The Impact of Unemployment Insurance and Unsecured Credit on Business Cycles[†]

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Abstract

How does unsecured consumer credit impact the effectiveness of unemployment insurance (UI) in insuring households against aggregate risk? The answer depends on whether credit acts as a complementary or substitutable form of consumption insurance for households. Using a real business cycle model with frictional labor markets and defaultable debt, I find that unsecured credit amplifies the consumption-equivalent welfare gains of a counter-cyclical policy which extends the duration of UI during all recessions. This occurs because UI extensions mitigate the rise in the default-risk premium during recessions, which allows households to better smooth consumption over the business cycle.

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1 Introduction

Unemployment insurance (UI) is a well-established automatic stabilizer of the economy. In 1970, the US government enhanced the UI program by instituting automatic triggers to extend the duration of benefits by 13 weeks during recessions.[1] This policy was enacted with the goal of mitigating the welfare costs of business cycles by providing additional consumption insurance to households when income risk is high. Since this time, the unsecured consumer credit market has grown at an unprecedented rate in the US. The total balance of revolving consumer credit now exceeds $1.2 trillion, and nearly 45% of households report having positive balances of credit card debt. Despite the growing significance for the balance sheets of US households, it is unclear how unsecured credit impacts the effectiveness of UI in insuring households against aggregate risk. The answer depends on whether credit acts as a complementary or substitutable form of consumption insurance for households over the business cycle.

There are two main channels that determine whether unsecured credit complements or substitutes for UI: a substitution effect and a risk premium effect. When households become unemployed, many borrow to replace a fraction of their lost income. An increase in the transfer of resources via UI allows households to borrow less to finance the same level of consumption. I refer to this as the substitution effect. In isolation, this channel could dampen the impact of UI on consumption because households are substituting one form of insurance for the other. The risk premium effect moves in the opposite direction. When the government increases the transfer of resources to households, financial intermediaries reduce the default-risk premium for a given level of debt because the probability of a bankruptcy falls. The risk premium effect could amplify the impact of UI on consumption because the two forms of insurance are complementing each other: enhancements to UI make it cheaper to use unsecured credit.

The main quantitative result of this paper is that unsecured credit amplifies the consumption-equivalent (CE) welfare gains of a policy which extends the duration of UI during recessions. The result crucially depends on the presence of business cycles. During recessions, credit

1. The Federal-State Extended Benefits (EB) Program provides 13 additional weeks of UI benefits when unemployment is persistently high in a state.

contracts which significantly limits the ability of households to substitute between UI and unsecured credit for consumption insurance. This causes the complementary forces to dominate. Extending the duration of UI not only insures against income loss during unemployment, it mitigates the fall in unsecured credit balances by reducing the rise in the default-risk premium. By contrast, I find that the substitutable forces dominate in an economy without business cycles. Extending the duration of UI in a stationary equilibrium without aggregate risk results in smaller welfare gains when unsecured credit is available because households can readily substitute between UI and credit to smooth consumption.

The results of this paper come from an incomplete markets general equilibrium real business cycle model that incorporates frictional labor markets into a model with unsecured credit and consumer bankruptcy. In the style of Krusell et al. (2012, 2017), the labor market features standard labor supply forces and frictions. Flows between employment and unemployment are determined by endogenous labor supply decisions by households and by exogenous labor market frictions. The credit market is modeled in the style of Chatterjee et al. (2007) and Livshits, MacGee, and Tertilt (2007), where financial intermediaries offer a menu of loan prices to households dependent on default probabilities. Business cycles are driven by cyclical changes to TFP and labor market frictions. In this setting, changes in bankruptcy behavior over the business cycle result in fluctuations in the menu of loan prices offered by financial intermediaries. UI policies have the potential to mitigate cyclical fluctuations in unsecured credit markets by insuring against bankruptcy risk. The theory that the price of unsecured credit depends on default behavior is supported by empirical work from Gross et al. (2021), which finds that a 1 percent increase in bankruptcy risk results in a 70-90 basis points increase in the interest rate of credit cards.

Unsecured consumer credit is highly volatile and pro-cyclical in the data.[2] In order to quantitatively assess the importance of liquidity constraints and borrowing behavior for consumption smoothing over the business cycle, we need a model that can explain these facts: a task that has not yet been completed by pre-existing literature. Herkenhoff (2019) generates pro-cyclical credit by assuming that credit supply exogenously expands following a recession via the efficiency of matching lenders to households. Nakajima and Ríos-Rull

2. Revolving credit balances are about 3 times as volatile as GDP.

(2019) provides a theory to explain why credit is pro-cyclical, but their model with cyclical earnings skewness shocks can only generate about one-quarter of the volatility of unsecured credit. By comparison, my model generates pro-cyclical credit and over 84% of the standard deviation of unsecured credit balances despite being untargeted in the calibration procedure. To better understand why my model with unemployment risk improves in matching the data, I run a decomposition exercise where I remove cyclical changes to TFP, job separation rates, and job finding rates for unemployed workers one at a time. I find that over 92% of the volatility in unsecured credit is driven by the cyclical dynamics of job finding rates. Job finding rates drive aggregate fluctuations because UI is designed to insure households against relatively short unemployment spells. When job finding rates fall during recessions, intermediaries raise the default-risk premium on credit, and households delever (or save) to insure themselves against the possibility of a prolonged unemployment spell. My model improves on the literature's ability to match the cyclical properties of unsecured credit in the data because I specifically model the underlying unemployment dynamics that generate changes in the skewness of earnings over the business cycle.

The main experiment of this paper is to quantify the implications of counter-cyclical UI policies in the benchmark economy with unsecured credit and in a counter-factual economy without credit. I find that a policy which extends the average duration of UI by 13 weeks during recessions has larger CE welfare gains for households in the economy with credit. Specifically, households would trade 0.054% of lifetime consumption on average to obtain the policy in the economy with credit, and they would only trade 0.043% to obtain the same policy in the economy without credit.[3] I also find that UI is more effective at stabilizing aggregate fluctuations when households have unsecured credit. The policy which extends the duration of UI by 13 weeks during recessions reduces the average peak-to-trough fall in aggregate consumption during recessions by 0.42pp in the economy with credit. The same policy only reduces the average peak-to-trough fall in aggregate consumption by 0.24pp in the economy without credit. This result adds to the literature which studies the usefulness of credit as consumption insurance. Athreya, Tam, and Young (2009) finds that unsecured

3. CE welfare is the share of lifetime consumption a household born during an expansion in the economy with an acyclical UI policy would trade to be in the economy where the government extends the duration of UI during recessions.

credit does not smooth consumption over the life cycle, and Nakajima and Ríos-Rull (2019) finds that it does not smooth aggregate consumption over the business cycle. Although unsecured credit does not smooth cyclical consumption fluctuations by itself, I show that it does amplify the extent to which UI stabilizes aggregate consumption: the largest component of aggregate demand.

I then measure how much of the main quantitative results depend on the presence of business cycles. Specifically, I measure the effects of extending the duration of UI in a stationary equilibrium without aggregate risk. In this environment, the main result of the paper changes, and UI extensions lead to smaller welfare gains and a smaller increase in aggregate consumption in the model with unsecured credit. These results add to the work of Braxton, Herkenhoff, and Phillips (2023), which measures the optimal replacement rate (RR) of UI in an economy without aggregate risk. They find that the government can optimally reduce the RR of UI when unsecured credit is available because households can substitute between UI and credit to smooth consumption. I show that business cycles play a meaningful role for the relationship between UI and unsecured credit because cyclical fluctuations in consumer credit markets limit the extent to which households can substitute between UI and credit.

I conclude the analysis of this paper by comparing the aggregate implications of the UI policy which extends the duration of benefits during recessions to a counterfactual policy which increases the level of benefits. It is essential to understand how these policies impact aggregate fluctuations because both have been implemented in recent recessions.[4] I find that a policy which increases the replacement rate (RR) of benefits during recessions has a smaller impact on aggregate fluctuations. Even though the policy costs the same for the government, increasing the RR of benefits only reduces the average peak-to-trough fall in aggregate consumption during recessions by 0.13pp: compared to 0.42pp for UI extensions. In terms of welfare, households on average prefer the policy which extends the duration of benefits, and unsecured credit amplifies the difference between the policies. In the model with credit, the welfare gains from UI extensions are 0.013 percentage points higher than

4. The Emergency Unemployment Compensation Act extended the duration of UI up to 99 weeks during the Great Recession in the US. The Federal Pandemic Unemployment Compensation Program provided up to $600 of additional benefits per week to UI recipients during Covid-19.

increasing the RR, and they are only 0.005 percentage points higher in the model with no credit. Unsecured credit amplifies the differences between the two policies because of both supply side and demand side factors. On the supply side, extending the duration of UI during recessions leads to a significantly smaller contraction in the average borrowing limit offered by financial intermediaries. On the demand side, UI extensions limit the incentive of households to delever (or save) for precautionary reasons.

1.a Related Literature

Since Zeldes (1989) showed empirical evidence that liquidity constraints have a significant impact on consumption for a sizeable portion of the population, the quantitative importance of borrowing constraints for consumption smoothing behavior has become well-established in the macroeconomics literature. Papers such as Kaplan and Violante (2010, 2014) show that the consumption response to income shocks and fiscal policy is significantly affected by the tightness of borrowing constraints. Imrohoroglu (1989) found that borrowing can reduce the welfare costs of business cycles by as much as a factor of six depending on the borrowing limit in the economy. My work contributes to this literature by developing a model which can explain the business cycle properties of unsecured credit. Previously, the model with cyclical earnings skewness shocks in Nakajima and Ríos-Rull (2019) was able to explain about one-quarter of the volatility in unsecured credit over the business cycle. They calibrate their model to match moments from Guvenen, Ozkan, and Song (2014), which uses annual tax return data to find that earnings risk becomes significantly more left-skewed during recessions. Changes to wages, job separation rates, and job finding rates can all generate earnings that becomes more left-skewed during a recession. I add to their work by showing that a model with empirically consistent unemployment fluctuations over the business cycle can explain over 84% of the standard deviation of credit balances, and the majority of the volatility is coming from cyclical changes to job finding rates.

This paper also contributes to the literature that studies the relationship between forms of public and private insurance. The most similar paper in the literature is Braxton, Herkenhoff, and Phillips (2023). Similar to my work, they study how unsecured credit affects the welfare gains of UI policies. I add to the literature by quantifying how aggregate risk and business cycle fluctuations impact this channel. The most related empirical work is by Hsu, Matsa, and Melzer (2014, 2018), which finds evidence that more generous UI policies result in lower interest rates and higher borrowing limits on credit cards.[5] This is a key mechanism driving results in my analysis. Their paper also finds that UI extensions significantly reduced mortgage defaults during the Great Recession. Other papers include Athreya and Simpson (2006), which shows that increasing the generosity of UI can actually lead to more bankruptcies in the aggregate because households increase debt balances.[6] Bornstein and Indarte (2023) finds evidence that higher levels of Medicaid result in more credit card borrowing. My work contributes to the literature by showing that business cycle fluctuations significantly limit the extent to which households can substitute between UI and credit for consumption insurance. Focusing on business cycle dynamics provides an important contribution to the literature because most changes to UI are temporary and occur during recessions.

Quantifying the relationship between unsecured credit and UI also contributes to the literature that studies the impact of UI policies on spending. There are two main takeaways from this literature: First, temporary changes to UI benefits can provide significant stimulus for aggregate spending, and second, providing benefits for a longer duration allows for greater consumption-smoothing than an equivalent increase in the level of benefits. With regards to the stimulus effects of UI, Ganong et al. (2023) shows that households increased spending significantly following the Covid-19 supplements to UI in the US. Kekre (2023) finds that UI extensions during the Great Recession led to an increase in aggregate demand that prevented a further rise in unemployment. His results are driven by heterogeneous MPCs and a reduced precautionary savings motive associated with UI extensions. Ganong and Noel (2019) and Gerard and Naritomi (2021) compare the effectiveness of different UI policies. The former finds that extending the duration of UI provides almost 4 times as much consumption insurance as an equivalent increase in the level of benefits. The latter calibrates a model to expenditure and employment data from Brazil, and they find that 5

5. The results pertaining to the interest rate and borrowing limit on credit cards are in the 2014 working paper version of the paper.

6. Preliminary work by Makoto Nakajima also studies the relationship between UI, unsecured credit, and consumer bankruptcies using a model economy.

months of UI benefits provides greater consumption-smoothing than an equivalent amount of severance pay regardless of whether severance is paid in lump-sum fashion or over the course of 5 months. My work adds to the literature by showing that unsecured credit amplifies the impact of counter-cyclical UI policies on aggregate spending, and it intensifies the differences between UI extensions and an equivalent increase in the level of benefits.

The rest of the paper is organized as follows. Section 2 describes the model economy. Section 3 maps the model to the data. Section 4 runs a decomposition exercise to better understand the sources of aggregate fluctuations. Section 5 provides results to the main research question. Section 6 provides concluding remarks.

2 Model

This section defines a general equilibrium real business cycle model with four types of economic agents. A representative firm rents capital and labor to produce a single output good. Overlapping generations of households choose whether or not to supply labor to the firm in a frictional labor market. They also borrow and save by purchasing securities from financial intermediaries. Idiosyncratic risk and incomplete asset markets give rise to an endogenous distribution of households in the spirit of Huggett (1993) and Aiyagari (1994). Financial intermediaries sell securities to households at a discount price that reflects the probability of a bankruptcy occurring. Intermediaries also own capital and rent it to the firm in a competitive market. The government uses income taxes to fund transfers to households. The model is defined recursively in discrete time.

