Lending Standards and Consumption Insurance over the Business Cycle*

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February 15, 2019

Abstract

How much do changes in credit supply affect consumers' ability to insure against income risk over the business cycle and what is the valuation of such insurance? Using loan-level data from the Senior Loan Officer Opinion Survey (SLOOS), we construct measures of key credit supply variables, such as lending standards and terms for consumer credit in the U.S. and build a heterogeneous model of unsecured credit and default that accounts for credit supply dynamics as estimated from these data. Our economy is quantitatively consistent with key features of the unsecured credit market, earnings dynamics, and measures of consumption volatility in the U.S. We find that variability in standards and terms for credit is welfare improving despite the loss in consumption insurance that such an environment may induce. The key mechanism behind this result is the asymmetric effect that changes in standards induce for loan pricing in good and bad states of the economy.

JEL Codes: E21, E32, E44, E51, G12, G21, G22

Keywords: Bankruptcy, business cycles, consumer credit, consumption insurance, default

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*The views expressed here are those of the authors and do not necessarily represent the views of the Federal Reserve Board of Governors or the Federal Reserve System. We thank Jared Barry for outstanding research assistance.

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1 Introduction

Consumption is procyclical and less volatile than output, a stylized fact established by numerous studies.[1] The most common explanation provided is that consumers have a high incentive to smooth consumption over the life-cycle. Consequently, they consume only partly the increase in productivity during economic booms while saving some for the future. Similarly, in times of low productivity, consumers take on credit to consume more than otherwise feasible. Indeed, Gross and Souleles (2002) and Sullivan et al (2000) argue that in the data unsecured credit is used to smooth consumption as households with worsening income prospects tend to accumulate more debt and use bankruptcy more often. Consequently, consumption fluctuates less than productivity and output, and this crucially depends on the structure and availability of credit. For example, in a market setup that features a complete set of contingent claims, consumers will be able to perfectly smooth consumption, and as the economy departs from this setup, so does the degree of consumption insurance with the extreme case where only non-contingent debt is available.[2]

In this paper, we study the role of unsecured credit in providing consumption insurance against income risk to U.S. households in an environment that accounts for bank credit conditions in the U.S.. Specifically, we account for empirically accurate bank lending standards and terms on consumer credit in an economy that features competitively priced defaultable debt as in Chatterjee et al. (2007). We quantify the impact of dynamics in credit supply, as measured by bank lending standards, on consumers' ability to insure against income risk over business cycles.

Our research is motivated by two main facts. First, in line with the body of research that argues for consumers' need of credit to smooth consumption, we document, using the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) that consumers' demand for consumer credit does not fluctuate much across business cycles. In contrast, consumer credit supply is procyclical. Specifically, banks tighten standards and terms on consumer loans, such as credit limits and spreads, during recessions and ease them during economic booms. The dynamics of credit standards and terms seem to account for credit risk in the economy. Banks have an incentive to be stingy (lax) with consumer loans when the risk of delinquency is high (low) as it is the case during recessions (expansions). In fact, according to the SLOOS, one of the most cited reasons why banks decide to change lending standards and terms is the deteriora-

[1] See Cooley (1995) for an overview of seminal work and advancements on the topic.

[2] See Huggett (1993); Storesletten et al. (2004); Krueger and Perri (2006).

tion of (improvement in) their loan portfolio for that particular category of loan.

These two facts taken together suggest that there may be less availability of credit during downturns relative to consumers' needs and this may affect the ability of households to use credit card loans to insure against income risk during recessions. This may be an important effect given that individual income risk is relatively higher during recessions.[3] At the same time, easier standards and terms during expansions may translate into credit offering a good amount of insurance against income risk during good times and, in addition, allow households to accumulate wealth in times of high productivity. Furthermore, the fact that credit supply dynamics account for credit risk may positively affect the insurance value overall, as the absence of such dynamics, which, in turn, translate into inaccurate risk pricing, may potentially have adverse effects on the ability of households to use credit effectively. Our paper provides insight precisely into how these channels affect consumption variability in the U.S.

In order to answer the proposed question we build a heterogenous model of unsecured credit and default with idiosyncratic income risk that accounts for the observed patterns in the unsecured credit market. Our economy is an incomplete markets setting in the spirit of Huggett and includes competitively priced, defaultable debt as in Chatterjee et al. (2007). The key addition our model makes relative to the literature is the inclusion of bank lending standards and terms, which we specify in a flexible way that allows to incorporate the estimated processes of dynamics in standards and terms from the SLOOS. Our calibrated economy is therefore consistent with supply of bank credit for consumer loans and it delivers empirically consistent implications for demand for credit, credit limits and default rates for credit card loans. In particular, when standards on consumer credit are tight and loan spreads are high, our model implies that consumers face lower credit limits. Furthermore, for any given level of standards and prices, consumers with high income levels face relatively loose limits compared to consumers with low income levels.

Encouraged by the consistency of our model's implications for unsecured credit markets, we now turn to the central question of our paper: How much and how do the credit supply dynamics in the U.S. affect consumers' ability to insure against income risk over the business cycle? To address this question we run a counterfactual experiment in which the dynamics of bank credit conditions are absent, and instead, consumers face constant lending standards. Specifically, we replace the stochastic process of changes in lending

[3]Guvenen et al. (2013) show that while the variance of income shocks is very stable during both recessions and expansions (and for nearly all subpopulations of workers), the skewness of income shocks is strongly procyclical. So during recessions, the dispersion of shocks doesn't increase, but income shocks become more left-skewed and hence more risky.

standards in the baseline economy to an invariant index that is set to the mean historical value of lending standards. To isolate the effect of changes in credit supply on consumption insurance we measure the change in consumption volatility in this counterfactual economy relative to the baseline.

Our findings show that, overall, in an economy where variability in bank lending standards is not present consumption volatility does indeed decrease, albeit by a small margin (0.1 percent). This confirms the intuition that in a scenario where supply of credit does not fluctuate and standards and terms on credit card loans do not change with the state of the economy, consumers' ability to use credit to insure against income risk is positively affected. However, looking beyond the net effect on consumption variability, our findings provide several useful insights into the role of credit supply dynamics in the economy.

First, at odds with a relatively low level of consumption insurance in the baseline economy, there is a relatively higher level of indebtedness and participation in the unsecured credit market when credit standards variability is accounted for (debt-to-income ratio is 5 percent higher and the fraction in debt is 4.5 percent higher in the baseline than in the constant standards economy). Second, the default rate in the baseline economy is also higher relative to the economy where credit standards are held constant. These two sets of results suggest that consumers have a higher incentive to use credit and take on more risk in the unsecured credit market in an environment that accounts for changes in credit supply. Borrowing and default behavior has been associated in previous work, as argued before, with more insurance against income risk provided by credit markets, and not less.[4] Third, interestingly, the interest rate on credit card loans is relatively lower in the baseline, which apparently may be at odds with a relatively high risk of default in this economy. Last, an economy with variable credit standards promotes wealth accumulation relative to an environment where credit supply does not fluctuate.

