The Interaction of Unemployment Insurance with Credit and Bankruptcy Over the Business Cycle

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Abstract

How does the interaction between unemployment insurance (UI) policies and unsecured consumer credit impact consumption and welfare over the business cycle? Improvements in the terms of credit can significantly amplify the gains in consumption coming from increases in UI benefits. However, the relationship is theoretically ambiguous because UI can also substitute for credit use if households use the improved benefits to delever. I measure the effects of this relationship using a quantitative equilibrium model of labor markets and competitive credit markets calibrated to reflect the employment risk, credit use and bankruptcy behavior of US households. I first show that the majority of the volatility in credit and consumer bankruptcies over the business cycle can be explained by aggregate fluctuations in extensive margin employment risk. I then find that the extension in the duration of UI benefits during the Great Recession prevented over a 29 percentage point further drop in consumer credit use and a 2.0 percentage point further drop in aggregate consumption. I show that the complementary relationship between UI and consumer credit accounted for over 10% of the gains in welfare for new working-age households and over 60% of the gains in aggregate consumption from extensions in the duration of benefits.

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1. Introduction

During the Great Recession, the US government extended the duration of unemployment insurance (UI) benefits from 26 weeks to 99 weeks. This follows a trend where the benefits associated with UI have been increased in every major recession since 1958. In this paper, I measure how the interaction of UI policies with unsecured consumer credit impacts aggregate consumption and welfare over the business cycle. I show that to fully measure the gains in consumption from improved benefits, we need to incorporate the feedback between UI and consumer credit.

UI interacts with consumer credit and default in a theoretically ambiguous way. Improvements in UI can have a complementary relationship with unsecured credit use if the benefits lead to better terms of credit for households. In this situation, financial intermediaries offer better terms of credit if the improved benefits result in fewer bankruptcies. The improved terms of credit can significantly amplify the gains in consumption and welfare from counter-cyclical UI policies. However, increased benefits could also substitute for unsecured credit use if households use the UI to delever. It is essential to understand the interaction of UI with unsecured credit because both have become important means of insurance against income and employment risk for households. Sullivan, Warren and Westbrook (2000) report that over two-thirds of bankruptcy filers choose job-related income disruptions as the main cause of bankruptcy, and over 32% of unemployed households in the 2010 SCF have positive credit card balances. It follows that policies affecting income loss from unemployment can have significant implications for aggregate credit and consumption.

To better understand the connection between UI and unsecured consumer credit, I build a quantitative equilibrium model of labor markets and consumer credit markets with a default option. The framework I generate combines elements from the bankruptcy models of Chatterjee et al. (2007) and Livshits et al. (2007) with the labor markets models of Krusell et al. (2010, 2017). The default option is modeled to capture a chapter 7 bankruptcy in the United States. The terms of credit reflect the probability of a bankruptcy on a given loan. This provides a direct feedback between UI and the terms of credit. Households also make extensive margin quitting decisions when working and search decisions when not working. It is essential to model the relationship between labor market decisions and UI because individuals are not eligible to receive benefits if they quit their job or refrain from search. Additionally, households are subject to labor market frictions in the form of job separation rates and job arrival rates. These frictions fluctuate with the aggregate state of the economy to depict the cyclical employment risk experienced by households over the business cycle. Furthermore, a household's intensive margin earnings risk also fluctuates with the aggregate state so as to represent counter-cyclical income risk in the data.[2]

Before measuring the interaction of UI policies with unsecured consumer credit, it is first necessary to show that the model can depict key moments from the data. I calibrate the model to replicate aggregate credit use, bankruptcy behavior and labor market outcomes in the data from 1968-2019. Furthermore, the model generates the distribution of credit use across employed and unemployed households despite being uncalibrated moments. This is an essential benchmark towards showing that the model can accurately quantify the consumption response from the interaction of UI with credit use. In the first contribution of this paper, I show that the model explains the high volatility and pro-cyclicality of unsecured credit along with the high volatility and counter-cyclicality of consumer bankruptcy seen in the data. Specifically, the model generates over 69% of the total volatility in unsecured consumer credit between 1968 and 2019. This is a meaningful result for the literature where a leading article by Nakajima and Ríos-Rull (2019) generates 13% of the total volatility in credit in their benchmark model.

I run a decomposition exercise where I show that fluctuations in extensive margin employment risk explain over 86% of the volatility in consumer credit and 74% of the volatility in consumer bankruptcies over the business cycle. Employment risk drives the results because decreases in job arrival rates during recessions significantly tighten the terms of credit. Furthermore, reduced arrival rates cause unemployed households to delever to insure against being unemployed without benefits. Increases in job separation rates have a smaller impact on household-level decisions, but they facilitate a stronger flow of agents from employment to unemployment. In addition to being a contribution to the literature that looks to understand the sources of fluctuations in consumer credit and bankruptcy, these results also show that policies impacting the income of unemployed households can have a large effect

[2] Storesletten, Telmer and Yaron (2004).

on aggregate quantities over the business cycle.

I use the calibrated model to measure the interaction of UI with unsecured consumer credit during the Great Recession. From 2008 to 2013 the US government increased the duration of UI benefits from 26 weeks to a maximum level of 99 weeks. I simulate the model economy starting at the end of 2007 incorporating the extension in the duration of UI. I reproduce the recession by inputting aggregate shocks to TFP, job separation rates and job arrival rates from the data. This allows the model to replicate the severity and persistence of employment risk during the Great Recession. To quantify the implications of the extension in UI benefits, I simulate a counter-factual economy where the duration of benefits remains constant through the entire recession. I find that the extension in the duration of benefits prevented over a 29 percentage point further drop in unsecured consumer credit use. This shows that there was a significant complementary relationship between UI and credit use during the Great Recession. I also find that the extension in benefits prevented over a 2.0 percentage point further drop in aggregate consumption. Moreover, new working-age households at the start of the Great Recession would be willing to give up 0.80% of lifetime consumption to have the extended benefits.

The extension in UI benefits had a large impact on aggregate quantities and welfare during the Great Recession, but we need to quantify how much of these results are due to the complementary relationship between UI and unsecured consumer credit. To do so, I simulate the economy with the extended benefits directly inputting the terms of credit from the counter-factual economy with no change in UI. This effectively allows households to receive the extension in benefits, but it prevents the terms of credit from adjusting to reflect the complementary relationship with credit. I show that the complementary relationship between UI and unsecured consumer credit had a significant amplifying effect on the consumption response from extended benefits. Over 60% of the peak-to-trough gains in aggregate consumption from UI during the Great Recession can be accounted for by adjustments in the terms of credit. Furthermore, over 10% of the gains in the welfare of new working-age households can also be accounted for by the terms of credit. However, the response is even stronger for unemployed households. Over 13% of the gains in welfare for the unemployed can be accounted for by adjustments in the terms of credit. The complementary relationship between UI and credit is needed to fully measure the impact of counter-cyclical UI policies on total spending and welfare during a recession.

After measuring the impact of UI policies during the Great Recession, I use the model to quantify the implications of policies over all business cycles. Because counter-cyclical changes in UI policy have been used in every major recession since 1958, it is important to understand the implications of these policies if economic agents begin acting as if they will always occur. I test two different counter-cyclical UI regimes. In the first, the government expands the replacement rate of benefits by 25% during recessions. In the second regime, the duration of benefits is extended by 25% during recessions. I show that both counter-cyclical policies generate a strong complementary relationship with unsecured credit. Both policies also reduce the volatility in consumption and labor force participation over the business cycle. However, extensions in the duration of benefits have a stronger impact on all three of these margins. Extensions generate a stronger complementary relationship with unsecured credit because they facilitate significantly more borrowing by unemployed households. Not only do extensions improve the terms of credit, they also reduce the motive to delever to insure against being unemployed without benefits. Both counter-cyclical expansions and extensions in UI benefits reduce the volatility of bankruptcy over the business cycle. However, expansions lead to a much stronger reduction in bankruptcy volatility. This occurs because expansions provide unemployed households more income to repay their debts and avoid default. Extensions have a weaker impact on bankruptcies during a recession for two main reasons. Unemployed households receiving benefits do not have more income, and they are more willing to take on larger quantities of debt.

1.a) Related Literature

This paper is most closely related to work studying the interaction of UI policies with credit and bankruptcy. Athreya and Simpson (2006) study expansions and extensions in UI benefits using a steady-state to steady-state analysis. I expand upon their work by studying the implications of UI policies over the business cycle in a model where households are subject to both individual and aggregate risk. This is an essential contribution because changes in UI policies are often temporary and occur during recessions. Nakajima (2019) uses both a steady-state analysis and an environment with aggregate uncertainty. I make a significant contribution to his work by quantifying the implications of both expansions and extensions of UI benefits in an environment where credit is pro-cyclical. Among other things, this allows me to measure the effectiveness of the specific policy implemented during the Great Recession. Further work in this area is done by Braxton, Herkenhoff and Phillips (2019) where they solve for the optimal replacement rate of benefits in an environment with consumer credit and bankruptcy. Finally, papers by Farber, Rothstein and Valletta (2015) and Hsu, Matsa and Melzer (2014) measure the implications of extended benefits using data from the Great Recession. The first of these papers finds that extended benefits led to more unemployment via an increase in labor force participation, not a decrease in job arrival rates. The model used in the current paper is consistent with predictions that extended benefits led to a smaller drop in labor force participation during the Great Recession. Hsu et al. (2014) finds that extended benefits led to fewer mortgage defaults.

The current paper is also intimately related to work studying unsecured consumer credit and default in an incomplete markets setting. Seminal papers in this literature include Athreya (2002), Chatterjee, Corbae, Nakajima and Ríos-Rull (2007) and Livshits, MacGee and Tertilt (2007).[3] More recently, Nakajima and Ríos-Rull (2019) have shown that counter-cyclical income risk is needed to generate the business cycle moments of consumer credit and bankruptcy[4]. However, the benchmark model used in their paper can only account for a fraction of the total volatility in consumer credit before mandating that certain goods must be purchased on credit. I make an important contribution to the literature by developing a model that generates the high volatility in unsecured credit through individual and aggregate risk alone. By showing that the majority of the volatility in credit and bankruptcy comes from extensive margin employment risk, I provide a greater understanding of the sources of aggregate fluctuations in competitive credit markets. My work is also related to Athreya, Sanchez, Tam and Young (2015) which studies the impact of the Bankruptcy Abuse and Consumer Proctection Act (BACPA) on the Great Recession. Using realistic shocks to

[3]More recent work on unsecured consumer credit includes Mitman (2016), Herkenhoff (2017), Gordon (2017), and Herkenhoff, Phillips and Cohen-Cole (2019) among others.

[4]They document that consumer credit is highly volatile and pro-cyclical while bankruptcy is highly volatile and counter-cyclical

employment outcomes, both their work and mine predict a counter-factually large drop in unsecured consumer credit during the Great Recession when there is no change in UI. I contribute to their work by showing that when the duration of benefits is increased to 99 weeks to match the policy from the Great Recession, the model can match a realistic drop in the magnitude of unsecured credit seen in the data.

2. Model

The model economy is populated by a distribution of households who differ across age, productivity, asset level, employment and credit status. A representative firm rents capital and hires labor to produce a single output good. Financial intermediaries lend to households by purchasing a security at a discount price, and the government uses income taxes to fund transfers to households. I begin with a description of the household problem, followed by intermediaries, the firm and the government. I end this section with a definition of the equilibrium.

2.a) Households

Time is discrete, and there are N_j overlapping generations of households. Every period, a new cohort of size ϕ_1 is born into the economy. All age 1 households have good credit, zero assets, and I assume that a fraction Λ have an employment opportunity. These agents move deterministically to the next age of life until dying at age N_j. There is a measure one continuum of households such that $\sum_{j=1}^{N_j} \phi_j = 1$. Each period, households make three choices: a discrete labor choice, a discrete default choice, and a consumption-savings decision. I assume that all households will retire with certainty at age N_r. Utility is generated each period from consuming the single output good with value $u(c)$, and future utility is discounted at rate β. I assume households differ with respect to their discount rate, but the rate will remain constant throughout the entire life-cycle. Additionally, let μ be the distribution of households over idiosyncratic states.

