Can the Unemployed Borrow? Implications for Public Insurance*

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Abstract

We show that individuals maintain significant access to credit following job loss. Unconstrained workers who lose their jobs borrow, while constrained workers who lose their jobs default and delever. Both default and borrowing allow unemployed workers to smooth consumption, and they pay an interest rate premium to do so, i.e. the credit market acts as a limited *private* unemployment insurance market. We show theoretically that a credit-registry and long-term credit relationships allow credit markets to serve as a market for private unemployment insurance, despite adverse selection. We then ask, given current U.S. credit access, what is the optimal provision of public unemployment insurance? We find that the optimal provision of public insurance is unambiguously lower as credit access expands. The median individual in our simulated economy would prefer to have the income replacement rate from public unemployment insurance lowered from the current US policy of 42% to 38%. However, a utilitarian planner would actually prefer to raise public unemployment insurance relative to current US levels.

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We examine credit access as well as the borrowing behavior of unemployed individuals and the impact of credit and borrowing on the provision of public unemployment insurance. Using newly linked administrative earnings and credit bureau data, we show that borrowers retain significant credit access after job loss. We document that unconstrained workers who lose their jobs borrow, while constrained workers who lose their jobs delever and default. Both borrowing and defaulting allow job losers to transfer resources across time and states of the world, i.e. credit markets serve as a form of private unemployment insurance.

Our theoretical contribution is to show that long-term relationships and reputation concerns allow credit markets to act like private unemployment insurance markets, despite various forms of asymmetric information. Our model integrates adverse selection in the credit market (e.g. Guerrieri, Shimer, and Wright [2010], Chang [2010], Corbae and Glover [2017]) into an environment with credit lines (e.g. Mateos-Planas and Ríos-Rull [2010]) and employment risk (e.g. Moen [1997], Burdett et al. [2001], and Menzio and Shi [2011]). We then use this new framework to calculate the optimal public provision of unemployment insurance given current U.S. credit access. After estimating our model to match aggregate moments on credit access and credit use, we find that the median voter in our simulated economy would vote for a 38% replacement rate, which is lower than the current US replacement rate of 42%. However, the utilitarian planner would opt to raise the public provision of unemployment insurance. Limiting the ability to substitute out of public insurance and into private borrowing is that default rates rise and credit markets contract if public insurance is cut. Therefore, moderate levels of public insurance complement and sustain credit access among the unemployed.

Using administrative earnings records merged with a random sample of credit reports we establish 4 facts: (i) prior to displacement, workers who lose their jobs can replace a significant fraction of their prior income with unused credit (on average, 43% with unused revolving credit), (ii) credit limits and credit scores do not immediately respond to job loss and do not decline in an economically significant manner up to five years following job loss, (iii) unconstrained individuals, those with credit scores in the top two quintiles prior to job loss, borrow and replace a significant fraction of lost earnings with credit, and (iv) constrained individuals, who have credit scores in the bottom two quintiles prior to job loss, default and delever.

These facts suggest that the credit market acts like a *private* unemployment insurance market whereby unemployed workers can borrow and default to offset income losses. An insurance contract is an equitable transfer of risk: individuals pay premiums in good states of the world in order to receive resources in bad states of the world. In the credit market, individuals pay premiums when they borrow on their credit card, i.e. a spread over the risk free rate, which reflects default risk. In bad states of the world, such as when a borrower loses their job, borrowers may default to smooth consumption. From the perspective of the lender, default transfers resources to the borrower in bad states of nature. This type of transfer is, by definition, insurance. Similar to Zame [1993], borrowing and default partially complete the market, allowing individuals to imperfectly mimic contracts which transfer resources to bad states of nature.

How can the credit market act like a private unemployment insurance market? The prior literature has argued that a private market for unemployment insurance does not exist due to private information about search effort and future job loss (e.g. Chiu and Karni [1998] and Hendren [2015]). Our theory is that there are two reasons that credit markets act as a limited market for private unemployment insurance: (i) there is a credit registry which generates reputation concerns (e.g. exclusion from credit markets in the event of default, as well as stigma), and (ii) lenders issue long-term contracts (e.g. revolving lines of credit such as credit cards, etc.) whose limit and interest rate are not contingent on subsequent income changes. Despite adverse selection, lenders are still willing to offer credit contracts to individuals both before job loss and after job loss because reputation concerns ensure that most agents will repay their debts.

We quantitatively evaluate our theory using a defaultable debt model with unemployment risk. The innovation relative to existing studies is to integrate a theory of credit lines and unemployment risk into an environment with asymmetric information in the credit market. In a model without credit lines, where debt is individually priced each period, unemployed agents would face a sudden change in borrowing limits, which is inconsistent with the facts we establish. By modeling credit lines, we are able to capture the stability of credit limits following job loss, and thus capture the degree of self-insurance provided by credit markets. In addition, we consider different forms of asymmetric information in the credit market, including private information about discount factors and the future probability of job loss.

We calibrate the model to be consistent with current U.S. credit access. We then compute the optimal public provision of unemployment insurance under two different welfare criteria: (i) utilitarian and (ii) median welfare. Under both welfare criteria, we find that the optimal provision of public insurance is unambiguously lower as credit access expands. We find that the median voter in our simulated economy would prefer to have the earnings replacement rate of public insurance lowered from the current US policy of 42% to 38%. However, a utilitarian planner would actually prefer to raise the UI replacement rate to 54%. The inability of the planner to fully substitute out of public insurance reflects two tradeoffs. With a lower replacement rate, fewer taxes need to be raised to fund the unemployment insurance system. However, if the unemployment insurance replacement rate becomes too low, the default rate of workers who lose their jobs increases and credit access among the unemployed drops sharply. For the median household in our economy, these competing forces are balanced at a replacement rate of 38%.

We add to the recent studies that have integrated credit markets into models with labor markets (e.g. Athreya and Simpson [2006], Herkenhoff [2013], Bethune et al. [2013], Bethune [2017]). The most closely related paper is by Athreya and Simpson [2006] who compute the responsiveness of bankruptcies to public insurance provisions, showing that more generous unemployment insurance may actually raise bankruptcies. There are four key differences between our exercises: (i) we show that the private market for UI exists despite adverse selection and asymmetric information, (ii) we model long-term credit contracts which allows us to match the degree of private insurance provided by the credit market, (iii) we calculate an optimal unemployment insurance policy, and (iv) our labor market is in general equilibrium, and thus wages and job finding rates are endogenous.

Our model contributes to a small but growing literature on individual credit lines, models of credit scoring, as well as the large literature on long-term relationships of individual borrowers with lenders.[1] Related work by Mateos-Planas and Ríos-Rull [2010] studies bankruptcy reform in an economy with credit lines and private information about endowments. We depart from their work in two ways: (i) we model the labor market, and (ii) we obtain tractability via competitive search over contracts.

Existing studies based on checking-account data and the Survey of Consumer Finances suggest that there is roughly zero net borrowing, on average, by workers who lose their jobs (e.g. Bethune [2017], Gelman, Kariv, Shapiro, Silverman, and Tadelis [2015], Baker and Yannelis [2015], and Ganong and Noel [2015]), whereas direct questions about borrowing among workers who lose their jobs and other survey data imply that roughly 20% of the unemployed borrow (e.g. Sullivan [2008], Hurd and Rohwedder [2010], Herkenhoff [2013], and Collins et al. [2015]), and roughly 30% become delinquent on debt obligations (e.g. Hurd and Rohwedder [2010], Gerardi et al. [2015], and Herkenhoff et al. [2015]).[2] We reconcile these results by showing that some job losers borrow, while other job losers default and delever. While these offsetting forces yield zero net-borrowing by the unemployed, both the borrowers and defaulters are using credit to smooth consumption.

Our paper is also related to studies which integrate unemployment insurance into Bewley-Huggett-Aiyagari frameworks (e.g. Lentz and Tranaes [2001], Krusell et al. [2010], Nakajima [2012a], and Nakajima [2012b]) as well as studies of optimal unemployment insurance with assets (*inter alia* Shimer and Werning [2005], Chetty [2008], Lentz [2009], Koehne and Kuhn [2015] and Kolsrud et al. [2015]).[3] Of particular note are Shimer and Werning [2005] and Lentz [2009], who compute optimal UI in models with savings. Relative to these studies we make several contributions: (i) we show that credit markets function as private UI markets, (ii) we incorporate the institutions that allow this private UI market to exist in our model (unsecured credit, long-term contracts and exclusion from credit markets in the event of default), and lastly (iii) we quantify the substitutability between private and public forms of insurance.

[1]See Mateos-Planas and Seccia [2006], Mateos-Planas and Ríos-Rull [2010], and Mateos-Planas [2013] on models of credit lines; Chatterjee, Corbae, and Rios-Rull [2008a], Chatterjee, Corbae, and Rıos-Rull [2008b], and Chen [2012] on models of credit scoring; and Mitman [2011] and Hedlund [2011] for models on long term relationships between borrowers and lenders.

[2] Herkenhoff [2013] updates Hurd and Rohwedder [2010] through 2015 and shows that 25% of workers who lose their jobs increase their debt in response to job loss, and a similar fraction report delinquency. Likewise, small-sample surveys of bankrupt individuals cite job loss an important factor in their decision to file (Sullivan et al. [1999]). Aggregate data reveals countercyclical borrowing but also countercyclical default (e.g. Rocheteau et al. [2012], Nakajima and Ríos-Rull [2014], and Hundtofte and Pagel [2017]) which is consistent with the mechanisms in this paper.

[3]Our paper also complements studies on optimal UI over the business cycle (Mitman and Rabinovich [2011], Birinci and See [2017], and references therein).

Finally Hendren [2015] describes the current state of the literature on the existence of private unemployment insurance markets. Hendren [2015] shows that the pooled premium for private unemployment insurance given that individuals have private information about future job loss would be too high for anyone to actually use such a policy. A key difference is that Hendren [2015] focuses on two period models which abstract from the type of reputation concerns and long-run interactions present in our framework. However, our results are consistent with Hendren [2015] in the sense that the scope for private insurance is still quite limited, even with reputation concerns.

1 Empirics

Do the unemployed have access to credit? Do they borrow? Do they default? We answer these questions by studying time-series and cross-sectional credit market outcomes for workers who lose their jobs. To generate exogenous variation in employment we exploit mass layoff episodes as in Jacobson et al. [1993]. We first compare the average response of borrowing, credit limits, and scores across workers who lose their jobs versus those that do not. We find that workers who lose their jobs have significant amounts of credit access, and that credit access does not respond in an economically meaningful way to job loss. Our results show that the mean amount borrowed by workers who lose their jobs is approximately zero. We then explore the heterogeneity across borrowers. We show that the zero-net-borrowing result is driven by heterogeneity. Using the cross-section of workers who lose their jobs, we show that roughly 1/3 of workers who lose their jobs borrow, 1/3 default or delever, and roughly 1/3 do not alter their borrowing. We establish that unconstrained individuals, those with credit scores in the top two quintiles prior to job loss, borrow and replace a significant fraction of lost earnings with credit, and constrained individuals, who have credit scores in the bottom two quintiles prior to job loss, default and delever.

1.1 Data

Our main dataset is a randomly drawn panel of 5 million TransUnion credit reports linked through a scrambled social security number to the Longitudinal Employment and Household Dynamics (LEHD) database. The TransUnion database contains information on the balance, limit, and status (delinquent, current, etc.) across different types of consumer debt held by individuals at the annual frequency from 2001 through 2008. TransUnion also provides us with their "bankruptcy score," which is designed to measure the propensity for an individual to have a bankruptcy. The LEHD database is a matched employer-employee dataset covering 95% of U.S. private sector jobs. The LEHD includes quarterly data on earnings, worker demographic characteristics, firm size, firm age, and average wages. Our primary sample of employment records includes individuals with credit reports between 2001 and 2008 from the 11 states for which we have LEHD data: California, Illinois, Indiana, Maryland, Nevada, New Jersey, Oregon, Rhode Island, Texas, Virginia, and

Washington. Since job dismissal and reason of dismissal are not recorded in the LEHD, we follow Jacobson et al. [1993] and focus on mass layoffs. Unlike Jacobson et al. [1993] who focus on workers from Pennsylvania, who worked predominately in manufacturing, with 6 years of tenure before job loss, we focus on a representative cross-section of workers with just 3 years of tenure prior to job loss. We show that the bulk of earnings losses in our sample are temporary and that nearly 1/3 of the workers who lose their jobs immediately find a job that paid more than their prior job, and thus their earnings losses are purely temporary.[4]

Our analysis focuses on revolving credit because it can be drawn down immediately after job loss, with no additional applications or income checks, and it can be repaid slowly. The main components of revolving credit include bank revolving (bank credit cards), retail revolving (retail credit cards), finance revolving credit (other personal finance loans with a revolving feature), and mortgage related revolving credit. Appendix B includes an analysis of bank cards as well as total credit, each of which exhibit similar patterns to revolving credit. However, it is important to note that not all types of credit balances affect the budget constraints in the same way. A first mortgage *lowers* liquid resources on hand (buying a house involves handing money to the bank), whereas an increase in revolving debt augments liquid resources on hand. We also study the response of credit scores, delinquencies (30 days late and 60 days late), and chargeoffs to job loss.

1.2 Sample Description and Summary Statistics

We use two samples in this paper.

1. **Panel Sample:** Our first sample includes all individuals who were at a firm that underwent a mass layoff episode, who had at least 3 years of tenure at the time of the mass layoff and made at least $5,000 dollars at the firm in the prior year. These restrictions on tenure and prior earnings are common in the literature, e.g. Davis and Von Wachter [2011], and are used to mitigate issues associated with seasonal employment or weak labor force attachment. We split this sample into a treatment group of 31,000 individuals (to the nearest thousand) who were displaced as part of the mass layoff, and a control group of 30,000 individuals (to the nearest thousand) who were not displaced. We restrict our sample to individuals between the age of 18 and 64 in the year of mass layoff at their firm. We also require that individuals in the treatment group are never displaced as part of another mass layoff episode, and we

[4]It is worth noting that when we attempted to identify transitory vs. permanent earnings losses among mass-displaced workers based on ex-post wage outcomes, we saw similar borrowing and default patterns across the two groups. One theory for this result is that workers expect the shock to be temporary, and ex-post some workers are lucky and some are unlucky, but they exhibit similar borrowing patterns due to similar beliefs. To test this we look at credit inquiries prior to layoff, and we find similar patterns across the two groups, suggesting similar beliefs about future layoff outcomes. In a related paper, we use a filtering method to disentangle permanent and transitory earnings losses, and we show that the behavior is consistent with standard consumption smoothing models. Results available upon request.

require the control group is never displaced as part of a mass layoff event. This sample covers displacements in the years 2003-2007.

2. **Cross Sectional Sample:** Our second sample includes all individuals in the treatment group of the Panel Sample in the year of their displacement who had an earnings loss in that year. This sample of 21,000 individuals (rounded to the nearest thousand) covers the years 2003-2007.

Table 1 includes summary statistics for both samples. The top panel of Table 1 provides summary statistics for the treatment and control groups in the Panel Sample in the year prior to the mass layoff event. Annual earnings, as well as credit limits and balances are deflated by the CPI. Column (1) of Table 1 summarizes the treatment group while column (2) summarizes the control group. The treatment group earned $44k in the year prior to displacement while the control group earned over $49k. In the empirical analysis we include individual fixed effects, controls for age, and proxies for wealth to account for differences across treatment and control groups.

The treatment and control groups are very similar in terms of their credit market variables. Our measure of credit score is the TransUnion bankruptcy score. Rather than using a traditional credit risk score, we use the TransUnion bankruptcy score which is designed to be a measure of bankruptcy propensity. The bankruptcy score lies between 0 and 1000 and higher scores reveal lower odds of bankruptcy. Bankruptcy scores are used only by more sophisticated lenders, and when they are used, they are used in conjunction with a traditional credit risk score. The bankruptcy score is on a log scale, and thus reported means and averages must be adjusted accordingly. The treatment group has an average credit score in the year before displacement of 423, while the control group's average score is 434. Revolving credit balances, limits and unused limits to income are also very similar across treatment and control groups.

Individuals have substantial revolving credit limits in the year before job loss, with an average of nearly $27k for the treatment group. On average individuals in the treatment group can replace 43 percent of their income with unused revolving debt in the year before job loss.[5] The magnitude of unused credit prior to layoff indicates that, on average, these individuals have significant reserves of unused credit which can be drawn down when they enter into unemployment.

The second panel of Table 1 includes summary statistics for the Cross Sectional sample in the year of mass layoff. In the analysis that follows, we define credit constraints using the credit score. Table 1 shows that unused credit is monotone increasing by credit score quintile. Additionally, the table shows that in the year of mass layoff individuals maintain a substantial amount of unused revolving credit. Individuals with the highest credit scores have unused revolving credit equivalent to more than two times their income, while individuals in the second credit score quintile could replace 25 percent of their income with revolving credit.

[5]Note unused revolving credit to income is winsorized at the 1 percent level at the top and bottom of the distribution.

The summary statistics of Table 1 indicate that individuals have, on average, a large stock of credit prior to layoff. We next examine how individuals access and use of credit evolves following job loss.

1.3 Average Response of Earnings and Credit Following Job Loss

Our first approach is to estimate the average response of credit variables following job loss using a distributed lag framework as in Jacobson et al. [1993] around a mass layoff episode.[6] This empirical strategy compares displaced to nondisplaced individuals before and after the mass layoff episode to identify how individuals use credit following job loss.

Let i index individuals and t index years. Let α_i denote a set of individual fixed effects and γ_t denote year dummies. Let $Y_{i,t}$ denote the outcome of interest (such as real earnings, credit score, real revolving debt balance, etc.). Let $D_{x,i,t}$ be a dummy variable taking the value 1 when an individual is x periods before (if x is negative) or after (if x is positive) displacement. For example, $D_{-1,i,t}$ is a dummy variable indicating an individual is 1 period before displacement. The vector $X_{i,t}$ contains control variables, including year fixed effects, a quadratic in age, and deciles for lagged cumulative earnings. We include deciles for lagged cumulative earnings to proxy for an individual's wealth prior to displacement. The specification we use is of the following form:

$$Y_{i,t} = \alpha_i + \gamma_t + \sum_{j=-4}^{5} \beta_j D_{j,i,t} + \mathit{\Gamma} X_{i,t} + \epsilon_{i,t} \tag{1}$$

The objects of interest are $\beta_0, \beta_1, ..., \beta_5$, which summarize the impact of job loss on the outcome variable in the year of displacement and subsequent years. To examine the validity of the point estimates, we show that the treatment and control groups have parallel trends prior to displacement (i.e. $\beta_{-4}, \beta_{-3}, .., \beta_{-1}$ are not statistically different from zero).

Table 2 documents the average response of earnings and borrowing behavior following job loss. The coefficients in Table 2 correspond to $(\beta_{-4}, \beta_{-3}, ..., \beta_4, \beta_5)$ in equation 1, and are interpreted as the difference in the outcome variable between displaced and nondisplaced individuals. Figure 1 plots the coefficient estimates from Table 2 along with 95 percent confidence intervals.

Panel (a) of Figure 1 plots the differences in real annual earnings between displaced and non-displaced individuals. The figure shows that earnings losses following job loss are large and persistent. In the year of job loss a displaced individual makes nearly $3k less than a nondisplaced individual, and one year later this difference in earnings swells to nearly $14k. Five years after job loss a displaced individual still has earnings nearly $3k less than a nondisplaced individual. These large and persistent effects of job loss are consistent with prior studies, e.g. Jacobson et al. [1993] and Davis and Von Wachter [2011].[7]

[6] Appendix A includes details on the identification of mass layoffs.

[7] The increase in earnings of the treatment group relative to the control group prior to displacement is also

Panel (b) of Figure 1 shows the impact of job loss on an individual's credit score. The graph shows that displaced and nondisplaced workers exhibit parallel pretrends. However, in the year of displacement a displaced individual's credit score declines by 6.5 points, on average, relative to a nondisplaced individual. In the following year, the difference in credit scores for displaced and nondisplaced individuals is roughly 16 points. While statistically significant, these changes are economically small. The average credit score for an individual in the treatment group is 423 in the year prior to displacement. Relative decreases of 6 and 16 points, then represent less than a 1.5 percent and 4 percent decline in credit scores, respectively. An individual's credit score represents their marginal cost of borrowing. Therefore our results indicate that the marginal cost of borrowing is unresponsive to job loss.

Panel (c) of Figure 1 demonstrates that the stock of credit, not just the marginal cost of credit, is largely unresponsive to job loss. Panel (c) compares the revolving credit limits of displaced and nondisplaced individuals around a displacement episode. In the year of displacement an individual's credit limit decreases relative to a nondisplaced individual by \$925 on average. One year after displacement the difference in credit limits between displaced and nondisplaced individuals increases to just under \$1,700. In the year prior to displacement, individuals in the treatment group had on average a revolving credit limit of over \$27k. Thus, in the year of displacement the borrowing limit drops from \$27k to \$26k, on average. Hence, in the year of job loss it appears individuals maintain substantial lines of credit.

Panel (d) of Figure 1 measures the impact of job loss on borrowing. We choose to focus on revolving credit, since it can be drawn down immediately, without notice or further income verification, upon job loss. Panel (d) shows that displaced individuals do not borrow more than nondisplaced individuals, on average. This zero response of borrowing following job loss is consistent with the recent work of Gelman et al. [2015], Baker and Yannelis [2015], and Ganong and Noel [2015].[8] However, the cross-sectional analysis in Section 1.4 reveals that nearly two-thirds of workers who lose their jobs alter their balances upon job loss, and a significant fraction use the credit market to smooth consumption.

1.3.1 Default Following Job Loss

We now investigate whether individuals can use credit markets to relax their budget constraint by defaulting and refusing to make scheduled debt repayments. When a lender and borrower enter into a debt contract both sides know that there is a potential for the borrower to not repay the loan. Due to this default risk the lender charges a premium over the risk-free rate to the borrower. We can think of a debt contract as an *insurance* contract, since the borrower is paying a premium

observed in Davis and Von Wachter [2011].

[8] The results presented in Table 2 and Figure 1 include all types of revolving credit (HELOCs, etc.) rather than just credit cards. In Appendix B.2, we present results for credit card (bank card) balances as well as limits. The pattern of the results for credit card balances are nearly identical to revolving balances.

to have the option to not repay the loan in a future state of the world. In this scenario, the borrower exercises the insurance component of their debt contract when they default. Table 3 and Figure 2 document the propensity of individuals to exercise the insurance component of their debt contracts through default following job loss.

Panel (a) of Figure 2 shows the difference in the probability of having a 30 day delinquency within the past year for displaced and nondisplaced individuals around a mass layoff episode. In the year of displacement, the probability that a displaced individual has a 30 day delinquency is over 1.2 percentage points higher than a nondisplaced individual. One year after job loss, displaced individuals are 3.1 percent more likely to be 30 days delinquent.[9] Panel (b) of Figure 2 shows that workers who lose their jobs default on mortgage payments. In the year of displacement, a displaced individual is nearly 0.5 percentage points more likely to have a 60 days delinquency on their mortgage relative to a nondisplaced individual. One year after displacement, this difference expands to nearly 1 percentage point.

After a sufficient amount of time (typically 6 months) the creditor ceases to try to collect missing payments and they notify the credit bureau to "chargeoff" the debt. Panel (c) of Figure 2 shows the difference in the probability of having a debt chargeoff within the past year for displaced and nondisplaced individuals. Prior to job loss, displaced and nondisplaced individuals are not significantly different in their probability of having a debt chargeoff. However, in the year of job loss, the probability a displaced individual will have a debt chargeoff is nearly 0.9 percentage points higher than a nondisplaced individual. One year after displacement, the difference is nearly 3 percentage points.

After charging off a debt, the creditor can sell the debt obligation to a collection agency who will attempt to collect on the debt. The collection agency reports to the credit bureau, and the credit bureau flags individuals in collection. Panel (d) of Figure 2 displays the difference in the probability of having a debt enter into collections within the past 12 months for displaced and nondisplaced individuals around a mass layoff. In the year they are laid off, the probability a displaced individual enters collection is 1.2 percentage points higher than a nondisplaced individual. This represents a 10% increase relative to the average collection rate of 11.2 percent between 2001 and 2008.[10] Additionally, the effect of job loss on collections is very persistent. Four years after job loss, displaced individuals remain nearly 2 percentage points more likely to be in collections than nondisplaced individuals. The persistent emergence of collections following job loss indicates that individuals relax their budget constraint by missing debt payments following job loss for a substantial period of time.

The results presented in Table 3 and Figure 2 indicate that individuals use missed debt repay-

[9] These results are robust to using 60 or 90 day delinquencies. See Appendix B.2 for results on 60 day delinquencies.

[10] The share of consumers in collections comes from the Federal Reserve Bank of New York's Quarterly Report on Household Debt and Credit. Accessed from "https://www.newyorkfed.org/microeconomics/databank.html" on 6/14/2017.

ments and default in response to job loss. A striking feature of these results is their persistence. Two years after job loss individuals remain significantly more likely to have their outstanding debts charged off, and four years after displacement individuals continue to be in collections. This illuminates that despite not borrowing on average, credit market play a central role in an individuals response to unemployment. Additionally, these results show that credit markets provide can provide a means for displaced individuals to adjust through borrowing or default to their job loss.[11]

1.4 Heterogeneous Response: Credit Replacement Rates

We now explore the cross-sectional patterns of borrowing by workers who lose their jobs. Despite the fact that there is zero net borrowing following job loss, we show that roughly 1/3 of workers who lose their jobs borrow, 1/3 delever or default, and roughly 1/3 do not alter their borrowing patterns. Both defaulters and borrowers are using credit markets to smooth consumption.

