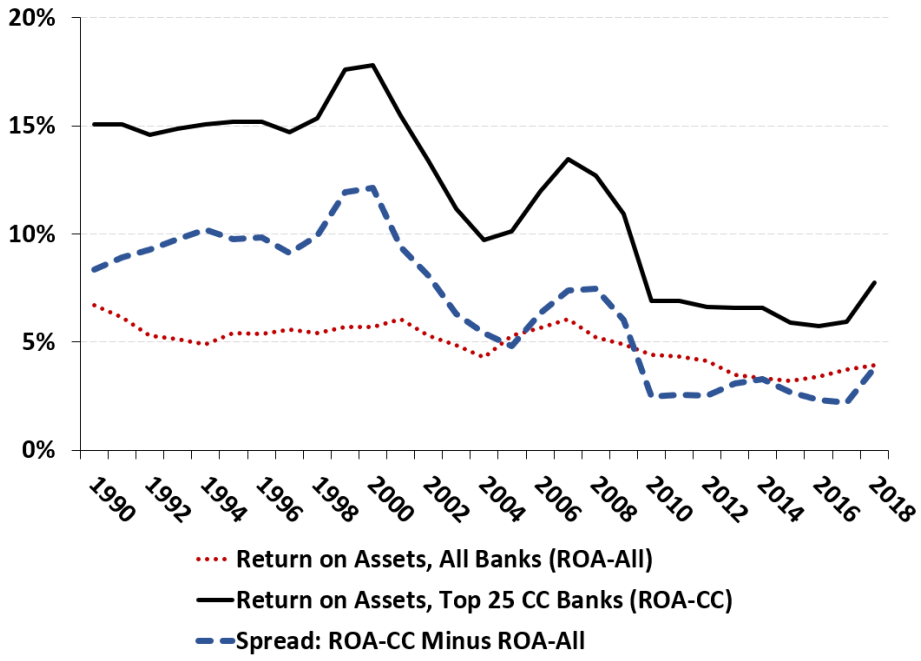
Table 4: Credit Card Industry Excess profits

Year	**Source**	**Avg. ROA (asset weighted): 25 large CC banks - all banks**
1984-88	Ausubel (1991)	5.7
1990	Grodzicki (2017)	7.3
2008	Grodzicki (2017)	5.0

The fourth defining feature of the U.S. credit card industry is antitrust violations. The payment networks and banks have been repeatedly sued for non-competitive practices. Table 5 describes a small sample of U.S. cases which have recently been brought against the credit card payment networks and issuer banks for colluding on prices (interchange fees) and colluding to block entry of new technologies and new competitors.

There are three important cases to highlight. The first case is about collusion. In 2005, several issuing banks and the major payment networks were sued for colluding over interchange fees. They lost the case in 2018 and must pay billions in penalties. While damages have been determined, the second part of this legal proceeding will involve prescribing changes to the way the industry operates in order to avoid further collusion. The second case is about entry barriers. In 2017, a new credit card issuer entrant, Black Card LLC, filed a lawsuit against the major issuers and payment networks for colluding to block entry of their credit card product. The case is currently in progress. The third case is about limiting competition among incumbents. In 2004, the major payment networks were sued for blocking member banks from issuing cards that operated on competing payment networks. They lost three major cases and were ordered to pay billions in penalties in each instance.

Figure 1: Return on assets, top 25 largest credit card banks vs. banking average



Notes. See appendix B for details.

In summary, the U.S. credit card industry is characterized by a large degree of market concentration, excess spreads, excess profits, and lawsuits for antitrust violations and non-competitive behavior. In what follows, we depart from standard competitive models of the consumer credit market and, instead, we model a finite number of non-atomistic credit card firms that issue non-exclusive credit lines. We use the model the quantify the welfare gains and losses from competitive reforms in the credit card industry (since the 1970s and in the future).

Table 5: Lawsuits against credit card payment networks and banks

Topic	Year Filed	Year Settled	Type of Suit	Plaintiffs	Defendants	Description of case	Resolution
Interchange Fee Collusion	2010	2010	Government Antitrust	US	Visa, Mastercard	Focus was on anti-steering provisions in the merchant contracts. Merchants were previously prohibited from steering consumers to lower cost cards by offering discounts, telling consumers about high fees, etc... Steering is now allowed.[a]	Settled immediately. Agreed to end practice
Interchange Fee Collusion	2010	2018	Government Antitrust	US	American Express	Fought decision. Supreme court has ruled the anti-steering provisions are not anti-competitive[b]	American expresss won case.
Interchange Fee Collusion	2005	2018	Class Action	Merchants	Visa, Mastercard, JP Morgan, Citigroup, and Bank of America	Visa/Mastercard accused of price fixing interchange fees through anti-steering provisions (see above)[c]	$6.2 Billion Breakdown: Visa ordered to pay $4.1 Billion Mastercard ordered to pay $900 Million Other Banks ordered to pay $1.3 Billion
Interchange Fee Collusion	2005	Present	Class Action	Merchants	American Express	Anti-steering provisions[d]	Currently Unresolved. Likely was on hold awaiting outcome of the government antitrust case. Since the supreme court has ruled that Amex's interchange fee structure was not anticompetitive, this case is probably dead (although I haven't found any references to this case since 2016)
Collusion to Block Entry	2017	Present	Private Suit	Black Card LLC	Visa, JP Morgan, Chase, Capital One	Visa colluded with JP Morgan and Capital One to block entry of Black Card LLC[e]	Currently Unresolved.
Exclusionary Contracts	1998	2001	Government Antitrust	US	Visa, Mastercard	Government enforcement suit over rules that Visa and Mastercard had prohibiting their constituent banks from doing business with American Express or Discover. Appeals ended in 2004 when supreme court refused to hear case[f]	1. Ordered to stop using exclusionary rules 2. Finding of fact that the rules were anticompetitive
Exclusionary Contracts	2004	2007	Private Suit	American Express	Visa	Related to 2001 US gov't settlement. Visa refused to allow its member banks to issue Amex cards[g]	Visa ordered to pay $2.25 Billion
Exclusionary Contracts	2004	2008	Private Suit	American Express	Mastercard	Related to 2001 US gov't settlement. Mastercard refused to allow its member banks to issue Amex cards[h]	Mastercard ordered to pay $1.8 Billion
Exclusionary Contracts	2004	2008	Private Suit	Discover	Visa, Mastercard	Related to 2001 US gov't settlement. Visa and Mastercard refused to allow its member banks to issue Discover cards[i]	Defendants ordered to pay $2.8 Billion Breakdown: Visa ordered to pay $1.9 Billion Mastercard ordered to pay $900 Million
Honor All Cards Rule	1996	2003	Class Action	Merchants (4 million members of the class)	Visa, Mastercard	Visa and Mastercard required merchants to accept debit cards, and then imposed high swipe-fees on debit card purchases. Note that since the Durbin Amendment (2010) there are limits to the debit card fees that credit card companies can charge.[j]	$3.05 Billion settlement Breakdown: Visa paid $2.025 Billion Mastercard paid $1.025 billion Agreed to change the rules
Pin vs. Signature	2016	2017	Private Suit	Walmart	Visa	Walmart wanted to require debit card users to use their pin instead of signing for purchases because pin transactions are routed over a lower cost network than transactions that are verified by signature. As part of the litigation, in 2016 Walmart threatened to stop accepting visa cards in its Canadian stores.[k]	Undisclosed Settlement

[a] https://www.mintz.com/insights-center/viewpoints/2016-08-what-have-merchants-gained-payment-card-antitrust-litigation

[b] https://caselaw.findlaw.com/us-supreme-court/16-1454.html

[c] https://www.wsj.com/articles/mastercard-visa-agree-to-settle-merchant-antitrust-suit-1537273419

[d] https://www.mintz.com/insights-center/viewpoints/2016-08-what-have-merchants-gained-payment-card-antitrust-litigation

[e] https://www.courthousenews.com/wp-content/uploads/2018/01/BlackCard.pdf

[f] https://www.rollcall.com/news/Mallory-Duncan-Credit-Card-Market-Is-Unfair-Noncompetitive-215965-1.html
United States v. Visa USA, Inc., 163 F. Supp. 2d 322 (S.D.N.Y. 2001)

[g] Kim, J. J. (2007, Nov 08). Visa, american express settle over lawsuit. Wall Street Journal Retrieved from http://login.ezproxy.lib.umn.edu/login?url=https://search-proquest-com.ezp3.lib.umn.edu/docview/399094692?accountid=14586

[h] https://www.nytimes.com/2008/06/26/business/26credit.html

[i] Discover settles with rivals. (2008, Oct 15). Los Angeles Times Retrieved from http://login.ezproxy.lib.umn.edu/login?url=https://search-proquest-com.ezp3.lib.umn.edu/docview/422213258?accountid=14586

[j] https://www.sec.gov/Archives/edgar/data/1403161/000119312507140569/dex101.htm

[k] https://www.bloomberg.com/news/articles/2018-01-12/visa-nixes-need-for-chip-card-signatures-in-victory-for-wal-mart

3 Model

Our model economy shares many elements with existing general equilibrium, competitive models of consumer credit, in particular Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007). We build on Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) by integrating a lender oligopoly into a production economy with heterogeneous consumers. We also depart from the existing literature by allowing lenders to issue non-exclusive long-term credit lines.

