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CARD INDUSTRY

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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 perfectly 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 20 to 50 percent of the spreads observed in the data. Welfare gains from competitive reforms in the 1970s are equivalent to a one-time transfer worth between 0.24 and 1.66 percent of GDP. Along the transition path, 93 percent of individuals are better off. Poor households benefit from increased consumption smoothing, while rich households benefit from higher general equilibrium interest rates on savings. Transitioning from 1970 to 2016 levels of competition yields welfare gains equivalent to a one-time transfer worth between 1.87 and 3.20 percent of GDP. Lastly, homogeneous interest rate caps in 2016 deliver limited welfare gains.

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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 refuted repeatedly (see a summary of arguments by [Schmitz \(2012\)](#)). Recent work by [Schmitz \(2016\)](#) argues 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 with default 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 monopolistic credit card pricing. We study policies that have recently been discussed in the context of mitigating credit market power, and find that a homogeneous cap on lender spreads delivers a small fraction of the gains from competitive pricing.

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 develop a model with a finite number of credit card banks that imperfectly compete to issue non-exclusive credit lines.

We use our framework to measure the distributional consequences of changes in credit market power between 1970 and 2016. During this time period, several landmark competitive reforms, including the abolition of exclusivity rules and the 1978 Marquette decision, generated higher inter-regional competition among lenders. We model these reforms in two ways: increased lender entry and competitive pricing. These two exercises provide benchmark estimates and upper bounds, respectively, on the welfare gains that arise from eliminating credit market power. In the 1970s we do not allow lenders to price discriminate, which is consistent with existing empirical evidence. The welfare gains from adding another lender in the 1970s are equivalent to a one-time transfer worth 0.24 to 0.38 percent of GDP, depending on the way the lenders compete. Gains from perfectly competitive credit card pricing in the 1970s are equivalent to a one-time transfer worth 1.66 percent of GDP to U.S. consumers. During the transition from a monopoly to a duopoly, 93 to 96 percent of individuals alive at the time of the transition are better off. We find that the poorest U.S. households gain from better consumption smoothing, whereas the richest households gain from greater interest rates on savings due to general equilibrium effects.

To capture credit scoring and other technological innovations in the 1980s and 1990s, we allow lenders to price discriminate by earnings when we consider the transition path from 1970 to 2016 levels of competition. We find that transitioning from 1970 to 2016 levels of competition yields welfare gains equivalent to a one-time transfer worth 1.87 percent of GDP, whereas transitioning to competitive pricing yields a welfare gain worth 3.20 percent of GDP. Despite significant gains from perfectly competitive

pricing by lenders, household earnings heterogeneity limits the ability of interest rate caps to deliver those gains. Our estimated model implies that no homogeneous cap on lender spreads can simultaneously make high- and low-income individuals better off in 2016. In particular, caps on lender spreads that are too tight hurt low-income households the most because lenders tighten credit limits.

We begin by documenting several features of the U.S. credit card industry. First, the credit card market has been concentrated from its inception to the present. During the 1960s and 1970s, the founding banks of Visa, Mastercard, and American Express enjoyed limited regional competition, colluded on prices ([Knittel and Stango \(2003\)](#)), and did not pass through declining costs of funds to individuals ([Ausubel \(1991\)](#) and [Grodzicki \(2019\)](#)). By 2016, nine credit card issuers, such as Citigroup, JP Morgan, Capital One, and Bank of America, accounted for 86 percent of outstanding revolving credit. 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. We refer to these large spreads as excess spreads. A consequence of these excess spreads is abnormal profits. Following [Ausubel \(1991\)](#) and [Grodzicki \(2019\)](#), we show that the average rate of return on assets for the largest 25 credit card banks is 6.2 percentage points higher than that of the banking industry as a whole between 1990 and 2018.¹ Third, the credit card industry has been the subject of numerous antitrust lawsuits throughout its existence.

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 in small open economies (e.g., [Wasmer and Weil \(2004\)](#), [Drozd and Nosal \(2008\)](#), [Petrosky-Nadeau and Wasmer \(2013\)](#), [Galenianos and Nosal \(2016\)](#), [Herkenhoff \(2017\)](#), and [Raveendranathan \(2019\)](#)). 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. After estimating our model to match key credit card market moments, we show that the benchmark non-competitive model accounts for 20 to 50 percent of the observed excess spreads in the credit card industry between 1970 and 2016.

We first measure the welfare gains of replacing the regional monopolies that prevailed in the late 1960s and early 1970s with duopolies. This experiment is designed to capture increasing – yet still limited – competition among credit card issuers following the Marquette decision and the abolition of exclusivity rules. This time period predates the widespread adoption of credit scoring, and so we assume lenders cannot price discriminate (e.g., [Livshits, MacGee, and Tertilt \(2016\)](#)), an assumption we relax in later time periods. Moving from monopoly to duopoly lowers excess spreads by nearly 40 percent. We find that transitioning from a credit card monopoly to a duopoly generates aggregate gains to those living at the time of the transition that are equivalent to a one-time transfer worth between 0.24 and 0.38 percent of GDP. The range of gains depends on how the duopolists compete. During the transition from monopoly to duopoly, 93 to 96 percent of consumers are weakly better off. The lending sector remains profitable

¹The average rate of return on assets refers to interest and non-interest income net of charge-offs normalized by total assets.

throughout the transition and the default rate rises as borrowing increases. Measuring the distributional consequences of greater lender entry in the 1970s, we find that duopoly generates welfare gains among consumers in the lowest earnings decile equivalent to a one time transfer worth 4 to 6 percent of their annual earnings. Poor individuals benefit from the ability to borrow more at a cheaper rate. High earners also benefit from higher interest rates on savings in general equilibrium.

Our second exercise is to measure the welfare gains from perfectly competitive pricing in the 1970s. We define perfectly competitive pricing as the credit card spread and credit card limit that maximize newborn consumer welfare subject to weakly positive profits. Because monopolists restrict quantity and raise prices, spreads fall and credit limits expand in the competitive economy. Relative to the gains from additional lender entry, we find that perfectly competitive pricing in the 1970s generates gains that are roughly 4-7 times larger. The aggregate gains to contemporary cohorts from competitive pricing are equivalent to a one-time transfer worth 1.66 percent of GDP. Half of the gains come from lower spreads, the other half from greater credit limits. These gains primarily accrue to low- and high-earning households. Those in the lowest decile of the earnings distribution require a one-time transfer worth 25 percent of their annual earnings to be indifferent between monopolistic and competitive pricing.

Our third exercise is to measure welfare gains generated as the economy moves from duopoly in the 1970s to a nine lender oligopoly in 2016. Unlike in our earlier experiments, we allow lenders to explicitly price discriminate by permanent earnings levels. We find individuals with high permanent earnings gain the most from lender entry, whereas gains among individuals with low permanent earnings are largely unresponsive. Since low-earning individuals default at a higher rate, lenders offer very restrictive credit limits independent of competition. In terms of welfare, high-earning individuals require a transfer worth 4.9 percent of GDP per capita to be as well-off in an economy with a duopoly instead of a nine lender oligopoly whereas low-earning individuals only require a transfer worth 0.3 percent of GDP per capita. While the majority of welfare gains come from increased limits, two forces affect the way oligopolists change their spreads in response to entry: (1) increased competition tends to lower spreads, and (2) debt dilution tends to raise spreads. Initially the competition effect wins, generating lower spreads and higher limits. However, we find that the additional gains of adding more than nine lenders are positive but quickly diminishing. The reason for this is that the second effect of debt dilution eventually puts upward pressure on spreads. Lenders understand that the consumer can borrow more from another lender ex-post, and so the lenders increase their interest rates ex-ante to reflect this threat of debt dilution.

Our fourth exercise is to measure welfare gains from perfectly competitive pricing in 2016. Unlike in our 1970s exercises, we allow for price discrimination by permanent earnings when computing perfectly competitive prices. Aggregating across individuals, the welfare gains of moving from duopoly in 1970 to perfectly competitive pricing in 2016 are equivalent to a one-time transfer worth 3.20 percent of GDP. Similar to the 1970s, we find significant gains from competitive pricing in 2016.

Consequently, we consider a policy that has been discussed recently in the context of credit market power: homogeneous caps on lender spreads. We find that a cap on spreads could, at most, yield one-third of the welfare gains from competitive pricing. Moreover, the cap that generates the largest welfare gain would leave low-earning households worse off. Caps that are too tight can generate welfare losses

among low-earning households since they will face tighter credit limits. More generally, any one-size-fits-all cap on lender spreads generates welfare losses among either high- or low-earning individuals.

Literature. 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 \(2017\)](#), and [Raveendranathan \(2019\)](#)). What makes the search models of the credit market tractable are the assumptions of atomistic lenders, free entry, and a small open economy. There is also a relatively new and innovative literature in Industrial Organization that generates monopoly power among credit card lenders using discrete choice frameworks ([Grodzicki \(2015\)](#), [Nelson \(2018\)](#), and [Galenianos and Gavazza \(2019\)](#)). What makes [Grodzicki \(2015\)](#) and [Nelson \(2018\)](#) tractable is the partial equilibrium nature of the models and exogenous default. Our paper is closest to [Galenianos and Gavazza \(2019\)](#), who develop and estimate a static search model of lending that they use to study welfare implications of interest rate caps. 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 limits and greater competition in the credit market (e.g., [Livshits et al. \(2016\)](#), [Grodzicki \(2019\)](#), and [Sánchez \(2018\)](#)). While early contributions such as [Ausubel \(1991\)](#) document a lack of competition in the credit market throughout the 1970s and 1980s, [Grodzicki \(2019\)](#) 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 quantitatively 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., as the market moves from monopoly and duopoly in the 1970s to oligopoly in the 2000s), our competitive structure generates increases in credit access and defaults that likely complement 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 the 2000s are significant despite greater 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 \(2017\)](#), [Raveendranathan \(2019\)](#), and [Braxton, Herkenhoff, and Phillips \(2018\)](#)). [Drozd and Nosal \(2008\)](#), [Raveendranathan \(2019\)](#), 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 [Bizer and DeMarzo \(1992\)](#), [Hatchondo and Martinez \(2018\)](#), and [Kovrijnykh, Livshits, and Zetlin-Jones \(2019\)](#), consider borrowing without commitment. Closest to us is [Hatchondo and Martinez \(2018\)](#), who consider one-period loans without commitment. In these environments, the borrowing contracts resemble credit lines because the amount borrowed – capped by a limit – does not affect a consumer’s interest rate. Our contribution to this literature is to incorporate non-exclusive credit lines into a Bewley-Huggett-Aiyagari economy with default.

Our model is also related to the quantitative banking literature (e.g., [Corbae, D’erasmo, et al. \(2011\)](#)

and [Corbae and D’Erasmus \(2019\)](#)) and the partial equilibrium industrial organization banking literature (e.g., [Egan, Hortaçsu, and Matvos \(2017\)](#), [Wang, Whited, Wu, and Xiao \(2018\)](#), and [Benetton \(2018\)](#)). Of particular note, [Corbae and D’Erasmus \(2019\)](#) 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.

Lastly, our model contributes to a recently growing macroeconomic literature that attempts to quantify the welfare consequences of market power and strategic interactions (e.g., [Mongey \(2017\)](#), [Edmond, Midrigan, and Xu \(2018\)](#), [Baqae and Farhi \(2017\)](#), and [Berger, Herkenhoff, and Mongey \(2019\)](#)).

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 beginning 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., was founded in California in 1958 and only began franchising the program to other banks in 1966. Part of the franchise agreement was the restriction that banks could only issue Visa cards (often called *exclusivity*), 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. The predecessor to Mastercard was a “cooperative” of banks which began expanding around the same time period. Nonetheless, the programs were quite 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

Several important court cases and academic studies have argued that the credit card market was non-competitive throughout the 1970s and 1980s. We discuss evidence regarding (i) the lack of competition of

networks across regions and the inability of banks to issue competing network cards, (ii) network rules preventing competitive new-entrant credit cards from being issued, and (iii) evidence of interest rate collusion among 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 among 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 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. The company 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. Although Sears owned MountainWest Financial, a Visa member bank, Visa prohibited Sears from issuing the card. Visa adopted a new rule banning Visa membership 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. According to [Wildfang and Marth \(2005\)](#), legal scholars believe 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 quoted industry analyst 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 among issuing banks were widespread. Wells Fargo and First Interstate Bank of California were sued by the California Attorney General for interest rate fixing on millions of credit cards ([White \(1992\)](#)). The two banks ultimately settled the case for \$55 million, 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 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 little publicly available data exists 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) no inter-regional competition, (ii) lawsuits establishing non-competitive behavior, including the blocking of competitive new entrant credit cards, and (iii) academic and legal cases arguing that there was widespread price collusion, motivate our modeling assumption of the early 1970s as a monopoly.

The main exercise in this paper is to measure the welfare gains from competitive reforms. In addition to the *Worthen* and *MountainWest* cases, which led to greater competition, one particularly prominent competitive reform occurred in 1978 when the Supreme Court unanimously determined that state-level usury laws (interest rate caps) were not legally binding for nationally chartered banks (e.g., [Evans and Schmalensee \(2005\)](#)). This decision was the result of *Marquette Nat. Bank of Minneapolis v. First of Omaha Service Corp.* (1978). Prior to the Marquette decision, states with relatively tight usury laws faced limited competition. After the Marquette decision, these credit card markets became nationally contested. The Marquette decision facilitated the opening of inter-regional competition among lenders. We model the Marquette decision, as well as reforms spurred by the *Worthen* and *MountainWest* cases, as increasing competition in the credit card market.

2.2 Indicators of Competitiveness in the 2000s

We document the following features of the credit card industry in the 2000s: (i) it is highly concentrated; (ii) even after adjusting for default risk, operational cost, 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 is still sued repeatedly for antitrust violations.

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, and 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 in 2016, three payment networks (Visa, American Express, Master Card) accounted for 96 percent of credit card purchase volume. The issuing banks founded and still jointly own (to varying degrees) the main payment networks, Visa and Mastercard, whereas American Express is a

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

vertically integrated issuer and payment network. Since issuers own significant portions of the payment networks, and as we discuss in Appendix C.3, the payment networks and issuers have been repeatedly sued for colluding, it is difficult to treat the price setting decisions of these institutions separately. 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 a range of cases in our quantitative analysis.

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

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 break-even. Let τ_{zero} denote the zero-profit spread, let D denote the charge-off rate, let B denote outstanding revolving credit, let r denote the Moody's Aaa rate, and let τ_o denote the transaction cost net of non-interest income. τ_o is computed as follows: (operational cost + rewards and fraud - fees income - interchange income)/(outstanding revolving credit). Note that interchange income accrues to the issuing bank (e.g., Bank of America), not to the network (e.g., Visa).² Given D , B , r , and

²Visa and Mastercard 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. A common misconception is that these fees go to Visa and Mastercard because Visa and Mastercard set these fees. These interchange fees are tied to the generosity of the

τ_o , the zero-profit spread is estimated from the following break-even equation:

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

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, Chomsisengphet, Mahoney, and Stroebel (2015). The negative τ_o implies that the credit card industry makes profits even if we ignore interest income.

Figure 1 plots the credit card industry’s interest rate minus the break-even spread. This measure of *excess spread* is positive every year from 1974 to 2016 if non-interest income is accounted for. Even ignoring non-interest income yields significant spreads that have only marginally declined since the 1970s. Table 3 shows that the average spread on credit cards is 3.42 percentage points above break-even if we ignore transaction costs net of non-interest income and 8.84 percentage points above break-even if we include transaction costs net of non-interest income. This implies a markup of 44-115 percent on the Moody’s Aaa rate.

Table 3: Credit card industry excess spreads (source: authors’ calculations, see text)

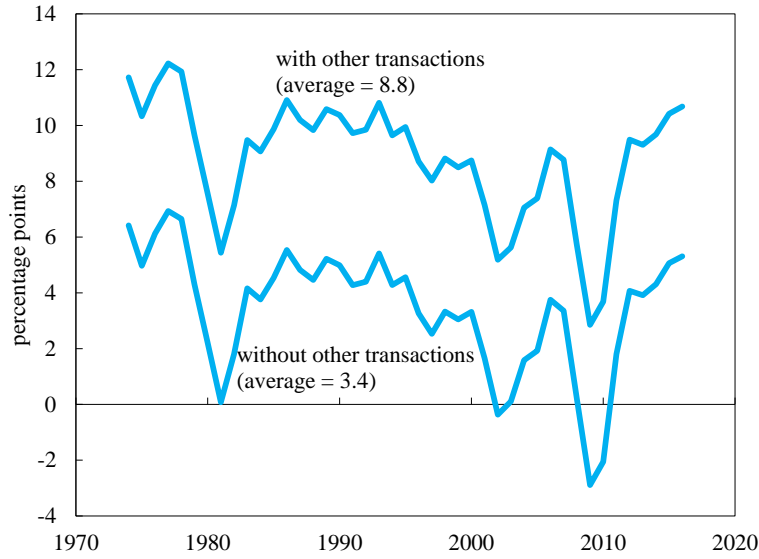
Excess spread	Average, 1974-2016 (percentage points)
Excluding other transactions	3.42
Including other transactions	8.84

Notes. Excess spread ‘Excluding other transactions’ is defined to be $\tau_{actual} - \tau_{zero}^{ex}$ where τ_{zero}^{ex} is defined by $(1 - D)B(1 + r + \tau_{zero}^{ex}) = B(1 + r)$. Excess spread ‘Including other transactions’ is defined to be $\tau_{actual} - \tau_{zero}$ where τ_{zero} is calculated from equation 1. See text for details.

