Market Power in Credit Markets*

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Abstract

This paper studies the effects of limiting lender market power in the unsecured credit market. We propose an imperfectly competitive model with credit pricing determined not only by default probability but also by households' current and future outside options, giving rise to profit margins distribution consistent with the data. We show that the parameterized economy features strong general equilibrium effects, by which imposing a cap on interest rates which binds for a small fraction of contracts affects the whole interest rate distribution. The model implies increased access to credit and lower bankruptcy rate, implying significant welfare gains from the policy.

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1 Introduction

The scope and impact of lender market power in the unsecured credit market has long been a topic of intense debate in academic and policy circles[1], especially in the context of regulating financial products. On the one hand, regulating lender ability to extract profits can lead to credit rationing and welfare losses if the market is close to competitive. On the other hand, regulating high markup contracts can benefit borrowers if these markups are due to monopoly rents. These considerations spurred a variety of regulatory actions affecting the unsecured credit market, most recently the 2009 CARD Act, which regulated financial re-pricing and fee structures, and the proposed Loan Shark Prevention Act, which advocates for universal interest rate caps on credit cards. Empirical evidence is consistent with departures from perfect competition in the unsecured credit market,[2] which suggests that accounting for these features of the market is important for any policy discussion about potential interventions in consumer credit markets. However, theoretical literature offering a discussion of the qualitative and quantitative implications of market power in credit markets, and in particular, its effect on policy evaluation, is still scant.[3] This paper aims to fill this gap by providing a theoretical and quantitative analysis of the effect of market power, as well as the impact of limiting it via regulation.

In our analysis, we build a quantitative model of unsecured borrowing in which the market is imperfectly competitive and contract pricing depends on households' outside options, current *and* future. Specifically, we explore the implications of market power of lenders in a parameterized quantitative dynamic incomplete markets model with income risk. We micro-found the distribution of markups in the economy by modeling search and matching frictions with high markup outside option for unmatched households. Specifically, in order to obtain a loan contract, the household searches in a competitive search environment. Market tightness (ratio of lenders to borrowers) determines the probability of obtaining a loan in the search market and the pricing for each household type, given by the household's current debt and income. Crucially, if the household fails to match

[1] See, for example, Ausubel (1991), Evans and Schmalensee (2005), Galenianos and Gavazza (2021), Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015), Herkenhoff and Raveendranathan (2020).

[2] For an overview of empirical evidence, see Herkenhoff and Raveendranathan (2020), also Dempsey and Ionescu (2021) and Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015), who additionally document a positive relationship between default risk and profits per dollar of debt (profitability).

[3] Notable exceptions include Herkenhoff and Raveendranathan (2020) and Dempsey and Ionescu (2021). These papers, however, do not study the effects of interest rate caps.

with a competitive search lender, it gets an option of borrowing from a lender who realizes the household was not able to find a match and makes a high markup, take-it-or-leave-it offer, i.e. acts as a monopolist. This option captures reduced borrowing opportunities faced by households who fail to obtain the competitive search contract, and can be generalized to involve other outside options. As a consequence, the search friction determines markups in the competitive search market and the monopolistic market, but does not imply credit rationing. That is, if there exist a credit contract for a household that generates positive surplus, then the household is able to borrow. Depending on how attractive the household is as a borrower, the markups on the contract vary endogenously in both markets. We parameterize the model to two groups of households using income processes for 'High School' and 'College' in Guvenen (2009), and set the empirical targets for debt and default for the two groups using the Survey of Consumer Finances, which contains information on education. Our main parameterization, called *Benchmark*, matches aggregate debt and default statistics well, as well as untargeted average interest rates, charge-off rates, and additionally gives a good account of the distribution of interest rates vis-a-vis the data. The Benchmark model also implies profitability which *decreases* with repayment probability - consistent with empirical evidence.

Next, we show that modeling market power has significant implications for the evaluation of regulation and policies that impact markups and profitability of the lenders, even if the regulation directly applies to only a small number of contracts. Specifically, we consider the policy of introducing universal interest rate caps on credit contracts. Regulating unsecured lending interest rates is a mainstay in policy discussion on oversight of financial products, and introducing interest rate caps has been proposed as recently as 2019 as part of the Loan Shark Prevention Act which would impose a 15% limit on credit cards nationwide. In the baseline parameterization, the cap is set at 100%, which means that it is virtually not binding and we treat this as a reflection of the current state of regulation in the U.S.[4] In our experiment, we tighten the cap on interest rates gradually from 100% to 10%.

We find that in the Benchmark model, limiting market power of lenders has a significant negative effect on the interest rates, but a significant *positive* effect on debt and fraction of households

[4]Even though in principle each state has an interest rate cap policy (on credit cards), in practice the applicability of the caps is limited. The 1978 Supreme Court ruling in Marquette National Bank v. First of Omaha Corp. implies that lenders can apply the interest rate cap of the state where they headquarter rather than the state of the location of the borrower, which limited the ability to enforce strict state-level usury limits.

borrowing. Crucially, the pricing of *all* loans is more favorable: the entire distribution of interest rates shifts down as a result of the cap, even though only a small fraction of interest rates are actually directly against the cap. This suggests significant general equilibrium effects of regulating just the top interest rates. More favorable pricing of debt implies more households decide to borrow in equilibrium, and borrow more while they do. Additionally, debt becomes safer in response to cheaper borrowing and roll-over costs – both the chargeoff rate and the bankruptcy rate go down under tighter interest rate caps. The response to the policy across the two income group differs substantially. The 'High School' group sees a moderate increase in debt and fraction borrowing (by 4% and 14%, respectively), and a 3-fold reduction in bankruptcy rate. For 'College', cheaper credit results in a large increase in debt (by 50%) and fraction borrowing (by 26%), but virtually no change in bankruptcy rate. For both groups, we find significant welfare gains from the policy, ranging from 4% of lifetime consumption equivalent for the poorest households to 0.5% and 0.7% for the median household in the 'High School' and 'College' groups, respectively.

We provide further evidence of strong general equilibrium effects of interest rate caps in the Benchmark model in three counterfactual exercises. First, we fix the matching probabilities in the competitive search market to baseline values, thus controlling for the extensive margin of switching between the monopolistic and search market contracts. We find that the impact of changing search probabilities on debt outcomes is extremely small, implying the overwhelming importance of loan pricing. Second, we counterfactually allocate all borrowers to their relevant competitive search contracts, implying no household receives the monopoly outside option. We find that this counterfactual economy accounts for the entirety of the extensive margin increase of borrowing in response to the interest rate cap, and 56% of the increase in debt. This implies that the endogenous response of the competitive search market pricing accounts for the majority of the equilibrium effects of the interest rate caps. Finally, we document the fraction of interest rates in the search market and the monopoly market that decrease in response to the tightening cap despite being strictly below it to begin with. We find that between 56% and 84% of such interest rates are optimally adjusted downward. From these three experiments, we conclude that the majority of the effects in the model comes from equilibrium propagation from binding caps on a small number of high interest rate contracts to pricing of all contracts due to changing outside options of households.

In order to provide a baseline for comparisons of our Benchmark economy results, we consider a version of our economy with ex-post competitive pricing (*Competitive* model economy). We then compare the predictions of the Benchmark model to the analogously parameterized Competitive economy. Relative to the Benchmark model, the Competitive model has fundamentally different responses to the interest rate cap policy in terms of debt, default and welfare. In the Competitive model, the interest rate cap works through mostly the extensive margin of credit. The interest rates there exhibit low dispersion, and hence the cap does not bind initially and has no effect. Eventually, however, it starts binding for a large fraction of contracts, rendering them unprofitable and shutting down those loans. Importantly, in the Competitive model, there is very little general equilibrium effect on the interest rate distribution: the interest rates that are below the cap are barely affected by the fact that other, high interest rate contracts have to be repriced. This is in stark contrast to the Benchmark model, in which even contracts far below the cap are affected by the policy. This results in lower debt with tighter caps, eventually leading to no borrowing. The increasingly limited access to borrowing entails a significant welfare loss of about 1.5% of lifetime consumption for the median income household, and is significantly larger for the lowest incomes (up to 20%). Additionally, a contrasting cross-sectional prediction of the Competitive model relative to the Benchmark model is that the Competitive model predicts that profitability is monotonically increasing with repayment probability – opposite to the data and Benchmark model.