3.1 1970 Environment

Time is discrete and runs forever ($t = 0, 1, \ldots$). For ease of exposition, we focus on a recursive exposition of the steady state, omitting the time subscript. However, when we compute transition paths in later sections, the value functions are time dependent. The economy is populated by a unit measure of infinitely-lived heterogeneous consumers, N credit card firms (which we will also refer to as *lenders*), and a final good firm. Consumers differ ex-ante with respect to their permanent earnings ability. They face idiosyncratic earnings shocks as well as taste shocks over their decision to default/repay. They make savings/borrowing and default/repayment decisions to maximize utility. The final good firm is perfectly competitive and produces the consumption good using labor and capital as inputs in a Cobb-Douglas production function. Lastly, lenders imperfectly compete to issue non-exclusive credit lines. In the 1970 environment, we assume that lenders cannot price discriminate. We view the 1970s as a period when credit lines were homogeneous due to technology constraints and the limited development of credit scoring as documented by Livshits et al. (2016) and Grodzicki (2017) among others. We relax this assumption when we consider later time periods in Section 3.2.

3.1.1 1970 Consumers

Consumers have discount factor $\beta \in (0, 1)$. They make savings/borrowing and default/repayment decisions to maximize the present value of their flow utility over consumption, $u(c)$, as well as any utility gain or loss associated with default. There are three preference parameters associated with default. Consumers have independent and identically distributed Gumbel taste shocks over default and repayment $\zeta_R \sim^{iid} F(\zeta_R) = e^{-e^{-\kappa\zeta_R}}$ and $\zeta_D \sim^{iid} F(\zeta_D) = e^{-e^{-\kappa\zeta_D}}$, respectively. The Gumbel scaling parameter κ is common for both shocks. We view these taste shocks as unmodeled sources of default such as divorce, health, and other lawsuits (Chakravarty and Rhee (1999)). If the consumer chooses to default, they incur an additional one-time utility penalty of χ.

The consumer's idiosyncratic state is given by their credit standing $i \in \{g, b\}$, permanent earnings ability $\theta \in \{\theta_L, \theta_M, \theta_H\} \equiv \Theta \subset \mathbb{R}_+$, earnings shock $\epsilon \in \mathbb{R}_+$, and net assets $a \in \mathbb{R}$. If the consumer is in good credit standing, then $i = g$, and the consumer may borrow. Otherwise, the consumer is in bad credit standing ($i = b$) and cannot borrow. Permanent

earnings ability θ is fixed, and thus we refer to *type-θ consumers* when referencing permanent earnings ability. The earnings shock ϵ is persistent, where $E_{\epsilon'|\epsilon}$ is the conditional expectation operator over next period's earnings shock ϵ' given current period earnings shock ϵ. Positive values of a indicate saving, whereas negative value of a indicate borrowing. The state of a consumer is therefore given by the tuple, (i, θ, ϵ, a). We define the distribution of consumers across states as $\Omega(i, \theta, \epsilon, a)$ where $\Omega : \{g, b\} \times \mathbb{R}_+ \times \Theta \times \mathbb{R}_+ \times \mathbb{R} \to [0, 1]$.

In order to exposit the consumer's problem, we must briefly discuss the credit card market (more details about the formation of the credit lines appear in Section 3.1.2). If a consumer chooses to borrow, they borrow from a set of credit lines $S \in (\mathbb{R}_+, \mathbb{R}_+)^N$. A credit line is a long-term defaultable debt contract that specifies a spread $\tau \in \mathbb{R}_+$ and a borrowing limit $\bar{l} \in \mathbb{R}_+$. S is the collection of credit line spreads and borrowing limits offered by the N lenders.

In the 1970s, as mentioned above, there is no price discrimination and hence all consumers in good credit standing have access to the same set of credit lines S. Furthermore, credit lines are non-exclusive. If there are N credit lines available in equilibrium, the consumer will first borrow from the cheapest credit line independent of the lender that issues the credit line. Let j denote the interest rate ranking of a credit line, where $j = 1$ is the lowest interest rate and $j = N$ is the highest interest rate. Therefore, the credit lines can be sorted in ascending order with respect to the spreads $(\tau_1 \leq \tau_2 \leq \ldots \tau_j \leq \ldots \leq \tau_N)$ and the corresponding borrowing limits $(\bar{l}_1, \bar{l}_2, \ldots, \bar{l}_N)$, ignoring the issuing credit card firm's identity. With this notation, the set of credit lines available is $S = \{(\tau_1, \bar{l}_1), \ldots, (\tau_N, \bar{l}_N)\} \in (\mathbb{R}_+, \mathbb{R}_+)^N$. For any net asset level a (recall $a < 0$ implies debt), let $a_j(a) \leq 0$ denote the balance on the credit line with interest rate ranking $j \in \{1, ..., N\}$:

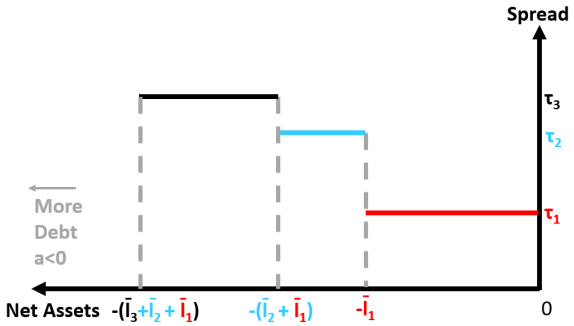
$$a_j(a) = \begin{cases} -\bar{l}_j & \text{if} \quad a \leq -\sum_{k=1}^{j} \bar{l}_k \\ \min\{a + \sum_{k=1}^{j} \bar{l}_k - \bar{l}_j, 0\} & \text{if} \quad a > -\sum_{k=1}^{j} \bar{l}_k \end{cases}$$

If net assets are less than or equal to the sum of the borrowing limits on credit lines $\{1, ..., j\}$, then the consumer has reached the limit on credit line j. Otherwise, if net assets are greater than the sum of the borrowing limits on credit lines $\{1, ..., j-1\}$ and net assets are negative, then the balance on credit line j is $a + \sum_{k=1}^{j} \bar{l}_k - \bar{l}_j$. Lastly, if net assets are positive, then the balance on credit line j (and all other credit lines) is zero. Figure 2 provides an example of the spreads and limits consumers face with three lenders, $N = 3$. They borrow from lowest spread first, τ_1, then next lowest, τ_2, etc.

Using this notation for credit lines, we now describe the consumer's value functions. Let $V(i, \theta, \epsilon, a)$ denote the consumer's continuation value at the start of the period. Let $V^D(\theta, \epsilon)$ be the value of default and $V^R(i, \theta, \epsilon, a)$ be the value of repayment. The first choice the consumer makes is between repayment and default:

$$V(i, \theta, \epsilon, a) = E_{\zeta_D, \zeta_R} \max\{V^D(\theta, \epsilon) + \zeta_D, V^R(i, \theta, \epsilon, a) + \zeta_R\} \tag{2}$$

Figure 2: Example of credit lines available to consumer with three lenders, $N = 3$, in 1970s.



Since ζ_D and ζ_R were assumed to be Gumbel with a common inverse scaling parameter κ, we can express the default probability as follows:

$$p(i, \theta, \epsilon, a) = \frac{exp(\kappa V^D(\theta, \epsilon))}{\exp(\kappa V^D(\theta, \epsilon)) + \exp(\kappa V^R(i, \theta, \epsilon, a))} \tag{3}$$

Given our assumptions about default penalties, default is universal. That is, the consumer repays credit card debt on all credit lines or defaults on all credit lines. The policy functions for repayment/default, consumption, and savings/borrowing — $p(\cdot), c(\cdot), a'(\cdot)$ — are functions of (i, θ, ϵ, a). However, we omit this state dependence of policy functions for ease of exposition.

A consumer who defaults consumes labor earnings and profits, $w\theta\epsilon + \Pi$, where w refers to the wage rate and Π refers to the profits uniformly transferred to consumers from credit card firms. Furthermore, the consumer cannot save or borrow ($a' = 0$) and incurs a one-time disutility cost (stigma χ) only during the default period. In the next period, the consumer may regain good credit standing with probability ϕ or stay in bad credit standing with probability $1 - \phi$. The continuation value of defaulting is given by:

$$V^D(\theta, \epsilon) = U\big(w\theta\epsilon + \Pi\big) - \chi + \beta E_{z', \epsilon'|\epsilon}\big[\phi V(g, \theta, \epsilon', 0) + (1 - \phi)V(b, \theta, \epsilon', 0)\big]$$

A consumer who chooses to repay and is in good credit standing ($i = g$), may borrow from the set of credit lines or save ($a' \geq -\sum_{j=1}^{N} \bar{l}_j$). Furthermore, this consumer retains good credit standing for the next period. The value of repayment when $i = g$ is given by:

$$\begin{aligned} V^R(g, \theta, \epsilon, a) = &\max_{c, a'} \; U(c) + \beta E_{\epsilon'|\epsilon} V(g, \theta, \epsilon', a') \\ &s.t. \\ c + a' = &w\theta\epsilon + (1 + r)a + \sum_{j=1}^{N} \tau_j a_j(a) + \Pi \\ a' \geq &-\sum_{j=1}^{N} \bar{l}_j \end{aligned} \tag{4}$$

Because of the taste shock for default, consumers in bad standing ($i = b$) may redefault, a common occurrence in the data (Athreya et al. (2019)). A consumer who chooses to repay and is in bad credit standing can only save ($a' \geq 0$). Furthermore, the consumer regains good credit standing in the next period with probability ϕ and stays in bad credit standing with probability $1 - \phi$. The value of repayment when $i = b$ is given by:

$$\begin{aligned} V^R(b, \theta, \epsilon, a) = &\max_{c, a'} \; U(c) + \beta E_{\epsilon'|\epsilon}\big[\phi V(g, \theta, \epsilon', a') + (1-\phi)V(b, \theta, \epsilon', a')\big] \\ &s.t. \\ c + a' = &w\theta\epsilon + (1+r)a + \Pi \\ a' \geq &0 \end{aligned} \tag{5}$$

Note that the budget constraint drops the term $\sum_{j=1}^{N} \tau_j a_j(a)$ because the consumer in bad credit standing cannot hold debt in equilibrium regardless of the repayment choice.