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 on assets (ROA). Following Grodzicki (2019), the average rate of return for a bank is computed as interest and non-interest income net of charge-offs normalized by assets (see Appendix C for details). Excess profits are computed as the difference between the average (asset-weighted) return on assets for the 25 largest credit card banks and the average (asset-weighted) return on assets for all banks. In Table 4, we report estimates from the literature. Existing estimates imply that the average rate of return on assets for the largest 25 credit card banks is 5.0 to 7.3 percentage points higher than that of the banking industry. Figure

rewards program that the issuing banks choose. Cards that provide greater rewards can charge higher interchange fees. The fact that these fees, set by networks, scale with rewards suggests a lack of separation between networks and issuing banks. 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. See Hunt (2003) for more discussion.

Figure 1: Credit card industry excess spreads (source: authors' calculations, see text)



Notes. Excess spread defined to be $\tau_{actual} - \tau_{zero}$. Break-even spread τ_{zero} calculated from equation 1. Actual spread is difference between Flow of Funds (FoF) credit card interest rate and Moody's Aaa rate. See text for details.

2 plots an updated time series of return on assets for the 25 largest credit card banks. Panel (A) plots the average return on assets of the 25 largest credit card issuing banks as well as the banking sector on average. Panel (A) illustrates that the return on assets is positive in every year from 1990 through 2018 and higher among credit card issuing banks. Panel (B) plots the difference in return on assets between credit card banks and the banking sector average. The average return on assets of credit card banks is 6.2 percentage points higher than that of the banking sector over this time period.

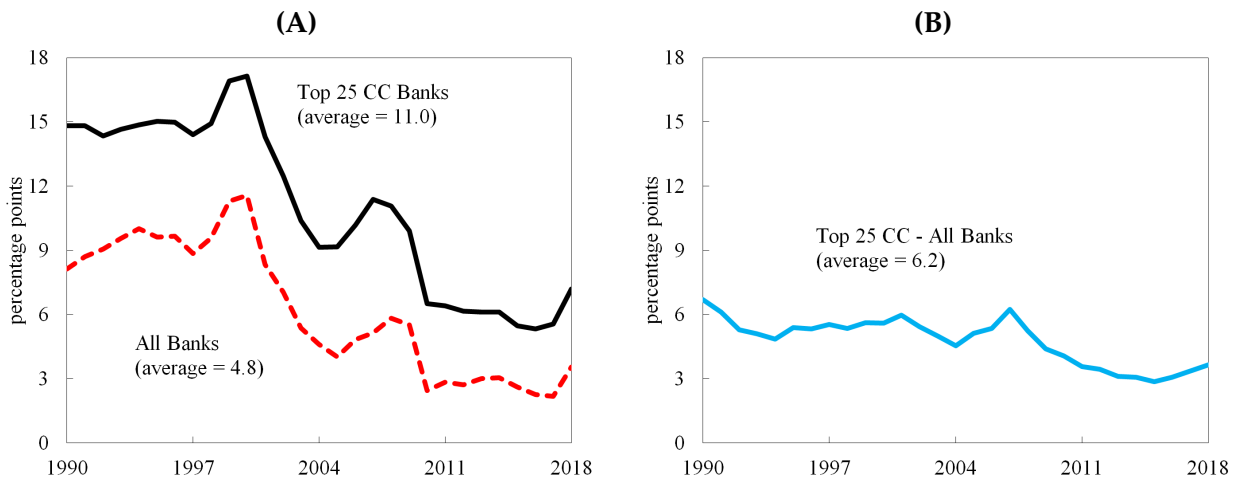
Table 4: Credit card industry excess profits

Year	Source	Avg. ROA (asset weighted): 25 large CC banks - all banks
1984-88	Ausubel (1991)	5.7
1990	Grodzicki (2019)	7.3
2008	Grodzicki (2019)	5.0

The fourth defining feature of the U.S. credit card industry is antitrust violations. The banks and payment networks have been sued repeatedly for non-competitive practices. Table 15 in Appendix C.3 describes a small sample of U.S. cases that have recently been brought against the credit card payment networks and issuer banks for collusion on prices (interchange fees) and collusion to block entry of new technologies and new competitors.

Here we highlight three important cases. The first case is about limiting competition among incumbents. In 2004, the major payment networks were sued for blocking member banks from issuing cards

Figure 2: Return on assets (ROA), 25 largest credit card banks vs. banking average



Notes. See appendix C for details.

that operated on competing payment networks. The major networks lost three key cases and were ordered to pay billions in penalties in each instance. 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 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 were ordered to 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.

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, model a finite number of non-atomistic credit card firms that issue non-exclusive credit lines. We use the model to quantify the welfare gains and losses from competitive reforms in the credit card industry (since the 1970s and in the future).

3 Model

Our model economy shares many elements with existing general equilibrium, competitive models of consumer credit, in particular [Livshits, MacGee, and Tertilt \(2007\)](#) and [Chatterjee, Corbae, Nakajima, and Ríos-Rull \(2007\)](#). We build on [Livshits et al. \(2007\)](#) and [Chatterjee et al. \(2007\)](#) 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 ($t = 0, 1, \dots$). 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 of this paper, the value functions, policy functions, and prices 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 \(2019\)](#) 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 (e.g., [Auclert and Mitman \(2018\)](#) and [Chatterjee, Corbae, Dempsey, and Rios-Rull \(2019\)](#)). 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 (stigma).

The consumer's idiosyncratic state is given by their credit standing $i \in \{g, b\}$, permanent earnings ability $\theta \in \{\theta_L, \theta_H\} \equiv \Theta \subset \mathbb{R}_+$, a persistent earnings shock $\eta \in \mathbb{R}_+$, an iid 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 η is persistent and follows a Markov chain, whereas ϵ is perfectly transitory. Positive values of a indicate saving, whereas negative values of a indicate borrowing. The state of a consumer is therefore given by the tuple, $(i, \theta, \eta, \epsilon, a)$. We define the distribution of consumers across states as $\Omega(i, \theta, \eta, \epsilon, a)$ where $\Omega : \{g, b\} \times \Theta \times \mathbb{R}_+ \times \mathbb{R}_+ \times \mathbb{R} \rightarrow [0, 1]$.

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 $\tau \in \mathbb{R}_+$ over the general equilibrium risk-free rate $r \in \mathbb{R}_+$ 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 discussed 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.³ Let j denote the credit card interest rate ranking of a credit line, where $j = 1$ is the lowest credit card interest rate and $j = N$ is the highest credit card interest rate. Therefore, the credit lines can be sorted in ascending order with respect to the spreads ($\tau_1 \leq \tau_2 \leq \dots \tau_j \leq \dots \leq \tau_N$) and the corresponding borrowing limits ($\bar{l}_1, \bar{l}_2, \dots, \bar{l}_N$), ignoring the issuing credit card firm's identity. With this notation, the set of credit lines available is $S = \{(\tau_1, \bar{l}_1), \dots, (\tau_N, \bar{l}_N)\} \in (\mathbb{R}_+, \mathbb{R}_+)^N$. 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 credit card interest rate ranking $j \in \{1, \dots, N\}$:

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

If net assets are less than or equal to the sum of the borrowing limits on credit lines $\{1, \dots, j\}$, 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 $\{1, \dots, j-1\}$ 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 3 provides an example of the spreads and limits consumers face with three lenders, $N = 3$. They borrow from the lowest spread first, τ_1 , then the next lowest, τ_2 , and lastly, τ_3 . The total principal and interest expense incurred on the lowest spread credit card is $(1 + r + \tau_1)a_1(a)$, the next lowest spread $(1 + r + \tau_2)a_2(a)$, and lastly, $(1 + r + \tau_3)a_3(a)$. More generally, since $\sum_{j=1}^N a_j(a) = a$, the principal and interest expense of a household can be written $(1 + r)a + \sum_{j=1}^N \tau_j a_j(a)$.

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

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

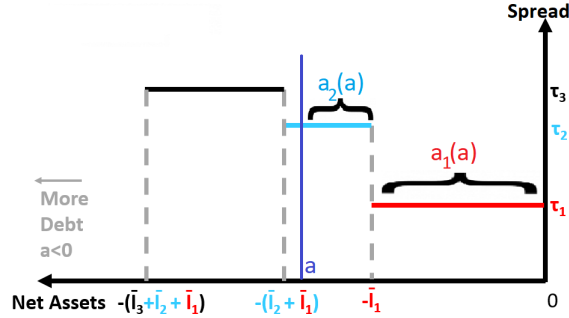
Since ζ_D and ζ_R were assumed to be Gumbel with a common inverse scaling parameter κ , we can express the default probability as follows:

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

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,

³This is an equilibrium outcome in our model because there are no switching costs. This keeps the model tractable.

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



Notes: Non-calibrated example with three lenders and three credit lines. More negative net asset positions imply greater debt. The function $a_j(a)$ allocates net assets a most efficiently across the credit lines ordered by spreads τ_j . Consumers first max-out credit card 1 with the lowest spread τ_1 . If they borrow more than \bar{l}_1 , they then begin borrowing from the credit card with the second lowest spread, τ_2 etc.

consumption, and savings/borrowing — $p(\cdot), c(\cdot), a'(\cdot)$ — are functions of $(i, \theta, \eta, \epsilon, a)$. However, we omit this state dependence of policy functions for ease of exposition.

A consumer who defaults consumes labor earnings and profits, $w\theta\eta\epsilon + \Pi$, where w refers to the wage rate and Π refers to the profits uniformly transferred to consumers from credit card firms (in Section 7 we consider alternate distributions of profits). 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:

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

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:

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

Because of the taste shock for default, consumers in bad standing ($i = b$) may redefault, a common occurrence in the data (Athreya, Mustre-del Río, and Sánchez (2019)). Because of the taste shocks, de-

faults may occur with a balance of zero net assets or greater. We interpret the data analogue of these defaults to be shocks which are not modeled explicitly in our framework, such as divorce, health shocks, or lawsuits. 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:

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

Compared to the consumer problem with good standing (4), the budget constraint for those in bad standing 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 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, $i \in \{g, b\}$, and they only issue credit lines to those in good standing. When we consider later time periods in Section 3.2, we allow for price discrimination with respect to permanent earnings, θ .

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 $k \in \{1, \dots, N\}$. 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 credit card interest rate ranking of a lender. Lender k 's objective is to choose the terms of their credit line, (τ^k, \bar{l}^k) , to maximize their net present value of profits, π_t^k , discounted at rate r_t :

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

When we consider transition dynamics, the time path of r_t will matter for lender pricing decisions. For the rest of this section, we will omit time subscripts from the lender's problem and focus on steady states of the model economy. Since lenders commit to credit lines, the lender's steady state objective is equivalent to maximizing per-period profits π^k .

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

profits resulting from offering the j^{th} highest credit card interest rate are given by Π_j :

$$\Pi_j = \int \left[- (1 - p(g, \theta, \eta, \epsilon, a)) \tau_j a_j(a) + p(g, \theta, \eta, \epsilon, a) (1 + r) a_j(a) \right] d\Omega(g, \theta, \eta, \epsilon, a) \quad (7)$$

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 $k \in \{1, 2, \dots, N\}$ chooses spread τ^k and borrowing limit \bar{l}^k . Let $j(\tau^k, \tau^{-k})$ be a function that maps τ^k and $\tau^{-k} = (\tau^1, \dots, \tau^{k-1}, \tau^{k+1}, \dots, \tau^N)$ to the rank of τ^k when the spreads are sorted in ascending order, $j : \mathbb{R}_+ \times \mathbb{R}_+^{N-1} \rightarrow \{1, \dots, N\}$. 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:

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

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) credit card 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 credit card interest rate $\tau^1 < \tau^2$, then $j(\tau^1, \tau^2) = 1$. Firm 1's credit line offers the lowest credit card interest rate in the economy and therefore it is ranked first in terms of credit card interest rates. When consumers borrow, they will borrow on firm 1's credit line before borrowing on any other credit line.

Forms of lender competition. When we analyze competitive reforms, we consider four forms of competition: (i) *Monopoly* ($N = 1$), (ii) *Stackelberg* competition, (iii) *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 (iv) *Perfect Competition*. We numerically characterize lender behavior for each of these forms of competition in Section 5.

Lender entry costs. When we consider the transition path, we must make assumptions regarding lender entry costs. Our benchmark model assumes zero lender entry costs. However, in Section 7, we impose up-front lender entry costs equal to the net present value of profits. Since there was profitable

lender entry between 1970 and 2016, we view this robustness exercise as providing an upper bound on lender entry costs. We show that these costs have second-order effects on welfare compared to the gains from increased competition.

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 $\Omega(i, \theta, \eta, \epsilon, a)$, a wage rate w , a risk-free interest rate r , total profits Π , a repayment/default policy function $p(i, \theta, \eta, \epsilon, a)$, a consumption policy function $c(i, \theta, \eta, \epsilon, a)$, a savings/borrowing policy function $a'(i, \theta, \eta, \epsilon, a)$, 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 $p(i, \theta, \eta, \epsilon, a)$, $c(i, \theta, \eta, \epsilon, a)$, and $a'(i, \theta, \eta, \epsilon, a)$ solve the consumer's problem in (2), (4), and (5).
- (ii) for $k \in \{1, 2, \dots, N\}$, $\{\tau^k(\cdot), \bar{l}^k(\cdot)\}_{k=1}^N$ 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 $\Omega(i, \theta, \eta, \epsilon, a)$ is consistent with the policy functions $p(i, \theta, \eta, \epsilon, a)$ and $a'(i, \theta, \eta, \epsilon, a)$, and the exogenous process for earnings.
- (v) labor market clears:

$$L = \int \theta \eta \epsilon d\Omega(i, \theta, \eta, \epsilon, a)$$

- (vi) capital market clears:

$$K = \int a d\Omega(i, \theta, \eta, \epsilon, a)$$

- (vii) final good market clears:

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

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 and many more lenders. In particular, we assume that lenders discriminate with respect to permanent earnings ability θ . To rule out complicated portfolio problems that 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, $S_\theta = \{(\tau_1(\theta), \bar{l}_1(\theta)), \dots, (\tau_N(\theta), \bar{l}_N(\theta))\} \in (\mathbb{R}_+, \mathbb{R}_+)^{N_\theta}$. For each type- θ consumer, the credit lines can be sorted in ascending order with respect to the spreads $(\tau_1(\theta) \leq \tau_2(\theta) \leq \dots \tau_j(\theta) \leq \dots \leq \tau_N(\theta))$ and the corresponding borrowing limits $(\bar{l}_1(\theta), \bar{l}_2(\theta), \dots, \bar{l}_N(\theta))$. Within each set of type- θ consumers, let j denote the credit card 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 credit card interest rate ranking $j \in \{1, \dots, N\}$ for a type- θ consumer:

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

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 ($a' \geq -\sum_{j=1}^N \bar{l}_j(\theta)$):

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

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 credit lines. For each lender $k \in \{1, \dots, N_\theta\}$ 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 r_t :

$$\sum_{t=0}^{\infty} \left(\frac{1}{1+r_t} \right)^t \pi_t^k(\theta)$$

As before, the time subscripts are relevant only along the transition path. We will focus on steady states in this exposition and drop the subscripts. Since lenders commit to credit card 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 credit card interest rate and borrowing limit of the lender offering the j^{th} highest credit card interest rate. The flow profits resulting from offering the j^{th} highest credit card interest rate are given by $\Pi_j(\theta)$:

$$\begin{aligned} \Pi_j(\theta) = \int \left[- (1 - p(g, \theta, \eta, \epsilon, a)) \tau_j(\theta) a_j(a, \theta) \right. \\ \left. + p(g, \theta, \eta, \epsilon, a) (1 + r) a_j(a, \theta) \right] d\Omega(g, \theta, \eta, \epsilon, a) \end{aligned} \quad (10)$$

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, Tam, and Young \(2012\)](#), [Livshits et al. \(2016\)](#) and [Sánchez \(2018\)](#). Within each set of type- θ lenders, we consider both (i) *Collusive-Cournot* and (ii) *Perfect Competition*. While indicators of competitiveness in credit markets have improved over time, e.g., [Grodzicki \(2019\)](#), we show that even after calibrating to the observed number of lenders in the data, *Collusive-Cournot* is still unable to generate observed spreads in 2016.