How to reconcile these effects? The aggregate shifts in lending standards introduce rich dynamics in loan pricing in the baseline economy resulting in quite a bit of variation in the loan spread borrowers pay on a loan of a given size. We demonstrate that it is the asymmetric effect induced by this variation, and more generally, the asymmetric behavior of prices and default risk in *good* (loose lending standards) and *bad* (tight lending standards) states of the economy that is key in understanding the impact of credit supply dynamics. Specifically, our experiments predict that loan prices increase by more under loose lending standards than they contract under tight lending standards. This, in turn,

[4] One notable exception is Athreya et al. (2009), research that we discuss in the next section. Our results are consistent with their findings.

induces consumers to borrow more frequently, larger amounts, and default more when facing bad income draws in the variable standards economy. The relatively larger decline in prices in the *good* state of the world, automatically implies that the variable lending standards economy supports lower interest rates, on average, for the same level of indebtedness and default risk in the economy. Last, usage of credit in the good state of the economy is more likely to be associated with wealth accumulation than financial distress and so the asymmetric effect that we find explains the higher level of wealth-to-earnings in the baseline relative to the constant standards economy.

We evaluate the welfare implications of credit supply dynamics. We find that consumers prefer an economy where lending standards are variable, with those with relatively low levels of earnings valuing the variability in standards the most. This might seem counter-intuitive, given the constant demand of credit documented in the data and the belief that consumers with low income levels might be hurt by tight credit during recessions. However, given the asymmetric and large variation of loan pricing dynamics that variability in lending standards introduces, our welfare implications are, in fact, not surprising. We conclude that banks incentives to account for loan performance of their portfolios and consequently adjust standards and terms for credit is welfare improving despite the loss in consumption insurance that such an environment may induce.

1.1 Related literature

Our paper contributes to the large and growing literature on the insurance of consumption against income shocks and the role of credit markets in helping households insure. Blundell et al. (2008) show empirically that longer-lived income shocks have resulted in increased consumption inequality relative to income inequality. While these authors find no evidence that the degree of insurance available for a given shock has changed, increased variance in earnings processes leaves households more exposed to existing methods of insurance.[5] This speaks to the importance of understanding the supply side of this market, which is the key jumping off point for our analysis.

We analyze consumption insurance through the lens of an incomplete markets model in the vein of Huggett (1993) and Aiyagari (1994), similar in spirit to the exercise of Kaplan and Violante (2010). These authors find that the degree of insurance available to agents in a standard incomplete markets model for transitory shocks is in line with the estimates

[5] Other important references within this literature include Attanasio and Browning (1995); Lusardi et al. (2011); Jappelli et al. (2008).

of Blundell et al. (2008) (about 95%), while the analogous figure for permanent shocks is lower (22% vs 35%). In our framework, similar to more recent models in this literature,[6] consumers have the option to default, and in equilibrium competitive lenders must price this risk. Recent contributions to this literature, notably Athreya et al. (2018); Gorbachev and Luengo-Prado (2016); Meier and Sprenger (2010), have documented that individuals' financial distress is highly persistent. Our primary innovation is to augment the supply side of credit in these models through the inclusion of lending standards which vary over the business cycle.

The closest paper to our study is the work by Athreya et al. (2009) who study the role of unsecured credit market for the transmission of increased income risk to consumption variability in the past several decades. They find that unsecured credit markets pass through increased income risk to consumption, irrespective of bankruptcy policy and the information possessed by lenders. They argue that use of unsecured credit does not neccesarily affect consumption variabily and conclude that changes in household use of a plausible set of markets and institutions (unsecured debt and bankruptcy) are not the mechanisms that seem to have decoupled income and consumption volatility in the past decades. Although Athreya et al. (2009) propose a different research question and explore different mechanisms present in the unsecured credit market, our results are highly consistent with theirs.

We measure lending standards using the Senior Loan Officer Opinion Survey (SLOOS) and the methodology developed by Bassett et al. (2014). This method filters out both bank-specific and macroeconomic factors that affect the demand for credit as well as its supply, and therefore produces a measure that is a viable, aggregate measure of changes in credit supply.[7] The authors find that adverse shocks to their credit supply measure yield significant effects on GDP and household borrowing capacity.

A related empirical literature studies the interplay between lending standards and macroeconomic outcomes. Lown and Morgan (2006) conduct a VAR analysis and find that shocks to lending standards explain most of the variance in business lending in the U.S.; notably, the effect of lending standards is far more economically significant than loan spreads. Using data from both the U.S. and the Euro area, Maddaloni and Peydró (2011) find that low short term interest rates lead to softer loan standards across loan types.[8] There is no analogous relationship, however, for long term rates. While a richer analysis would explicitly account for the drivers of this type of link, our aim in this paper is simply

[6] See, for example, Livshits et al. (2007) and Chatterjee et al. (2007).

[7] Macroeconomic variables can be filtered out using standard, publicly available data. In order to filter out bank-specific variables, Bassett et al. (2014) use (proprietary) bank-level responses in the SLOOS data.

[8] Driscoll (2004) performs a state level analysis and finds similar results.

to take changes in standards as given and map out their impacts on borrowers seeking loans.[9] To the best of our knowledge, our paper is the first to quantify the effects of cyclical changes in lending standards on heterogeneous agents' consumption insurance.

2 Empirical analysis

We construct an index to measure lending standards and terms on and demand of credit card loans (and on consumer loans more broadly) using bank-level responses from the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS). This survey is conducted four times per year by the Federal Reserve Board and asks banks about changes in their lending standards and terms for the major categories of loans to households and businesses beginning with the April 1990 survey. About up to 80 U.S. commercial banks participate in each survey. Questions are asked for the following categories of core loans: commercial and industrial loans; commercial real estate loans; residential mortgages to purchase homes; home equity lines of credit; credit cards; auto; and consumer loans other than credit cards or auto loans. We are using the portion of these questions related to credit card loans and consumer loans, more broadly.

2.1 Standards and terms on consumer loans

2.1.1 Lending standards

To construct an index for changes in standards and terms of credit we follow the methodology in Bassett et al. (2004) and use questions that ask participating banks to report whether they have changed their standards, or changed terms during the survey period.[10] Specifically, questions about changes in standards follow the general pattern of "Over the past three months, how have your bank's credit standards for approving credit card loans changed?" The possible answers are 1=eased considerably; 2=eased somewhat; 3=about unchanged; 4=tightened somewhat; and 5=tightened considerably. Historically, however, SLOOS respondents have very rarely characterized their reported changes in standards as having changed "considerably." Therefore, we use a three numbering scale

[9] There is a large literature in banking and financial intermediation which offers candidate explanations for this link. Some key references include Adrian and Shin (2010); Allen and Gale (2007); Diamond and Rajan (2012); Rajan (1994); Diamond and Rajan (2009), among many others.

[10] Bassett et al. (2014) construct an aggregate index for lending standards and demand for all categories of loans and focus on commercial and industrial loans. We use a similar approach in creating an index for consumer loans.

for changes in standards and terms as follows: $S_t^i = -1$, if bank i reported easing standards in quarter t, $S_t^i = 0$, if bank i left standards unchanged in quarter t, and $S_t^i = +1$ if bank i reported tightening standards in quarter t. We aggregate the banks specific indexes over all banks, weighting for each bank' $i's$ share of credit card loans of the total amount held by all banks and obtain the aggregate measure of changes in lending standards, $\Delta S_t = \sum_i w_{i,t-1} S_t^i$, where $w_{i,t-1}$ is the fraction of total credit card loans on banks balance sheets that are held by bank i at the end of quarter t . These weights are computed using Call Reports data.[11] The indexes created in this way reflect the net percent of credit card loans that tightened standards, in the case the aggregate index takes positive values or eased standards, in the case the index takes negative values. We normalize the historical average of these aggregate measures of changes in standards for credit card loans and create an overall lending standards index, I_t^S, which measures standard deviations in each quarter t from its historical average. Figure 1 shows the index for lending standards for credit card loans.