Households are subject to both idiosyncratic and aggregate risk while moving through the life-cycle. The aggregate state of the economy z will evolve according to the transition matrix π_z where $\pi_z(z', z) = Pr\big[z_{t+1} = z'|z_t = z\big]$.[5] I assume individual-level productivity ϵ follows the stochastic AR(1) process detailed below. This represents the intensive-margin earnings risk experienced by households in the model. The innovation of the random variable η_{j+1} is a function of the aggregate state of the economy. This setting allows the model to exhibit counter-cyclical income risk described in previous papers.[6] Furthermore, the productivity process of households evolves with age. Let γ_j represent the age-component of individual level productivity. This age-component will exhibit an empirically consistent hump-shaped profile over the life-cycle. Despite adding to the state-space of the household problem, I choose to explicitly model the life-cycle because a hump-shaped earnings profile generates borrowing by young households.

$$\log \epsilon_{j+1} = \rho \log \epsilon_j + \eta_{j+1}, \quad where \quad \eta_{j+1} \in N\big(0, \sigma^2_\eta(z)\big)$$

I model labor markets using an island model in the spirit of Krusell, Mukoyama Rogerson and Sahin (2010,2017). Let n define the current employment state of an agent where E is the employment island and N is the leisure island. Households are subject to labor market frictions in the form of job separation rates and job arrival rates. Specifically, a household on the employment island will exogenously transition to the leisure island next period with probability $\xi(z)$. Households on the leisure island have the option to search for work which will be described shortly. Searching results in a transition to island E next period with probability $\lambda(z)$. Both labor market frictions are functions of the aggregate state which allows the model to replicate the employment risk faced by households over the business cycle. In summary, households experience extensive margin employment risk and intensive margin earnings risk, both of which fluctuate with the aggregate state of the economy.

After realizing the individual and aggregate state of the economy, households first make an extensive margin employment choice. Agents on island E make an endogenous separation decision which I call quitting. The binary choice for quitting is described in equation (1) below. Any household that quits a job will transition to the leisure island next period. A

[5] I use recursive notation to describe the household problem where x' indicates the future value of a variable x.

[6] Storesletten, Telmer and Yaron (2004)

working household receives wage w for each efficiency unit of productivity but also has to pay a utility cost. A household on the leisure island makes a binary search decision defined in equation (2). Search results in a transition to the employment island with probability $\lambda(z)$, but households must pay a utility cost to search. Let $h \in \{e, u\}$ be the subsequent decision rule for equations (1) and (2) where s is the credit status of a household.

$$V_j(\epsilon, a, E, s; z, \mu) = \max\left[W_j^e(\epsilon, a, E, s; z, \mu), W_j^u(\epsilon, a, E, s; z, \mu)\right] \tag{1}$$

$$V_j(\epsilon, a, N, s; z, \mu) = \max\left[W_j^e(\epsilon, a, N, s; z, \mu), W_j^u(\epsilon, a, N, s; z, \mu)\right] \tag{2}$$

$$h_j(\epsilon, a, n, s; z, \mu) = \begin{cases} e \quad if \quad W_j^e(\epsilon, a, n, s; z, \mu) \geq W_j^u(\epsilon, a, n, s; z, \mu) \\ u \quad otherwise \end{cases}$$

UI is modeled to represent the key features of the US system. I first assume that part of island N does not have access to the UI program. Let $\tilde{N}$ represent the side of the island without UI, and N will now be the side with UI. Households that quit a job will transition to $\tilde{N}$, but agents that are fired will move to N. This represents the fact that people who quit their job are not eligible to receive benefits. Furthermore, agents on the leisure island must be searching for work to receive benefits. Any household that doesn't search for work will be immediately moved to $\tilde{N}$. The level of benefits is a fraction of the wages that would be earned if working.[7] Let $\overline{\omega}$ be the maximum level of benefits that a household can receive. Another key feature of the US UI system is that benefits do not last forever. I assume that with probability $\psi(z)$ a household will be moved from N to $\tilde{N}$ when receiving benefits. This allows the model to replicate the average duration of UI benefits. To quantify the impact of UI it is essential to model the relationship between extensive margin employment decisions and UI because households are not eligible to receive benefits if they quit their job or refrain from search.

After making a labor market choice, households make a discrete default choice. This

[7] This is referred to as the replacement rate of benefits from here on.

default decision is modeled to represent a chapter 7 filing in the US bankruptcy code.[8] All unsecured assets are immediately dis-charged resulting in $a = 0$. I assume that households pay a utility cost χ and cannot save while declaring bankruptcy. Defaulting households will move to the bad credit state s_b next period. While in bad credit, households no longer have access to borrowing. I assume that agents will leave bad credit each period with probability θ. This allows the model represent the fact that a bankruptcy remains on an individual's credit history for a finite period of time. Equation (3) describes the bankruptcy choice where $d \in \{b, p\}$ is the resulting decision rule. In this equation h defines the labor market decision that already occurred.

$$W_j^h(\epsilon, a, n, s_g; z, \mu) = \max \left[Y_j^{h,p}(\epsilon, a, n, s_g; z, \mu), Y_j^{h,b}(\epsilon, 0, n, s_b; z, \mu) \right] \tag{3}$$

$$d_j(\epsilon, a, n, s_g; z, \mu) = \begin{cases} b \quad if \quad Y_j^{h,b}(\epsilon, 0, n, s_g; z, \mu) > Y_j^{h,p}(\epsilon, a, n, s_b; z, \mu) \\ p \quad otherwise \end{cases}$$

Financial markets are incomplete. Households smooth consumption by borrowing or saving using a security a where $a > 0$ indicates saving and $a < 0$ is borrowing. All securities are modeled as agreements between the financial intermediary and the household. Households pay a price q to receive the security that will repay a units next period. Therefore, a household borrowing qa' today will repay a' next period. The discount price is determined by the financial intermediary based on the probability of default. The specific details of the discount price will be discussed when describing the financial intermediaries. Without a full set of state-contingent assets, the idiosyncratic risk will lead to a rich distribution of households over age j, productivity ϵ, asset levels a, employment states n and credit states s.[9]

Households finish a model period by making a consumption-savings decision. Equation (4) describes the decision made by households in good credit who have decided to not default. The factor prices r, w are functions of the aggregate state which includes the distribution

[8] This setting is in the spirit of Chatterjee, Corbae, Nakajima and Ríos-Rull (2007) and Livshits, MacGee and Tertilt (2007).

[9] The model is a heterogeneous agent model in the spirit of Aiyagari (1994) and Huggett (1996)

of households. Let F be the law of motion for the distribution of households. The law of motion accounts for all exogenous transitions and endogenous choices that impact the allocation of households across individual states. Let χ_w^n be the utility cost from work paid when on island E. Let $\chi_s^{h,n}$ be the utility cost of search paid when searching from the leisure island. $\omega^{h,n}(z)$ is the replacement rate of UI benefits. Households only receive benefits when searching from the leisure island, and I assume that $\omega = 1$ when an agent is working.[10] Households pay a tax τ on earnings and receive a lump-sum transfer T from the government. When borrowing, the discount price q incorporates the employment state and labor market decision of the household. This allows for the terms of credit to reflect the employment risk experienced by households. The discount price will also create a direct relationship between the terms of UI and the terms of credit. This will be a crucial channel to quantify the relationship between UI and consumer credit. Expanding competitive credit with default in an equilibrium environment to account for labor market states and decisions is the main departure I make from Chatterjee et al. (2007) when modeling credit markets.

$$Y_j^{h,p}(\epsilon, a, n, s_g; z, \mu) = \max_{a',c} u(c) - \chi_w^n - \chi_s^{h,n} + \beta E\Big[V_{j+1}(\epsilon', a', n', s_g; z', \mu')|\epsilon, n, h; z\Big] \tag{4}$$

$$\text{s.t.} \quad c + q_j^h(\epsilon, a', n; z, \mu')a' = a + \omega^{h,n}(z)\,(1-\tau)w(z,\mu)\epsilon\gamma_j + T$$

$$\text{and} \quad \mu' = F(z, \mu), \quad g_j(\epsilon, a, n, s_g; z, \mu) = a'$$

$$Y_j^{h,b}(\epsilon, a, n, s_g; z, \mu) = u(c) - \chi - \chi_w^n - \chi_s^{h,n} + \beta E\Big[V_{j+1}(\epsilon', 0, n', s_b; z', \mu')|\epsilon, n, h; z\Big] \tag{5}$$

$$\text{s.t.} \quad c = \omega^{h,n}(z)\,(1-\tau)w(z,\mu)\epsilon\gamma_j + T$$

$$\text{and} \quad \mu' = F(z, \mu), \quad g_j(\epsilon, a, n, s_g; z, \mu) = 0$$

When filing for bankruptcy, no further decisions are made this period. Equation (5) describes the value from defaulting. The value is determined by the utility derived from

[10] The function $\omega^{h,n}(z)$ also accounts for the fact that the maximum benefit that can be earned is $\overline{\omega}$.

consuming labor earnings and any transfer received from the government minus the cost of filing χ. It is possible for a household to default on positive values of securities, but this will never happen because there is no benefit from doing so. The problem solved by an agent with bad credit is described in equation (6). The expectation operator accounts for the probability θ of transitioning to good credit next period. The main punishment for bankruptcy is that households cannot borrow while in bad credit. Because households cannot borrow while in bad credit, the menu of discount prices q is the inverse of the expected return on capital.

$$W_j^h(\epsilon, a, n, s_b; z, \mu) = \max_{a', c} u(c) - \chi_w^n - \chi_s^{h,n} + \beta E\Big[V_{j+1}(\epsilon', a', n', s'; z', \mu')|\epsilon, n, h; z\Big] \qquad (6)$$

$$\text{s.t.} \quad c + q^h(\epsilon, a, n; z, \mu)a' = a + \omega^{h,n}(z)\,(1-\tau)w(z,\mu)\epsilon\gamma_j + T$$

$$\text{and} \quad \mu' = F(z, \mu), \quad g_j(\epsilon, a, n, s_b; z, \mu) = a', \quad a' \geq 0$$

I model retirement so households have a realistic life-cycle savings motive while working. However, retirement will not be of primary interest to the current paper because these households will not be affected by employment risk or UI benefits. Further, unsecured credit and default is largely concentrated among young households. To complete the life-cycle, I assume that agents consume a transfer from the government and a fraction of their savings in each period of retirement. There is no bequest motive for households at the end of the life-cycle.

2.b) Financial Intermediaries

Financial intermediaries are deep-pocketed institutions that own all of the capital in the economy. The market for inter-mediation is competitive. Financial intermediaries offer a menu of securities which facilitate all saving and borrowing by households. The function q describes the price for each security. The aggregate savings of households will act as the liabilities on the balance sheets of intermediaries. The intermediaries will have two types of assets. Loans are made to households, and the net aggregate savings is rented to firms in the form of capital. Because the intermediaries have two assets on their balance sheets, the expected returns must be equal in equilibrium.

$$q_j^h(\epsilon, a', n; z, \mu') = \Big(\frac{1}{1+i}\Big) \sum_{z'} \pi_z(z', z) E\Big[1 - d_j^h(\epsilon', a', n'; z', \mu')|\epsilon, n, h\Big] \tag{7}$$

$$\text{where} \quad \mu' = F(z, \mu)$$

When a household borrows, the intermediaries buy securities at a discount price. The intermediary creates a menu of loan prices described in equation (6) for each of the possible discount securities that can occur. Because the market for credit is competitive, intermediaries will choose a price that earns zero profits in expectation. However, in the presence of aggregate risk it is possible for profits or losses to be realized. These net profits will be quantitatively insignificant, and I assume that the intermediaries will absorb the profits or losses. The price in equation (6) is the discount rate implied by the expected return on capital tomorrow i multiplied by the probability of bankruptcy on the loan with value a'. This is needed to equate the expected returns of capital and loans. Intermediaries know the employment state and the labor market decisions when pricing the loan because these decisions are made by households before borrowing takes place. Because labor market decisions affect the transition between islands, they also affect the default probability in future periods. This allows for employment risk and extensive margin labor decisions to be explicitly priced into the loan agreement which creates an interaction between UI benefits and the terms of credit. Because each loan earns zero profits in expectation, the market for credit will clear each period.