3.1.2 1970 Lenders

There are N lenders in the economy. We assume that in the 1970 environment that lenders cannot price discriminate, nor do we allow them to learn (e.g. there are no credit scoring institutions). Lenders only observe the default status of individuals, $i \in \{G, B\}$. When we consider later time periods in Section 3.2, we allow for price discrimination.

Each lender may issue one credit line. Since we restrict our analysis to the case where each credit card firm issues one credit line, there are N credit lines. We assume lenders commit to the terms of their lines of credit. Consider lender $k \in \{1, \ldots, N\}$. We will use the convention that superscripted k refers to a lender's identity and does *not* reflect any ranking of lenders, and subscripted j refers to the interest rate ranking of a lender. Lender k's objective is to choose the terms of their credit line, $(\tau^k, \bar{l}^k)$, to maximize their net present value of profits, π_t^k, discounted at rate β:

$$\sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t \pi_t^k \tag{6}$$

Since lenders commit to credit lines, the lender's objective is equivalent to maximizing π^k in steady state. From this point forward, we will omit time subscripts from the lender's problem.

The interest rate ranking of a lender is denoted by j and is such that $j = 1$ is the lowest interest rate and $j = N$ is the highest interest rate. Let τ_j and $\bar{l}_j$ denote the interest rate and borrowing limit of the lender offering the j^{th} highest interest rate. The profits resulting

from offering the j^{th} highest spread are given by Π_j:

$$\Pi_j = \int \Big[-(1 - p(g, \theta, \epsilon, a))\tau_j a_j(a) + p(g, \theta, \epsilon, a)(1 + r)a_j(a) \Big] d\Omega(g, \theta, \epsilon, a) \tag{7}$$

Lenders borrow from households and since households can costlessly access capital markets, the lenders must offer a riskless savings rate r. The resulting profits are comprised of two components: The first term, $-\tau_j a_j(a)$, captures the gains from repayment; The second term, $(1 + r)a_j(a)$, captures the losses from default (lenders must repay their depositors). Total profits are computed as $\Pi = \sum_{j=1}^{N} \Pi_j$, which as mentioned above, are uniformly transferred to consumers.

Suppose lender $k \in \{1, 2, ..., N\}$ chooses spread τ^k and borrowing limit $\bar{l}^k$. Let $j(\tau^k, \tau^{-k})$ be a function which maps τ^k and $\tau^{-k} = (\tau^1, ..., \tau^{k-1}, \tau^{k+1}, ..., \tau^N)$ to the rank of τ^k when the spreads are sorted in ascending order, $j : \mathbb{R}_+ \times \mathbb{R}_+^{N-1} \to \{1, \ldots, N\}$. Then the set of credit lines can be written $S = \{(\tau_{j(\tau^k, \tau^{-k})}, \bar{l}_{j(\tau^k, \tau^{-k})})\}_{k=1}^{N}$ and the profits to credit card firm k are given by:

$$\pi^k = \Pi_{j(\tau^k, \tau^{-k})} \tag{8}$$

To understand the notation, consider two *steady state* examples. First, if there is one firm (monopolist), then the monopolist chooses the spread τ^1 and the borrowing limit $\bar{l}^1$ to maximize total profits, $\pi^1(\tau^1, \bar{l}^1) = \Pi_1(\tau_1, \bar{l}_1) = \Pi$, where the first expression refers to profits by the lender's identity, the middle expression refers to profits using the (degenerate) interest rate ranking, and the last expression refers to total profits.

Second, if there are two credit card firms and they move sequentially (Stackelberg competition), then firm 2 (the second mover) will pick its spread $\tau^2(\tau^1, \bar{l}^1)$ and borrowing limit $\bar{l}^2(\tau^1, \bar{l}^1)$ to maximize its profits $\pi^2(\tau^1, \bar{l}^1, \tau^2, \bar{l}^2)$ for any given combination of firm 1's spread τ^1 and borrowing limit $\bar{l}^1$. Firm 1 will pick its spread and borrowing limit to maximize its profits $\pi^1(\tau^1, \bar{l}^1, \tau^2(\tau^1, \bar{l}^1), \bar{l}^2(\tau^1, \bar{l}^1))$, given firm 2's best response functions $\tau^2(\tau^1, \bar{l}^1)$ and $\bar{l}^2(\tau^1, \bar{l}^1)$. If, for example, firm 1 sets the lowest interest rate $\tau_1 < \tau_2$, then $j(\tau^1, \tau^2) = 1$. Firm 1's credit line offers the lowest interest rate in the economy and therefore it is ranked first in terms of interest rates. When consumers borrow, they will borrow on firm 1's credit line before borrowing on any other credit line.

It is important to note that outside of steady state, lender's will maximize the net present value of profits, given by equation (6).

Forms of Lender Competition. We consider three forms of imperfect competition in the 1970s: (i) *Stackelberg* competition (where N=1 corresponds to the pure monopoly case), (ii) *Collusive-Cournot* competition which is a two-stage game where lenders collude on spreads in the first stage and then Cournot compete on limits in the second stage, and (iii) *Pure collusion* in which lenders collude on spreads and limits [X] perfect comp

[X]. As we discussed in Section 2, most legal and academic studies of the 1970s and early 1980s document widespread non-competitive practices in the credit card industry, including interest rate collusion. We view both forms of competition as plausible. When we turn to calibration, even with these relatively strong forms of imperfect competition (including pure monopoly), we can only account for less than 50% of the observed spreads and excess profits in the credit card industry.

It is important to note that since lenders in our economy will offer both a price (interest rate) and quantity (credit limit), our model does not feature monotone best-response functions, nor can we classify theoretically whether the interest rate and/or credit limit policy functions are strategic complements or substitutes (e.g. Bulow, Geanakoplos, and Klemperer (1985)). We must therefore quantitatively evaluate whether there is a first-mover or second-mover advantage when considering Stackelberg competition.[5]

3.1.3 1970 Final Good Producer

There is a representative, perfectly competitive firm that produces the final good by hiring labor, L, and renting capital, K, in order to maximize profits:

$$\max_{K,L} K^{\alpha} L^{1-\alpha} - wL - rK$$

Factor prices are given by $r = \alpha(K/L)^{\alpha-1}$ and $w = (1-\alpha)(K/L)^{\alpha}$. The firm earns zero profits.

3.1.4 1970 Equilibrium

A stationary recursive competitive equilibrium is given by a set of credit lines S, a stationary distribution over idiosyncratic states $\Omega(i, \theta, \epsilon, a)$, a wage rate w, an interest rate r, total profits Π, a repayment/default policy function $p(i, \theta, \epsilon, a)$, a consumption policy function $c(i, \theta, \epsilon, a)$, a savings/borrowing policy function $a'(i, \theta, \epsilon, a)$, a set of credit card firms' best response functions $\{\tau^k(\cdot), \bar{l}^k(\cdot)\}_{k=1}^N$, and the final good firm's choices for aggregate capital K and aggregate labor L such that:

(i) given S, w, r, and Π, the allocations $p(i, \theta, \epsilon, a)$, $c(i, \theta, \epsilon, a)$, and $a'(i, \theta, \epsilon, a)$ solve the consumer's problem in (2), (4), and (5).

(ii) for $k \in \{1, 2, ..., N\}$, $\{\tau^k(\cdot), \bar{l}^k(\cdot)\}_{k=1}^N$ maximizes each credit card firm's profits in (8).

(iii) final good firm's choices give factor prices $r = \alpha(K/L)^{\alpha-1}$ and $w = (1-\alpha)(K/L)^{\alpha}$.

(iv) the distribution of consumers $\Omega(i, \theta, \epsilon, a)$ evolves given the policy functions $p(i, \theta, \epsilon, a)$ and $a'(i, \theta, \epsilon, a)$, and the exogenous process for the earnings shock ϵ.

[5] Gal-Or et al. (1985), Dowrick (1986), and Amir and Stepanova (2006) characterize conditions under which there is a first-mover (strategic substitutes, e.g. Stackelberg Cournot) or second-mover (strategic complements, e.g. Stackelberg Bertrand) advantage. Amir and Stepanova (2006) proves that with enough cost heterogeneity, there may be a first-mover advantage, even in a Stackelberg Bertrand game.

(v) labor market clears:

$$L = \int \epsilon \; d\Omega \left(i, \theta, \epsilon, a\right)$$

(vi) capital market clears:

$$K = \int a \; d\Omega \left(i, \theta, \epsilon, a\right)$$

(vii) final good market clears:

$$\int c(i, \theta, \epsilon, a) \; d\Omega \left(i, \theta, \epsilon, a\right) + \delta K = K^{\alpha} L^{1-\alpha}$$

3.2 2016 Environment

To capture technological innovations in credit scoring and increases in lender competition that occurred from the 1970s to 2016, we modify the environment to allow for price discrimination. In particular, we assume that lenders discriminate with respect to permanent earnings ability θ. To rule out complicated portfolio problems which would render the environment intractable, we assume that lenders only lend to one type-θ consumer. Therefore, we assume that there are N_θ lenders who compete for type-θ consumers. The total number of lenders in the economy is now $\sum_{\theta \in \Theta} N_\theta$. The environment remains very similar to the 1970 environment, except now all spreads, limits, and lender profit functions are indexed by θ. The final goods firm problem remains the same, and the equilibrium concept is identical to that of the 1970s environment. For the sake of brevity, we only exposit portions of the model that change.