To formalize the analysis of heterogeneous responses of borrowing to job loss, we measure *credit replacement rates* (hereafter the 'replacement rate'). The replacement rate is the ratio of an individual's change in their revolving debt balance to the change in their earnings in the year of displacement. Since the replacement rate is only defined for those with an earnings loss, we restrict our sample to individuals with an earnings loss in the year of displacement. We set the numerator in the replacement rate to the negative of the change in revolving debt to ease the interpretation. A replacement rate of 0.2 indicates that an individual who was displaced as part of a mass layoff and had an earnings loss replaced 20 percent of their lost earnings with revolving debt. A replacement rate of -0.3 indicates that an individual decreased their revolving debt by 30 percent of the income they lost in the year of displacement. Figure 3 presents a smoothed density of the replacement rates in our cross-sectional sample. The density exhibits significant variance, with some individuals replacing their entire earnings loss with revolving debt (replacement rate of 1) and some individuals who decrease their balances by the same magnitude as their entire earnings loss (replacement rate of -1).[12]

Our theory which we present later in Section 2, as well as existing theories, predict that credit constraints are an important determinant of the borrowing decision. To proxy for credit constraints, we separate individuals into credit score quintiles based on their credit score in the year prior to displacement.[13] Let $C_{y,i,t-1}$ be a dummy variable taking the value 1 when individual i is in credit score group y in year $t-1$ and will be displaced in year t. For example, $C_{3,i,t-1}$ is a dummy variable indicating an individual is in credit score quintile 3 one year before being

[11] See Appendix B.2 for additional average response results for measures of credit access, usage and default.

[12] In Appendix B.4, we show that the credit replacement rate for the unemployed measured in the 2007-09 SCF panel reveals a similar pattern of credit usage around job loss.

[13] Note the credit score quintiles are defined among all displaced individuals with an earnings loss in the year of displacement.

displaced in year t. Let $RR_{it} = \frac{-\Delta debt_{it}}{\Delta earnings_{it}}$ denote the replacement rate for individual i who was displaced in year t, and had an earnings loss, i.e. $\Delta earnings_{it} < 0$. We then estimate the following regression on a cross sectional sample of individuals who were displaced and had an earnings loss:

$$RR_{it} = \lambda_1 + \lambda_2 C_{2,i,t-1} + \lambda_3 C_{3,i,t-1} + \lambda_4 C_{4,i,t-1} + \lambda_5 C_{5,i,t-1} + \gamma_t + \Phi X_{it} + \epsilon_{it} \tag{2}$$

The objects of interest are $(\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5)$. The coefficient λ_k for $k \geq 2$, gives the difference in replacement rates for individuals in the kth credit score quintile relative to individuals in the first credit score quintile, holding all else constant. The vector X_{it} contains controls variables, in particular year fixed effects, a quadratic in age, and deciles for lagged cumulative earnings.

To estimate the average replacement rate for an individual in the kth credit score quintile we take the average values of the control variables for individuals in the sample denoted by $\bar{X}_i$ and use the OLS coefficients in the following expression:

$$\hat{RR}_k = \hat{\lambda}_k + \hat{\lambda}_1 + \hat{\Phi}\bar{X}_i \tag{3}$$

The statistic $\hat{RR}_k$ can be interpreted as the average replacement rate for the kth group conditioning on the controls in X. Additionally, taking the difference between $\hat{RR}_k$ and $\hat{RR}_1$ returns the marginal effect at the mean of moving from credit score group 1 to credit score group k.

Table 4 documents the role that credit scores prior to displacement play in determining an individuals replacement rate. The coefficients in Table 4 correspond to $(\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5)$ in equation 2. The regressions that include controls contain year fixed effects, a quadratic in age, and deciles for lagged cumulative earnings. The second column of Table 4 documents significant differences in replacement rates across credit score quintiles.[14] Holding all else constant an individual in the fifth credit score quintile has a replacement rate that is 26.2 percentage points higher than an individual in the first credit score quintile.

Figure 4 displays the estimated replacement rate ($\hat{RR}_k$) by credit score quintile. The figure shows that average replacement rates are an increasing function of credit score quintile. Individuals in the bottom two credit score quintiles reduce their revolving debt balances while individuals in the top three credit quintiles replace earnings losses with revolving debt.

The magnitude of the replacement rates for individuals in the top two credit score quintiles are substantial. Individuals in the fourth credit score quintile have a replacement rate of nearly 14 percent, while individuals in the highest credit score quintile replace over 20 percent of their lost earnings with revolving credit. For comparison, in Section 3 we estimate in the PSID that total transfers to the unemployed replace, on average, 42% of lost earnings. Hence the amount of insurance that individuals with the highest credit scores obtain through increasing their revolving credit balances is equivalent to almost half of the amount of public insurance currently offered in

[14]Note the replacement rate used in the estimation of equation 2 is winsorized at the top and bottom of the distribution by 10 percent.

the US.

While replacement rates are easy to interpret and capture overall credit market use during job loss, replacement rates may be driven by factors other than earnings losses. For example, expectations about permanent and transitory losses, moving, and other life events. The section that follows isolates the portion of the replacement rate attributable to earnings losses.

1.5 Heterogeneous Response: Role of Earnings Losses

Our final approach is to estimate the heterogeneous responses of credit outcomes to earnings losses associated with job loss across individuals with different credit scores. Let $\Delta e_{i,t}$ be the change in earnings for an individual i who was displaced in year t and had an earnings loss. As above, let $C_{y,i,t-1}$ be a dummy variable taking the value 1 when individual i is in credit score group y in year $t-1$ and will be displaced in year t. Let $Y_{i,t}$ be the outcome variable of interest (such as the change in real revolving debt balances, or an indicator for a 60 day mortgage delinquency, etc.). The specification we use is of the form:

$$Y_{i,t} = \gamma_t + \eta + \mu \Delta e_{i,t} + \sum_{j=2}^{5} (\eta_j C_{j,i,t-1} + \mu_j C_{j,i,t-1} \times \Delta e_{i,t}) + \Psi X_{i,t} + \epsilon_{i,t} \tag{4}$$

The objects of interest are $(\mu, \mu_2, \mu_3, \mu_4, \mu_5)$. The coefficient μ summarizes the marginal change in borrowing for each dollar lost for individuals in the lowest credit score group, and the sum of the coefficients $\mu + \mu_j$ return the marginal effect for individuals in the jth credit score group.

1.5.1 Revolving Balance Results

Table 5 examines the impact of changes in earnings on changes in revolving credit balances. Column (1) estimates the average relationship between changes in earnings and changes in revolving credit balances for individuals with an earnings loss in the year of displacement. The point estimate on the change in earnings is negative but insignificant, indicating that, on average, borrowing behavior for displaced individuals is not a function of the size of earnings losses. This result is consistent with the findings of Section 1.3 that individuals do not borrow following job loss on average. However, a zero average effect can mask heterogeneous responses across credit score groups.

In column (3) we separate individuals by their credit score in the year prior to job loss and estimate the effect of earnings losses on changes in revolving credit balances, while controlling for the year of layoff as well as age and proxies for wealth. Panel (a) of Figure 5 plots the marginal effect of an additional $10k earnings loss on revolving credit balances by credit score quintiles, and shows that the average response reported in column (1) of Table 5 masked heterogeneous responses across individuals with different credit scores. In particular, individuals with the highest credit scores *borrow* an additional \$490 ($490 = -10,000 \times [0.022 - 0.0709]$) for every \$10k of earnings lost during their unemployment spell. For individuals in lower credit score quintiles, changes in their revolving credit balances *are not* a function of their earnings losses, at the 5 percent significance level.[15] These results highlight that there is heterogeneity in the role that earnings losses play in an individual's borrowing behavior following displacement. Hence part of the heterogeneity in replacement rates observed in Figure 4 is attributable to differences across credit score groups in the response of revolving debt balances to earnings losses.

We plot the heterogeneous responses of several other outcomes, such as default and equity access.[16] Panel (b) of Figure 5 plots the marginal effect of an additional \$10k earnings loss on the probability of taking out a new home equity line of credit. The figure shows that the response of earnings losses on obtaining a new home equity line is heterogeneous by credit score quintile. For individuals in the lowest two credit score quintiles a decline in earnings *decreases* the probability that an individual takes out a new home equity line, while for individuals in the highest credit score quintile a decline in earnings *increases* the probability of taking out a new home equity line. Panel (c) of Figure 5 plots the marginal effect of an additional \$10k earnings loss on the probability of having a 30 day delinquency. The figure shows that individuals in the second and third credit score quintiles see their probability of having a 30 day delinquency increase with greater declines in earnings. For an individual in the second credit score quintile, an additional \$10k earnings loss *increases* the probability of having a 30 day delinquency by 1.4 percentage points. Panel (d) of Figure 5 plots the marginal effect of an additional 10K earnings loss on the probability of having a 60 day mortgage delinquency by credit score quintile. The figure shows that a decline in earnings significantly impacts the propensity to have a 60 day mortgage delinquency for individuals in the bottom three credit score quintiles. For an individual in the lowest credit score quintile, an additional \$10k earnings loss *increases* the probability of having a mortgage delinquency by 0.739 percentage points. For individuals in the top two credit score quintiles earnings losses do not impact their probability of having a 60 day mortgage delinquency.

1.6 Taking Stock: Heterogeneous Responses

We document that across credit score quintiles there are significant differences in the role that earnings losses play in an individual's credit market response to displacement. Individuals in the highest credit score quintile increase their revolving credit balances and have higher uptake of new home equity lines in response to decreases in earnings. Conversely, individuals in the middle and bottom of the credit score distribution increase the use of default and delinquency in response to earnings losses associated with job loss. These results highlight that individuals are using credit

[15] With a p-value of just over 0.07, individuals in the third quintile *decrease* their revolving debt holdings by an additional \$383 ($383 = -10,000 \times [0.022 + .0163]$) for every \$10K of income lost. All other credit score quintiles are not significant at the 10 percent level.

[16] Appendix B.3 includes the full set of tables and point estimates underlying these graphs.

markets in response to job loss, but the manner in which they use credit markets depends upon their credit score prior to job loss.

2 Model

We quantify the optimal provision of public unemployment insurance in an environment where workers who lose their jobs have the degree of access to credit markets observed in the data. To do so, we develop an equilibrium labor search model with two key features (i) credit lines (e.g. Mateos-Planas and Ríos-Rull [2010]) and (ii) adverse selection in the credit market (e.g. Guerrieri, Shimer, and Wright [2010] and Chang [2010]). By modeling credit lines, we are able to replicate the non-responsiveness of credit access to job loss. An important conceptual point of the paper is that workers who lose their jobs can borrow in the credit market despite adverse selection. The reason is that there are long-term relationships and reputational concerns in credit markets (agents value future access to the credit market). To speak to the large literature on the non-existence of private-UI markets in the presence of adverse selection, we explicitly model asymmetric information in the credit market (we consider both private discount factor and future job loss heterogeneity, e.g. Chiu and Karni [1998] and Hendren [2015]). We show that while a private unemployment insurance market still exists, adverse selection limits the ability of the government to substitute out of unemployment benefits.

Time is discrete and runs forever. There is a continuum of households, potential risk-neutral lenders, and potential entrant firms. There are $T \geq 2$ overlapping generations of risk averse households that face idiosyncratic risk, similar to Menzio et al. [2012]. Each household lives T periods. Households have heterogeneous discount factors in the benchmark economy, and in Section 4.2, we consider the case of heterogeneous job layoff rates. Let β_i be a type i agent's discount factor, where $i \in \{H, L\}$ denote an agent's type and types are permanent. We set $0 < \beta_H < \beta_L < 1$, i.e. type L agents are more patient than type H agents. The share of type i agents in the economy is π_i. The information structure is such that firms observe, and may condition on, a household's type but lenders do not observe, and cannot condition on, a household's type. We elaborate on contracts and market structure in the paragraphs that follow.

At the start of each period, workers not matched with a firm direct their search over firms (e.g. Moen [1997], Burdett et al. [2001], and Menzio and Shi [2011]). Households then participate in an asset market where they make asset accumulation, borrowing, and default decisions. We assume that households must apply (i.e. search) for credit contracts at utility cost κ_S, and we let S denote the credit application policy function. Households maximize the present discounted value of utility over non-durable consumption (c) net of any utility penalties of default ($\psi_D D$) and application costs ($\kappa_S S$). Let t denote age and t_0 denote birth cohort. Then $c^i_{t,t+t_0}$, $D^i_{t,t+t_0}$, and $S^i_{t,t+t_0}$ respectively denote the consumption, default, and credit search decisions of a type i, age t

agent in period $t + t_0$. The objective of a household is to maximize

$$\mathbb{E}_{t_0}\left[\sum_{t=1}^{T}\beta_i^t\left(u(c^i_{t,t+t_0}) - \psi_D D^i_{t,t+t_0} - \kappa_S S^i_{t,t+t_0}\right)\right]$$

For the remainder of the paper we focus on a recursive representation of the problem.

In addition to types, households are heterogeneous along multiple dimensions. Households are either employed or unemployed, with employed value functions denoted W, and unemployed value functions denoted U. Let $e \in \{W, U\}$ denote employment status. Let $b \in \mathcal{B} \equiv [\underline{B}, \bar{B}] \subset \mathbb{R}$ denote the net asset position of the household, where $b > 0$ denotes that the household is saving, while $b < 0$ indicates that the household is borrowing. Let $h \in \mathcal{H} \equiv [\underline{h}, \bar{h}] \subset \mathbb{R}_+$ denote the human capital of a worker. Human capital is subject to idiosyncratic shocks, allowing us to match the borrowing patterns of both employed and non-employed agents. Workers also differ with respect to their piece-rate $\omega \in [0, 1]$ which denotes the share of their per-period match output that they receive as a wage. Households also differ with respect to their credit access $a \in \{C, N\}$, where $a = C$ denotes individuals with credit access who can borrow, and $a = N$ denotes individuals without credit access who are not able to borrow. Household that have credit access are heterogeneous in their borrowing limit $\underline{b} \in [\underline{B}, 0]$ as well as in their interest rate $r \in [\underline{r}, \bar{r}] \subset \mathbb{R}_+$.

Unemployed households direct their search for employment across vacancies which specify a fixed piece rate ω for the duration of the employment match. Let $M(u, v)$ denote the labor market matching function, and define labor market tightness to be the ratio of vacancies (v) to unemployment (u). Since search is directed, there is a separate labor market tightness for each submarket, defined by an agent's age (t), type (i) which is observed by firms, requested piece-rate (ω), and human capital (h). Although households differ along other dimensions, an agent's age, type, human capital, and requested piece-rate are the only characteristics that matter for firm profitability. In each submarket, the job finding rate for households, $p(\cdot)$, is a function of labor market tightness $\theta_{i,t}(\omega, h)$, such that $p(\theta_{i,t}(\omega, h)) = \frac{M(u_{i,t}(\omega,h), v_{i,t}(\omega,h))}{u_{i,t}(\omega,h)}$. On the other side of the market, the hiring rate for firms p_f is also a function of labor market tightness and is given by $p_f(\theta_{i,t}(\omega, h)) = \frac{M(u_{i,t}(\omega,h), v_{i,t}(\omega,h))}{v_{i,t}(\omega,h)}$. Once matched with a firm, a worker produces $f(h) : \mathcal{H} \rightarrow \mathbb{R}_+$ and keeps a share ω of this production as their wage. Matches end exogenously each period with probability δ (in the current formulation, firm profits are not impacted by the worker type, however, in Section 4.2 we allow δ_i to differ by worker type, and in that case firm profits do depend on worker type).

Every period households without credit access choose whether or not to search for a credit line, which entails a utility cost κ_S. After incurring the utility cost, the agent then directs their search over the menu of credit lines, which specify a borrowing limit $\underline{b}$, and interest rate r. Let $M_C(u_C, v_C)$ denote the credit market matching function, and define the credit market tightness to be the ratio of vacant credit contracts (v_C) to agents searching for a credit contract (u_C). As in the labor market, since search is directed, credit market tightness is specific to each submarket, however, unlike the labor market, we assume that lenders cannot observe the workers type. Thus a submarket is defined by an agent's age (t), employment status ($e \in \{W, U\}$), piece-rate wage (ω), prior debt (b), human capital (h), and the requested contract ($\underline{b}, r$). In each submarket, the credit finding rate for households, $p^c(\cdot)$, is a function of the credit market tightness $\theta_t^{c,e}(\omega, b, h; \underline{b}, r)$, such that $p^c(\theta_t^{c,e}(\omega, b, h; \underline{b}, r)) = \frac{M_C(u_{C,e,t}(\omega,b,h;\underline{b},r), v_{C,e,t}(\omega,b,h;\underline{b},r))}{u_{C,e,t}(\omega,b,h;\underline{b},r)}$. On the other side of the market, the probability a lender matches with a borrower, denoted p_f^c, is also a function of credit market tightness and is given by $p_f^c(\theta_t^{c,e}(\omega, b, h; \underline{b}, r)) = \frac{M_C(u_{C,e,t}(\omega,b,h;\underline{b},r), v_{C,e,t}(\omega,b,h;\underline{b},r))}{v_{C,e,t}(\omega,b,h;\underline{b},r)}$. A household remains matched with a lender until the household defaults, or the match is destroyed exogenously (the exogenous credit separation rate is given by δ_C).

The timing is such that individuals enter the credit search stage and must decide whether to apply for a credit line. They then make borrowing, saving, and consumption decisions. Idiosyncratic human capital risk is then realized. At the start of the next period agents enter the labor market and apply for jobs, and they may endogenously separate from lenders by defaulting or they may receive an exogenous credit separation shock.

Let $U_{i,t}^S(b, h; 0, 0)$ denote the value of entering the credit search stage for an unemployed, age t, type i individual with net worth b, and human capital h. The last two elements of the state space are zero, reflecting the fact that the agent does not have a credit contract, and thus $\underline{b} = 0$ and $r = 0$. This agent must decide whether to pay the utility cost κ_S of searching for a credit contract or remaining without credit,

$$U_{i,t}^S(b, h; 0, 0) = \max\left\{-\kappa_S + U_{i,t}^A(b, h; 0, 0);\ U_{i,t}^N(b, h; 0, 0)\right\} \quad \forall t \leq T$$

$$U_{i,T+1}^S(b, h; 0, 0) = 0$$

where $U_{i,t}^N(b, h; 0, 0)$ is the value of an unemployed individual without credit access, specified below, and $U_{i,t}^A(b, h; 0, 0)$ is the value of applying for a credit contract which is given by

$$U_{i,t}^A(b, h; 0, 0) = \max_{(\underline{b},r)\in\underline{\mathcal{B}}\times\mathcal{R}} p^c(\theta_t^{c,U}(b, h; \underline{b}, r))U_{i,t}^C(b, h; \underline{b}, r) + \left(1 - p^c(\theta_t^{c,U}(b, h; \underline{b}, r))\right) U_{i,t}^N(b, h; 0; 0)$$

After the asset market closes, the agent makes their consumption and savings decisions with savings accruing interest at the risk free rate r_f. For an agent that did not not receive a credit contract, their consumption and savings problem is constrained in that the agent is not allowed to borrow. An unemployed household receives as public unemployment insurance a transfer z.[17] The transfer to unemployed households is funded through a proportional tax τ on labor income that is

[17] We model public unemployment insurance as a transfer to incorporate all form of assistance that unemployed workers receive, which can include unemployment compensation and disaster unemployment assistance as well as general transfer programs that unemployed individuals may be enrolled in. As discussed in Section 3, we will calibrate z to be consistent with the average ratio of total transfers to income loss among unemployed individuals.

levied across all employed households. Additionally, the unemployed household receives the value of home production g, which is assumed to be constant across the duration of unemployment as well as homogeneous across unemployed households.

After consuming, idiosyncratic human capital risk is realized with the expectations operator. Unemployed agents, on average, lose human capital, while employed agents gain human capital. Agents then enter the labor market where they direct their search over piece-rate wage contracts ω. At the end of the period, agents without credit access enter the credit search stage. The value function representing the payoffs of an unemployed agent without credit access is

$$U_{i,t}^{N}(b,h;0,0) = \max_{b^{'}\geq 0} u(c) + \beta_i \mathbb{E}\Big[\max_{\tilde{\omega}} p(\theta_{i,t+1}(\tilde{\omega},h^{'}))W_{i,t+1}^{S}(\tilde{\omega},b^{'},h^{'};0,0) + \\ + \Big(1 - p(\theta_{i,t+1}(\tilde{\omega},h^{'}))\Big) U_{i,t+1}^{S}(b^{'},h^{'};0,0)\Big] \quad \forall t \leq T$$

$$U_{i,T+1}^{N}(b,h;0,0) = 0$$

subject to the budget constraint,

$$c + q(b^{'},r)b^{'} \leq z + g + b$$

where $q(b^{'},r) = \mathbb{I}\{b^{'} < 0\}\frac{1}{1+r} + \mathbb{I}\{b^{'} \geq 0\}\frac{1}{1+r_f}$ summarizes the discount on the face-value of loans as well as the savings rate. We assume that human capital abides by the following law of motion (note that the process is indexed by employment status U):

$$h^{'} = H(h,U)$$

For an agent that received a credit contract, their consumption and savings problem is constrained by their borrowing limit $\underline{b}$. The agent chooses their asset position for today and in the following period, will search over firms and then decide whether or not to default on any outstanding debts. The value function representing these payoffs is

$$U_{i,t}^{C}(b,h;\underline{b},r) = \max_{b^{'}\geq \underline{b}} u(c) + \beta_i \mathbb{E}\Big[\max_{\tilde{\omega}} p(\theta_{i,t+1}(\tilde{\omega},h^{'}))W_{i,t+1}^{D}(\tilde{\omega},b^{'},h^{'};\underline{b},r) \\ \Big(1 - p(\theta_{i,t+1}(\tilde{\omega},h^{'}))\Big) U_{i,t+1}^{D}(b^{'},h^{'};\underline{b},r)\Big] \quad \forall t \leq T \tag{5}$$

$$U_{i,T+1}^{C}(b,h;0,0) = 0$$

subject to the budget constraint,

$$c + q(b^{'},r)b^{'} \leq z + g + b$$

where $q(b^{'}, r) = \mathbb{I}\{b^{'} < 0\}\frac{1}{1+r} + \mathbb{I}\{b^{'} \geq 0\}\frac{1}{1+r_f}$. After directing their search over firms in the labor market, the agent observes if their credit match has been exogenously destroyed. With probability δ_c the agent looses their credit market access. After the realization of the credit separation shock the agent decides whether or not to default. The default decision and the resulting continuation value for an unemployed worker is given by

$$\begin{aligned} U^D_{i,t+1}(b^{'}, h^{'}; \underline{b}, r) = &\ \delta_c \max\{U^N_{i,t+1}(0, h^{'}; 0, 0) - \psi_D;\ U^N_{i,t+1}(b^{'}, h^{'}; 0, 0)\} \\ &+ (1-\delta_c)\max\{U^N_{i,t+1}(0, h^{'}; 0, 0) - \psi_D;\ U^C_{i,t+1}(b^{'}, h^{'}; \underline{b}, r)\} \end{aligned} \tag{6}$$

Let $D^{N,U}_{i,t+1}(b^{'}, h^{'}; \underline{b}, r)$ be an indicator function denoting an individual's default decision when they are unemployed and were hit by the credit separation shock, i.e. $D^{N,U}_{i,t+1} = 1$, when the individual defaults and is equal to zero otherwise. Let $D^{C,U}_{i,t+1}(b^{'}, h^{'}; \underline{b}, r)$ be an indicator function denoting an individuals default decision when they are unemployed and are not hit by the credit separation shock.

Employed agents in the economy face similar credit constraints to unemployed agents. The primary difference is that with probability δ, employed agents are laid off and must search for a new job. Appendix C.1 contains the Bellman equations for employed workers.