The prime feature of our quantitative model that differentiates it from other search-based credit market frictions modeled in the literature is the explicit introduction of the high markup outside option of unmatched households. We view this as a tractable way of capturing the fact that credit can be accessed by a household if there is positive surplus, but the exact pricing of that credit is endogenously pinned down due to the presence frictions. To capture the impact of allowing for the high markup outside option on model predictions, we analyze the quantitative predictions of a model with the competitive search market but no high markup option for unmatched households. What that means in equilibrium is that unmatched households with debt must repay or default. We find that this *No Outside Option* version of the model, parameterized using the same targets as the Benchmark, has a hard time matching aggregate statistics for debt and charge-offs, and requires implausible values of the time discount factor of households. Additionally, we find that the response to interest rate caps is dramatically different than in the Benchmark model. In the No Outside Option model, just like in the Competitive model, interest rate caps mostly affect contracts when they bind and do not have an equilibrium effect on the overall distribution of interest rates. As a result, caps on interest rates, when binding, reduce the surplus from matches and lead to shutting down of the corresponding markets, leading to *lower* debt and fraction borrowing, and implying a welfare loss from the policy of 0.8% and 1.2% of lifetime consumption for the median College and High School household, respectively, driven mostly by the extensive margin of credit supply.

Related Literature Our study relates to the broader literature providing motivation for and evaluation of policies that can potentially improve the functioning of credit markets. In the context of behavioral biases, this literature includes Heidhues and Kőszegi (2010), Heidhues and Kőszegi (2017) and Exler, Livshits, MacGee, and Tertilt (2020) and in the context of frictions in credit markets that lead to lender market power it includes Herkenhoff (2019), Herkenhoff and Raveendranathan (2020), Raveendranathan (2020), Galenianos and Gavazza (2021), Nelson (2020), Stango (2002) and Cuesta and Sepúlveda (2021). Generally, relative to search-based credit market frictions modeled in the literature, we are the first to explicitly include the endogenously determined outside option to unmatched households, which as we show is quantitatively very important. We discuss the three most related papers in turn. Herkenhoff and Raveendranathan (2020) study the effects of improved competition through entry in the unsecured credit market in an oligopolistic setup. They focus on equilibria with interest rate collusion and quantity competition, reflecting early evolution of the credit market. By contrast, we model a simpler contract structure, in which we allow contracts to vary by household state and focus on the general equilibrium effects of policy via the endogenous response of the price distribution. Galenianos and Gavazza (2021) study the aggregate response of the credit market to interest rate caps in an incomplete information environment in which the equilibrium response works through household search effort. Stango (2002) also consider a static environment and find that the welfare cost/benefit of interest rate cap regulation depends on the strength of market power of the lenders. Relative to these papers, we provide a fully dynamic consumption/saving model with full information in which the impact of interest rate caps comes from general equilibrium impact of households' changing dynamic outside options. Raveendranathan (2020) studies the determinants of average profitability in an search environment with credit lines, focusing on the effects of information frictions. We focus on the impact of market power on the distribution of profitability and study its consequences for the effects of regulation.

Finally, our Competitive model closely follows the perfectly competitive setups in Chatterjee, Corbae, Nakajima, and Rios-Rull (2007), Livshits, MacGee, and Tertilt (2007) or Livshits, MacGee, and Tertilt (2010), where we allow for non-negative upfront cost of making loans.

2 The Model

In this section, we set up a quantitative model of unsecured borrowing with endogenous level of competition for borrowers.

Time is discrete, and the economy is populated by ex-ante identical, infinitely lived households, who receive income shocks and use unsecured credit for consumption smoothing. A household enters the period with default status $d \in \{0,1\}$ and state $x \equiv (b,y)$. Default status $d = 1$ indicates that the household ended the previous period in default and $d = 0$ indicates that it did not. The state of a household consists of its default status d, debt level b (negative if the household is a saver) and current income y.

At the beginning of the period, households who are not in default (enter the period with $d = 0$) choose whether to become savers, borrowers or default on their debt obligations. Household in default are restricted to save. After the saving, borrowing and default decisions are made, the household draws next period's income y' from a distribution $G(y', y)$ with support $Y \times Y$. Then, households who enter the period in default transits out of default, i.e. enter next period with $d = 0$.[5] Households die stochastically at the end of each period with probability δ.

The value function of a household with default status d, debt b and income y at the beginning of the period is $V_d(b,y)$. Denote the value function of saving for a household by $V^S(b,y)$ and the value functions of borrowing and defaulting by $V^B(b,y)$ and $V^D(y)$, respectively. Then:

$$\begin{aligned} V_0(b,y) &= \max\left[V^D(y), V_0^S(b,y), V^B(b,y)\right], \\ V_1(y) &= V^S(0,y). \end{aligned} \tag{1}$$

Denote the next period's debt (or savings, if negative) of the household by b'. A household has

[5] This sets the period of exclusion from financial markets to the period of default plus 1 model period. Consistent with empirical literature finding that post-bankruptcy exclusion from borrowing is short (Jagtiani and Li (2013)). Longer, stochastic exclusion lengths do not change any of the conclusions from our quantitative analysis.

access to a competitive saving market at the risk-free rate r, which gives the value of saving:

$$
\begin{aligned}
V^S(b,y) &= \max_{c,b'} \Big(u(c) + \beta(1-\delta) \int_{y' \in Y} V_0(b',y') dG(y',y) \Big) \\
\text{s.t.} \quad & b' \leq 0 \\
\text{and} \quad & y - b = c - \frac{b'}{1+r}
\end{aligned}
\tag{2}
$$

A household can only default if it is not currently in default. A defaulting household's debt is erased ($b = 0$), it transits to the default state ($d = 1$) which precludes borrowing or saving during the period (i.e. consumption equals current income) and it incurs a one-off utility cost Δ.[6] We denote the value of defaulting by $V^D(y)$:

$$
V^D(y) = u(y) - \Delta + \beta(1-\delta) \int_{y' \in Y} V_1(y') dG(y',y) \tag{3}
$$

A household can only borrow if it is not currently in default. We denote the value of borrowing by $V^B(b,y)$, and it is pinned down by the equilibrium of the loan market, which we discuss in detail next.

The loan market Lenders are risk neutral, have access to borrowing at the risk free rate r, and pay cost κ to make an offer of a one-period loan to a customer of a specific type $x = (b,y)$. A loan specifies the amount that the household receives in the current period qb' and the amount that the household repays in the following period b'. The loan market is subject to frictions and consists of two options for the household. The first one is modeled as a competitive search equilibrium. Lenders post loans for each type x at cost κ (if profitable) and households observe all posted loans and decide which loan to search for. The probability of getting a loan in the competitive search market depends on the matching functions and the household-lender ratio at that loan. Specifically, denote the measure of lenders posting loan (q,b') targeted at type x by $L_x(q,b')$, the measure of households of type x searching for that loan by $H_x(q,b')$ and the resulting household-lender ratio (tightness) by $\theta_x(q,b') = \frac{H_x(q,b')}{L_x(q,b')}$. When the household-lender ratio is $\theta_x(q,b')$, a lender makes a loan with probability $\alpha_L(\theta_x(q,b'))$, the household receives a loan with probability $\alpha_H(\theta_x(q,b'))$ and,

[6] Potentially, current income is also reduced by proportion ϕ, either as payment to creditors or as a pure utility cost. These two specifications are equivalent for log utility and can easily be added for different risk aversion values.

with the complementary probabilities, they are left unmatched. We make the following standard assumption about the trading probabilities:

Assumption 1. The trading probabilities satisfy $\alpha_L(\theta) = \theta\alpha_H(\theta)$, $\alpha_L(\theta)$ is increasing and concave in θ, $\alpha_H(\theta)$ is decreasing and convex in θ, $\lim_{\theta\to\infty} \alpha_L(\theta) = \alpha_H(0) = 0$ and $\alpha_L(0) = \lim_{\theta\to\infty} \alpha_H(\theta) = 1$.

The second part of the lending market consist of an option of a high markup monopolistic contract, which the household can get with probability 1. Hence, this option is only attractive to households who are left unmatched in the competitive search market for loans. Specifically, when a household fails to match with a lender, we assume that they are matched to a monopoly lender, who makes a take-it-or-leave-it loan offer to the household. The household's outside option in such case is the value of default or saving, whichever is highest. Hence, if the household's search is unsuccessful, it receives the monopolistic contract's value, which absent constraints on the market power of the monopolist is equal to the value of financial autarky (default or repayment, whichever is better) but without necessarily reducing debt levels to zero, since it receives a loan from the monopoly lender.[7] This assumption is intended to capture the fact that households with low probability of obtaining a competitive offer may still be able to obtain a loan, just at less attractive terms, and can easily be relaxed to allow for more competitive outside option than a monopolistic offer. What is crucial is that it prevents the households who fail to match with a lender in the search market to be forced into bankruptcy by requiring that they repay their debt immediately. The existence of the monopolistic contract option means that the level of competition for a specific household type pins down the markup in the competitive search market and the probability of getting the competitive search contract versus the monopolistic contract, which then determines average markups. Crucially, however, it does not lead to credit rationing, i.e. households whose surplus from a lending relationship is positive always get a contract offer.