2.c) A Representative Firm

A representative firm will rent capital from intermediaries and hire labor from households to produce the single output good in the economy. This firm is subject to productivity shocks dependent on the aggregate state of the economy. The firm will maximize profits described in equation (8). Therefore, each period the returns to capital and labor are equal to their marginal products in the aggregate production function. The markets for capital and labor clear according to equations (9) and (10).

$$\Pi = \max_{K,L} zF(K, L) - r(z, \mu)K - \delta_k K - w(z, \mu)L \tag{8}$$

$$K' = \sum_{j=1}^{N_j} \sum_{\epsilon} \sum_{n} \sum_{s} \int_{\infty}^{\infty} g_j(\epsilon, a, n, s, z, \mu)\, \mu_j(\epsilon, da, n, s) \tag{9}$$

$$L = \sum_{j=1}^{N_r} \sum_{\epsilon} \sum_{s} \int_{-\infty}^{\infty} \epsilon \gamma_j\, \mu_j(\epsilon, da, E, s) \tag{10}$$

2.d) The Government

The government collects income taxes from all working households. The government also facilitates transfers to households in three different ways: UI benefits, social security and lump-sum transfers. Let G be the net government expenditures which are described in equation (11). The UI benefits are meant to capture the key institutional features of the US system, and the details were described earlier in section 2. The social security benefits are paid out as a lump-sum transfer to all retired households. Let T_r be the social security transfer. I assume that the government also makes a transfer T to all working-age households. The value of this transfer is chosen such that net government expenditures are zero on average in the stochastic equilibrium. I assume that net government expenditures fluctuate to clear markets in every period. The hat variables represent the total revenue or expenditure associated with each policy respectively.

$$\begin{aligned}
G &= \hat{\tau} - \hat{T}_u - \hat{T}_r - \hat{T} \qquad (11)\\
\hat{\tau} &= \sum_{j=1}^{N_r} \sum_{\epsilon} \sum_{s} \int_{-\infty}^{\infty} \tau w(z, \mu) \epsilon \gamma_j\, \mu_j(\epsilon, da, E, s)\\
\hat{T}_u &= \sum_{j=1}^{N_r} \sum_{\epsilon} \sum_{s} \int_{-\infty}^{\infty} \omega^{n,h}(z)(1-\tau) w(z, \mu) \epsilon \gamma_j\, \mu_j(\epsilon, da, E, s)\\
\hat{T}_r &= \sum_{j=N_r}^{N_j} \sum_{\epsilon} \sum_{n} \sum_{s} \int_{-\infty}^{\infty} T_r\, \mu_j(\epsilon, da, E, s)\\
\hat{T} &= \sum_{j=1}^{N_r} \sum_{\epsilon} \sum_{n} \sum_{s} \int_{-\infty}^{\infty} T\, \mu_j(\epsilon, da, n, s)
\end{aligned}$$

2.e) A Recursive Equilibrium

A Recursive Competitive Equilibrium is a set of functions for value V, W, Y, decision rules g, c, h, d, prices r, w, q and the distribution of households μ such that:

1. The decision rules g, c, h, d solve the household problem for value functions V, W, Y described by equations (1)-(6).

2. Financial intermediaries offer a menu of prices q to earn zero profits in expectation described by equation (7).

3. Firms maximize profits in equation (8) where r, w are the resulting prices.

4. The distribution of households is consistent with individual decisions described in equations (12)-(16) in appendix A.1.

5. The markets for capital, labor, credit, government expenditures and goods clear from equations (9), (10), (11) and

$$C + K' - (1 - \delta_K)K + G = F(K, L)$$

3. Model to Data and Solution

Mapping the model to data proceeds in three stages. I first choose parameters outside of the model solution. These parameters are either chosen because they represent institutional features of US policies or because they occur in previous papers in the literature. I then calibrate a set of parameters to match moments from the data that are essential targets to measure the interaction of UI policies with unsecured consumer credit. Finally, I test the validity of the model by comparing model-generated results to untargeted moments from the data. Section 3 ends with a description of the solution concept used to solve the model from section 2.

3.a) Parameters Chosen Outside the Model Solution

I set the length of a period in the model to be one quarter. I assume that households are born into the economy at age 25, they retire at age 65 and they die at age 75. Therefore, I set N_j equal to 200 to depict the total number of ages in the life-cycle of a household. Quarterly life-cycle stages significantly increase the size of the state-space of the household problem, but it is needed to represent the relatively high frequency of movements between employment states. Households value utility with constant relative risk aversion (CRRA) preferences $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. The coefficient of relative risk aversion σ is set to 2.0. I also assume aggregate production follows a Cobb-Douglass function $F(K, L) = zK^{\alpha}L^{1-\alpha}$. The capital share of production is set to 0.335 and 1.7% of capital depreciates each period.

Table 1 outlines parameters from the model that are chosen outside of the model solution. Consistent with Krusell, Mukoyama, Rogerson and Sahin (2017), the persistence of the productivity process is set to 0.989. This equates to a persistence in annual wages of 0.957 which is commonly used in the literature. In line with Mendoza, Razin and Tesar (1994), the tax rate τ is set to 30%. To map the age-component of productivity to the data, I parameterize the process such that $\gamma_j = \phi_1^j j + \phi_2^j j^2$. Using data on earnings from the 2010 SCF, I estimate ϕ_1^j and ϕ_2^j to be $4.39e^{-2}$ and $-8.59e^{-4}$ respectively. Because age is only report in one-year intervals in the SCF, I assume the age-component of earnings will only change once every 4 model periods. The key feature of this process is that households experience hump-shaped life-cycle earnings profiles which incentivize borrowing when young.

Numerous parameters are chosen to represent specific features of the US systems for UI and bankruptcy. The probability of leaving bad credit θ is set to 2.50% so the average duration of bad credit lasts 10 years. This is the amount of time a bankruptcy can remain on an individual's credit score. Households receiving benefits have a replacement rate of lost earnings of 50%, and the maximum level of benefits is set to equal 40% of the average earnings in the economy. This is the average value of maximum benefits across states. The probability of losing benefits is set at 50% so that the average household has UI for 2 quarters which is the median duration of benefits across US states.

Quarterly job separation rates and job arrival rates are taken from Low, Meghir and Pistaferri (2010). I use these values for labor market frictions in good states. The values of the aggregate transition matrix are chosen to match the average duration of expansions and recessions from 1968-2019.

3.b) Calibrated Parameters

The calibration strategy is chosen so the model economy can replicate the employment

Description	Parameter	Value	Source
Coef. Risk Aversion	σ	2.000	Common Literature
Capital Share	α	0.335	Common Literature
Depreciation	δ_k	0.017	Common Literature
Earnings Persistence	ρ	0.989	Common Literature
Income Tax	τ	0.300	Common Literature
Duration Bad Credit	θ	0.025	Bank. Institution
UI Replacement	ω	0.500	UI Institution
UI Duration	ψ	0.500	UI Institution
Max UI Benefit	$\overline{\omega}$	1.940	UI Institution
Separation Rate	$\xi(z_g)$	0.0304	Low et al. (2010)
Arrival Rate	$\lambda(z_g)$	0.6865	Low et al. (2010)

Table 1: **Chosen Parameters**

risk, credit use and bankruptcy behavior of households in the US. Specifically, I use data from 1968Q1 to 2019Q4 to generate a consistent set of moments for the model to target. I choose 1968Q1 as the start date because this is when the flow of funds has data available on revolving credit balances. As stated in section 2, I assume that households can have one of two different discount factors for future utility. Half of the households receive a low beta value of $\beta_2 = 0.880$ when born which is chosen to match the average aggregate revolving credit to GDP ratio seen in the data.[11] The remaining households have a discount factor of $\beta_1 = 0.988$ to match the average capital to GDP ratio. The discount factor is permanent throughout life. I choose to target the aggregate level of revolving credit so the model can replicate total unsecured credit usage in the US. Credit usage is an equilibrium outcome simultaneously accounting for the desire to borrow and the willingness to lend by intermediaries.

The dis-utility from bankruptcy is set to $\chi = 0.82$ so the model matches the average bankruptcy rate by households from 1968-2019. Quarterly data on bankruptcies is only available from 1994, so I use annual data reported in table F-2 of the annual report of the director of the administrative office of the U.S. Courts.[12] This allows the model to replicate credit usage and default behavior in the US which is needed to quantify an interaction with UI. As the dis-utility of bankruptcies increases, households will default less and borrow more. They borrow more because the terms of credit improve. As the discount factor for

[11] In the model this is the average value across the entire stochastic equilibrium simulation

[12] The data tables are organized by LLMC digital

a household decreases, households both borrow and default more. Because these two terms do not generate the exact same effect in household decision problems, it is relatively easy to calibrate aggregate debt and bankruptcy simultaneously.

Description	Parameter	Target	Data	Model
Discount 1	β_1	Capital:GDP	9.479	9.478
Discount 2	β_2	Revolving Credit:GDP	0.156	0.138
Bank Cost	χ	Bankruptcy Rate	$1.88e^{-3}$	$1.97e^{-3}$
Working Disutility	X_w	Participation Rate	0.643	0.648
Search Disutility	χ_s	Unemployment Rate	0.061	0.061
Productivity Variance	$\sigma^2_\eta(z_g)$	Earnings Variance	0.865	0.876
Productivity Variance	$\sigma^2_\eta(z_b)$	Change in Variance	0.212	0.195
TFP Recession	z_b	Std. Dev. GDP	0.014	0.013

Table 2: **Calibrated Parameters**

Notes: Data targets are average values from 1968Q1-2019Q4. Earnings variance is from 1978-2010 because this is when data is available. Change in variance is the implied value from Storesletten et al. (2004).

I use the dis-utilities from work and search to target average unemployment and participation rates from the data. When calibrating the productivity process, I want to replicate the counter-cyclical income risk described in Storesletten et al. (2004). However, the model does not have the same income process they estimate. I choose the variance in individual level productivity $\sigma^2_\eta(z_g) = 0.0157$ in good times to match the average cross-sectional variance of log earnings in the economy. I choose the variance in bad times to be $\sigma^2_\eta(z_b) = 0.0190$ so the implied steady-state variance of the process is 0.211 higher during recessions. This increase is consistent with the implied increase in variance from the Storesletten et al. (2004) process. The remaining parameters are calibrated to match second moments over the business cycle. The value of TFP during a recession is set to $z_b = 0.97$ to target the standard deviation in real GDP in the US.[13] Job separation rates and job arrival rates are set to 0.0365 and 0.47 during recessions respectively. The recession values of labor market frictions are chosen to match results from Shimer (2012) where he shows that 69% of the volatility in unemployment is from job arrival rates and 31% is from separation rates in US data.