2.a The Firm's Problem

A representative firm produces output from aggregate capital and aggregate labor. Let $\Omega = \{x, \mu\}$ be the aggregate state space of the model economy, where μ is the endogenous distribution of households over individual state variables, and x is the exogenous state of the economy. The exogenous state fluctuates between expansions x_g and recessions x_b, and $\pi_x(x, x')$ is the probability matrix governing the transitions. I assume that aggregate productivity $z(x)$ is a function of exogenous state such that TFP falls during recessions.

$$\max_{K,L}\ z(x)F(K,L) - \delta K - r(\Omega)K - w(\Omega)L \tag{1}$$

The firm rents capital and labor to solve the problem described by equation (1). Let K be the aggregate demand for capital. The equilibrium return to capital that solves the firm's problem is $r(\Omega)$. The labor market is modeled in the spirit of a Lucas-Prescott island economy. Only workers on the production island supply labor to the firm. As in Lucas and Prescott (1974), the labor market is competitive such that the firm demands labor to the point where the wage rate $w(\Omega)$ equals the marginal value of labor for workers on the production island. Let L be the aggregate demand for labor.

2.b Households

There are J overlapping generations of households in the model economy. Every period, a cohort of size ϕ_J dies and is replaced by a new cohort of the same size. I assume there is a measure one continuum of households such that $\sum_{j=1}^{J} \phi_j = 1$. Age 1 households are born into the economy with good credit, zero assets, and a fraction Φ_E are employed. They retire at age J_r and die at age J. They derive utility $u(c,n)$ by consuming the single output good minus utility costs of work. Households discount future utility at rate β. Let $\Psi_j = (j, \epsilon, a, n, s, \beta)$ be a point in the individual state space of the household problem.

Households differ with respect to their labor productivity. Productivity has two components: an age component and a persistent component. The age component of productivity γ_j exhibits a hump-shaped life cycle profile which gives young households an incentive to borrow against future earnings. I assume that the persistent component of productivity ϵ evolves according to the stochastic AR(1) process detailed below. Let η be the innovations to the persistent process where σ_η^2 is the variance of innovations. The persistence of individual productivity is ρ.

$$\log(\epsilon') = \rho \log(\epsilon) + \eta, \quad where \quad \eta \in N\big(0, \sigma_\eta^2\big)$$

The labor market builds off the work of Krusell et al. (2012, 2017) where households have the option to supply labor to the firm in a frictional market.[7] The environment simulta-

7. Krusell et al. (2012) is the NBER working paper version of Krusell et al. (2017). The working paper

neously accounts for labor market frictions and standard labor supply forces that are present in the stochastic growth model. A household's employment state n can have one of three realizations: employed E, nonemployed N, or nonemployed with no UI $\tilde{N}$. I assume that all households who begin the period in state E are on the production island. Therefore, the aggregate supply of labor by households is the sum of individual productivity of all workers with state E. Those who have state N or $\tilde{N}$ are on the leisure islands.[8] An employed household chooses whether or not to quit a job, and a nonemployed household chooses whether or not to search for work. Equation (2) describes the extensive-margin labor supply decision where $h \in \{e, u\}$ is the corresponding decision rule.[9] I assume that households pay a utility cost of χ_s to search for work when in nonemployment. Therefore, households must weigh the expected future earnings of work against the costs of participating in the labor market.

$$V(\Psi_j, \Omega) = \max \Big[V^e(\Psi_j, \Omega) - \chi(n), V^u(\Psi_j, \Omega) \Big] \tag{2}$$

$$h(\Psi_j, \Omega) = \begin{cases} e \quad if \quad V^e(\Psi_j, \Omega) - \chi(n) \geq V^u(\Psi_j, \Omega) \\ u \quad otherwise \end{cases}$$

$$\chi(n) = \begin{cases} \chi_s \quad if \quad n \in \{N, \tilde{N}\} \\ 0 \quad otherwise \end{cases}$$

Flows between employment states are affected by the endogenous decisions of households and the exogenous labor market frictions. Figure 1 describes the transitions between labor market states. Workers who quit a job transition to $\tilde{N}$, and workers who are exogenously separated transition to N. Let $\xi(x)$ be the involuntary separation rate: the fraction of households who transition to unemployment despite choosing to work. Households on the leisure islands can choose whether or not to search for work. Let $\lambda(x)$ be the job finding rate: the probability of transitioning to $n' = E$ when searching for work. The labor market frictions vary with the exogenous state of the economy such that the labor market becomes

was set in general equilibrium, and the final published version was in partial equilibrium. The model in the current paper is most similar to the NBER working paper.

8. I also assume that all retired households are on a leisure island.

9. Let e be the decision to keep a job while employed or search for a job when not employed. Similarly, u is the decision to quit a job or refrain from search.

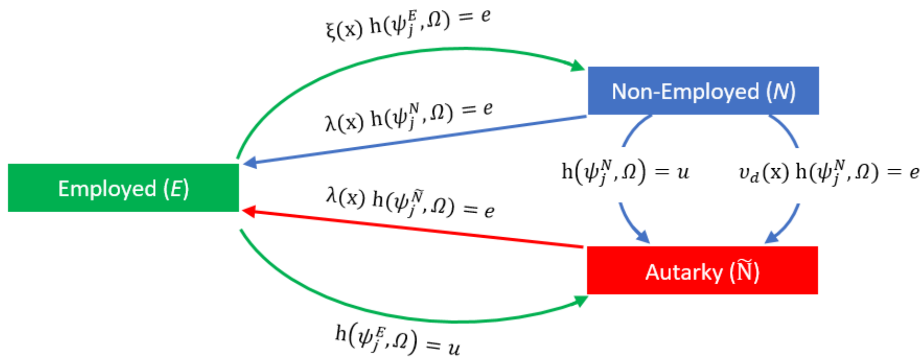


Figure 1: Labor Market Transitions

Note. — h is the decision to quit a job while working or the decision to search for a job when in not working. $\xi(x)$ is the exogenous job separation rate, and $\lambda(x)$ is the job finding rate; both frictions depend on the exogenous aggregate state of the economy. υ_d is the inverse expected duration of UI. Assume that all households with $n = E$ are on the production island.

more frictional during recessions. I assume that all employment transitions take place after production, meaning aggregate labor is known at the start of a model period.[10]

The UI regime is modeled to depict the key features of the US system. A worker who is involuntarily separated transitions to N and is eligible for UI. However, workers who quit a job are not eligible for benefits and transition to $\tilde{N}$. The level of benefits is determined by the replacement rate υ_r which is the fraction of lost labor earnings. Let $\overline{\upsilon}$ be the maximum level of benefits that an individual can receive. Households must be searching for work to receive UI. While receiving benefits, $\upsilon_d(x)$ is the probability of losing access to UI and transitioning to $\tilde{N}$. This allows the model to replicate the average duration of benefits during an unemployment spell without adding a variable to the state space. The duration of UI depends on the aggregate exogenous state so the benchmark economy can be calibrated to replicate the Federal-State Extended Benefits Program (EB) which provides 13 additional weeks of benefits during recessions.

Equation (3) describes the default decision where $d \in \{p, b\}$ is the subsequent decision rule.[11] Let $a \in A$ be the current asset level where I make the standard assumption that $a < 0$ is debt and $a > 0$ is savings. In the spirit of Chatterjee et al. (2007) and Livshits, MacGee,

10. In the online appendix, I show that assuming quits take place before production has a quantitatively insignificant effect on the results.

11. I define p as the decision to repay debts and b as the decision to declare bankruptcy.

and Tertilt (2007), the default decision is modeled to depict a chapter 7 bankruptcy filing in the US. I make the following assumptions about bankruptcy: all assets are immediately discharged, the household pays a utility cost χ_b, and there is no saving allowed in the period of a bankruptcy. Furthermore, access to credit is determined by credit status s. Bankruptcy causes a household to move to bad credit s_b where there is no borrowing. Let $V^{h,b}$ be the value of declaring bankruptcy and moving to bad credit.

$$V^h(\Psi_j, \Omega) = \max \left[V^{h,p}(\Psi_j, \Omega), V^{h,b}(\Psi_j, \Omega) - \chi_b \right] \tag{3}$$

$$d(\Psi_j, \Omega) = \begin{cases} p & if \quad V^{h,p}(\Psi_j, \Omega) \geq V^{h,b}(\Psi_j, \Omega) - \chi_b \\ b & otherwise \end{cases}$$

Let $q(a'; \Psi_j, \Omega)$ be the menu of discount prices over all of the possible choices of securities. The price for a specific security a' reflects the probability of a bankruptcy occurring next period. In this setting, the discount price decreases with the amount borrowed, and a household's borrowing limit $\underline{a}(\Psi_j, \Omega)$ is an endogenous outcome of the loan price schedule. The intuition for the endogenous borrowing limit is similar to a Laffer Curve: if a household tried to borrow an infinite amount of debt, intermediaries would offer a discount price of zero and households could not borrow any resources. Similarly, households do not borrow if they choose $a' = 0$. Therefore, along the menu of loan prices there is a maximum amount of debt that can be borrowed. Equation (4) describes this borrowing limit. I use the average borrowing limit across households in sections 4 and 5 to display how the supply of credit responds to aggregate risk and UI policies.[12] The equilibrium menu of loan prices provides an essential feedback mechanism for my analysis. UI affects bankruptcy behavior which feeds back through the menu of prices for credit to impact the consumption decisions of households.

$$\underline{a}(\Psi_j, \Omega) = \begin{cases} \min\limits_{a'} \left[q(a'; \Psi_j, \Omega)\, a' \right] & if \quad s = s_g \\ 0 & otherwise \end{cases} \tag{4}$$

12. Equation (4) is a better representation of the supply of credit by intermediaries than the realized discount price because households choose where on the menu of prices they want to borrow. Therefore, the realized discount price is a combination of supply-side and demand-side effects.

Households choose consumption and net savings as described by equation (5). Let $W(\Psi_j, \Omega)$ be a function that determines the pre-tax labor earnings of a household with characteristics Ψ_j. Labor earnings are individual productivity times the equilibrium wage rate when employed. Similarly, $T^U(\Psi_j, \Omega)$ is the transfer of UI benefits dependent on the eligibility of the household. I assume that benefits are calculated using the persistent productivity ϵ from the most recent period of employment.[13] This reflects the fact that UI benefits are based on an individual's labor earnings from before the unemployment spell began. Households also receive transfers during retirement T^R, and they receive a lump-sum transfer of T from the government during working years. Households who begin the period in bad credit still solve Bellman equations (2)-(5) except that the borrowing limit is set to 0, and they transition to good credit next period with probability θ. This assumption allows the model to replicate the average duration that a bankruptcy stays on the credit score of an individual without increasing the size of the state space.

$$V^{h,p}(\Psi_j, \Omega) = \max_{c,\, a'} \; u(c, n) + \beta \sum_{x'} \pi_x(x, x')\, E\Big[V(\Psi_{j+1}, \Omega')|\Psi_j\Big] \tag{5}$$

$$\text{s.t.} \qquad c + q(a'; \Psi_j, \Omega)\, a' = a + (1-\tau)W(\Psi_j, \Omega) + T^U(\Psi_j, \Omega) + T_j$$

$$\text{and} \qquad \mu' = \Gamma(\Omega), \qquad c > 0, \qquad q(a'; \Psi_j, \Omega)a' \geq \underline{a}(\Psi_j, \Omega)$$

$$W(\Psi_j, \Omega) = \begin{cases} w(\Omega)\gamma_j\epsilon \quad if \quad n = E \\ 0 \quad otherwise \end{cases}$$

$$T^U(\Psi_j, \Omega) = \begin{cases} \min\{\upsilon_r w(\Omega)\gamma_j\epsilon, \overline{\upsilon}\} \quad if \quad n = N \quad and \quad h(\Psi_j, \Omega) = e \\ 0 \quad otherwise \end{cases}$$

$$T_j = \begin{cases} T^R \quad if \quad j \geq J^R \\ T \quad otherwise \end{cases}$$

Retired households are permanently out of the labor force. I choose to model retirement to create a realistic life cycle savings motive for working households. Retirement is not of primary interest to the paper because retired households are not affected by unemployment

13. This is accomplished by assuming $\epsilon' = \epsilon$ when a household is not employed.

risk or UI policies. I assume that retired households do not have access to unsecured credit. This assumption should not have a significant effect on the results of the paper because unsecured credit and default are concentrated in young households in the model and in the data.

All of the decision problems outlined in equations (2) through (5) assume households have rational expectations. Uninsurable idiosyncratic risk coupled with incomplete asset markets creates an endogenous distribution of households over state variables. In the spirit of Krusell and Smith (1998), the distribution of households follows the law of motion $\mu' = \Gamma(\Omega)$. Agents in the model economy know the law of motion which allows them to form rational expectations over future prices.