4 Calibration

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 1971-75 moments. As

discussed in Section 2.1.1, the credit card industry was characterized by (1) lack of inter-regional competition, (2) non-competitive behavior, including antitrust litigation regarding the blocking of competitive new entrant credit cards, and (3) alleged price collusion. Therefore, we calibrate the model assuming that there is *pure monopoly* ($N = 1$) in the 1970s as an approximation to the limited competition and regional monopolies during that time period.

We assume that each period corresponds to one year. Table 5 presents the parameters determined outside of the model equilibrium. We use standard estimates for the capital share ($\alpha = 0.33$), depreciation rate ($\delta = 0.045$), and risk aversion ($\sigma = 2$). The re-entry probability of good credit standing $\phi = .1$ is chosen such that it takes the average consumer 10 years to re-enter the credit card market upon default. The earnings process is taken from Storesletten, Telmer, and Yaron (2000) (Table 1, Panel D).⁴ We assume that permanent types are distributed such that $\ln(\theta) \sim^{idd} N(0, \sigma_\theta^2)$. We approximate this on a symmetric two-point distribution, yielding equal masses of agents at $\theta_H = 1.46$ and $\theta_L = 0.54$. We assume that the persistent component of income η follows an AR(1), $\ln(\eta') = \rho \log(\eta) + u$ where $u \sim^{idd} N(0, \sigma_\eta^2)$. Lastly, the perfectly transitory component is log normally distributed, $\ln(\epsilon) \sim^{idd} N(0, \sigma_\epsilon^2)$.

Table 5: 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 (10 year exclusion)	0.1
σ_θ^2	Variance permanent component θ	0.244
σ_η^2	Variance of innovation to AR(1) component η	0.024
σ_ϵ^2	Variance transitory component ϵ	0.063
ρ	Persistence of AR(1) component η	0.977

The remaining parameters $\{\beta, \chi, \kappa\}$ are estimated to target moments between 1971 and 1975. We estimate $\beta = 0.968$, which implies a discount rate of 3.31 percent per annum, to match the average real interest rate of 1.27 percent from 1971 to 1975.⁵ We calibrate stigma $\chi = 7.768$ to match the average charge-off rate of 2.57 from 1971-75, the earliest five years of available charge-off rate data (Ausubel, 1991). Since there are taste shocks, defaults may occur when agents have weakly positive net worth which we attribute to *unmodeled shocks*. We interpret the data analogue of defaults attributable to *unmodeled shocks* as the share of bankruptcies due to divorce, health, or lawsuits reported by Chakravarty and Rhee (1999). We therefore set $\kappa = .776$ so that the share of defaults in the model with weakly positive net worth coincides with the share of bankruptcies due to divorce, health, or lawsuits.

⁴The working paper version of Storesletten, Telmer, and Yaron (2004), since the working paper reports the relevant income process for our exercise.

⁵We measure this as the Moody's AAA rate less inflation implied by the NIPA GDP Deflator.

Table 6: Parameters determined jointly in equilibrium

	Parameter	Value	Target	Data	Model
χ	Stigma	7.768	Charge-off rate	2.57	2.43
κ	Scaling parameter	0.776	Fraction of bankruptcy due to divorce, health, lawsuits	44.81	45.19
β	Discount rate	0.968	Risk free rate	1.27	1.24

Notes: The charge-off rate is based on digitized data from the appendix of (Ausubel, 1991). Bankruptcy data statistics are based on the PSID and taken from Chakravarty and Rhee (1999). The fraction of bankruptcy due to divorce, health and lawsuits within model is the fraction of defaults that occur when an agent has weakly positive net worth. The risk-free rate is the Moody’s AAA rate less inflation implied by the NIPA GDP Deflator. See text for more discussion.

5 Gains from Inter-regional Competition: 1970s Monopoly to Duopoly

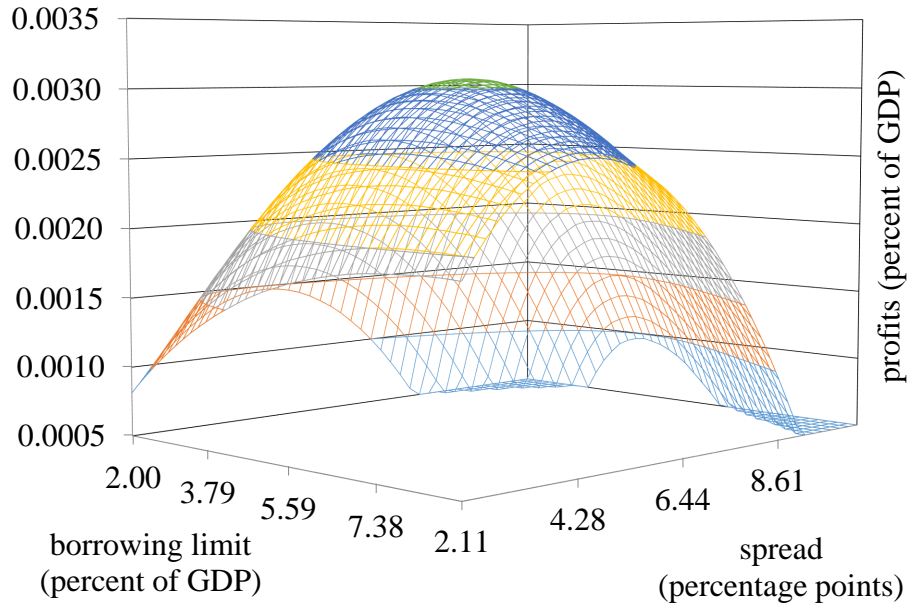
As discussed in Section 2.1.1, the 1970s credit card market was characterized by non-competitive behavior, but landmark cases challenging exclusivity and legal reforms such as the Marquette decision in 1978 facilitated inter-regional competition. While we do not explicitly have regions in our framework, we model these reforms as a transition from monopoly to a duopoly. We consider various forms of duopoly in the lending market and compute the distribution of welfare gains and losses along the transition path. These experiments are designed to measure the short- and long-run gains and losses associated with the transition from regional monopolies in the 1970s to greater, but still limited, inter-regional competition. To provide an upper bound on welfare gains from early reforms in the credit card market, we also measure outcomes along the transition path to perfectly competitive pricing.

5.1 Characterization of the Monopolist’s Problem

In this section, we numerically explore the properties of the monopolist’s problem. Figure 4 plots profits to the monopolist ($\pi^1(\tau^1, \bar{l}^1) = \Pi_1(\tau_1, \bar{l}_1)$) as a function of the spread τ^1 and the borrowing limit \bar{l}^1 . The monopolist maximizes profits at an interior spread and an interior borrowing limit. This is because if the monopolist chooses a low spread, then the profit margin is low, and hence, profits are low. If the monopolist chooses a high spread, then consumers will borrow less, leading to low profits. If the monopolist chooses a low borrowing limit, profits are low since there is limited borrowing. If the monopolist chooses a high borrowing limit, then profits are low (or losses are high) due to high default rates.

To understand why the profit function is concave and admits an interior solution, Figure 5 plots the monopolist’s optimal policy functions and corresponding profits. Panels (A) and (B) plot the limits that maximize profits and the corresponding profits as a function of the spread. Hence, the spread that maximizes profits in Panel (B) is the optimal contract. We see that for high values of the spread, the monopolist restricts the amount that can be borrowed by cutting limits. This is because for high values of the spread, the only agents who borrow are those who have realized extremely low earnings shocks, and so they default at a very high rate. Panels (C) and (D) plot the spreads that maximize profits and the

Figure 4: 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.

corresponding profits as a function of the limit. Hence, analogous to Panel (B), the limit that maximizes profits in Panel (D) is the optimal contract. In Panel (C), spreads increase as the credit limit declines. This feature is consistent with neoclassical models of monopoly where quantity restrictions raise prices.

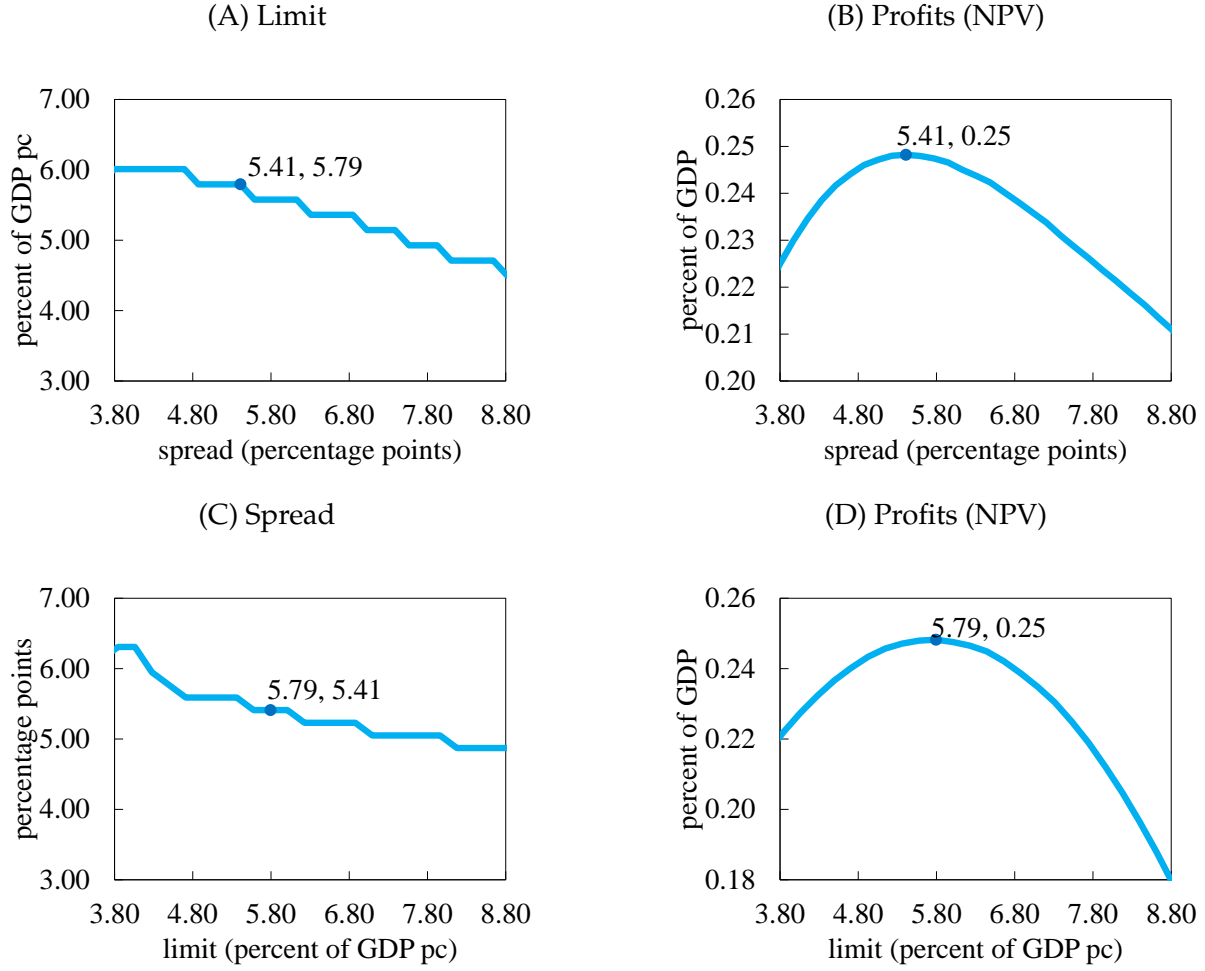
5.2 Non-targeted Moments

Before discussing the reforms, we show that the monopoly model does a reasonable job at approximating several of our key competitiveness indicators in the 1970s. Table 7 shows that the model generates a spread of 5.4 percentage points, accounting for more than 60 percent of the observed spreads in the data. The model generates an excess spread (the spread over and above the break-even spread) of 2.89 percentage points, accounting for more than 50 percent of the data. Hence, even with the most limited form of competition – pure monopoly – almost half of excess spreads remain unaccounted for.

The model produces a high bankruptcy rate of 0.10 percent per capita versus 0.06 percent in the data. We generate reasonable bankruptcy rates for two reasons: (1) the model features taste shocks over repayment and default, and (2) lender commitment to credit lines allows individuals to take high-default net asset positions without facing a steep profile of interest rates.

In terms of credit usage, the model's credit to GDP ratio is 0.11 percent versus 0.74 percent in the data. Unlike in partial equilibrium environments (e.g., [Livshits et al. \(2007, 2010\)](#), [Galenianos and Nosal \(2016\)](#), and [Raveendranathan \(2019\)](#)), lowering the discount factor does not increase credit in our general equilibrium framework. In general equilibrium, a lower discount rate increases the risk-free rate

Figure 5: Monopolist policy functions



Notes: Panel (A) plots the lender's optimal limit when their spread is fixed at the value on the x-axis. Panel (B) plots the lender's NPV profits as a percent of GDP when their spread is fixed at the value on the x-axis and the limit is allowed to freely adjust. Panel (C) plots the lender's optimal spread when their limit is fixed at the value on the x-axis and the spread is allowed to freely adjust. Panel (D) plots the lender's NPV profits as a percent of GDP when their limit is fixed at the value on the x-axis and the spread is allowed to freely adjust. Borrowing limits are expressed as a percent of GDP per capita. Spreads are expressed as percentage points over the savings interest rate.

decreasing the incentive for the consumer to borrow. Since credit markets are likely to have significantly affected U.S. savings rates since the 1970s (e.g., [Carroll, Slacalek, and Sommer \(2019\)](#) and [Herkenhoff \(2017\)](#)), our benchmark model is in general equilibrium. As robustness in Section 7, we consider the partial equilibrium version of our framework.

5.3 Monopoly to Stackelberg Duopoly

We assume there is a one-time, unexpected, and permanent change from monopoly to duopoly at date $t = 1$. The new entrant and incumbent compete as Stackelberg duopolists. Solving for an unrestricted

Table 7: Credit card market variables (1970s)

Variable (unit=percent)	Monopoly	Data	Source
Spread	5.41	8.48	Board of Governors & Author's Calc.(1974-1975)
Excess spread: actual - zero-profit	2.89	5.69	Board of Governors & Author's Calc. (1974-1975)
Bankruptcy rate	0.10	0.06	ABI (1971-1975)
Credit to GDP	0.11	0.74	Board of Governors & NIPA (1971-1975)
Borrowing limit to GDP per capita	5.79	—	—

Notes: See Section 2 for details on construction of the excess spread in the data. The excess spread in model is defined as $\tau_{avg} - \tau_{zero}$ where $\tau_{avg} = \sum_{j=1}^N \tau_j a_j(a) / \sum_{j=1}^N a_j(a)$ and $\tau_{zero} = D(1+r)/(1-D)$ where D is the economy-wide chargeoff rate.

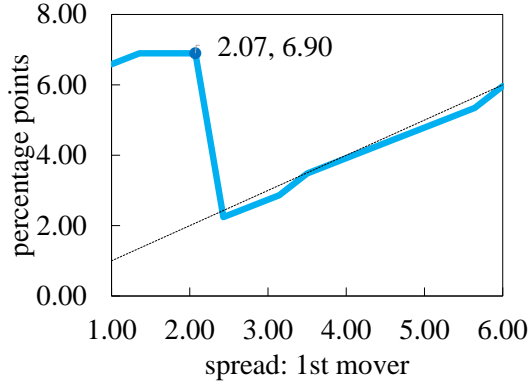
path of spreads and limits would be computationally infeasible. Therefore, we make the following restriction: at date $t = 1$, lenders reoptimize and commit to their new strategies. That is, strategies are restricted to be constant over time. The incumbent lender is the first mover and the new entrant is the second mover, without loss of generality. Let $\tau^{1'}$ and $\bar{l}^{1'}$ denote the first mover's new spread and new limit. Let $\tau^{2'}$ and $\bar{l}^{2'}$ denote the second mover's new spread and limit. At date $t = 1$, lenders choose their new limits and spreads $\{(\tau^{1'}, \bar{l}^{1'}), (\tau^{2'}, \bar{l}^{2'})\}$ to maximize the net present value of profits along the transition path given by (6). To understand the transition path from monopoly to Stackelberg duopoly in the 1970s, we first characterize each Stackelberg duopolist's optimal policy functions.

It is important to note that since lenders in our economy will offer both a price (interest rate) and a quantity constraint (borrowing limit), we cannot classify theoretically whether the interest rate and borrowing 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.