2.1 Lenders

There is a continuum of potential lenders who are risk neutral and can obtain funds without constraint at the risk free rate r_f. Lenders discount their stream of future profits at rate $\beta_{lf} \in (0, 1)$. Lenders offer credit contracts which specify a borrowing limit $\underline{b} < 0$ and an interest rate r. Let $\Pi^U_{i,t}(\vec{x})$ denote the profits to a lender of being matched with a type i, age t, unemployed individual where an individual's state is given by $\vec{x} = (b, h; \underline{b}, r)$.[18] The profits to the lender of offering a contract with borrowing limit $\underline{b}$, and interest rate r is

$$\begin{aligned} \Pi^U_{i,t}(b, h; \underline{b}, r) = &\ \beta_{lf} b^{'}_{i,t}(\vec{x})\left(\frac{(r_f - r)}{1+r} + \mathbb{E}\left[\delta_c \hat{D}^{N,U}_{i,t+1}(\vec{x}^{'}) + (1-\delta_c)\hat{D}^{C,U}_{i,t+1}(\vec{x}^{'})\right]\right) \times \mathbb{I}\{b^{'}_{i,t}(\vec{x}) < 0\} \\ &+ \beta_{lf}(1-\delta_c)\mathbb{E}\left[\left(1 - \hat{D}^{C,U}_{i,t+1}(\vec{x}^{'})\right)\hat{\Pi}^U_{i,t+1}(\vec{x}^{'})\right] \end{aligned} \tag{7}$$

At the end of period t, the agent makes their consumption/savings decision $b^{'}_{i,t}$. If the individual is borrowing, $b^{'}_{i,t} < 0$, then in period $t+1$ the lender receives income from the difference between the interest rate r and the risk free rate r_f. However the lender faces default risk on the outstanding loan $b^{'}_{i,t}$. The default risk faced by the lender incorporates the probability of the credit separation shock, as well as shocks to human capital and the agents job search decision. The default probability of the agent who receives the credit separation shock is denoted $\hat{D}^{N,U}_{i,t+1}(\vec{x}^{'})$, and is given

[18] Let $\vec{x}^{'}$ denote the state space of the individual in the next period.

by:[19]

$$\hat{D}^{N,U}_{i,t+1}(\vec{x}') = p\left(\theta_{i,t+1}(\hat{\omega}, h')\right) D^{N,W}_{i,t+1}(\hat{\omega}, b', h'; \underline{b}, r) + \left(1 - p\left(\theta_{i,t+1}(\hat{\omega}, h')\right)\right) D^{N,U}_{i,t+1}(b', h'; \underline{b}, r) \quad (8)$$

where $\hat{\omega}$ is the unemployed worker's choice for where to search for a job.[20] If the agent does not default and the credit match is not hit by the credit separation shock the match between the lender and borrower continues to the next period. The profits to the lender in period $t+1$, are denoted by $\hat{\Pi}^U_{i,t+1}(\vec{x}')$, and take into account the agent's choice for where to search for a job. The continuation profits to the lender are

$$\hat{\Pi}^U_{i,t+1}(\vec{x}') = p\left(\theta_{i,t+1}(\hat{\omega}, h')\right) \Pi^W_{i,t+1}(\hat{\omega}, b', h'; \underline{b}, r) + \left(1 - p\left(\theta_{i,t+1}(\hat{\omega}, h')\right)\right) \Pi^U_{i,t+1}(b', h'; \underline{b}, r)$$

Lenders cannot observe the borrower's type i. Lenders can however see if an individual is employed or unemployed when they meet the potential borrower, as well as all additional household state variables (assets, firm type, and age). Since lenders cannot observe the type i of a potential borrower, they form beliefs about the type of a borrower who is searching for a given contract. Let $\chi^U_{i,t}(b, h; \underline{b}, r)$ denote the share of individuals who "arrive" in market $(\underline{b}, r)$ with states (b, h) that are type i, unemployed, and age t. A free entry condition pins down the number of lenders who enter in the market in equilibrium. The free entry condition is

$$\kappa_C \geq p^c_f\left(\theta^{c,U}_t(b, h; \underline{b}, r)\right) \sum_i \chi^U_{i,t}(b, h; \underline{b}, r) \Pi^U_{i,t}(b, h; \underline{b}, r) \quad (9)$$

Note that individuals who are searching for credit contracts are not currently able to borrow, hence the free entry condition (equation 9) holds for $b \geq 0$.

Lenders in a match with an employed individual face a similar problem, but their continuation value must take into account the probability that the household becomes unemployed. Appendix C.2 contains the Bellman equation for a lender in a match with an employed worker.

2.2 Firms

Firms are assumed to have access to a linear production technology, and to have an exogenous job destruction rate δ. Firms have the same discount factor β_{lf} as lenders, and the value to a firm of

[19] The default probability when the agent is not hit by the credit separation shock is denoted $\hat{D}^{C,U}_{i,t+1}(\vec{x})$. It follows the same structure as equation 8, but with the policy functions for default when the agent is not hit by the credit separation shock, $D^{C,W}_{i,t+1}$ and $D^{C,U}_{i,t+1}$.

[20] Note the choice of where to search for a job is a function of state variables, which are suppressed for convenience.

an ongoing match to a worker with human capital h, at piece rate ω is

$$J_{i,t}(\omega, h) = (1-\omega) f(h) + \beta_{lf} \mathbb{E}\left[(1-\delta) J_{i,t+1}(\omega, h^{'})\right]$$
$$J_{i,T+1} = 0$$

subject to the law of motion for human capital for employed agents,

$$h' = H(h, W)$$

Firms must pay cost κ to post a vacancy. A vacancy specifies a wage piece rate ω, worker type i, as well as a human capital requirement h, and age t. Free-entry requires that:

$$\kappa \geq p_f\left(\theta_{i,t}(\omega, h)\right) J_{i,t}(\omega, h) \tag{10}$$

The free entry condition binds for all credit contracts such that $\theta_{i,t}(\omega, h) > 0$.

2.3 Government

The government runs the public unemployment insurance benefit system. We assume the government must maintain budget balance in every period.

All unemployed individuals receive public unemployment insurance benefit z. Unemployment insurance benefits are paid for by a proportional labor income tax, τ, which is levied on all employed individuals, to satisfy

$$z \sum_{(i,t)} \sum_{\vec{x}} \hat{u}_{i,t}(\vec{x}) = \sum_{(i,t)} \sum_{\vec{x}} \tau\left(\omega f(h) \hat{e}_{i,t}(\vec{x})\right) \tag{11}$$

where $\hat{u}_{i,t}(\vec{x})$ is the share of individuals with state $\vec{x}$ that are type i and age t who are unemployed, and $\hat{e}_{i,t}(\vec{x}) = 1 - \hat{u}_{i,t}(\vec{x})$ is the share who are employed.

2.4 Equilibrium

The definition of equilibrium follows from Guerrieri, Shimer, and Wright [2010]. See Appendix D for the formal definition of equilibrium.[21]

[21] In Appendix E, we show that the assumption of Guerrieri et al. [2010] are satisfied in our model where workers are heterogeneous by discount factor.

3 Calibration

Our calibration strategy is to assign values to standard parameters from the literature, while non-standard parameters will be calibrated to match labor and credit market moments from the US.[22]

The period is set to one quarter. We set the annualized risk free rate to 4%. The period discount factor for firms and lenders is set to $\beta_{lf} = 0.99$. The low worker type (who generate *low* profits to the lender) have a discount factor $\beta_L = 0.99$. We calibrate the discount factor of the high type (who generates high profits for the lender), β_H, by targeting the 90th percentile of the real credit card interest rate distribution. We measure the 90th percentile of real credit card interest rates to be 17.45% using the SCF between 1995 and 2007.[23]

We set the job destruction rate to a constant 10% per quarter, $\delta = 0.1$ (Shimer [2005]). For the labor market matching function, we use a constant returns to scale matching function that yields well-defined job finding probabilities:

$$M(u, v) = \frac{u \cdot v}{(u^{\zeta} + v^{\zeta})^{1/\zeta}} \in [0, 1)$$

The matching elasticity parameter is chosen to be $\zeta = 1.6$ as in Schaal [2012].

Based on the estimates of Fulford [2015], we set the quarterly exogenous credit separation rate to 2.6% per quarter, $\delta_c = 0.026$. For the credit market matching function, we again use a constant returns to scale matching function that yields well-defined credit finding probabilities:

$$M_C(u_C, v_C) = \frac{u_C \cdot v_C}{(u_C^{\zeta_C} + v_C^{\zeta_C})^{1/\zeta_C}} \in [0, 1)$$

The matching elasticity parameter is chosen to be $\zeta_C = 0.37$ as in Herkenhoff [2013].

Households preferences over non-durable consumption are given by:

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

We set the risk aversion parameter to a standard value, $\sigma = 2$. We assume the production function is linear in the human capital of the worker, and is given by $f(h) = h$.

There is an exogenously given grid on interest rates for credit contracts over the interval $[\underline{r}, \bar{r}]$. We set the minimum annual interest rate ($\underline{r}$) to be 10.5%, and the maximum interest rate ($\bar{r}$) to be 43.9%. These interest rates come from taking the sum of average interest charges and total fees as reported in Agarwal et al. [2014] for individuals with a FICO scores greater than 800, and for individuals with FICO scores less than 620, respectively.

The public transfer to unemployed workers z is calibrated to match the change in transfers

[22] Appendix F describes our solution algorithm in detail.

[23] Interest rates are made real by subtracting the CPI inflation rate in a given year.

over income loss among unemployed individuals. We focus on the change in transfers around job loss rather than the level of transfers to focus on the transfers that are received upon job loss. Using the 2001-2013 waves of the PSID we estimate that transfers to the unemployed replace 42% of their lost income among households with an involuntary layoff and an unemployment duration of at least three months.[24]

The labor vacancy posting cost κ is chosen to target a mean unemployment rate of 5.1%, which is the average for 1994-2007. The credit posting cost κ_C is chosen so that the credit finding rate in the model matches the new-borrower credit approval rate of 65.0%, which is measured from the 2007-09 SCF panel. The utility cost of searching for a credit contract κ_S is calibrated to match the share of individuals with credit access. From the 1995 through 2007 waves of the SCF we measure 69.8% of the population has a credit card. We set the utility penalty of default to ψ_D to match the bankruptcy rate in the US from 1998-2007 of 0.145% per quarter.[25]

A worker's life span is set to $T = 80$ quarters (20 years). Newly born agents enter as unemployed workers, with zero assets and without a credit contract. Their human capital is drawn from a uniform distribution over the grid of human capital.

The evolution of human capital depends upon whether an individual is employed or unemployed. The processes for human capital are calibrated to generate the increase in earnings associated with an increase in age, as well as the long term consumption losses of displaced individuals. These processes for human capital are governed by two parameters p_L and p_H.

$$H(h,U) = h^{'} = \begin{cases} h - \mathit{\Delta} & \text{w/ pr. } p_L \text{ if unemployed} \\ h & \text{w/ pr. } 1 - p_L \text{ if unemployed} \end{cases}$$

$$H(h,W) = h^{'} = \begin{cases} h + \mathit{\Delta} & \text{w/ pr. } p_H \text{ if employed} \\ h & \text{w/ pr. } 1 - p_H \text{ if employed} \end{cases}$$

In the calibration below, the grid for human capital $h \in [0.6,\ 0.7,\ 0.8,\ 0.9,\ 1]$, as well as the step size $\mathit{\Delta} = 0.1$, between grid points is taken as given. To estimate the probability that a worker's productivity decreases while unemployed p_L, we estimate the consumption loss 8 quarters following job loss. As in Herkenhoff et al. [2015] we target a 3 percent decline in consumption 8 quarters following job loss.

To estimate the probability that a worker's human capital increases while employed p_H, we target the relative earnings gain associated with an increase in age. With a higher value of p_H

[24] We focus on involuntary layoffs to avoid unemployment spells due to quits, and as involuntary layoffs are more consistent with the notion of a layoff in the model. We similarly use individuals with an unemployment duration of at least three months given the quarterly timing of the model where unemployed individuals are out of work for at least a full quarter. Using the SIPP, Rothstein and Valletta [2017] estimate a replacement rate (changes in transfers over changes in earnings) of 43.6%.

[25] Using the SCF from 1998-2007, we measure that 0.58% of individuals with a credit card report having filed for bankruptcy within the past year.

workers have more frequent increases in their human capital, and hence more frequent increases in their earnings. We estimate the earnings gain associated with an increase in age using the following regression of age on earnings on a cross-section of agents in period t:

$$ln(Y_{i,t}) = \alpha + \beta_{age} Age_{i,t} + \epsilon_{i,t} \tag{12}$$

In equation 12, $Y_{i,t}$ denotes the earnings of individual i in year t, and $Age_{i,t}$ denotes the age of individual i in year t. The coefficient β_{age} estimates the average increase in earnings associated with an increase in age. Using data from the CPS for the years 1996-2007, we estimate a relative gain in earnings with a 1-year increase in age of 0.82%.[26]

The value of home production g is calibrated to target the decline in consumption in the quarter following job loss relative to the quarter prior to job loss among individuals who remain unemployed. A higher value of g replaces a larger share of the income lost and reduces the decline in consumption. We focus on consumption losses in the quarter after losing their job since immediately after job loss workers are less likely to have suffered a decline in human capital. Browning and Crossley [2001] estimate a 16% decline in consumption after 6 months of unemployment for Canadians.

Finally, we calibrate the fraction of agents that are high types, denoted π_H, to target the fraction of households that have a negative ratio of net liquid assets to income. From the SCF 24.8% of households report having a negative ratio of net liquid assets to annual gross income.[27]

Table 6 contains a summary of the model parameters, and Table 7 displays the calibrated parameters and their calibration targets.

3.1 Model Validation

In the above section, we calibrated the model to be consistent with aggregate moments for earnings, credit access, and credit usage. In our targeted moments, we deliberately did not target variables measuring how individuals use credit following job loss. In this section, we use the model generated policy functions to simulate a large mass of agents, and estimate the borrowing and default responses around job loss. These moments were not targeted in the calibration of the model and provide a validation of the model.

To estimate the average effect of job loss on credit access and usage we estimate the distributed lag regression model of equation 1 on model simulated data.[28] Figure 6 presents the average

[26]We additionally include educational attainment dummies, as well as industry and year dummies in the estimation of equation 12.

[27]As in Herkenhoff et al. [2015], for each household we sum cash, checking, money market funds, CDS, corporate bonds, government savings bonds, stocks, and mutural funds less credit card debt over annual gross income. We take the mean of this liquid asset to income ratio across households in each survey year, and then average over 1995 and 2007.

[28]We impose the same sampling requirements in the simulation as in the data. In particular, we require individuals

response results from the model simulation. To facilitate the comparison between model estimates and the data, we normalize the OLS coefficients from estimating equation 1 on model simulated data for earnings, borrowing limits, and borrowing by dividing by the average earnings of the displaced one year prior to displacement. Panel (a) presents the difference in earnings between displaced and non-displaced individuals from the model simulation. As in the data, displaced individuals suffer large earnings losses, of nearly 30% around job loss. While not as persistent as the data, the model predicts that a displaced individuals earnings remain depressed several years after job loss. Despite the large decline in earnings, Panel (b) shows that borrowing limits are only modestly impacted following job loss. Individuals take out credit lines, as opposed to one period debt as in Herkenhoff [2013], and thus borrowing limits are unresponsive to job loss, similar to the data. Panel (c) focuses on borrowing by workers who lose their jobs. While agents suffer severe earnings losses as shown in Panel (a), Panel (c) reveals that agent's total debt is unresponsive to job loss. We will revisit this result and show that there is a distribution of responses both in the model and data, with some agents delevering and defaulting while other agents borrow. The net effect is zero-borrowing following job loss. Panel (d) examines the propensity of individuals to default in the model following job loss. As on an individual's credit report, we create a "bankruptcy flag" variable in the model which identifies if an individual has had a bankruptcy (default in the model) within the past 7 years. The figure shows that as in the data, bankruptcy flags increase steadily following job loss.

Finally, we also consider the model's estimate of the heterogeneous response of borrowing activity around job loss. Figure 7 presents the model's estimate of the replacement rate of credit following job loss against the replacement rate of credit as measured in the SCF. The figure shows that the model is able to replicate the observation from the data of limited borrowing on average that is masking the fact that there are agents with significant increases as well as decreases in borrowing around job loss. We interpret the results of Figures 6 and 7 as indicating that the model generates behavior around job loss that is consistent with the data.

4 Optimal Unemployment Insurance

In this section, we use the calibrated model to find optimal replacement rate of the public transfer to the unemployed under various levels of credit access. Our benchmark U.S. economy features a transfer to the unemployed that replaces 42% of lost earnings on average. When assessing optimality, we use two different social welfare criteria: (i) utilitarian welfare and (ii) median welfare. Our utilitarian welfare criterion is an equally weighted average of consumption-equivalent gains of moving to the new policy, whereas the median welfare criterion is the median consumption-

to have 3 years of tenure at a firm to be in either the treatment or control samples.

equivalent gain of moving to the new policy.[29]

We first consider the baseline model where workers have private information about their discount factors. We then consider the case of workers who have private information about their odds of being laid off as well as their discount factor. In both cases we find that access to credit implies a lower optimal UI replacement rate relative to a world without credit access; however, relative to current U.S. policy, the optimal utilitarian policy is to *raise* public unemployment insurance, whereas the median voter would want to *lower* public unemployment insurance. These results indicate that even with private information about the probability of future job loss, credit may serve as a substitute for public insurance, i.e. credit access provides private unemployment insurance.

4.1 Heterogeneous Discount Factors

We first compute optimal policy in our baseline model economy which features private information about discount factors. Figure 8 displays our utilitarian welfare criterion and median welfare criterion for various levels of public transfers to the unemployed. Panel (a) shows that under the utilitarian welfare criterion, welfare is maximized with a transfer to the unemployed replacing 54% of prior earnings. On average, individuals are willing to give up 0.15% of lifetime consumption to move from the US policy of a 42% replacement rate to a 54% replacement rate. This is a slightly higher replacement rate than what is observed in the U.S. Panel (b) shows that under the median welfare criterion, welfare is maximized at a UI replacement rate of 38%.

While the above policies raise welfare on average, or for the median individual, they are not Pareto-improving. Figure 9 plots the distribution of welfare effects. Panel (a) plots the distribution of welfare effects for changing the public insurance replacement rate to 54%. Panel (b) plots the distribution of welfare effects for changing the UI replacement rate to 38%. In both cases, individuals with low initial human capital levels are most sensitive to the replacement rate. Raising the replacement rate in panel (a) primarily benefits low human capital individuals, leaving high-human capital individuals largely unaffected. Lowering the replacement rate in panel (b) primarily benefits high human capital individuals, leaving low-human capital individuals substantially worse-off.

Under both the utilitarian and median welfare criteria, the optimal replacement rates differ from the current US policy of a 42% replacement rate. Under the utilitarian welfare criterion, benefits should be raised, and under the median welfare criterion, benefits should be lowered. These results obfuscate the fact that relative to optimal public insurance in an economy without credit access (i.e. no borrowing, $\underline{b} = 0$ for all available contracts), it is always optimal under both welfare criteria to lower public unemployment insurance when credit access expands. Table 8

[29] See Appendix G for details on the estimation of the share of lifetime consumption an individual would be willing to give up to move across economies.

makes this point by computing the optimal public provision of unemployment insurance under the assumption that agents cannot borrow. Without credit access, the optimal utilitarian policy is a 66% replacement rate. This is significantly higher than both the current U.S. replacement rate of 42%and the optimal replacement rate of 54% under current levels of U.S. credit access. Using the median welfare criterion, the optimal unemployment insurance rate is 42% without credit access, and 38% with credit access.

Why is it so difficult to substitute from public forms of insurance into private forms of insurance? The reason is that with a very low level of public insurance there are more defaults in the economy, which decreases profits to lenders and decreases the entry of lenders into the market. The mean and median individuals thus have less credit access and are strictly worse off with very low levels of public insurance. Conversely, when the UI policy becomes too generous, taxes are raised and the generosity of the public UI system crowds out the private insurance being provided by the credit system. In this case, the distortionary impact of taxes makes the mean and median individual worse off with extremely high levels of public insurance. The optimal provision of public insurance balances these competing forces.

4.2 Heterogeneous Job Loss Probabilities

In this subsection, we consider a version of our model that is closer to Hendren [2015]. We assume that workers have private information about their probability of future job loss *as well as* their discount factor. In this exercise, the "high" worker types have a higher probability of future job loss as well as a lower discount factor. The "low" worker types have a lower probability of future job loss and are more patient (higher discount factor). We consider a range of job loss probabilities for high and low types (denoted δ_H and δ_L, respectively), and in all exercises we use the discount factors β_H and β_L as calibrated in Section 3. We assume that lenders cannot see a worker's job loss probability or discount factor whereas firms can.

Table 9 contains the optimal public UI replacement rate in this environment. In the column (2) of Table 9, low worker types have a quarterly probability of job loss of 9%, while the job loss probability for high worker types is 13.4%.[30] In an economy with credit access, the optimal UI replacement rate is 33% under the median welfare criterion. In the same economy without credit access, the optimal UI replacement rate is 38%. Therefore, even with private information about future job loss, the credit market acts as a limited private unemployment insurance market, and the planner unambiguously cuts public insurance as credit access expands.

Table 9 also reveals that the degree of private information is relevant for optimal policy. With more heterogeneity (Column (3)), some agents rarely lose their jobs and thus do not need much public insurance or credit, whereas other agents lose their jobs regularly and thus value both credit access and public insurance. Workers with high-layoff probabilities are very likely to repay their

[30] These job loss probabilities keep the aggregate probability of job loss fixed at 10%, as in the baseline economy.

debts as they value, and want to maintain, future access to credit. As a result, the government is better able to substitute out of public insurance as job loss heterogeneity increases.

5 Conclusions

Our empirical contribution is to show that workers who lose their jobs maintain access to credit and that unconstrained workers who lose their jobs borrow, while constrained workers who lose their jobs default and delever. We argue that by defaulting and through borrowing, the unemployed use credit markets to smooth consumption. They pay an interest premium in order to access this consumption smoothing technology, and thus the credit market acts as a limited *private* unemployment insurance market.

Our theoretical contribution is to show that default costs allow credit markets to serve as a market for private unemployment insurance despite adverse selection. Finally, our quantitative contribution is to measure the optimal degree of public insurance in an economy that matches current U.S. levels of credit access. We find that the optimal provision of public insurance is unambiguously lower as credit access expands. The median individual in our simulated economy would prefer to have the income replacement rate from public insurance lowered from the current US policy of 42% to 38%.

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Tables and Figures

Table 1: Summary Statistics

Panel Sample (Year Prior to Mass Layoff)		
	(1) Treatment	(2) Control
Annual Earnings	$44,254	$49,176
Credit Score	423	434
Age	40.6	41.3
Revolving Credit Balance	$10,654	$11,056
Revolving Credit Limit	$26,669	$28,128
Unused Revolving Credit to Income	0.43	0.41
Observations (Rounded to 000s)	31000	30000

Cross Sectional Sample (Year of Mass Layoff)	
	Avg. Unused Revolving Credit to Income
Credit Score Quintile 1	0.13
Credit Score Quintile 2	0.25
Credit Score Quintile 3	0.60
Credit Score Quintile 4	1.17
Credit Score Quintile 5	2.02

Note: Sample selection criteria in Section 1.2. Annual earnings, revolving credit balance and revolving credit limit are in 2008 dollars. Credit score refers to the TransUnion bankruptcy score. Unused revolving credit to income is winsorized at the 1-percent level at the top and bottom of the distribution.

Table 2: Average Response of Earnings and Credit Variables to Displacement

	(1) Earnings	(2) Credit Score	(3) Revolving Credit Limit	(4) Revolving Credit Balance
4 Years Before Displacement (d)	1,191***	-0.0814	-192.0	48.95
	(137.4)	(1.662)	(218.8)	(141.3)
3 Years Before Displacement (d)	2,795***	-0.942	-324.4	-23.03
	(165.5)	(1.995)	(301.0)	(188.5)
2 Years Before Displacement (d)	5,107***	0.991	-316.7	-4.129
	(186.0)	(2.163)	(347.7)	(214.4)
1 Year Before Displacement (d)	5,211***	-4.397*	-283.7	99.80
	(201.8)	(2.342)	(395.6)	(245.3)
Year of Displacement (d)	-2,829***	-6.596***	-925.9**	-398.5
	(225.8)	(2.491)	(435.0)	(269.2)
1 Year After Displacement (d)	-13,841***	-16.11***	-1,680***	-524.5*
	(260.0)	(2.594)	(454.0)	(284.0)
2 Years After Displacement (d)	-9,723***	-15.72***	-1,465***	-394.0
	(273.5)	(2.794)	(490.9)	(309.4)
3 Years After Displacement (d)	-7,210***	-12.40***	-1,185**	-176.1
	(290.5)	(3.033)	(545.4)	(348.2)
4 Years After Displacement (d)	-5,255***	-12.04***	-1,366**	-136.3
	(324.8)	(3.385)	(616.9)	(395.1)
5 Years After Displacement (d)	-3,057***	-9.041**	-1,542**	-560.3
	(380.9)	(3.984)	(712.1)	(463.9)
Individual Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Age and Wealth Controls	Y	Y	Y	Y
R-squared	0.153	0.019	0.027	0.017
Indiv.-Yr Obs.	472000	472000	472000	472000
No. of Indiv.	61000	61000	61000	61000

Notes: Robust SE in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. *Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. The symbol (d) indicates a dummy variable. Annual earnings, revolving credit balance and revolving credit limit are in 2008 dollars. Credit score refers to the TransUnion bankruptcy score.*

Table 3: Average Response of Default Measures to Displacement

	(1) 30 Day Delinq. (d)	(2) 60 Day Mortgage Delinq. (d)	(3) Chargeoff (d)	(4) Collections (d)
4 Years Before Displacement (d)	0.00470	-0.000479	0.00296	0.00356
	(0.00467)	(0.00170)	(0.00354)	(0.00388)
3 Years Before Displacement (d)	-0.00261	0.00318*	0.00402	-3.71e-05
	(0.00509)	(0.00192)	(0.00367)	(0.00409)
2 Years Before Displacement (d)	-0.00936*	0.000133	-0.00657*	0.00287
	(0.00527)	(0.00200)	(0.00366)	(0.00421)
1 Year Before Displacement (d)	-0.00352	0.00156	-0.00173	0.00409
	(0.00558)	(0.00218)	(0.00383)	(0.00443)
Year of Displacement (d)	0.0123**	0.00483**	0.00875**	0.0118**
	(0.00583)	(0.00236)	(0.00398)	(0.00466)
1 Year After Displacement (d)	0.0311***	0.00917***	0.0299***	0.0290***
	(0.00601)	(0.00256)	(0.00414)	(0.00479)
2 Years After Displacement (d)	0.0190***	0.00227	0.0159***	0.0316***
	(0.00655)	(0.00276)	(0.00446)	(0.00518)
3 Years After Displacement (d)	0.00448	0.000794	0.00689	0.0261***
	(0.00723)	(0.00305)	(0.00491)	(0.00567)
4 Years After Displacement (d)	-0.0176**	-0.00434	0.00158	0.0195***
	(0.00813)	(0.00350)	(0.00547)	(0.00631)
5 Years After Displacement (d)	-0.0248**	-0.00823*	-0.00706	0.0134*
	(0.00973)	(0.00445)	(0.00660)	(0.00757)
Individual Fixed Effects	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y
Age and Wealth Controls	Y	Y	Y	Y
R-squared	0.008	0.009	0.003	0.010
Indiv.-Yr Obs.	472000	472000	472000	472000
No. of Indiv.	61000	61000	61000	61000

Notes: Robust SE in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. *Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. The symbol (d) indicates a dummy variable. All outcome variables are indicators for having the outcome occur within the past 12 months.*