2.c Financial Intermediaries

A continuum of risk-neutral financial intermediaries serve two main purposes in the model economy: they sell securities to households, and they rent capital to the firm. I assume that the market for intermediation is competitive such that zero profits are earned in expectation on each security. Equation (6) describes the menu of equilibrium prices offered to an age j household for all possible choices of a'. I assume that the intermediary knows the productivity and employment status of a household, and the intermediary has rational expectations with respect to the future return on capital. The prices offered to an age j household depend on the probability of a bankruptcy next period at age $j+1$. All else equal, an increase in the probability of a bankruptcy reduces the expected return of the loan, and the discount price falls to ensure zero profits in expectation. I assume that ι is a proportional cost paid by the intermediary to monitor debt contracts. For savings, the discount price is always equal to the inverse of the expected return on capital because there is no default on positive assets.

$$q(a'; \Psi_j, \Omega) = \sum_{x'} \pi_x(x, x')\, E\left[\frac{1 - d(\Psi_{j+1}, \Omega') - \iota(a')}{1 + r(\Omega')}\right] \tag{6}$$

$$\text{where} \quad \mu' = \Gamma(\Omega), \quad \text{and} \quad \iota(a') = \iota \quad if \quad a' < 0$$

Financial intermediaries own all of the capital in the model economy. They rent net household savings in the form of capital to the firm. Because intermediaries have both loans and capital on the balance sheet, these assets must have the same expected return in equilibrium. This has important general equilibrium implications for credit. All else equal, a fall in the return to capital increases the discount price of credit making it cheaper to borrow.

$$\begin{aligned}\Pi(\Omega) = (1 + r(\Omega))\, K - K' + \sum_{j=1}^{J} \int_{\Psi} q(a'; \Psi_j, \Omega)\, a'\, \mu(d\Psi_j) \\ - \sum_{j=1}^{J} \int_{\Psi} (1 - d(\Psi_j, \Omega) - \iota(a))\ a\, \mu(d\Psi_j)\end{aligned} \tag{7}$$

Intermediaries earn zero profits in expectation on each security, but aggregate uncertainty makes it such that they can have realized profits or losses. Equation (7) details the profits of intermediaries $\Pi(\Omega)$ in a model period. Intermediaries receive the returns to capital net of depreciation, and they invest capital with the firm for next period's production. They also sell new securities a' at the discount price q. Intermediaries pay out the net balance of securities that were sold last period. No revenue is received from debt that is in a bankruptcy claim. They also pay monitoring costs for pre-existing debt contracts. The total return on past securities and the total liabilities from newly issued securities are aggregated over the distribution of households.[14] I assume that net profits are taxed fully each period by the government. Realized net profits in the calibrated model economy are quite small such that distributing them in a different way should have a small effect on the results of the paper.

2.d The Government

The government collects income taxes from all households where τ is the tax rate. The government also facilitates transfers to households through three different programs: UI benefits, social security benefits, and lump-sum transfers. Equation (8) describes the government budget constraint where $G(\Omega)$ is net government expenditures. The government

14. I integrate over the entire individual state space for households. I represent this with an integral over Ψ_j. A more detailed description of the aggregation process would be to sum over discrete states ϵ, n, and s and integrate over the continuous state a. I suppress the full notation to improve the readability of the model equations.

consumes the remaining goods after collecting taxes and distributing transfers. I assume that government consumption fluctuates in response to changes in the aggregates state of the economy.[15]

$$\begin{aligned} G(\Omega) = & \sum_{j=1}^{J_R} \int_{\Psi} \tau\, W(\Psi_j, \Omega) \mu(d\Psi_j) - \sum_{j=1}^{J_R} \int_{\Psi} T^U(\Psi_j, \Omega)\, \mu(d\Psi_j) \\ & - \sum_{j=1}^{J} \int_{\Psi} T_j\, \mu(d\Psi_j) + \Pi(\Omega) \end{aligned} \tag{8}$$

2.e Equilibrium Definition

An equilibrium in the model economy occurs when economic agents behave optimally and all markets clear. Before defining the equilibrium concept, I define aggregate variables needed to solve for an equilibrium in the model economy. Aggregate labor supply is the total productivity of households who are currently employed at the market wage. Similarly, aggregate consumption is the total consumption summed over the distribution of households. Aggregate investment I is derived from the intermediaries problem as invested capital less non-depreciated capital.

$$C = \sum_{j=1}^{J} \int_{\Psi} c(\Psi_j, \Omega)\, \mu(d\Psi_j) \tag{9}$$

$$K' = \sum_{j=1}^{J} \int_{\Psi} q(a'; \Psi_j, \Omega)\, a'\, \mu(d\Psi_j) \tag{10}$$

$$I = K' - (1 - \delta)K \tag{11}$$

$$\iota A^- = \sum_{j=1}^{J} \int_{\Psi\{a<0\}} \iota\, a\, \mu(d\Psi_j) \tag{12}$$

Definition 1 A recursive equilibrium is the household value function V, decision rules $(a\prime, c, h, d)$, prices (r, w), the menu of discount prices q, and the distribution of households μ

15. G is never negative in the calibrated model economy, so the government budget constraint is never violated in equilibrium.

such that

1. Factor prices (r, w) solve the firm problem described by equation (1).

2. The decision rules (a', c, h, d) solve the household problems described by equations (2)-(5) where V is the resulting value function.

3. Financial intermediaries offer a menu of prices q to earn zero profits in expectation described by equation (6).

4. Net government expenditures are described by the government budget constraint in equation (8).

5. The distribution of households is consistent with individual decisions and the transition probabilities for individual state variables.

6. The market for securities clears at the menu of loan prices. The market for capital clears at the factor price $r(\Omega)$ that solves the firm's problem. The market for labor clears by equation (13), where the demand for labor from the firm's problem equals to the total supply of labor of workers on the production island. The market for goods clear in equation (14) below where ιA^- are the resources spent to monitor debt contracts.

$$L = \sum_{j=1}^{J_r} \int_{\Psi\{n=E\}} \gamma_j \epsilon \, \mu(d\Psi_j) \tag{13}$$

$$C + I + G(\Omega) + \iota A^- = zF(K, L) \tag{14}$$

3 Model to Data

The model is mapped to the data to depict the US economy from 1980Q1 to 2019Q4. The specified period covers five recessions in which the Federal Government extended the duration of UI benefits. The US economy also experienced significant cyclical fluctuations in unsecured credit and consumer bankruptcies making it an excellent basis to study how credit affects the implications of UI policies. Mapping the model to the data proceeds in three stages. First, a group of parameters are chosen outside the model solution. A separate group of parameters are then calibrated so the model replicates a set of key moments from the data. Finally, I compare simulated results to a set of untargeted moments from the data to test the validity of the model.

3.a Parameters Set Outside the Model Solution

The values of the aggregate exogenous transition matrix π_x are set using the average duration of expansions and recessions in the US. To this end, let the length of a model period be 1 quarter. The persistence of expansions is set such that the average expansion lasts just under 7 years, and the persistence of recessions is set such that the average recession lasts 4.6 quarters. The transition values reported below make the model consistent with business cycle data on peak and trough quarters reported by the NBER from 1980Q1 to 2019Q4.

$$\pi_x = \begin{vmatrix} 0.964 & 0.036 \\ 0.217 & 0.783 \end{vmatrix}$$

The parameters governing the UI regime in the model economy are chosen to be consistent with the Regular Benefits and the Federal-State Extended Benefits (EB) Program in the US. There are four parameters that determine the level and duration of benefits: $\{\upsilon_r, \overline{\upsilon}, \upsilon_d(x_g), \upsilon_d(x_b)\}$. I set $\upsilon_d(x_g)$ so the average duration of UI benefits is 2 quarters during expansions. Similarly, I set $\upsilon_d(x_b)$ so the average duration of benefits is 3 quarters during recessions. This policy is consistent with the EB Program which provides 13 additional weeks of benefits when unemployment is high. The replacement rate of UI is set to 50% of pre-tax earnings. Therefore, the replacement rate of after-tax earnings is 71%. The maximum level of benefits is 42% of average earnings in the economy. The parameters governing the UI regime are consistent with the summary statistics on benefits reported in Hsu, Matsa, and Melzer (2018).[16]

16. They look at data on UI in the United States from 1991-2010. They report the median duration of benefits across states to be 26 weeks. They also report that the ratio of max weekly benefits to average weekly wages is 0.42, and they discuss that most states replace about 50% of lost earnings.

The parameters governing the life cycle of the household are set such that the model exhibits an empirically consistent hump-shaped earnings profile. Households are born into the economy at age 25, they retire at age 65, and they die at age 75. Due to the quarterly frequency of the model, the total number of periods in the life cycle of a household is 200. The retirement age J_r is set to 160. The age-component of productivity is parameterized such that $\gamma_j = \nu_1 j + \nu_2 j^2$. Using data on earnings from the SCF, I estimate ν_1 and ν_2 to be $4.58e^{-2}$ and $-9.36e^{-4}$ respectively.[17] Because age is only reported in one-year intervals in the SCF, I assume that γ_j changes deterministically every 4 model periods. The estimated age-component of productivity generates a hump-shaped earnings profile over the life cycle which has been shown by Livshits, MacGee, and Tertilt (2007) and Athreya, Tam, and Young (2009) to be a significant component of the demand for borrowing by young households who have higher default rates.

The remaining parameters chosen outside the model solution are set to be consistent with commonly used values from the literature.[18] The process governing the persistent-component of productivity is consistent with Krusell et al. (2017): the persistence of the productivity process is 0.989 and the standard deviation is 0.103. Households value consumption with constant relative risk aversion (CRRA) preferences $u(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \chi_w \mathbb{1}_{\{n=E\}}$. The coefficient of relative risk aversion σ is set to 2.0. Let χ_w be the utility cost of work. Aggregate production follows a Cobb-Douglass function $F(K,L) = zK^\alpha L^{1-\alpha}$ where the capital share of production is 35%. The tax rate τ is set to 30%, and the pre-tax transfer to retired households is 50% of average earnings in the model economy. The probability of leaving bad credit θ is 2.5% so the average duration of bad credit lasts 10 years, which is the amount of time a bankruptcy remains on an individual's credit score in the US.

3.b Model Calibration

The remaining parameters are calibrated so the model reproduces a set of key moments from the data over the time period of interest. To this end, I simulate the benchmark economy and update parameters until the model generated moments match the data. Table 1 details

17. I estimate the age-component of earnings in every survey from 1989 through 2019 and take the average.
18. A table with the full set of model parameters is included in appendix A.

Table 1: Calibration Targets

	Data	Model
	First Moments	
Capital / GDP	224.07	224.04
Investment / Capital	7.89	7.88
Government exp / GDP	5.38	5.27
Credit balance / GDP	4.83	4.86
Debt share	41.37	41.69
Credit spread	11.73	11.69
Bankruptcy rate	0.88	0.86
Participation rate	73.73	73.63
Unemploy. rate	6.32	6.33
Unemploy. duration (weeks)	20.93	20.92
	Second Moments	
σ(GDP)	1.23	1.23
σ(Unemp. Rate)	11.12	11.02
σ(Job Find)/ σ(Job Sep)	1.62	1.58

Note.— Data from 1980Q1-2019Q4 except for debt share which begins in 1983 and credit spreads which begin in 1994Q4. First moments are annualized and in percentages except for unemployment duration which is in weeks. Government exp is national defense spending in the data. Debt share is the fraction of households in the labor force with credit card debt. Second moments are log and HP filtered with a smoothing parameter of 1600. σ(Job Find) is standard deviation of job finding rates, and σ(Job Sep) is standard deviation of job separation rates.

all of the moments targeted in the calibration procedure.

To simultaneously match aggregate capital holdings and revolving credit balances, I assume heterogeneity in household discount factors. Specifically, there are two types of households: patient who discount the future at rate β_h, and impatient who discount at rate β_ℓ. The discount factors are calibrated to match the ratios of capital and revolving credit balances to GDP. The share of impatient households π_ℓ is then set to match the fraction of households in the labor force with positive balances of credit card debt. The assumption of preference heterogeneity is supported by empirical work from Fulford and Schuh (2017) who estimate a life cycle model of consumption, unsecured credit, and default with patient and impatient individuals. The calibrated share of impatient households in my benchmark economy is within their range of estimates.

The model is also calibrated to match various moments for output and unemployment. I normalize the expansion value of TFP to 1, and I set the recession value in order to match the standard deviation of real GDP in the data. The expansion value of involuntary job separation rates ξ is chosen to match the average unemployment rate in the data. Similarly, the expansion value of job finding rates λ is chosen to match the average duration of unemployment. The recession values for job separation rates and finding rates are chosen to match second moments for unemployment. Specifically, the model matches the standard deviation of unemployment rates in the data. The model also matches the ratio of the standard deviation of job finding rates to the standard deviation of job separation rates. This is done to ensure that the share of fluctuations in unemployment coming from each labor market friction is consistent with the data. To calculate these moments in the data, I use the methodology described in Shimer (2012). This methodology calculates job separation rates and finding rates using readily available aggregate time series data.

Furthermore, the model is calibrated to match various aggregate and financial variables in the data. The disutility of bankruptcy χ_b and the cost of monitoring ι are set to match the bankruptcy rate and the credit spread respectively.[19] Capital depreciation δ is set to match the average aggregate investment to capital ratio. The lump-sum transfer to working households T is chosen to match the ratio of government expenditures to real GDP. I choose to target national defense spending as the measure of government expenditures in the data for two main reasons. First, it is intuitively the closest measure to government consumption in the model, which is expenditures that do not flow back to households. Second, it ensures that government consumption is always positive in equilibrium. With regards to labor markets, I make the simplifying assumption that the utility cost of work is equal to the utility cost of search, and χ_w is calibrated to match the labor force participation rate. I also assume that the share of new households who are employed is equal to the average share of employed households in the model economy.

3.c Model Validation

This section tests the validity of the model by comparing model-generated results to empirical moments that were not targeted in the calibration procedure. There are two stages to the

19. The unsecured credit spread in the data is the spread of the average interest rate on credit card accounts that are assessed interest over the interest rate on 1-year treasury bills.

model validation: (1) macro-level moments; (2) micro-level moments. For the macro-level validation, the model is compared to standard moments used for business cycle analysis: second moments of aggregate and financial time series. Table 2 details the standard deviation and cross-correlation with real GDP for key times series in the benchmark model economy and in the data. The empirical moments are generated using quarterly data that is seasonally adjusted, in logs, and HP filtered with a smoothing parameter of 1600.[20] All data is available from 1980Q1 except for unsecured credit spreads which are available from 1994Q4. For the micro-level validation, I simulate a large number of households who experience a job separation, and I compare the results to papers in the literature that estimate the effects of unemployment using micro data. The results from the model are described in figure 2. The online appendix includes additional model validation results including the distribution of unsecured credit over income and comparisons to papers that estimate the impact of UI on re-employment wages.