Given the above, the value to a household of type $x = (b, y)$ of receiving loan (q, b') is:

$$v_x(q, b') \quad = \quad u(y - b + qb') + \beta(1-\delta)\int_{y'\in Y} V_0(b', y')dG(y', y) - V^M(b, y),$$

[7] Under limits to market power, such as the ones considered in Section 3.1, the value delivered by the monopolistic contract may exceed the value of financial autarky.

where V^M is the value of monopolistic outside option, formally defined below. The value function of borrowing satisfies:

$$\begin{aligned} V^B(b,y) &= \max_{(q,b')} \Big(\alpha_H\big(\theta_x(q,b')\big) v_x(q,b') + V^M(b,y) \Big) \\ \text{s.t. } \kappa &= \alpha_L(\theta_x(q,b'))\Big(-qb' + \frac{b'\rho(b',y)}{1+r} \Big) \end{aligned}$$

where $\rho(b',y)$ is the repayment probability. The constraint determines market tightness and lender entry to satisfy the free entry condition which states that expected profits cover the up-front cost κ.

Define the profits of delivering net value v to household type x as:

$$\begin{aligned} \Pi_x(v) &= \max_{q,b'} \ -qb' + \frac{\rho(b',y)b'}{1+r} \\ &\quad \text{subject to} \\ v &= u(y-b+qb') + \beta(1-\delta)\int_{y'\in Y} V_0(b',y')dG(y',y) - V^M(b,y) \end{aligned} \tag{4}$$

In equilibrium, entry determines the optimal contract (q^*, b'^*) and corresponding market tightness $\theta_x(q^*, b'^*)$ such that the free entry condition is satisfied:

$$\alpha_L(\theta_x(q^*,b'^*))\Pi_x(v_x(q^*,b'^*)) = \kappa.$$

Finally, the loan offered to a type-x household by the monopoly lender solves:

$$\begin{aligned} &\max_{q,b'} \ -qb' + \frac{\rho(b',y)b'}{1+r} \\ \text{s.t. } u(y-b+qb') + \beta(1-\delta)\int_{y'\in Y} V_0(b',y')dG(y',y) &\geq \max[V^S(b,y), V^D(0,y)] \\ \pi_x^M(q,b') &\geq \kappa \end{aligned} \tag{5}$$

Notice that if monopoly profits are below κ then there is no lender entry in that market and the household can only choose between default and saving. Denote the solution to (5) as (q^M, b'^M).

Then the value of the monopolistic contract to the household is:

$$V^M(b,y) = u(y - b + q^M b'^M) + \beta(1-\delta)\int_{y'\in Y} V_0(b'^M, y')dG(y', y).$$

3 Parameterization and Results

In this section, we detail the choices of our functional forms and parameter values. The utility function is CRRA, with relative risk aversion coefficient of $\sigma = 2$:

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma}.$$

The matching function $m(H, L)$ is

$$m(H, L) = LH(L^\gamma + H^\gamma)^{-1/\gamma}$$

which gives the matching probabilities as functions of the household-lender ratio $\theta \equiv H/L$:

$$\alpha_H = m(H, L)/H = (1+\theta^\gamma)^{-1/\gamma}, \quad \alpha_L = m(H, L)/L = (\theta^{-\gamma}+1)^{-1/\gamma}.$$

In the benchmark parameterization, we set $\gamma = 1$.

The period in the model is one year, and accordingly, we set the death hazard rate to $\delta = 2\%$ (so that households live for 50 years, i.e. enter the economy at 21 and live up to 71 in expectation). We set the real risk free rate to $r = 1.44\%$ which is the real yield on 3-month t-bills over the period 1990-2004. We focus our calibration on this period, as it covers the years before the 2005 BAPCPA overhaul of the bankruptcy filing regulation, and the Great Recession, hence avoiding any regime changes or unusually large shocks to the credit market.

We calibrate the income processes in the model to the early 2000s, allowing for two groups of households, identified in the data by their education attainment. Specifically we take the income processes estimated in Guvenen (2009) for 'High School' and 'College', and then we approximate the process for income of each of the groups, of the form

$$\ln(Y_t) = ln(z_t) + \varepsilon_t,$$

where the persistent part is

$$\ln(z_t) = \rho \ln(z_{t-1}) + \eta_t,$$

and η_t and ε_t are i.i.d. with means zero and standard deviations σ_ε and σ_η. Both the persistence parameter and the volatilities of innovations are education-group-specific. We map the above continuous log processes into a 25 state Markov chain using the method in Rouwenhorst (1995). To compute the model, we use the income process in levels.[8]

We calibrate the set of parameters which are at the heart of this paper: the discount factor by education group g, β_g, the utility cost of default by education group, Δ_g, and the common entry cost of lenders, κ.

Details of data targets For targets, we use the education group specific debt-to-income ratios, bankruptcy rates, and percent of households holding credit card debt. We use micro-data from the Survey of Consumer Finances (SCF) in 2001 and 2004 and aggregate data from the Flow of Funds for 2000-2004 and filing rates for Chapter 7 bankruptcy over 2000-2004. Using the SCF, we place a household in the 'High School' group if the household head has less than 16 years of education (i.e. this includes 'some college'); this group accounts for 69.11% of all households in our sample. We place a household in the 'College' group if the household head has 16 years of education or more, which accounts for 30.89% of households in our sample. We use these group weights to calculate the aggregates for the various variables. The data targets from the SCF are calculated using survey years 2001 and 2004, in order to avoid using the data after the introduction of the bankruptcy reform of 2005 (BAPCPA). As Albanesi, DeGiorgi, and Nosal (2022) show, the reform had major effects on the bankruptcy and delinquency behavior of households, and it is not within the scope of the current paper to address these responses. For the group specific debt/income targets, we first calculate the average debt on major credit cards relative to average income for

[8] Specifically, the persistence and the variances of the normal disturbances η and ε shocks are taken from Table 1 in Guvenen (2009).

each of the 2 educational groups, averaged over survey years 2001 and 2004. Since unsecured debt is underreported in the SCF relative to aggregate data, we scale all groups debt/income by the same proportion so that the aggregate implied revolving credit/income over survey years 2001 and 2004 matches the aggregate revolving debt to income of 9.24%, which is the Flow of Funds 2000-2004 average. That gives 2 debt/income targets: 12.45% for High School and 6.7% for College. To calculate the group-specific proportion of households with unsecured debt, we compute the fraction of households in the SCF that carry a positive balance *and* pay interest on their credit cards, for each education group on average over the survey years 2001 and 2004.[9] The proportion of households with credit card debt is 39.77% for the High School group and 39.41% for the College group. Finally, for the default rate, we first compute the fraction of households in the SCF with a new bankruptcy over the last 3 years, for each education group on average over the survey years 2001 and 2004. We then rescale these fractions so that the aggregate bankruptcy rate equals the aggregate filing rate for Chapter 7 bankruptcy over 2000-2004 which is 5.82 per thousand. The default rate for the High School group and the College group is then 7.73 and 1.54 per thousand, respectively.

The above strategy gives us 5 calibrated parameters, $(\beta_{HS}, \beta_C, \Delta_{HS}, \Delta_C, \kappa)$ in total to match 6 moments in the data (debt/income, bankruptcy rate, fraction with debt for 2 education groups).

In addition to the *Benchmark* calibration of the model of Section 2, we calibrate the *Competitive* model, which is based on the standard model of default with competitive pricing of default risk, with entry cost for lenders (κ) and no matching frictions. This serves as a useful benchmark for our analysis, as this model is features ex-post perfect competition which is the basis of a large proportion of the papers used in the literature. Specifically, the loan size (b') and price (q) is determined by the following zero profit condition

$$-qb' + \frac{b'\rho(b',y)}{1+r} \quad = \quad \kappa \tag{6}$$

For each of the two models, we pick the calibration which minimizes the sum of square deviations

[9]Some households with a positive credit card balance might repay their debts every months, i.e. use their credit card for transacting rather than borrowing purposes. Requiring that a household also makes interest payments on the credit card restricts attention to households that roll over at least some of their debt from month to month and, hence, are borrowing on their credit cards.

from the targets. Parameter values are reported in Table 1.

Table 1: Model parameters.