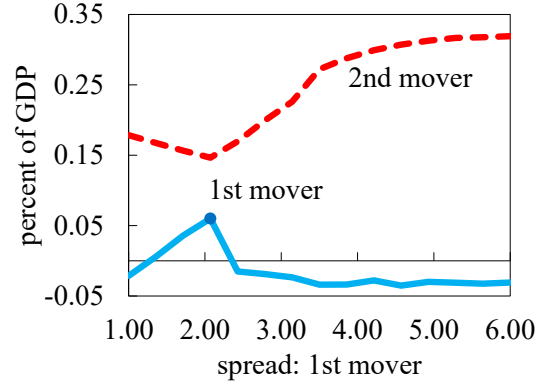
Let τ^{1*} and \bar{l}^{1*} be the spread and limit that maximize the first mover's profits. Figure 6 describes each Stackelberg duopolist's optimal spreads and limits. Panel (A) plots the second mover's best response of spreads to the first mover's spread $\tau^2(\tau^1, \bar{l}^{1*})$, holding fixed the first mover's limit at the profit maximizing limit. Panel (B) plots the corresponding profits for both the first mover and second mover. If the first mover commits to a large spread ($\tau^1 > 2.07\%$), the second mover will undercut the first mover and set τ^2 just below τ^1 , $\tau^2 = \tau^1 - \epsilon$ for arbitrarily small ϵ . In this region ($\tau^1 > 2.07\%$), spreads are strategic complements, $\frac{d\tau^2(\tau^1, \bar{l}^{1*})}{d\tau^1} \geq 0$. If the first mover increases their spread, the second mover also increases their spread and undercuts the first mover. This is typical in Stackelberg-Bertrand games. However, strategic complementarity of spreads does not hold for all first-mover spreads. There is a threshold at which the second mover's undercutting strategy is no longer profitable relative to the alternate strategy of charging a higher spread and becoming the second-ranked lender. For extremely low spreads, the second mover is made strictly better off by setting a high spread. The point that induces the second mover to abandon

Figure 6: Stackelberg policy functions

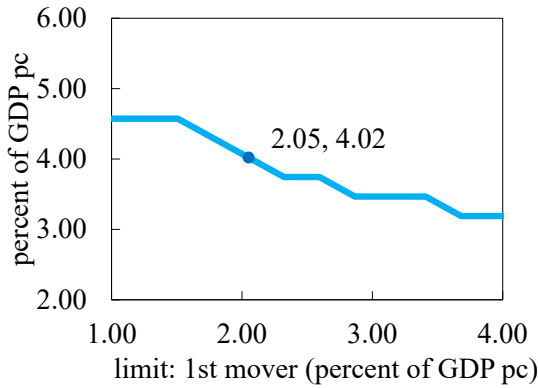
(A) 2nd Mover's Best Response Spread



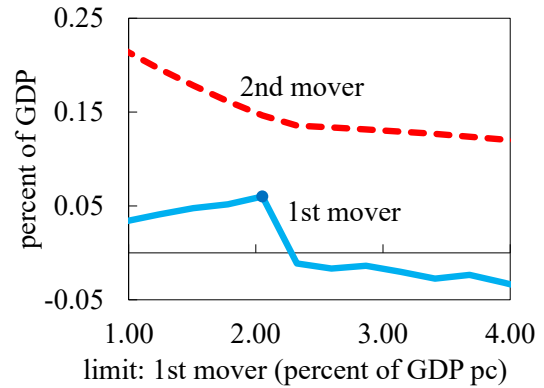
(B) Profits (NPV) by 1st Mover Spread



(C) 2nd Mover's Best Response Limit



(D) Profits (NPV) by 1st Mover Limit



Notes: Panel (A) plots the 2nd mover's best response function for spreads. This is the optimal spread of the 2nd mover given the 1st mover chooses the spread specified on the x-axis, holding the 1st mover's limit fixed at their optimum. Panel (B) plots the corresponding NPV profits of the 1st and 2nd mover. Panel (C) plots the 2nd mover's best response function for limits. This is the optimal limit of the 2nd mover given the 1st mover chooses the limit specified on the x-axis, holding the 1st mover's spread fixed at their optimum. Panel (D) plots the corresponding NPV profits of the 1st and 2nd mover. Borrowing limits are expressed as a percent of GDP per capita. Spreads are expressed as percentage points over the savings interest rate.

the undercutting strategy is the equilibrium in our calibration.⁶ Therefore, the equilibrium features the first mover setting a low spread and the second mover setting a high spread.

Panel (C) plots the second mover's best response of limits to the first mover's limit $\bar{l}^2(\tau^{1*}, \bar{l}^1)$, holding fixed the first mover's spread at the profit maximizing spread. Analogous to Panel (B), Panel (D) plots the corresponding profits for both the first mover and second mover. Panel (C) illustrates the fact that credit limits are strategic substitutes. As the first mover sets a higher limit, default risk increases and the second mover sets a lower limit, $\frac{d\bar{l}^2(\tau^{1*}, \bar{l}^1)}{d\bar{l}^1} \leq 0$. This is typical in Stackelberg-Cournot games, and tends

⁶This logic is also why a pure strategy Nash equilibrium does not exist. For low spreads, a profitable deviation is to set a high spread. However, if your competitor sets a high spread then a profitable deviation is to undercut, etc.

to yield a first-mover advantage.

Since lenders are choosing both spreads (which are complements) and limits (which are substitutes), there are regions of the parameter space where the first-mover advantage dominates, and there are regions of the parameter space where the second-mover advantage dominates. Our estimated parameters yield a second-mover advantage. This is evident in Panels (B) and (D) where the second mover's profits are higher than the first mover's profits.

We begin by comparing the initial steady state ($t = 0$) and the terminal steady state. Column (2) of Table 8 reports spreads, limits, and other credit-related summary statistics. As discussed above, Column (2) demonstrates that the first mover chooses a low borrowing limit (2.05 percent of GDP per capita) and a low spread (2.07 percent). The second mover chooses a borrowing limit that is almost twice that of the first mover (4.02 percent of GDP per capita) and a significantly higher spread (6.90 percent). The second mover captures a slightly smaller share of the market, 36.87 percent of outstanding credit. Recall that all borrowers will first borrow from the first mover and then the second mover, given our equilibrium ranking of spreads. However, the second mover charges a significantly higher spread, and therefore, captures 72.03 percent of total lender profits.

Table 8: Comparison of steady state outcomes in the 1970s

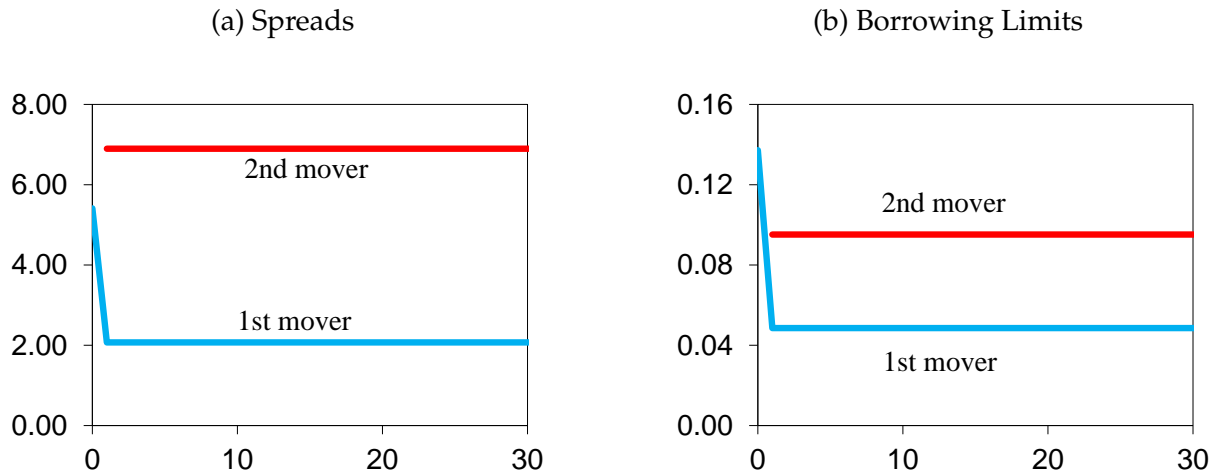
Summary Statistics	(1) Monopoly	(2) Stackelberg	(3) Collusive- Cournot	(4) Competitive Pricing
Firm 1 (first mover in Stackelberg)				
Borrowing limit to initial GDP pc	5.79	2.05	3.81	10.13
Spread	5.41	2.07	5.10	2.72
Market share of outstanding credit	100	63.13	50	100
Market share of total profits	100	27.97	50	100
Firm 2 (second mover in Stackelberg)				
Borrowing limit to initial GDP pc	-	4.02	3.81	-
Spread	-	6.90	5.10	-
Market share of outstanding credit	-	36.87	50	-
Market share of total profits	-	72.03	50	-
Credit to GDP	0.11	0.13	0.16	0.39
Bankruptcy rate	0.10	0.10	0.12	0.16
Charge-off rate	2.43	2.10	3.14	2.58
Excess spread: actual - zero-profit	2.89	1.67	1.81	0

Notes: Table reports credit-related summary statistics for the initial monopoly steady state at $t = 0$ (Column (1)) relative to the duopoly steady-state at the end of the transition path. Column (2) is Stackelberg duopoly, in which Firm 1 is the first mover. Column (3) is Collusive-Cournot, in which lenders collude in the first stage on interest rates and then compete on limits in the second stage. Column (4) is perfectly competitive pricing. We define the competitive pricing equilibrium to be the limit and spread that maximize welfare of an unborn agent, subject to weakly positive profits.

In terms of credit outcomes, Column (2) of Table 8 shows that total credit increases by more than 15 percent from 0.11 percent of GDP to 0.13 percent of GDP. Column (2) also demonstrates that while total borrowing limits do not increase much from monopoly to Stackelberg duopoly (5.79 percent vs 6.07[=2.05+4.02] percent of GDP per capita), the excess spread decreases significantly from 2.89 percent to 1.67 percentage points, a reduction of 42 percent.

Figure 7 illustrates the optimal spreads and credit limits for the first and second mover along the transition path. Panels (a) through (f) of Figure 8 plot key variables along the transition path from monopoly to Stackelberg duopoly.

Figure 7: Transition from monopoly to duopoly

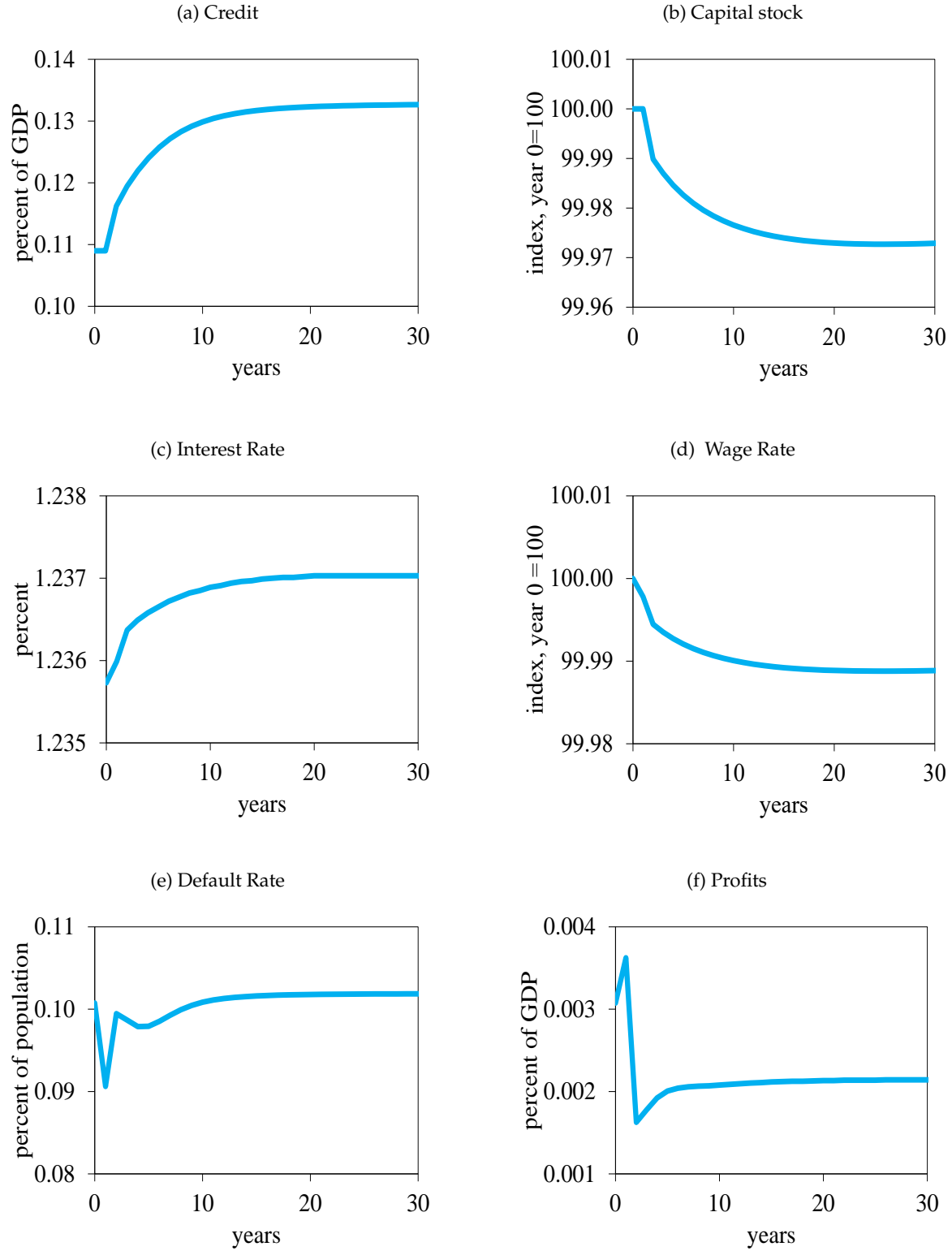


Notes: The initial steady state ($t=0$) is a monopoly. At date $t = 1$, the economy unexpectedly transitions to a Stackelberg duopoly. We assume perfect foresight for subsequent periods. Panel (a) plots the optimal spread of the first and second mover. Panel (b) plots the optimal limit of the first and second mover.

Since total borrowing limits increase and average spreads decrease, individuals begin to borrow more. As a result, credit rises monotonically in Panel (a) of Figure 8. An implication of dissaving is that the capital stock declines monotonically in Panel (b). Reduced saving has two general equilibrium effects: a higher risk free rate and lower wage rate. Panel (c) illustrates that the risk-free interest rate increases. With less capital, the marginal product of labor falls. As a result, the wage rate falls in Panel (d). While these general equilibrium price effects are small in magnitude, they have important consequences for the distributional burden of monopoly power, discussed in the next section.

Since borrowing limits increase discontinuously and net assets slowly adjust according to the consumers' Euler equations, utilization rates fall and consumers have extra slack in the credit market. This generates the sharp drop in defaults shown in Panel (e). In the long run, however, consumers dissave and borrow more, which causes defaults to rise in the cross-section. Panel (f) plots the resulting path for aggregate lender profits. The consumer credit sector remains profitable throughout the transition path. The discontinuous decline in defaults generates a positive spike in profits. However, increased competition eventually lowers profits of lenders by roughly 30 percent.

Figure 8: Transition from monopoly to duopoly



Notes: The initial steady state ($t=0$) is a monopoly. At date $t = 1$, the economy unexpectedly transitions to a Stackelberg duopoly. We assume perfect foresight for subsequent periods.

Table 9 presents the welfare gains generated by transitioning from monopoly to duopoly in the 1970s. 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 monopoly steady state such that a consumer is indifferent between the economy with a monopolist and an economy with a duopoly. In our model, we compute CEV numerically, taking into account default costs and taste shocks.

Wealth equivalent variation is the one-time transfer that the consumer requires in the initial monopoly steady state to be as well-off with duopoly. Wealth equivalent variation is our preferred measure because (1) it allows for aggregation across heterogeneous consumers and (2) it takes into account that consumers re-optimize on their decisions given the one-time transfer. Following [Conesa, Costa, Kamali, Kehoe, Nygard, Raveendranathan, and Saxena \(2018\)](#), it is calculated as follows:

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

$V_0(i, \epsilon, z, a + \text{WEV})$ 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. The last two inequalities ensure that the minimization problem is well defined. When computing $V_0(i, \epsilon, z, a + \text{WEV})$, the consumer takes into account price changes resulting from the reform, but not price changes resulting from the WEV transfers. When measuring welfare for unborn agents, we assume agents enter in good standing with zero assets and that they draw their earnings states from the ergodic earnings distribution. When aggregating wealth equivalent variation over living cohorts, we use the initial steady state distribution of agents.

Column (1) of Table 9 provides both consumption and wealth equivalent gains from Stackelberg duopoly. At the date of the transition experiment ($t = 1$), an unborn agent requires an increase in lifetime consumption of 0.09 percent to be as well-off living in an economy with a single monopoly lender rather than a Stackelberg duopoly. Equivalently, an unborn agent requires a one-time transfer at birth worth 0.42 percent of initial GDP per capita to be as well-off living in an economy with a single monopoly lender rather than a Stackelberg duopoly. Among those that are alive at the date of the transition experiment ($t = 1$), the aggregate sum of wealth equivalent variation across workers equals 0.24 percent of GDP. Lastly, 93 percent of agents are better off from a new lender entrant.