[13]Quarterly real GDP is HP filtered with a smoothing parameter of 1600

3.c) Moments Not Targeted in Calibration

I now compare key model-generated moments to their counterparts in the data. In figure 1, I compare the distribution of unsecured credit over employment states from the model to the data. I use the 2010 Survey of Consumer Finances to assess the distribution of credit-card debt. Specifically, I look at the share of total unsecured consumer credit over the employment states of working-age households. Figure 1 shows that the model generates the pattern of the distribution of unsecured credit. The majority of credit balances are held by the employed, and unemployed households hold more credit than those out of the labor force (OLF). The model under-predicts the credit held by the OLF households because most of this debt comes from students or disabled individuals in the data. The model does not measure either of these margins. This should not have a first-order impact on the results of the model because OLF households cannot interact with UI benefits. Considering these moments are not targeted in the calibration, the model does quite well replicating the empirical facts. It is essential that the model can replicate credit use across employed and unemployed households because this will directly impact the relationship between UI policies and consumer credit.

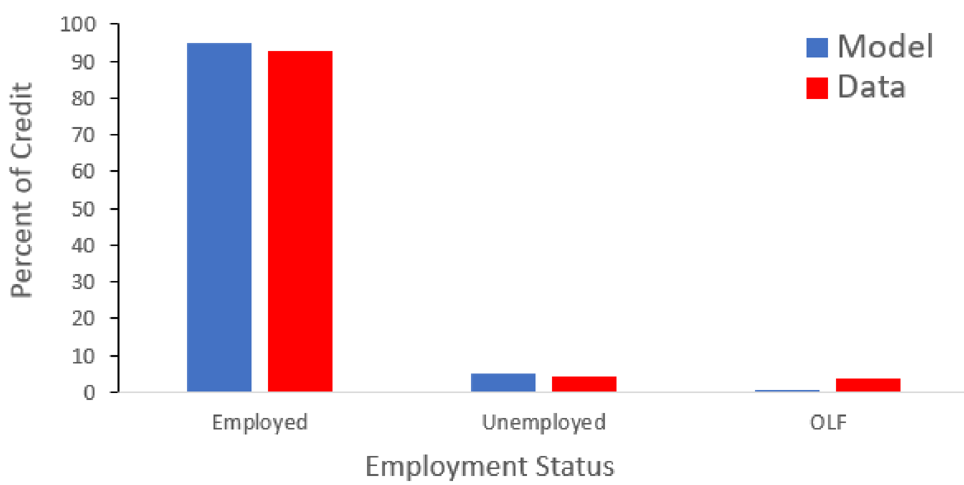

Figure 1: **Share of Total Credit by Employment**

Notes: Data is the share of total credit card debt of working-age households reported in the 2010 SCF.

I also test the model by comparing second moments of aggregate quantities over the business cycle to their counterparts in the data. To generate a consistent set of targets, I use quarterly data from 1968Q1 through 2019Q4 HP filtered with a smoothing parameter of 1600. However, bankruptcy data is only used from 1994Q1 because this is when it became available. All data is in logs and seasonally adjusted before being HP filtered. Credit data is measured as total revolving credit balances reported in the Flow of Funds. Most notably, the model is able to generate the high volatility and pro-cyclicality of credit along with the high volatility and counter-cyclicality of bankruptcy seen in the data. This is an essential preliminary step towards quantifying the interaction of UI policy with unsecured credit and default over the business cycle. Despite being un-targeted moments, the model also depicts the pattern of cyclical labor market outcomes, consumption and investment for US households. It is particularly important that the model is able to generate the volatility and cross-correlation of consumption. To quantify meaningful predictions for for how UI and credit interact to affect consumption and welfare over the business cycle, the model must succeed on these fronts.

	Relative SD (%)		Cross-Corr. GDP		Auto-Corr	
	Data	Model	Data	Model	Data	Model
GDP (Y)	(0.014)	(0.013)	1.0	1.0	0.87	0.78
Consumption	0.58	0.57	0.81	0.89	0.86	0.55
Investment	4.19	1.90	0.90	0.84	0.86	0.89
Credit	5.67	3.92	0.31	0.55	0.89	0.89
Bankruptcy	17.29	22.68	-0.51	-0.80	0.57	0.48
Unemployment Rate	7.96	8.09	-0.86	-0.72	0.92	0.66
Participation Rate	0.22	0.13	0.37	0.55	0.72	0.65

Table 3: **Business Cycle Moments**

Notes: Data is in logs, seasonally adjusted and HP filtered with a smoothing parameter of 1600. All data is from 1968Q1-2019Q4 except for bankruptcy which begins in 1994Q1.

3.d) The Model Solution

The state-space of the household problem includes the infinite-dimensional distribution of households. To solve the problem, I implement the state-space approximation method developed by Krusell and Smith (1998). In the current setting, the first moment for the distribution of capital will not be sufficient to approximate future prices because of endogenous labor market decision. I proxy the distribution of households using both the first moments for the distribution of capital and labor in the economy. This requires having two forecasting rules to predict future prices. I parameterize the forecasting rules using the equations for K' and L' seen below. All parameters are dependent on the aggregate state of the economy. The first moments for the distributions of capital and labor are sufficient statistics to generate an accurate solution as long as they are both included in the forecasting rules.

$$K' = \beta_0^k(z) + \beta_1^k(z)\log(K) + \beta_2^k(z)\log(L)$$

$$L' = \beta_0^l(z) + \beta_1^l(z)\log(L) + \beta_2^l(z)\log(K)$$

The algorithm to solve the model begins with a guess for each of the parameters in the forecasting rule. I then solve individual household decisions for consumption, savings (or borrowing), bankruptcy and search (or separation). The state space of the model is very large which necessitates the use of a powerful method of solving individual level decisions. I modify the endogenous grid method (EGM) so that it can be used in the presence of non-concavities in the expected future value function.[14] The method relies on using locally concave regions to solve for local solutions, then choosing the best local solution as a global solution. Modifying EGM in this way leads to gains in accuracy and significant gains in speed relative to pre-existing methods. The method is also very easily applied to problems with occasionally binding constraints. This makes it well-suited for consumer default problems. Household decision rules are used to simulate the model for 2300 periods, dropping the first 300. Using simulated data, I run a regression to estimate the parameters of the forecasting rule. The forecasting rules are updated, and I iterate until there is convergence in the parameter values.

To test the accuracy of the solution method, I conduct multi-period Den Haan errors. These errors calculate the percent difference in simulated values for capital and labor compared to predicted values if forecasting rules were used from the initial period. This is a good test of the model because in a rational expectations setting, households should be able

[14] I am not the first one to modify EGM to be used with non-concavities. Fella (2014) and Iskhakov, Jorgensen, Rust and Schjerning (2017) do as well.

to predict the future aggregate state. The resulting Den Haan errrors for a 2000 period simulation are recorded in figure 10.[15] The max error in the simulation is 1.0%. This compares with the max error in the stochastic beta version of the Krusell and Smith (1998) model of approximately 2.0%, and this is considered to be a highly accurate solution in the literature.

4. A Decomposition of Risk

A key contribution of this paper is the model's ability to represent the cyclical moments of unsecured consumer credit and bankruptcy. In this section, I run a decomposition exercise to better understand why the model is able to succeed on this front. The decomposition exercise provide a further understanding of the sources of fluctuations in competitive credit markets. The results in this section will also provide important information to help in interpreting quantitative results in future sections.

I begin the decomposition by removing GE price movements in the factor prices for capital and labor. This amounts to solving a partial equilibrium version of the model where the returns to capital and labor are constant at their average values throughout the entire simulation. I find that the model with constant factor prices will generate over a 20 percent increase in the standard deviation of unsecured consumer credit. This occurs because the discount prices on loans are directly impacted by the return on capital. A drop in the factor price of capital during a recession will limit the drop in credit during this time. Models with constant factor prices will be missing this dampening effect. I also remove GE factor price movements first to prevent any feedback when removing elements of risk from the model.

	Baseline	Employment		Earnings	
	Std Dev	Std Dev	% Change	Std Dev	% Change
Credit	6.25	0.82	-86.89	5.37	-14.08
Bankruptcy	27.13	7.02	-74.12	23.88	-11.98

Table 4: **Decomposition of Risk**

Notes: Baseline model in this table is the model without fluctuations in the factor prices of capital and labor. Each experiment removes one form of income risk from the model. For example, the "Employment" column is the model without fluctuations in employment risk.

[15] Figure 10 is in the appendix.

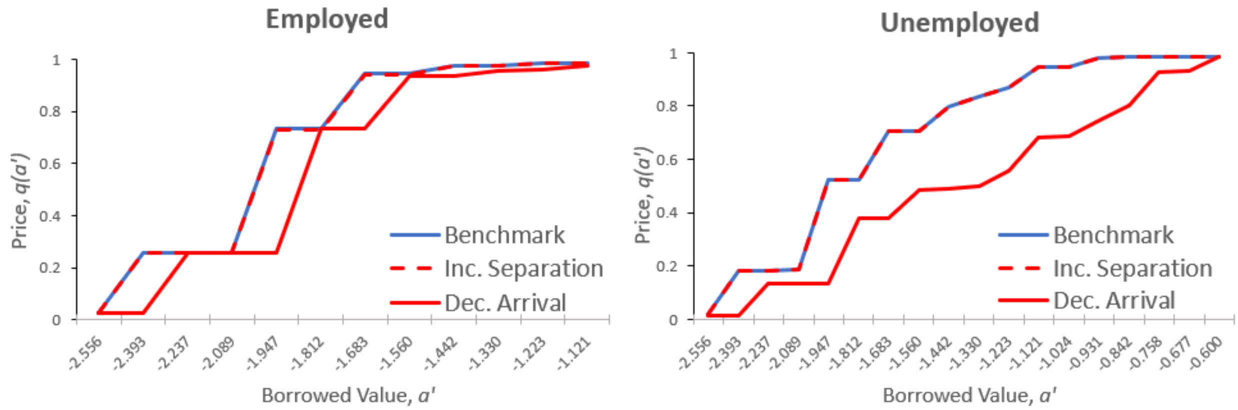

Figure 2: **Discount Prices**

Notes: Discount prices from changes in labor market frictions. Discount prices are the inverse of the probability of a bankruptcy occurring.

Using the model with constant factor prices, I remove cyclical changes in extensive margin employment risk and intensive margin earnings risk one at a time. Table 4 outlines the results from the decomposition exercise. When removing changes in extensive margin employment risk, the volatility in credit and bankruptcy fall by over 86% and 74% respectively. Removing changes in intensive margin earnings risk from the benchmark model results in drops in the standard deviations by over 14% for credit and 11% for bankruptcies. Most notably, the decomposition exercise shows that the majority of the volatility in credit and bankruptcy depicted in the benchmark model is the result of changes in employment risk over the business cycle. Previous papers in the literature have not incorporated extensive margin employment risk in a real business cycle model of consumer credit and bankruptcy. This explains why the model in this paper is able to make significant improvements in explaining the standard deviation of unsecured consumer credit over the business cycle. However, the decomposition exercise does not just make a contribution to the literature that looks to better understand the sources of fluctuations in consumer credit. This result also shows that targeting income loss from unemployment can result in large changes to credit use over the business cycle.