Parameter		Value
	Common Parameters	
σ	risk aversion	2
γ	elasticity of the matching function	1
δ	death hazard rate	2%
r	risk free rate	1.44%
ρ_C, ρ_{HS}	persistence of income process	0.979, 0.972
σ_ε^2 , σ_η^2 College	volatility of the income innovations	0.047, 0.0099
σ_ε^2 , σ_η^2 High School	volatility of the income innovations	0.052, 0.011
	Benchmark	
β_C , β_{HS}	time discount factors	0.8925, 0.84
Δ_C , Δ_{HS}	bankruptcy stigma	3.8, 1.6
κ	loan upfront cost	0.0011
	Competitive	
β_C , β_{HS}	time discount factors	0.88, 0.835
Δ_C , Δ_{HS}	bankruptcy stigma	3.57, 1.775
κ	loan upfront cost	0.0163

Model fit and aggregate statistics Below, we present quantitative results from our two model versions: *Benchmark* and *Competitive*. Table 2 presents the aggregate statistics. On top of the targeted statistics, we additionally report the un-targeted chargeoff rate and average interest rate.[10]

It is clear that both model versions are able to match the aggregate debt and bankruptcy statistics reasonably well. Additionally, both of them come close to also matching the un-targeted charge-off rates and interest rates. However, the differences between the models become apparent in the statistics related to the distribution of prices and profitability. Specifically, Figures 1-2 present average interest rates, debt balances and profitability (profit/debt) as a function of the expected repayment probability across the two models.

Figure 1, panel (a), shows that interest rates are higher for lower repayment (higher default) probabilities in the Benchmark model, falling monotonically as repayment probabilities go up. By

[10]The model fit by education group is presented in Table 6 in the Appendix.

Table 2: Data and model outcomes.

Targeted Moments	Data 2000-04	Benchmark	Competitive
Debt/Income %	9.24	9.05	9.5
Bankruptcies per 1000	5.81	5.12	6.12
Fraction with debt %	39.7	42	40
Untargeted Moments			
Average interest rate %	13	14	13
Charge-Off Rate %	4.9	3.6	3.6

[a] Data point for interest rates is a 2001-2004 SCF average.

contrast, in the Competitive model, interest rates vary much less with default probabilities and exhibit no clear monotonic pattern.[11] As for debt balances, presented in panel (b) of Figure 1, both models predictably imply a negative relationship between repayment probability and debt balances, with the Benchmark model implying higher debt balances per capita for higher risk individuals compared to the Competitive model.

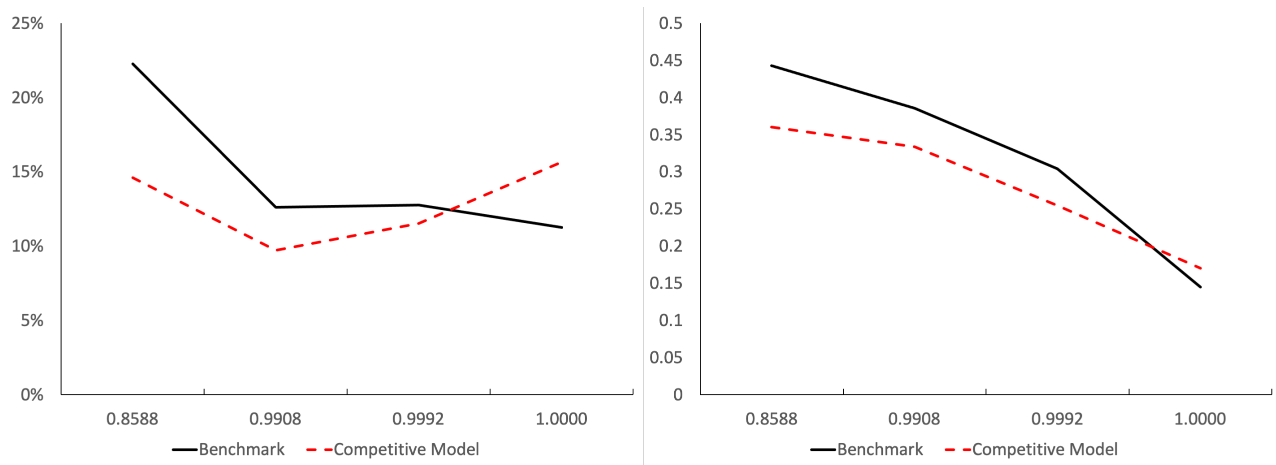
The distinction in the predictions of the two models is in the distribution of profitability as a function of default risk, as presented in Figure 2. Profitability in the Benchmark model is high for high risk borrowers and generally decreases with repayment probability, in stark contrast to the Competitive model, which implies that profitability *increases* with repayment probability. Intuitively, the difference in the two models' predictions for the distribution of profitability is driven by the fact that in the Competitive model, pricing is exclusively determined by the risk of default, as in equation (6), while in the Benchmark model, it is additionally affected by the household's outside options, as implied by problem defined by (4). This implies that the Benchmark model comes close to the empirical pattern documented in Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015) that profitability peaks at low credit scores.[12] Panel (b) of Figure 2 also presents profitability in the Benchmark model split between the competitive search and the monopolistic market. Both

[11]This is a feature of the competitive model with an upfront cost of making a loan $\kappa > 0$. The low risk borrowers borrow less (panel (b) of Figure 1) and hence in order for the contracts to break even, the interest rates have to be relatively high. For the case of $\kappa = 0$ in the Competitive model, interest rates qualitatively mimic those in the Benchmark model, but profitability is just flat at zero.

[12]We take repayment probability as a negatively-related proxy to credit scores, in line with the empirical and theoretical literature, for example Musto and Souleles (2006), Chatterjee, Corbae, Dempsey, and Ríos-Rull (2020) or Albanesi, DeGiorgi, and Nosal (2022).

Figure 1: Interest rates and debt by repayment probability.

(a) Interest rates (b) Borrowing b'



markets are characterized by a hump-shaped profitability distribution, peaking at relatively low repayment probability. This is qualitatively in line with the low-FICO hump documented in Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015) . Additionally, the Benchmark model peaks at profitability of around 8%, which is within 5% and 12% the range reported for low FICO scores.

The models' predictions for the median, 10th, 90th and 95th percentile of the interest rate distribution are presented in Table 3, where we also present the empirical moments reported in Galenianos and Gavazza (2021). The interest rate distribution implied by the model does not imply large numbers of high interest contracts - which means that even the monopolistic contract interest rates are endogenously curtailed by the households' participation constraint. At the same time it shows promise in the ability to account for interest rates of very high risk contracts, as implied by the 95th percentile of the distribution of 44%. These very high interest rates have been reported in Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015), who compute fee- and interest-inclusive rate *charges* of 45%.[13] Overall, we view the predictions of the models in terms of interest rates as falling within the range reported in the empirical literature, with the Benchmark model better able to capture the range of interest rates of high risk groups.

[13]See Table III in Agarwal, Chomsisengphet, Mahoney, and Stroebel (2015). For unsecured loans in Chile, Cuesta and Sepúlveda (2021) report the 90th percentile of interest distribution of 38%.

Figure 2: Profitability (profit per unit of debt) by repayment probability.

(a) Benchmark and Competitive models (b) Search Market and Monopoly Market

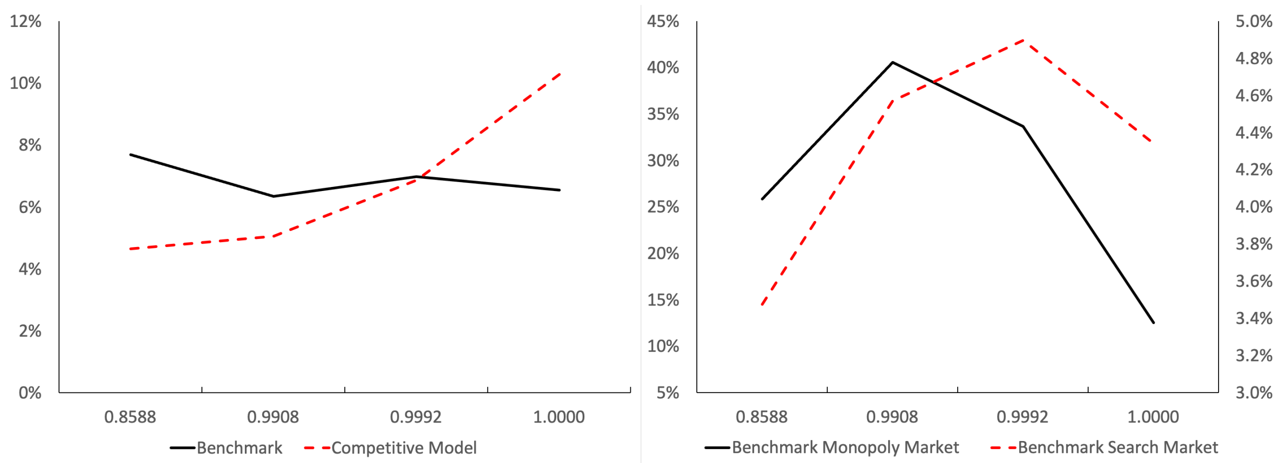


Table 3: Distribution of interest rates in the model and data (in %).