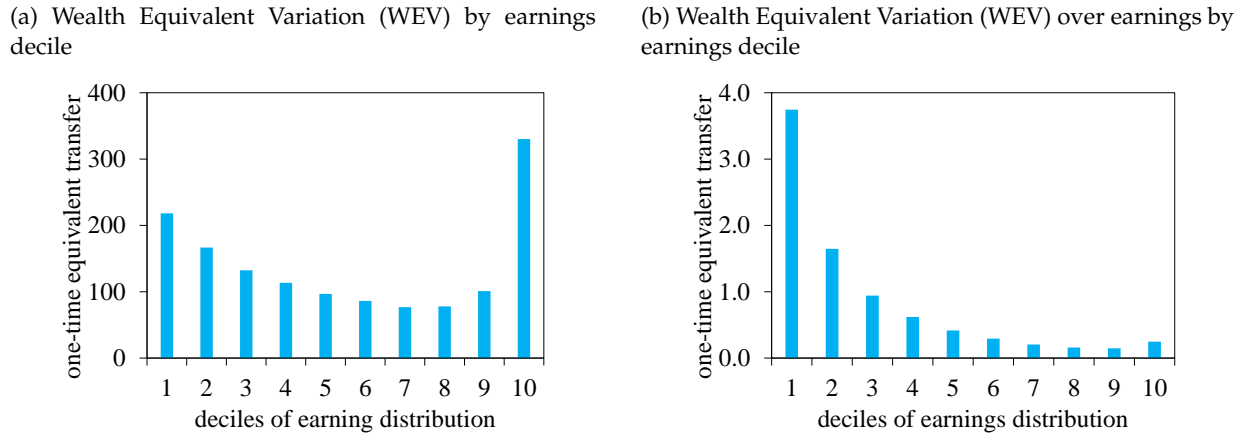
Panel (a) of Figure 9 plots wealth equivalent variation by earnings decile. Individuals in the lowest earnings decile require a transfer worth \$200 (2016 dollars) to be indifferent between the status quo and transitioning to Stackelberg duopoly. Individuals in the highest earnings decile require a transfer worth \$300. Panel (b) of Figure 9 expresses the WEV as a ratio of earnings in each decile. Individuals in the

Table 9: Welfare gains from different forms of competition in the 1970s.

Welfare gains: Monopoly to...	(1) Stackelberg	(2) Collusive- Cournot	(3) Competitive pricing
CEV unborn at $t = 1$ (% of lifetime consumption)	0.09	0.14	0.55
WEV unborn at $t = 1$ (% of initial GDP pc)	0.42	0.66	2.74
WEV alive at $t = 1$ (% of initial GDP)	0.24	0.38	1.66
Population better off (% of population)	92.55	95.51	99.40

Notes: This table reports welfare gains along the transition path relative to monopoly steady state. When measuring wealth or consumption equivalent variation for unborn agents, we assume agents enter in good standing with zero assets and that they draw their earnings states from the ergodic income distribution. When aggregating wealth equivalent variation over living cohorts, we use the initial steady state distribution of agents. Welfare is measured as either (a) consumption equivalent variation (CEV) for an unborn agent at the date of the transition $t = 1$, (b) the wealth equivalent variation (WEV) using equation (11) for unborn agents, or (c) WEV for the cohort that is alive at the date of the transition $t = 1$. Column (1) is Stackelberg duopoly. Column (2) is Collusive-Cournot, in which lenders collude in the first stage on interest rates and then compete on limits in the second stage. Column (3) is competitive pricing.

Figure 9: Welfare gains by earnings decile along transition path from monopoly to Stackelberg duopoly

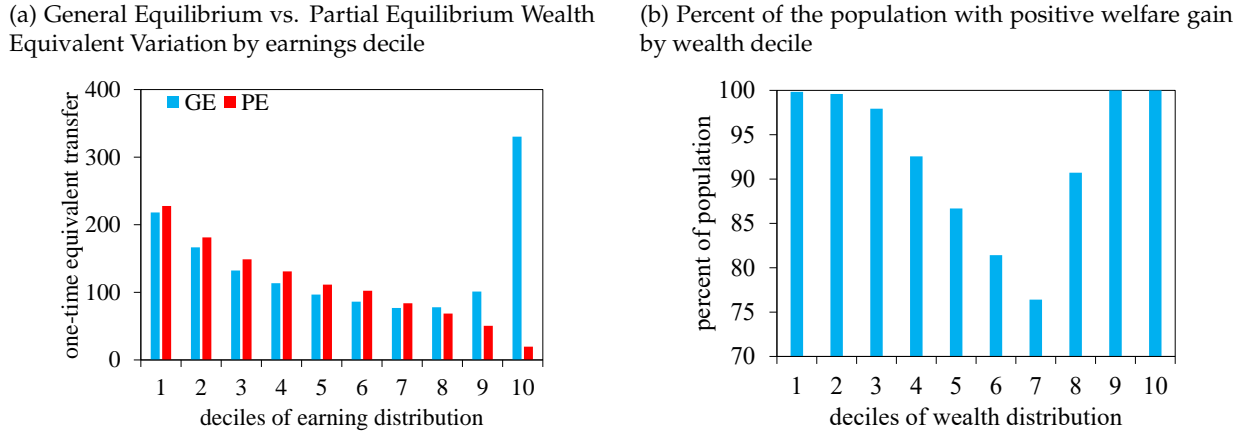


Notes: Welfare gains from the transition are measured using wealth equivalent variation in Panel (a). Panel (b) takes the ratio of the wealth equivalent variation to earnings in each decile.

lowest decile of earnings would require a transfer worth nearly 4 percent of their annual earnings to be indifferent between the status quo and transitioning to Stackelberg duopoly. Individuals in the highest deciles would require transfers worth very little of their annual earnings.

Given that profits and wages fall, it is not necessarily the case that high earning individuals gain from increased competition in the lending market. For our parameterization, the majority of high earning individuals realize welfare gains. General equilibrium price adjustments play an important role in determining who realizes welfare gains and losses. Panel (a) of Figure 10 illustrates the distribution of

Figure 10: Welfare gains by earnings decile along transition path from monopoly to Stackelberg duopoly



Notes: In Panel (a) GE refers to general equilibrium. PE refers to partial equilibrium. PE economy holds interest rates and wages constant at initial steady state levels. Panel (b) plots fraction realizing positive welfare gain along transition path from monopoly to Stackelberg duopoly.

welfare gains in general equilibrium (GE) and partial equilibrium (PE). In partial equilibrium, r and w are held fixed at their initial steady state values. Without general equilibrium price adjustments, welfare gains among the top two earnings deciles would be close to zero.

Panel (b) of Figure 10 plots the percent of individuals who realize welfare gains after the new lender enters, stratified by their wealth. Those at the low-end of the wealth distribution can now borrow more cheaply. Those at the high-end earn more on their savings. But those in the middle are more likely to lose since wages fall and they are not borrowing or saving significant amounts.

In summary, the welfare costs of monopoly in the lending market are borne primarily by low and high earning individuals. Eliminating monopoly benefits those in the tails of the earnings distribution. High earning individuals benefit from higher interest rates on savings, whereas low earning individuals benefit from lower credit card spreads and higher limits. As a percent of earnings, low earning individuals are willing to give up the most to eliminate monopoly in the credit market.

5.4 Monopoly to Collusive-Cournot

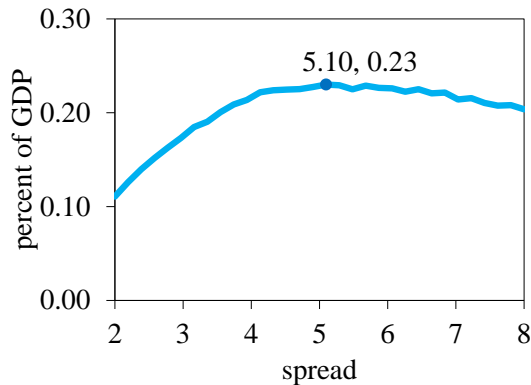
In this section, we consider a different form of competition between duopolists: Collusive-Cournot. Motivated by the evidence of interest rate collusion discussed in Section 2, we develop a two-stage game in which lenders collude to set a common spread (τ) in the first stage and then they compete over borrowing limits in the second stage. In the second stage, we assume the lenders compete in a simultaneous move game, and we consider the symmetric Nash equilibrium of that game.

Figure 11 illustrates lender policy functions in each stage of the game for the case with two lenders. Panel (a), which plots the net present value of profits as a function of the spread, shows that in the first stage lenders collude on a spread of 5.1 percentage points to maximize their second stage profits. Since

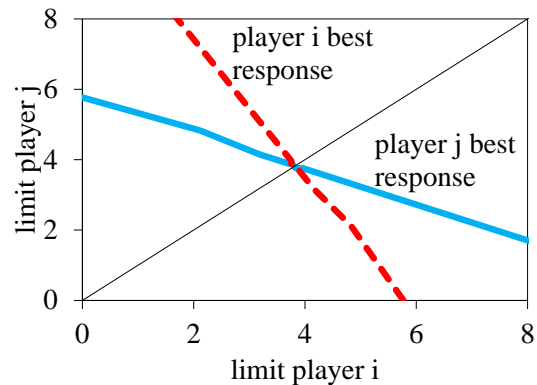
the second stage yields a symmetric outcome, all lenders agree on the optimal spread and earn the same profits. Taking the spread from the first stage as given, lenders simultaneously compete over borrowing limits. Panel (b) plots the best response function of the lenders in the second stage for the case where the spread is 5.1 percentage points. The symmetric Nash equilibrium is determined by the point where the best response function crosses the 45 degree line. Each lender sets a borrowing limit to GDP per capita of 3.8 percent.

Figure 11: Collusive-Cournot policy functions

(a) Net present value of profits in stage 1



(b) Borrowing limit best response in stage 2



Notes: Panel (a) plots lender profits as a function of the spread in the first stage. Lenders collude in the first stage to set the spread that maximizes profits. Panel (b) plots the lenders' best response functions in the second stage. The symmetric Nash equilibrium is the point where the limits cross the 45 degree line.

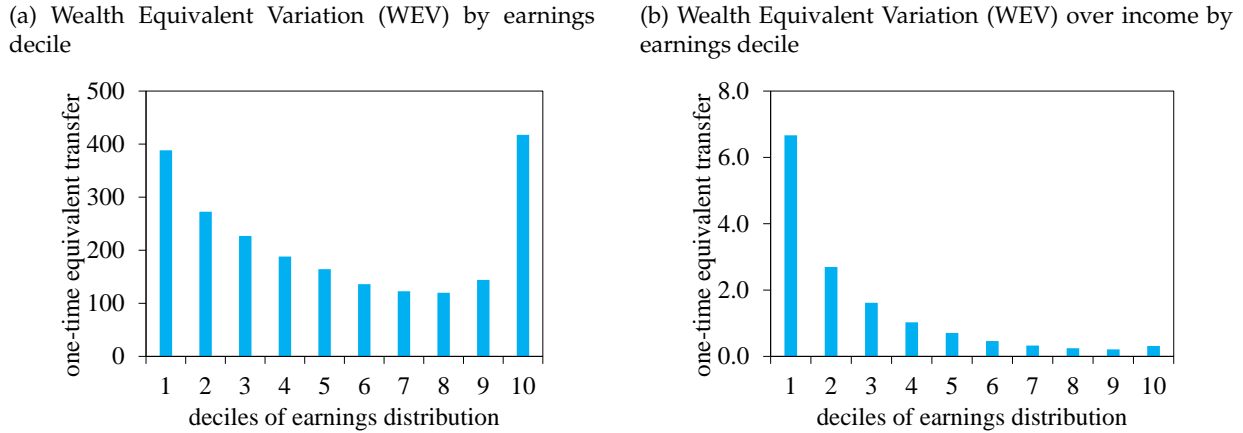
Column (3) of Table 8 compares the initial monopoly steady state to the terminal Collusive-Cournot steady state. Spreads decline from 5.4 percent with a monopoly lender to 5.1 percent with two Collusive-Cournot lenders. The Collusive-Cournot lenders equally split profits and market-share since the Nash equilibrium is symmetric. Relative to a monopoly lender, the aggregate borrowing limit to GDP ratio increases by 30 percent from 5.8 to 7.6 percent ($=2 \times 3.8$ percent since there are two lenders). The excess spread drops from 2.89 to 1.81 percentage points, a reduction of more than 37 percent.

Column (2) of Table 9 provides both consumption and wealth equivalent gains from Collusive-Cournot duopoly. At the start of the transition, an unborn agent would require an increase in lifetime consumption of 0.14 percent to be as well-off living in an economy with a single monopoly lender rather than a Collusive-Cournot duopoly. In terms of wealth equivalent variation, an unborn agent would require a one-time transfer at birth worth 0.66 percent of initial GDP per capita to be indifferent between a single monopoly lender and Collusive-Cournot duopoly. Among those alive at the start of the transition, 96 percent are better off in Collusive-Cournot duopoly. The corresponding aggregate wealth equivalent variation across workers equals 0.38 percent of GDP. Relative to Stackelberg duopoly, Collusive-Cournot generates larger welfare gains. This is because the Collusive-Cournot economy features both higher

limits and lower spreads.

When we decompose the source of the gains between credit limits and spreads, we find that roughly 80 percent of the welfare gains are due to increased limits. That is, the aggregate wealth equivalent variation across consumers equals 0.31 percent of GDP if we increase only the limits ($0.31/0.38 \approx 0.8$). Limits are the dimension along which lenders compete, and thus limits move closer towards what competitive pricing would dictate. Since lenders collude on spreads, only 20 percent of the welfare gains are due to lower spreads. That is, the aggregate wealth equivalent variation across consumers equals 0.06 percent of GDP if we decrease only the spreads ($0.06/0.38 \approx 0.2$).

Figure 12: Welfare gains by earnings decile along transition path from monopoly to Collusive-Cournot duopoly



Notes: Welfare gains from the transition are measured using wealth equivalent variation in Panel (a). Panel (b) takes the ratio of the wealth equivalent variation to earnings in each decile.

Similar to our prior findings, Figure 12 shows that the welfare losses from monopoly are largest at the extremes of the earnings distribution. Panel (a) plots wealth equivalent variation by earnings decile. Individuals in the lowest earnings decile would require a transfer worth \$400 to be indifferent between monopoly and transitioning to Collusive-Cournot duopoly. Individuals in the highest earnings decile would require a similar magnitude transfer. Expressing the wealth equivalent variation as a ratio of earnings in Panel (b), we find that individuals in the lowest decile of earnings would require a transfer worth over 6 percent of their annual earnings to be indifferent between monopoly and transitioning to Collusive-Cournot duopoly.

In summary, a Collusive-Cournot duopoly generates larger increases in limits than Stackelberg duopoly. The resulting welfare gains of transitioning to Collusive-Cournot duopoly are therefore larger. Nonetheless, the distributional implications from Collusive-Cournot and Stackelberg duopoly are similar – those in the lowest and highest earnings deciles benefit most from new lender entry.

5.5 Monopoly to Perfectly Competitive Pricing

The last 1970s transition path we consider is from monopoly pricing to perfectly competitive pricing. Unlike the prior experiment, there is no lender entry in this section. Rather, we assume that there is a single lender that unexpectedly and permanently changes from monopoly pricing to perfectly competitive pricing at $t = 1$. This captures an upper bound on welfare gains from competitive pricing in the 1970s.

We must define what perfectly competitive pricing means in this context. Our first condition for competitive pricing is zero profits. However, this condition alone is not sufficient to uniquely determine the equilibrium. For any given limit, Figure 4 shows that there are two zero-profit spreads. Likewise, for any given spread, there are two zero-profit credit limits.

The way we resolve this issue is to define perfectly competitive pricing to be the combination of spreads and limits that maximizes the expected utility of an unborn agent in good standing with zero assets, subject to weakly positive lender profits:

$$\begin{aligned} \max_{\tau, \bar{l}} \quad & E_{\theta, \eta, \epsilon} V_0(g, \theta, \eta, \epsilon, 0) \\ \text{s.t.} \quad & \\ & \sum_{t=0}^{\infty} \left(\frac{1}{1+r_t} \right)^t \pi_t \geq 0 \end{aligned}$$

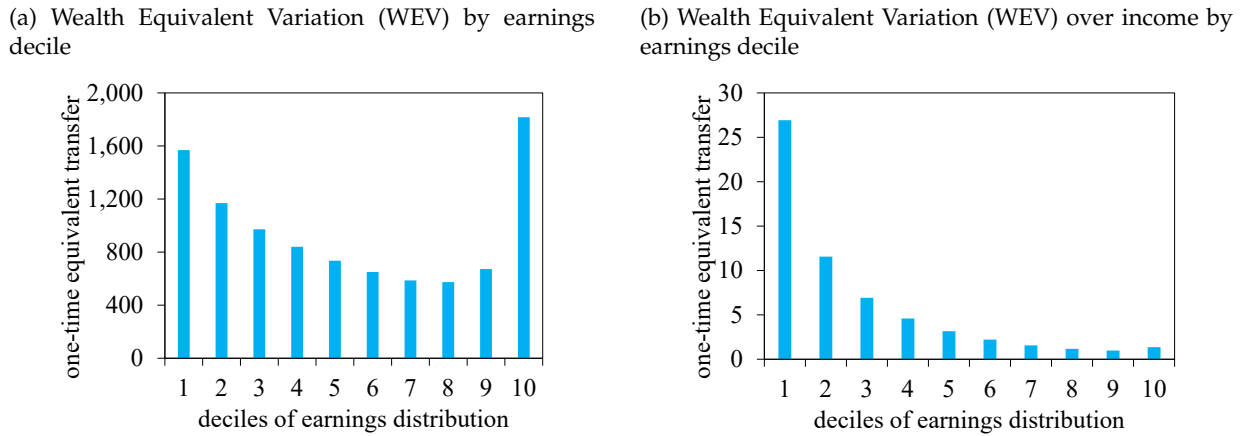
Column (4) of Table 8 describes the competitive pricing steady state with a single lender, $N = 1$. Compared to monopoly pricing, the credit limit is nearly twice as large (10.13 versus 5.79 percent) and the spread falls by 50 percent (5.41 vs. 2.72 percentage points). Credit to GDP more than triples, increasing from 0.11 to 0.39 percent. A side-effect of increased borrowing is a 60 percent greater default rate, rising from 0.10 to 0.16 percent. Because the lender breaks even, excess spreads are zero by construction.