As expected, standards tightened during the past two recessions (the shaded gray areas in Figure 1), in particular during the financial crisis and subsequently eased, although they have tightened in the most recent quarters. This pattern holds for all categories of bank loans, in particular for the broader category of consumer loans, which includes auto and other loans in addition to credit card loans. As shown in the top panel of Figure 4, standards ease during expansion periods for the consumer loans and start tightening before economic downturns, to then gradually decline after the recession peaks.[12] It is not surprising that the changes in standards for consumer loans and for credit card loans are quite similar, given the fact that credit card loans represent the largest category of loans included.

2.1.2 Terms of credit

Similarly to the index of changes in lending standards, we create an index for changes in each term k on credit card loans, for bank i, in quarter t, $T_t^{i,k} \in \{-1, 0, +1\}$. The questions and answers about changes in terms follow a similar structure to those for lending standards with separate questions for several terms on credit card loans. For our purposes, we are going to use questions on credit card limits, term $k = 1$ and credit card spreads,

[11] In constructing our indexes, we revisit the method used in Bassett et al. (2014) in two directions: first, we use more granular data by loan types when we compute the share for each loan category on banks balance sheet; second, when computing weights associated with each type of loan, we expand the universe of banks beyond respondents in the SLOOS in line with the Call Reports data.

[12] The details for constructing the index for the broader category of consumer loans are included in the Appendix.

Figure 1: Lending standards for credit card loans

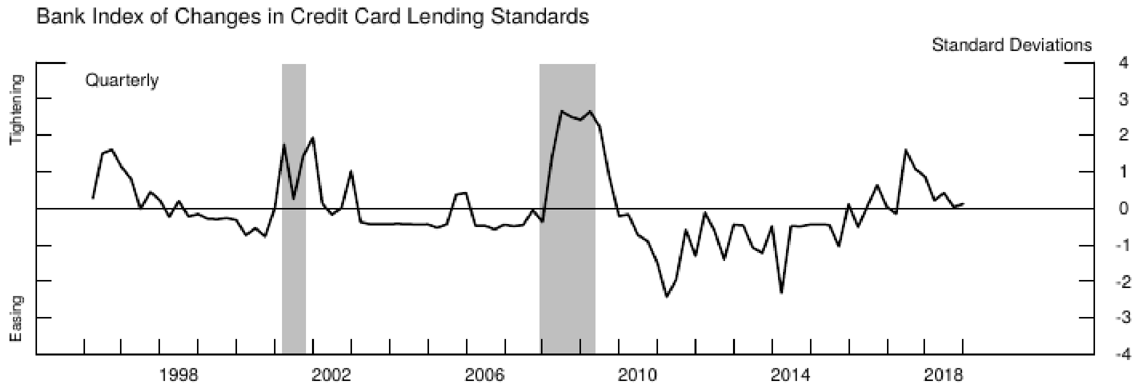
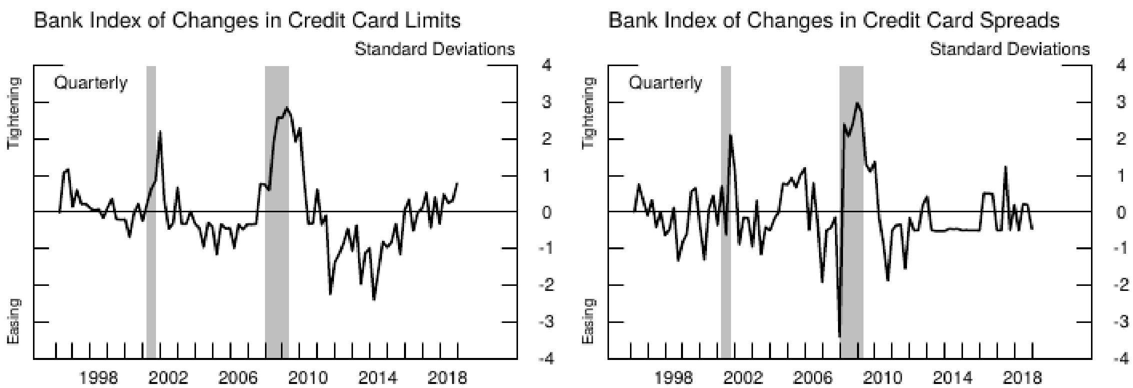


Figure 2: Terms for credit card loans



$k = 2$. We create an aggregate measure of changes in credit term k, $\Delta T_t^k = \sum_i w_{i,t-1} T_t^{i,k}$, where, as before,$w_{i,t-1}$ weights are computed using the Call Reports data, and represent the fraction of total credit card loans on banks balance sheets that are held by bank i at the end of quarter t. As in the case of changes in lending standards, we standardize the indexes created in this way to obtain an overall credit term index, $I_t^{T_k}$ for term each term k. Figure 2 shows the two indexes created in this manner for changes in credit card limits and credit card spreads. They measure standard deviations in each quarter t from their historical averages and a positive value means tightening while a negative value means easing for term k.

As illustrated in these figures, both price and non-price terms of credit move closely to changes in lending standards with limits and spreads on credit card loans tightening during recessions and loosening during expansions. In fact, as shown in the next section, the processes that fit these three time series are quite similar.

2.1.3 Estimating stochastic processes for credit standards and terms

To account for dynamics in standards in our model, we fit the time series of overall changes in the standards for credit card loans with an AR(1) process, $I_t^S = \rho I_{t-1}^S + \nu_t$, with $\nu_t \sim N(0, \sigma_\nu^2)$. We obtain the auto-correlation coefficient $\rho = 0.72$ and the variance of the error term,$\sigma_\nu^2 = 0.46$.

As argued before, the time series for the indexes of changes in terms of credit track closely the time series of the index of changes in lending standards. Indeed, when fitting the time series of overall changes in credit card limits and spreads, with AR(1) processes, we obtain similar estimates for the auto-correlation coefficient and for the variance of the error term.