Moments	p10	p50	p90	p95
Benchmark	7.8	9.2	19.1	44
Competitive	8.9	11.2	18.9	20
Data Galenianos and Gavazza (2021) sub-prime	11.9	20.65	30	
Data Galenianos and Gavazza (2021) near-prime	10.5	18.24	29	
Data Galenianos and Gavazza (2021) prime	9.9	16.7	26	
Agarwal et al.(2015) fee-inclusive charges highest risk				45[a]

[a] This number comes from Agarwal et al. (2015), Table III and is the income (interest and fee charges) as a fraction of average daily balance for accounts below FICO score of 620.

3.1 Limiting Market Power: Interest Rate Caps

The analysis in the previous section indicates that the Benchmark model matches well the features of the distribution of pricing and profitability. The model implies pricing that is linked not only to default risk, but also to households' outside options, that in turn are a function of the distribution of contracts in the market. Intuitively, this can have significant implications for the evaluation of regulation or policies that impact markups and profitability of the lenders, even if the regulation directly applies to only a small number of contracts. If the general equilibrium effects are strong, the whole distribution of offered rates can shift in response, implying significant effects on aggregates.

In this section, we illustrate this point by considering the effects of the introduction of universal interest rate caps. Regulating unsecured lending interest rates is a mainstay in policy discussion on oversight of financial products, and introducing interest rate caps has been proposed as recently as 2019 as part of the Loan Shark Prevention Act which would impose a 15% limit on credit cards nationwide. Below, we consider varying interest rate caps from the Benchmark value of 100%, i.e. virtually not binding, which we take as the current state of affairs in the US, to a much tighter level of 10%. We discuss the aggregate effects of introducing this policy, as well as the effect on the distribution of interest rates. Then, we conduct counterfactual exercises to shed more light on the mechanism behind the model's response, isolating in turn the general equilibrium effect of changing caps on the distribution of interest rates, the effects of changing matching probabilities, and the general equilibrium impact of the changing the monopolistic outside option.

Figure 3, panel (a) and Figure 4 present the average interest rates, debt and fraction borrowing as a function of the interest rate cap. In the Benchmark model, limiting market power of lenders has a significant negative effect on the interest rates, but a significant *positive* effect on debt and fraction of household holding a balance. On the extensive margin, the fraction of households with a monopolistic and search market contracts both increase under the tighter cap (Figure 5). Both of these markets face more favorable pricing of debt (Figure 3 panel (b)), which explains why more households decide to borrow in equilibrium. Despite growing debt and fraction borrowing, debt becomes safer in the Benchmark model – both the chargeoff rate and the bankruptcy rate go down under tighter interest rate caps (Figure 6).

The interest rate cap applies to a small fraction of contracts in equilibrium, ranging from 2% to 11% at 19% cap, all the way up to the tightest cap of 10%, when 19% of contracts are at cap.[14] However, in the Benchmark model it results in significant effects on the *entire* interest rate distribution, suggesting strong general equilibrium effects. Specifically, Figure 7 presents the percentiles of the interest rate distribution as a function of the interest rate cap. We can see that the whole distribution of offered interest rates shifts down in response to the cap in the Benchmark model, even though the cap does not directly bind for the majority of the contracts: the 90th percentile of the interest rate distribution is below the cap up until the cap hits 19%. This illustrates the effect of pure outside option value of regulating a small number of high interest

[14] See Figure 14 in Appendix A.

Figure 3: Average interest rates under different interest rate caps.

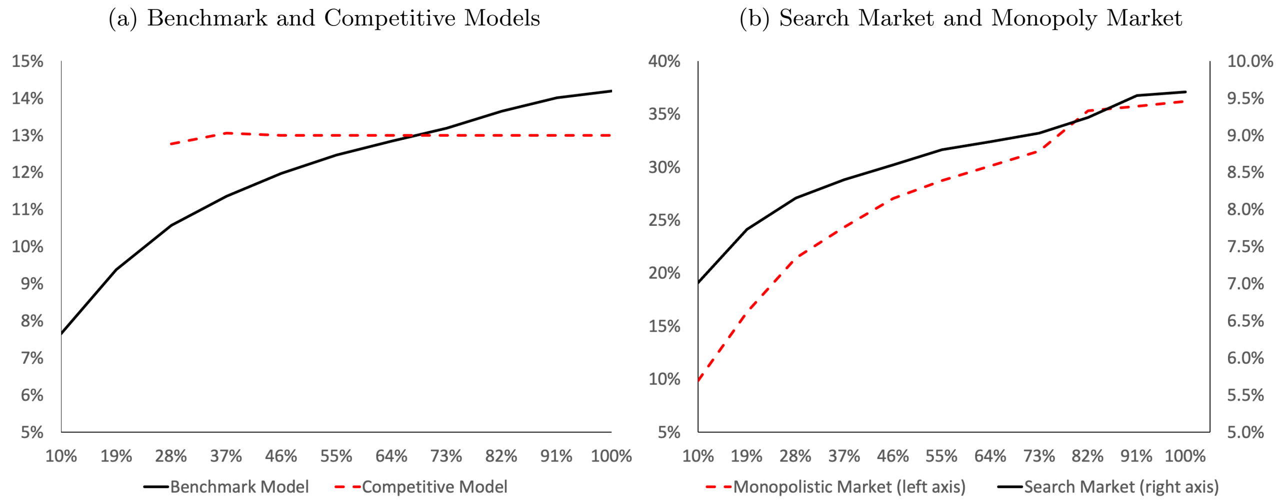


Figure 4: Debt/income and fraction borrowing under different interest rate caps.

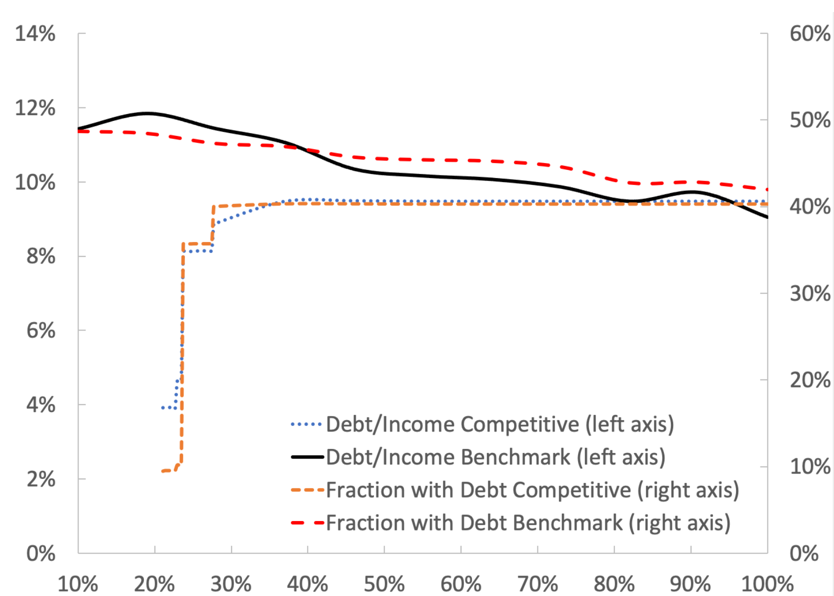


Figure 5: Fraction with Monopoly and Competitive Search contracts under different interest rate caps.

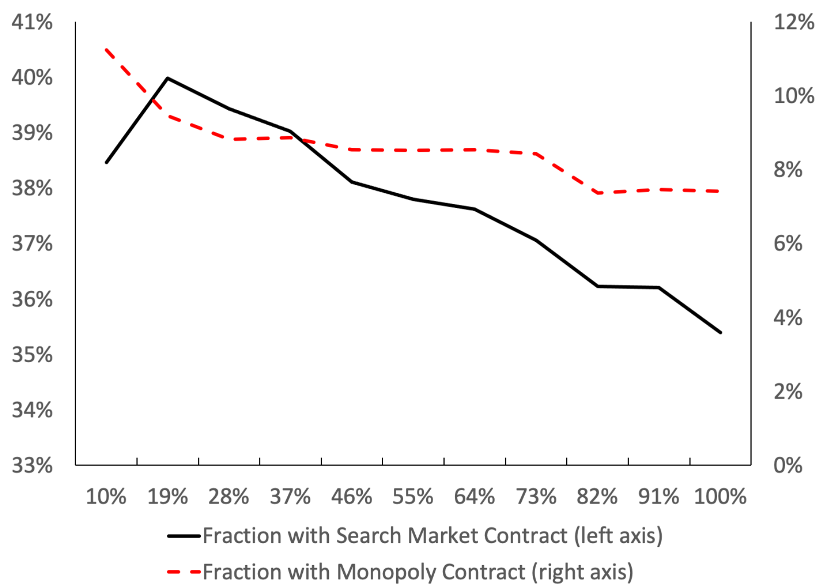


Figure 6: Bankruptcy rates and chargeoff rates under different interest rate caps.