The most important result from this section of the paper is the model generates the cyclical properties of unsecured revolving credit balances in the data. This is a significant contribution to the consumer credit and default literature because the leading models have had trouble explaining why unsecured credit is so volatile over the business cycle. The model with cyclical earnings skewness shocks in Nakajima and Ríos-Rull (2019) can explain about one-quarter of the total standard deviation of unsecured credit. Fieldhouse, Livshits, and MacGee (2016) finds that their model needs intermediation shocks to generate credit that is procyclical, and their model also under-predicts the volatility of unsecured credit balances. My benchmark model economy generates over 84% of the volatility in unsecured credit balances by using empirically consistent unemployment dynamics over the business cycle. The model also generates consumer bankruptcies and unsecured credit spreads which are highly volatile and counter-cyclical.[21] Reproducing the cyclical properties of unsecured credit and consumer bankruptcies is not just an important contribution to the literature, it is also a necessary step towards quantifying how unsecured credit affects the usefulness of

20. Revolving credit balances, unemployment rates, and participation rates are quarterly averages of monthly data. Bankruptcy data is non-business filings.

21. Non-business bankruptcies are still highly volatile and counter-cyclical in the data if you use a shorter time period that ignores the effects of the 2005 Bankruptcy Abuse and Consumer Protection Act.

Table 2: Untargeted Business Cycle Properties

		C	I	D	B	Q	U	P
$\sigma(X)/\sigma(GDP)$	Data	0.77	4.89	2.97	13.62	5.17	9.05	0.20
	Model	0.50	2.49	2.51	13.38	1.76	8.96	0.02
Corr(X,GDP)	Data	0.86	0.90	0.32	-0.35	-0.71	-0.86	0.42
	Model	0.88	0.68	0.58	-0.59	-0.85	-0.83	0.91

Note.— Data is from 1980Q1-2019Q4 except for credit spreads which begin in 1994Q4. Data is in logs, seasonally adjusted and HP filtered with a smoothing parameter of 1600. C is aggregate consumption; I is investment; D is unsecured credit balances; B is consumer bankruptcies; Q is unsecured credit spreads; U is unemployment; P is labor force participation. $\sigma(X)/\sigma(GDP)$ is relative standard deviation of variable X to GDP. $Corr(X, GDP)$ is correlation coefficient of variable X with GDP.

UI in insuring households against aggregate risk.

The model also has success generating the cyclical properties of other aggregate time series in the data. Aggregate consumption is pro-cyclical and less volatile than GDP. Aggregate investment is pro-cyclical and more volatile than GDP. One reason why the model under-predicts the volatility of investment is there are offsetting forces for households. During a recession, households want to save more for precautionary reasons, which puts upward pressure on investment. However, the return to capital falls, which puts downward pressure on investment. Under-predicting the volatility of investment should not be of first-order importance to the results of the paper because investment dynamics are largely driven by high-wealth households who do not rely on unsecured credit for consumption smoothing. With regards to labor markets, the standard deviation of unemployment was targeted in the calibration procedure, but the model also generates a counter-cyclical correlation very close to the data. Labor force participation is pro-cyclical and much less volatile than GDP. The model under-predicts the volatility of labor force participation, but this should not be of first-order importance to the results of the paper because UI isn't available to individuals who are out of the labor force.

Figure 2 describes the average change in consumption, income, debt balances, and bankruptcy rates for households who experience a job separation in the model economy. Formally, I simulate 80,000 households and collect data on those who experience a job separation over an 11-quarter period. The first period of unemployment is $t = 0$. For consumption and income, I calculate the average percent change from the $t = -1$ value. Debt balances

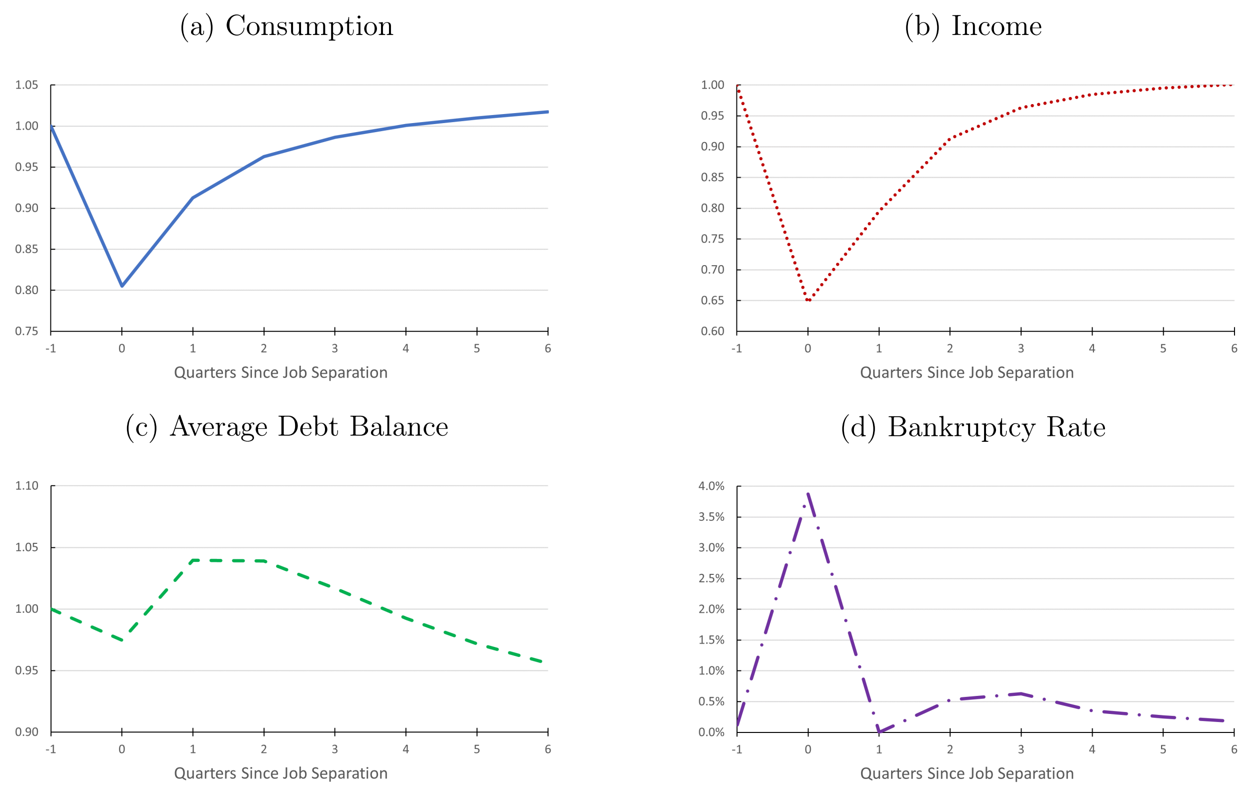


Figure 2: Change following a Job Separation

Note.— Average change following a job separation in the model economy. Period $t = 0$ is the first period of unemployment. Consumption and Income are measured as the average percent change from the $t = -1$ value. Average debt balance is normalized to the $t = -1$ value.

are the average debt held by the cohort, and bankruptcy rates are the share of the cohort declaring bankruptcy.[22]

The model predicts a fall in consumption during unemployment that is within the range of estimates in the empirical literature. There is an average fall in consumption of 19.6% in the first quarter of unemployment. The average change in consumption for the cohort rebounds quickly because most unemployment spells are only one or two quarters, but consumption continues to fall for households who experience a longer unemployment spell. Overall, the average fall in consumption for unemployed households compared to their most recent period of employment is 24.2%. There is a large literature that estimates the consumption fall during unemployment using micro data. Using data from the Consumer Expenditure Survey

22. I use the average debt balance instead of the percent change in debt balances because there are many individuals in the cohort who have zero debt in period $t = -1$.

(CE), Chodorow-Reich and Karabarbounis (2016) finds that expenditures on nondurables and services fall by 21% during unemployment. They also find that expenditures on food, clothing, recreation, and vacations fall by 24.5% in the CE and 23.5% in the PSID. Ganong and Noel (2019) find smaller estimates using data on Chase checking accounts. Relative to pre-employment levels, they find that consumption falls by approximately 9% after 3 months of receiving UI payments. Aguiar (2005) uses scanner data to show that consumption falls by 19% during unemployment. Earlier work by Burgess et al. (1981) find in a survey of UI recipients that expenditures on food, clothing, entertainment, and travel fell by 25.7% after 5 weeks of unemployment.

Income falls by an average of 35.3% in the first quarter of unemployment in the model economy. The most comparable empirical results in the literature come from Ganong and Noel (2019), who report that income falls by about 23% after 3 months of receiving UI. My model over-predicts the average fall in income from their empirical estimates, but the difference in results largely comes from high-income households. High-income households in my model experience a very large drop in income because their UI benefits are capped by the maximum threshold $\overline{v}$. This skews the average drop in income downwards. For comparison, the median drop in income after 1-quarter of unemployment is 24.9%, which is quite close to the Ganong and Noel (2019) estimates. There is also a large literature estimating earnings losses following a mass layoff event. Jacobson, LaLonde, and Sullivan (1993) estimates an average earnings loss of 40% in the year of a separation. Lachowska, Mas, and Woodbury (2020) finds an average earnings loss of 43% during the Great Recession. Finally, my parameter for the UI replacement rate of lost earnings is within the range of estimates from the literature. Braxton, Herkenhoff, and Phillips (2023) estimates a replacement rate of 41.2% in the PSID, and Rothstein and Valletta (2017) estimates 43.6% in the SIPP. Mitman and Rabinovich (2015) uses a replacement rate of 40%, which they take as the average in the U.S. Finally, Hsu, Matsa, and Melzer (2018) estimates the impact of max UI benefits across states, and they discuss that most states use a replacement rate of about 50%. I use the top end of this group of replacement rates so as to be as close to the Ganong and Noel (2019) estimates as possible.

With regards to unsecured credit, the average balance of unsecured credit for the cohort that experiences a job separation falls by 2.5% in the first quarter of unemployment in the model economy. It then increases for the second and third quarter of unemployment, and it decreases monotonically after that. There is a non-monotonic response of credit balances in the periods following a job separation because there are heterogeneous effects in the model. Relatively constrained households default and delever, and unconstrained households borrow more to smooth consumption after a job separation. Specifically, 23% of households decrease debt balances in the quarter after a job separation and 26% increase. These heterogeneous effects are qualitatively consistent with what Braxton, Herkenhoff, and Phillips (2023) find in the TransUnion data. In their sample, 37% decrease debt balances and 30% increase.[23] With regards to the path of debt, they find that a job separation causes a 1.4% decrease in debt balances in the year following the unemployment spell in the TransUnion data. In my model economy, average debt balances are 0.8% lower four quarters after the separation, and they are 2.8% lower after five quarters. These results are comfortably within the 95% confidence intervals of their estimates.

The empirical literature has consistently found that unemployment is a main cause of consumer default. For example, Sullivan, Warren, and Westbrook (2000) finds that almost 67% of bankruptcies are due to a job-related income disruption. More recent data comes from Braxton, Herkenhoff, and Phillips (2023), which estimates the impact of a job separation on multiple types of consumer defaults. They find that workers who experience a job separation are 0.52 percentage points more likely to have a new derogatory flag in the year following a job separation, and they calibrate their model to match this moment. This estimate depicts a 0.66 percentage points increase relative to the year before a job separation, with a max increase of 1.13 percentage points within a 95% confidence interval. My model predicts that consumer bankruptcy rates increase by 1.07 percentage points in the year following a job separation relative to the year before. My model is within the 95% confidence interval for their estimate of this moment. However, my model predicts an immediate spike in bankruptcies in the first quarter of unemployment that does not appear in the data.[24] This occurs

23. Braxton, Herkenhoff, and Phillips (2023) have annual data, so they are calculating the share of individuals who increase or decrease credit card balances between the year before an unemployment spell to the year after an unemployment. Because I have a quarterly model, I am calculating the share of households who increase or decrease borrowing in the first quarter of unemployment.

24. In Braxton, Herkenhoff, and Phillips (2023), the largest increase in consumer defaults within a 95%

because bankruptcies are front-loaded in the model. Relatively constrained households who experience an unemployment spell want to default immediately . In the data, unemployed workers most likely spend a period of time in delinquency trying to regain their credit standing before a bankruptcy occurs. In the online appendix, I run a robustness exercise where I set the replacement rate of UI to $\upsilon_r = 0.79$, which eliminates the spike in bankruptcies in the first period of unemployment. The main quantitative results all go through in this robustness exercise.[25] The spike in bankruptcies in the first period of unemployment has a relatively small effect on the quantitative predictions of the model because the model still generates a change in consumption and credit balances that are within the range of estimates from the data.

With regards to the impact of UI on employment incentives, the model is consistent with papers in the literature that estimate a small positive relationship between UI extensions and the unemployment rate. For example, the model predicts that at the end of a 5-period recession the unemployment rate is 8.96% when the government extends the average duration of UI by 13 weeks, and it is 8.95% without the UI extension. The most relevant papers to my analysis estimate the impact of UI extensions that occur during recessions. Chodorow-Reich, Coglianese, and Karabarbounis (2019) find that the UI extensions during the Great Recession had a small impact on unemployment. Specifically, they use a measurement error approach and estimate that a one-month extension in UI benefits led to between a 0.02 percentage point increase and a 0.03 percentage point decrease in the unemployment rate. Their data does not reject the zero response on the unemployment rate at any horizon. Work from Rothstein (2011) and Farber and Valletta (2015) both estimate that UI extensions led to a small increase in unemployment rates during the Great Recession.[26] They find that the majority of the impact is due to a decrease in labor force exits and not from a decrease in job finding rates. Their estimates are consistent with the operative mechanism in my model: UI extensions incentivize fewer workers to leave the labor force which puts a small upward pressure on unemployment rates. Hagedorn et al. (2013) finds much larger effects.

confidence interval in the year of a job separation is a 1.81 percentage points increase in the probability of a charge-off relative to the year before a job separation.