The large reduction in spreads and increase in limits generates considerable welfare gains. Column (3) of Table 9 shows that an unborn agent would require an increase in lifetime consumption of 0.55 percent to be as well-off living in an economy with a single lender that behaves monopolistically rather than a single lender that behaves competitively. The wealth equivalent gain to the same consumer, expressed as a one-time transfer, is equal to 2.74 percent of initial GDP per capita. Among those alive at the start of the transition, 99.4 percent are better off with a single lender that behaves competitively. The aggregate wealth equivalent variation across workers who are alive at the date of the transition equals 1.66 percent of GDP. Relative to the other transition experiments, a single competitive lender generates welfare gains that are 4 to 7 times larger than Stackelberg or Collusive-Cournot duopoly. Of the aggregate wealth equivalent variation, 50 percent of the welfare gains (worth 0.86 percent of GDP) are explained by higher limits alone. The remaining welfare gains are generated by lower spreads, as well as the interaction between lower spreads and higher limits.

We now find much larger distributional effects of monopoly. Panel (a) of Figure 13 shows that the lowest earning individuals would require a one-time transfer worth \$1,600 to be indifferent between a

single lender that prices monopolistically and a single lender that prices competitively. Individuals in the highest earnings decile would require a transfer worth \$1,800. Expressing the wealth equivalent variation as a ratio of earnings in Panel (b), we find that individuals in the lowest decile of earnings would require a transfer worth over 25 percent of their annual earnings to be indifferent between a single lender that prices monopolistically and a single lender that prices competitively.

Figure 13: Welfare gains by earnings decile along transition path from monopolistic single lender to a perfectly competitive single lender.



Notes: Welfare gains from the transition are measured using wealth equivalent variation in Panel (a). Panel (b) takes the ratio of the wealth equivalent variation to earnings in each decile.

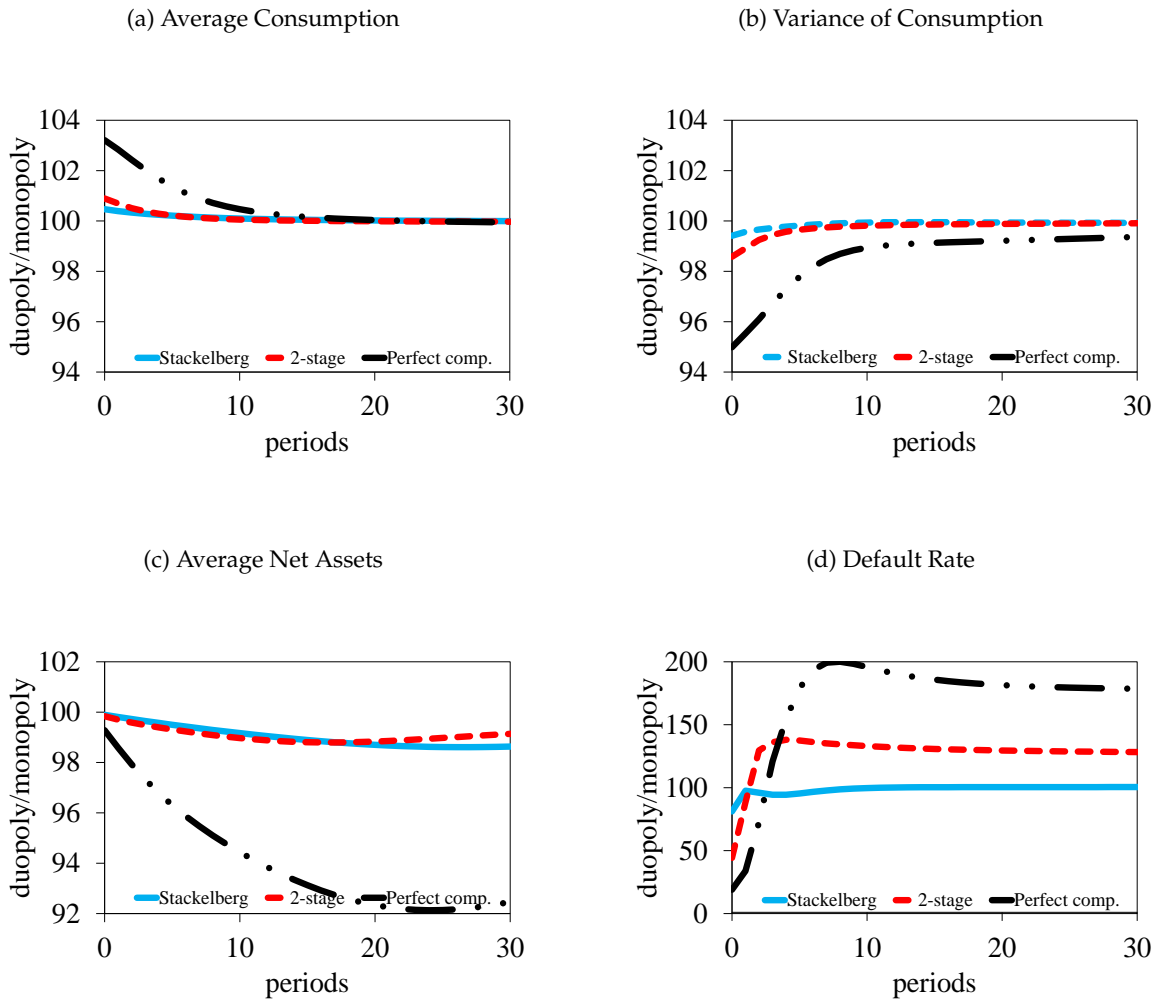
5.6 What Drives Welfare Gains Among Low Earning Individuals?

To better understand what drives the welfare gains among low-earning individuals, we study implications for average consumption, variance of consumption, average net assets, and default probabilities of agents in the lowest decile of earnings at the start of the transition experiment ($t = 1$). We compare implications between remaining in the monopoly economy and transitioning to a duopoly. We find that low earning individuals benefit from higher average consumption, lower variance of consumption, and lower default rates along the transition path.

Panel (a) of Figure 14 plots the relative average consumption profile of agents in the bottom-decile of earnings at the time of the transition ($t = 1$). More specifically, Panel (a) plots the ratio of average consumption along the duopoly transition path divided by the *status quo* average consumption if the agent remained in the monopoly economy. Agents consume roughly 0.5 percent more along the transition path to Stackelberg duopoly relative to status quo. With competitive pricing, agents on average consume roughly 3 percent more during the transition relative to status quo. In terms of consumption volatility, increased lender competition allows agents to better smooth consumption. Panel (b) shows that the variance of consumption decreases by 0.5 percent along the transition path to Stackelberg duopoly relative to status quo. With competitive pricing, consumption variance falls by nearly 5 percent relative to status

quo. Over time, consumption variance remains significantly low, especially in the case of competitive pricing. Panel (c) shows that low earning individuals are able to dissave relatively more with greater lender competition. In the case of competitive pricing, their net asset position falls by nearly 8 percent towards the end of the transition relative to status quo, consistent with time series patterns documented by [Carroll et al. \(2019\)](#). Because credit limits expand, default rates initially decline in Panel (d). In the long run, however, default rates rise above the monopoly case because agents accumulate more debt. While not the focus of our paper, these patterns are broadly consistent with the evolution of defaults in the U.S. (e.g., [Livshits et al. \(2010\)](#)).

Figure 14: Average consumption, asset, and default profiles of a low earning newborn



Notes: Panels (a) through (d) derived from simulating agents in the bottom-decile of earnings at date $t = 1$ on the transition path to (1) Stackelberg duopoly (Stackelberg), (2) the Collusive-Cournot duopoly (2-stage), and (3) single-lender competitive pricing (Perfect Comp.). Panel (a) plots the average consumption path along the transition path expressed as a ratio to average consumption if the agent remained in a world with a single-lender monopoly. Panel (b) plots the variance of consumption along the transition path expressed as a ratio to the variance of consumption if the agent remains in a world with a single-lender monopoly. Panels (c) and (d) repeat the same exercise for net assets and defaults, respectively.

5.7 Summary of Findings

Overall, consumers benefit moderately when lenders enter and compete imperfectly (e.g., Stackelberg or Collusive-Cournot). However, they gain substantially from perfect competition. In each case considered, we find that the extremes of the earnings distribution stand to benefit the most from competitive reforms in the lending market. We interpret Stackelberg duopoly as providing a lower bound on the welfare gains from increased competition in the credit market and we interpret competitive pricing as providing an upper bound. In the case of Stackelberg duopoly, the lowest earners require a transfer worth 4 percent of their annual earnings to be indifferent between monopolistic and Stackelberg pricing. In the case of competitive pricing, the lowest earners require a transfer worth 25 percent of their annual earnings to be indifferent between monopolistic and competitive pricing. Those in the bottom decile of the earnings distribution gain from their greater ability to smooth consumption. Those in the top decile gain from general equilibrium price effects and the ability to reduce their stock of precautionary savings.

6 Gains from National Competition: Duopoly to 2016 Oligopoly

As various barriers to inter-state credit card competition fell in the 1970s (Evans and Schmalensee (2005)), and as lawsuits continued to challenge exclusivity clauses and other restrictions to credit card competition (e.g., Appendix C.3), credit card markets became nationally competitive. While we do not explicitly model regions, we capture these changes in credit card competition by measuring the welfare gains from transitioning between duopoly in the 1970s (our proxy for limited inter-regional competition) to oligopoly in 2016. Unlike our prior exercise, we now allow lenders to price discriminate with respect to the worker's permanent earning ability, which we discretized into two types, $\theta \in \{\theta_L, \theta_H\}$. This is designed to capture the adoption of credit scoring, the digitization of banking, and other factors that led to the rise of heterogeneous interest rate pricing (*inter alia* Mester (1997) and Livshits et al. (2016)). Based on the observation that nine lenders control roughly 90 percent of the credit card market in 2016 (see Table 1), we assume that there are nine lenders for each level of permanent earnings in the 2016 oligopoly, i.e., $N_\theta = 9$ for $\theta \in \{\theta_L, \theta_H\}$. All other preference and technology parameters are fixed at 1970s values given by Tables 5 and 6. Subsequently, we study the role for policy in 2016. In particular, we measure the welfare consequences of homogeneous interest rate caps that have been proposed recently.

6.1 Duopoly to 2016 Oligopoly

The main challenge to modeling oligopolistic competition in 2016 is allowing for strategic interactions among nine lenders. We make the problem computationally feasible by maintaining the assumption of Collusive-Cournot competition *within* each consumer type, $\theta \in \{\theta_L, \theta_H\}$. Within each consumer type, lenders first collude on the spread and then compete on limits. The resulting Nash equilibrium yields monotone best response curves for the limits within each consumer type. This market structure allows us to preserve price dispersion and to also solve the problem.

We begin by showing that with $N_\theta = 9$ lenders, our model does well at matching several non-targeted credit market moments in 2016. Table 10 shows that we account for almost all of the total borrowing limit in 2016. Our model produces a borrowing limit to GDP per capita of 28 percent compared to 30 percent in the data. We also do well at matching the default rate. Our model generates a default rate of 0.17 versus 0.15 percent in the data. Lastly, even though we assume fairly restrictive competition among lenders, we are only able to account for 20 percent of the excess spreads observed in the data. Given our understatement of excess spreads, we view the gains from competitive reforms as conservative estimates.

Table 10: Credit card market variables (2016)

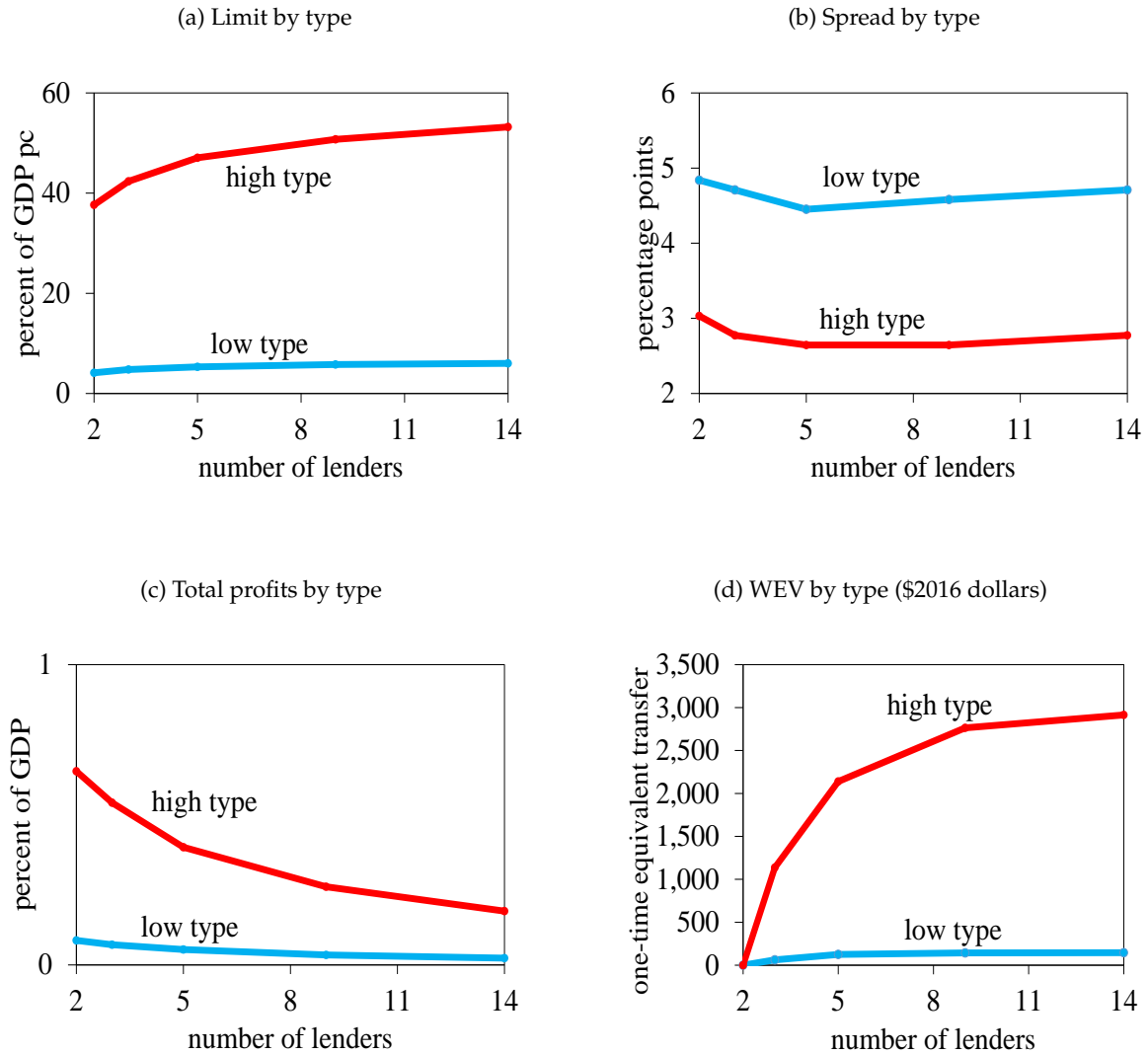
Variable (unit=percent)	$N_\theta = 9$	Data
Borrowing limit to GDP per capita	28.26	30.21
Default rate	0.17	0.15
Charge-off rate	2.38	3.15
Excess spread: actual - zero-profit	1.14	5.31

Notes: This table reports non-targeted 2016 moments under the assumption of Collusive-Cournot equilibrium with nine lenders ($N_\theta = 9$). Preference and technology parameters remain fixed at 1970 values given by Tables 5 and 6.