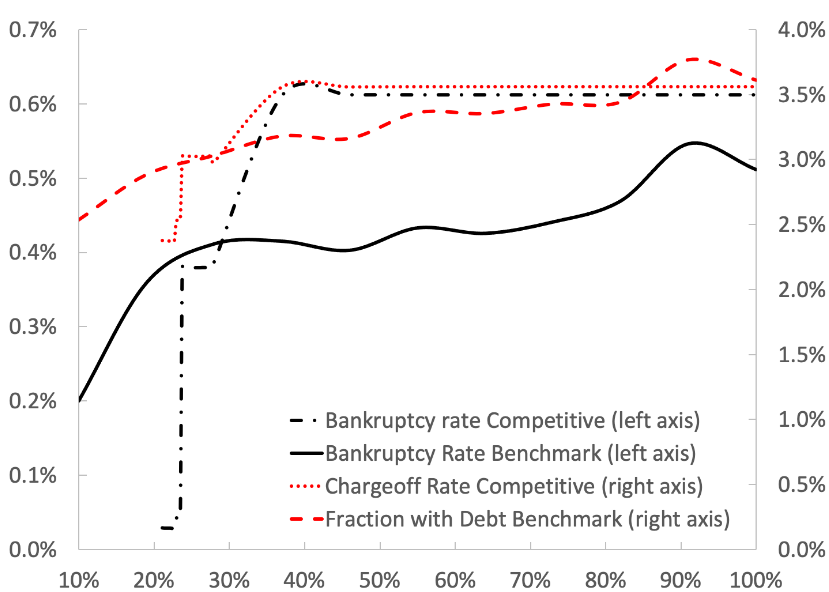
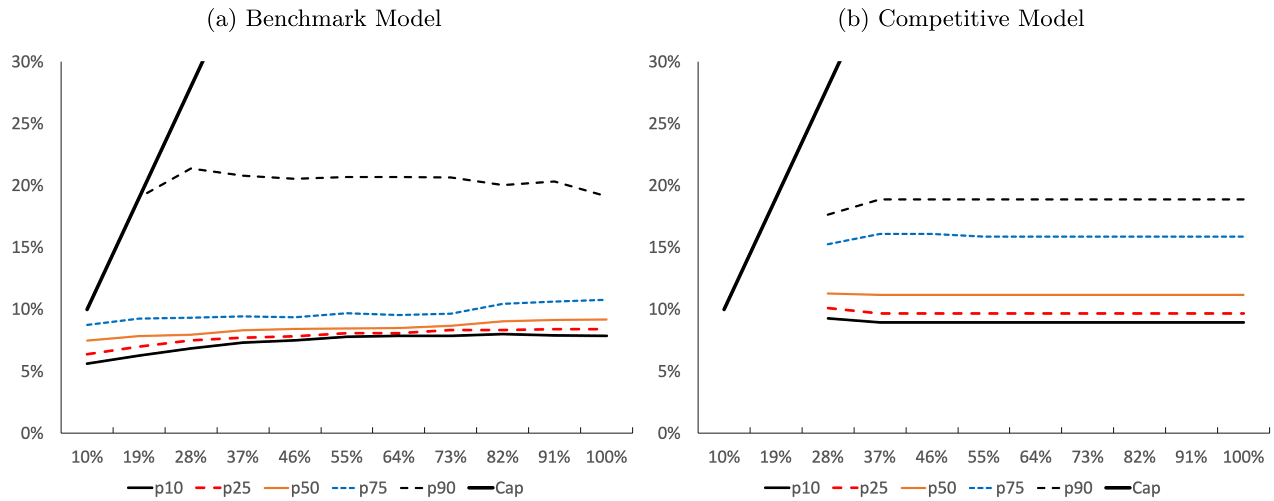


Figure 7: Percentiles of interest rate distribution under different interest rate caps.



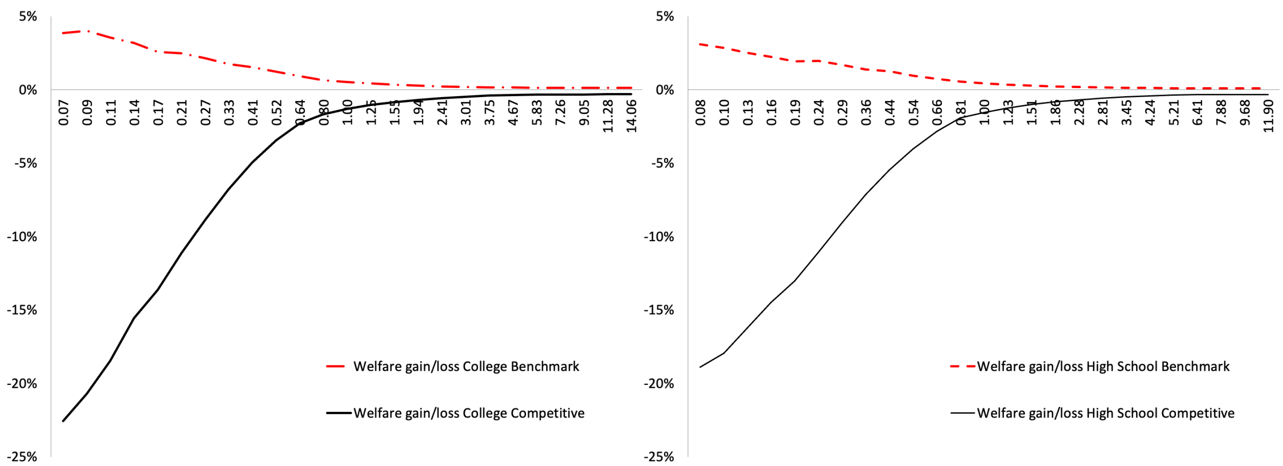
contracts: the fact that with positive probability the household may be directly affected by the cap *in the future*, changes the contract received today. This is also reflected in Figure 3, panel (b): both the monopolistic and search market average interest rates go down significantly in response to the cap.

For comparison, Figures 3 – 6 also present the prediction of the Competitive model in response to interest rate caps. The differences between the predictions of the two models are stark. In the competitive model, both interest rates and debt barely respond to the interest rate caps initially, followed by a drop in both and then a shutdown of the debt market. In the Competitive model, the dispersion of interest rates is smaller than in the Benchmark model, and hence initially the tightening cap has little effect. However, when it starts binding for more contracts, this results in markets actually closing down, as more constraints renders more households unprofitable and there are no markups to cushion the cap tightening. The tightening of the upper bound of the interest rate distribution actually mechanically (due to closing of markets) corresponds to an increase in the lower percentiles, contrary to the Benchmark model. Finally, because profits in the Competitive model are brought down to break-even by competition, a binding interest rate results in households being cut off from credit entirely.

The increased access to cheaper credit in the Benchmark model results in significant welfare gains, measured as lifetime consumption equivalent variation. Figure 8 presents the welfare

Figure 8: Welfare gain/loss 10% interest cap relative to benchmark as a function of income (relative to group specific median).