25. The model still predicts that unsecured credit amplifies the welfare effects of counter-cyclical UI extensions, and the model still depicts unsecured credit balances that are highly volatile and pro-cyclical.

26. Farber and Valletta (2015) finds similar estimates during the 2001 recession in the U.S.

Table 3: Decomposition of Aggregate Fluctuations

		C	I	D	B	Q	U
Std Dev (X)	(1) Benchmark	0.62	3.05	3.09	16.44	2.17	10.97
	(2) Fixed z	0.47	2.46	3.87	14.98	1.48	10.96
	(3) Fixed ξ	0.50	2.46	2.03	13.67	1.47	6.63
	(4) Fixed λ	0.26	2.52	0.23	5.14	1.29	4.69
	(5) Fixed λ; recalibrate	0.38	3.03	0.82	12.40	1.78	11.26
Corr(X,GDP)	(1) Benchmark	0.88	0.68	0.59	-0.59	-0.83	-0.85
	(2) Fixed z	0.23	0.48	0.85	-0.13	-0.44	-1.00
	(3) Fixed ξ	0.94	0.70	0.49	-0.57	-0.86	-0.74
	(4) Fixed λ	0.98	0.94	-0.62	-0.73	-0.87	-0.72
	(5) Fixed λ; recalibrate	0.96	0.92	0.47	-0.57	-0.67	-0.85

Note.— C is aggregate consumption; I is investment; D is unsecured credit balances; B is average bankruptcy rate; Q is average spread of credit over capital returns; U is unemployment rate. Fixed z has no cyclical fluctuations in TFP. Similarly, Fixed ξ holds involuntary job separation rates constant, Fixed λ holds job finding rates constant, and simulation (5) recalibrates the model with fixed λ to match the standard deviation in unemployment.

They estimate that unemployment rates would have been about 2 percentage points lower in 2011 without UI extensions. Because the empirical estimates vary widely, I choose a model framework in the middle-ground where UI extensions have a limited effects on employment incentives so as to not drive the main quantitative results of the paper.

4 The Sources of Aggregate Fluctuations

I now conduct a decomposition exercise to quantify the sources of aggregate fluctuations over the business cycle. To this end, I simulate the model economy removing cyclical changes to TFP, involuntary job separation rates, and job finding rates for unemployed workers one at a time.[27] This methodology allows me to isolate the impact of each dynamic variable in driving aggregate fluctuations. The decomposition exercise accomplishes two things: it explains why the model improves on the literature's ability to match the cyclical properties of unsecured consumer credit, and it highlights the importance of studying business cycles in an environment with incomplete asset markets and idiosyncratic risk.

27. Even when involuntary job separation rates are held constant, households are still allowed to endogenously separate from a job by quitting.

The main result from the decomposition exercise is job finding rates for unemployed workers are the main driver of aggregate fluctuations over the business cycle. As seen in simulation (4) of table 3, the majority of the volatility in consumption, unsecured credit, and consumer bankruptcies is explained by job finding rates: the standard deviation of all three variables falls by more than half when job finding rates are held constant. Additionally, unsecured credit balances would be counter-cyclical which is inconsistent with the data. Comparing the results to simulation (3), it is easy to see that involuntary job separation rates have a smaller impact on aggregate fluctuations. Part of this result is simply explained by the fraction of unemployment that is caused by each labor market friction. Consistent with results from Shimer (2012), the majority of the volatility in unemployment is driven by job finding rates. However, this does not fully explain why job finding rates have a stronger impact on aggregate fluctuations.

Unsecured credit plays a key role in understanding why job finding rates have the largest impact on aggregate fluctuations. Figure 3 depicts how the aggregate debt balance and the average borrowing limit evolve during a 5-quarter recession in the decomposition exercise. The figure shows evidence of both supply-side and demand-side forces that drive results in the decompostion exercise. The model with fixed job finding rates has the smallest decrease in the average borrowing limit throughout the recession. This shows that the supply of credit via the menu of loan prices offered by financial intermediaries responds most strongly to cyclical fluctuations in job finding rates. However, this is not the whole story. Even though the supply of credit falls, unsecured credit balances actually increase during the recession in the model with fixed job finding rates, which indicates that demand for credit increases. Job finding rates have such a significant effect on the demand for credit because of the precautionary behavior of households. When job finding rates fall, indebted households want to delever to avoid a future bankruptcy and to smooth consumption. These results are of independent interest towards understanding the aggregate implications of recessions with different fluctuations in job separation and job finding rates, but they also highlight key mechanisms at play in the model. UI insures households against relatively short unemployment spells, but when job finding rates fall intermediaries contract the supply of credit and households delever to insure themselves against the possibility of a prolonged unemployment

(a) Aggregate Debt Balance (b) Average Borrowing Limit

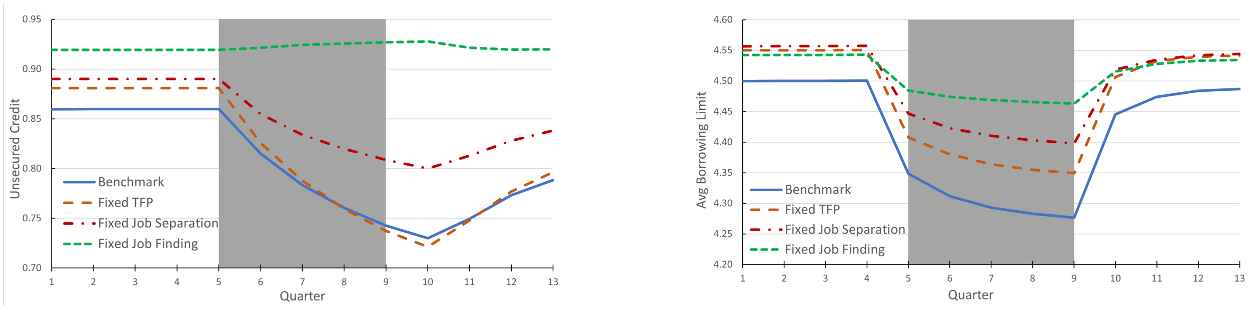


Figure 3: The Impact of UI Policies on Unsecured Credit

Note.— A five period recession starting in quarter 5. This corresponds to period 1301 in the aggregate simulation. Panel (a) is the aggregate debt balance and panel (b) is the average borrowing limit across households with good credit. Fixed TFP is simulation (2), Fixed Job Separation is simulation (3), and Fixed Job Finding is simulation (4) in table 3.

spell.

The results from the decomposition exercise highlight why the model is able to generate the cyclical properties of aggregate consumption, unsecured credit, and consumer bankruptcies. The most important contribution to the consumer credit literature is that the model explains over 84% of the standard deviation of unsecured revolving credit balances in the data. The model with cyclical earnings skewness shocks in Nakajima and Ríos-Rull (2019) generates about one-quarter of the same volatility. Their earnings process is calibrated to match annual moments from Guvenen, Ozkan, and Song (2014), which shows earnings risk becomes more left-skewed during recessions. Cyclical changes to earnings skewness in the data could be caused by changes to wages, job separation rates, or job finding rates, but I show that the latter is what drives aggregate fluctuations. Calibrating an earnings process to annual tax return data can miss some of the key details that result in large aggregate fluctuations because you cannot determine the underlying cause of a fall in earnings during a recession. An earnings shock caused by a fall in job finding rates has a larger impact on consumption and unsecured credit because it causes a stronger increase in precautionary behavior and default risk.

The insight that job finding rates have a larger impact on aggregate fluctuations highlights the importance of studying business cycles in an environment with incomplete asset markets and idiosyncratic risk. If asset markets were complete, separation rates and finding rates would have the same impact on macroeconomic aggregates if they caused the same change in unemployment because they would result in the same change in income for a representative household. To quantify how important it is to distinguish between fluctuations in job finding rates and separation rates, I recalibrate the model with fixed job finding rates to generate the same volatility in unemployment. Specifically, I assume that job separation rates increase to 6.4% during recessions while job finding rates remain constant at 65%. The results are depicted in simulation (5) of table 2. Even though the recalibrated model generates the same volatility in unemployment, there are significantly different fluctuations in aggregate consumption and unsecured credit balances. Consumption is over 38% less volatile when job finding rates are held constant. Moreover, the model only generates 22% of the total volatility in unsecured consumer credit from the data. There are two clear conclusions coming from the results of the model with fixed job finding rates. First, the model's success in generating the high volatility of unsecured credit seen in the data is attributed to having empirically consistent fluctuations in job finding rates over the business cycle. Second, cyclical fluctuations in unemployment can have a vastly different impact on the aggregate economy depending on whether the change is driven by an increase in job separation rates or a decrease in job finding rates, a result that would not occur in a complete markets setting.[28]

5 Quantitative Results

This section quantifies how unsecured credit impacts the effectiveness of counter-cyclical UI policies. I first measure the effects of a policy which extends the duration of UI during recessions in the benchmark economy with unsecured credit and in a counterfactual economy with no credit. To compare the effectiveness of the policy across the two economies, I use two statistics: a consumption-equivalent (CE) welfare analysis and peak-to-trough changes in aggregate consumption during recessions. Using both statistics allows me to simultaneously quantify how credit impacts the welfare gains of the UI policy and the extent to which UI

28. Job finding rates and job separation rates also have a different impact on aggregate investment via precautionary savings motives. When job finding rates are fixed, households save less for precautionary reasons, which means there are less resources available for consumption throughout a recession. In the online appendix, I show that this channel is quantitatively small, and it mitigates the differences between the benchmark model and the model with fixed job finding rates.

smooths aggregate fluctuations over the business cycle. I conclude this section by comparing the policy which extends the duration of UI to a budget-neutral policy which increases the level of benefits during recessions.

5.a The Amplifying Effects of Unsecured Credit

I begin by measuring the welfare gains of the policy which extends the duration of UI by 13 weeks during recessions. The welfare calculation used is CE: it is the share of lifetime consumption a household would trade to be indifferent between two policies. In this case, the household is indifferent between the policy which extends the duration of UI and a policy where the terms of UI don't change over the business cycle. I refer to the former as the *extending UI* policy and the latter as the *acyclical UI* policy. Welfare is calculated for age 1 households in order to quantify the full lifetime consumption that makes the household indifferent between the policies.[29]

Equation (15) describes the CE welfare calculation used in this paper. The equation is generalizable to separable household preferences with a CRRA utility function for consumption. Let ω be the share of lifetime consumption that equates value function V from the *extending UI* policy to value function $\tilde{V}$ from the *acyclical UI* policy. In order to calculate CE welfare with separable preferences, it is important to differentiate between the household value function and the value of future consumption streams V_c. For the model used in this paper, households have separable preferences with respect to consumption, utility costs of work, utility costs of search, and the utility costs of filing for bankruptcy. I provide additional details about how to derive equation (15) in appendix D. There are two main benefits of calculating welfare in this way. First, the solution is analytical, meaning there is no additional computational burden to solve for ω. Second, the measurement is CE, making it easy to compare welfare gains across different policy counterfactuals and different models in the literature.

29. It is easy to calculate the welfare of older households, but the interpretation differs slightly. Then, you are calculating the share of remaining lifetime consumption that makes the household indifferent between the two policies.

$$\omega(\Psi_j;\Omega) = \left[\frac{V(\Psi_j;\Omega) - \tilde{V}(\Psi_j;\Omega) + \tilde{V}_c(\Psi_j;\Omega)}{\tilde{V}_c(\Psi_j;\Omega)}\right]^{\frac{1}{1-\sigma}} - 1 \tag{15}$$

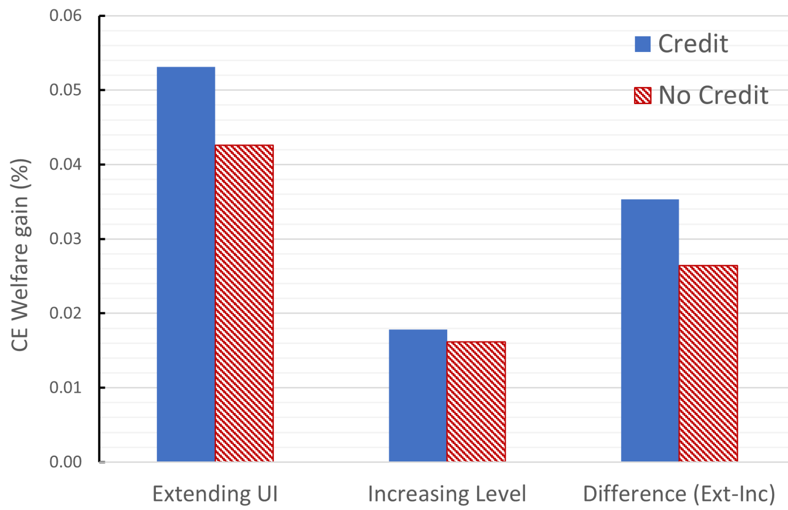
Figure 4 details the CE welfare gains of the policy which extends the duration of UI during recessions in the benchmark economy with unsecured credit and in the counterfactual economy with no credit.[30] The main result is that unsecured credit amplifies the CE welfare gains of the *Extending UI* policy. The average household born into the economy with credit would trade 0.054% of lifetime consumption to obtain the extending UI policy. Whereas, the average household would only trade 0.043% to obtain the same policy in the model with no credit. The impact of credit is even larger for impatient households. These households would trade 0.080% of lifetime consumption for the extending UI policy in the economy with credit, but only 0.057% in the economy without credit.