The discount prices offered to households on loans depict the inverse of the probability of a future bankruptcy. Figure 2 shows the discount prices for employed and unemployed

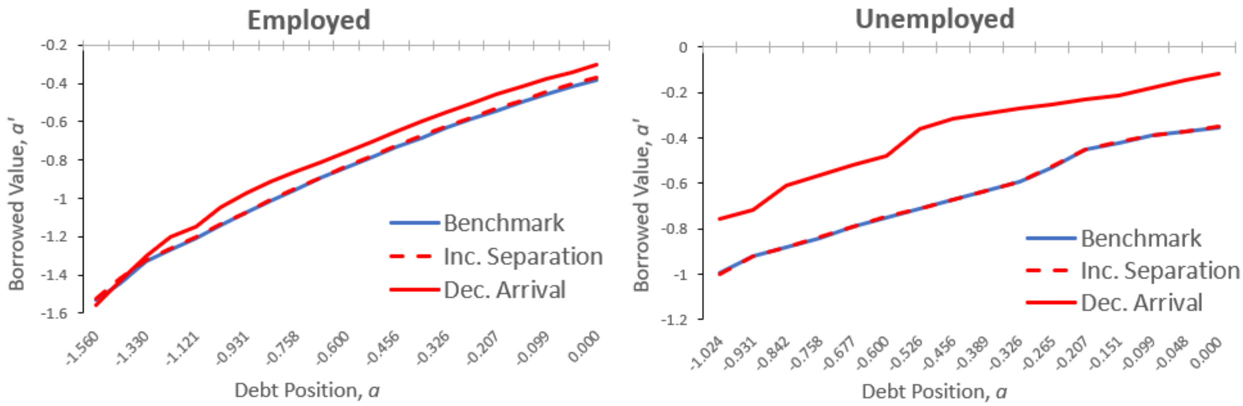

Figure 3: **Borrowing Decision Rules**

Notes: borrowing decisions from changes in labor market frictions. Decisions rules are for households already in debt.

households when subject to changes in labor market frictions.[16] The first key takeaway is that unemployed households are more likely to declare bankruptcy compared to their employed counter-parts. This result is consistent with evidence from the data that bankruptcy rates are higher among the unemployed. The essential implication from discount prices is that low job arrival rates significantly increase the probability of bankruptcy, particularly among unemployed households. The change in default probability directly leads to worse credit terms for households. High job separation rates have almost no effect on bankruptcy probability. However, high job separation rates facilitate a stronger flow of agents from employment to unemployment which will still have a significant effect on bankruptcy rates during recessions.

In addition to higher bankruptcy rates, we also see less unsecured consumer credit use during recessions in the data. As stated in the previous section, the model is able to replicate the pro-cyclicality of credit. To better understand the mechanism driving this result, I plot household borrowing decision rules in figure 4. Unemployed households borrow less than their employed counterparts. Furthermore, decreases in arrival rates have a much stronger impact on borrowing than increases in separation rates. This effect is particularly impactful for unemployed households. Decreased arrival rates significantly decrease borrowing at the individual level for two main reasons. First, deteriorated terms of credit will make borrowing

[16]The discount prices are for an age 35 household with productivity one standard deviation below the mean

less appealing. Also, households have a stronger desire to save (or delever) to self-insure for the possibility of being unemployed without benefits. These results suggest that a recession with particularly low job arrival rates will have a stronger impact on individual-level household decisions and thus aggregate quantities of unsecured consumer credit. Overall, we can see that two main forces drive the cyclical moments of credit and bankruptcy in the model. Decreased job arrival rates during recession directly impact household-level borrowing and bankruptcy decisions. Also, increased separation rates facilitate a stronger flow of households from employment to unemployment.

5. The Implications of UI During the Great Recession

In this section, I quantify the interaction of UI policies with unsecured consumer credit during the Great Recession. Specifically, I find how extensions in the duration UI benefits impact credit use, and I quantify how this relationship feeds back into consumption and welfare. I also quantify the implications of a budget-neutral expansion in the replacement rate of benefits, and I compare results.

5.a) Replicating Data from the Great Recession

Beginning in 2008, the federal government provided funds to states to extend the duration of UI benefits. The duration of benefits was originally increased from 26 weeks to 79 weeks. In 2009, an additional 20 weeks of benefits were provided reaching a total of 99 weeks which lasted through most of 2013. I simulate the model economy starting at the end of 2007 inputting extensions in the duration of benefits into the model. Specifically, this implies that the probability of losing UI will drop from $\psi = 0.50$ to $\psi = 0.131$. I begin the simulation from a steady-state equilibrium calibrated to match stationary moments in 2007. Recall that the calibration strategy in section 3 depicted average moments from 1968-2019. To simulate the Great Recession, it is important that the economy begins at levels of credit use, bankruptcy behavior and employment risk seen just before the start of the recession. To replicate the recession, I input aggregate shocks to TFP, job separation rates and job arrival rates seen in the data. I assume that agents have perfect foresight over the series of shocks after the initial period of the simulation. For each quarter, I input values of TFP measured as percent deviations from the 2007Q4 value which reaches a peak-to-trough drop of just below 3% in 2009 Q1. To measure labor market frictions, I use seasonally adjusted data on flows between employment and unemployment from the current population survey (CPS). Flows between employment and unemployment provide a good proxy for labor market frictions because they are highly correlated with separations and arrivals. Figure 7 plots the percent change in aggregate shocks from their 2007Q4 values. Both labor market frictions experience a severe and persistent change which increases employment risk during the recession and recovery. The main focus of this analysis is on 2008-2013 because this is when UI policies were changed. Therefore, once shocks return to their 2007Q4 level, I assume they remain there, and the economy returns to a steady-state equilibrium in the long-run.

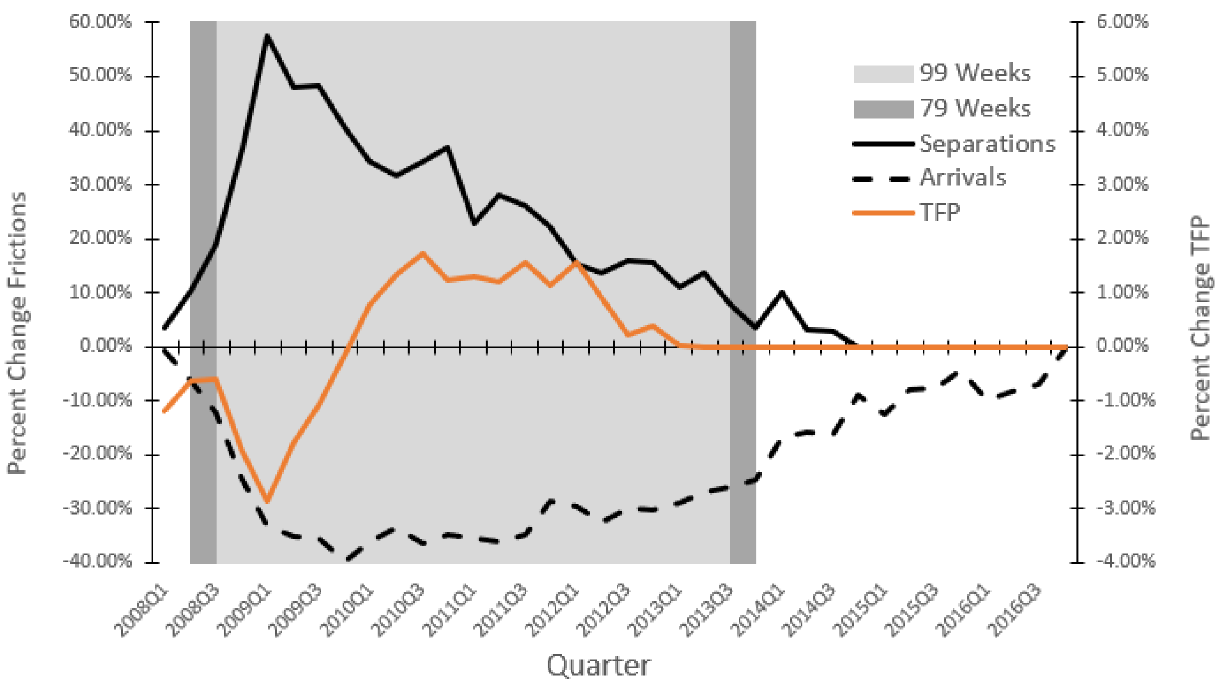

Figure 4: **Shocks and Policies**

Notes: Aggregate shocks and policies inputted into the model during the Great Recession. Data on labor market frictions from the CPS.

In section 3, I showed that the model can replicate the business cycle moments from 1968Q1-2019Q4. However, it is also important to show that the simulated model can depict key trends from the data during the Great Recession before running counter-factual exercises. Figure 5 compares the model to data for the simulated recession. All data is in logs, seasonally adjusted and HP filtered with a smoothing parameter of 1600 except for unemployment. I don't HP filter unemployment rates because this variable doesn't have a meaningful secular trend. The model replicates the large and persistent spike in unemployment which is an indication that the CPS data provides a good approximation of labor market frictions. Furthermore, the model does a good job replicating trends seen in the data for aggregate quantities. Consumption for example is low during the recession, begins to rise during the recovery but then falls slightly after 2012. However, the model does predict a spike in bankruptcies in the first date of the recession which doesn't occur in the data. This is the result of the perfect foresight nature of the exercise. Many households default immediately after learning about the time series path of shocks. After the initial date, the model depicts the persistent hump-shaped trend in bankruptcies.

The model predicts a peak-to-trough drop in credit of 20% which is larger than what is seen in the data. However, the peak-to-trough drop in unfiltered credit use is about 28% which is close to what the model predicts. Furthermore, the model is significantly closer to the data compared to leading articles in the literature. The model used in Athreya, Sanchez, Tam and Young (2015) predicts a peak-to-trough drop in the credit to GDP ratio of over 80% during the Great Recession. Overall, the model greatly succeeds at generating trends from the Great Recession considering none of these moments were directly targeted in the calibration.

5.b) The Impact of Extensions in the Duration of UI

I use the model to run a counter-factual simulation where the duration of UI benefits remains constant at 26 weeks for the entire recession. This allows me to quantify the impact of extended benefits on aggregate quantities. Figures 6 illustrates the changes in aggregate quantities from the counter-factual experiment.[17] Most notably, the extension in the duration of UI benefits prevented over a 29 percentage point further drop in unsecured consumer credit use measured from peak to trough. This shows that there was a significant complementary relationship between counter-cyclical UI policies and credit use during the Great Recession.

[17] The benchmark model contains the extended duration of benefits that occurred during the Great Recession.

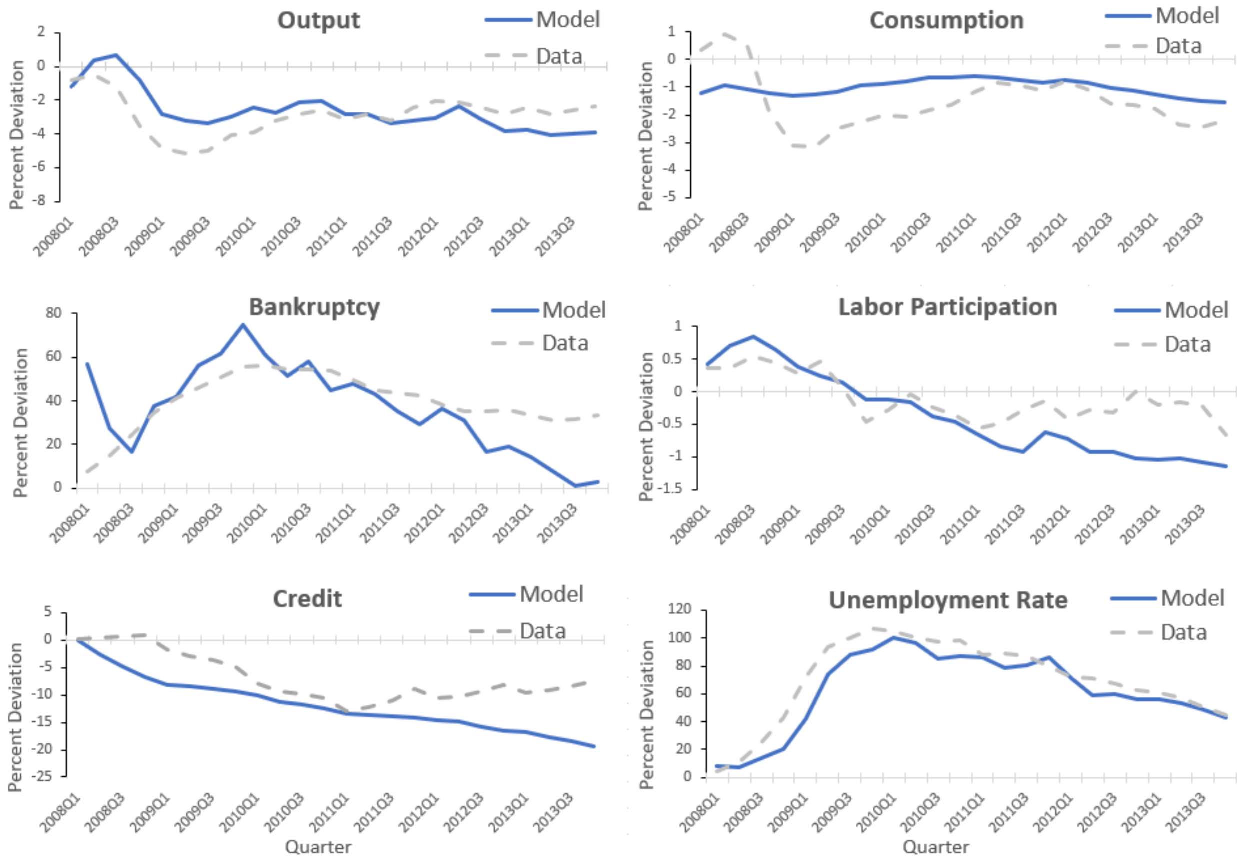

Figure 5: **Model to Data During the Great Recession**

Notes: Data log, seasonally adjusted and HP filtered with a smoothing parameter of 1600. Unemployment rate data is not HP filtered.