3.2.1 2016 Consumers

Consumers borrow from a set of credit lines that now depends on their permanent earnings, $S_\theta = \{(\tau_1(\theta), \bar{l}_1(\theta)), \ldots, (\tau_N(\theta), \bar{l}_N(\theta))\} \in (\mathbb{R}_+, \mathbb{R}_+)^{N_\theta}$. For each type-$\theta$ consumer, the credit lines can be sorted in ascending order with respect to the spreads ($\tau_1(\theta) \leq \tau_2(\theta) \leq \ldots \tau_j(\theta) \leq \ldots \leq \tau_N(\theta)$) and the corresponding borrowing limits $(\bar{l}_1(\theta), \bar{l}_2(\theta), \ldots, \bar{l}_N(\theta))$. Within each set of type-θ consumers, let j denote the interest rate ranking of a credit line.

For any net asset level a (recall $a < 0$ implies debt), let $a_j(a, \theta) \leq 0$ denote the balance on the credit line with interest rate ranking $j \in \{1, ..., N\}$ for a type-θ consumer:

$$a_j(a, \theta) = \begin{cases} -\bar{l}_j(\theta) & \text{if} \quad a \leq -\sum_{k=1}^{j} \bar{l}_k(\theta) \\ \min\{a + \sum_{k=1}^{j} \bar{l}_k(\theta) - \bar{l}_j(\theta), 0\} & \text{if} \quad a > -\sum_{k=1}^{j} \bar{l}_k(\theta) \end{cases}$$

A type θ consumer who chooses to repay and is in good credit standing ($i = g$) may

borrow from the set S_θ of credit lines or save ($a' \geq -\sum_{j=1}^{N} \bar{l}_j(\theta)$):

$$\begin{aligned} V^R(g,\theta,\epsilon,a) = &\max_{c,a'} \; U(c) + \beta E_{\epsilon'|\epsilon} V(g,\theta,\epsilon',a') \\ &s.t. \\ c + a' = &w\theta\epsilon + (1+r)a + \sum_{j=1}^{N} \tau_j(\theta) a_j(a,\theta) + \Pi \\ a' \geq &-\sum_{j=1}^{N} \bar{l}_j(\theta) \end{aligned} \tag{9}$$

The remaining value functions undergo similar modifications.

3.2.2 2016 Lenders

We assume there are N_θ lenders that lend to type-θ consumers. They do not lend to other consumer types. Each lender may issue one credit line to type-θ consumers, and so there are N_θ credit lines available to type-θ consumers. We maintain the assumption that lenders commit to the terms of their lines of credit. For each lender $k \in \{1, \ldots, N_\theta\}$ their objective is to choose the terms of their credit line, $(\tau^k(\theta), \bar{l}^k(\theta))$, to maximize their net present value of profits, $\pi_t^k(\theta)$, discounted at rate β:

$$\sum_{t=0}^{\infty} \Big(\frac{1}{1+r}\Big)^t \pi_t^k(\theta)$$

Since lenders commit to interest rates and limits, the lender's objective is to maximize steady state profits $\pi^k(\theta)$ by choosing $(\tau^k(\theta), \bar{l}^k(\theta))$.

Among the N_θ lenders who make loans to type -θ consumers, let $\tau_j(\theta)$ and $\bar{l}_j(\theta)$ denote the interest rate and borrowing limit of the lender offering the j^{th} highest interest rate. The profits resulting from offering the j^{th} highest interest rate are given by $\Pi_j(\theta)$:

$$\begin{aligned} \Pi_j(\theta) = \int \Big[&-(1 - p(g,\theta,\epsilon,a))\tau_j(\theta) a_j(a,\theta) \\ &+ p(g,\theta,\epsilon,a)(1+r) a_j(a,\theta) \Big] d\Omega(g,\theta,\epsilon,a) \end{aligned} \tag{10}$$

Total profits are therefore computed as $\Pi = \sum_{\theta \in \Theta} \sum_{j=1}^{N_\theta} \Pi_j(\theta)$, which are rebated uniformly to consumers independent of their type.

3.2.3 2016 Lender Competition

Relative to the 1970s, we consider many more credit card lenders, e.g. $\sum_{\theta \in \Theta} N_\theta > N$, and we allow for price discrimination by permanent earnings ability. These modifications are designed to capture the expansion of credit card networks and the rise of credit scoring,

e.g. Drozd and Nosal (2008), Athreya et al. (2012), Livshits et al. (2016) and Sánchez (2018). *Within* each set of type-θ lenders, we consider both *Stackelberg* and *Collusive-Cournot*. While indicators of competitiveness in credit markets have improved over time, e.g. Grodzicki (2017), we show that even after calibrating to the observed number of lenders in the data, both forms of competition are still unable to generate observed spreads and excess profits in 2016.

4 Calibration

[X] need to fix [X]

Given the computationally demanding nature of the model, we take as many standard parameters from the literature as possible, and then we calibrate the remaining parameters to target 1971-1975 moments.

We assume that each period corresponds to one year. Table 6 presents the parameters determined outside of the model equilibrium. We use standard estimates for the capital share ($\alpha = 0.333$), depreciation rate ($\delta = 0.045$), and risk aversion ($\sigma = 2$). The re-entry probability of good credit standing ϕ is chosen such that it takes the average consumer seven years to re-enter the credit card market upon default. The idiosyncratic productivity ϵ follows a log $AR(1)$ process given by $\log \epsilon' = \rho_\epsilon \log \epsilon + \eta'$. The innovation η' is normal, i.i.d., with mean zero and variance σ_η^2. The permanent type takes three values [X] (Gajen). The permanent types map to the fixed effects in the log earnings regressions in Heathcote et al. (2004) [X] (Gajen). We parameterize this process using estimates from Heathcote et al. (2004) [X] (Gajen).

Table 6: Parameters determined outside the model equilibrium

Parameter	**Description**	**Value**
α	Capital share	0.333
δ	Depreciation rate	0.045
σ	Risk aversion	2
ϕ	Re-entry prob. good credit standing	0.149 [X] (Gajen)
ρ_ϵ	Persistence	0.953 [X] (Gajen)
σ_ϵ^2	Variance persistent component	0.060 [X] (Gajen)

We calibrate the model assuming that there is a single monopolist lender (the *monopoly* calibration). We estimate $\beta = 0.96$, which implies a discount rate of 4.17 percent per annum, in order to match the average real interest rate of 1.27 percent from 1971 to 1975. We calibrate stigma in 1970 (χ_{1970}) to match the average charge-off rate from 1971-75, the earliest 5 years of available charge-off rate data (Ausubel, 1991). We estimate the stigma of default $\chi_{1970} = 7.82$ to match a charge-off rate of 2.57 percent from 1971 to 1975. Lastly, we estimate the variance of the taste shock to match the fraction of bankruptcies that are driven by unmodeled shocks. In particular, we compute the share of bankruptcies in which the individual has a higher value of repaying than defaulting, $V^R(\cdot) > V^D(\cdot)$, and yet the individual enters default. We estimate κ to target the share of bankruptcies due to divorce,

health, or lawsuits reported by Chakravarty and Rhee (1999).

Table 7: Parameters determined jointly in equilibrium

	Parameter	Value	Target	Data	Model
β	Discount rate	0.960	Risk Free Rate (AAA less GDP Deflator), %	1.27	1.27
χ	Stigma	8.188	Chargeoff Rate, %	2.57	2.56
κ	Taste Shock	0.712	Fraction of bankruptcy due to divorce, health and lawsuits, %	44.81	44.90

5 Results

In this section we compute the distribution of welfare gains as well as the macroeconomic implications under two sets of competitive reforms: (1) reforming the 1970s monopoly into an oligopoly, (ii) reforming the 2016 oligopoly into perfect competition.

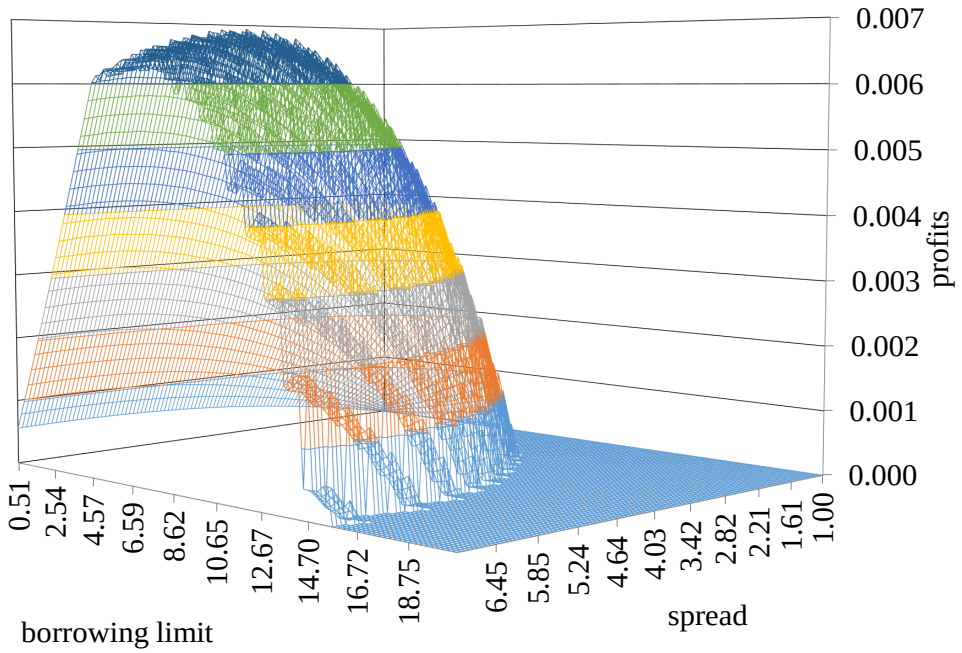
5.1 Competitive reforms after 1970: monopoly to oligopoly

We begin by analyzing competitive reforms when there is a single monopolist lender (one exclusive credit line), such as in the 1970s. Since this environment is new, we first explore the properties of the monoplist's problem. Figure 3 plots profits to the monopolist ($\pi^1(\tau^1, \bar{l}^1) = \Pi_1(\tau_1, \bar{l}_1) = \Pi(S)$) as a function of the spread τ^1 and the borrowing limit $\bar{l}^1$. Note that the monopolist maximizes profits at an interior spread and an interior borrowing limit. This is because if the monopolist chooses a low borrowing limit, profits are low due to less borrowing. If the monopolist chooses a high borrowing limit, then profits are low (or losses are high) due to high default rates. If the monopolist chooses a low spread, then the profit margin is low. If the monopolist chooses a high spread, then consumers will borrow less, leading to low profits.