Unsecured credit amplifies the welfare gains of the policy because credit and UI work as complimentary forms of insurance. When the government extends the duration of UI, households reduce their default rates. Lower default rates allow financial intermediaries to lower the default risk premium on unsecured credit which allows households to more readily use credit to smooth consumption. This explains why the welfare gains are largely being driven by impatient households. Impatient households are more likely to use unsecured credit during their lifetime, so they benefit more when the terms of credit improve. The mechanism where UI impacts the default risk premium of unsecured credit is supported by empirical evidence from the literature. Hsu, Matsa, and Melzer (2014, 2018) showed evidence that people in states with more generous UI policies receive credit card offers with higher borrowing limits and lower interest rates. Gross et al. (2021) also provided evidence of this mechanism by showing that a 1 percent reduction in bankruptcy probability translates to a 70-90 basis point decrease in the interest rate on credit cards in the US.

I now measure how unsecured credit impacts the extent to which UI stabilizes aggregate consumption fluctuations. UI has long been considered an automatic stabilizer of the economy, so it is important to understand how the emergence of unsecured credit has impacted the stabilizing effects of UI. To quantify aggregate fluctuations, I measure the peak-to-trough

30. Figure 4 also details the CE welfare gains of a counterfactual policy which increases the level of UI benefitis during recessions. This policy will be discussed in section 5.c.

Figure 4: CE Welfare: extending the duration and increasing the level



Note.— Share of lifetime consumption households would trade to get a counter-cyclical UI policy. Measured for age 1 households born during an expansion. *Extending UI* extends average duration of UI by one quarter during recessions, and *Increasing Level* increases the level of UI transfers by 6% during recessions. *Difference* measures how much consumption households with the *Increasing Level* policy would trade to get the *Extending UI* policy. Credit is benchmark model with unsecured credit and No Credit is the economy with no borrowing.

change in aggregate consumption averaged across all recessions in a 2000 period simulation. Table 4 details how the peak-to-trough change in consumption is affected by the policy which extends the duration of UI by 13 weeks during recessions. In the benchmark economy with unsecured credit, the UI policy reduces the average peak-to-trough fall in consumption by 0.42pp. In the economy with no credit, the policy only reduces the average peak-to-trough fall in consumption by 0.24pp. In appendix **??**, I show that the same result holds if you use the total deviation in aggregate consumption during a recession as opposed to the peak-to-trough change.

Unsecured credit amplifies the extent to which the *Extending UI* policy stabilizes aggregate consumption because credit acts as a complementary form of consumption insurance. Evidence of this complementary relationship is seen by looking at the peak-to-trough change in aggregate credit balances. Credit is pro-cyclical in the model and in the data. When the government extends the duration of UI during recessions, it reduces the average peak-to-trough fall in credit balances during recessions by 2.01pp. Households use the additional credit to smooth consumption expenditures during recessions. This equilibrium credit chan-

Table 4: Peak-to-Trough Declines: Extending Duration of UI

	Benchmark		No Credit	
	C	D	C	D
Acyclical UI (%)	2.62	10.14	1.89	0.00
Extending UI (%)	2.20	8.11	1.65	0.00
Difference (pp)	0.42	2.03	0.24	0.00

Note.— Peak-to-trough fall in aggregate consumption (C) and credit balances (D) averaged over all recessions in a 2000 period simulation. Peak is the period before a recession starts. Simulation results are in logs and HP filtered with a smoothing parameter of 1600. Benchmark is the economy with unsecured credit and No Credit is the economy with no borrowing.

nel is the result of both supply and demand factors. Extending the duration of UI during recessions mitigates the rise in consumer bankruptcies which allows financial intermediaries to supply credit with a lower default risk premium. On the demand side, the UI extension reduces the incentive for households to delever for precautionary reasons. The culminating effect is a significant increase in the extent to which UI stabilizes aggregate consumption fluctuations.

The results from this section make a significant contribution to the real business cycle literature and to the unsecured credit literature. Athreya, Tam, and Young (2009) shows that unsecured credit does not smooth consumption for households over the life cycle. Nakajima and Ríos-Rull (2019) shows that unsecured credit does not smooth aggregate fluctuations in consumption over the business cycle. Although credit does not smooth aggregate consumption fluctuations by itself, I find that it does amplify the extent to which cyclical UI policies stabilize consumption over the business cycle. The mechanism driving this result is that extensions in the duration of UI promote more unsecured credit during recessions, which allows households to better smooth consumption.

5.b The Effects of Business Cycle Fluctuations

How important are business cycle fluctuations for understanding the relationship between UI and unsecured credit? It is essential to answer this question because most changes to UI policies are counter-cyclical in the sense that they transfer more resources to households during recessions. It is also important to know if future work on the subject needs to directly account for business cycle fluctuations when quantifying the effects of UI policies. With these goals in mind, I solve for a stationary equilibrium without aggregate risk. The model is the same as what is described in section 2 of the paper except that there are no fluctuations between the exogenous aggregate states of the economy. When calibrating, all the acyclical parameters are the same as the benchmark model, and the cyclical parameters are fixed at the values for a good aggregate state x_g.[31] I refer to the equilibrium without aggregate risk as the *Deterministic Equilibrium* where the benchmark model with aggregate risk is the *Stochastic Equilibrium*. Comparing the effects of UI extensions between the two economies allows me to directly quantify how cyclical fluctuations impact the relationship between UI and unsecured credit.

Figure 5 describes the consumption-equivalent (CE) welfare gains of extending the average duration of UI by 13 weeks in the *Deterministic Equilibrium*.[32] Since there are no cyclical fluctuations, this is a permanent change in UI policy. Without aggregate risk, the main quantitative result of the paper changes. The substitutable forces dominate, and extending the duration of UI leads to smaller welfare gains in the economy with unsecured credit. The same change in results occurs whether you look at extensions in the duration of UI or increases in the replacement rate (RR). Cyclical fluctuations play a prominent role in understanding the relationship between UI and unsecured credit because credit contracts during recessions. These credit contractions significantly limit the extent to which households can substitute between UI and unsecured credit for consumption insurance. Extending the duration of UI during recessions not only mitigates the fall in household income, it mitigates the contraction in unsecured credit markets. By comparison, households can much more easily substitute between UI and credit for consumption insurance in the *Deterministic Equilibrium*, which reduces the welfare gains of extending the duration of UI. (idea: add the permanent bad aggregate state calibration to figure 5, then say "whether you calibrate the model to an equilibrium with relatively high or low amounts of unsecured credit, the substitutable forces dominate when there is no aggregate risk")

The aggregate implications of the UI policies also differ depending on whether you ac-

31. For robustness, I also conduct the same policy experiment for an economy that is calibrated to use the parameter values from a bad aggregate state x_b. This does not have a significant impact on the results.

32. Compare the results to figure 4 which has the CE welfare analysis in the model with aggregate risk.

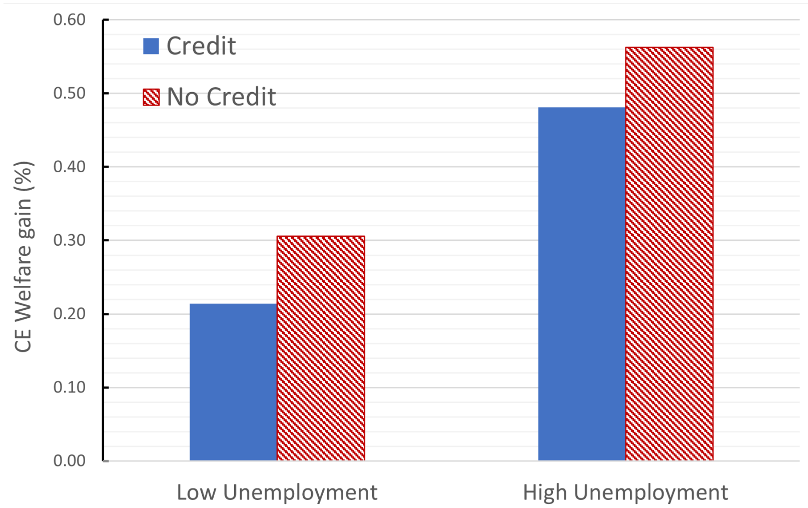


Figure 5: Welfare Effects of UI Extensions with no Aggregate Risk

Note.— Consumption equivalent (CE) welfare measured as the change in lifetime consumption a household would trade to extend the average duration of UI from 2 quarters to 3. Measured for age-1 households. *Low Unemployment* is the stationary equilibrium with an unemployment rate of 5.8%. *High Unemployment* is the stationary equilibrium unemployment rate of 9.1%.

count for aggregate risk. Table 5 shows the change in aggregate consumption associated with extending the duration of UI in the *Deterministic Equilibrium*. Without aggregate risk, UI extensions result in a smaller increase in aggregate consumption in the model with unsecured credit. This is in stark contrast to the business cycle analysis, where unsecured credit significantly amplified the extent to which extending the duration of UI during recessions reduced the average peak-to-trough fall in aggregate consumption. It is also apparent that the aggregate implications of the UI extension is quite small in the *Deterministic Equilibrium*. This occurs because households are relatively successful at insuring themselves with precautionary savings and unsecured credit when there is no aggregate risk in the economy. Therefore, extending the duration of UI has a smaller impact on aggregate consumption because households can already smooth consumption during an unemployment spell with other forms of insurance.[33] The aggregate implications of extending the duration of UI are much more significant in the *Stochastic Equilibrium* because economic agents cannot perfectly predict when a recession will start. Therefore, households do not have as much precautionary savings built up before a recession, and financial intermediaries offer terms of credit that are

33. Table 4 details how extending the duration of UI during recessions impacts the average peak-to-trough fall in aggregate consumption and credit balances in the benchmark model with aggregate risk.

relatively more risky. This causes the counter-cyclical UI extensions to have a relatively large impact on aggregate consumption fluctuations because households need the extra insurance to better smooth their individual consumption paths and to protect against a sudden rise in default risk.

	Credit	No Credit
Benchmark UI	3.2654	3.3013
Extended UI	3.2676	3.3043
Difference (%)	0.0674	0.0909

Table 5: Aggregate Consumption without Aggregate Risk

Note.— Extended UI has average duration of 3 quarters. Credit is the economy with borrowing, and No Credit is the economy with no borrowing.

Quantifying how cyclical fluctuations affect the relationship between UI and unsecured credit makes a significant contribution to the literature because previous papers have studied this channel using a stationary equilibrium without aggregate risk. The most recent paper in the literature is Braxton, Herkenhoff, and Phillips (2023). Similar to my paper, their analysis also has mechanisms that could generate a complementary or substitutable relationship between credit and UI. They find that the government optimally reduces the RR of UI when unsecured credit is available to households, which is an indication that the substitutable forces dominate in their analysis. Although I do not solve for an optimal UI policy, my work also predicts that the substitutable forces dominate in a stationary equilibrium without aggregate risk because the welfare gains of UI extensions are smaller with unsecured credit. The results from my paper make a significant contribution to the literature by showing that cyclical fluctuations actually cause the relationship between UI extensions and unsecured credit to change from substitutable to complementary. In an economy with empirically realistic fluctuations in unsecured credit markets, extending the duration of UI during recessions has larger welfare gains and aggregate implications when unsecured credit is available.

Another important difference between the current paper and Braxton, Herkenhoff, and Phillips (2023) is that the former uses one-period debt competitively priced by financial intermediaries where the latter uses a theory of credit lines. In section 3, I showed that the theory of one-period debt is able to endogenously reproduce key empirical moments for unsecured credit over the business cycle. It is unclear if a theory of credit lines could generate the same moments. Herkenhoff (2019) captures cyclical fluctuations using exogenous shocks to the efficiency of matching lenders to borrowers. However, exogenously generating credit contractions means that UI policies have limited scope to mitigate the fall in credit balances during recessions, which is a key mechanism driving results in my analysis. With lines of credit, the interest rate and borrowing limit only update for borrowers that experience a credit separation. To endogenously generate cyclical fluctuations in unsecured credit, consumer bankruptcies, and credit card interest rates in line with the data, the theory would most likely have to rely on a high level of separations during recessions. It is largely an empirical question whether there are enough credit separations over the business cycle to generate realistic aggregate moments using the current theory of credit lines. This could be an interesting question for future research, but given the current state of the literature, I argue that one-period debt competitively priced by intermediaries is an appropriate choice for my research question. Furthermore, the current paper and Braxton, Herkenhoff, and Phillips (2023) both predict that UI and unsecured credit work as substitutes in a stationary equilibrium without aggregate risk indicating that the difference in results is mainly driven by the inclusion of cyclical fluctuations, not the assumptions made when modeling consumer credit markets.

5.c Extending the Duration vs. Increasing the Level

I now compare the policy that extends the average duration of UI by one quarter during recessions to a counterfactual policy that increases the level of benefits. The counterfactual policy is budget-neutral in the sense that it generates the same average level of government expenditures as the *Extending UI* policy. Specifically, the policy increases the level of benefits by 6% during recessions. In order to generate an increase in level for all unemployed workers, both the replacement rate υ_r and the maximum threshold of UI $\overline{\upsilon}$ increase. I refer to the counterfactual as the *Increasing Level* policy. Previous work by Ganong and Noel (2019) found that UI extensions provide greater consumption insurance than an equivalent increase in the level of benefits. It is important to further study the aggregate implications of these policies because both have been used during recent recessions, and there are many unanswered questions that can be addressed with the quantitative real business cycle model of this paper.

The main result from this section is that extending the duration of UI during recessions provides greater consumption insurance than increasing the level of benefits, and unsecured credit intensifies the differences between the two policies. Figure 4 depicts the CE welfare gains associated with each policy, and it shows the difference, which is the amount of lifetime consumption households with the *Increasing Level* policy would trade to get the *Extending UI* policy. The welfare gains from counter-cyclical UI extensions are almost three times larger than those for an equivalent increase in the level of benefits. Furthermore, the difference in welfare gains between the two policies is larger in the model with credit. Households would trade 0.035% of lifetime consumption to switch policies in the benchmark model with unsecured credit and only 0.026% in the counterfactual economy with no borrowing.