Table 4: Replacement Rates of Revolving Credit by Credit Score Quintile (Year of Displacement)

	OLS		Predicted Values
	(1)	(2)	(3)
	Replacement Rate	Replacement Rate	Replacement Rate
Credit Score Quin 1 (d)			-0.0540***
			(0.00630)
Credit Score Quin 2 (d)	0.00302	0.00192	-0.0521***
	(0.00944)	(0.00945)	(0.00720)
Credit Score Quin 3 (d)	0.0769***	0.0811***	0.0271***
	(0.0110)	(0.0110)	(0.00903)
Credit Score Quin 4 (d)	0.185***	0.192***	0.138***
	(0.0118)	(0.0119)	(0.0100)
Credit Score Quin 5 (d)	0.248***	0.262***	0.208***
	(0.0118)	(0.0121)	(0.0102)
Constant	-0.0492***	-0.163***	
	(0.00620)	(0.0553)	
Year FE	N	Y	Y
Age and Wealth Controls	N	Y	Y
R square	0.030	0.034	
No Obs.	21000	21000	21000

Notes: Robust SE in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. *Replacement rate is the negative of the change in revolving credit balance over the change in earnings for individuals with an earnings loss in year of displacement. Credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. Columns (1) and (2) reports are OLS estimates of equation 2 which estimates the replacement rate as a function of credit score quintile. The replacement rate used in the estimation is winsorized at the top and bottom at the 10 percent level. Column (3) reports predicted values of the replacement rate by credit score quintile implied by the results of Column (2), where the control variables are evaluated at their sample means, as in equation 3.*

Table 5: Earnings Losses and Change in Revolving Credit Balances by Credit Score

	(1) Chg. Revolving Credit	(2) Chg. Revolving Credit	(3) Chg. Revolving Credit
Chg. Earning	-0.0156	0.0280*	0.0220
	(0.00954)	(0.0149)	(0.0154)
Chg. Earnings x Credit Score Quin 2 (d)		0.000683	0.000186
		(0.0210)	(0.0211)
Chg. Earnings - x Credit Score Quin 3 (d)		0.0161	0.0163
		(0.0256)	(0.0257)
Chg. Earnings x Credit Score Quin 4 (d)		-0.0610**	-0.0601**
		(0.0273)	(0.0274)
Chg. Earnings x Credit Score Quin 5 (d)		-0.0723***	-0.0709***
		(0.0263)	(0.0264)
Constant	413.6***	-767.2***	-3,840***
	(147.5)	(183.6)	(1,303)
Constant x Credit Score Quin 2 (d)		-225.6	-243.9
		(277.8)	(278.9)
Constant x Credit Score Quin 3 (d)		652.0*	718.3**
		(354.8)	(355.0)
Constant x Credit Score Quin 4 (d)		2,508***	2,603***
		(439.3)	(436.9)
Constant x Credit Score Quin 5 (d)		4,240***	4,417***
		(470.3)	(469.2)
Year FE	N	N	Y
Age and Wealth Controls	N	N	Y
R-Square	0.000	0.023	0.025
No of Indiv.	21000	21000	21000
P-Value Chg Earn Quin 2		0.0536	0.148
P-Value Chg Earn Quin 3		0.0345	0.0709
P-Value Chg Earn Quin 4		0.150	0.104
P-Value Chg Earn Quin 5		0.0401	0.0271

Notes: Robust SE in parenthesis. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. *The change in real annual earnings, and the change in real revolving balance are both winsorized at the top and bottom at the 1 percent level, and are measured in 2008 dollars. Credit Score Quin k refers to credit score quintile k, where credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. The symbol (d) indicates a dummy variable. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. P-Value Chg Earn Quin k refers to the p-value for the sum of the coefficients Chg. Earn and Chg. Earn x Credit Score Quin k.*

Table 6: Model Parameters

Parameter	Description	Value
	Assigned Parameters	
r_f	Risk free rate	0.04
β_{lf}	Discount factor: lenders and firm	0.99
β_L	Discount factor low worker type	0.99
δ	Exogenous job destruction rate	0.1
ζ	Labor match elasticity	1.6
δ_C	Exogenous credit destruction rate	0.026
ζ_C	Credit match elasticity	0.37
$\underline{r}$	Minimum (annualized) interest rate	10.5%
$\bar{r}$	Maximum (annualized) interest rate	43.9%
σ	Risk aversion	2
T	Lifespan in quarters	80
	Calibrated Parameters	
z	Public insurance transfer to unemployed	0.256
κ	Firm entry cost	1.076
κ_C	Lender entry cost	2.301×10^{-5}
κ_S	Utility penalty of searching for credit	1.727×10^{-3}
ψ_D	Default utility penalty	62.010
p_L	Prob human capital decrease	0.247
p_H	Prob human capital increase	0.053
g	Home production	0.119
$\underline{B}$	Lowest value of asset grid	-1.40
β^H	Discount factor: high worker type	0.600
π_H	Share of high type agents	0.225

Table 7: Model Estimates

Variable	Value	Target	Model	Data	Source
z	0.256	Transfer to Income Loss	41.8%	42.0%	PSID, 2009-2013
κ	1.076	Unemployment Rate	5.3%	5.1%	BLS, 1994-2007
κ_C	2.301×10^{-5}	Credit Finding Rate	65.1%	65.0%	SCF, 2007-2009
κ_S	1.727×10^{-3}	Share of Agents w/ Credit Access	71.0%	69.8%	SCF, 1995-2007
ψ_D	62.010	Bankruptcy Rate	0.062%	0.145%	SCF, 1998-2007
p_L	0.247	Consumption Drop 8 Qtr After Layoff	0.975	0.970	HPC (2015)
p_H	0.053	Earnings Gain With Age	0.772%	0.82%	CPS, 1996-2007
g	0.119	Consumption Drop 1 Qtr After Layoff	0.84	0.84	BC (2001)
$\underline{B}$	-1.40	Unused Credit Limit to Income	0.32	0.29	LEHD/TU, 2003-2008
β^H	0.600	P90 Real Credit Card Interest Rate	15.2%	17.5%	SCF, 1995-2007
π_H	0.225	Share of Agents w/ Negative Net Liquid Assets	25.0%	24.8%	SCF, 1995-2007

Notes: *HPC (2015) refers to Herkenhoff et al. [2015] and BC (2001) refers to Browning and Crossley [2001].*

Table 8: Optimal Unemployment Insurance

	(1)	(2)	(3)	(4)	(5)
	US Policy w/ Credit	Optimal Policy w/ Credit (Utilitarian)	Optimal Policy w/ Credit (Median)	Optimal Policy w/o Credit (Utilitarian)	Optimal Policy w/o Credit (Median)
Transfer/Income Loss	42%	54%	38%	66%	42%
Mean Welfare Chg.	-	0.15%	−0.13%	0.22%	0.00%
Median Welfare Chg.	-	−0.23%	0.01%	−0.53%	0.00%
Unemployment Rate	5.3%	5.8%	5.2%	6.3%	5.3%
Fraction Borrowing	25.0%	23.2%	25.5%	-	
Default Rate	0.061%	0.013%	0.142%	-	
Consumption Loss 1Q After Job Loss	0.843	0.879	0.818	0.944	0.753
Marginal Tax rate	2.15%	3.08%	1.91%	4.11%	2.15%

Notes: Welfare changes are measured using consumption equivalents from leaving an economy with the US policy of a of 42% replacement rate for unemployed workers and entering an economy a different replacement rate policy. For example, at a replacement rate of 54%, the mean welfare change of 0.15% indicates that ex-ante, on average, an individual would give up 0.15% of lifetime consumption to leave the US policy and be indifferent to moving to an economy with the 54% policy.. Additionally, at a replacement rate of of 54%, the median welfare change of −0.23% indicates that ex-post, the median individual would have to be given 0.23% of lifetime consumption to leave the US policy and be indifferent to moving to an economy with the 54% policy. See Appendix G for details on the estimation of the welfare effect.

Table 9: Optimal UI Replacement Rate with Private Information on Future Job Loss

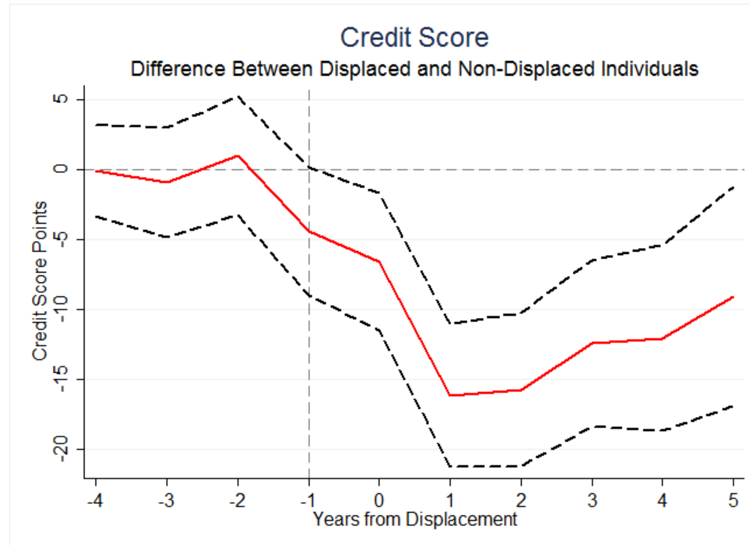
	1	2	3
Job Loss Probability of Low Type (δ_L)	0.1	0.09	0.08
Job Loss Probability of High Type (δ_H)	0.1	0.134	0.168
Optimal Policy w/ Credit (Utilitarian)	54%	43%	30%
Optimal Policy w/ Credit (Median)	38%	30%	13%
Optimal Policy w/o Credit (Utilitarian)	66%	43%	33%
Optimal Policy w/o Credit (Median)	42%	38%	28%

Notes: The table shows the optimal UI replacement rate when workers have private information on future job loss probabilities and discount rates. The optimal UI replacement rate is chosen by selecting the replacement rate that maximizes either the utilitarian welfare change or the median welfare change. Welfare changes are measured using consumption equivalents from leaving an economy with the US policy of a of 42% *replacement rate for unemployed workers and entering an economy a different replacement rate policy. See Appendix G for details on the estimation of the welfare effect. In all estimations* $\beta_H = 0.600$, *and* $\beta_L = 0.99$.

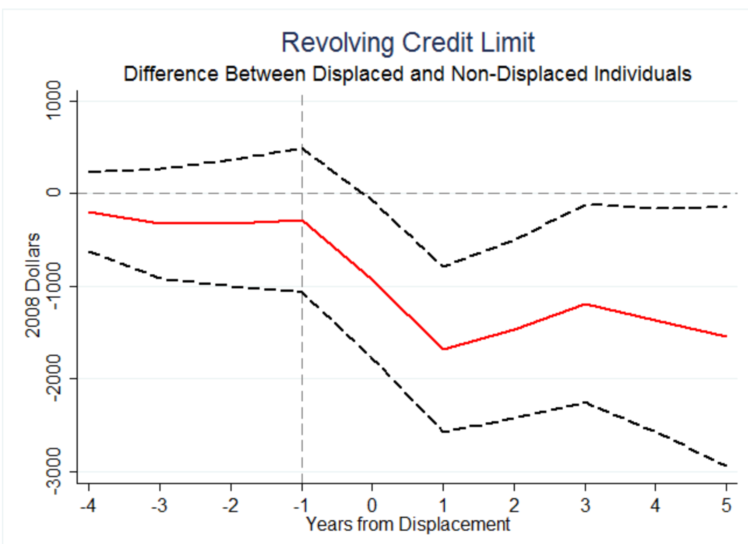
Figure 1: Average Response of Earnings and Credit Variables to Displacement

(a) Real Annual Earnings

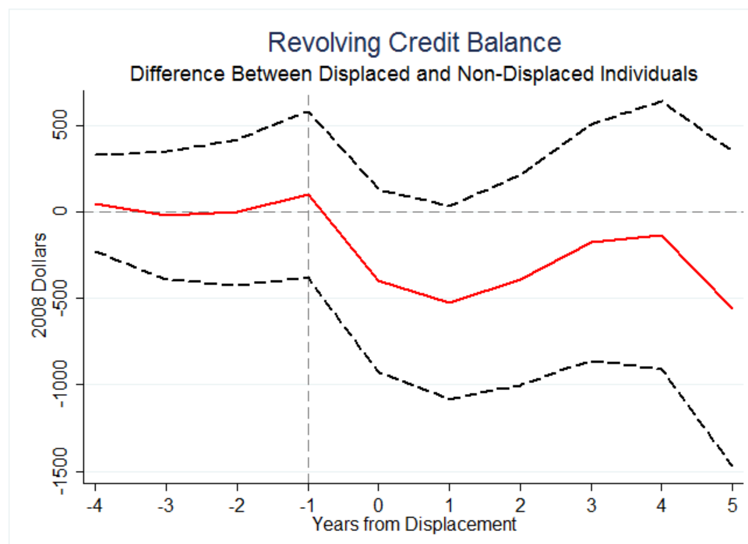
(b) Credit Score



(c) Revolving Credit Limit



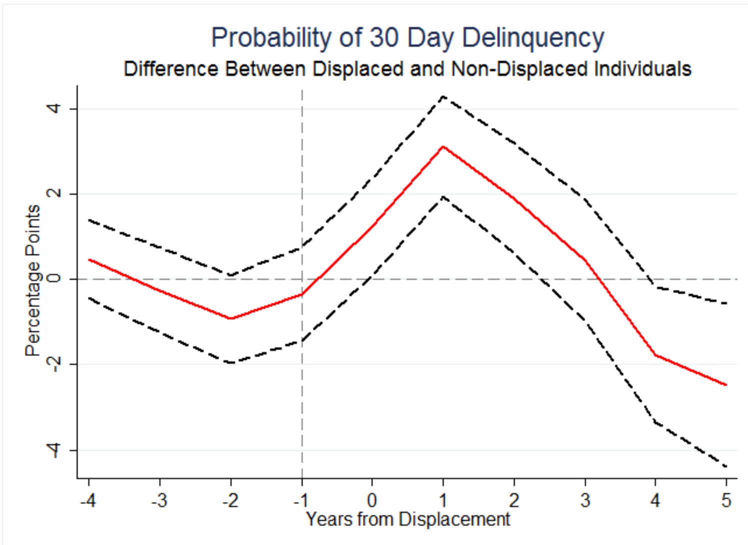
(d) Revolving Credit Balance



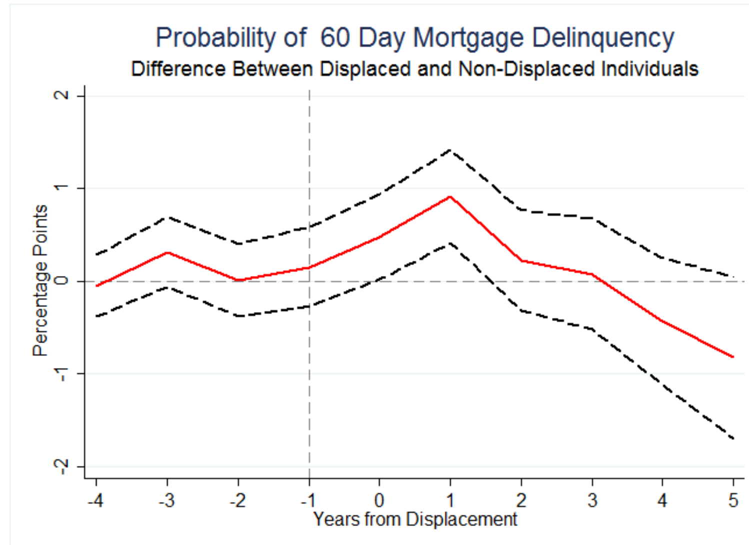
Notes: Figure presents estimates of the effect of job loss on earnings and credit variables. Solid line is interpreted as the difference in the outcome variable between displaced and nondisplaced individuals. Dashed line represents a 95 percent confidence interval. Figures present coefficient estimates from Table 2.

Figure 2: Average Response of Default Measures to Displacement

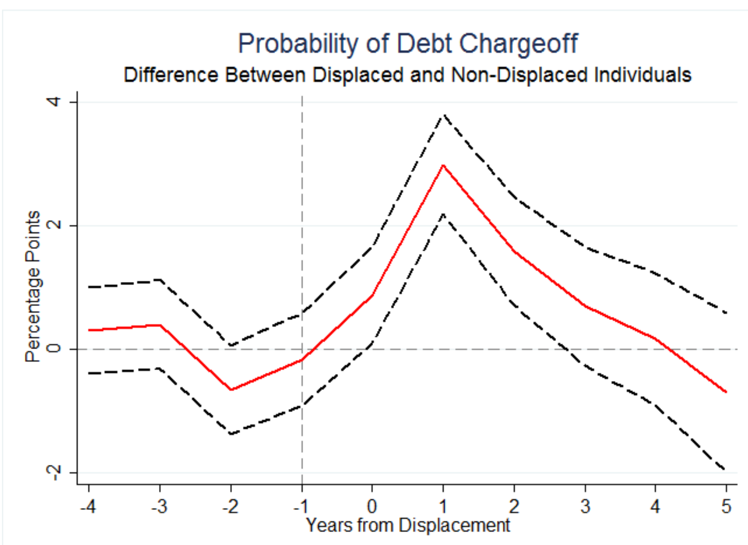
(a) 30 Day Delinquency



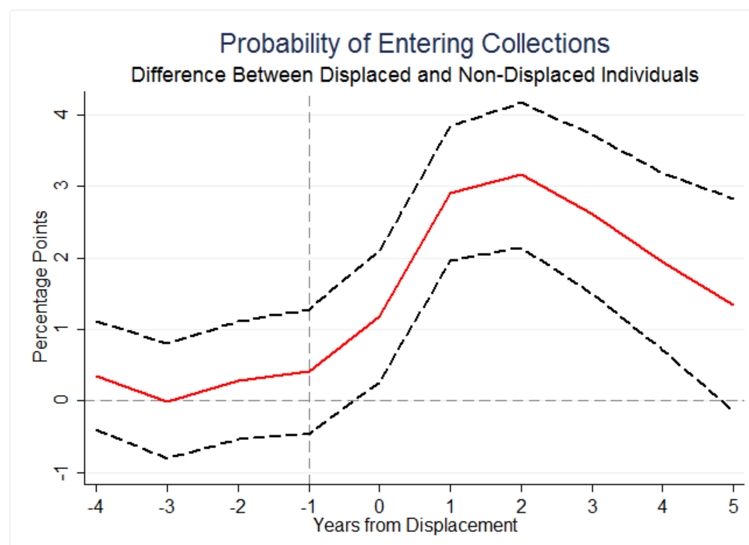
(b) 60 Day Mortgage Delinquency



(c) Chargeoffs

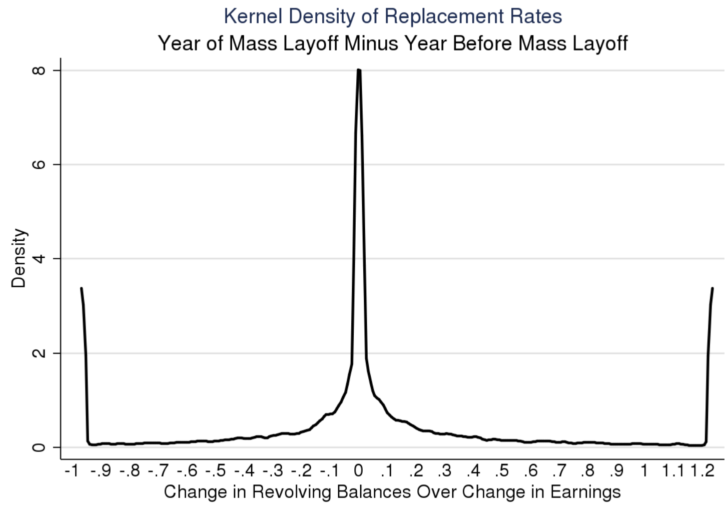


(d) Collections



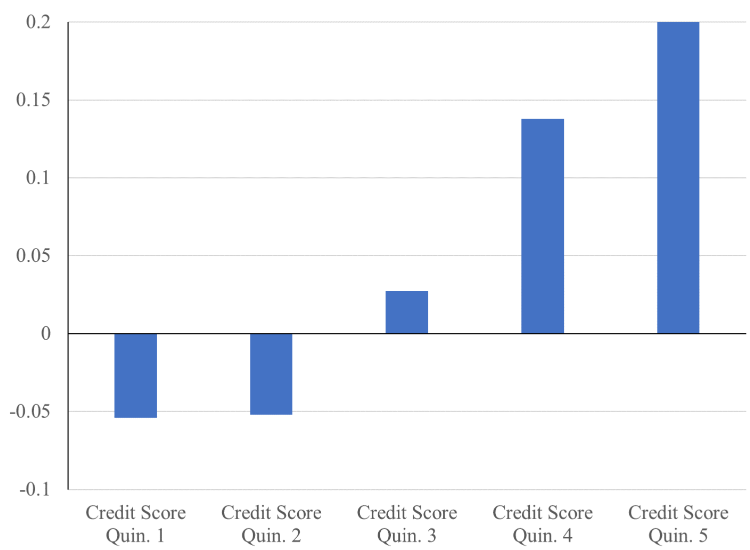
Notes: Figure presents estimates of the effect of job loss on measures of default and delinquency. Solid line is interpreted as the difference in the outcome variable between displaced and nondisplaced individuals. Dashed line represents a 95 percent confidence interval. Figures present coefficient estimates from Table 3.

Figure 3: Replacement Rate of Lost Earnings with Revolving Credit



Notes: Replacement rate is the negative of the change in revolving credit balance over the change in earnings for individuals with an earnings loss in year of displacement. A replacement rate of 0.2 indicates that an individual replaced 20 percent of their lost earnings with revolving credit.

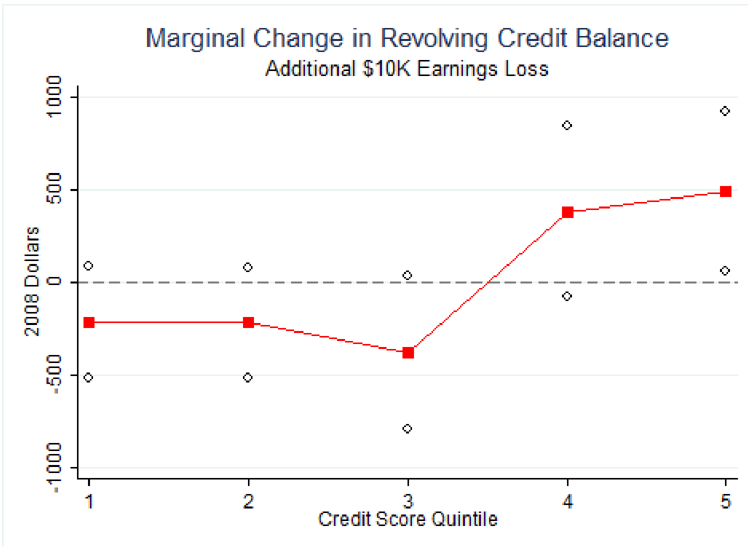
Figure 4: Replacement Rate of Lost Earnings with Revolving Credit by Credit Score Quintile in Year of Mass Layoff



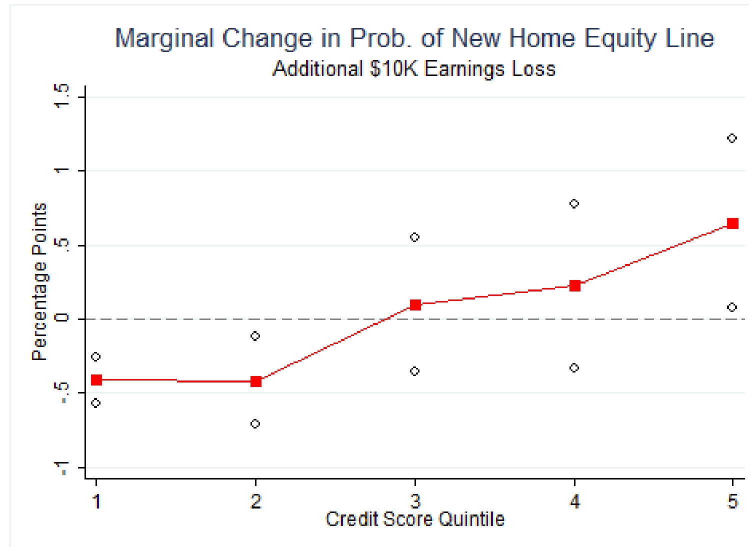
Notes: Replacement rate is the negative of the change in revolving credit balance over the change in earnings for individuals with an earnings loss in year of displacement. Replacement rate of 0.2 indicates that an individual replaced 20 percent of their lost earnings with revolving credit. Credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. Estimates are from column (3) of Table 4.