This occurs because the increased duration of benefits insures against persistently low job arrival rates which improves terms of credit and reduces the motive to delever by indebted households. The model predicts a substantial 49 percentage point peak-to-trough drop in unsecured credit use with constant UI policies. This is a severe drop, but it is in line with results from Athreya, Sanchez, Tam and Young (2015) whose model predicts over an 83 percentage point drop in consumer credit during the Great Recession.[18] Both models predict a counter-factually large drop in credit use when benefits remain constant. This indicates that the extended duration of UI benefits played a key role in explaining the degree of the drop in credit use during the Great Recession. The extension in the duration of UI benefits also prevented over a 2.0 percentage point further drop in aggregate consumption. This

[18]Athreya et al. (2015) do not measure changes in UI benefits.

shows that the UI policy was effective at promoting more spending during the recession.

Furthermore, the bankruptcy rate in the economy would return to steady-state quicker after a larger initial spike if there had been no extension in benefits. The main reason extensions in benefits prevented bankruptcies from returning to steady-state quicker is they allowed households to take on riskier levels of debt due to a reduced motive to delever. The model also shows that the change in UI policy prevented a 0.4pp further drop in labor force participation. Extended duration of benefits can promote more participation during a recession because households have to search to receive benefits. Individuals experiencing a prolonged unemployment spell will continue having an incentive to search for work with extended benefits. This result is consistent with the empirical findings of Farber, Rotherstein and Valletta (2015). To my knowledge, this is the first paper to incorporate their finding into a quantitative model. I finish this section by comparing consumption-equivalent welfare changes from the policy. I find that new working-age households at the start of the Great Recession would be willing to give up 0.80% of lifetime consumption to have the extension in benefits.

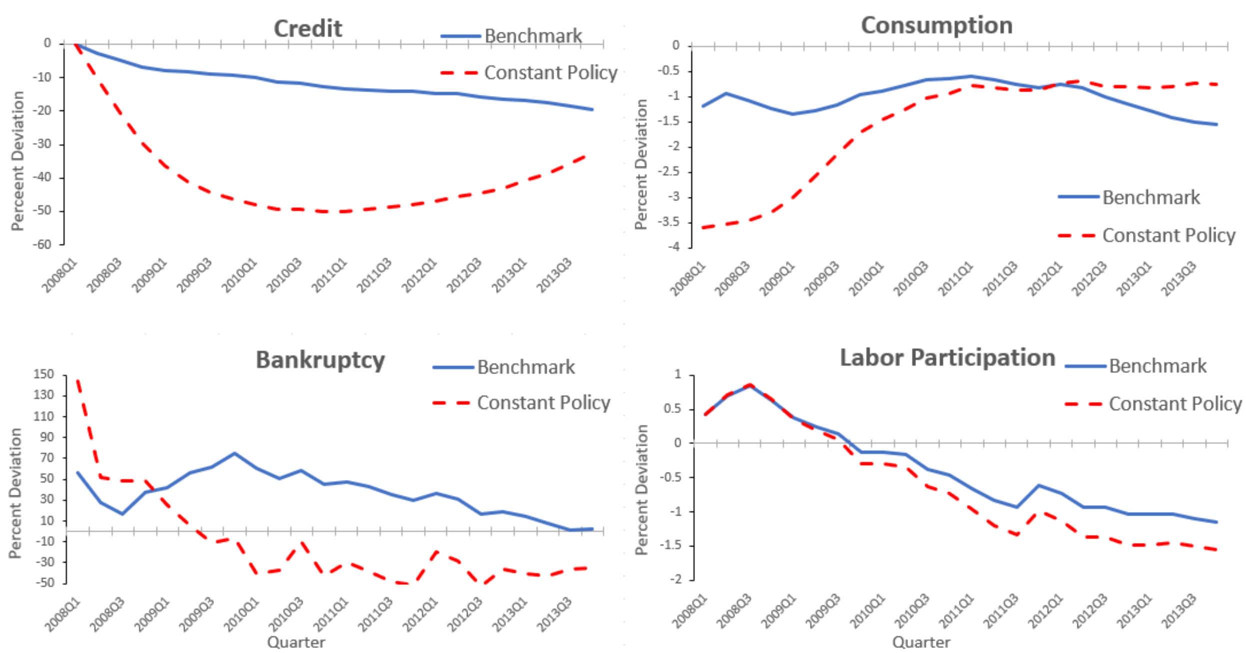

Figure 6: **The Impact of UI Extensions**

Notes: Benchmark model is the model with extensions in the duration of UI. Constant policy model is the model with no extension in the duration of UI.

5.c) Isolating the Interaction of UI with Unsecured Consumer Credit

The extension in UI during the Great Recession had a strong impact on aggregate consumption and welfare. However, we need to know how much of these gains can be directly attributed to the complementary relationship between counter-cyclical UI policies and unsecured consumer credit. To isolate the impact of unsecured credit use, I simulate the model with extensions in benefits while directly inputting the terms of credit from the constant-policy simulation. This allows households to receive improvements in benefits, but it forces financial intermediaries to price loans as if there was no policy change. This counter-factual exercise isolates the complementary relationship because it cuts the tie in the feedback between policies and terms of credit. Figure 7 depicts the change in aggregate quantities when preventing any changes in the terms of credit. Without any improvements in the terms of credit, aggregate consumption would drop by over 1.24 percentage point more. This accounts for over 60% of the gains in consumption from extensions in benefits. The complementary relationship with consumer credit had a significant amplifying effect on the gains in total spending from the extension in UI policy.

To further test the relationship between UI extensions and unsecured consumer credit, I compare the consumption-equivalent welfare changes. Table 5 outlines the total amount of lifetime consumption new working-age households at the start of the recession would pay to have extended benefits. The welfare calculations are compared to the economy with no change in policy. The complementary relationship between UI and the terms of credit accounted for over 10% of the total gains in welfare. This result is even stronger for unemployed households. 13% of the gains in welfare for the unemployed can be accounted for by improvements in the terms of credit. In order to fully quantify the gains in consumption and welfare from extensions in UI benefits, we need to account for the relationship with unsecured consumer credit.

5.d) A Budget-Neutral Expansion of UI

I now use the model to measure the implications of a budget neutral expansion of replacement rates during the Great Recession. Suppose the government took all resources

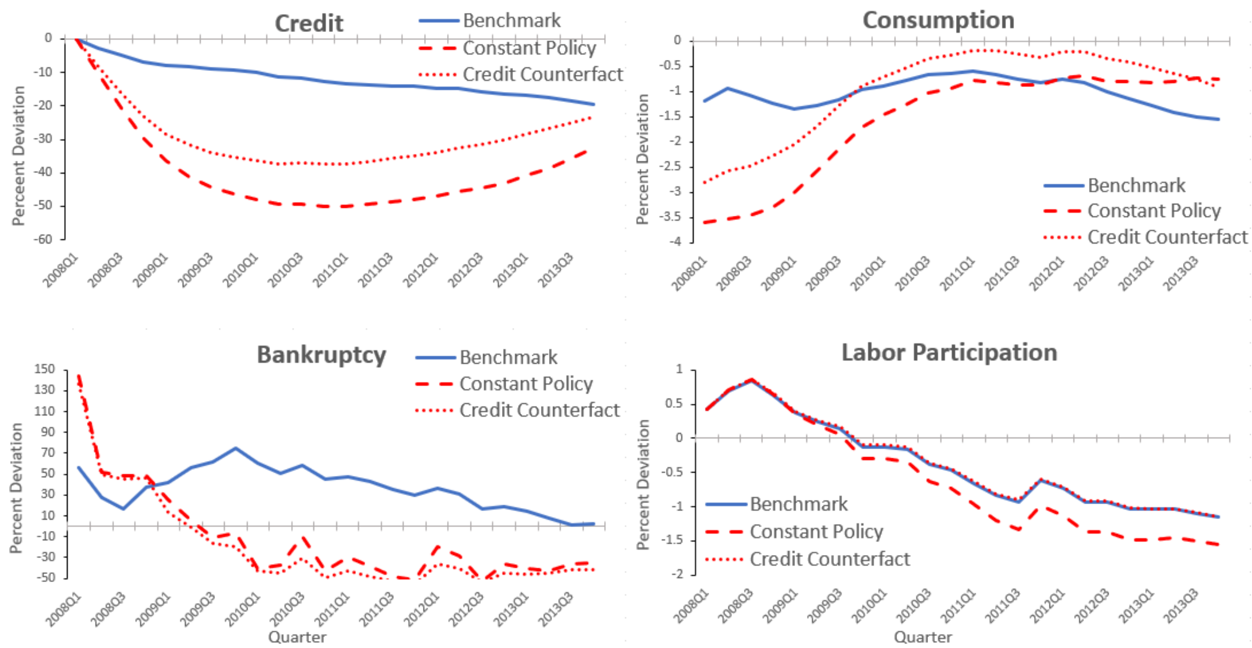

Figure 7: **The Complementary Relationship Between UI and Credit**

Notes: Benchmark model is the model with extensions in the duration of UI. Constant policy model is the model with no extension in the duration of UI. The credit counter-factual inputs terms of credit form the constant policy simulation into the economy with extended benefits.

used to extend the duration of benefits and put them towards expanding the replacement rates from 2008-2013. This exercise gives us insightful information about policies that can be implemented during future recessions. For example, during the Covid pandemic the government expanded the level of UI benefits not the duration. Figure 8 plots the implications of expansions in replacement rates on aggregate quantities. This counter-factual policy has a smaller impact on unsecured credit use resulting in a 17 percentage point further reduction relative to the benchmark case. Expansions won't have as strong of an impact on credit use because it will not alleviate the incentive for unemployed households to delever in the presence of persistently low job arrival rates. However, bankruptcy rates during the recession are significantly reduced resulting from an increased ability for unemployed households to repay debts. Furthermore, aggregate consumption and labor force participation see smaller changes from expansions.

Even though aggregate consumption is not impacted as strongly by replacement rates, it is still unclear on the welfare effects across the distribution of households. Figure 9

	Extension	Credit Exp.	Share from Credit
Employed	0.619%	0.561%	9.413%
Unemployed	0.184%	0.159%	13.401%
Total	0.803%	0.720%	10.326%

Table 5: **Welfare Gains of New Working-Age Households**

Notes: Credit Exp. represents the welfare gains from the counter-factual where the terms of credit cannot change with UI. Welfare is calculated relative to economy with no change in UI policy.