In addition to Ganong and Noel (2019), the result showing that UI extensions provide greater consumption insurance than increasing the level of benefits is related to results from Gerard and Naritomi (2021). They find that five months of UI benefits provide greater consumption insurance than equivalent severance payments regardless of whether the severance is paid out in lump-sum at layoff or monthly installments over five months. UI provides greater insurance than severance in part because the payments are conditional on a worker remaining unemployed. Severance is paid to all workers who lose their job, meaning that the government must make a smaller transfer to each individual. This is one of the main driving forces for my results on counterfactual policies as well. Transfers made through extended benefits programs are conditional on a worker remaining unemployed for more than six months, whereas an increase in the level of benefits is paid to all unemployed workers. The main difference in my analysis from previous papers is the presence of unsecured credit, which I show intensifies the difference between the two policies.

I also find that extending the duration of UI during recessions has a larger impact on aggregate fluctuations than increasing the level of benefits. Table 6 details how the policy that increases the level of benefits during recessions impacts the average peak-to-trough change in consumption and unsecured credit balances over the business cycle. The

Table 6: Peak-to-Trough Declines: Increasing Level of UI

	Benchmark		No Credit	
	C	D	C	D
Acyclical UI (%)	2.62	10.11	1.89	0.00
Increasing Level (%)	2.48	9.56	1.80	0.00
Difference (pp)	0.14	0.55	0.09	0.00

Note.— Peak-to-trough fall in aggregate consumption (C) and credit balances (D) averaged over all recessions in a 2000 period simulation. Peak is the period before a recession starts. Simulation results are in logs and HP filtered with a smoothing parameter of 1600. Benchmark is the economy with unsecured credit and No Credit is the economy with no borrowing. *Increasing Level* is a policy that increases the level of UI benefits by 6% during recessions.

Increasing Level policy reduces the average fall in aggregate consumption during recessions by 0.14pp. By comparison, the *Extending UI* policy reduced the average fall in aggregate consumption by 0.42pp. You see a similar result when looking at fluctuations in unsecured credit balances. The *Increasing Level* policy reduces the fall in credit balances by 0.55pp, compared to the 2.01pp reduction from the *Extending UI* policy.[34] These results begin to highlight why unsecured credit amplifies the differences between the two policies. There is a much smaller contraction in aggregate credit balances with UI extensions meaning that households are using more credit to help smooth consumption throughout the recession. Furthermore, the impact of counter-cyclical UI policies on credit fluctuations could be of independent interest for financial markets. My results suggest that extending the duration of UI during recessions can play a significant role in stabilizing financial markets over the business cycle by mitigating fluctuations in unsecured credit balances. However, more work would need to be done to fully quantify the importance of these policies for financial stability, so I leave it for future work.

Unsecured credit amplifies the difference between these policies through both the supply side and the demand side. On the supply side, panel (b) in figure 6 shows that there is a smaller drop in the average borrowing limit offered by financial intermediaries during a recession when the government extends the duration of UI. Intermediaries are concerned that indebted households will be forced to default if they do not find a job before UI expires, so

34. Appendix **??** also shows that this results holds when looking at the total deviation in aggregate variables, as opposed to the peak-to-trough change

benefit extensions allow lenders to supply more credit. Therefore, more credit is available to smooth consumption throughout a recession with the *Extending UI* policy, which further improves the consumption-smoothing benefits. On the demand side, households have less of an incentive to delever for precautionary reasons when the government extends the duration of UI. This precautionary deleverage channel operates in similar way to a standard precautionary savings motive present in models with forward-looking agents with one important difference: when income risk is high, indebted households have an incentive to delever to avoid the penalties associated with a bankruptcy, in addition to the standard incentive to smooth future consumption. Increasing the level of benefits has a smaller impact on consumption because households use a significant share of the transfers to delever to avoid a future default.

It is unclear if the precautionary deleverage channel is at odds with micro data estimates from the literature. Gerard and Naritomi (2021) and Ganong et al. (2023) both show that unemployed workers fail to smooth consumption when receiving a transitory increase in income during a persistent decline in earnings associated with an unemployment spell. This suggests limited forward-looking behavior. However, the papers do not directly estimate whether highly indebted households use the transitory increase in income to delever to avoid a future default. Also, my model suggests that households exhibit less forward-looking behavior when they expect the government to extend the duration of UI during recessions, which is the case in the US. Directly testing the precautionary deleverage channel in micro data is out of the scope of the current paper, so I leave it for future work.

6 Conclusion

Since 1970, the UI program in the US has been counter-cyclical in the sense that the duration of benefits is automatically extended by 13 weeks when unemployment is high. Throughout the tenure of this policy, there has been an unprecedented rise in the magnitude and extent of unsecured debt. It is theoretically ambiguous whether unsecured credit amplifies or dampens the effectiveness of these UI policies. The objective this paper was to answer this question using a quantitative real business cycle model calibrated to the US economy.

(a) Aggregate Debt Balance (b) Average Borrowing Limit

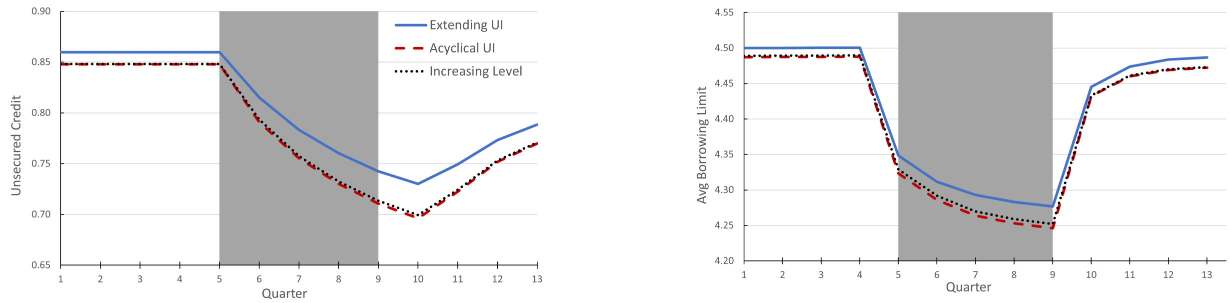


Figure 6: The Impact of UI Policies on Unsecured Credit

Note.— A five period recession starting in quarter 5. This corresponds to period 1301 in the aggregate simulation. Panel (a) is the aggregate debt balance and panel (b) is the average borrowing limit across households with good credit. *Extending UI* is a policy that extends the average duration of UI from 2 to 3 quarters during recessions. *Increasing Level* increases the level of UI benefits by 6% during recessions.

There are three main results from the paper. First, unsecured credit amplifies the effectiveness of counter-cyclical extensions in the duration of UI both in terms of household welfare and in terms of smoothing aggregate fluctuations. Extending the duration of UI limits the contraction in the supply of unsecured credit by insuring households against default risk, which further enhances the consumption smoothing benefits of the policy. Second, the main result of the paper flips, and credit dampens the effectiveness of UI extensions in a stationary economy with no aggregate risk. Without aggregate risk and business cycle fluctuations, households can readily substitute between UI and credit for consumption-insurance, which limits the gains from extending the duration of benefits. Third, UI extensions are more effective at stabilizing aggregate fluctuations than an equivalent increase in the level of benefits during recessions, and unsecured credit magnifies the differences between the policies. When the government increases the level of benefits, indebted households have an incentive to delever to insure themselves against the possibility of a prolonged unemployment spell instead of increasing their consumption.

The results of this paper come from an incomplete markets general equilibrium real business cycle model with frictional labor markets and defaultable debt. The model endogenously generates revolving credit balances that are highly volatile and pro-cyclical as in the data using empirically consistent fluctuations in unemployment risk. Job finding rates drive a larger share of aggregate fluctuations than job separation rates or total factor productivity.

These results suggest that a recession driven by low job finding rates should have a larger contraction in aggregate demand than a recession driven by high job separation rates, even if the change in unemployment is the same.

Given the recent surge in Heterogeneous-Agent New Keynesian (HANK) models, future research should analyze how the channels studied in the current paper impact the transmission of monetary policy. Kaplan, Moll, and Violante (2018) showed that most of the transmission of monetary policy occurs through indirect effects on labor demand. A key driving force to generate this result is the presence of high MPC hand-to-mouth households who face high borrowing costs. It is essential to understand how the transmission of monetary policy is affected by the presence of unsecured credit that is highly volatile and pro-cyclical because in this setting the costs of borrowing are increasing and borrowing constraints become tighter during recessions. Also, the results from my paper suggest that a change in labor demand could have significantly different aggregate implications depending on if it is being transmitted through a change in hours worked, layoffs, or vacancy posting by firms. I leave these analyses for future research.

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Appendix

A Model Parameters

Table 7: Model Parameters

	Description	Parameter	Value
	Risk Aversion	σ	2.00
	Capital Share	α	0.35
	Income Tax	τ	0.30
	Duration Bad Credit	θ	0.03
	Earnings Persistence	ρ	0.99
	Earnings SD	σ_η	0.10
	Patient Discount	β_h	0.99
	Impatient Discount	β_ℓ	0.86
	Share of Patient	π_ℓ	0.50
	Bankruptcy Disutility	χ_b	1.20
	Credit Markup	ι	0.02
	Work Disutility	χ_w	0.14
	Search Disutility	χ_s	0.14
	Capital Depreciation	δ	0.02
	Share Age 1 Workers	Φ_E	0.86
	Transfer	T	0.35
	Retirement Transfer	T_R	1.39
	UI Replacement Rate	υ_r	0.50
	UI Max Benefit	$\overline{\upsilon}$	1.67
Expansion Values	TFP	$z(x_g)$	1.00
	Separation Rate	$\xi(x_g)$	0.04
	Finding Rate	$\lambda(x_g)$	0.65
	UI Duration	$\upsilon_d(x_g)$	0.50
Recession Values	TFP	$z(x_b)$	0.97
	Separation Rate	$\xi(x_b)$	0.05
	Finding Rate	$\lambda(x_b)$	0.48
	UI Duration	$\upsilon_d(x_b)$	0.33

B Data

NBER recession dates are used to pin down the aggregate transition matrix of the model economy. There are 5 recessions that occur between 1980Q1 and 2019Q4. The average duration of a recession over this time-period is 4.6 quarters. The average duration of the expansions that lie between these recessions is 27.4 quarters. An alternative way of mapping the model to the data would be to combine the 1980 and 1981 recessions. The justification for doing so is that unemployment rates never fell during the short-lived expansion at the end of 1980. If these recessions were combined, then the persistence of recessions would increase from 0.78 to 0.82. The corresponding persistence of expansions would increase from 0.96 to 0.97. Constructing the aggregate transition matrix using 4 recessions as opposed to five does not have a significant impact on the results of this paper.

Table 8: Peak and Trough Quarters in US

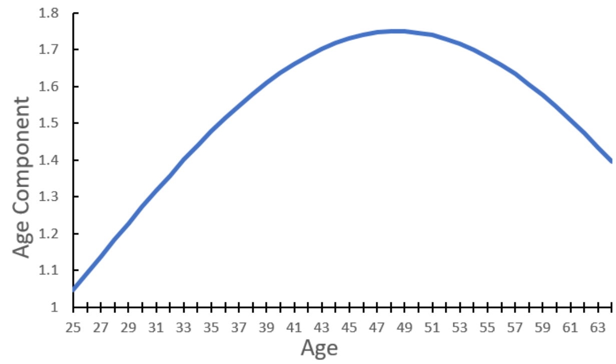
Peak	Trough	Quarters
1980Q1	1980Q3	3
1981Q3	1982Q4	6
1990Q3	1991Q1	3
2001Q1	2001Q4	4
2007Q4	2009Q2	7

The Survey of Consumer Finances (SCF) is used to pin down the hump-shaped life cycle earnings profile in the model economy. The age-component of productivity takes the form $\gamma_j = \nu_1 j + \nu_2 j^2$. To estimate the age-component of earnings in the data, I regress log earnings on age, age-squared and numerous control variables. Earnings in the estimation is income from wages plus two-thirds of business income. The control variables include, sex of the head of household, race, education, education of the spouse and multiple dummy variables for occupation types. Estimating the equation for γ_j in every survey year from 1989 to 2019, the average values for the coefficients are $\nu_1 = 4.6e^{-2}$ and $\nu_2 = -9.4e^{-4}$. This setting causes households to experience hump-shaped earnings where they earn more each year through age 49 (model period 96). After this age, there are decreasing earnings each year until retirement.

The SCF is also used to calculate the share of households with unsecured credit balances. Specifically, I calculate two different statistics: the debt share and the credit share. Debt share is the fraction of households who report having positive balances of credit card debt after making their last payment. Credit share is the fraction of households who have at least one credit card account. To calculate both moments, I focus on bank credit cards (Visa,

Figure 7: Age-Component of Earnings

Survey Year	ν_1	ν_2
1989	$5.72e^{-2}$	$-1.24e^{-3}$
1992	$4.42e^{-2}$	$-8.91e^{-4}$
1995	$4.11e^{-2}$	$-7.55e^{-4}$
1998	$5.07e^{-2}$	$-1.02e^{-3}$
2001	$4.15e^{-2}$	$-9.00e^{-4}$
2004	$4.27e^{-2}$	$-8.18e^{-4}$
2007	$4.11e^{-2}$	$-8.56e^{-4}$
2010	$4.70e^{-2}$	$-9.54e^{-4}$
2013	$4.98e^{-2}$	$-1.07e^{-3}$
2016	$4.86e^{-2}$	$-1.01e^{-3}$
2019	$3.95e^{-2}$	$-7.86e^{-4}$
Average	$4.58e^{-2}$	$-9.36e^{-4}$



Note.— Data from the Survey of Consumer Finances. Age-component of earnings takes the form $\gamma_j = \nu_1 j + \nu_2 j^2$. Earnings in the data is income from wages plus two-thirds of business income. Each coefficient is significant to 1.0%.