Figure 5: Marginal Effect of Earnings Loss on Borrowing Activity

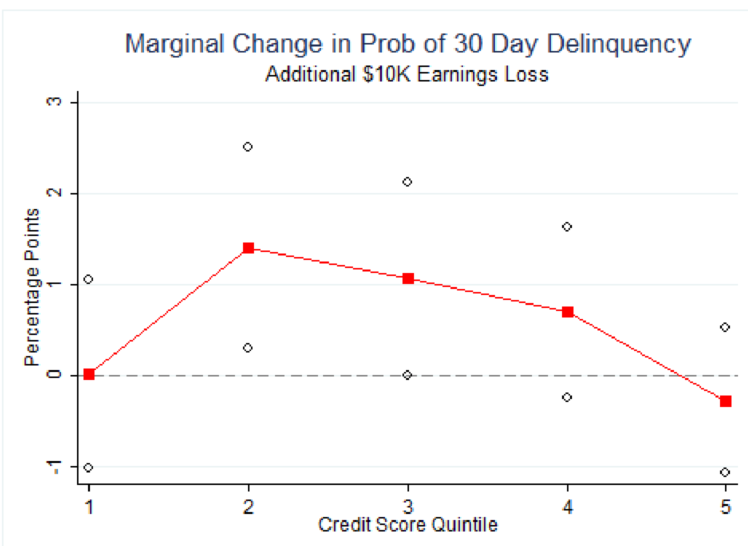
(a) Revolving Credit Balance



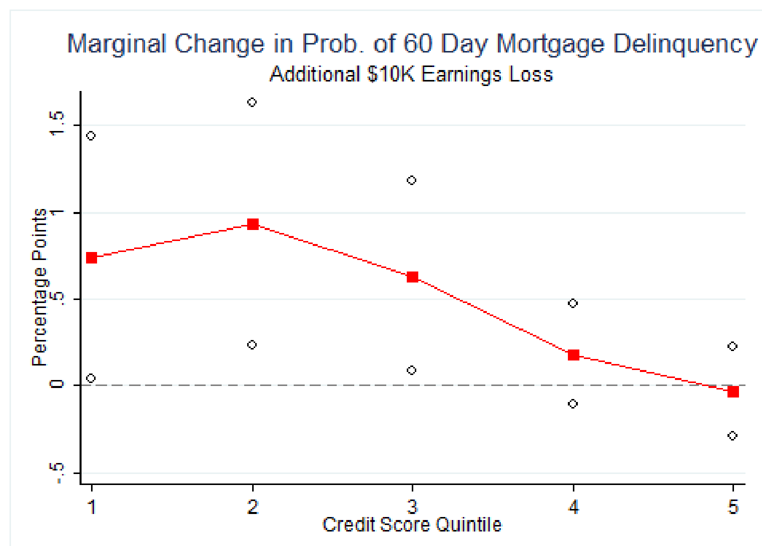
(b) New Home Equity Borrowing



(c) 30 Day Delinquency



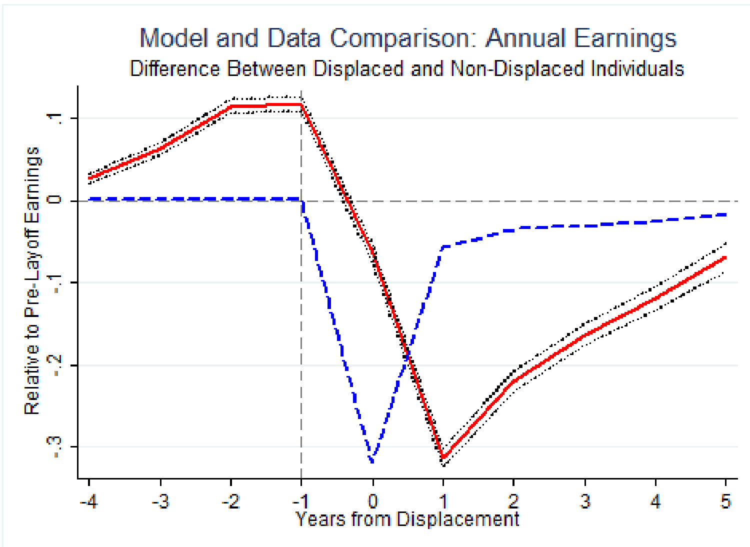
(d) 60 Day Mortgage Delinquency



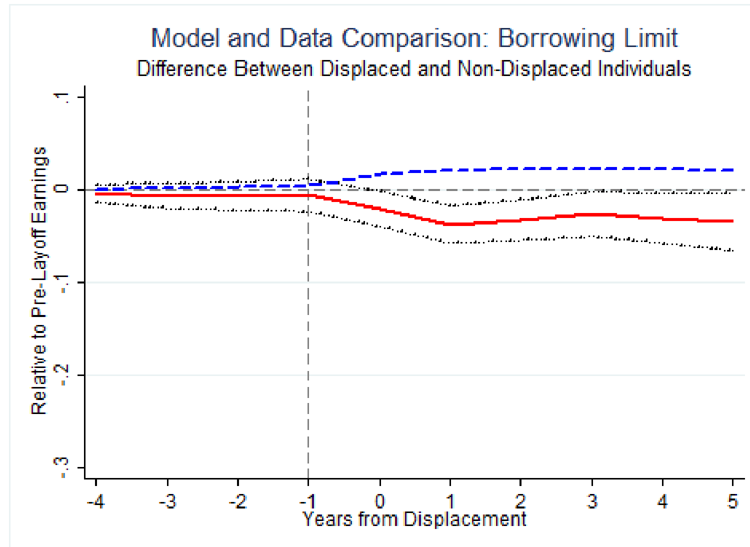
Notes: Squares in the figures present the marginal effect of earnings loss on the variable of interest. The estimates are taken from Column (3) of Tables 5, and 13-15. The coefficient for Credit Score Quintile 1 correspond to the coefficient Chg. Earnings from the table, while the coefficient for Credit Score Quintile k corresponds to the sum of the coefficients Chg. Earnings and Chg. Earnings Credit Quin k. The dots represent a 95 percent confidence interval.

Figure 6: Model Predictions of the Average Response of Earnings and Credit Variables to Displacement

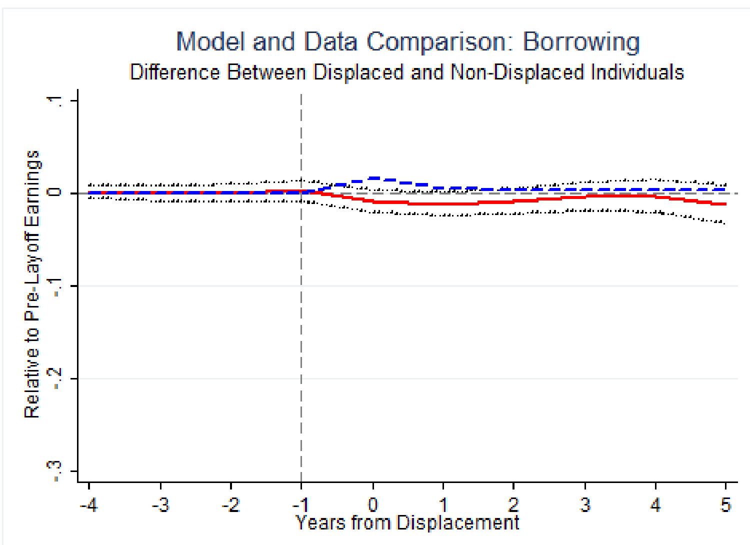
(a) Annual Earnings



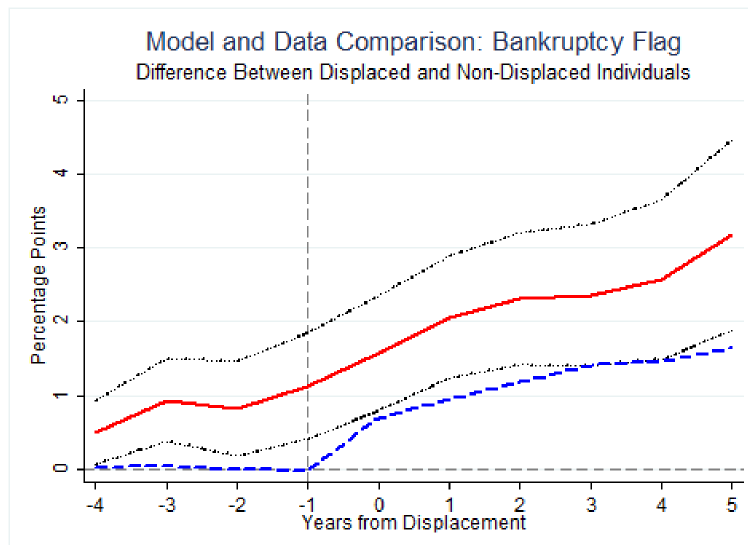
(b) Borrowing Limit



(c) Borrowing

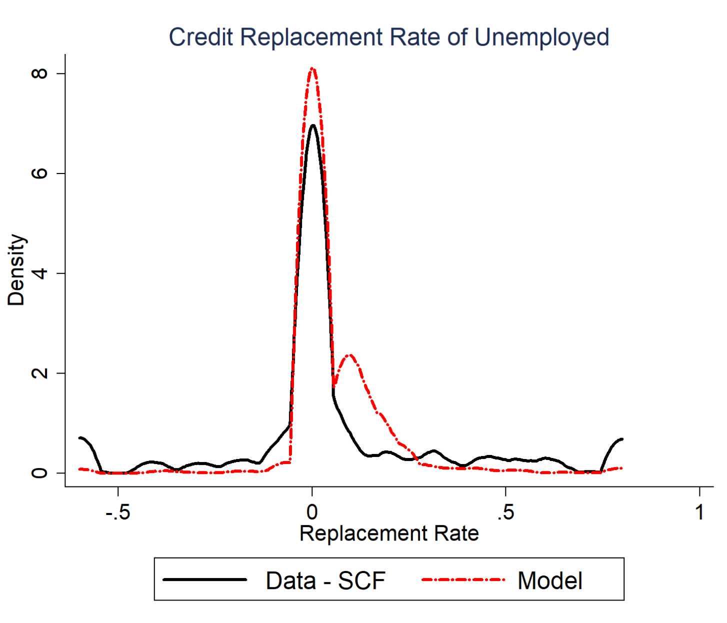


(d) Default



Notes: Figure presents estimates of the effect of job loss on earnings and credit variables. Solid line is interpreted as the difference in the outcome variable between displaced and nondisplaced individuals. Dashed line represents a 95 percent confidence interval.

Figure 7: Model Predictions of the Replacement Rate

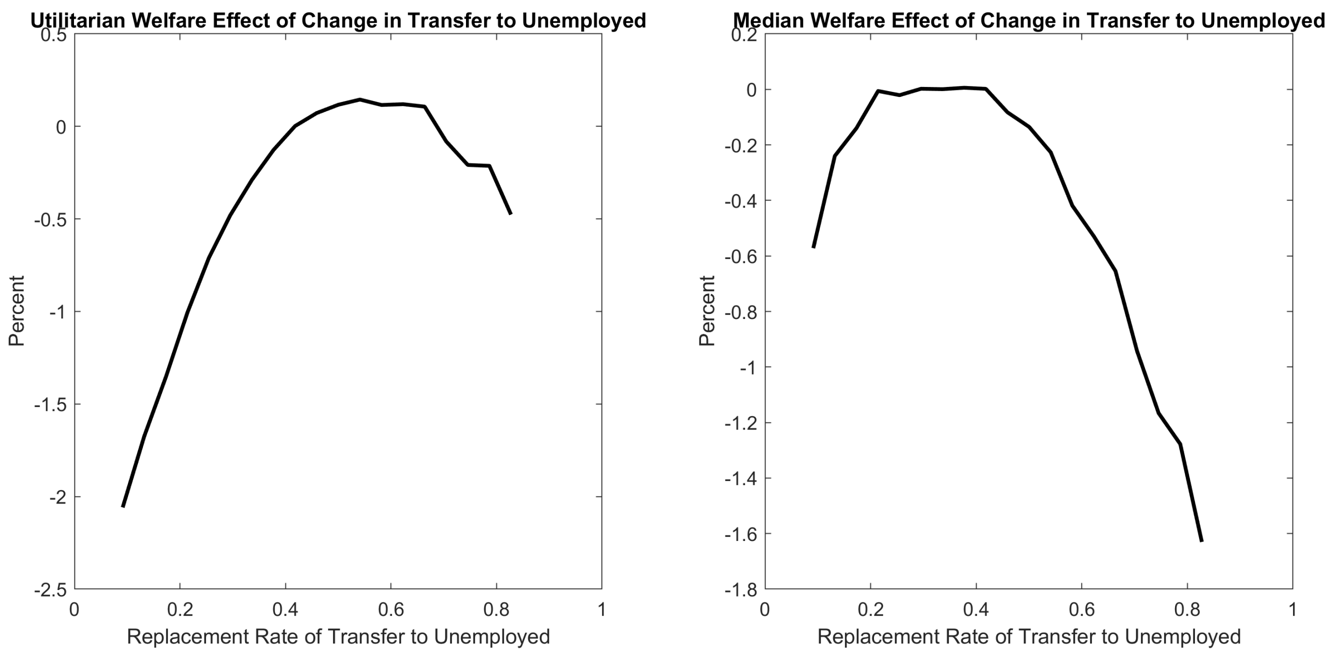


Notes: Figure presents estimates of the models estimate of the replacement rate of credit following job loss, against data estimates of the replacement rate of credit around job loss as measured in the SCF.

Figure 8: Welfare Effect of Change in Unemployment Insurance Replacement Rate

(a) Utilitarian Welfare Effect

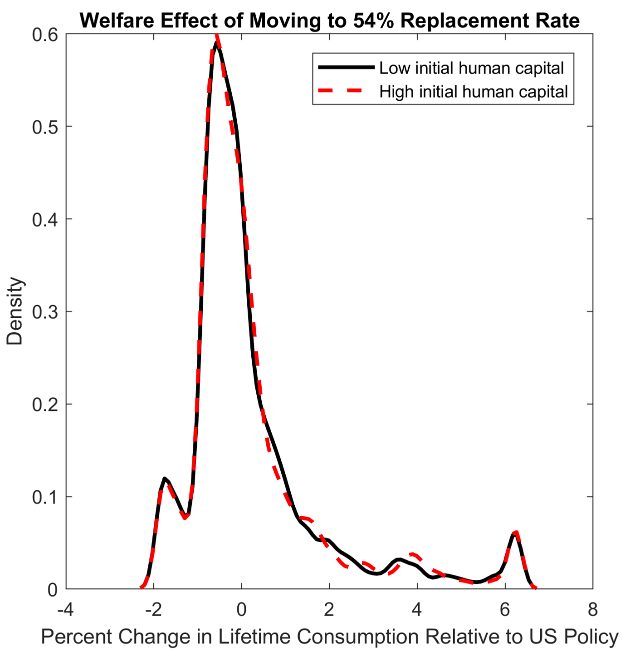
(b) Median Welfare Effect



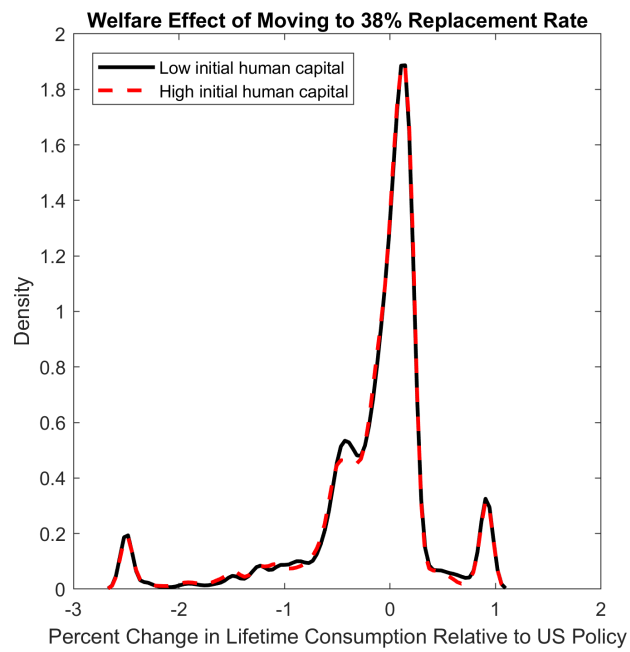
Notes: Welfare changes are measured using consumption equivalents from leaving an economy with the US policy of a of 42% *replacement rate for unemployed workers and entering an economy a different replacement rate policy. For example, at a replacement rate of* 54%*, the mean welfare change of* 0.15% *indicates that ex-ante, on average, an individual would give up* 0.15*% of lifetime consumption to leave the US policy and be indifferent to moving to an economy with the* 54% *policy. Additionally, at a replacement rate of of* 54%*, the median welfare change of* -0.23% *indicates that ex-post, the median individual would have to be given* 0.23% *of lifetime consumption to leave the US policy and be indifferent to moving to an economy with the* 54% *policy. See Appendix G for details on the estimation of the welfare effect.*

Figure 9: Distribution of Welfare Changes from Changing Public Transfer to Unemployed

(a) Transfer Replacing 54% of Lost Earnings



(b) Transfer Replacing 38% of Lost Earnings



Notes: Welfare changes are measured using consumption equivalents from leaving an economy with the US policy of a of 42% replacement rate for unemployed workers and entering an economy a different replacement rate policy. The tails of the distribution have been winsorized at the 2.5% level. See Appendix G for details on the estimation of the welfare effect.

A Data Appendix

A.1 Identifying Mass Layoffs

To identify mass layoffs, we combine data from the Longitudinal Business Dynamics (LBD) database on establishment exits with the LEHD. In each state, employers are assigned a State Employment Identification Number (SEIN) in the LEHD database. This is our unit of analysis for mass layoffs. We define a mass layoff to occur when an SEIN with at least 25 employees reduces its employment by 30% or more within a quarter and continues operations, or exits in the LEHD with a contemporaneous plant exit in the LBD. In California, we do not have LBD establishment exit information, however. To ensure that the there was actually a mass layoff, we then verify that fewer than 80% of laid-off workers move to any other single SEIN using the Successor Predecessor File (SPF). This allows us to remove mergers, firm name-changes, and spin-offs from our sample.

B Robustness

In this appendix, we provide various robustness checks on our primary results. We include summary statistics for an additional measures of consumer credit. We also presents additional results for the average response of credit variables following job loss, additional results for the heterogeneous response of credit variables following job loss, and estimates of the response of borrowing to unemployment as measured in the SCF.

B.1 Summary Statistics: Additional Credit Measures

Table 10 provides summary statistics for the panel sample on their balance, limits and unused limit to income for bank cards in the year prior to mass layoff. The table shows that the treatment and control groups are very similar in their use of bank cards as well as their limits and unused limits to income in the year prior to mass layoff. The table also shows that individuals in the treatment and control groups are similar in their amount of total outstanding credit as well as credit limit in the year prior to layoff.

Table 10: Summary Statistics: Bank Cards

Panel Sample (Year Prior to Mass Layoff)		
	(1) Treatment	(2) Control
Bank Card Balance	\$5584	\$6004
Bank Card Limit	\$16447	\$17703
Unused Bank Card to Income	0.29	0.28
Total Credit Balance	\$118475	\$126098
Total Credit Limit	\$144553	\$154418
Observations Rounded to 000s	31000	30000

B.2 Additional Average Response Results

In this section, we estimate the average response of additional credit variables to job loss. First, we examine estimates of credit access as well as usage (Table 11), and then examine the impact on measures of default (Table 12). The coefficients in Tables 11 and 12 correspond to $(\beta_{-4}, \beta_{-3}, ..., \beta_4, \beta_5)$ in equation 1, and are interpreted as the difference in the outcome variable between displaced and nondisplaced individuals. Figure 10 plots the coefficient estimates from Tables 11 and 12 along with 95 percent confidence intervals for bank card limits and balances, as well as 60 day delinquencies and bankruptcy flags.

B.2.1 Credit Access and Usage

Table 11 documents the average response of additional measures of credit access and usage following job loss. Column (1) of Table 11 and Panel (a) of Figure 10 shows the difference in bank card limits for displaced and nondisplaced individuals around a mass layoff event. The figure shows that displaced and nondisplaced individuals do not have significantly different bank card limits prior to job loss; however in the years following displacement, displaced individuals have bank card limits which are significantly lower than nondisplaced individuals. While statistically significant the size of the difference in bank card limits between displaced and nondisplaced individuals never exceeds $1200 and is economically small relative to the size of limits that individuals have prior to job loss (nearly $16.5K for individuals in the treatment group).

Column (2) of Table 11 and Panel (b) of figure 10 displays the difference in bank card balances for displaced and nondisplaced individuals around a mass layoff event. The figure shows that displaced and nondisplaced individuals do not have significantly different bank card balances in the years prior to job loss, and for the first several years following job loss. Three years after job loss the difference in bank card balances between displaced and nondisplaced individuals is only $370, which while statistically significant is not economically significant, especially relative to the size of earnings losses, which three years after layoff remain over $7k).

Columns (3) and (4) show that there are similar results for total credit limits and balances around job loss. The magnitude of the decline in total credit balances is larger and statistically significant, however, column (5) shows the decline in total credit balances following job loss is driven almost entirely by declining mortgage balances.

Finally, column (6) of Table 11 shows the difference in the probability to take out a new home equity line of credit for displaced and nondisplaced individuals around a mass layoff event. One year after job loss, the probability a displaced individuals takes out a new home equity line is 0.371 percentage points less than a nondisplaced individual. In all other years, there is no significant difference between the probability of taking out a new home equity line for displaced and nondisplaced individuals.

B.2.2 Measures of Default

Table 12 documents the average response of additional measures of default activity following job loss.

Column (1) of Table 12 and Panel (c) of Figure 10 shows the difference in the probability of having a 60 day delinquency within the past year between displaced and nondisplaced individuals. The figure shows that individuals begin to default on their outstanding debt balances following job loss. One year after displacement, the probability that a displaced individual has a 60 day delinquency is over 3 percentage points higher than a nondisplaced individual.

Column (2) of Table 12 and Panel (d) of Figure 10 shows the difference in the probability of having a bankruptcy flag between displaced and nondisplaced individuals. The figure shows that following job loss there is a steady increase in the probability that an individual has a bankruptcy flag on their credit report.

Finally, Column (3) of Table 12 shows the difference in the probability of having a foreclosure within the past year between displaced and nondisplaced individuals. The coefficient estimates show that in the year following displacement the probability an individual has a foreclosure increases by nearly 0.7 percentage points.

Table 11: Average Response of Additional Credit Variables to Displacement: Credit Access and Usage

	(1) Bank Card Limit	(2) Bank Card Balance	(3) Total Credit Limit	(4) Total Credit Balance	(5) Mortgage Balance	(6) New Home Equity Line (d)
4 Years Before Displacement (d)	-82.52	33.97	720.4	886.9	983.1	-0.000144
	(121.2)	(69.43)	(970.4)	(920.2)	(864.5)	(0.00151)
3 Years Before Displacement (d)	-196.4	-8.048	-503.4	-245.3	-430.5	0.000137
	(155.4)	(85.07)	(1,267)	(1,187)	(1,103)	(0.00159)
2 Years Before Displacement (d)	-276.8	-31.42	-1,291	-928.7	-1,364	0.000577
	(177.8)	(92.54)	(1,485)	(1,390)	(1,285)	(0.00163)
1 Year Before Displacement (d)	-210.7	17.44	-2,011	-1,364	-2,070	0.000230
	(196.8)	(100.2)	(1,708)	(1,600)	(1,472)	(0.00175)
Year of Displacement (d)	-465.5**	-126.0	-6,574***	-5,442***	-5,128***	-0.000169
	(211.4)	(106.4)	(1,870)	(1,755)	(1,615)	(0.00181)
1 Year After Displacement (d)	-819.8***	-142.9	-13,993***	-11,918***	-10,636***	-0.00371**
	(222.7)	(111.5)	(1,948)	(1,830)	(1,680)	(0.00173)
2 Years After Displacement (d)	-947.2***	-263.7**	-12,922***	-10,727***	-9,658***	0.000188
	(240.3)	(120.7)	(2,107)	(1,983)	(1,819)	(0.00191)
3 Years After Displacement (d)	-1,034***	-371.1***	-10,703***	-8,335***	-7,577***	0.00288
	(263.7)	(132.6)	(2,346)	(2,209)	(2,028)	(0.00218)
4 Years After Displacement (d)	-1,128***	-298.1**	-12,229***	-9,628***	-9,288***	0.00175
	(299.0)	(149.9)	(2,625)	(2,474)	(2,270)	(0.00235)
5 Years After Displacement (d)	-1,092***	-402.2**	-11,973***	-9,583***	-8,828***	0.00335
	(353.5)	(176.5)	(3,024)	(2,862)	(2,636)	(0.00257)
Individual Fixed Effects	Y	Y	Y	Y	Y	Y
Year Fixed Effects	Y	Y	Y	Y	Y	Y
Age and Wealth Controls	Y	Y	Y	Y	Y	Y
R-squared	0.012	0.006	0.085	0.078	0.077	0.008
Indiv-Yr Obs.	472000	472000	472000	472000	472000	472000
No. of Indiv	61000	61000	61000	61000	61000	61000

Notes: Robust SE in parenthesis. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. *Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. The symbol (d) indicates a dummy variable. Bank card limit and balance are in 2008 dollars.*

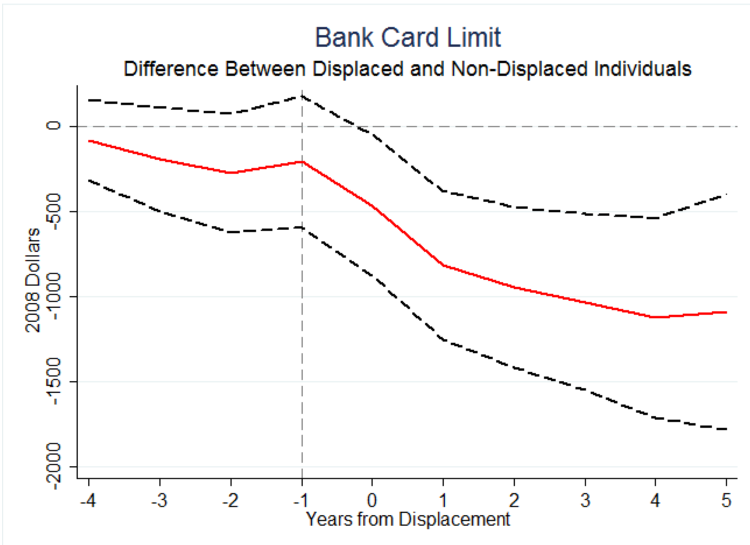
Table 12: Average Response of Additional Credit Variables to Displacement: Measures of Default