Before discussing the reforms, we show that the model does a reasonable job at approximating several of our key competitiveness indicators. Table 8 compares the credit card market variables from the monopoly model with the limited set of available data in 1970. We targeted the charge-off rate, but not the interest rate spreads. The model accounts for more than half of the interest rate spread and excess spread observed in the data. Given the lower estimates for the excess spread in the model, we view the gains from competitive reforms (discussed below) as conservative estimates.

Given the model's success at reproducing key moments, we use the model as a laboratory to study the welfare consequences of reforming the 1970 monopoly into an oligipoly. We begin by comparing steady states, and then we turn to the transition path. Table 9 compares

Figure 3: Monopolist profit function



Notes: borrowing limits are expressed as a percent of GDP per capita. Spreads are expressed as percentage points over the savings interest rate. Profits are expressed as a percent of GDP.

Table 8: Credit card market variables (1970)

Variable (unit=percent)	**Monopoly model**	**Data**
Spread	5.55	10.86
Charge-off rate	*2.20*	*1.95*
Excess spread: actual - zero-profit	3.20	6.22

steady state outcomes when there is a monopoly in the 1970s versus a duopoly. We hold parameter values fixed at the 1970 values in this experiment. This experiment is designed to measure the long-run gains associated with the U.S. transition from regional monopolies in the 1970s to current levels of oligopolistic competition. For the case of duopoly, there are two credit lines (one credit line per firm), and they compete in the form of Stackelberg competition. We find that the first mover commits by picking a low borrowing limit (2.50 percent of GDP per capita) and a low spread (2.25 percent). The second mover picks a borrowing limit that is twice that of the first mover (5.29 percent of GDP per capita) and a slightly higher spread (2.36 percent). Hence, the second mover captures a slightly larger share of the market, 56.87 percent of outstanding credit and 52.90 percent of total lender profits.

In terms of credit outcomes, Table 9 shows that total credit increases by more than 50 percent from 0.20 percent of GDP to 0.36 percent of GDP. Table 9 also shows that while the total borrowing limit does not increase much from a monopoly to a duopoly (7.40 percent

vs 7.79 percent of GDP per capita), the spread decreases significantly from 5.55 percent to 2.25 percent on the first lender's credit line and 2.36 percent on the second lender's credit line. The excess spread and excess profits also decrease significantly. As we will see below, this generates significant welfare gains among the poor, who previously had to borrow at the higher monopoly interest rate.

Table 9: Competitive reforms from 1970 monopoly to duopoly.

Variable	**Monopoly**	**Duopoly**
Firm 1: first mover		
Borrowing limit to initial GDP pc	7.40	2.50
Spread	5.55	2.25
Market share of outstanding credit	100.00	43.13
Market share of total profits	100.00	47.10
Firm 2: second mover		
Borrowing limit to initial GDP pc	_	5.29
Spread	_	2.36
Market share of outstanding credit	_	56.87
Market share of total profits	_	52.90
Credit to GDP	0.20	0.36
Default rate	0.13	0.13
Charge-off rate	2.20	1.46
Excess spread: actual - zero-profit	3.20	0.78
Excess profits: return on assets	3.12	0.76
Welfare gains of moving from monopoly to duopoly		
CEV unborn: steady state (% of lifetime consumption)	_	0.35
WEV unborn: steady state (% of initial GDP pc)	_	0.98
CEV unborn: transition (% of lifetime consumption)	_	0.36
WEV unborn: transition (% of initial GDP pc)	_	1.01
WEV current cohort (% of initial GDP)	_	0.81
Population better off (% of population)	_	99.95

Table 9 presents the welfare estimates from reforming the 1970 lender monopoly to a duopoly. We use two measures of welfare: consumption equivalent variation (CEV) and wealth equivalent variation (WEV). Consumption equivalent variation is a standard measure that calculates the lifetime increase of consumption in the initial steady state (model with monopolist) such that a consumer is indifferent between the economy with a monopolist and an economy with a duopoly. Wealth equivalent variation calculates the one time transfer that the consumer requires in the initial steady state to be indifferent between the economy with a monopolist and an economy with a duopoly. Wealth equivalent variation is our preferred measure because it allows for aggregation across consumers and takes into account that consumers re-optimize on their decisions given the one-time transfer. Following Conesa

et al. (2018), it is calculated as follows:

$$\begin{aligned} &\min \quad WEV \\ &\qquad s.t. \\ V_0(i,\epsilon,z,a+WEV) \geq & V_t(i,\epsilon,z,a) \\ a+WEV \geq & -\bar{l}^1 \qquad \text{if} \quad i=g \\ a+WEV \geq & 0 \qquad\quad \text{if} \quad i=b, \end{aligned} \tag{11}$$

where $V_0(i,\epsilon,z,a+WEV)$ refers to the value at the initial steady state (monopolist) given a one-time transfer of WEV, $V_t(i,\epsilon,z,a)$ refers to the value in period t along the transition path, and $\bar{l}^1$ refers to the borrowing limit in the initial steady state (borrowing limit picked by the monopolist). The last two inequalities ensure that the minimization problem is well defined.

The welfare gains from competitive reforms range from a lifetime increase in consumption of 0.35-0.36 percent for an unborn consumer. The gains to the same consumer, measured in units of a one-time transfer range from 0.98-1.01 percent of initial GDP pc. The lower spreads are key for the welfare gains because the increase in the total borrowing limit is small. When we take the transition into account, note that the gains are slightly higher. Finally, Table 9 shows that the aggregate welfare gain to the current cohort is equivalent to a one-time transfer of 0.81 percent of initial GDP. Furthermore, almost every consumer (99.95 percent of total population) is better off with the transition to a duopoly.

Before decomposing the welfare gains, we first discuss the implications for the interest rate, wage rate, profits to GDP, credit to GDP, default rate, and charge-off rate along the transition path. In Figure 4, we plot the transition path where in period 1, the economy switches from a monopoly to a duopoly. With a lower spread and a higher total borrowing limit, consumers have a lower precautionary savings motive. This leads to lower aggregate savings (equal to capital K) resulting in a higher interest rate and a lower wage rate (Figures 4a and 4b). Profits increase initially along the transition path, subsequently they decrease to a a lower value (Figure 4c). Given a lower spread, consumers borrow more, but do not default more (Figures 4d and 4e). This leads to a lower charge-off rate (Figure 4f).

Thus far, we have estimated the aggregate welfare gains and showed that almost 100 percent of the population is better off. Now we turn to a discussion of the distribution of welfare gains from competitive reforms. This is illustrated in Figure 5. The first sub-figure plots the welfare gains (in units of the one time transfer normalized by initial GDP pc) for consumers with the lowest, highest, and median earnings shock (and no expense shock) as a function of net assets. We see that consumers with the lowest earnings shock and low net assets are better off due to the lower spread and higher borrowing limit. We also see that consumers with the highest earnings shock and high net assets are also better off. This is because these consumers benefit from a higher savings interest rate. Finally,

consumers with a median earnings shock are better off, but not as much as those with the lowest earnings shock and low assets or those with the highest earnings shock and high assets. This is because consumers with a median earnings shock do not benefit as much from the increased ability to borrow more at a cheaper rate and does not benefit as much from a higher savings interest rate. This mechanism is reflected in the second sub-figure, which plots the distribution of welfare gains by earnings and wealth deciles. We see that the consumers with the lowest earnings or wealth and the consumers with the highest earnings or wealth are the ones who benefit the most from competitive reforms.

5.2 Competitive reforms after 2016: oligopoly to perfect competition

Thus far, we analyzed the implications of the U.S. credit card industry experiencing competitive reforms from the 1970 monopoly to oligopoly. Now we analyze competitive reforms from the 2016 oligopoly to perfect competition.

We begin by showing that our 2016 calibration does well at capturing several of our key competitiveness indicators. Table 10 shows that we account for almost all of the total borrowing limit and more than half of the spread. We also account for 40 percent of the excess spread and excess profits. Again, given the lower estimates for excess spreads and excess profits in the model compared to data, we view the gains from competitive reforms as conservative estimates.