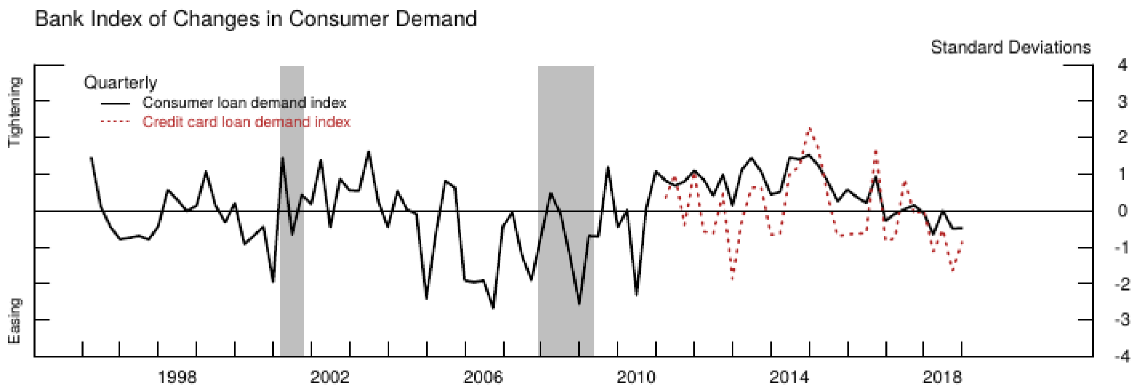
Furthermore, the similarity in the times series for lending standards for credit cards and for the broader category of consumer loans is transparent in the estimates of the coefficients for the the AR(1) processes that fit the two series. For consumer loans, we obtain, the auto-correlation coefficient $\rho = 0.81$ and the variance of the error term, $\sigma_\nu^2 = 0.47$. These coefficients confirm the expectation of high persistence of these time series.[13]

2.2 Credit demand

The SLOOS also asks banks about changes in demand for most types of loans starting with the October 1991 survey. However, the survey started to specifically ask about changes in demand for credit card loans only in April 2011, with the preceding surveys asking generally about consumer loans (which include credit card loans, auto loans and other loans). We are going to create an index for demand for consumer loans for the period 1991:Q2-2018:Q4 and one for demand for credit card loans for 2011:Q2-2018:Q4. As in the case of standards and terms, banks are asked every quarter about changes in demand over the previous period. The typical question is " Over the past three months, how has the demand for consumer/credit card loans at your bank changed?" Banks answer all of these questions using a qualitative scale ranging from 1 to 5. To characterize changes in loan demand, the possible answers include the following: 1=increased considerably; 2=increased somewhat; 3=about unchanged; 4=decreased somewhat; and 5=decreased considerably. To characterize changes in demand, we use a similar approach as before with $D_t^i \in \{-1, 0, +1\}$, where -1 stands for a reported decreased demand for credit card loans at bank i in quarter t, 0 stands for unchanged demand for credit card loans at bank i

[13] We abuse notations in using the letter ρ for the auto-correlation coefficient and σ_ν^2 for the variance of the error term in any of these processes. As shown in the quantitative analysis of our paper, we want to preserve flexibility in feeding any of these indexes into our model as a way of understanding different margins of how changes in credit supply operate.

Figure 3: Demand for credit card loans



in quarter t, and $+1$ stands for a reported increased demand for credit card loans at bank i in quarter t.

We follow the same procedure as in the case of standards and terms and create an aggregate demand index, weighting for each bank' $i's$ share of credit card loans of the total amount held by all banks. This measure is given by $\Delta D_t = \sum_i w_{i,t-1} D_t^i$ where $w_{i,t-1}$ is the fraction of total credit card loans on banks balance sheets that are held by bank i at the end of quarter t. Again, we normalize the historical average of the aggregate measure of changes in demand for credit card loans and create an overall demand index, I_t^D which measures standard deviations in each quarter t from this historical average. Given the short history of responses for credit card terms, we recreate this index for changes in demand for the broader category of consumer loans. This assumes taking into account a new set of weights, for each category of consumer loans, credit card, auto and other loans, within the broader category of consumer loans on banks balance sheet. We include details on constructing the demand index for the broader category of consumer loans in the Appendix. Figure 3 shows the indexes for demand for credit card loans, in dotted red and for the broader category of consumer loans, in solid black. Note that the trend in changes in demand for credit card loans closely tracks the trend in changes in demand for the broader category of consumer loans, although the credit card series is more volatile, as expected.

2.3 Demand and supply for consumer loans

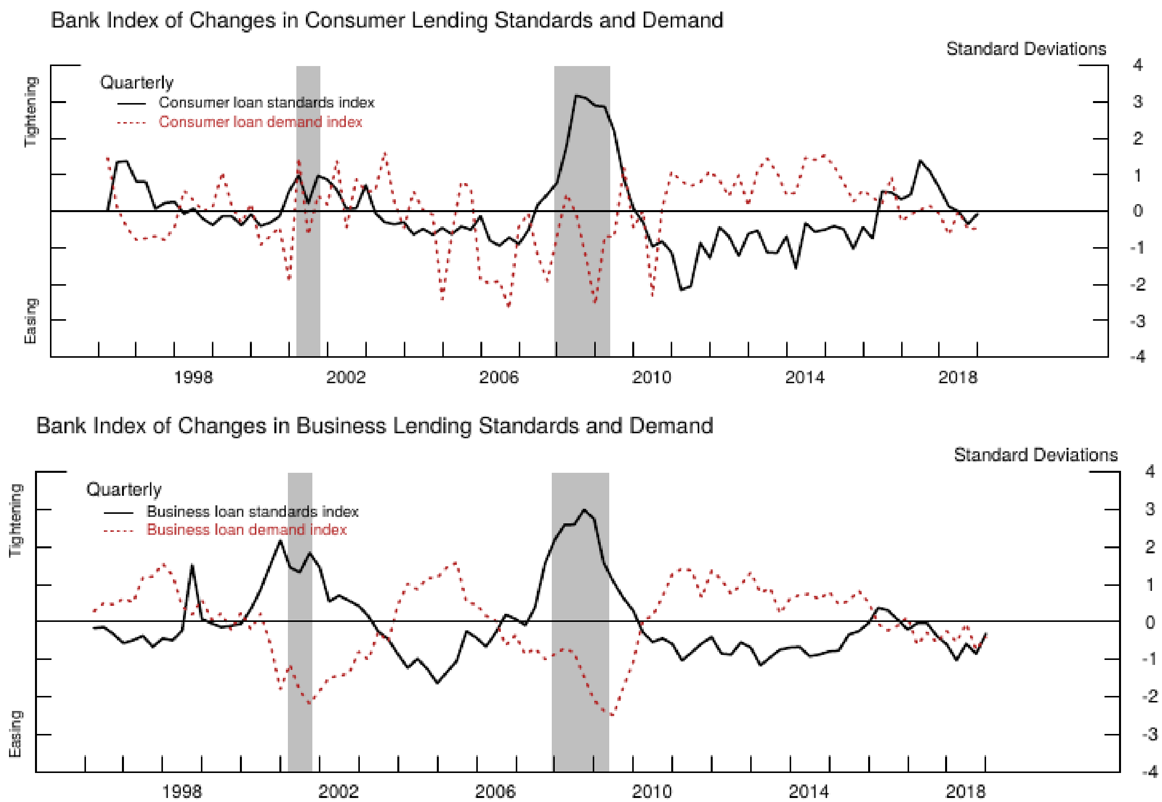
There are two main takeaways from our data findings, which guide our modeling choices and quantitative analysis. First, changes in standards (and terms) for credit card loans and, more generally, for consumer loans are procyclical, whereas demand for consumer loans does not fluctuate much across business cycles. Figure 3 clearly shows this contrast. This feature is unique to consumer loans and contrasts with the co-movement of both demand for and standards of loans to businesses.[14] This feature of the consumer credit market suggest that, unlike in the case for business loans, the dynamics in standards for consumer loans are mainly supply driven.[15] We will use the stochastic process that fits the time series of changes in standards for consumer loans as a proxy for credit supply standards in our model.