(a) College (b) High School

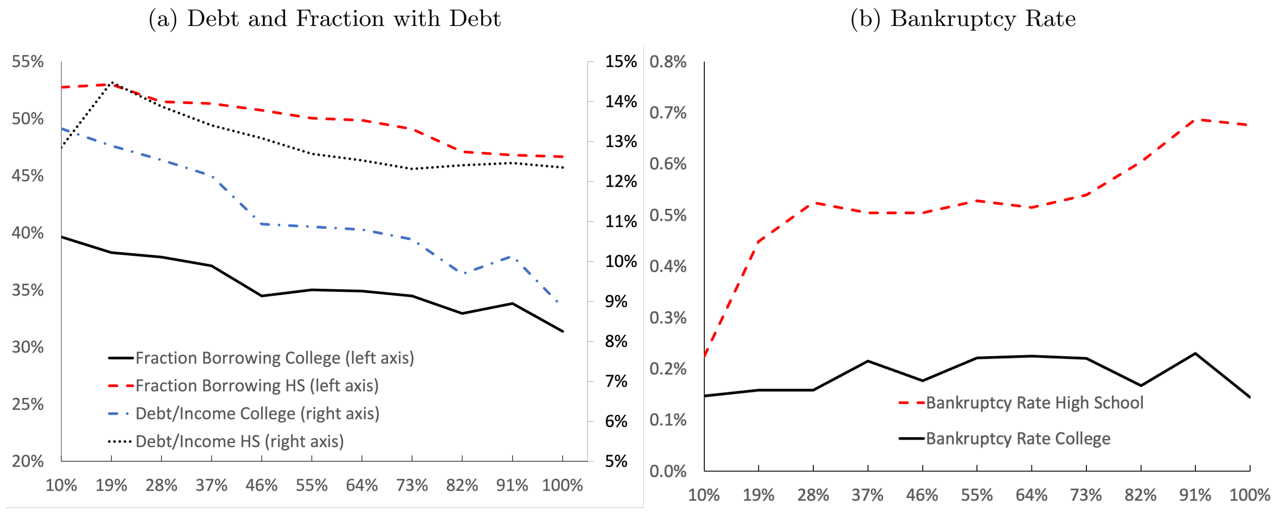


gain/loss by income for each of the education groups in the model, evaluated at initial zero debt.[15] The welfare gain in the Benchmark model is as high as 4% of lifetime consumption for the lowest incomes, and around 0.5% for median income households (0.5% and 0.7% on average for High School and College, respectively). By contrast, the credit rationing in the Competitive model results in a welfare loss of up to 20% of lifetime consumption for the poorest households, and around 1.5% for the median income household (-2.1% and -1.8% on average for High School and College, respectively). Intuitively, the contrasting predictions of the two models fit into two narratives of the proposed policy. One narrative claiming that regulating interest rates will make credit cards unprofitable and cut households off from credit is supported by the Competitive model. The other narrative that markups are high in the credit card market and regulating interest rates will make borrowing cheaper and increase access to credit, is supported by the Benchmark model.

The interest rate caps impact the two educational groups' in different ways in terms of debt and bankruptcy, as presented in Figure 9. For the High School group, debt/income goes up by only 4% going from 100% to 10% cap, while fraction with debt goes up 14%. Together with these modest increases, cheaper credit is consistent with significantly reduced bankruptcy rate. By contrast, for the College group mostly gains from the reform by increased credit access, with a 50% increase in debt/income and 26% increase in fraction borrowing, while the bankruptcy rate for that group

[15] We use income relative to median for each of the groups in order to be able to express them on the same axis.

Figure 9: Debt and default by education group.

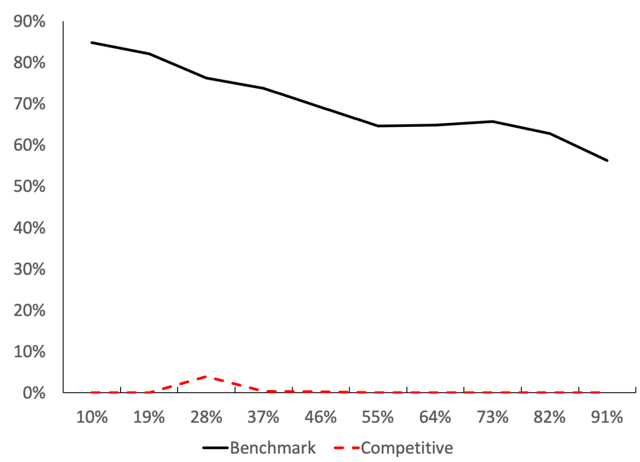


remains roughly constant.

Equilibrium effects of outside options on pricing In order to provide more evidence of general equilibrium effects of interest rate caps, below, we document how optimal policy functions on interest rates respond to the tightening interest rate caps. In particular, for the distribution of offered interest rates in the baseline calibration (i.e. cap of 100%), we calculate the fraction of those interest rates that fall strictly below each of the increasingly tightening caps, but are nevertheless optimally adjusted down under the new equilibria. That is, what is the fraction of interest rates that do not *have* to be adjusted down in the new equilibrium but still do. Figure 10 presents the result for the Benchmark and Competitive models. In the Benchmark model, the majority of contracts that are not affected by the cap still adjust downwards, from 56% for the 90% cap to 85% for the 10% cap, suggesting strong general equilibrium effects. By contrast, in the Competitive model, almost none of the contracts under the cap are adjusted, which is consistent with the interpretation that outside options do not impact pricing in the Competitive model.

Effects of matching probabilities Clearly, the response of the Benchmark economy to the policy involves changes to the equilibrium matching probabilities, which implies varying fractions of borrowers with the search market versus monopoly contract. Below, we isolate this effect by simulating a counterfactual economy which is endowed with the same matching probability function

Figure 10: Fraction of baseline contracts under the caps (horizontal axis) that are adjusted downward.



α_H as the baseline calibration. Panel (a) of Figure 11 presents the result for debt and fraction borrowing. The aggregate response of the economy is almost identical, implying that changing the probabilities of matching with the search market lender or monopoly lender (i.e. $1 - \alpha_H$) is not a significant driver of the results.

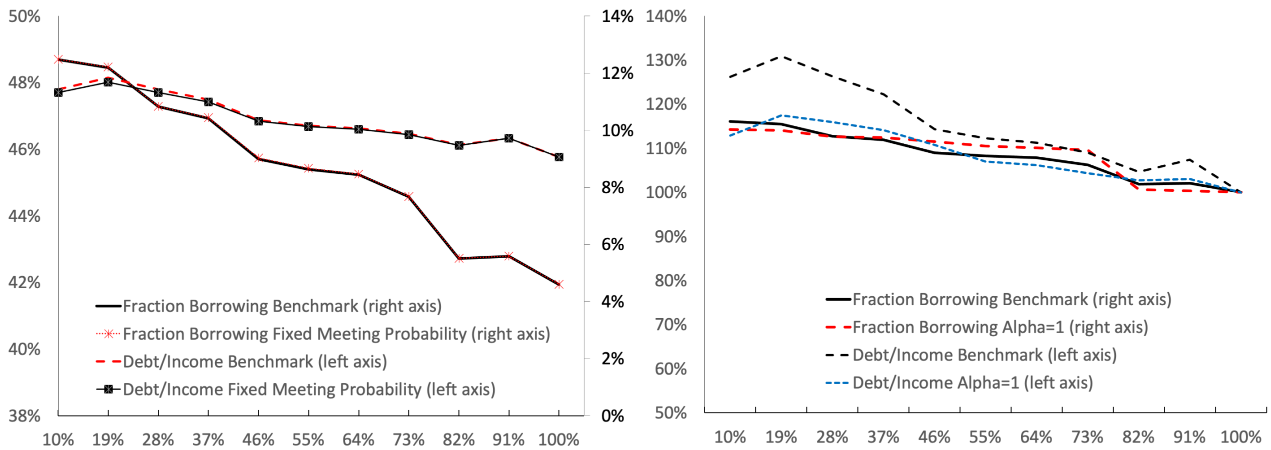
Direct versus indirect effect of high markup option Below, we quantify the indirect, equilibrium effect of changing monopolistic option pricing on search market pricing. To that end, we simulate the Benchmark economy with an counterfactual value of $\alpha_H \equiv 1$, i.e. no borrowers get the monopoly contract, but the search market contracts they receive are still impacted by the general equilibrium distribution of outside options in the economy. Panel (b) of Figure 11 presents the change in debt/income and fraction revolving *relative to the baseline case* for the counterfactual and actual response of the economy.[16] We find that the pricing impact within the competitive search market accounts at the peak for 56% of the debt/income response and all of the response of fraction of population borrowing.[17] We conclude that the general equilibrium effects of changing the outside options of households account for the majority of the aggregate response of the economy to the policy.

[16]The normalization is necessary because at $\alpha_H = 1$, both the level of debt and the fraction revolving do not overlap with the baseline economy.

[17]This last finding is not by construction, as the number of open markets on the simulation path depends on the now-different debt choices of households.

Figure 11: Debt and fraction borrowing under different interest rate caps: Benchmark Model and Fixed α_H model.

(a) Benchmark and Fixed α_H responses of the economy (b) Benchmark and $\alpha_H \equiv 1$ responses of the economy



3.1.1 No Outside Option Model

One of the fundamental features of our quantitative model that differentiates it from other search-based credit market frictions modeled in the literature is the explicit introduction of the high markup outside option of unmatched households. We view this as a tractable way of capturing the fact that credit can be accessed by a household if there is positive surplus, but the exact pricing of that credit is pinned down by frictions. In this section, we present results from the version of the Benchmark model without that outside option. What that means in equilibrium is that unmatched households with debt must repay or default. We parameterize this version of the model, labeled *No Outside Option*, using the same targets as the Benchmark, and present the aggregate statistics and the policy experiment.