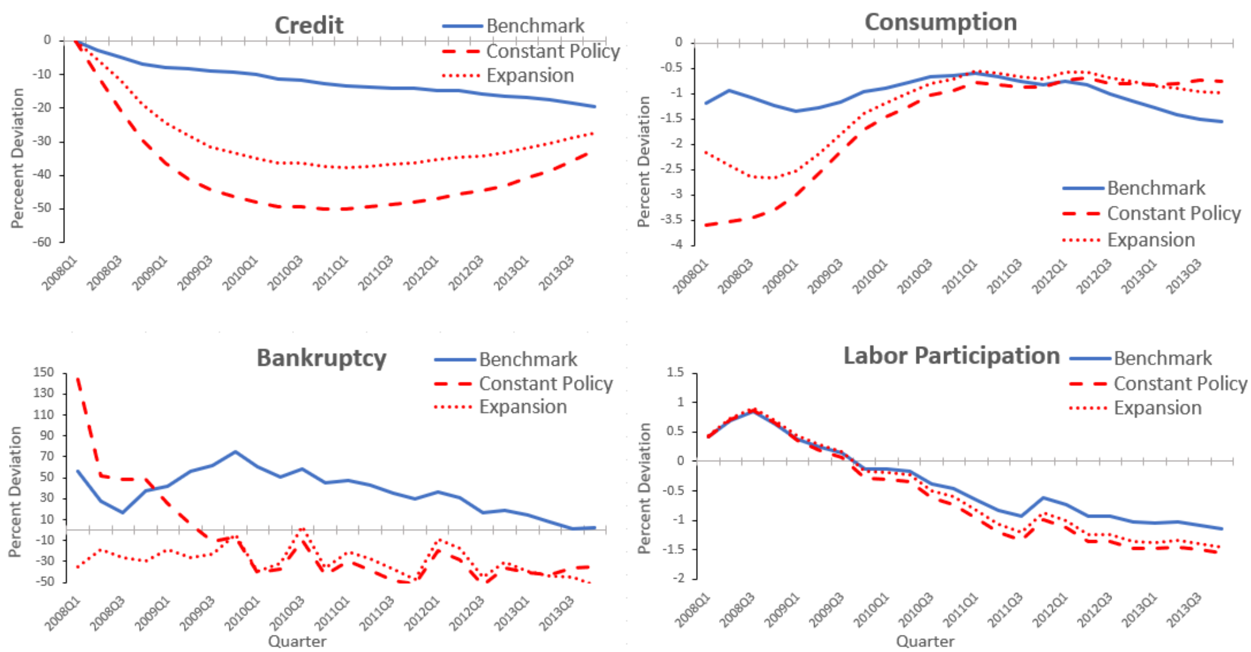

Figure 8: **An Expansion in Replacement Rates**

Notes: Benchmark model contains the extension in the duration of UI. Expansion is a budget-neutral expansion of replacement rates. Constant policy has no change in UI.

plots the average percent of lifetime consumption a household is willing to give up to have access to improved benefits across the distribution of income deciles. The model predicts that expansions in replacement rates will have a stronger redistributional effect in the sense that low-productivity households prefer these policies. Although extensions have a stronger impact on aggregate quantities, expansions will better help the households most harmed by a recession, the low-productivity unemployed.

6. The Implications of UI Over the Business Cycle

In every major recession since 1958 the US government has increased the benefits as-

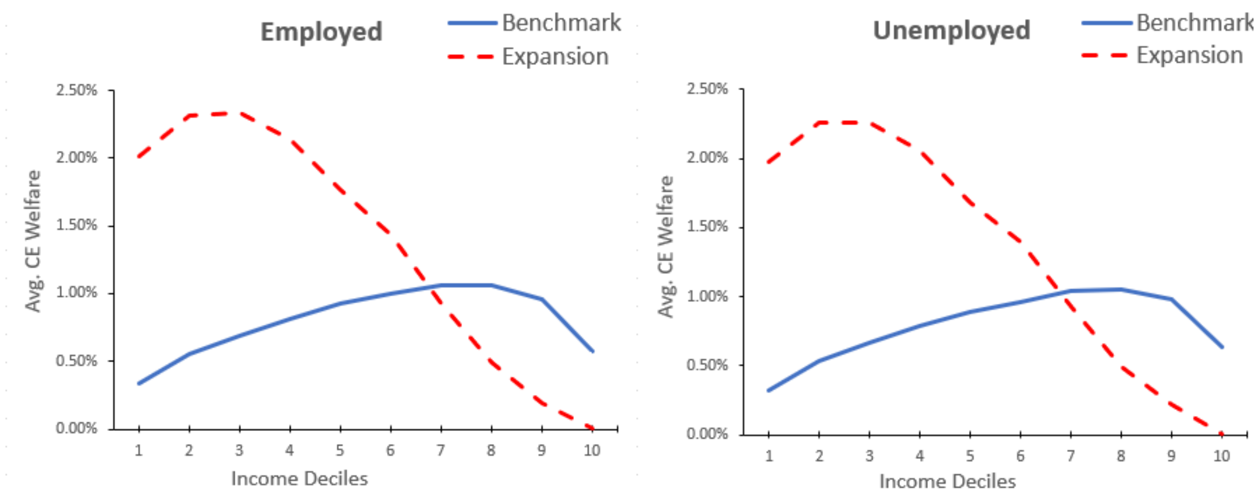

Figure 9: **Welfare from UI Policies**

Notes: The distribution of welfare gains from expansions in the replacement rates and extensions in the duration of UI.

sociated with UI to help protect unemployed households. These policies have usually taken the form of extensions in the duration of benefits, but during the Covid-19 pandemic the government increased the level of payments. I use the calibrated model to quantify the implications of UI regimes across all business cycles. This allows us to better understand how these policies affect aggregate quantities and individual households in an environment where economic agents know that the benefits will always be changed during recessions.

	Benchmark	Expansion		Extension	
	Std Dev	Std Dev	% Change	Std Dev	% Change
Consumption	0.76	0.73	-4.09	0.72	-5.97
Credit	5.20	4.84	-7.00	4.64	-10.76
Bankruptcy	30.08	22.35	-25.70	29.17	-3.04
Participation	0.173	0.170	-1.69	0.166	-4.10

Table 6: **Cyclical UI Regimes**

Notes: Extension has an increase in the duration of benefits during recessions. Expansion has an increase in the replacement rate of benefits during recessions. Benchmark has no change in policy.

Specifically, I compare the implications of two different policies: extensions in the duration of benefits and expansions in the replacement rate of benefits during recessions. I assume that economic agents know that the government will always implement these counter-cyclical

UI policies. Table 6 summarizes the implications of the UI regimes on aggregate quantities. When the government commits to a 25% increase in the replacement rate of benefits during recessions, the economy will experience significant reductions in the volatility of consumption, unsecured credit, bankruptcy and labor force participation. Increased transfers to unemployed households enhance consumption, and decrease bankruptcies by allowing unemployed households to better repay their debts. The drop in individual-level bankruptcy probability promotes better terms of credit and more credit use during recessions. There is also a non-trivial drop in the precautionary savings motive by employed households. Additionally, there are smaller drops in participation rates during recessions because better UI benefits create an incentive for more agents to search for work.

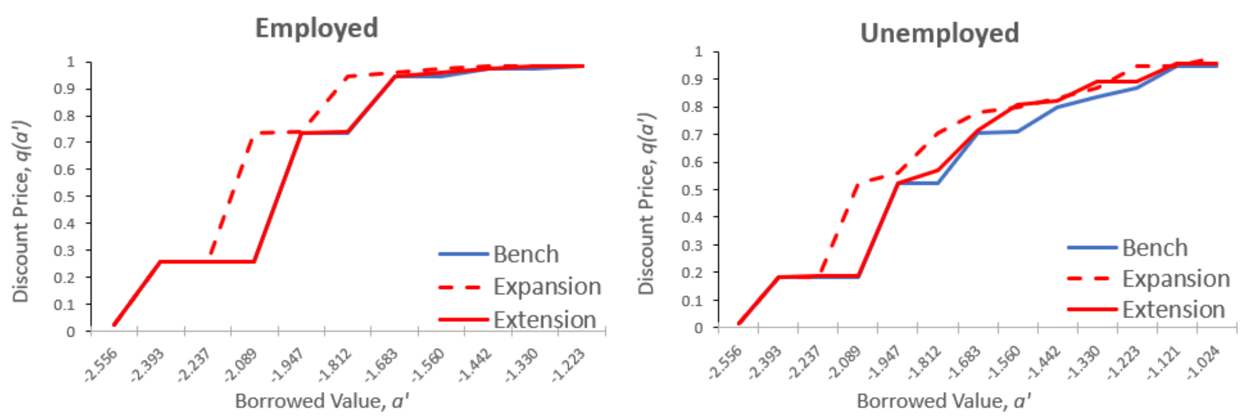

Figure 10: **The Terms of Credit and UI**

Notes: Discount prices from extensions in the duration of UI and expansions in the replacement rates.

I also measure the implications of a 25% extension in the duration of UI benefits during recessions. When the government chooses a counter-cyclical extension, the economy also experiences a reduction in the volatility of aggregate quantities. However, there are a few key differences between the two policies. Extensions have a significantly stronger impact on credit, consumption and participation. However, expansions are much more effective at reducing the volatility of bankruptcies. Bankruptcies are not as strongly impacted by extensions for the same reason we saw during the Great Recession. Extensions in the duration of benefits allow unemployed households to take on riskier levels of debt. To better understand the impact of UI regimes on aggregate quantities, figures 8 and 9 outline the household level discount prices and borrowing decisions respectively. The first key result that stands out is that expansions in the replacement rate have a stronger impact on the terms of credit. Expansions lead to a significant drop in bankruptcy probabilities, and therefore aggregate bankruptcy filings, because they allow unemployed household to better repay their debts. Furthermore, figure 9 shows us that expansions and extensions have differing effects on borrowing behavior. Extensions allow unemployed households to borrow more, but expansions will cause the unemployed to delever. This occurs because with expansions, unemployed agents still have a strong precautionary savings motive to insure for the possibility of losing access to UI benefits. However, expansions will lead to more borrowing by employed households. Both policies reduce the volatility in unsecured consumer credit, but expansions generate this result via employed households and extensions via unemployed.

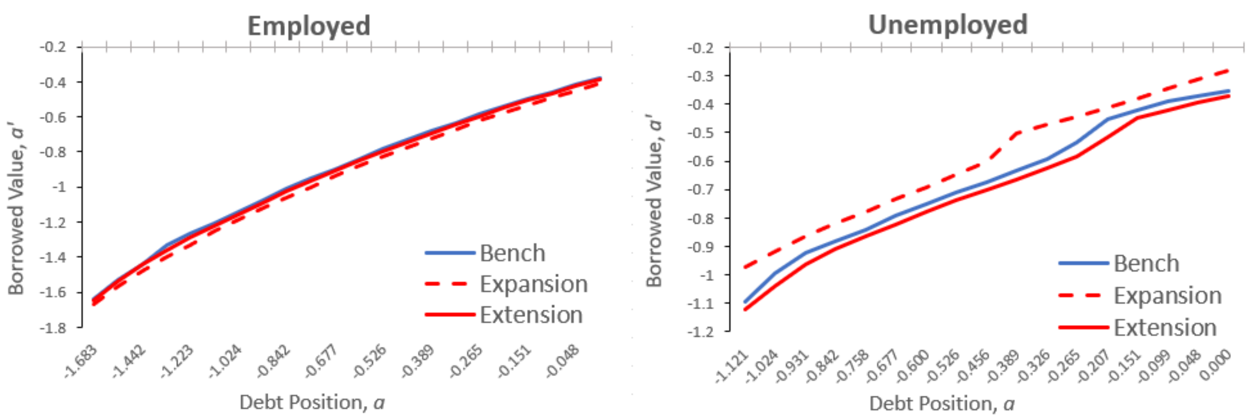

Figure 11: **Borrowing Decisions and UI**

Notes: Borrowing decisions from extensions in the duration of UI and expansions in the replacement rates.