	(1) 60 Day Delinq. (d)	(2) Bankruptcy Flag (d)	(3) Foreclosure (d)
4 Years Before Displacement (d)	0.000988	0.00496**	0.00134
	(0.00438)	(0.00221)	(0.000831)
3 Years Before Displacement (d)	-0.000926	0.00935***	0.00138
	(0.00480)	(0.00286)	(0.000859)
2 Years Before Displacement (d)	-0.0119**	0.00821**	0.00166*
	(0.00497)	(0.00328)	(0.000918)
1 Year Before Displacement (d)	-0.00513	0.0113***	0.00216**
	(0.00524)	(0.00367)	(0.00101)
Year of Displacement (d)	0.00785	0.0157***	0.00350***
	(0.00550)	(0.00397)	(0.00113)
1 Year After Displacement (d)	0.0328***	0.0206***	0.00686***
	(0.00569)	(0.00423)	(0.00133)
2 Years After Displacement (d)	0.0199***	0.0231***	0.00519***
	(0.00619)	(0.00457)	(0.00143)
3 Years After Displacement (d)	0.0102	0.0236***	0.00372**
	(0.00685)	(0.00489)	(0.00157)
4 Years After Displacement (d)	-0.00804	0.0257***	0.00241
	(0.00770)	(0.00552)	(0.00187)
5 Years After Displacement (d)	-0.0198**	0.0317***	-0.000804
	(0.00927)	(0.00661)	(0.00253)
Individual Fixed Effects	Y	Y	Y
Year Fixed Effects	Y	Y	Y
Age and Wealth Controls	Y	Y	Y
R-squared	0.007	0.019	0.009
Indiv-Yr Obs.	472000	472000	472000
No. of Indiv	61000	61000	61000

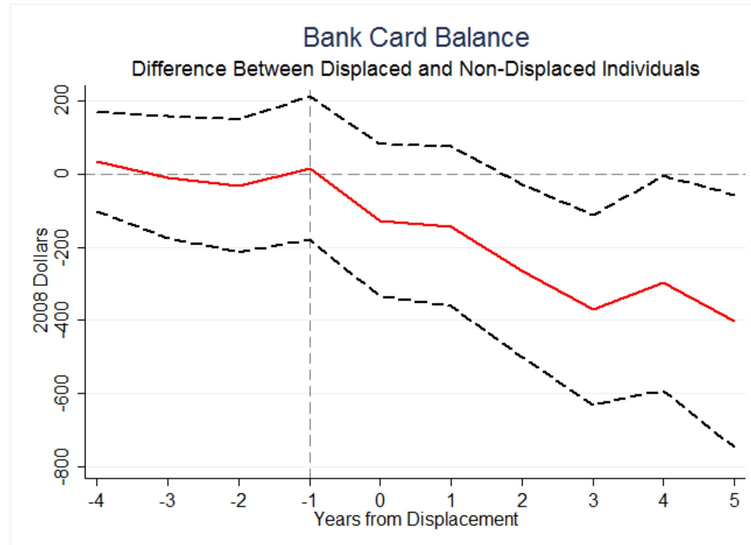
Notes: Robust SE in parenthesis. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. *Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. The symbol (d) indicates a dummy variable. Bank card limit and balance are in 2008 dollars.*

Figure 10: Additional Average Response Results

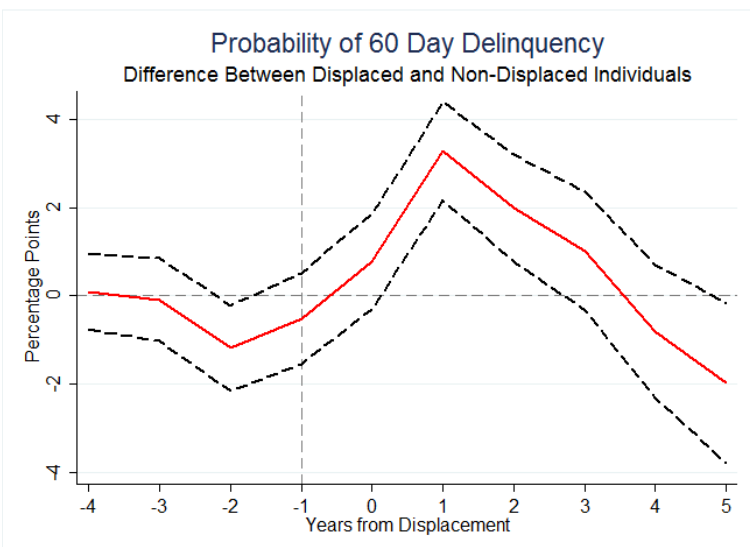
(a) Bank Card Limit



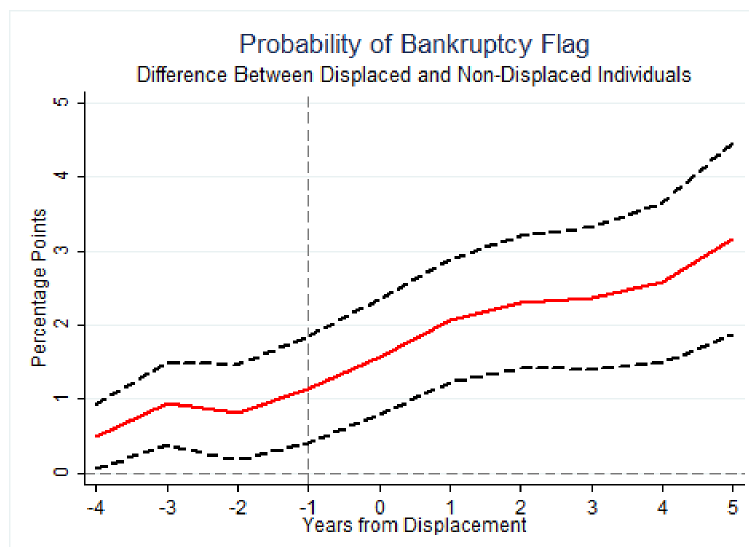
(b) Bank Card Balance



(c) 60 Day Delinquency



(d) Bankruptcy Flag



Notes: Figure presents estimates of the effect of job loss on credit market variables and measures of default and delinquency. Solid line is interpreted as the difference in the outcome variable between displaced and nondisplaced individuals. Dashed line represents a 95 percent confidence interval. Figures present coefficient estimates from Table 11.

B.3 Additional Heterogeneous Response Results

In this Appendix we show additional results for the heterogeneous response of credit activity in response to a change in earnings.

B.3.1 Home Equity

Table 13 considers the impact of changes in earnings on the propensity to take out a new home equity line of credit. Column (1) estimates the average relationship between changes in earnings and taking out new home equity lines of credit. The coefficient estimate on the change in earnings is positive and indicates that an additional \$10K decline in earnings *increases* the probability that an individual will take out a new home equity line of credit by 0.79 percentage points ($0.0079 = -7.91e - 07 \times -10,000$).

Column (3) separates individuals by their credit score in the year prior to job loss and estimates the impact of earnings losses on the propensity to take out a new home equity line, while controlling for the year of layoff as well as age and proxies for wealth. Panel (b) of Figure 5 plots the marginal effect of an additional \$10K earnings loss on the probability of taking out a new home equity line of credit. The figure shows that the response of earnings losses on obtaining a new home equity line is heterogeneous by credit score quintile. For individuals in the lowest two credit score quintiles a decline in earnings *decreases* the probability that an individual takes out a new home equity line. An additional \$10K decline in earnings *decreases* the likelihood that an individual in the lowest credit score quintile takes out a new home equity line by 0.415 percentage points ($0.00415 = 4.15e - 07 \times -10,000$), ceteris paribus. Conversely, for an individual in the top credit score quintile further decreases in earnings *increase* their probability of taking out a new home equity line. An additional \$10K decline in earnings *increases* the probability that an individual in the highest credit score quintile takes out a new home equity line by 0.65 percentage points ($-0.0065 = [4.15e - 07 \ - \ 1.06e - 06] \times -10,000$). The size of this increase in the probability of taking out a new home equality line of credit is large given that only 7.9 percent of consumers have a revolving home equity line.[31]

B.3.2 30 Day Delinquency

Table 14 considers the effect of changes in earnings on the propensity to have a 30 day delinquency in the year of displacement. Column (1) estimates the average relationship between changes in earnings and having a 30 day delinquency. The coefficient is positive but insignificant, indicating that the size of earnings losses does not impact the probability of having a 30 day delinquency. Column (3) separates individuals by their credit score in the year prior to job loss and estimates

[31]The share of consumers with a revolving home equity line comes from the Federal Reserve Bank of New York's Quarterly Report on Household Debt and Credit. Accessed from "https://www.newyorkfed.org/microeconomics/databank.html" on 6/14/2017.

the impact of earnings losses on the probability of having a 30 day mortgage, while controlling for the year of layoff as well as age and proxies for wealth. Panel (c) of Figure 5 plots the marginal effect of an additional \$10K earnings loss on the probability of having a 30 day delinquency. The figure shows that individuals in the second and third credit score quintiles see their probability of having a 30 day delinquency increase with greater declines in earnings. For an individual in the second credit score quintile, an additional \$10K earnings loss *increases* the probability of having a 30 day delinquency by 1.4 percentage points ($.014 = [-2.47e-08 \ - \ -1.38e-06] \times 10,000$).

B.3.3 Mortgage Default Results

Table 15 illustrates the impact of changes in earnings on the odds of having a 60 day mortgage delinquency. Column (1) estimates the average relationship between changes in earnings and having a 60 day mortgage delinquency. The coefficient estimate on the change in earnings is negative and indicates that an additional \$10K earnings loss increases the probability that an individual will have a mortgage delinquency by 0.517 percentage points ($0.00517 = -5.17e-07 \times -10,000$).

In column (3) we allow for potentially heterogeneous responses by credit score prior to displacement and control for the year of layoff as well as age and proxies for wealth. Panel (d) of Figure 5 plots the marginal effect of an additional 10K earnings loss on the probability of having a 60 day mortgage delinquency by credit score quintile. The figure shows that a decline in earnings significantly impacts the propensity to have a 60 day mortgage delinquency for individuals in the bottom three credit score quintiles. For an individual in the lowest credit score quintile, an additional \$10K earnings loss *increases* the probability of having a mortgage delinquency by 0.739 percentage points ($0.00739 = -7.39e-07 \times -10,000$). For individuals in the top two credit score quintiles earnings losses do not impact their probability of having a 60 day mortgage delinquency.

B.4 SCF Evidence

In this section we present results from the publicly available SCF and show that the they are consistent with the results from our LEHD/TransUnion sample.

In Figure 11, we present the credit replacement rate of the unemployed as measured in the SCF. To estimate the credit replacement rate in the SCF, we exploit the panel nature of the SCF between 2007 and 2009. In particular, we estimate the change in debt and income for individuals who experienced at least one week of unemployment in the past year when interviewed as part of the 2009 SCF. Figure 11 reveals a similar pattern on the borrowing activity of the unemployed as our LEHD/TransUnion sample (Figure 3).

Table 13: Earnings Losses and New Home Equity Lines by Credit Score

	(1) New Home Equity Line (d)	(2) New Home Equity Line (d)	(3) New Home Equity Line (d)
Chg. Earning	-7.91e-07***	-8.68e-09	4.15e-07***
	(1.14e-07)	(5.81e-08)	(8.01e-08)
Chg. Earnings x Credit Score Quin 2 (d)		-2.78e-08	7.00e-10
		(1.53e-07)	(1.55e-07)
Chg. Earnings - x Credit Score Quin 3 (d)		-5.71e-07**	-5.09e-07**
		(2.33e-07)	(2.33e-07)
Chg. Earnings x Credit Score Quin 4 (d)		-7.57e-07***	-6.36e-07**
		(2.86e-07)	(2.85e-07)
Chg. Earnings x Credit Score Quin 5 (d)		-1.20e-06***	-1.06e-06***
		(2.89e-07)	(2.89e-07)
Constant	0.0275***	0.00312***	-0.0507***
	(0.00188)	(0.00114)	(0.0170)
Constant x Credit Score Quin 2 (d)		0.00820***	0.00867***
		(0.00270)	(0.00274)
Constant x Credit Score Quin 3 (d)		0.0187***	0.0180***
		(0.00383)	(0.00385)
Constant x Credit Score Quin 4 (d)		0.0525***	0.0497***
		(0.00546)	(0.00545)
Constant x Credit Score Quin 5 (d)		0.0593***	0.0546***
		(0.00584)	(0.00583)
Year FE	N	N	Y
Age and Wealth Controls	N	N	Y
R-Square	0.004	0.029	0.040
No of Indiv.	21000	21000	21000
P-Value Chg Earn Quin 2		0.797	0.00612
P-Value Chg Earn Quin 3		0.0102	0.682
P-Value Chg Earn Quin 4		0.00625	0.436
P-Value Chg Earn Quin 5		2.03e-05	0.0257

Notes: Robust SE in parenthesis. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. *The change in real annual earnings is winsorized at the top and bottom at the 1 percent level, and is measured in 2008 dollars. Credit Score Quin k refers to credit score quintile k, where credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. The symbol (d) indicates a dummy variable. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. P-Value Chg Earn Quin k refers to the p-value for the sum of the coefficients Chg. Earn and Chg. Earn x Credit Score Quin k.*

Table 14: Earnings Losses and 30 Day Delinquency by Credit Score

	(1) 30 Day Delinq. (d)	(2) 30 Day Delinq. (d)	(3) 30 Day Delinq. (d)
Chg. Earning	2.10e-07	-1.64e-07	-2.47e-08
	(2.26e-07)	(5.14e-07)	(5.25e-07)
Chg. Earning x Credit Score Quin 2 (d)		-1.37e-06*	-1.38e-06*
		(7.53e-07)	(7.54e-07)
Chg. Earning - x Credit Score Quin 3 (d)		-1.04e-06	-1.04e-06
		(7.35e-07)	(7.36e-07)
Chg. Earning x Credit Score Quin 4 (d)		-7.12e-07	-6.70e-07
		(6.95e-07)	(6.96e-07)
Chg. Earning x Credit Score Quin 5 (d)		2.25e-07	2.94e-07
		(6.45e-07)	(6.47e-07)
Constant	0.516***	0.696***	0.721***
	(0.00475)	(0.00983)	(0.0502)
Constant x Credit Score Quin 2 (d)		-0.0704***	-0.0700***
		(0.0143)	(0.0144)
Constant x Credit Score Quin 3 (d)		-0.184***	-0.184***
		(0.0145)	(0.0145)
Constant x Credit Score Quin 4 (d)		-0.315***	-0.316***
		(0.0142)	(0.0143)
Constant x Credit Score Quin 5 (d)		-0.403***	-0.405***
		(0.0137)	(0.0138)
Year FE	N	N	Y
Age and Wealth Controls	N	N	Y
R-Square	0.000	0.093	0.094
No of Indiv.	21000	21000	21000
P-Value Chg Earn Quin 2		0.00525	0.0124
P-Value Chg Earn Quin 3		0.0224	0.0481
P-Value Chg Earn Quin 4		0.0609	0.148
P-Value Chg Earn Quin 5		0.876	0.505

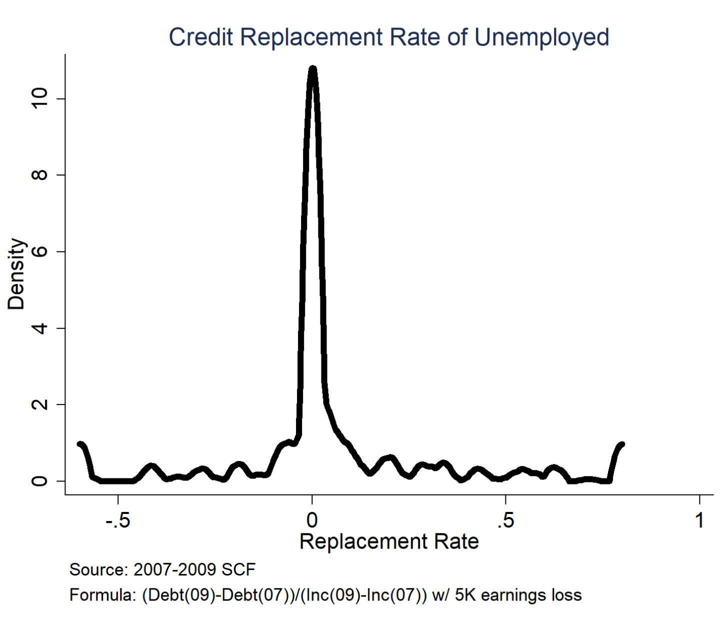
Notes: Robust SE in parenthesis. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$. *The change in real annual earnings is winsorized at the top and bottom at the 1 percent level, and is measured in 2008 dollars. Credit Score Quin k refers to credit score quintile k, where credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. The symbol (d) indicates a dummy variable. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. P-Value Chg Earn Quin k refers to the p-value for the sum of the coefficients Chg. Earn and Chg. Earn x Credit Score Quin k.*

Table 15: Earnings Losses and 60 Day Mortgage Delinquency by Credit Score

	(1) 60 Day Mortgage Deliq. (d)	(2) 60 Day Mortgage Deliq. (d)	(3) 60 Day Mortgage Deliq. (d)
Chg. Earning	-5.17e-07***	-9.87e-07***	-7.39e-07**
	(1.05e-07)	(3.52e-07)	(3.56e-07)
Chg. Earnings x Credit Score Quin 2 (d)		-2.32e-07	-1.95e-07
		(4.99e-07)	(4.98e-07)
Chg. Earnings - x Credit Score Quin 3 (d)		8.78e-08	1.06e-07
		(4.46e-07)	(4.47e-07)
Chg. Earnings x Credit Score Quin 4 (d)		5.30e-07	5.59e-07
		(3.78e-07)	(3.79e-07)
Chg. Earnings x Credit Score Quin 5 (d)		7.68e-07**	7.75e-07**
		(3.73e-07)	(3.75e-07)
Constant	0.0373***	0.0668***	0.00822
	(0.00193)	(0.00586)	(0.0194)
Constant x Credit Score Quin 2 (d)		-0.00874	-0.00759
		(0.00812)	(0.00810)
Constant x Credit Score Quin 3 (d)		-0.0395***	-0.0389***
		(0.00729)	(0.00727)
Constant x Credit Score Quin 4 (d)		-0.0563***	-0.0568***
		(0.00630)	(0.00633)
Constant x Credit Score Quin 5 (d)		-0.0586***	-0.0594***
		(0.00630)	(0.00635)
Year FE	N	N	Y
Age and Wealth Controls	N	N	Y
R-Square	0.001	0.022	0.026
No of Indiv.	21000	21000	21000
P-Value Chg Earn Quin 2		0.000588	0.00895
P-Value Chg Earn Quin 3		0.00108	0.0237
P-Value Chg Earn Quin 4		0.00108	0.222
P-Value Chg Earn Quin 5		0.0779	0.784

*Notes: Robust SE in parenthesis. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The change in real annual earnings is winsorized at the top and bottom at the 1 percent level, and is measured in 2008 dollars. Credit Score Quin k refers to credit score quintile k, where credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. The symbol (d) indicates a dummy variable. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. P-Value Chg Earn Quin k refers to the p-value for the sum of the coefficients Chg. Earn and Chg. Earn x Credit Score Quin k.*

Figure 11: Credit Replacement Rate of Unemployed from SCF



Notes: Figure presents the credit replacement rate using the 2007-2009 waves of the SCF.

C Employed Value Functions

In this appendix we present the value functions for employed households, as well as lenders who are matched with an employed household.

C.1 Bellman Equations for Employed Agents

In this appendix, we present the Bellman equations for an employed agent.

Every period employed agents without a credit contract, decide whether or not to search for a credit contract:

$$\begin{aligned} W^S_{i,t}(\omega, b, h; 0, 0) &= \max\left\{-\kappa_S + W^a_{i,t}(\omega, b, h; 0, 0);\ W^N_{i,t}(\omega, b, h; 0, 0)\right\} \quad \forall t \leq T \\ W^S_{i,T+1}(\omega, b, h; 0, 0) &= 0 \end{aligned}$$

where:

$$\begin{aligned} W^a_{i,t}(\omega, b, h; 0, 0) = \max_{(\underline{b}, r) \in \underline{\mathcal{B}} \times \mathcal{R}} & p^c(\theta^{c,W}_t(\omega, b, h; \underline{b}, r)) W^C_{i,t}(\omega, b, h; \underline{b}, r) \\ & + \left(1 - p^c(\theta^{c,W}_t(\omega, b, h; \underline{b}, r))\right) W^N_{i,t}(\omega, b, h; 0, 0) \end{aligned}$$

After the asset market closes, the agent makes their consumption and savings decisions. For an agent that did not not receive a credit contract, their consumption and savings problem is constrained in that the agent is not allowed to borrow. At the start of the next period with probability δ the agent looses their job, and is immediately able to search for a job.[32] The value function summarizing the payoffs of an employed agent without credit access is

$$W^N_{i,t}(\omega, b, h; 0, 0) = \max_{b' \geq 0} u(c) + \beta_i \mathbb{E}\Big[(1-\delta) W^S_{i,t+1}(\omega, b', h'; 0, 0) + \delta \Big(\max_{\tilde{\omega}} p(\theta_{i,t+1}(\tilde{\omega}, h')) W^S_{i,t+1}(\tilde{\omega}, b', h'; 0, 0) + \Big(1 - p(\theta_{i,t+1}(\tilde{\omega}, h'))\Big) U^S_{i,t+1}(b', h'; 0, 0)\Big)\Big] \quad \forall t \leq T$$

$$W^N_{i,T+1}(\omega, b, h; 0, 0) = 0$$

subject to the budget constraint,

$$c + q(b', r) b' \leq (1-\tau)\omega f(h) + b$$

where: $q(b', r) = \mathbb{I}\{b' < 0\}\frac{1}{1+r} + \mathbb{I}\{b' \geq 0\}\frac{1}{1+r_f}$.

For an agent with a credit contract, their consumption and savings problem is constrained by their borrowing limit $\underline{b}$. At the start of the next period with probability δ the agent looses their job, and is immediately able to search for a job. The value function summarizing the payoffs of an employed agent with credit access is

$$W^C_{i,t}(\omega, b, h; \underline{b}, r) = \max_{b' \geq \underline{b}} u(c) + \beta_i \mathbb{E}\Big[(1-\delta) W^D_{i,t+1}(\omega, b', h'; \underline{b}, r) + \delta \Big(\max_{\tilde{\omega}} p(\theta_{i,t+1}(\tilde{\omega}, h')) W^D_{i,t+1}(\tilde{\omega}, b', h'; \underline{b}, r) + \Big(1 - p(\theta_{i,t+1}(\tilde{\omega}, h'))\Big) U^D_{i,t+1}(b', h'; \underline{b}, r)\Big)\Big] \quad \forall t \leq T$$

$$W^C_{i,T+1}(\omega, b, h; 0, 0) = 0$$

subject to the budget constraint,

$$c + q(b', r) b' \leq (1-\tau)\omega f(h) + b$$

where: $q(b', r) = \mathbb{I}\{b' < 0\}\frac{1}{1+r} + \mathbb{I}\{b' \geq 0\}\frac{1}{1+r_f}$. After the labor market closes, the agent observes if their credit match has been exogenously ended. With probability δ_c the agent looses their credit market access. After the realization of the credit separation shock the agent decides whether or not to default. The default decision and the resulting continuation value for an unemployed worker is given by

$$W^D_{i,t+1}(\omega, b', h'; \underline{b}, r) = \delta_c \max\{W^N_{i,t+1}(\omega, 0, h'; 0, 0) - \psi_D;\ W^N_{i,t+1}(\omega, b', h'; 0, 0)\} + (1-\delta_c)\max\{W^N_{i,t+1}(\omega, 0, h'; 0, 0) - \psi_D;\ W^C_{i,t+1}(\omega, b', h'; \underline{b}, r)\}$$

[32]Given the model period is 1 quarter we must allow agents to search immediately for the model to match labor flows in the data.

Let $D^{N,W}_{i,t+1}(\omega, b', h'; \underline{b}, r)$ be an indicator function denoting an individual's default decision when they are employed and were hit by the credit separation shock, i.e. $D^{N,W}_{i,t+1} = 1$, when the individual defaults and is equal to zero otherwise. Let $D^{C,W}_{i,t+1}(\omega, b', h'; \underline{b}, r)$ be an indicator function denoting an individuals default decision when they are employed and are not hit by the credit separation shock.

C.2 Bellman Equation for Lender Matched with Employed Worker

In this appendix, we present the Bellman equations for a lender in a match with an employed worker.