Mastercard, etc...) and observations where the head of the household is currently in the labor force. I choose to restrict attention to households in the labor force because workers who are out of the labor force are not eligible for UI. The average share of households with positive balances of credit card debt is 41.4% and the average share of households with at least one credit card is 69.2%.

Data organized by the Bureau of Labor Statistics (BLS) from the Current Population Survey (CPS) is used to pin down unemployment dynamics in the model economy. Monthly data from the CPS on employment, unemployment, and short-term unemployment (5 weeks or less) is used to calculate job separation rates and job finding rates. Job separation rates are calculated in continuous time using the methodology described in Shimer (2012), who shows that alternative methods that ignore the time aggregation problem overstate the importance of job separation rates in driving unemployment fluctuations over the business cycle. All statistics for job separation rates and job finding rates are quarterly averages of monthly data. To calculate business cycle properties, log data is HP filtered with a smoothing parameter of 1600. Detrended job separation rates have a standard deviation of 4.75 and a correlation coefficient with real GDP of -0.58. Job finding rates have a standard deviation of 7.68 and a correlation with real GDP of 0.83.

Table 9: Share of Households with Credit Card Debt

Survey Year	Debt Share	Credit Share
1983	27.44%	47.81%
1989	36.43%	61.15%
1992	40.06%	68.34%
1995	45.19%	71.77%
1998	43.91%	71.90%
2001	45.53%	77.15%
2004	46.74%	75.02%
2007	46.52%	72.27%
2010	39.13%	66.90%
2013	36.85%	66.64%
2016	43.60%	73.54%
2019	44.99%	77.74%
Average	41.37%	69.19%

Note.— Data from the SCF. Debt share is the share of households with debt after making their last payment. Credit share is share of households with at least one credit card. I restrict attention to households where the head is in the labor force.

C Forecasting Rules

To solve for an equilibrium with rational expectations, economic agents know the law of motion that governs the distribution of households. Forecasting an infinite-dimensional endogenous state variable causes a well-established computational problem for the heterogeneous-agent macro literature. This paper uses the state-space approximation method described in Krusell and Smith (1998). Specifically, the first moments for the distribution of capital and labor are used to approximate the distribution of households. These moments are sufficient to know the equilibrium prices in the model economy. Now, forecasting the future aggregate state of the economy is achieved by forecasting the future values capital and labor. Because all employment transitions take place after production, aggregate labor is known at the beginning of the period, and agents must only forecast future labor.

$$K'(x) = \nu_0^k(x) + \nu_1^k(x)\log(K) + \nu_2^k(x)\log(L) \tag{16}$$

$$L'(x) = \nu_0^\ell(x) + \nu_1^\ell(x)\log(L) + \nu_2^\ell(x)\log(K) \tag{17}$$

Table 10: Coefficients for Forecasting Rules

	ν_0	ν_1	ν_2	R^2	Max Res.	Mean Res.
$K'(x_g)$	0.037	0.985	0.073	0.999	$3.38e^{-4}$	$5.38e^{-5}$
$K'(x_b)$	0.032	0.986	0.077	0.999	$4.32e^{-4}$	$8.30e^{-5}$
$L'(x_g)$	0.388	0.321	-0.055	0.993	$7.49e^{-4}$	$1.42e^{-4}$
$L'(x_b)$	0.251	0.491	-0.036	0.998	$6.97e^{-4}$	$2.39e^{-4}$

Note.— Coefficients for the forecasting rules described by equations (16) and (17). Results obtained using a 2300 period simulation, dropping the first 300 periods.

Equations (16) and (17) describe the forecasting rules for the first moments of capital and labor. The coefficients depend on the aggregate exogenous state of the economy x. Therefore, agents have a set of forecasting rules during expansions and a set of rules during recessions. Solving for an equilibrium in the model economy proceeds as follows. I first guess a set of values for the coefficients in the forecasting rules. I then solve for the optimal decision rules of households at each possible point in the state space. Using the decision rules, I simulate the distribution of households for a sequence of fluctuations in the aggregate exogenous state.[35] I calculate the first moments for the distributions of capital and labor in each period of the simulation. Given the sequences for capital and labor, I regress future capital and labor realizations using the reduced form equations described by (16) and (17). Finally, I update the guesses for the coefficients of the forecasting rules and iterate until convergence.

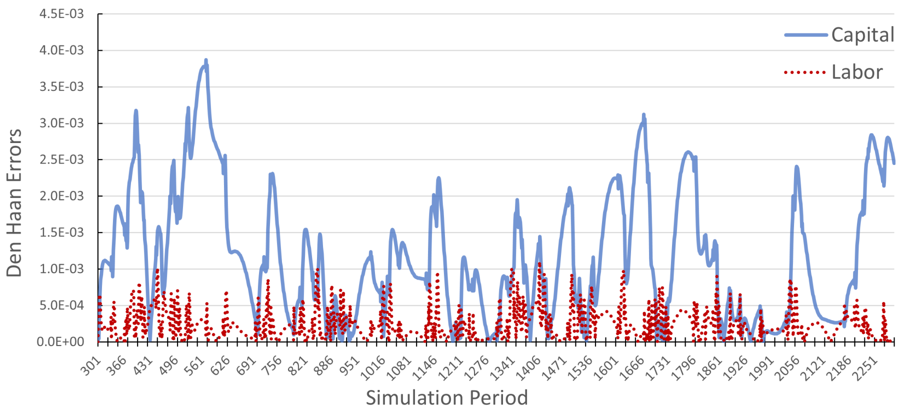
Table 10 details the coefficients for the forecasting rules in the benchmark model economy.[36] As described in Krusell and Smith (1998), there is no functional form for the forecasting rules that guarantees an equilibrium solution with rational expectations. To check if the forecasting rules approximate the law of motion with sufficient accuracy, I calculate the R^2 values and the residuals. The chosen functional form proves to have high accuracy, accounting for over 99% of the fluctuations in capital and labor, with maximum residuals all less less than $8.0e^{-4}$.

To further check the accuracy of the forecasting rules, I use multi-period ahead forecasting errors. Specifically, I simulate capital and labor for 2300 periods using the initial values

35. In practice, I simulate the economy for 2300 periods, and I drop the first 300 periods before proceeding to the next step.

36. Each experiment has its own set of forecasting rules. I only report the coefficients for the benchmark economy to minimize the space used for the table.

Figure 8: Multi-period ahead forecasting errors



Note.— Calculated as the difference between simulated model data, and aggregate capital and labor values obtained by simulating the forecasting rules for the same number of periods.

for capital and labor, and the forecasting rules described by equations (16) and (17). The error in each period is the difference between these sequences and the values for capital and labor from the simulated model economy. Den Haan (2010) suggests evaluating accuracy using the maximum error from the multi-period ahead forecasting test. In this model economy, the maximum error for capital is 0.38% and the maximum error for labor is 0.11%. To assess the accuracy of this model relative to the literature, I compare the errors with the two models used in Krusell and Smith (1998). In their benchmark model, the maximum error is 0.3%. In their stochastic beta model, the maximum errors is 2.0%. By comparison, the model economy in my paper proves to be highly accurate.

D Welfare with Separable Preferences

This section derives the analytical expression for consumption-equivalent (CE) welfare described by equation (15). The welfare expression is generalized to the class of separable preferences with CRRA utility functions for consumption. The main advantage of having an analytical expression for welfare is that it requires no additional computational burden. A numerical calculation of CE welfare could be quite cumbersome in a heterogeneous-agent model with a large state space.

The welfare calculation is the share of lifetime consumption which equates the household value function across two regimes. Let V be the value function for a household in the benchmark model economy. Similarly, $\tilde{V}$ is the value function in the alternative model economy. For the rest of this section, I assume that the benchmark economy has the *Extending UI* policy, and the alternative economy has the *Acyclical UI* policy. Equation (18) describes the household value function in state $(\Psi_j; \Omega)$. For generality, I define $v(x_i)$ to be the utility of all model elements that are not consumption; in the current model, v is the utility costs of work, search, and filing for bankruptcy. In order to calculate CE welfare, we must differentiate between the household's value function and the value of expected future consumption. Let V_c be the value of expected future consumption streams. Similarly, $\tilde{V}_c$ is the value of consumption streams with the *Acyclical UI* policy.

$$V(\Psi_j; \Omega) = E_j \sum_{i=j}^{J} \beta^{i-j} \left[u(c_i) + v(x_i) \right] \tag{18}$$

$$V_c(\Psi_j; \Omega) = E_j \sum_{i=j}^{J} \beta^{i-j} \, u(c_i) \tag{19}$$

Equation (20) describes the share of lifetime consumption $\omega(\Psi_j; \Omega)$ that makes the household indifferent between the two regimes. Let $\tilde{c}$ be consumption in the economy with the *Acyclical UI* policy.[37] Absent an analytical expression for ω, you must solve equation (20) numerically. To begin the derivation, add the expected value of consumption streams in the alternative model economy to each side of equation (20). Then, rearrange terms and substitute $\tilde{V}$ and $\tilde{V}_c$ into the equation. Finally, factor $(1+\omega)^{1-\sigma}$ out of the consumption stream and solve for ω. This final step is standard in analytical calculations of CE welfare with CRRA preferences. What differs from the standard calculation is the separable preferences. With separable preferences, it is necessary to save the value of consumption streams and rearrange terms before solving for ω.

$$E_j \sum_{i=j}^{J} \beta^{i-j} \left[u\Big(\big(1 + \omega(\Psi_j; \Omega)\big) \tilde{c}_i \Big) + v(\tilde{x}_i) \right] = V(\Psi_j; \Omega) \tag{20}$$

37. Let $v(\tilde{x})$ be the utility costs of work, search, and filing for bankruptcy in the economy with the *Acyclical UI* policy.

$$E_j \sum_{i=j}^{J} \beta^{i-j} \left[u\Big(\big(1+\omega(\Psi_j;\Omega)\big)\tilde{c}_i\Big) + v(\tilde{x}_i)\right] + E_j \sum_{i=j}^{J} \beta^{i-j}\, u(\tilde{c}_i) = V(\Psi_j;\Omega) + E_j \sum_{i=j}^{J} \beta^{i-j}\, u(\tilde{c}_i)$$

$$E_j \sum_{i=j}^{J} \beta^{i-j} \left[u\Big(\big(1+\omega(\Psi_j;\Omega)\big)\tilde{c}_i\Big) + u(\tilde{c}_i) + v(\tilde{x}_i)\right] = V(\Psi_j;\Omega) + \tilde{V}_c(\Psi_j;\Omega)$$

$$E_j \sum_{i=j}^{J} \beta^{i-j}\, u\Big(\big(1+\omega(\Psi_j;\Omega)\big)\tilde{c}_i\Big) + \tilde{V}(\Psi_j;\Omega) = V(\Psi_j;\Omega) + \tilde{V}_c(\Psi_j;\Omega)$$

$$\big(1+\omega(\Psi_j;\Omega)\big)^{1-\sigma}\tilde{V}_c(\Psi_j;\Omega) = V(\Psi_j;\Omega) - \tilde{V}(\Psi_j;\Omega) + \tilde{V}_c(\Psi_j;\Omega)$$

$$\therefore \quad \omega(\Psi_j;\Omega) = \left[\tfrac{V(\Psi_j;\Omega) - \tilde{V}(\Psi_j;\Omega) + \tilde{V}_c(\Psi_j;\Omega)}{\tilde{V}_c(\Psi_j;\Omega)}\right]^{\frac{1}{1-\sigma}} - 1$$

I now compare CE welfare described by equation (15) to two alternative calculations of welfare. The first alternative calculation is what I call the standard method, which is described by the equation for ω_s below. The standard method is consumption-equivalent in a model with only CRRA utility for consumption. When there are separable preferences over leisure, this calculation is no longer consumption-equivalent. The second alternative calculation is what I call *consumption only* welfare, which is described by the equation for ω_c below. This calculation is specifically calculating the share of lifetime consumption that equates the value of future consumption streams between the two regimes. However, the *consumption only* calculation ignores the effects of leisure and the utility costs of default.

$$\omega_s(\Psi_j;\Omega) = \left[\frac{V(\Psi_j;\Omega)}{\tilde{V}(\Psi_j;\Omega)}\right]^{\frac{1}{1-\sigma}} - 1; \qquad \omega_c(\Psi_j;\Omega) = \left[\frac{V_c(\Psi_j;\Omega)}{\tilde{V}_c(\Psi_j;\Omega)}\right]^{\frac{1}{1-\sigma}} - 1$$

In table 11, I replicate the results from figure 4 using the three different calculations of welfare. Regardless of the welfare calculation, the main qualitative result of this paper holds: unsecured consumer credit amplifies the welfare gains of a policy which extends the duration of UI during recessions. Moreover, the *consumption only* welfare calculation gives very similar quantitative results to the CE calculation. However, the quantitative results differ non-trivially when you use the standard method of calculating welfare. The standard method says that households would need 0.041% of lifetime consumption to be indifferent between the who polices; the CE welfare calculation says households would need 0.054%.

Table 11: Comparing Difference Welfare Calculations

	Benchmark			No Credit		
	(A)	(B)	(C)	(A)	(B)	(C)
Patient HHs	0.027	0.027	0.021	0.028	0.028	0.022
Impatient HHs	0.080	0.083	0.061	0.057	0.057	0.044
All HHs	0.054	0.055	0.041	0.043	0.043	0.033

Note.— Welfare effects of the policy which extends the duration of UI by 13 weeks during recessions. All results are percentages. Benchmark is the economy with unsecured credit. No Credit is the economy with no borrowing. (A) is CE Welfare, which is calculated by equation (15); (B) is the consumption only calculation, which is the equation for ω_c; (C) is the standard calculation, which is the equation for ω_s.