7. Concluding Remarks

In this paper, I quantified how the interaction of counter-cyclical UI with unsecured consumer credit affected aggregate consumption and welfare. To do so, I developed a quantitative heterogeneous agent model that captured the employment risk, credit use and bankruptcy behavior of US households. I showed that the majority of the volatility in unsecured consumer credit and bankruptcy can be explained by aggregate fluctuations in extensive margin employment risk over the business cycle. This occurs because low job arrival rates directly increase the probability of bankruptcy, particularly by unemployed households. High job separation rates do not have a strong impact on individual-level decisions, but they facilitate a stronger flow of households to unemployment.

I used the model to quantify the implications of extended duration of UI benefits during the Great Recession. I found that extending the duration of benefits to 99 weeks prevented a significant further drop in aggregate consumption and unsecured consumer credit use. This occurs because, at the micro-level, extended benefits promote better credit terms and diminish the precautionary savings motive of unemployed households. I isolate the impact of the complementary relationship between UI and consumer credit. I find that over 60% of the gains in aggregate consumption an 10% of the gains in welfare from the extension in the duration of benefits can be attributed to improvement in the terms of credit. This shows that unsecured consumer credit use can significantly amplify the gains from counter-cyclical UI policies. If we want to fully quantify the gains from UI policies, we need to account for the relationship with consumer credit.

Given the findings on the interaction of UI with credit and default, an important course for future research would be to quantify the implications of expanded benefits during the Covid-19 pandemic. The results from this paper would suggest that increases in the level of benefits prevented a significant rise in bankruptcies and promoted more unsecured credit use. The framework developed in this paper provides a starting point to quantify the specific results, but future work would need to make modifications to address the pandemic specifically. This would allow for other policy questions to be answered such as the implications of unexpectedly stopping or extending the time-frame of the increased policy.

References

Aiyagari, R. (1994). "Uninsured Idiosyncratic Risk and Aggregate Saving," *The Quarterly Journal of Economics*, 109(3): 659-684.

Athreya, K. (2002). "Welfare Implications of the Bankruptcy Reform Act of 1999," *Journal of Monetary Economics*, 49 (8): 1567-1595.

Athreya, K. and N. Simpson (2006). "Unsecured Debt with Public Insurance: From Bad to Worse," *Journal of Monetary Economics*, 53: 797-825.

Athreya, K. (2008). "Default, Insurance and Debt over the Life-Cycle." *Journal of Monetary Economics*, 55: 752-774.

Athreya, K., J. Sanchez, X. Tam and E. Young (2015). "Labor Market Upheavel, Default Regulations and Consumer Debt." *Review of Economic Dynamics*, 18: 32-52.

Braxton, J., K. Herkenhoff and G. Phillips (2020). "Can the Unemployed Borrow? Implications for Public Insurance," *Working Paper*.

Chatterjee, S., D. Corbae, M. Nakajima, and J.V. Ríos-Rull (2007). "A Quantitative Theory of Unsecured Consumer Loans with a Risk of Default," *Econometrica*, 75 (6): 1525-1589.

Farber, H., J. Rothstein and R. Valletta (2015). "The Effect of Extended Unemployment Insurance Benefits: Evidence from the 2012-2013 Phase-Out," *American Economic Review P+P*, 105(5): 171-176.

Gordon, G. (2017). "Optimal Bankruptcy Code: A Fresh Start for Some," *Journal of Economic Dynamics and Control*, 85: 123-149.

Herkenhoff, K. (2017). "The Impact of Consumer Credit Access on Unemployment," *Review of Economic Studies*, 86 (6): 2605-2642.

Herkenhoff, K., G. Phillips and E. Cohen-Cole (2020). "How Credit Constraints Impact Job Finding Rates, Sorting and Aggregate Output," *Working Paper*.

Hsu, J., D. Matsa and B. Melzer (2018). "Unemployment Insurance as a Housing Market Stabilizer," *American Economic Review*, 108(1): 49-81.

Huggett, M. (1996). "Wealth Distribution in Life-cycle Economies," *Journal of Monetary Economics*, 38: 469-494.

Irwin, M. (2020). "An Overlapping Endogenous Grid Method to Solve Problems with Non-Concavities," *Working Paper*.

Krusell, P., T. Mukoyama, R. Rogerson and A. Sahin (2010). "Aggregate Labor Market Outcomes: The Roles of Choice and Chance," *Quantitative Economics*, 1 (1): 97-127.

Krusell, P., T. Mukoyama, R. Rogerson and A. Sahin (2017). "Gross Worker Flows Over the Business Cycle," *American Economic Review*, 107 (11): 3447-3476.

Krusell, P and A. Smith (1998). "Income and Wealth Heterogeneity in the Macroeconomy." *Journal of Political Economy*, 106(5): 867-896.

Livshits, L., J. MacGee, and M. Tertilt (2007). "Consumer Bankruptcy: a Fresh Start," *The American Economic Review*, 97 (1): 402-418.

Low, H., C. Meghir and L. Pistaferri (2010). "Employment Risk and Wage Risk over the Life Cycle," *American Economic Review*, 100: 1432-1467.

Mendoza, E., A. Razin and L. Tesar (1994). "Effective Tax Rates in Macroeconomics: Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption," *Journal of Monetary Economics*, 34: 297-323.

Mitman, K (2016). "Macroeconomic Effects of Bankruptcy and Foreclosure Policies," *American Economic Review*, 106(8): 2219-2255.

Nakajima, M. (2019). "Unemployment Insurance and Unsecured Credit," *Working Paper.*

Nakajima, M. and J.V. Ríos-Rull (2019). "Credit, Bankruptcy and Aggregate Fluctuations," *Working Paper.*

Shimer, R. (2012). "Reassessing the Ins and Outs of Unemployment," *Review of Economic Dynamics*, 15: 127-148.

Storesletten, Telmer and Yaron (2004). "Consumption and Risk Sharing Over the Life Cycle," *Journal of Monetary Economics*, 51(3), 609-633.

Sullivan, T., E. Warren and J. Westbrook (2000). "The Fragile Middle Class: Americans in Debt," *Yale University Press, New Haven.*

A.1 The Distribution of Households

The distribution of households is consistent with all individual level decisions and transition probabilities. Equation (12) shows that the total amount of households on the employment island in age $j+1$ will be equal to the number of age j households that do not quit and are not fired plus the households that search for work and find a job from the non-employment island. Equation (13) shows that the number of households who are non-employed with access to benefits is all households who were fired from island E and those with an unsuccessful search from island N. As described by equation (14), the population in state $\tilde{N}$ is all agents who quit their jobs or didn't search added to those who searched but lost benefits.

With regards to credit states, the total amount of households in age $j+1$ in good credit is equal to the age j agents that do not declare bankruptcy plus the households with bad credit that move back to s_g. Conversely, the households with bad credit are those who in a previous age declared bankruptcy added to the agents who remain in bad credit. These two transitions are described by equations (15) and (16) below. These equations provide the mathematical foundation for all of the exogenous transitions and endogenous decisions that govern the distribution of households. This ensures that aggregate transitions are consistent with individual decisions.

$$\mu_{j+1}(\epsilon', a', E, s') = \sum_{\epsilon} \sum_{s} \int_{-\infty}^{\infty} \pi_{\epsilon}(\epsilon', \epsilon) \mathbb{1}_{g_j = a'} \Big[(1-\xi)\mu_j^e(\epsilon, da, E, s) + \lambda \mu_j^e(\epsilon, da, N, s)\Big] \quad (12)$$

$$\mu_{j+1}(\epsilon', a', N, s') = \sum_{\epsilon} \sum_{s} \int_{-\infty}^{\infty} \pi_{\epsilon}(\epsilon', \epsilon) \mathbb{1}_{g_j = a'} \Big[\xi \mu_j^e(\epsilon, da, E, s) + (1-\lambda)(1-\psi)\mu_j^e(\epsilon, da, N, s)\Big] \quad (13)$$

$$\mu_{j+1}(\epsilon', a', \tilde{N}, s') = \sum_{\epsilon} \sum_{s} \int_{-\infty}^{\infty} \pi_{\epsilon}(\epsilon', \epsilon) \mathbb{1}_{g_j = a'} \Big[\mu_j^u(\epsilon, da, n, s) + (1-\lambda)\psi \mu_j^e(\epsilon, da, N, s)\Big] \quad (14)$$

$$\mu_{j+1}(\epsilon', a', n', s_g) = \sum_{\epsilon} \sum n \int_{-\infty}^{\infty} \pi_{\epsilon}(\epsilon', \epsilon) \mathbb{1}_{g_j = a'} \Big[\mu_j^c(\epsilon, da, n, s_g) + \theta \mu_j(\epsilon, da, n, s_b)\Big] \quad (15)$$

$$\mu_{j+1}(\epsilon', a', n', s_b) = \sum_{\epsilon} \sum n \int_{-\infty}^{\infty} \pi_{\epsilon}(\epsilon', \epsilon) \mathbb{1}_{g_j = a'} \Big[\mu_j^b(\epsilon, da, n, s_g) + (1-\theta)\mu_j(\epsilon, da, n, s_b)\Big] \quad (16)$$

A.2 Forecasting Parameters

In this section I provide tables and figures with additional information about the solution method. Figure 11 depicts the Den Haan errors for the simulated model. The errors for both capital and labor are low relative to accurate models in the literature. The errors for capital are even lower than labor because previous papers have shown how capital is very linear at the aggregate level. Table 7 provides forecasting parameters in the equilibrium solution.

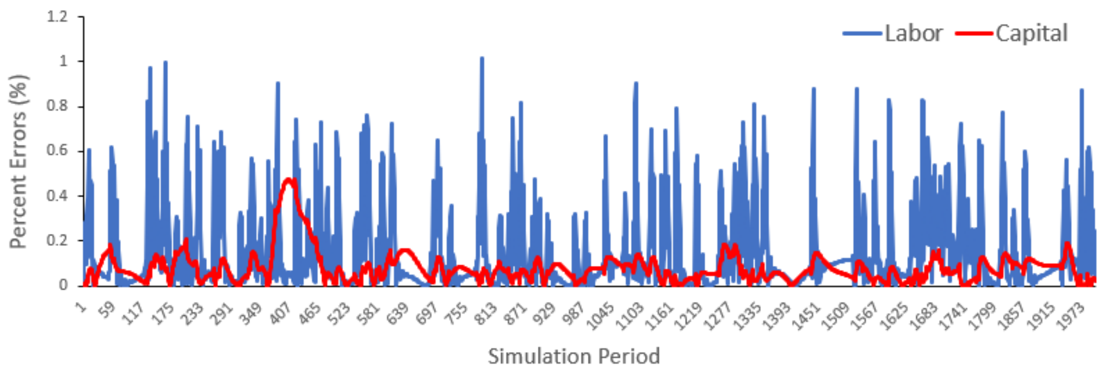

Figure 12: Den Haan Errors

Table 7: Parameters for Forecasting Rules

	z	β_0	β_1	β_2	R^2	Max Res.	Mean Res.
K	z_g	0.0302	0.9895	0.0389	0.999	$3.92e^{-4}$	$5.83e^{-5}$
K	z_b	-0.0072	0.9997	0.0439	0.999	$4.51e^{-4}$	$7.86e^{-5}$
L	z_g	2.0509	0.4339	-0.5468	0.867	$9.87e^{-3}$	$1.17e^{-4}$
L	z_b	1.0864	0.6465	-0.2912	0.982	$4.76e^{-3}$	$9.40e^{-4}$

Parameters for forecasting rules in the benchmark model