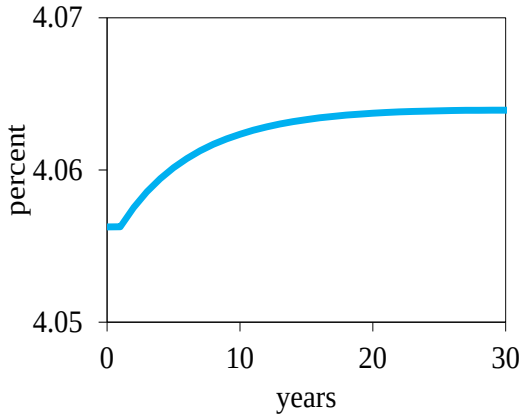
Table 10: Credit card market variables (2016)

Variable (unit=percent)	**Duopoly model**	**Data**
Borrowing limit to GDP pc	24.82	30.47
Spread	5.38	11.94
Charge-off rate	*3.23*	*3.34*
Excess spread: actual - zero-profit	1.90	4.53
Excess profits: return on assets	1.82	5.00

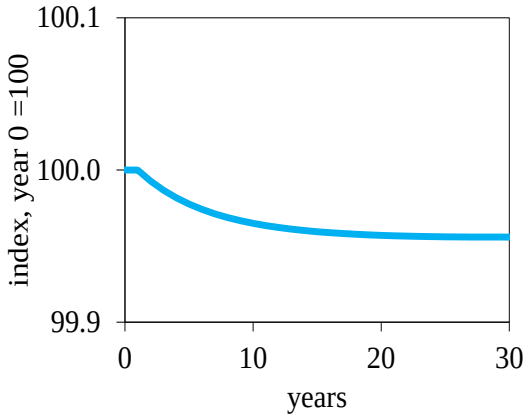
Table 11 compares steady state outcomes when there is a duopoly in 2016 versus perfect competition. We hold parameter values fixed at the 2016 values in this experiment. In the case of a duopoly, given that firm 2 (second mover) could always undercut firm 1 (first mover) with a lower spread, firm 1 commits to a low borrowing limit and a low spread. In response, firm 2 chooses a high borrowing limit and a high spread. We also see this in the market share with respect to outstanding credit and profits, where firm 1 has 37.94 percent and 22.01 percent of the market share, respectively. Compared to the 1970 duopoly, the duopoly in 2016 generates significantly higher profits. What differs between the two calibrations is the value of the stigma default penalty χ, which is significantly higher in the 2016 calibration. This allows lenders to charge higher spreads and offer greater borrowing

Figure 4: Transition from monopoly to duopoly

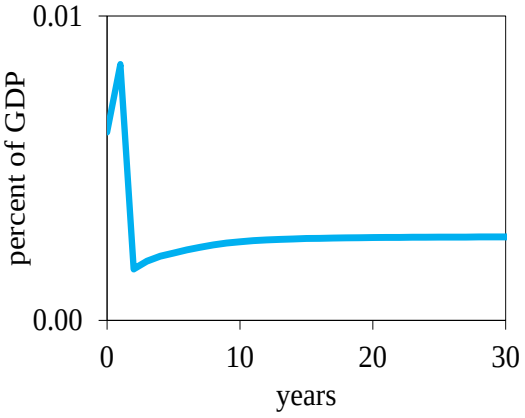
(a) Interest Rate



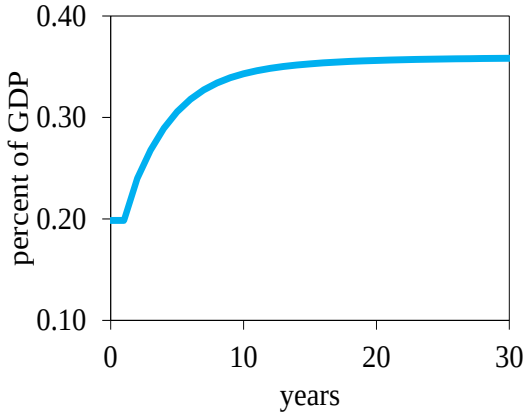
(b) Wage Rate



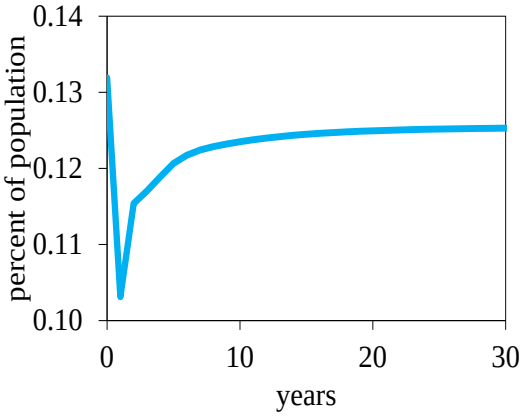
(c) Profits



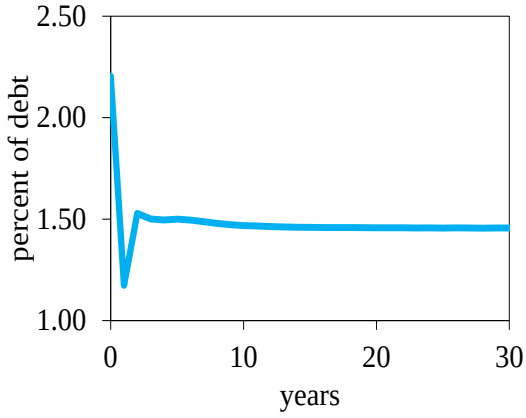
(d) Credit



(e) Default Rate



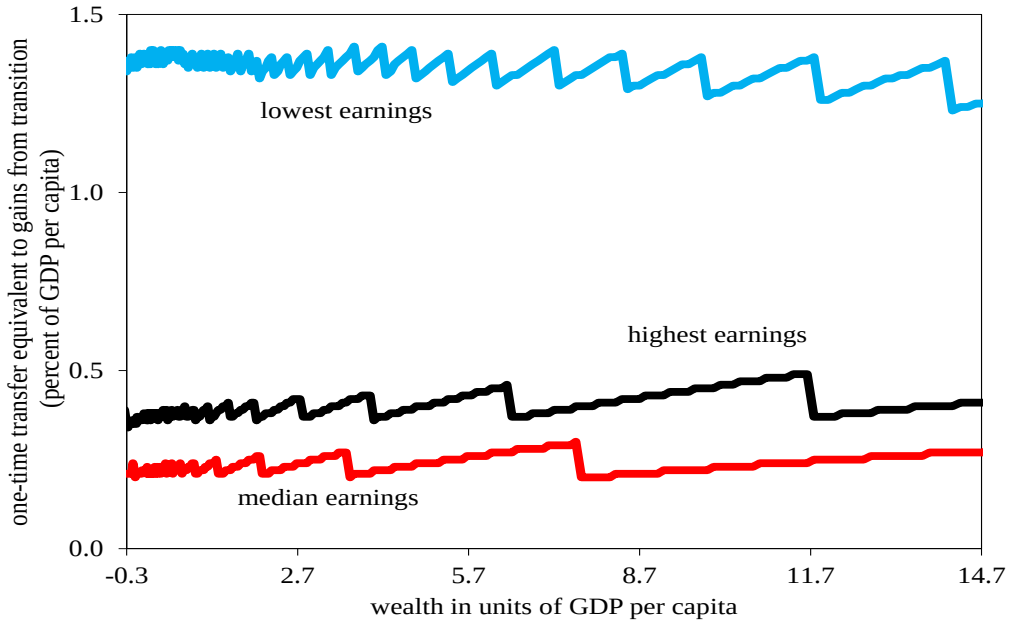
(f) Charge-off Rate



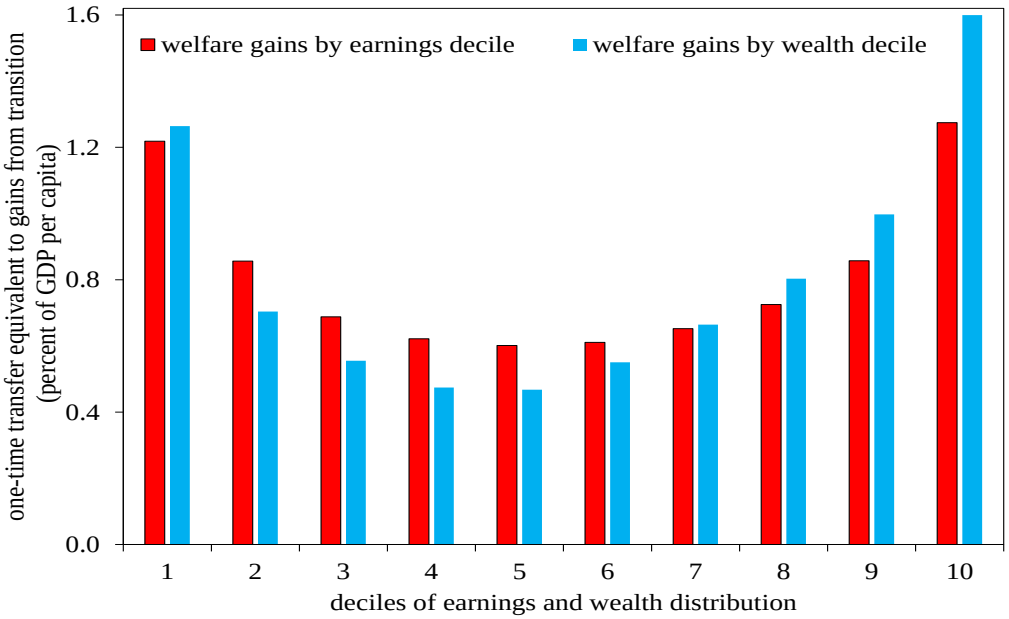
Notes: the initial steady state (year=0) is a monopoly. In year 1, the economy unexpectedly transitions to a duopoly. We assume perfect foresight for subsequent periods.

Figure 5: Welfare gains by earnings and wealth of transition from monopoly to duopoly

(a) Welfare gains as a function of earnings and wealth



(b) Welfare gains stratified by earnings deciles and wealth deciles



Notes: welfare gains from the transition are measured using wealth equivalent variation (one-time transfer that yields gains of reform from monopoly to duopoly) and expressed as a percent of GDP per capita. The measure is defined in equation 11.

limits without generating more defaults since the stigma cost of default is higher.