Second, changes in lending standards for credit card loans and for consumer loans are quite similar as are the indexes measuring demand for credit card loans and for consumer loans. This feature is not surprising given that the majority of consumer loans are, in fact, credit card loans (70 percent). Consequently, the stochastic processes that fit the time series for changes in standards for credit cards and for consumer loans are quite similar. Therefore, comparing our model implications for demand to the consumer demand index, for which a longer time series is available is without loss of generality.

[14]The details for constructing the index for business loans are included in the Appendix.

[15]Bassett et al. (2014) use a clever approach to disentangle the supply factors in the dynamics of credit in the context of commercial and industrial loans and use that measure as a proxy for aggregate supply of credit. We do not face the same challenge when it comes to consumer loans given that the factors that affect the changes in standards for consumer loans do not seem to affect demand of such loans.

Figure 4: Demand for and standards of consumers and business loans over business cycles



3 Baseline Model

3.1 Environment

There are two types of agents: risk averse households (HH) and risk neutral lenders. Time is discrete, and both types of agents are infinitely lived. There is a single good, and all quantities are defined and measured in real terms. The individual state of a HH is given by $x = (e, z, a, f, \epsilon)$, where: $e \in \mathcal{E}$ is the persistent component of the HH's endowment, which is drawn from a distribution $\Gamma(e, e')$; $z \in \mathcal{Z}$ is a mean zero transitory income shock drawn i.i.d. from a distribution $H(z)$; $a \in \mathcal{A}$ is the level of assets (if positive; debt if negative); $f \in \{G, B\}$ is an indicator of if the HH is in good (G) or bad (B) credit standing; and ϵ is a vector of transitory, action-specific preference shocks associated with each choice of debt (or savings) and default that is distributed type one extreme value. We assume that z is unobservable to lenders; therefore while it affects HH decisions, it does not affect prices. The preference shock ϵ takes on a nested structure: the scale parameter is equal to α_D for the default / no default decision, and $\alpha_{a'}$ for the debt / savings level decision.

The aggregate state $s \in \mathcal{S}$ is exogenous and measures lending standards, as discussed in detail below. This variable is persistent, following a distribution $F(s, s')$.

If in debt and in good credit standing ($a < 0$ and $f = G$), the HH must choose whether to repay ($d = 0$) or default ($d = 1$). If the HH defaults, three things occur: (i) it cannot borrow or save in the current period ($a' = 0$); (ii) it incurs a default cost κ; and (iii) it loses its good credit standing, transitioning from $f = G$ to $f' = B$. If the HH does not default, it must choose whether to borrow ($a' < 0$) or save ($a' \geq 0$). If in bad credit standing ($f = B$), the HH is excluded from the credit market, and so is constrained to choose $a' \geq 0$. HH in bad credit standing regain access to the credit market with probability θ. An individual HH's regaining of access to credit is independent and identically distributed through time, so the average duration of bad credit standing is $1/\theta$.

HH save $a' \geq 0$ at an exogenously specified risk free rate of $\bar{r}$. HH borrow $a' < 0$ at discount price $q(e, a'; s)$. We assume that lenders are perfectly competitive and must break even in expectation. The rate at which lenders can borrow, and therefore the default-risk-free price of a loan is given by $r(s)$, which moves with the aggregate state of the economy.

3.2 Households' decision problem

3.2.1 Good credit standing

A household in good credit standing ($f = G$) first decides whether or not to default:

$$V_G(e, z, a; s, \epsilon) = \max \left\{ V_G^D(e; s) + \epsilon^D, V_G^{ND}(a, e; s) + \epsilon^{ND} \right\}, \tag{1}$$

where ϵ^D and ϵ^{ND} are extreme value shocks associated with defaulting and not defaulting, respectively. The fundamental value of defaulting and not defaulting are given respectively by

$$V_G^D(e; s) = u(e - \kappa) + \beta \mathbb{E}\left[V_B(e', z', 0; s', \epsilon')\right] \tag{2}$$

$$V_G^{ND}(e, z, a; s, \epsilon) = \max_{a' \in \mathcal{F}(x; s)} v_G^{(0,a')}(e, z, a; s) + \epsilon^{a'} \tag{3}$$

$$v_G^{(0,a')}(e, z, a; s) = u\left(a + e - q(e, a'; s)a'\right) + \beta \mathbb{E}\left[V_G(e', z', a'; s', \epsilon')\right] \tag{4}$$

where the default value (2) reflects the fact that a defaulting HH can neither borrow nor save, incurs default cost κ is incurred, and loses good credit standing. The value of not defaulting (3) reflects the fact that the HH can either borrow at $q(e, a'; s)$ or save at $\bar{q} = 1/\bar{r} - 1$. $\mathcal{F}(x)$ is the set of feasible actions for an agent in state s, and comprises all actions that result in positive consumption. Let the optimal policies from solving the good standing HH problem specified by (1) through (3) be denoted by $\sigma^{(d,a')}(x;s)$, which is a probability mass function associated with each feasible action. If default is feasible, the probability of default is given by

$$\sigma_G^{(1,0)}(x;s) = \frac{\exp\{V_G^D(e,z;s)/\alpha_D\}}{\exp\{V_G^D(e,z;s)/\alpha_D\} + \exp\{V_G^{ND}(e,z,a;s)/\alpha_D\}} \tag{5}$$

and the probability of choosing any other feasible action $(0, a')$ is given by

$$\sigma_G^{(0,a')}(x;s) = \frac{\exp\{v_G^{(0,a')}(e,z,a;s)/\alpha_{a'}\}}{\sum_{\tilde{a}\in\mathcal{F}(x;s)} \exp\{v_G^{(0,\tilde{a})}(e,z,a;s)/\alpha_{a'}\}} \tag{6}$$

3.2.2 Bad credit standing

A household in bad credit standing ($f = B$) can neither default nor borrow. Therefore, it solves

$$V_B(e,z,a;s,\epsilon) = \max_{a'\in\mathcal{F}(x;s)} v_B^{(0,a')}(e,z,a;s) + \epsilon^{a'}, \tag{7}$$

$$v_B^{(0,a')}(e,z,a;s) = u(a+e-\bar{q}a') + \beta\mathbb{E}\left[(1-\theta)V_B(e',z',a';s',\epsilon') + \theta V_G(e',z',a';s',\epsilon')\right] \tag{8}$$

with savings policy

$$\sigma_B^{(0,a')}(x;s) = \frac{\exp\{v_B^{(0,a')}(e,z,a;s)/\alpha_{a'}\}}{\sum_{\tilde{a}\in\mathcal{F}(x;s)} \exp\{v_B^{(0,\tilde{a})}(e,z,a;s)/\alpha_{a'}\}} \tag{9}$$

3.3 Lender pricing

Lenders are risk neutral and perfectly competitive, and loans are therefore priced to break even. Given the decision rules discussed above, the probability of repayment next period on a loan of size a' to a HH with state x in aggregate state s is

$$p(e,a';s) = \int_{\mathcal{E}}\int_{\mathcal{Z}}\int_{\mathcal{S}} (1-\sigma^{(1,0)}(e',z',a';s')H(dz')\Gamma(e,de')F(s,ds'). \tag{10}$$

Given intermediation costs, lenders' cost of funds is $1/(1+r(s))$. Thus, the discount price which must hold in equilibrium is defined by

$$q(x,a';s) = \frac{p(e,a';s)}{1+r(s)} \tag{11}$$

If higher s denotes tighter lending terms, then $r'(s) > 0$.