Let $\Pi^W_{i,t}$ denote the profits to a lender of being matched with a type i, age t, employed individual. The profits to the lender of offering a contract with borrowing limit $\underline{b}$, and interest rate r is

$$\begin{aligned}\Pi^W_{i,t}(\omega, b, h; \underline{b}, r) = \beta_{lf} b'_{i,t}(\vec{x}) \left(\frac{(r_f - r)}{1+r} + \mathbb{E}\left[\delta_c \hat{D}^{N,W}_{i,t+1}(\vec{x}') + (1-\delta_c)\hat{D}^{C,W}_{i,t+1}(\vec{x}') \right] \right) \times \mathbb{I}\{b'_{i,t}(\vec{x}) < 0\} \\ + \beta_{lf}(1-\delta_c)\mathbb{E}\left[\left(1 - \hat{D}^{C,W}_{i,t+1}(\vec{x}')\right) \hat{\Pi}^W_{i,t+1}(\vec{x}') \right]\end{aligned}$$

At the end of period t, the agent makes their consumption/savings decision $b'_{i,t}$. If the individual is borrowing, $b'_{i,t} < 0$, then in period $t+1$ the lender receives income from the difference between the interest rate r and the risk free rate r_f. However the lender faces default risk on the outstanding loan $b'_{i,t}$. The default risk faced by the lender incorporates the probability of the credit separation shock, as well as shocks to human capital and probability that the borrower loses their job. When the worker separates exogenously separates from the firm, the worker immediately is able to search again. The default probability when hit by the credit shock is

$$\begin{aligned}\hat{D}^{N,W}_{i,t+1}(\vec{x}') &= (1-\delta) D^{N,W}_{i,t+1}(\vec{x}') \\ &+ \delta \left[p\left(\theta_{i,t+1}(\hat{\omega}, h')\right) D^{N,W}_{i,t+1}(\hat{\omega}, b', h'; \underline{b}, r) + \left(1 - p\left(\theta_{i,t+1}(\hat{\omega}, h')\right)\right) D^{N,U}_{i,t+1}(b', h'; \underline{b}, r) \right]\end{aligned}$$

where $\hat{\omega}$ is the unemployed workers choice for where to search for a job. If the agent does not default and the credit match is not hit by the credit separation shock the match between the lender and borrower continues to the next period. The profits to the lender in period $t+1$, are denoted by $\hat{\Pi}^W_{i,t+1}(\vec{x}')$, and take into account the probability that the agent loses their job. The continuation profits to the lender are

$$\begin{aligned}\hat{\Pi}^W_{i,t+1}(\vec{x}') &= (1-\delta)\Pi^W_{i,t+1}(\omega, b', h'; \underline{b}, r) \\ &+ \delta \left[p\left(\theta_{i,t+1}(\hat{\omega}, h')\right) \Pi^W_{i,t+1}(\hat{\omega}, b', h'; \underline{b}, r) + \left(1 - p\left(\theta_{i,t+1}(\hat{\omega}, h')\right)\right) \Pi^U_{i,t+1}(b', h'; \underline{b}, r) \right]\end{aligned}$$

Lenders pay cost κ_C to enter the lending market. Free-entry in the lending market requires that the cost of entering the market is equal to the expected payout of entering the market:

$$\kappa_C = p_f^c\left(\theta_t^{c,W}(\omega, b, h; \underline{b}, r)\right) \sum_i \chi_i^W(\omega, b, h; \underline{b}, r) \mathit{\Pi}_{i,t}^W(\omega, b, h; \underline{b}, r) \tag{13}$$

where $\chi_i^W(\omega, b, h; \underline{b}, r)$ is the share of individuals who "arrive" in market $(\underline{b}, r)$ with states (ω, b, h) that are type i and are employed. Note that individuals who are searching for credit contracts are not currently able to borrow, hence the free entry condition (equation 13) holds for $b \geq 0$.

D Equilibrium Definition

In this Appendix, we formally define an equilibrium for the model presented in Section 2.

Before defining the equilibrium, more notation is necessary. Define B as the set of all potential credit contracts, and define $B^P_{e,t}(\omega, b, h)$ as the set of all contracts that are posted in equilibrium for an age t agent with states (ω, b, h) where $e \in \{U, W\}$ denotes whether an individual is employed or unemployed.[33] Additionally, let $\lambda_{e,t}(\omega, b, h; \underline{b}, r)$ denote the distribution of contracts posted in equilibrium for age t agent with employment status e and states (ω, b, h).

A competitive search equilibrium is a set of *household policy functions for savings and borrowing* $(\{b'_{i,e,t}(\omega, b, h; \underline{b}, r)\}_{t=1}^{T})$, *credit applications* $\{S^e_{i,t}(\omega, b, h; 0, 0)\}_{t=1}^{T}$, *bankruptcy* $(\{D^{e,a}_{i,t}(\omega, b, h; \underline{b}, r)\}_{t=1}^{T})$, *job search choice* $(\{\hat{\omega}_{i,t}(\omega, b, h; \underline{b}, r)\}_{t=1}^{T})$, *a credit contract choice* $(\{(r, \underline{b})_{i,e,t}(\omega, b, h; 0, 0)\}_{t=1}^{T})$, *a labor market tightness function* $\{\theta_{i,t}(\omega, h)\}_{t=1}^{T}$, *a credit market tightness function* $\{\theta^{c,e}_t(\omega, b, h; \underline{b}, r)\}_{t=1}^{T}$, *an unemployment insurance replacement rate* z*, and a proportional tax rate* τ *that satisfy the following conditions*:

1. *Profit Maximization and Free Entry.*

    (a) *Labor Market:* For any labor market contract $(\omega, h)_{i,t}$, the firm's free entry condition (equation 10) is satisfied.

    (b) *Credit Market:* For any credit market contract $(\underline{b}, r) \in B$

    $$\kappa_C \geq p^c_f\left(\theta^{c,e}_t(\omega, b, h; \underline{b}, r)\right) \sum_i \chi^e_{i,t}(\omega, b, h; \underline{b}, r)) \mathit{\Pi}^e_{i,t}(\omega, b, h; \underline{b}, r)$$

    for $e \in \{W, U\}$, and with equality if $(\underline{b}, r) \in B^P_{e,t}(\omega, b, h)$.

2. *Agents optimal search.*

    (a) *Labor Search:* Let $\{\hat{\omega}_{i,t}(\omega, b, h; \underline{b}, r)\}_{t=1}^{T}$ be defined such that:

    $$\begin{aligned}\hat{\omega}_{i,t}(\omega, b, h; \underline{b}, r) \in \underset{\omega}{argmax}\ \Big\{& p(\theta_{i,t}(\omega, h)) W^D_{i,t}(\omega, b, h; \underline{b}, r) \\ &+ (1 - p(\theta_{i,t}(\omega, h)))\, U^D_{i,t}(\omega, b, h; \underline{b}, r)\Big\}\end{aligned}$$

    (b) *Unemployed Credit Search*: Let $\bar{U}_{i,t}(\omega, b, h) = \max\{0, \max_{(\underline{b},r)\in B} p^c(\theta^{c,U}_t(\omega, b, h; \underline{b}, r)) U^C_{i,t}(\omega, b, h; \underline{b}, r) - p^c(\theta^{c,U}_t(\omega, b, h; \underline{b}, r)) U^N_{i,t}(\omega, b, h; 0, 0) - \kappa_S\}$ and $\bar{U}_{i,t}(\omega, b, h) = 0$ if $B^p_{U,t}(\omega, b, h) = \emptyset$. Then for any $(\underline{b}, r) \in B$ and $\forall i$:

    $$\bar{U}_{i,t}(\omega, b, h) \geq p^c(\theta^{c,U}_t(\omega, b, h; \underline{b}, r)) U^C_{i,t}(\omega, b, h; \underline{b}, r) - p^c(\theta^{c,U}_t(\omega, b, h; \underline{b}, r)) U^N_{i,t}(\omega, b, h; \underline{b}, r) - \kappa_S$$

[33] For simplicity we assume the set of potential contracts does not depend on an agent's state. However, the set of contracts offered and obtained in equilibrium will depend on an agent's state.

with equality if $\theta_t^{c,U}(\omega,b,h;\underline{b},r)<\infty$ and $\chi_i^U(\omega,b,h;\underline{b},r)>0$. Moreover if $U_{i,t}^C(\omega,b,h;\underline{b},r)<U_{i,t}^N(\omega,b,h;0,0)$, either $\theta_t^{c,U}(\omega,b,h;\underline{b},r)=\infty$ or $\chi_{i,t}^U(\omega,b,h;\underline{b},r)=0$.

(c) *Employed Credit Search*: Let $\bar{W}_{i,t}(\omega,b,h)=\max\{0,\max_{(\underline{b},r)\in B} p^c(\theta_t^{c,W}(\omega,b,h;\underline{b},r))W_{i,t}^C(\omega,b,h;\underline{b},r)-p^c(\theta_t^{c,W}(\omega,b,h;\underline{b},r))W_{i,t}^N(\omega,b,h;0,0)-\kappa_S\}$ and $\bar{W}_{i,t}(\omega,b,h)=0$ if $B_{W,t}^p(\omega,b,h)=\emptyset$. Then for any $(\underline{b},r)\in B$ and $\forall i$:

$$\bar{W}_{i,t}(\omega,b,h)\geq p^c(\theta_t^{c,W}(\omega,b,h;\underline{b},r))W_{i,t}^C(\omega,b,h;\underline{b},r)-p^c(\theta_t^{c,W}(\omega,b,h;\underline{b},r))W_{i,t}^N(\omega,b,h;\underline{b},r)-\kappa_S$$

with equality if $\theta_t^{c,W}(\omega,b,h;\underline{b},r)<\infty$ and $\chi_i^W(\omega,b,h;\underline{b},r)>0$. Moreover if $W_{i,t}^C(\omega,b,h;\underline{b},r)<W_{i,t}^N(\omega,b,h;0,0)$, either $\theta_t^{c,W}(\omega,b,h;\underline{b},r)=\infty$ or $\chi_{i,t}^W(\omega,b,h;\underline{b},r)=0$.

3. *Agents asset and default choices:*

   (a) *Asset choice:* $\{b'_{i,e,t}(\omega,b,h;\underline{b},r)\}_{t=1}^T$ solves the agent's asset choice problem when they are employed $e=W$, and unemployed $e=U$.

   (b) *Default choice:* $\{D_{i,t}^{e,a}(\omega,b,h;\underline{b},r)\}_{t=1}^T$ solves agent's default problem when they are employed $e=W$, and unemployed $e=U$, as well as when they have been hit by the credit shock $a=N$, and have not been hit by the credit shock $a=C$.

   (c) *Credit Search:* $\{S_{i,t}^e(\omega,b,h;\underline{b},r)\}_{t=1}^T$ solves the agent's optimal credit application decision.

4. *Market Clearing (Consistency of Beliefs): For* $e\in\{W,U\}$ *and* $\forall t$

$$\int_{B^P}\frac{\chi_{i,t}^e(\omega,b,h;\underline{b},r)}{\theta_t^{c,e}(\omega,b,h;\underline{b},r)}d\lambda_{e,t}(\omega,b,h;\underline{b},r)\leq\pi_i\ \ \forall i$$

5. *Government Budget Balance:* The proportional tax τ on wages clears the governments budget constraint (equation 11).

E GSW Assumptions

In this appendix, we show the search model defined in Section 2 satisfies the assumptions of Guerrieri et al. [2010], when workers are heterogeneous in their discount factors.

E.1 Monotonicity

Let $\vec{x} = (\omega, b, h; \underline{b}, r)$ denote the state of an individual.[34] In this subsection, we show that the lenders profit function is monotone $\forall \vec{x}$, and $\forall t$

$$\Pi^U_{L,t}(\vec{x}) \leq \Pi^U_{H,t}(\vec{x}) \text{ and } \Pi^W_{L,t}(\vec{x}) \leq \Pi^W_{H,t}(\vec{x})$$

In showing that the lenders profit function is monotone we make the following assumptions:

1. *Limited default assumption:* $D^{N,e}_{L,t}(\vec{x}) = D^{N,e}_{H,t}(\vec{x}) \approx 0$, and $D^{C,e}_{L,t}(\vec{x}) = D^{C,e}_{H,t}(\vec{x}) \approx 0$ for $e \in \{U, W\}$.
2. *Homogeneous job finding probability:* $\forall (h, i, t)$: $p(\theta_{i,t+1}(h)) = \lambda_0$
3. There is a single wage rate ω
4. *All borrowing and saving occurs at the rate* r: $q(b, r) = q(r) = \frac{1}{1+r}$
5. *Borrowing constraints do not bind:* $\forall \vec{x}$: $b'_{i,t}(\vec{x}) > \underline{b}$

Before proving the monotonicity of the lenders Bellman we state and prove the following lemma, which establishes the relationship between discount factors and asset choices. This relationship will play a key role in establishing the monotonicity of the lenders profit function. We prove the lemma for the case of an unemployed worker. The proof for an employed worker follows in the same manner.

Lemma 1. *An agent's asset choice at* $b'_{i,t}(\vec{x})$ *is a weakly increasing function of their discount factor* β_i *for any age* t*, i.e.* $\frac{\partial b'_{i,t}(\vec{x})}{\partial \beta_i} \geq 0$.

Proof. The proof is performed recursively, by first considering the agent in period T and period $T-1$, and then finally in a general period t.

In period T, $b'_{i,T}(\vec{x}) = 0 \ \forall \vec{x}$, hence $\frac{\partial b'_{i,T}(\vec{x})}{\partial \beta_i} = 0$. Next, consider the households problem in period $T-1$. The household makes a consumption and savings decision to solve the following maximization problem:

$$U^C_{i,T-1}(b, h; \underline{b}, r) = \max_{b' \geq \underline{b}} u(c) + \beta_i \left[\lambda_0 W^D_{i,T}(\omega, b', h; \underline{b}, r) + (1 - \lambda_0)\, U^D_{i,T}(b', h; \underline{b}, r) \right]$$

[34] Note for an unemployed individual their state does not include a firm, i.e. $\vec{x} = (b, h; \underline{b}, r)$.

subject to: $c + q(r)b^{'} \leq z + g + b$. In the terminal period T, agents set their asset choice to zero (i.e. $b^{'}_{i,T}(\vec{x}) = 0 \; \forall \vec{x}$), which gives the following continuation values for the terminal period:

$$\begin{aligned} W^D_{i,T}(\omega, b, h; \underline{b}, r) &= u\left((1-\tau)\omega f(h) + g + b\right) \\ U^D_{i,T}(b, h; \underline{b}, r) &= u\left(z + g + b\right) \end{aligned}$$

To ease notation let $w(\omega, h) = (1-\tau)\omega f(h)$ denote an individuals wage when employed. Using the continuation values from the terminal period, and rewriting consumption in terms of the agents asset choice $b^{'}$, the agent's problem in period $T-1$ is:

$$\begin{aligned} U^C_{i,T-1}(b, h; \underline{b}, r) = \max_{b^{'} \geq \underline{b}} \; & u\left(z + g + b - q(r)b^{'}\right) \\ & + \beta_i \left[\lambda_0 u\left(w(\omega, h) + b^{'}\right) + (1-\lambda_0)\, u\left(z + g + b^{'}\right)\right] \end{aligned}$$

With the assumption that the borrowing constraint is slack at the solution ($b^{'} > \underline{b}$) the first order condition governing the agent's choice $b^{'}$ is:

$$u^{'}\left(z + g + b - q(r)b^{'}\right) = \frac{\beta_i}{q(r)}\left[\lambda_0 u^{'}\left(w(\omega, h) + b^{'}\right) + (1-\lambda_0)\, u^{'}\left(z + g + b^{'}\right)\right] \tag{14}$$

Since $u^{'}(\cdot) > 0$, as β_i increases, the right hand side of equation 14 increases. Since $u(\cdot)$ is concave, for the left hand side of the equation to increase $b^{'}$ must increase. Hence, we have as the discount factor increases, $b^{'}$ increases in period $T-1$, i.e. $\frac{\partial b^{'}_{T-1}(\vec{x})}{\partial \beta} \geq 0$.

Next, consider a general age t. The problem for an unemployed individual of age t is:

$$U^C_{i,t}(b, h; \underline{b}, r) = \max_{b^{'} \geq \underline{b}} u(c) + \beta_i \left[\lambda_0 W^D_{i,t+1}(\omega, b^{'}, h; \underline{b}, r) + (1-\lambda_0)\, U^D_{i,t+1}(b^{'}, h; \underline{b}, r)\right]$$

subject to: $c + q(r)b^{'} \leq z + g + b$. Rewriting the consumption in terms of the agents asset choice $b^{'}$, the problem is reformulated as:

$$\begin{aligned} U^C_{i,t}(b, h; \underline{b}, r) = \max_{b^{'} \geq \underline{b}} \; & u\left(z + g + b - q(r)b^{'}\right) \\ & + \beta_i \left[\lambda_0 W^D_{i,t+1}(\omega, b^{'}, h; \underline{b}, r) + (1-\lambda_0)\, U^D_{i,t+1}(b^{'}, h; \underline{b}, r)\right] \end{aligned}$$

Assuming the borrowing constraint is slack at the solution ($b^{'} > \underline{b}$), then the first order condition governing the agent's choice $b^{'}$ is:

$$u^{'}\left(z + g + b - q(r)b^{'}\right) = \frac{\beta_i}{q(r)}\left[\lambda_0 W^{'D}_{i,t+1}(b^{'}, h; \underline{b}, r) + (1-\lambda_0)\, U^{'D}_{i,t+1}(b^{'}, h; \underline{b}, r)\right] \tag{15}$$

where $W^{'D}_{i,t+1}(\cdot)$ and $U^{'D}_{i,t+1}(\cdot)$ denote the derivatives of $W^D_{i,t+1}$ and $U^D_{i,t+1}$ with respect to next periods asset choice $b^{'}$. Note that the value functions $W^{D}_{i,t+1}$ and $U^{D}_{i,t+1}$are the discounted sum of $T-(t+1)$ period utilities. Since $u^{'}(\cdot)>0$, we have that $W^{'D}_{i,t+1}>0$ and $U^{'D}_{i,t+1}>0$. Additionally, given that the period utility function $u(\cdot)$ is concave, and the sum of concave functions is a concave function we have that $W^{D}_{i,t+1}$ and $U^{D}_{i,t+1}$ are concave in $b^{'}$. Hence, as β_i increases the right hand side of 15 increases. Since $u(\cdot)$ is concave, for the left hand side of the equation to increase $b^{'}$ must increase. Thus, we have as the discount factor β increases, the agent's asset choice $b^{'}_{i,t}$ increases for a general period t, i.e. $\frac{\partial b^{'}_{i,t}(\vec{x})}{\partial \beta_i}\geq 0$. □

We next establish a condition for how lenders profits change with a borrowers initial level of assets. This will also aid in the proof that the lenders profits are monotone. Again this proof is for the profits of a lender matched with an unemployed worker, the proof for a lender matched with an employed worker follows in the same manner.

Lemma 2. *The profits to a lender $\mathit{\Pi}^{U}_{i,t}(b,h;\underline{b},r)$ are weakly decreasing in an agent's initial level of assets b,* $\frac{\partial \mathit{\Pi}^{U}_{i,t}(b,h;\underline{b},r)}{\partial b}\leq 0$.

Proof. We prove the claim using induction. As the base step, we will consider both age T and age $T-1$. For an age T lender there are zero profits, so the statement is trivially satisfied. For an age $T-1$ lender, with the limited default assumption, profits are given as:

$$\mathit{\Pi}^{U}_{i,T-1}(b,h;\underline{b},r)=\frac{\beta_{lf}b^{'}_{i,T-1}(b,h;\underline{b},r)\,(r_f-r)}{1+r}\times\mathbb{I}\{b^{'}_{i,T-1}(b,h;\underline{b},r)<0\}$$

Since profits are equal to zero if $b^{'}_{i,T-1}(b,h;\underline{b},r)\geq 0$, consider only cases where $b^{'}_{i,T-1}(b,h;\underline{b},r)<0$. Hence,

$$\mathit{\Pi}^{U}_{i,T-1}(b,h;\underline{b},r)=\frac{\beta_{lf}b^{'}_{i,T-1}(b,h;\underline{b},r)\,(r_f-r)}{1+r}$$

Taking the derivative with respect to b returns:

$$\frac{\partial \mathit{\Pi}^{U}_{i,T-1}(b,h;\underline{b},r)}{\partial b}=\frac{\beta_{lf}\,(r_f-r)}{1+r}\frac{\partial b^{'}_{i,T-1}(b,h;\underline{b},r)}{\partial b}$$

Since $r_f>r$, for $\frac{\partial \mathit{\Pi}^{U}_{i,T-1}(b,h;\underline{b},r)}{\partial b}\leq 0$, we need to show that $\frac{\partial b^{'}_{i,T-1}(b,h;\underline{b},r)}{\partial b}\geq 0$, that is an agent with a lower amount of assets today has a lower amount of assets in the next period. From equation 14, we can see that as b decreases, for the first order condition to be satisfied $b^{'}$ must decrease, i.e. $\frac{\partial b^{'}_{i,T-1}(b,h;\underline{b},r)}{\partial b}\geq 0$. This generates the desired condition for period $T-1$.

For the induction step, consider a general period t, and assume $\frac{\partial \mathit{\Pi}^{U}_{i,t+1}(b,h;\underline{b},r)}{\partial b}\leq 0$. With the limited default assumption, and again focusing on the region of the parameter space where

$b'_{i,t}(b,h;\underline{b},r) < 0$, profits to the lender in period t are given by:

$$\Pi^U_{i,t}(b,h;\underline{b},r) = \frac{\beta_{lf} b'_{i,t}(b,h;\underline{b},r)\,(r_f - r)}{1+r} + \beta_{lf}(1-\delta_c)\hat{\Pi}^U_{i,t+1}(b',h;\underline{b},r)$$

Taking the derivative with respect to b returns:

$$\frac{\partial \Pi^U_{i,t}(b,h;\underline{b},r)}{\partial b} = \frac{\beta_{lf}\,(r_f - r)}{1+r}\frac{\partial b'_{i,t}(b,h;\underline{b},r)}{\partial b} + \beta_{lf}(1-\delta_c)\frac{\partial \hat{\Pi}^U_{i,t+1}(b',h;\underline{b},r)}{\partial b'}\frac{\partial b'_{i,t}(b,h;\underline{b},r)}{\partial b}$$

From equation 15 as b decreases, we have that b' must decrease as well, that is $\frac{\partial b'_{i,t}(b,h;\underline{b},r)}{\partial b} \geq 0$.[35] Then along with the induction step, we have the desired result that $\frac{\partial \Pi^U_{i,t}(b,h;\underline{b},r)}{\partial b} \leq 0$. □

With Lemmas 1 and 2 established we now proceed to show that the lender's Bellman equation is monotone. Here we prove the case of lending to an unemployed worker. The case for lending to an employed worker following in the same manner.

Proposition. *Let $\vec{x} = (b,h;\underline{b},r)$ denote the state of an unemployed individual. With the given assumptions on limited defaults, homogeneous job finding probabilities, a single wage rate, borrowing and saving occurring at the same interest rate, and slack borrowing constraints, then the profit function to lenders is monotone $\Pi^U_{L,t}(\vec{x}) \leq \Pi^U_{H,t}(\vec{x})$ $\forall \vec{x}$ and $\forall t$.*

Proof. We prove the above proposition using a proof by induction starting from the last period of life.

Base Case Age T and Age $T-1$: For the base case we consider age T and age $T-1$.[36] From equation 7, lenders earns zero profits from an age T individual. Hence, trivially the condition $\Pi^U_{L,T}(\vec{x}) \leq \Pi^U_{H,T}(\vec{x})$ is satisfied. Next consider age $T-1$.

From equation 7 and using the limited default assumption, the difference in profits between lenders to the high and low type in period $T-1$, denoted $\Delta\Pi^U_{T-1}$, is given by:

$$\begin{aligned}\Delta\Pi^U_{T-1}(\vec{x}) &= \Pi^U_{H,T-1}(\vec{x}) - \Pi^U_{L,T-1}(\vec{x}) \\ &= \frac{\beta_{lf}\,(r_f - r)}{1+r}\left[b'_{H,T-1}(\vec{x}) \times \mathbb{I}\{b'_{H,T-1}(\vec{x}) < 0\} - b'_{L,T-1}(\vec{x}) \times \mathbb{I}\{b'_{L,T-1}(\vec{x}) < 0\}\right]\end{aligned} \quad (16)$$

From equation 16 it is clear that if $b'_{H,T-1}(\vec{x}) \leq b'_{L,T-1}(\vec{x})$, then $\Delta\Pi^U_{T-1}(\vec{x}) \geq 0$.[37] From Lemma 1 we have that since $\beta_H < \beta_L$, then $b'_{H,T-1}(\vec{x}) \leq b'_{L,T-1}(\vec{x})$, and hence $\Delta\Pi^U_{T-1}(\vec{x}) \geq 0$.

Induction Step: Age t: Now we consider a general age t, and assume that the condition $\Delta\Pi^U_{t+1}(\vec{x}) \geq 0$ is satisfied. From equation 7 and using the limited default assumption, the difference

[35] This follows from $W^D_{i,t+1}$ and $U^D_{i,t+1}$ being concave in b'.

[36] We consider age $T-1$ in addition to age T, given that the condition is satisfied trivially for age T.