To measure the welfare losses from oligopoly in the credit market, we must define the perfect competition counterfactual. Our benchmark definition of perfect competition is an economy in which we hold the number of lenders fixed and assume that they compete non-strategically on limits and spreads until each lender's profit is zero. However, there are an indeterminate number of combinations of borrowing limits and spreads that yield zero profits. Our selection criteria is to choose the combination of borrowing limits and spreads that maximize the welfare of an unborn agent with zero net assets, subject to weakly positive profits on all credit lines.

Using this definition of perfect competition, Table 11 reports key credit market variables. Under perfect competition, the total borrowing limit nearly doubles, and we observed an approximately 35 percent reduction in the spreads on both credit lines. Hence, total credit increases threefold, going from 0.61 to 2.07 percent of GDP. The higher borrowing limit leads to a higher charge-off rate and default rate, however. Lastly, by construction, profits decrease to zero.

Table 11: Competitive reforms after 2016 (duopoly to perfect competition)

Variable	**Duopoly**	**Perfect competition**
Firm 1: first mover		
Borrowing limit to initial GDP pc	4.62	0.97
Spread	3.18	1.91
Market share of outstanding credit	37.94	_
Market share of total profits	22.01	_
Firm 2: second mover		
Borrowing limit to initial GDP pc	20.20	45.68
Spread	6.73	4.50
Market share of outstanding credit	62.06	_
Market share of total profits	77.99	_
Credit to GDP	0.61	2.07
Default rate	0.11	0.19
Charge-off rate	3.23	4.06
Excess spread: actual - zero-profit	1.90	0
Excess profits: return on assets	1.82	0
Welfare gains of moving from duopoly to perfect competition		
CEV unborn: steady state (% of lifetime consumption)	_	1.84
WEV unborn: steady state (% of initial GDP pc)	_	5.59
CEV unborn: transition (% of lifetime consumption)	_	1.95
WEV unborn: transition (% of initial GDP pc)	_	6.02
WEV current cohort (% of initial GDP)	_	3.36
Population better off (% of population)	_	100

Table 11 also presents the welfare estimates from reforming the 2016 lender oligopoly

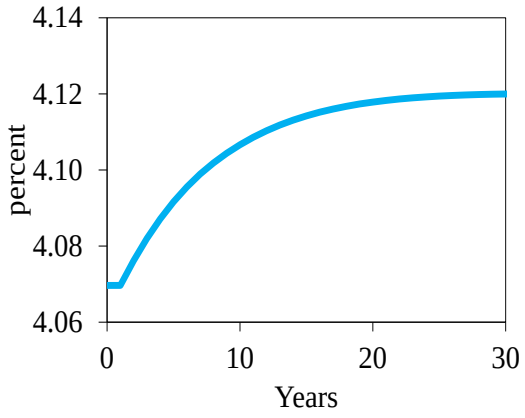
to perfect competition. The welfare gains, on average, are large for both an unborn agent and the current cohort. The lifetime consumption gains for unborn agents are 1.84 percent and 1.95 percent across steady states and along the transition path, respectively. We also compute the one time transfers equivalent to gains from competitive reforms for unborn agents. We find that the gains to unborn agents are equivalent to one time transfers of 5.59 percent and 6.02 percent in steady state and along the transition path, respectively. Among the agents that are currently living in 2016 levels of credit market competition, the gains are equivalent to a one time transfer worth 3.36 percent of GDP. Furthermore, every consumer is weakly better off with the transition.

Figure 6 plots the transition from the 2016 lender duopoly to perfect competition. In this case also the interest rate increases and the wage rate decreases, but the magnitudes are significantly larger compared to the 1970s reform (monopoly to duopoly) discussed in the previous subsection. Credit increases monotonically. Both the default rate and the charge-off rate decrease initially because consumers delay default, however, subsequently they increase to a higher steady state level. As a result, lender profits initially rise as defaults fall, but in the long run, as defaults rise, lender profits decline and then asymptote to zero.

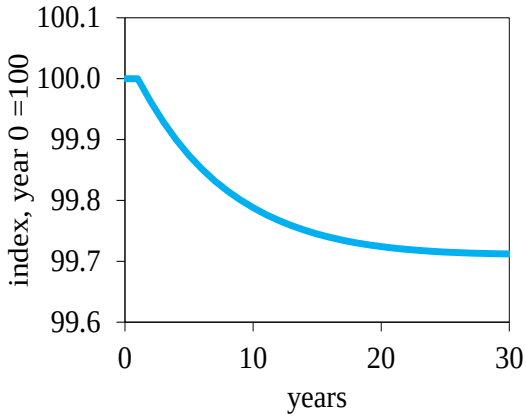
Figure 7 decomposes the welfare gains from further competitive reforms. While the implications are qualitatively similar to those discussed in the previous subsection, the magnitudes are larger. The wealth-equivalent gains to consumers in the lowest deciles of the earnings and wealth distributions are equivalent to a one time transfer worth 6.66 and 6.83 percent of GDP per capita, respectively. The wealth-equivalent gains to the highest deciles of the earnings and wealth distributions are equivalent to a one-time transfer worth 5.23 and 7.06 percent of GDP per capita, respectively. Similar to the 1970s reform, low-income and low-wealth consumers benefit from the ability to borrow more at a cheaper rate, and savers now receive a higher interest rate because of general equilibrium effects. Because of the significant expansion of limits and lowering of borrowing rates, we find that this reform is Pareto improving both across steady states as well as along the transition path (as shown in the last line of Table 11).