3.4 Equilibrium

A recursive competitive equilibrium in this environment consists of a value function $V_f(e, z, a; s, \epsilon)$ that solves the household problem (1) through (9) and a pricing function $q(x, a'; s)$ that satisfies (11), taking household behavior as given.

3.5 Distribution

Let the distribution of households over individual states x in period t be given by $\mu_t(x)$. Note that we re-introduce time dependency here because the evolution of the distribution will be governed by realizations of the aggregate state process $\{s_t\}_{t=0}^{\infty}$. In general, this would be inconsistent with the definition of recursive competitive equilibrium in Section 3.4. However, under the assumption that the risk-free rate is pinned down exogenously, the distribution of agents is not a state variable in the HH problem, and we are free to simply document the evolution of the distribution of agents through time given equilibrium behavior.

Unless a HH in good credit standing defaults, they will remain in good credit standing in the next period. A HH in bad credit standing recovers good credit with probability θ. Therefore, let $A \subseteq \mathcal{A}$ and $E \subseteq \mathcal{E}$ and define the operator T^* for agents in good standing not defaulting via

$$\begin{aligned}(T^*\mu_{t+1})(E, Z, A, f = G) \;=\; & \int_{E,Z,A}\int_{\mathcal{E},\mathcal{Z},\mathcal{A}} \Big\{ \sigma_G^{(0,a')}(e, z, a; s) H(dz')\Gamma(e, de')\mu_t(de, dz, da, f = G) \\ & + \theta\sigma_B^{(0,a')} H(z) H(dz')\Gamma(e, de')\mu_t(de, dz, da, , f = B) \Big\}\end{aligned}$$

Analogously, tomorrow's distribution for HH with bad credit is given by

$$\begin{aligned}(T^*\mu_{t+1})(E, Z, A, f = B) \;=\; & \int_{E,Z,A}\int_{\mathcal{E},\mathcal{Z},\mathcal{A}} \Big\{ \sigma_G^{(1,0)}(e, z, a; s) H(dz')\Gamma(e, de')\mu_t(de, dz, da, f = G) \\ & + (1-\theta)\sigma_B^{(0,a')} H(z) H(dz')\Gamma(e, de')\mu_t(de, dz, da, , f = B) \Big\}\end{aligned}$$

3.6 Discussion of assumptions

Exogenous interest rate. Currently, this assumption is made predominantly for tractability. Relaxing this assumption would make the model solution rely on a Krusell-Smith style algorithm, which is feasible but more complicated. To endogenize the interest rate $\bar{r}$, the equilibrium definition of Section 3.4 would have to be augmented to include a market clearing condition for financial assets

$$\int_{\mathcal{A}_-,\mathcal{X}} q_t(x, a'; s, \mu) g(x; s, \mu) \mu(dx) = \int_{\mathcal{A}_+,\mathcal{X}} \frac{g(x; s)}{1+\bar{r}} \mu(dx),$$

where $\mathcal{A}_-$ and $\mathcal{A}_+$ denote $\{a' | a' \in \mathcal{A}, a' < 0\}$ and $\{a' | a' \in \mathcal{A}, a' \geq 0\}$

Adoption of lending standards. Lending standards appear in the model directly in the loan terms q from equation (11). In subsequent work, these standards will be endogenized more richly, but this gives a sense of the aggregate effects of changing credit terms.

4 Quantitative Analysis

4.1 Calibration

We parameterize the model following Table 1. The top portion of Table 1 contains the key technological parameters. The direct cost of default is set to be 2% of median earnings. HH are not very risk averse, with a coefficient of relative risk aversion equal to 1.5, and are only modestly impatient relative to the rate of return on savings, with $\beta = 0.93$ and $\bar{r} = 3\%$. The probability of regaining access to the credit market, θ, is set equal to 1: for now, we ignore the effects of post-default credit market exclusion.

The bottom two panels of Table 1 contain the details of the individual earnings and aggregate state processes, respectively. Both are estimates of AR(1) processes of the form

$$x_{t+1} = (1-\rho_x)\mu_x + \rho_x x_t + u_{t+1}, \text{ where } u_{t+1} \sim \mathcal{N}(0, \sigma_x). \tag{12}$$

Both processes are discretized using the method of Adda and Cooper. The earnings process is adapted from Chatterjee et al. (2018), and exhibits modest persistence. The transitory earning shocks, while low in variance and equal to zero in expectation, are important for generating debt and default in the model. The credit spreads process is estimated using SLOOS data, as discussed in Section 2.

Table 2 documents the model's performance relative to the data. We evaluate the

Parameter		Value	Notes
technological parameters			
default cost	κ	0.02	2% median earnings
risk aversion	γ	1.5	CRRA preferences
subjective discount factor	β	0.97	quarterly frequency
risk-free rate (%)	$\bar{r}$	3.0	long run average
default scale parameter	α_D	0.0013	
asset scale parameter	$\alpha_{a'}$	0.0010	
prob of regaining credit status	θ	1.0	no barring from credit market
earnings process			
persistence	ρ_e	0.6536	
mean	μ_e	1.00	mean earnings of 1
variance (to innovations)	σ_e	0.0426	
grid points: persistent e	N_e	6	discretized by Adda-Cooper (in logs)
variance of transitory shock	σ_z	0.0312	
grid points: transitory z	N_z	7	
lending standards process			
persistence	ρ_s	0.389	See Empirical Analysis Section.
mean	μ_s	0.123	long run average credit spread
variance (to innovations)	σ_s	0.049	
grid points	N_s	7	discretized by Adda-Cooper

Table 1: **Model parameters**

model primarily by considering moments of the credit market and the endogenous wealth distribution. Along each of these dimensions, the baseline model performs sensibly. The aggregate default rate and the debt to income ratio are exactly in line with the data, while both the economy-wide fraction of households in debt and the average interest rate paid are somewhat low relative to the data. Notably, one important shortcoming of the calibration is that the link between wealth and income is much weaker in the model than in the data. Crucially given the main contribution of this paper, the standard deviation of consumption the model delivers is roughly in line with the data.

4.2 Comparison to constant lending standards

The main contribution of our work is to incorporate rich supply-side dynamics into the analysis of the insurance value of unsecured consumer credit markets. A natural benchmark model to which to compare the model of Section 3, then, is a standard, stationary incomplete markets model. This model is nested neatly within our baseline model by

Moment	Data	Baseline	Constant standards	%diff (cons. - base)
Default rate (%)	0.991	1.141	1.091	-0.103
Fraction in debt (%)	10.43	5.654	5.380	-4.523
Debt to income (%)	0.35	0.368	0.349	-5.093
Average interest rate (%)	12.87	8.344	8.395	5.586
Median wealth / earnings	3.22	3.441	3.243	-0.061
Corr wealth / earnings	0.52	0.116	0.116	-0.517
Corr wealth / consumption		0.580	0.579	-0.152
Corr earnings / consumption		0.264	0.262	-0.684
Consumption volatility	0.149	0.217	0.216	-0.104

Table 2: **Moments across the models**

Notes: Data moments are computed using the Survey of Consumer Finances (SCF). Model moments are computed by simulating $K = 10$ panels of $N = 1,000$ agents for $T = 2,000$ periods from the model. For each simulation, initial conditions are drawn from the stationary distribution of the constant standards economy. The rightmost column computes the percentage difference in the given moment between the baseline and constant standards model, relative to the constant standards model.

replacing $r(s)$ in the loan pricing equation (11) with the average credit spread

$$r^* = \int r(s) d\overline{F}(s),$$

where $\overline{F}(s)$ is the ergodic distribution implied by the first-order Markov process $F(s, s')$ estimated in Table 17. Under this calibration, $r^* = 12.3\%$.