Overall, the No Outside Option model offers a significantly worse aggregate fit compared to the Benchmark calibration (Table 5), significantly under-predicting aggregate debt/income and over-predicting fraction borrowing. In terms of untargeted moments, the model under-predicts charge-off rates by about 50%. It is important to note also that the No Outside Option model's calibration requires setting values of the time discount factors of the borrowers of around 0.6 (Table 4), which is very low relative to discount factors typically implied by the empirical rates of return savings. These predictions of the model are intuitive and follow directly from the credit rationing implied by the search friction. Because unmatched households must repay the debt or default, this lowers aggregate debt in equilibrium, and the model requires high rates of impatience to match debt/income ratios to compensate.

The crucial impact of the high markup option also shows up in the results from the interest rate cap policy experiment. Contrary to the Benchmark model, the No Outside Option model predicts that debt and fraction borrowing actually *decline* in response to the tightening caps (Figure 12). The reason for this is that even though the model does link pricing to outside option of saving or borrowing, the general equilibrium effect of changing these values in response to interest rate caps is not strong enough to affect the aggregate distribution. This can be seen in Figure 13, which presents the interest rate distribution. We can see that the tightening cap has very little effect except at the very top, in contrast to the Benchmark model (i.e. compared to Figure 7). As a result, the tighter caps in this version of the model work mainly by limiting the interest rates within matches, and hence reducing the efficiency of the match, eventually making an increasing fraction of them unprofitable. That extensive margin effect results in reduced credit access, as well as reduced welfare: the No Outside Option model predicts that the policy is associated with a welfare loss of 0.5% and 0.8% of lifetime consumption equivalent for College and High School groups, respectively.[18]

Table 4: Model parameter values in the No Outside Option model (if different from Benchmark).

Parameter		Value
β_C , β_{HS}	time discount factors	0.65, 0.61
Δ_C , Δ_{HS}	bankruptcy stigma	3.8, 1.5
κ	loan upfront cost	0.005

4 Conclusions

We provide a characterization of the impact of increased market power on the offered contracts in the credit market and the aggregate implications of the model. We propose a mechanism in which market power emerges due to search and matching frictions in the credit market where

[18]The figures for welfare gains/losses for this version of the model can be found in Appendix A.

Figure 12: Debt/income and fraction borrowing under different interest rate caps, No Outside Option model.

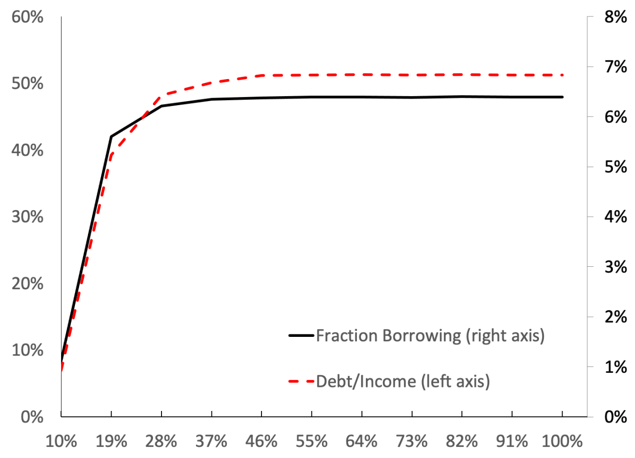


Figure 13: Percentiles of interest rate distribution under different interest rate caps, No Outside Option model.

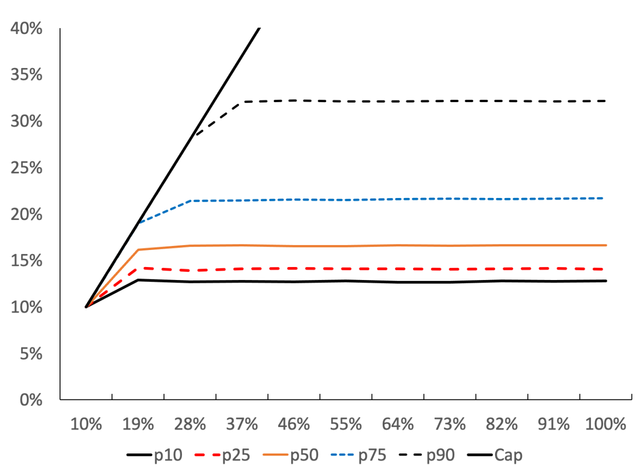


Table 5: Data and model outcomes.

Moments	Data 2000-04	No Outside Option
Debt/Income %	9.24	6.8
Bankruptcies per 1000	5.81	5.7
Fraction with debt %	39.7	48
ChargeOffs %	4.9	2.4
Interest rates %	13	20
Interest rate p10 %	10-12	12.8
Interest rate p50 %	16-20	16.4
Interest rate p90 %	26-30	32

[a] Data point for average interest rates is a 2001-2004 SCF average. Percentiles based on Galenianos and Gavazza (2021).

a high markup outside option is available. When embedded in a quantitative dynamic model, the mechanism delivers aggregate statistics, interest rates and profitability distribution consistent with the data. We show that the Benchmark model outperforms the No Outside Option model as well as the Competitive model. The parameterized model implies strong general equilibrium effects of households' outside options driving the distribution of offered rates. In the context of a policy limiting market power of lenders in the form of interest rate caps, we show that in the Benchmark model, these general equilibrium effects are responsible for the majority of the aggregate response, and imply increased and cheaper access to credit for all households, as well as lower bankruptcy and chargeoffs. The regulation implies significant welfare gains, especially for the poorest households. Our conclusions are in stark contrast to ones implied by the Competitive and Outside Option frameworks, in which the same interest rate cap implies *reduced* access to credit and welfare losses. Our research offers a tool for capturing the aggregate effects of regulation aimed at a small proportion of contracts, as it captures the equilibrium effects these contracts have on the entirety of the interest rate distribution.

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A Additional Tables and Figures

Figure 14: Fraction of interest rates at cap in the Benchmark model as a function of cap.

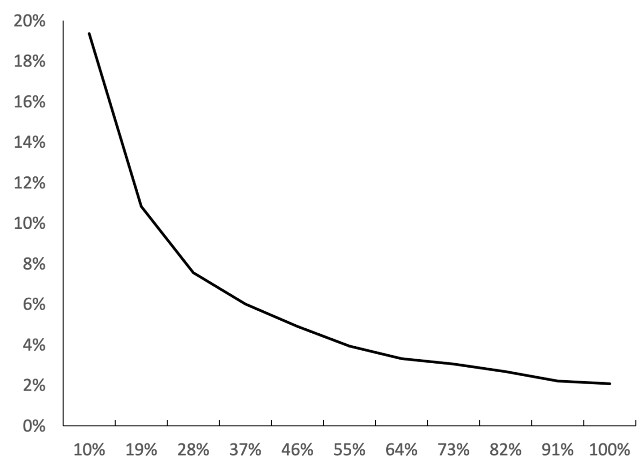

Figure 15: Welfare gain/loss 10% interest cap relative to benchmark as a function of income (relative to group specific median).

(a) College

(b) High School

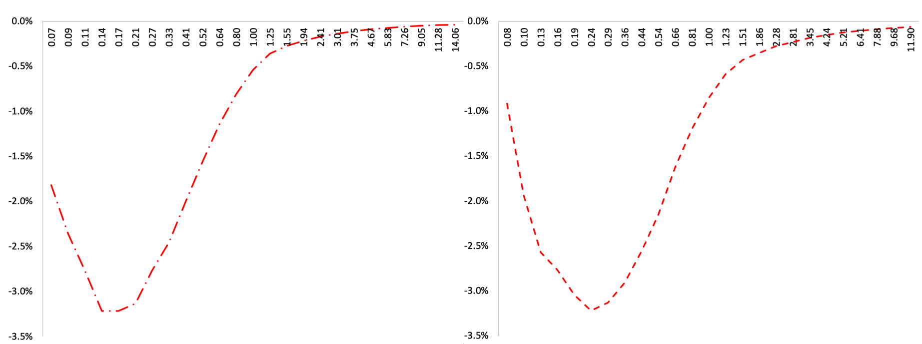

Table 6: Data and model outcomes by education group.

Moments	Data 2000-04	Benchmark	Competitive	No Outside Option
		High School		
Debt/Income %	12.45	12.35	12.67	8.6
Bankruptcies per 1000	7.73	6.76	8.2	7.4
Fraction with Debt %	39.77	47	43.6	50
		College		
Debt/Income %	6.7	8.86	9.46	7.4
Bankruptcies per 1000	1.54	1.43	1.41	1.56
Fraction with Debt %	39.4	31.37	32.8	45