Figure 6: Transition from duopoly to perfect competition

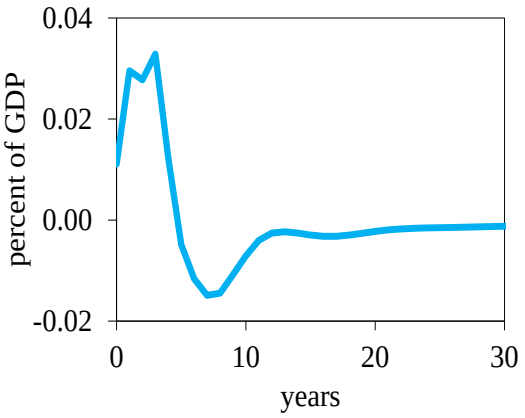
(a) Interest Rate



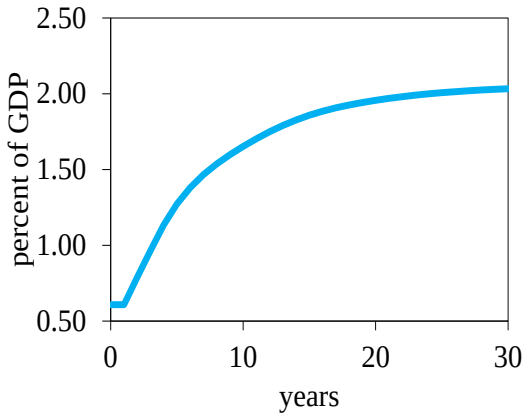
(b) Wage Rate



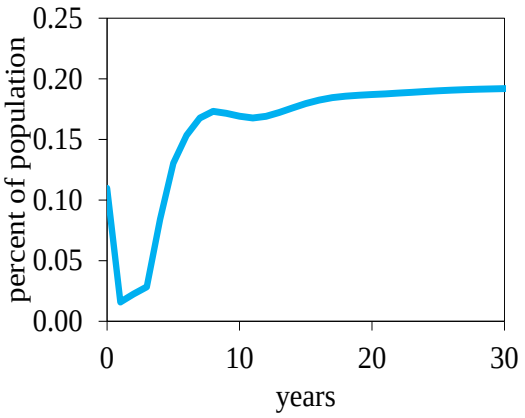
(c) Profits



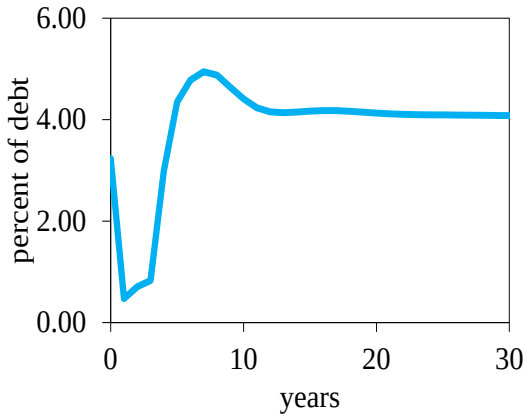
(d) Credit



(e) Default Rate



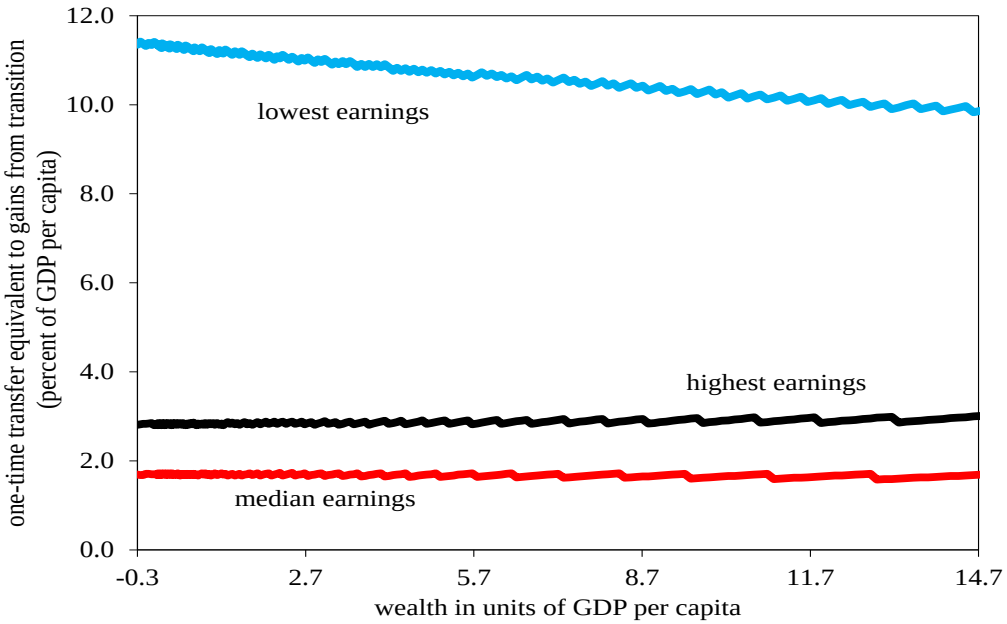
(f) Charge-off Rate



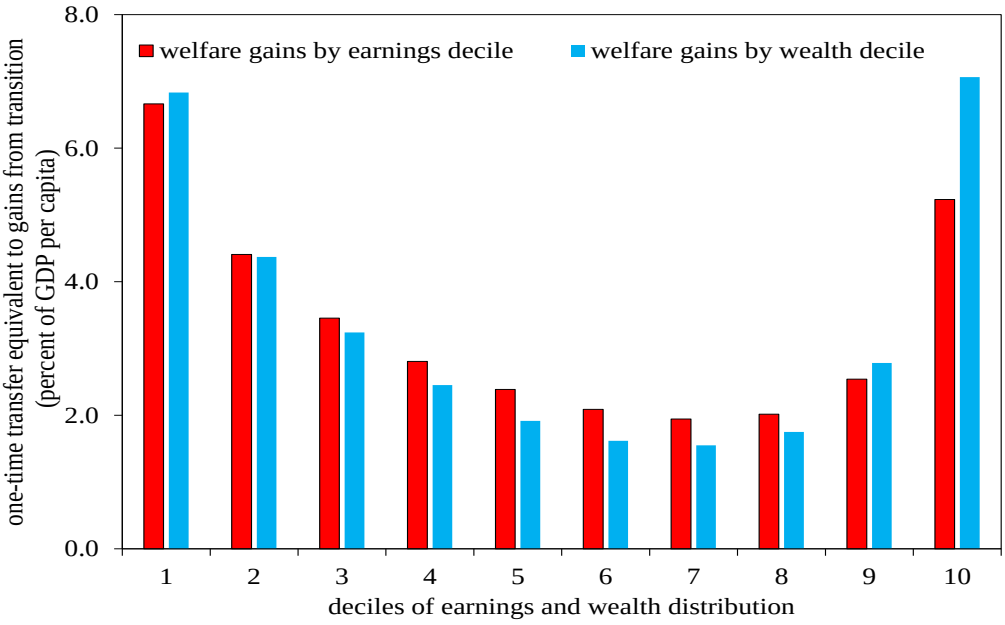
Notes: the initial steady state (year=0) is a duopoly. In year 1, the economy unexpectedly transitions to a perfect competition. We assume perfect foresight for subsequent periods.

Figure 7: Welfare gains by earnings and wealth of transition from duopoly to perfect competition

(a) Welfare gains as a function of earnings and wealth



(b) Welfare gains stratified by earnings deciles and wealth deciles



Notes: welfare gains from the transition are measured using wealth equivalent variation (one-time transfer that yields gains of reform from duopoly to perfect competition) and expressed as a percent of GDP per capita. The measure is defined in equation 11.

6 Conclusion

The U.S. credit card industry is characterized by a large degree of market concentration, excess spreads, and excess return on assets (abnormal profits) relative to the banking industry. However, workhorse consumer credit models assume atomistic zero-profit lenders. We relax this assumption and propose a new model that incorporates imperfect competition in the credit market. Our model accounts for roughly half the excess spreads and abnormal profits observed in the data. Furthermore, we find that welfare gains from competitive reforms in this industry are equivalent to a onetime transfer of approximately 3.36 percent of GDP to the current population. Those with the lowest earnings or net assets are better off due to increased borrowing limits and decreased spreads. Those with the highest earnings or net assets are better off due to a higher savings interest rate.

Our model yields several policy implications. Lender market power harms all households across the income and wealth spectrum. This result implies that reforms which promote credit market competition would pass unanimously in the U.S. and yield significant welfare gains to all current and future cohorts of households. Likewise, efforts to increase competitiveness and prevent collusion between issuers and banks, such as increased antitrust enforcement, would also yield significant welfare gains to all current and future cohorts of households.

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A Appendix

A.1 Computational algorithm

- Define grid on spreads and borrowing limits: $(\tau_1, \bar{l}_1), \ldots, (\tau_N, \bar{l}_N) \in (\mathbb{R}_+, \mathbb{R}_+)^N$
- For each set of credit lines $S = \{(\tau_1, \bar{l}_1), \ldots, (\tau_N, \bar{l}_N)\} \in (\mathbb{R}_+, \mathbb{R}_+)^N\}$, solve for the stationary equilibrium:
  1. Guess aggregate capital $K(S)$ and total profits $\Pi(S)$
  2. Given aggregate capital and total labor (exogenous), back out wage rate $w(S)$ and interest rate $r(S)$
  3. Given set of credit lines, total profits, interest rate, and wage rate, solve consumer's problem through value function iteration
  4. Given policy functions, simulate economy and solve for stationary distribution of $\Omega(i, \epsilon, z, a; S)$ where $\Omega : \{g, b\} \times \mathbb{R}_+ \times \mathbb{R}_+ \times \mathbb{R} \to [0, 1]$
  5. Given stationary distribution, update aggregate capital and total profits
  6. Repeat 2-5 until convergence
- Solve for monopoly, duopoly, and perfect competition outcome
  - Monopoly: pick spread and borrowing limit that maximizes total profits
  - Duopoly: solve for best response function of the second mover for all spreads and borrowing limits of the first mover, $(\tau^1, \bar{l}^1) \in (\mathbb{R}_+, \mathbb{R}_+)$. Pick first mover's spread and borrowing limit that maximizes her profits
  - Perfect competition: solve for set of credit lines that maximizes the welfare of an unborn agent subject to weakly positive profits on all credit lines

For transitions, we guess a sequence of aggregate capital and total profits. Given the sequence of aggregate capital, we back out sequences for both the interest rate and wage rate. We use backward induction to solve for consumer's problem. Given policy functions, we simulate the economy, which gives a new sequence for aggregate capital and total profits. We iterate until convergence.

B Data Appendix

B.1 Identifying Credit Card Banks

We follow Grodzicki (2017) and in each year, we identify banks as being a "Credit Card Bank" if they are in the top 25 holders of credit card assets (`RCFD2008` which we call `creditcards`) for the first quarter of that year.

B.2 Computing Return on Assets

Following Grodzicki (2017), we calculate return on assets for bank i in year t according to the following formula

$$\begin{aligned} \texttt{ROA}_{it} &= \frac{\texttt{RIAD4000}_{it} + \texttt{RIAD4230}_{it} - (\texttt{RIAD4635}_{it} - \texttt{RIAD4605}_{it})}{\texttt{RCFD2170}_{it} - \texttt{RCFD2143}_{it}} \\ &= \frac{\texttt{income}_{it} + \texttt{loanleaseloss}_{it} - (\texttt{chargeoffs}_{it} - \texttt{loanrecoveries}_{it})}{\texttt{assets}_{it} - \texttt{intangible}_{it}} \end{aligned} \tag{12}$$

Note that since the `RIAD` series is year-to-date income, we use the third quarter data for all income variables, and the first quarter data for the asset variables `assets` and `intangible`, as in Grodzicki (2017). This measure of profitability should not be interpreted as annual ROA, but rather as a general measure of profitability. We compute for each year the average ROA for both credit card banks and non-credit card banks. For credit card banks, we weight by credit card assets. For non-credit-card banks, we weight by total assets. Table 12 includes the computed ROA series.

Table 12: Return on Assets, 1990 to 2018 (Source: Call reports)

Year	Return on Assets, All Banks (ROA-All)	Return on Assets, Top 25 CC Banks (ROA-CC)	Spread: ROA-CC Minus ROA-All
1990	6.71%	15.08%	8.37%
1991	6.14%	15.06%	8.92%
1992	5.31%	14.58%	9.27%
1993	5.12%	14.88%	9.76%
1994	4.89%	15.07%	10.19%
1995	5.44%	15.21%	9.77%
1996	5.38%	15.20%	9.82%
1997	5.59%	14.69%	9.10%
1998	5.42%	15.34%	9.93%
1999	5.71%	17.62%	11.91%
2000	5.68%	17.79%	12.12%
2001	6.07%	15.45%	9.38%
2002	5.31%	13.39%	8.08%
2003	4.85%	11.15%	6.30%
2004	4.29%	9.70%	5.41%
2005	5.31%	10.14%	4.82%
2006	5.66%	11.99%	6.33%
2007	6.05%	13.45%	7.39%
2008	5.21%	12.69%	7.47%
2009	4.90%	10.91%	6.01%
2010	4.42%	6.92%	2.50%
2011	4.35%	6.92%	2.57%
2012	4.12%	6.63%	2.51%
2013	3.49%	6.59%	3.10%
2014	3.32%	6.60%	3.28%
2015	3.20%	5.90%	2.70%
2016	3.41%	5.73%	2.32%
2017	3.74%	5.96%	2.22%
2018	3.92%	7.75%	3.83%

Notes. See text for details of series construction.