Critically, the version of the model with constant lending standards admits a stationary distribution of agents, $\mu^*(e, z, a, f)$. After solving this model, we compute the associated stationary distribution. For all the results that follow for the stationary model, all model moments are computed either directly from this stationary distribution or from a simulation of a panel of N households for T periods from the model. For all the results that follow for the baseline model, we simulate K panels of size $N \times T$, with each panel k consisting of a different simulated path of the aggregate shock process, $\{s_{tk}\}_{k=1}^{K}$. All K panels begin with agents drawn from the stationary distribution of the constant lending standards economy for comparability, and all reported results average over the K simulations.

4.2.1 Consumption volatility and credit market moments

We first compare the two models in Table 2 by considering a range of standard credit market and wealth distribution statistics. Both the baseline and constant standards economies appear to have credit markets of a similar scale: default rates, fractions of HH in debt, and the average interest rate paid on debt are all quite similar across the two economies. However, the direction of changes in the two economies is noteworthy. Despite a higher default rate in the baseline economy, a larger fraction of HH borrow, and on average those HH pay a slightly lower interest rate. Therefore, these baseline economy HH also take on slightly larger debts, as viewed by the debt to income ratio.

An important measure of the extent of insurance available in an economy is agents' consumption volatility over time. Using simulated panels from the models, we compute the variance of consumption ($c_{n,t}$ for simulated agent n in period t) by calculating

$$\begin{aligned}
\sigma^n_{\text{cons}} &= \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(c_{n,t} - \frac{1}{T}\sum_{t=1}^{T} c_{n,t}\right)^2} \\
\overline{\sigma}_{\text{cons}} &= \frac{1}{N}\sum_{n=1}^{N}\sigma^n_{\text{cons}}
\end{aligned}$$

The results from computing this measure are presented in the bottom row of Table 2. Again, while the two economies deliver consumption volatility of a similar magnitude, the directional difference bears mentioning: agents appear to insure less in the baseline economy than in the constant lending standards economy, despite the higher rates of default and indebtedness. On average, agents in the baseline economy smooth consumption less than agents in the constant lending standards world. In the next section, we delve into the main mechanism of the model in order to explore these results.

4.2.2 Prices and credit limits

In order to understand the key mechanisms at play in the model we first present the model's pricing mechanics. Figure 5 depicts the equilibrium price schedule over a range of earnings levels e and aggregate states s. Recall that as specified, high s states correspond to tight lending standards; that is, $r'(s) > 0$. In addition, Figure 6 presents the quantity analog to the price schedules in Figure 5. For each of these plots, we consider the endogenous "credit limit" implied by the model

$$\underline{a}(e; s, \overline{q}) = \max\{a' | q(e, a'; s) > \overline{q}\} \tag{13}$$

This measures the level of debt at which agents can borrow up to a given interest rate. Since agents in our model tend to not borrow above rates of 30%, we use this as the effective cutoff.

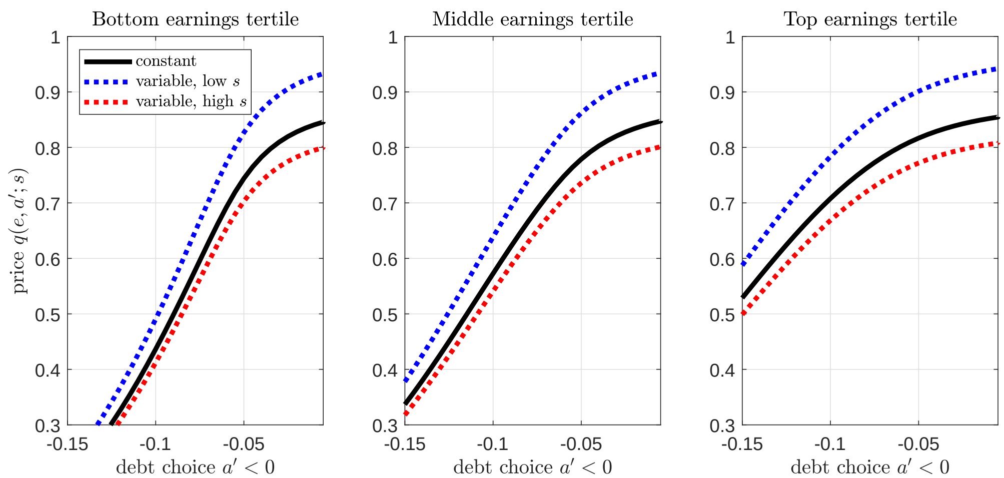


Figure 5: **Prices**

Notes: The price schedules in Panel 5 are those implied by equation (11). "Constant" refers to the constant lending standards economy, while "variable" refers to the baseline economy of Section 3.

First and foremost, the aggregate shifts in lending standards introduce rich dynamics in loan pricing in the baseline economy. For each tertile of earnings (smallest to largest from left to right in Figure 5), there is rich variation in the loan spread a given agent pays on a loan of a given size. For example, comparing the tightest lending standard state to the loosest state, the interest rate a low earner pays on a loan of a size equal to 5% of median earnings increases by 22 percentage points. Interestingly, this variability is muted for higher earners, who experience only an 18 percentage point increase in spreads on a loan of the same size. Of course, no such dynamics are present in the constant lending standards economy: interest rates on loans are specified entirely by agents' earnings and the size loan they choose.

An alternative way to assess the impact of changes in lending standards is by analyzing how credit limits change in the economy. While there are rich dynamics to the left of each figure in Panel 5, these prices play only a minor role in the equilibrium of the economy since agents tend to not borrow at the very high interest rates in these regions. Considering an interest rate ceiling of 30%, low earners can borrow only up to 4.5% of median earnings in the constant standards economy. By comparison, in the baseline economy, this limit increases (decreases) by more than 50% in the loosest (tightest) lending standards case. While high earners experience higher credit limits on average, they experience similar percentage deviations around the mean of their constant standards limit.