Panels (a) through (d) of Figure 15 plot outcomes from Collusive-Cournot competition among $N \in \{2, 3, 5, 9, 14\}$ lenders by low and high income types. Analyzing implications across income types, Panel (a) shows that low-type individuals (θ_L) face much tighter credit limits than high-type individuals (θ_H). The main force generating this result is the higher default rate among low-type individuals. Figure 16 illustrates the default policy functions for low- and high-type individuals. For the majority of the state space, low types default at a higher rate. However, for small negative net asset positions, the opposite is true since low types are hurt more by entering autarky. The higher default rate leads to higher spreads for low-type individuals and makes them less profitable to lenders (Figure 15, Panels (b) and (c)). This pattern of lower limits and higher interest rates among low earning individuals is consistent with SCF data, as explored in Raveendranathan (2019).

When more lenders enter the market, limits increase for both low-type and high-type individuals. There are two opposing effects on spreads: (1) competitive forces lower spreads, and (2) since individuals cannot commit to borrow from only one lender, debt dilution raises spreads (e.g., Bizer and DeMarzo (1992) and Hatchondo and Martinez (2018)). Since lenders collude on spreads, the portfolio choice of individuals is indeterminate. Regardless of the allocation rule of individual borrowing across lenders, debt dilution will be present. The individual is always free to borrow their next dollar from another lender and thus raise the default propensity on all past amounts borrowed. Since we assume that the lender commits to an interest rate and credit limit ex-ante, they must price their loans taking into account subsequent borrowing at other lenders by the individual. Panel (b) shows that, initially, the competitive effect of entry prevails and steady state spreads fall for both the low- and high-type individuals. However, as more lenders enter the economy, debt dilution eventually puts upward pressure on spreads. As

Figure 15: Oligopoly with price discrimination

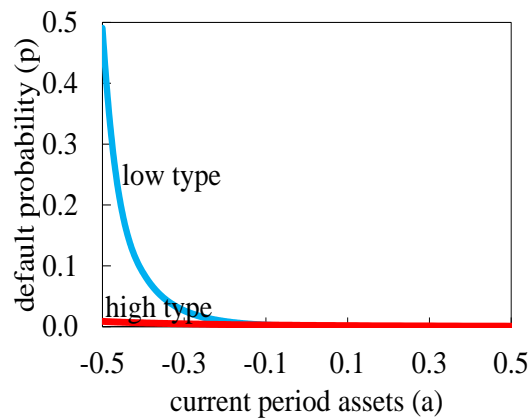


Notes: X-axis is number of lenders in steady state. Panel (a) plots the credit limit expressed as a percent of GDP per capita. Panel (b) plots the spread, Panel (c) plots profits by type expressed as a percent of GDP, and Panel (d) plots wealth equivalent variation by type in 2016 dollars where the WEV is computed individually and then aggregated according to the ergodic distribution within each type.

more lenders enter the market, total profits decline, especially from high-type individuals. However, profits still remain greater than zero, even with fourteen lenders.

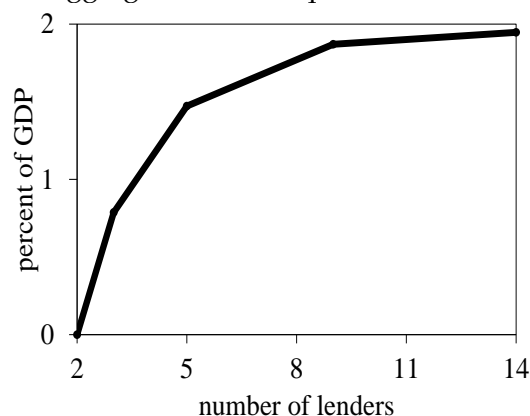
Panel (d) plots wealth equivalent variation across steady states by type. We compute wealth equivalent variation for each agent according to (11). High types require a transfer worth \$2,800 to be indifferent between living in an economy with two instead of nine lenders. Low types, however, would gain very little. They require a transfer worth \$150 to be indifferent between living in an economy with two instead of nine lenders.

Figure 16: Default policy function $p(\cdot)$ by individual type for $N_\theta = 9$ Collusive-Cournot lenders.



Despite the large welfare gains generated by moving from two to nine lenders, the marginal welfare gains generated by moving from nine to fourteen lenders are small. For example, in Figure 17, we aggregate the wealth equivalent variation across individuals. We find individuals would require a transfer worth approximately 1.87 percent of GDP to be as well off living in an economy with two instead of nine lenders; however, individuals would only require a marginally larger transfer worth approximately 1.95 percent of GDP to be as well off living in an economy with two instead of fourteen lenders. As Figure 17 shows, moving from nine to fourteen lenders generates small welfare gains.

Figure 17: Aggregate Wealth Equivalent Variation (WEV)



Notes: Aggregate wealth equivalent variation computed using equation (11). WEV expressed as one-time transfer required to be indifferent between the economy with $N_\theta = 2$ lenders and the economy with $N_\theta = X$ lenders (as specified by the x-axis). WEV is aggregated using the initial distribution in the $N_\theta = 2$ economy.

For the remainder of this section, we show that although more lender entry leads to small gains, competitive pricing in 2016 would lead to large gains. In Table 11, we report (1) welfare gains from lender

entry in Collusive-Cournot competition, (2) welfare gains if only interest rates were set competitively, and (3) welfare gains if both interest rates and limits were set competitively. These exercises inform us how far the 2016 oligopoly is from perfect competition with respect to welfare. We define *Competitive-Cournot* (case (2)) to be where lenders set the spread that maximizes the welfare of an unborn (given low- or high-type) subject to weakly positive profits in the first stage and then compete on limits in the second stage. We define perfectly competitive pricing (case (3)) to be the combination of spreads and limits for low and high types that maximize a newborn's expected utility subject to weakly positive profits. We maintain the assumption that the newborn is born in good standing with zero assets and draws their persistent and transitory earnings from the ergodic distribution. We find welfare gains that are significantly larger in Competitive-Cournot (case (2)) and competitive pricing (case (3)) compared to Collusive-Cournot (case (1)). The wealth equivalent variation for the current cohort from Competitive-Cournot pricing is equivalent to 2.55 percent of GDP, a 36 percent (2.55/1.87) increase relative to the gains from lender entry. The wealth equivalent variation from perfectly competitive pricing is even larger, totaling 3.20 percent of GDP. That is roughly 71 percent (3.20/1.87) more than the gains from lender entry. Despite understating lender spreads relative to the data, our 2016 oligopoly economy implies significant deviations from perfectly competitive pricing. In the next section, we explore what fraction of these potential welfare gains can be captured by recently proposed credit market regulations.

Table 11: Comparison of Collusive-Cournot, Competitive-Cournot, and Perfectly Competitive Pricing.

	(1)	(2)	(3)
Welfare gains: 2-Lender Collusive-Cournot to...	9-Lender Collusive- Cournot	9-Lender Competitive- Cournot	Competitive Pricing
CEV unborn at $t = 1$ (% of lifetime consumption)	0.17	0.27	0.31
WEV unborn at $t = 1$ (% of initial GDP pc)	0.81	1.38	1.70
WEV low-unborn at $t = 1$ (% of initial GDP pc)	0.30	0.78	0.92
WEV high-unborn at $t = 1$ (% of initial GDP pc)	4.93	6.30	8.02
WEV alive at $t = 1$ (% of initial GDP)	1.87	2.55	3.20
Population better off (% of population)	73.77	83.58	81.52

Notes: This table reports welfare gains along the transition path relative to 2-Lender Collusive-Cournot steady state (with price discrimination). When measuring wealth or consumption equivalent variation for unborn agents, we assume agents enter in good standing with zero assets and that they draw their earnings states from the ergodic earnings distribution. When aggregating wealth equivalent variation over living cohorts, we use the initial steady state distribution of agents. Welfare is measured as either (a) consumption equivalent variation (CEV) for an unborn agent at the date of the transition $t = 1$, (b) the wealth equivalent variation (WEV) using equation (11) for unborn agents, or (c) WEV for the cohort which is alive at the date of the transition $t = 1$. Column (1) is 9-Lender Collusive-Cournot. Column (2) is 9-Lender Competitive-Cournot in which lenders choose the spread that maximizes the welfare of an unborn (given low- or high-type) subject to weakly positive profits in the first stage and then compete on limits in the second stage. Column (3) is competitive pricing. We define the competitive pricing equilibrium to be the limit and spread that maximize welfare of an unborn agent (given low- or high-type), subject to weakly positive profits.

6.2 Policy: Capping Lender Spreads in 2016

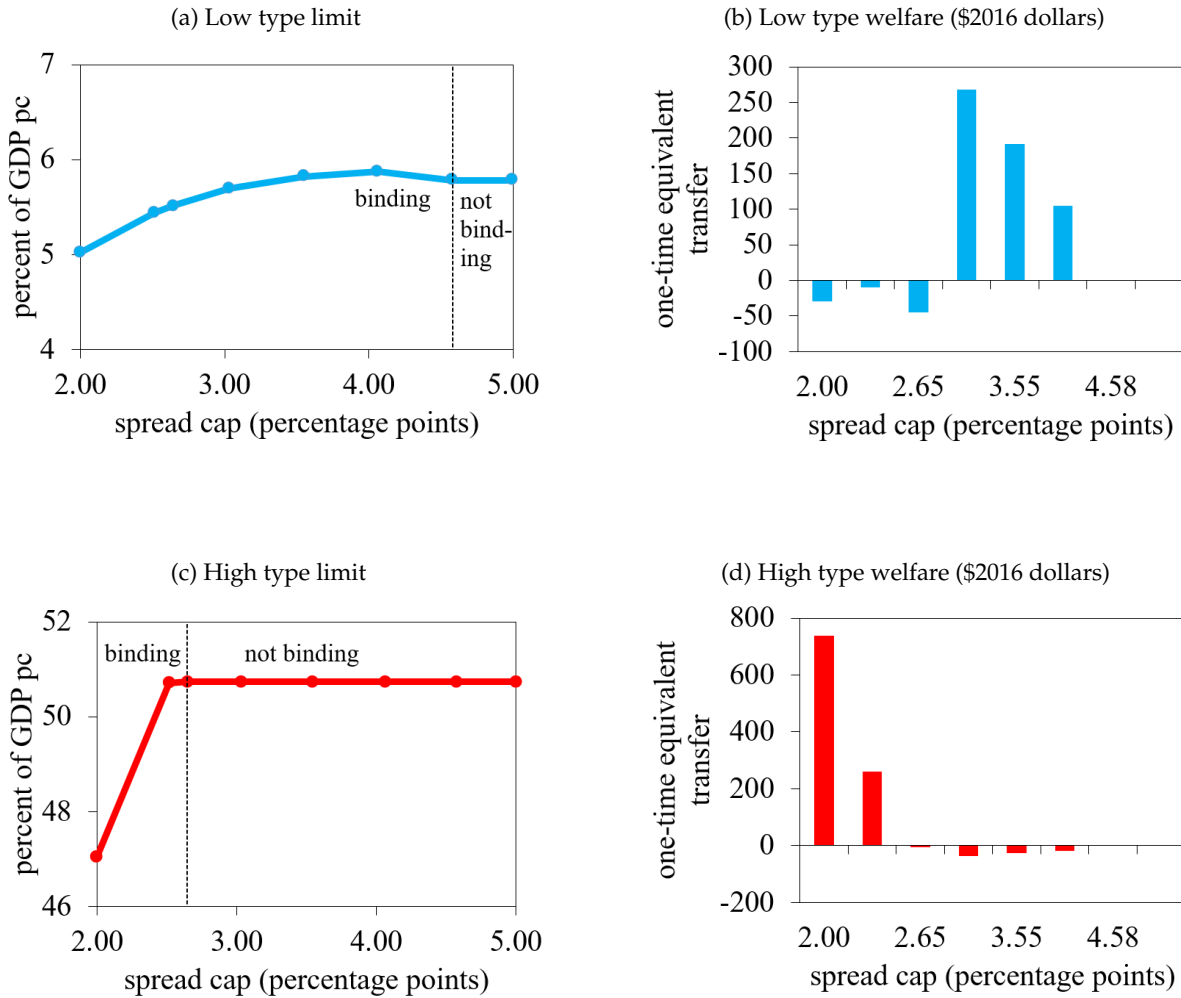
In this section, we ask whether there is a role for policy to correct lender market power. One policy that is often discussed in the context of lender market power is an interest rate cap. Credit card interest rate caps fall under the umbrella of usury laws (see [Evans and Schmalensee \(2005\)](#) for more discussion of usury laws in the U.S.). While roughly half of U.S. states have no interest rate cap on credit cards, they still maintain usury laws that apply to non-bank entities such as payday lenders and loans that are made without a written contract. For credit card lenders, the Marquette decision was an important legal ruling. It established that credit card lenders are subject to the usury laws of the states in which they are headquartered. After the Marquette decision, many credit card lenders moved their headquarters to states with no maximum interest rate. Thus the Marquette decision effectively nullified state interest rate caps. Recently, however, policymakers have renewed discussions of interest rates caps, including a non-discriminatory federal interest rate cap.⁷ Our model provides a unique opportunity to study the effects of interest rate cap policies.

Similar to existing and proposed laws, we consider a non-discriminatory cap on lender spreads, which can be equivalently implemented as an interest rate cap. Panels (a) through (d) of Figure 18 plot equilibrium credit limits and wealth equivalent variation resulting from various interest rate caps. Panel (a) plots the credit limit offered to low-type individuals as a function of the cap on lender spreads. When the cap begins to bind, limits offered to the low-type begin to increase. At some point, however, the cap is so tight that credit limits decline substantially below initial pre-cap levels. Panel (b) plots the wealth equivalent variation. Low type individual households benefit most from a 3 percent cap on spreads. Once the cap on spreads becomes tighter than 3%, low-type individuals are worse off. Despite the lower spreads, credit limits contract enough to impede consumption smoothing. Panel (c) plots credit limits for high-type individuals. High type individuals face much lower equilibrium credit card interest rates. As a result, spread caps greater than 2.65 are non-binding for these individuals. We find that high-type individuals benefit most from a 2 percent cap on spreads. High type individuals would require a one-time transfer worth \$700 (2016 dollars) to be just as well off in the pre-cap economy. Aggregating across high and low-type individuals, we find that imposing a cap of 2 percent on spreads would yield one-third of the welfare gains from competitive pricing. However, at a cap of 2%, low income individuals face both tighter credit limits and have weakly negative welfare losses.

Although caps on spreads generate gains for each type in isolation, there is no common spread cap that generates welfare gains simultaneously among both low- and high-type individuals. A one-size-fits-all cap on lender spreads generates welfare losses among either low- or high-type individuals. Caps that are too tight benefit high-earning individuals at the expense of low-earning individuals. Overall, homogeneous interest rate caps may have unintended distributional consequences and can only capture a fraction of the welfare gains from perfect competition.

⁷For example, the proposal by Alexandria Ocasio-Cortez and Bernie Sanders calls for a common federal interest rate cap: <https://www.bloomberg.com/news/articles/2019-05-09/aoc-bernie-sanders-credit-card-interest>.

Figure 18: Oligopoly with price discrimination



Notes: X-axis is non-discriminatory interest rate cap. Panel (a) plots the resulting credit limit for the low-type individuals. Panel (b) plots the resulting wealth equivalent variation of the low-type individuals. Panels (c) and (d) repeat the exercise for high-type individuals.

7 Robustness

In this section, we discuss several robustness exercises. We consider (1) fixed costs of lender entry, (2) an alternate redistribution of lender profits to high-earning households, and (3) a partial equilibrium recalibration that matches credit usage.

First, we assess the role of lender entry costs for our welfare analysis. We use our simulated lender profits and our aggregate wealth equivalent variation to provide bounds on what private parties and/or society would be willing to pay for a new entrant. Our first exercise recomputes household welfare if there is a fixed lender cost equal to the net present value of lender profits that must be paid up-front.

The net present value of profits is the maximum amount a lender would be willing to pay to enter the market. The initial lender loss is equally distributed among households. We know that there was lender entry in the 1970s, and so the fixed cost must be weakly lower than the discounted stream of profits.

Our second exercise is to compute the amount *society* would be willing to give up to have another lender enter. This amount is given by aggregating across wealth compensating variation (WCV), which we define in equation (12). WCV is negative for households that are better off with lender entry and positive for households that are worse off. In the case that WCV is a negative number, this is the amount households are willing to *give up* along the transition path with greater lender entry to be just as well-off as they were in the initial monopolistic steady state. Similar to WEV, WCV can be aggregated across households to obtain the total amount individuals would be willing to give up for lender entry.⁸

$$\begin{aligned}
& \min \quad WCV \\
& \quad \text{s.t.} \\
& V_0(i, \theta, \eta, \epsilon, z, a) \leq V_t(i, \theta, \eta, \epsilon, z, a + WCV) \\
& a + WEV \geq -\bar{l}^1 \quad \text{if } i = g \\
& a + WEV \geq 0 \quad \text{if } i = b,
\end{aligned} \tag{12}$$

Table 12 reports our results for the 1970 Stackelberg duopoly and the 1970 Collusive-Cournot duopoly. In both cases, we measure welfare among the cohort that is alive at the date of the transition. In the case of Stackelberg duopoly, the wealth compensating variation is nearly identical to the wealth equivalent variation in our benchmark counterfactual. Society would be willing to give up 0.24 percent of initial GDP for a new Stackelberg entrant. If we assume that the entry cost of the new Stackelberg lender is equal to the discounted flow profits of the lender, then the aggregate wealth equivalent variation from the new Stackelberg entrant falls to 0.16 percent of initial GDP. The fixed cost reduces the welfare gain by one-third relative to our benchmark counterfactual. We find a similar result when considering Collusive-Cournot. Given that there was profitable lender entry in the 1970s, we view an entry cost equal to the net present value of lender profits as an upper bound, and thus our reported welfare gains in 12 can be viewed as lower bounds.