How do these pricing and quantity effects across earners and lending standards states drive the results in Table 2? First and foremost, the pricing figure 5 highlights the asym-

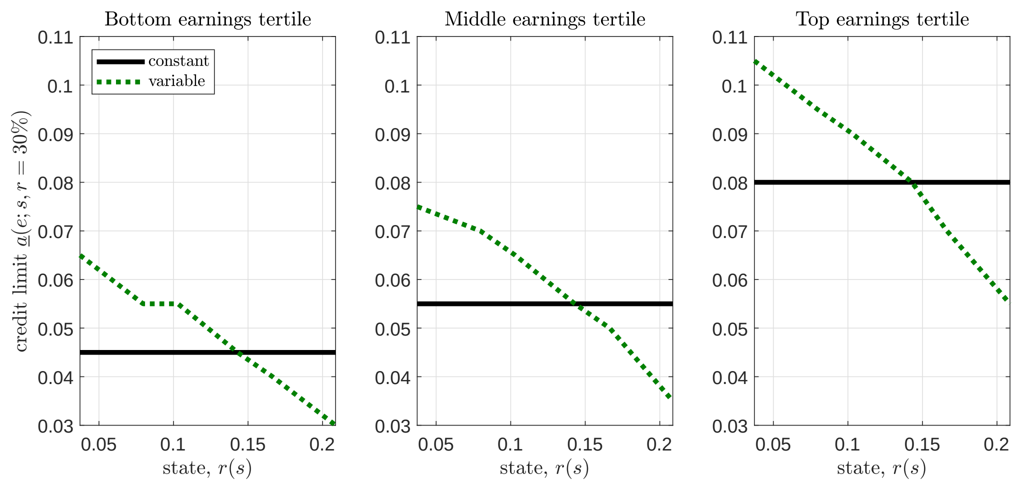


Figure 6: **Credit limits**

Notes: Panel 6 depicts credit limits for these two economies across s states according to equation 6. "Constant" refers to the constant lending standards economy, while "variable" refers to the baseline economy of Section 3.

metric effect of variable lending standards in the baseline economy compared to the constant standards economy. Specifically, loan prices increase by more under loose lending standards than they contract under tight lending standards. Therefore, agents in the baseline economy borrow more frequently and in greater amounts. As a result, they are indebted more often when experiencing the bad earnings shocks (either persistent or transitory) that drive default in the model, and drive up the default rate on the margin.

In addition, lending standards act mostly on the level of the pricing function, rather than altering the slope. This feature of the model explains the relatively stable debt to income ratio: on average, agents in the two economies take close to the same quantities of debt, because interest rates begin to increase precipitously at approximately the same point across standards states in the baseline economy and in the constant standards economy.

4.2.3 Welfare

In addition to measuring consumption volatility, we can directly compare welfare in the baseline economy and the constant lending standards using a Lucas-style consumption equivalent. Specifically, the amount of consumption a person in the variable standards economy would be willing to pay per period to switch to the constant standards economy

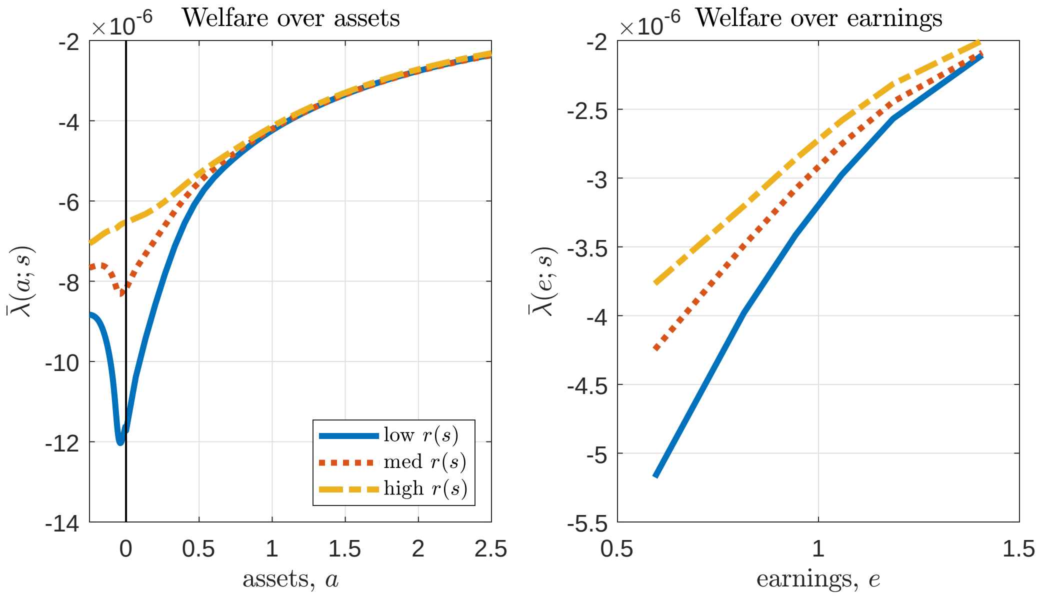


Figure 7: **Consumption equivalent welfare**

Notes: Consumption equivalent welfare is computed according to equation (14). Negative (positive) numbers indicate a preference baseline (constant standards) economy. In each figure, averaging over transitory earnings z and either assets a or persistent earnings e is done over the stationary distribution from the constant lending standards model.

is given by

$$\lambda(x,s) = \left[\frac{V_{\text{constant}}(x) + \frac{1}{(1-\gamma)(1-\beta)}}{V_{\text{variable}}(x;s) + \frac{1}{(1-\gamma)(1-\beta)}} \right]^{\frac{1}{1-\gamma}} - 1 \tag{14}$$

The results of calculating this measure across the state space are presented in Figure 7. In each case, the averaging over states not on the horizontal axis is done using the stationary distribution from the constant lending standards economy.

Strikingly, according to the right panel of Figure 7, agents of all earnings levels strictly prefer the baseline economy to the constant lending standards economy. Unsurprisingly, this effect is dampened as lending standards are tightened in the baseline economy: on average, agents prefer the more favorable borrowing terms of the baseline economy, but the value difference is much smaller when standards are tight and interest rates are therefore high.

The left panel of Figure 7 shows how the consumption equivalent measure varies over assets and is very informative about the mechanism of the model. For agents with positive wealth, the baseline economy is only modestly preferable: for the near term at least, these agents are not at risk of needing to borrow, and therefore do not interact with the differences between the two economies. As wealth approaches zero, however, agents become more and more likely to need to borrow in the near future, and the baseline economy begins to look more and more attractive. Furthermore, we see notable dispersion based on the lending standards state. When standards are currently loose, the baseline economy is especially attractive.

Turning to agents who are currently in debt, we see a mirroring of the effect documented for the asset side. According to the price figure 5, prices are much more favorable in loose standards states for small loan sizes. Thus agents with small debts much prefer the baseline economy. As the level of debt increases, however, the price schedules converge to very high interest rates, and the value difference between the economies begins to shrink.

5 Conclusion

We study the effect of changes in consumer credit supply on households' ability to insure against income risk in the U.S.. Using loan-level data from the Senior Loan Officer Opinion Survey (SLOOS), we construct measures of key credit supply variables, such as lending standards and terms for consumer credit and build a heterogenous model of unsecured credit and default that accounts for credit supply dynamics as estimated from these data.

Our economy is quantitatively consistent with key features of the unsecured credit market, such as demand for credit, credit limits, default and interest rates on credit card debt, as well as with earnings dynamics, and measures of consumption volatility in the U.S. When standards on consumer credit are tight and loan spreads are high, our model implies that consumers face lower credit limits. Furthermore, for any given level of standards and prices, consumers with high income levels face relatively loose limits compared to consumers with low income levels.

We find that in an economy with variable standards and terms for credit, consumers smooth less consumption, while, surprisingly, at the same time they borrow at higher rates, larger amounts and they default more frequently. These findings are explained by rich dynamics in loan pricing induced by aggregate shifts in lending standards and the resulting variation in the loan spread borrowers pay on a loan of a given size. Loan prices increase by more under loose lending standards than they contract under tight lending standards. This asymmetric effect is key in understanding the impact of credit supply dynamics. Our results reveal that, despite the loss in consumption insurance that variability in standards and terms for credit may induce, such credit supply dynamics improve welfare across all groups of consumers in the economy.

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