Our second robustness check is to consider an alternative distribution of lender profits. We assume that lender profits are only rebated to households in the top 0.1 percent of the earnings distribution. We recompute welfare gains in the 1970s from lender entry in Table 13. We find that welfare gains are generally higher in this economy. Low earning households no longer have flow-profits from lenders each period, and thus the fall in total profits does not affect them. As a result, individuals alive at the date of the transition from monopoly to Stackelberg duopoly would require a transfer worth 0.28 percent of GDP to be as well-off in the initial equilibrium. This welfare gain is roughly 16 percent larger than our

⁸Due to the timing assumption on the transition path, \bar{l}^1 is still the relevant borrowing constraint for WCV since previously borrowed money is owed to the prior monopoly lender. That monopoly lender committed to lend \bar{l}^1 .

Table 12: Welfare along transition path from 1970 monopoly to Stackelberg Duopoly or Collusive-Cournot under alternative assumption for lender fixed costs.

	Stackelberg	Collusive-Cournot
Benchmark WEV of alive at $t=1$ (% of initial GDP)	0.24	0.38
Wealth Compensating Variation (WCV) of alive at $t=1$ (% of initial GDP)	0.24	0.37
Fixed cost equal to NPV lender profits, WEV of alive at $t=1$ (% of initial GDP)	0.16	0.27

Notes: ‘Benchmark WEV of alive at $t=1$ (% of initial GDP)’ taken from Table 9, expresses aggregate WEV of the cohort alive at the time of the transition over GDP in the initial equilibrium. ‘Wealth Compensating Variation (WCV) of alive at $t=1$ (% of initial GDP)’ defined in equation (12). ‘Fixed cost equal to NPV lender profits, WEV of alive at $t=1$ (% of initial GDP)’ assumes lenders initially make a loss equal to the NPV of future profits. The loss is equally distributed among households.

benchmark counterfactual. We find similar results when we consider Collusive-Cournot competition.

Table 13: Welfare along transition path from 1970 monopoly to Stackelberg Duopoly or Collusive-Cournot assuming lender profits distributed to only those in the top 0.1 percent of the earnings distribution.

	Stackelberg	Collusive-Cournot
Benchmark WEV alive at $t=1$ (% of initial GDP)	0.24	0.38
Profits distributed to top 0.1%, WEV alive at $t=1$ (% of initial GDP)	0.28	0.39
Benchmark fraction who gain from lender entry	92.6	95.5
Profits distributed to top 0.1%, Fraction who gain from lender entry	97.4	96.5

Notes: ‘Benchmark WEV of alive at $t=1$ (% of initial GDP)’ taken from Table 9, expresses aggregate WEV of the cohort alive at the time of the transition over GDP in the initial equilibrium. ‘Profits distributed to top 0.1%, WEV alive at $t=1$ (% of initial GDP)’ computes aggregate WEV assuming that lender profits are only distributed to households in the top 0.1% of the earnings distribution.

Lastly, we recompute welfare in a partial equilibrium model with greater credit access. There are many partial equilibrium models that are capable of matching credit utilization rates (e.g., (Livshits et al., 2007, 2010), Galenianos and Nosal (2016), and Raveendranathan (2019)) by simply lowering the discount factor of households. Unlike these models, however, our cost of funds is endogenous, similar to Chatterjee et al. (2007). As a result, lowering the discount factor raises the risk-free rate, which mutes any borrowing response of households. We therefore drop the assumption of general equilibrium, and recalibrate our model economy to match observed credit to GDP and other target moments in 1970-75. We report the recalibration in Appendix D. We recompute welfare gains of transitioning to perfect competition in 1970. We find that gains in terms of wealth equivalent variation for the current cohort are 3.98 percent of GDP, which is significantly larger than the estimate in the benchmark of 1.66 percent. Therefore, we view our paper’s benchmark welfare analysis as conservative.

8 Conclusion

The U.S. credit card industry is characterized by a large degree of market concentration, excess spreads, and excess 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 oligopoly in the consumer credit market. Our model accounts for 20 to 50 percent of the excess spreads observed in the data between 1970 and 2016.

We use our estimated model to measure the gains from (i) increased lender entry, and (ii) competitive pricing. In an environment without lender price discrimination in the 1970s, we find moderate gains from increased lender entry. Individuals would require a one-time transfer worth between .24 and .38 percent of GDP to be as well-off in an economy with a single lender as a duopoly. Competitive pricing generates a much larger welfare gain that is equivalent to a one-time transfer worth approximately 1.66 percent of GDP. We find similarly large numbers when we consider the transition from 1970s duopoly with price discrimination to the nine lender oligopoly in 2016. We find individuals would require a transfer worth approximately 1.87 percent of GDP to be as well off living in an economy with two instead of nine lenders. Moreover, the welfare gains from competitive pricing in 2016 are worth roughly 3.20 percent of GDP.

We then turn to the distribution of welfare losses. We find that eliminating monopoly benefits those in the tails of the earnings distribution. High earning individuals benefit from greater interest rates, and low earning individuals benefit from lower credit card spreads, greater limits, and an improved ability to smooth consumption. In the case of competitive pricing in the 1970s, those in the lowest decile of the earnings distribution require a one-time transfer worth 25 percent of their annual earnings to be indifferent between monopolistic and competitive pricing.

Lastly, we use our model to assess the welfare implications of homogeneous caps on credit card interest rates. In particular, we consider a uniform cap on lender spreads over the risk-free rate. We find that in our calibrated economy, homogeneous caps on spreads generate welfare losses among either high-income or low-income individuals, and caps on spreads that are too tight can harm low-income individuals.

While our article tackles several important issues, many questions remain. Are strategic interactions among credit card lenders limiting pass-through of monetary policy to households? Does lender market power inhibit innovation and the adoption of new lending technologies? What type and magnitude of aggregate fluctuations would generate negative profits for lenders, and what types of policies would prevent lenders from exiting various segments of the credit card market? We believe that our framework is tractable enough for future researchers to make progress on these questions as well as other important and unanswered questions in the consumer credit literature.

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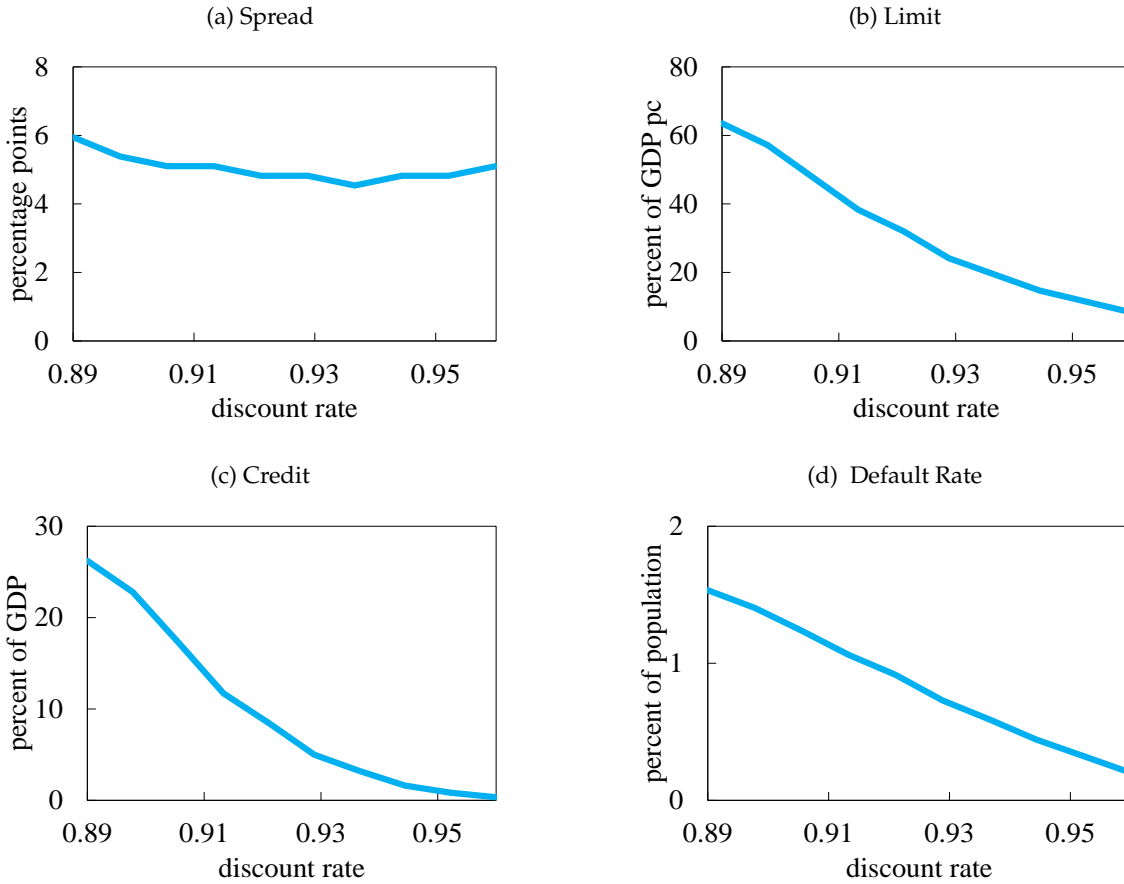
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Appendix

A Discount Factor Comparative Statics in Partial Equilibrium

Figure 19 plots comparative statics with respect to the discount factor in the economy with the 1970 monopoly in a small open economy. The risk-free savings rate is fixed at its 1970-75 target. The figure shows that a lower discount rate leads to higher levels of credit and default (panels c and d). However, most of the adjustment is through higher limits. There is little variation in the spread. Hence, with long-term contracts, lower discount factors in partial equilibrium don't account for the spreads observed in the data.

Figure 19: Discount Factor Comparative Statics for Monopoly in Partial Equilibrium



B Computational Algorithm

- Define grid on spreads and borrowing limits: $(\tau_1, \bar{l}_1), \dots, (\tau_N, \bar{l}_N) \in (\mathbb{R}_+, \mathbb{R}_+)^N$

- For each set of credit lines $S = \{(\tau_1, \bar{l}_1), \dots, (\tau_N, \bar{l}_N)\} \in (\mathbb{R}_+, \mathbb{R}_+)^N$, solve for the terminal 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 terminal stationary distribution of $\Omega(i, \theta, \eta, \epsilon, a; S)$ where $\Omega : \{g, b\} \times \mathbb{R}_+ \times \mathbb{R}_+ \times \mathbb{R}_+ \times \mathbb{R} \rightarrow [0, 1]$
 5. Given stationary distribution, update aggregate capital and total profits
 6. Repeat 2-5 until convergence
- For each set of credit lines $S = \{(\tau_1, \bar{l}_1), \dots, (\tau_N, \bar{l}_N)\} \in (\mathbb{R}_+, \mathbb{R}_+)^N$, solve for the transition path:
 1. Guess sequence of aggregate capital $K(S)$ and total profits $\Pi(S)$ for transition path
 2. Given sequence of aggregate capital and total labor (exogenous), back out sequence of wage rate $w(S)$ and interest rate $r(S)$
 3. Given set of credit lines, and sequence of total profits, interest rate, and wage rate, solve consumer's problem in each period through backward induction
 4. Given policy functions, simulate economy and solve for new sequence of aggregate capital and total profits
 5. Repeat 2-4 until convergence
- Solve for monopoly, Stackelberg duopoly, Collusive-Cournot, and perfectly competitive pricing
 - Monopoly: pick spread and borrowing limit that maximizes total profits across steady states
 - Stackelberg 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 net present value of profits
 - Collusive-Cournot
 1. Given number of lenders N and spread τ , solve for best response limit function of the second mover given the first mover's limit
 2. Solve for the symmetric Nash equilibrium limit (stage 2 outcome) for every spread τ
 3. Given stage 2 outcomes, pick the spread that maximizes profits in stage 1
 - Perfectly competitive pricing: solve for spread and borrowing limit that maximizes the welfare of unborn agent subject to weakly positive profits

If there is discrimination, we allow the lender to pick contracts that are dependent on the permanent component of earnings.

C Data Appendix

C.1 Identifying Credit Card Banks

We follow [Grodzicki \(2019\)](#) 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.

C.2 Computing Return on Assets

Following [Grodzicki \(2019\)](#), we calculate return on assets for bank i in year t according to the following formula

$$\begin{aligned} \text{ROA}_{it} &= \frac{\text{RIAD4000}_{it} + \text{RIAD4230}_{it} - (\text{RIAD4635}_{it} - \text{RIAD4605}_{it})}{\text{RCFD2170}_{it} - \text{RCFD2143}_{it}} \\ &= \frac{\text{income}_{it} + \text{loanleaseloss}_{it} - (\text{chargeoffs}_{it} - \text{loanrecoveries}_{it})}{\text{assets}_{it} - \text{intangible}_{it}} \end{aligned} \quad (13)$$

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 \(2019\)](#). 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 [14](#) includes the computed ROA series.

Table 14: 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	6.70%	14.82%	8.12%
1991	6.12%	14.82%	8.70%
1992	5.29%	14.35%	9.06%
1993	5.10%	14.65%	9.55%
1994	4.86%	14.87%	10.01%
1995	5.40%	15.03%	9.63%
1996	5.34%	14.99%	9.65%
1997	5.54%	14.40%	8.86%
1998	5.35%	14.93%	9.58%
1999	5.62%	16.92%	11.30%
2000	5.59%	17.15%	11.56%
2001	5.98%	14.31%	8.33%
2002	5.43%	12.47%	7.04%
2003	5.00%	10.38%	5.38%
2004	4.54%	9.14%	4.60%
2005	5.13%	9.16%	4.03%
2006	5.36%	10.19%	4.83%
2007	6.24%	11.38%	5.14%
2008	5.25%	11.07%	5.82%
2009	4.41%	9.91%	5.51%
2010	4.06%	6.51%	2.45%
2011	3.56%	6.40%	2.83%
2012	3.44%	6.16%	2.72%
2013	3.10%	6.10%	3.00%
2014	3.07%	6.11%	3.04%
2015	2.87%	5.47%	2.61%
2016	3.07%	5.33%	2.27%
2017	3.36%	5.55%	2.18%
2018	3.65%	7.20%	3.55%

Notes. See text for details of series construction.

C.3 Lawsuits

Table C.3 describes several relevant lawsuits against the credit card industry.

Table 15: Lawsuits against credit card payment networks and banks

Topic	Year Filed	Year Sued	Type of Suit	Plaintiffs	Defendants	Description of case	Resolution
Interchange Collusion	Fee 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 Collusion	Fee 2010	2018	Government Antitrust	US	American Express	Fought decision. Supreme court has ruled the anti-steering provisions are not anticompetitive. ^b	American Express won case.
Interchange Collusion	Fee 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 Collusion	Fee 2005	Present	Class Action	Merchants	American Express	Anti-steering provisions ^d	Currently Unresolved. Likely 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 Currently Unresolved.
Collusion Block Entry Exclusionary Contracts	to 1998	2001	Private Suit Government Antitrust	Black Card LLC US	Visa, JP Morgan, Chase, Capital One Visa, Mastercard	Visa colluded with JP Morgan and Capital One to block entry of Black Card LLC ^e	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 their member banks to issue Amex cards ^f	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 ^g	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 ^h	Defendants ordered to pay \$2.8 billion Breakdown: Visa ordered to pay \$1.9 billion Mastercard ordered to pay \$900 million \$3.05 billion settlement
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. ⁱ	Breakdown: Visa paid \$2.025 billion Mastercard paid \$1.025 billion Agreed to change the rules Undisclosed Settlement
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	

^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>

^g [United States v. Visa USA, Inc., 163 F. Supp. 2d 322 \(S.D.N.Y. 2001\)](https://www.nytimes.com/2008/06/26/business/26credit.html)

^h [Kim, J. I. \(2007, Nov 08\). 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](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](https://www.nytimes.com/2008/06/26/business/26credit.html)

^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>

D Parameters for Partial Equilibrium Re-calibration

We assume the small open economy risk free rate is 1.27 percent, which was our calibration target for the general equilibrium model.

Table 16: Parameters determined jointly in equilibrium

Parameter		Value	Target	Data	Model
χ	Stigma	8.490	Charge-off rate	2.57	2.73
κ	Scaling parameter	0.651	Fraction of bankruptcy due to divorce, health, lawsuits	44.81	42.69
β	Discount rate	0.953	Credit to GDP	0.74	0.73