[37] Recall that there is a spread between the rate lenders charge r, and the risk-free rate r_f such that $r > r_f$.

in profits between lenders to the high and low type in period t, is given by:

$$\begin{aligned}
\mathit{\Delta\Pi}_t^U(\vec{x}) &= \mathit{\Pi}_{H,t}^U(\vec{x}) - \mathit{\Pi}_{L,t}^U(\vec{x}) \\
&= \frac{\beta_{lf}\,(r_f - r)}{1+r}\left[b_{H,t}^{'}(\vec{x}) \times \mathbb{I}\{b_{H,t}^{'}(\vec{x}) < 0\} - b_{L,t}^{'}(\vec{x}) \times \mathbb{I}\{b_{L,t}^{'}(\vec{x}) < 0\}\right] \\
&+ \beta_{lf}(1-\delta_c)\left[\hat{\mathit{\Pi}}_{H,t+1}^U(b_{H,t}^{'}, h; \underline{b}, r) - \hat{\mathit{\Pi}}_{L,t+1}^U(b_{L,t}^{'}, h; \underline{b}, r)\right]
\end{aligned} \tag{17}$$

With the assumption of a constant job finding rate λ_0, recall that the continuation value of lenders profits is given by:

$$\hat{\mathit{\Pi}}_{i,t+1}^U(b_{i,t}^{'}(\vec{x}), h; \underline{b}, r) = \lambda_0 \mathit{\Pi}_{i,t+1}^W(\omega, b_{i,t}^{'}(\vec{x}), h; \underline{b}, r) + (1-\lambda_0)\,\mathit{\Pi}_{i,t+1}^U(b_{i,t}^{'}(\vec{x}), h; \underline{b}, r)$$

From the assumption of the induction step, as well as the fact that the proof for lending to an employed worker proceeds in the same manner we have: $\hat{\mathit{\Pi}}_{H,t+1}^U(b_{L,t}^{'}, h; \underline{b}, r) \geq \hat{\mathit{\Pi}}_{L,t+1}^U(b_{L,t}^{'}, h; \underline{b}, r)$. Thus, we have:

$$\begin{aligned}
\mathit{\Delta\Pi}_t^U(\vec{x}) &\geq \frac{\beta_{lf}\,(r_f - r)}{1+r}\left[b_{H,t}^{'}(\vec{x}) \times \mathbb{I}\{b_{H,t}^{'}(\vec{x}) < 0\} - b_{L,t}^{'}(\vec{x}) \times \mathbb{I}\{b_{L,t}^{'}(\vec{x}) < 0\}\right] \\
&+ \beta_{lf}(1-\delta_c)\left[\hat{\mathit{\Pi}}_{H,t+1}^U(b_{H,t}^{'}, h; \underline{b}, r) - \hat{\mathit{\Pi}}_{H,t+1}^U(b_{L,t}^{'}, h; \underline{b}, r)\right] \\
&\geq 0
\end{aligned}$$

where the first inequality follows from $\hat{\mathit{\Pi}}_{H,t+1}^U(b_{L,t}^{'}, h; \underline{b}, r) \geq \hat{\mathit{\Pi}}_{L,t+1}^U(b_{L,t}^{'}, h; \underline{b}, r)$. The second inequality follows from Lemma 1 in the first line and Lemma 2 in the second line.This completes the proof that the lenders Bellman equation is monotone. □

E.2 Sorting

Sorting requires that for all ages t, all contracts $(r, \underline{b}) \in B$, and $\epsilon > 0$, there exists a $(r', \underline{b}') \in B_\epsilon(r', \underline{b}')$ such that:

$$U_{L,t}^C(b, h; \underline{b}^{'}, r^{'}) > U_{L,t}^C(b, h; \underline{b}, r) \text{ and } U_{H,t}^C(b, h; \underline{b}^{'}, r^{'}) < U_{H,t}^C(b, h; \underline{b}, r) \tag{18}$$

That is a contract can always be found that makes the type L agent (the patient agent) better off, and the type H agent (the impatient agent) worse off. Note an equivalent sorting condition applies to contracts that are offered to employed individuals.

In showing that the lenders profit function is monotone we make the following assumptions:

1. $\beta_L > \beta_H = 0$
2. *Homogeneous job finding probability:* $\forall(h, i, t)$*:* $p(\theta_{i,t+1}(h)) = \lambda_0$

3. There is a single wage rate ω

4. The borrowing constraint of the patient agent ($i = L$) does not not bind

Note the sorting condition only holds for period $T-1$ and earlier. We proceed as above and prove the condition recursively starting from period $T-1$.

Proposition. *With the given assumptions that $\beta_L > \beta_H = 0$, job finding rates are homogeneous, there is a single wage rate, and the borrowing constraint of the patient agent is slack, the sorting condition presented in equation 18 is satisfied for ages $t = 1, ..., T-1$.*

Proof. We prove the sorting condition recursively starting from agents who are age $T-1$.

Age $T-1$ agents: Note the sorting condition for agents in period $T-1$ only applies to agents with states $\vec{x} = (b, h; \underline{b}, r)$ where both the high and low type agent will borrow.[38] In period $T-1$, the household makes a consumption and savings decision to solve the following maximization problem:

$$U^C_{i,T-1}(b, h; \underline{b}, r) = \max_{b' \geq \underline{b}} u(c) + \beta_i \left[\lambda_0 W^D_{i,T}(\omega, b', h; \underline{b}, r) + (1-\lambda_0)\, U^D_{i,T}(b', h; \underline{b}, r)\right]$$

subject to: $c + q(b', r)b' \leq z + g + b$. In the terminal period T, agents set their asset choice to zero (i.e. $b'_{i,T}(\vec{x}) = 0\ \forall \vec{x}$), which gives the following continuation values for the terminal period:

$$W^D_{i,T}(\omega, b, h; \underline{b}, r) = u\left((1-\tau)\omega f(h) + g + b\right)$$
$$U^D_{i,T}(b, h; \underline{b}, r) = u\left(z + g + b\right)$$

To ease notation let $w(\omega, h) = (1-\tau)\omega f(h)$ denote an individuals wage when employed. Using the continuation values from the terminal period, and rewriting consumption in terms of the agents asset choice b', the agent's problem in period $T-1$ is:

$$\begin{aligned} U^C_{i,T-1}(b, h; \underline{b}, r) = \max_{b' \geq \underline{b}}\ & u\left(z + g + b - q(b, r)b'\right) \\ & + \beta_i \left[\lambda_0 u\left(w(\omega, h) + b'\right) + (1-\lambda_0)\, u\left(z + g + b'\right)\right] \end{aligned} \tag{19}$$

Let ζ be the multiplier on the households borrowing constraint. The first order condition which governs the households asset choice is given by:

$$u'\left(z + g + b - q(b, r)b'\right) = \frac{\beta_i}{q(b, r)}\left[\lambda_0 u'\left(w(\omega, h) + b'\right) + (1-\lambda_0)\, u'\left(z + g + b'\right)\right] + \zeta$$

[38] This is the relevant region to consider the sorting condition, because it is in this area of the state space that lenders are unable to ex-ante observe an agent type.

First consider the patient agent ($i = L$). With the assumption that their borrowing constraint does not bind the first order condition simplifies to:

$$u^{'}\left(z+g+b-q(b,r)b^{'}\right)=\frac{\beta_L}{q(b,r)}\left[\lambda_0 u^{'}\left(w(\omega,h)+b^{'}\right)+(1-\lambda_0)\,u^{'}\left(z+g+b^{'}\right)\right] \tag{20}$$

The patient agent chooses assets $b_L^{'}$ to satisfy equation 20.

Next consider the impatient agent. Since the impatient agent has a discount factor $\beta_H = 0$, the agent will borrow until their borrowing constraint binds, i.e. $b_H^{'} = \underline{b}$.Consider an alternative contract $(r^{\epsilon}, \underline{b}^{\epsilon})$ where $\underline{b}^{\epsilon} > \underline{b}$ and $\underline{b}^{\epsilon} < b_L^{'}$, and $r^{\epsilon} < r$. We will show that at this alternative contract, the impatient agent is made worse off, while the patient agent is made better off. First, observe at the new contract the borrowing constraint for the type H agent still binds. Additionally, the choice of r^{ϵ} will be made such that the decrease in the interest rate does not allow the impatient agent to have an increase in consumption that will offset the tightening of the borrowing constraint. For the impatient agent, with the original credit contract $(\underline{b}, r)$ they select $b_H^{'} = \underline{b}$, which gives them the following consumption:

$$c_H = z + g + b - \frac{1}{1+r}\underline{b}$$

With the alternative contract, consumption for the high type is:

$$c_H^{\epsilon} = z + g + b - \frac{1}{1+r^{\epsilon}}\underline{b}^{\epsilon}$$

We restrict r^{ϵ} to insure that $c_H > c_H^{\epsilon}$. Let $\epsilon \in |\underline{b} - b_L^{'}|$ be given, and set $\underline{b}^{\epsilon} = \underline{b} + \epsilon$. With this new borrowing limit the consumption of the impatient agent is:

$$c_H^{\epsilon} = z + g + b - \frac{1}{1+r^{\epsilon}}(\underline{b} + \epsilon)$$

Then as long as $r^{\epsilon} < \frac{\epsilon(1+r)}{\underline{b}} + r$, we have that $c_H > c_H^{\epsilon}$. Since the impatient agent has $\beta_H = 0$, consumption in the current period is the only criterion for their value function. Hence, since $c_H > c_H^{\epsilon}$, we have that: $U_{H,T-1}^{C}(b, h; \underline{b}^{\epsilon}, r^{\epsilon}) < U_{H,T-1}^{C}(b, h; \underline{b}, r)$.

Next, we proceed to show that for the patient agent $U_{L,T-1}^{C}(b, h; \underline{b}^{\epsilon}, r^{\epsilon}) > U_{L,T-1}^{C}(b, h; \underline{b}, r)$. Observe that since $\underline{b} < 0$, and $r^{\epsilon} < \frac{\epsilon(1+r)}{\underline{b}} + r$, we have that $r^{\epsilon} < r$. Additionally, since $q(r) = \frac{1}{1+r}$, observe that $q(r^{\epsilon}) > q(r)$. Consider the patient agents asset choice under the original credit contract, denoted $b_L^{'}$, which was the solution to the Euler equation presented in equation 20. Consider this asset choice under the alternative credit contract $(r^{\epsilon}, \underline{b}^{\epsilon})$. First, observe that this choice is still feasible given the choice of ϵ above. Additionally, observe that since $q(r^{\epsilon}) > q(r)$, from equation 19 we have that at the agents original asset choice $b_L^{'}$ choice the agent receives a higher level of lifetime utility since:[39]

$$
\begin{aligned}
&\tilde{U}^{C}_{L,T-1}(b,h;\underline{b}^{\epsilon},r^{\epsilon})[b^{'}_{L}] = \\
&u\left(z+g+b-q(b,r^{\epsilon})b^{'}_{L}\right)+\beta_L\left[\lambda_0 u\left(w(\omega,h)+b^{'}_{L}\right)+(1-\lambda_0)\,u\left(z+g+b^{'}_{L}\right)\right] > \\
&u\left(z+g+b-q(b,r)b^{'}_{L}\right)+\beta_L\left[\lambda_0 u\left(w(\omega,h)+b^{'}_{L}\right)+(1-\lambda_0)\,u\left(z+g+b^{'}_{L}\right)\right] = \\
&U^{C}_{L,T-1}(b,h;\underline{b},r)
\end{aligned}
$$

Then since $U^{C}_{L,T-1}(b,h;\underline{b}^{\epsilon},r^{\epsilon}) = \max_{b^{'}\geq \underline{b}^{\epsilon}} \tilde{U}^{C}_{L,T-1}(b,h;\underline{b}^{\epsilon},r^{\epsilon})[b^{'}]$, we have that $U^{C}_{L,T-1}(b,h;\underline{b}^{\epsilon},r^{\epsilon}) > U^{C}_{L,T-1}(b,h;\underline{b},r)$. Effectively, since when the agent chooses $b^{'}_{L}$, they are better off with the new contract, when the agent picks makes their optimal savings decision under the new contract they are assured to be better off than under the original contract.

General Age t: The problem for an unemployed individual of age t is:

$$
U^{C}_{i,t}(b,h;\underline{b},r) = \max_{b^{'}\geq\underline{b}} u(c)+\beta_i\left[\lambda_0 W^{D}_{i,t+1}(\omega,b^{'},h;\underline{b},r)+(1-\lambda_0)\,U^{D}_{i,t+1}(b^{'},h;\underline{b},r)\right]
$$

subject to: $c+q(b^{'},r)b^{'}\leq z+g+b$. Rewriting the consumption in terms of the agents asset choice $b^{'}$, the problem is reformulated as:

$$
\begin{aligned}
U^{C}_{i,t}(b,h;\underline{b},r) = \max_{b^{'}\geq\underline{b}} &\; u\left(z+g+b-q(b,r)b^{'}\right) \\
&+\beta_i\left[\lambda_0 W^{D}_{i,t+1}(\omega,b^{'},h;\underline{b},r)+(1-\lambda_0)\,U^{D}_{i,t+1}(b^{'},h;\underline{b},r)\right]
\end{aligned}
$$

Let ζ be the multiplier on the agent's borrowing constraint. The first order condition which governs the agents asset choice is given by:

$$
u^{'}\left(z+g+b-q(b,r)b^{'}\right) = \frac{\beta_i}{q(b,r)}\left[\lambda_0 W^{'D}_{i,t+1}(\omega,b^{'},h;\underline{b},r)+(1-\lambda_0)\,U^{'D}_{i,t+1}(b^{'},h;\underline{b},r)\right]+\zeta
$$

First, consider the patient agent ($i=L$), and assume their borrowing constraint does not bind. The first order condition simplifies to:

$$
u^{'}\left(z+g+b-q(b,r)b^{'}\right) = \frac{\beta_i}{q(b,r)}\left[\lambda_0 W^{'D}_{i,t+1}(\omega,b^{'},h;\underline{b},r)+(1-\lambda_0)\,U^{'D}_{i,t+1}(b^{'},h;\underline{b},r)\right] \tag{21}
$$

The patient agent chooses assets $b^{'}_{L,t}$ to satisfy equation 21.

Next consider the impatient agent. Since the impatient agent has a discount factor $\beta_H = 0$, the agent will borrow until their borrowing constraint binds, i.e. $b^{'}_{H} = \underline{b}$.

[39] Note this requires $b^{'}_{L} < 0$, however since individuals pay a search cost to apply for credit, in period $T-1$, only individuals who plan to borrow would be willing to pay the search cost.

Consider an alternative contract $(r^{\epsilon}, \underline{b}^{\epsilon})$ where $\underline{b}^{\epsilon} > \underline{b}$ and $\underline{b}^{\epsilon} < b'_{L,t}$, and $r^{\epsilon} < r$. Following the same steps as in the case for the age $T-1$ agent by setting $r^{\epsilon} < \frac{\epsilon(1+r)}{\underline{b}} + r$, we ensure that the impatient agent consumes less under the alternative contract relative to the original contract. Since the impatient agent has $\beta_H = 0$, consumption in the current period is the only criterion for their value function, and hence we have that: $U^C_{H,t}(b, h; \underline{b}^{\epsilon}, r^{\epsilon}) < U^C_{H,t}(b, h; \underline{b}, r)$. Next we proceed to show that the patient agent is made better off under the alternative contract. With the alternative contract $r^{\epsilon} < r$, which lowers the cost of borrowing for all agents. Since the patient agent has chosen to search for a credit contract, then the agent puts a positive probability on borrowing in the future. In this state of the world, where the patient agent borrows, the lower interest rate will allow the agent to enjoy more consumption, raising the agents lifetime expected utility, holding their path of consumption/savings decisions fixed at their choices from the original contract. Since this path of asset choices raises the agents lifetime expected utility, when the agent re-optimizes their asset choices under the new contract, the agent is assured to have a higher level of lifetime expected utility relative to the original credit contract. □

E.3 One-period debt contracts

In this subsection, we highlight that our method for credit lines nests the case of one-period debt contracts when $\delta_c = 1$. Hence, the proofs presented above about the model satisfying the assumptions of Guerrieri et al. [2010] extends to a model with one-period debt contracts.

F Solution Algorithm

Solving the model proceeds in the following steps:

1. **Firms Bellman:** Update the value to a firm of being in a match in the terminal period $J_T(\omega, h)$. Using the value of a firm in the terminal period, invert the free entry condition to obtain labor market tightness $\theta_T(\omega, h)$.

2. **Household Problem:** Solve the household problem in the terminal period.

   (a) Update the value to the households of being in a credit match and not in a credit match for both employed and unemployed households, $W^C_{i,T}(\omega, b, h; \underline{b}, r)$, $U^C_{i,T}(b, h; \underline{b}, r)$ and $W^N_{i,T}(\omega, b, h; 0, 0)$, $U^N_{i,T}(b, h; 0, 0)$ respectively.

   (b) Solve the households default decisions, which returns the values $W^D_{i,T}(\omega, b, h; \underline{b}, r)$ and $U^D_{i,T}(b, h; \underline{b}, r)$.

3. **Lenders Bellman:** Update the lenders Bellman equation in the terminal period, $\Pi^W_{i,T}(\omega, b, h; \underline{b}, r)$ and $\Pi^U_{i,T}(b, h; \underline{b}, r)$.

4. **Households Credit Search:** The households credit search problem proceeds in the following steps.

   (a) *Solve for the low type's full information credit contract.*

      i. Set $\chi^U_{L,T}(b, h; \underline{b}, r) = 1$ and $\chi^U_{H,T}(\omega, b, h; \underline{b}, r) = 0$. Find the profits to the lender of offering contract $(\underline{b}, r)$ to a worker with observable characteristics (ω, b, h) for an age T unemployed individual.

      ii. Invert the free entry condition for lenders to obtain the credit market tightness for each credit contract $\theta^{c,U}_T(b, h; \underline{b}, r)$. Use $\theta^{c,U}_T(\omega, b, h; \underline{b}, r)$ to estimate the credit finding rate for each of these contracts.

      iii. Using the estimated credit finding rate solve the low type's credit search problem for an unemployed worker. Store each agents chosen credit contract. This is the agent's full information credit contract.

   (b) *Find contracts that violate the IC constraint where the low type agent mimics the high type agent.*

      i. Update $\chi^U_{L,T}$ to be equal to one at each agents chosen contract from step (a), and set $\chi^U_{L,T}$ to be zero at all other credit contracts. Set $\chi^U_{H,T} = 1$ for all states $(b, h; \underline{b}, r)$ such that $\chi^U_{L,T} = 0$, and set $\chi^U_{H,T} = 0$ for all states $(b, h; \underline{b}, r)$ such that $\chi^U_{L,T} = 1$. Update the estimate of the lenders profits using the updated $\chi^U_{L,T}$ and $\chi^U_{H,T}$. Conceptually, when the lender is estimating their profits for each contract, the lender believes that that the low type will go to their full information credit contract, and that only high types will go to all remaining contracts.

ii. Invert the free entry condition to obtain an updated value of $\theta_T^{c,U}(b, h; \underline{b}, r)$, as well as the credit finding rates.

iii. Solve the low type's credit search problem for an unemployed worker. Store each agents chosen credit contract. There are two cases to consider:

A. If any agent has chosen a credit contract that is different than their full information credit contract, then set $\chi_{L,T}^U = 1$ and $\chi_{H,T}^U = 0$ for that contract, and repeat step (b).

B. If all low type agents have chosen their full information credit contract, then we have found a set of lenders beliefs $\chi_{L,T}^U$ and $\chi_{H,T}^U$, and credit market tightness $\theta^{c,U}$ that is consistent with the low type choosing their full information contract, and not mimicking the high type.

(c) *Solve the high types credit search problem.*

i. Using the beliefs $\chi_{L,T}^U$ and $\chi_{H,T}^U$, and credit market tightness $\theta^{c,U}$solve the credit choice problem for the high type with the constraint that the high type cannot select any contract where $\chi_{L,T}^U = 1$. Conceptually these contracts would not satisfy the IC constraint, which prevents the low type from mimicking the high type.

(d) Repeat steps (a)-(c) for employed workers.

(e) Using the credit market tightness functions $\theta_T^{c,e}(\omega, b, h; \underline{b}, r)$ to find the values of $W_{i,T}^a(\omega, b, h; 0, 0)$ and $U_{i,T}^a(b, h; 0, 0)$. Using these value functions find each households policy function for searching for a credit contract $S_{i,T}^e(\omega, b, h; 0, 0)$ as well as the value of $W_{i,T}^S(\omega, b, h; 0, 0)$ and $U_{i,T}^S(b, h; 0, 0)$.

5. **Households Job Search:** Use the estimate of $\theta_T(\omega, h)$ to solve the households job search problem.

6. **Repeat for ages** $T-1$,$T-2, ..., 1$.

G Welfare Calculation

In this section, we describe our process for performing the welfare calculation.

Let $(\{c_t^{i,h_0}, D_t^{i,h_0}, S_t^{i,h_0}\}_{t=1}^{t_{max}})$ be the consumption, default and credit search policy functions for an individual over their lifetime under the baseline public insurance policy for a type i individual whose initial human capital is h_0.[40] Let $(\{\tilde{c}_t^{i,h_0}, \tilde{D}_t^{i,h_0}, \tilde{S}_t^{i,h_0}\}_{t=1}^{t_{max}})$ be the consumption and default

[40] Recall individual draw from a uniform distribution over human capital types when they are born.

policy functions for an individual under an alternative public insurance policy for a type i individual whose initial human capital is h_0. We will perform welfare calculations by estimating the share of lifetime consumption an individual would be willing to forgo (or must receive) to leave the baseline economy and move to an economy with an alternative public insurance policy. Formally, we estimate the scaling factor for consumption λ that makes an individual indifferent between living under either public insurance policy:

$$\mathbb{E}_0\left[\sum_t \beta_i^t\left(\frac{\left(\lambda c_t^{i,h_0}\right)^{1-\sigma}-1}{1-\sigma}-\psi_D D_t^{i,h_0}-\kappa_S S_t^{i,h_0}\right)\right]=\mathbb{E}_0\left[\sum_t \beta_i^t\left(\frac{\left(\tilde{c}_t^{i,h_0}\right)^{1-\sigma}-1}{1-\sigma}-\psi_D \tilde{D}_t^{i,h_0}-\kappa_S \tilde{S}_t^{i,h_0}\right)\right]$$

where the expectation is with regards to the individual's draw over their type i, initial level of human capital h_0, as well as the evolution of the individuals states over their working life.

H Additional Statistics / Tables

Table 16: Delevering Statistics: Year of Mass Layoff

Share of Treatment Group with:	Share
Decline in Revolving Credit Balances	0.39
Decline in Revolving Credit Balances and 60-day Delinquency	0.17
Decline in Revolving Credit Balances and Debt Chargeoff	0.08

Note: The figures shows the share of individuals in the treatment group in the year of mass layoff who have a decline in their revolving credit balance, as well as a 60-day delinquency and a debt chargeoff.

Table 17: Additional Summary Stats

Panel Sample (Year Prior to Mass Layoff)		
	(1)	(2)
	Treatment	Control
Collections (d)	0.23	0.21
Debt Chargeoff (d)	0.12	0.11
Derogatory Public Flag (d)	0.05	0.04
60-Day Mortgage Delinquency (d)	0.03	0.03
30-Day Delinquency (d)	0.48	0.47
60-Day Delinquency (d)	0.32	0.31
90-Day Delinquency (d)	0.25	0.23
Bankruptcy Flag (d)	0.15	0.15
Observations (Rounded to 000s)	31000	30000

Note: Sample selection criteria in Section 1.2. The symbol (d) indicates a dummy variable.

Table 18: Replacement Rates of Revolving Credit by Credit Score Quintile (Over 2 Years)

	OLS	Predicted Value
	(1)	(2)
	Replacement Rate	Replacement Rate
Credit Score Quin 1		-0.0359***
		(0.00435)
Credit Score Quin 2	-0.00804	-0.0439***
	(0.00651)	(0.00502)
Credit Score Quin 3	0.0319***	-0.00395
	(0.00790)	(0.00660)
Credit Score Quin 4	0.124***	0.0883***
	(0.00823)	(0.00696)
Credit Score Quin 5	0.184***	0.148***
	(0.00822)	(0.00685)
Constant	-0.0742*	
	(0.0390)	
Year FE	Y	Y
Age and Wealth Controls	Y	Y
R square	0.040	
No Obs.	19000	19000

Notes: Clustered SE in parenthesis, where the clustering is performed at the level of the firm where the worker was displaced. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. *The replacement rate is the negative of the change in revolving credit balance (year after displacement relative to year before displacement) over the change in earnings (year after displacement relative to year before displacement) for individuals with an earnings loss in the year after displacement relative to the year before. Credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. Columns (1) reports OLS estimates of equation 2 which estimates the replacement rate as a function of credit score quintile. The replacement rate used in the estimation is winsorized at the top and bottom at the 10 percent level. Column (2) reports predicted values of the replacement rate by credit score quintile implied by the results of Column (1), where the control variables are evaluated at their sample means, as in equation 3.*

Table 19: Earnings Losses and 60 Day Delinquency by Credit Score In Year After Mass Layoff

	(1) 60 Day Delinq (d)	(2) 60 Day Delinq (d)	(3) 60 Day Delinq (d)
	(Year After Mass Layoff)		
Chg. Earning	8.57e-07***	-6.54e-07*	-1.23e-06***
	(1.33e-07)	(3.78e-07)	(3.90e-07)
2 Yr. Chg. Earning x Credit Score Quin 2 (d)		-2.21e-08	-2.22e-08
		(5.45e-07)	(5.45e-07)
2 Yr.Chg. Earning x Credit Score Quin 3 (d)		9.57e-07*	9.67e-07*
		(4.96e-07)	(4.96e-07)
2 Yr. Chg. Earning x Credit Score Quin 4 (d)		7.70e-07*	8.11e-07*
		(4.53e-07)	(4.53e-07)
2 Yr. Chg. Earning x Credit Score Quin 5 (d)		9.88e-07**	1.03e-06**
		(4.24e-07)	(4.25e-07)
Constant	0.419***	0.526***	0.486***
	(0.00557)	(0.0129)	(0.0540)
Constant x Credit Score Quin 2 (d)		-0.0302	-0.0320*
		(0.0185)	(0.0185)
Constant x Credit Score Quin 3 (d)		-0.0835***	-0.0822***
		(0.0179)	(0.0179)
Constant x Credit Score Quin 4 (d)		-0.241***	-0.236***
		(0.0170)	(0.0170)
Constant x Credit Score Quin 5 (d)		-0.309***	-0.301***
		(0.0163)	(0.0164)
Year FE			
Age and Wealth Controls	N	N	Y
R-Square	0.002	0.074	0.078
No of Indiv.	19000	19000	19000
P-Value 2-Year Chg Earn Quin 2		0.0862	0.00190
P-Value 2-Year Chg Earn Quin 3		0.354	0.432
P-Value 2-Year Chg Earn Quin 4		0.646	0.116
P-Value 2-Year Chg Earn Quin 5		0.0851	0.325

*Notes: Clustered SE in parenthesis, where the clustering is performed at the level of the firm where the worker was displaced. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. The 2-year change in real annual earnings measures the change in earnings from the year after mass layoff relative to the year before mass layoff and is winsorized at the top and bottom at the 1 percent level. Earnings are measured in 2008 dollars. Credit Score Quin k refers to credit score quintile k, where credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. The symbol (d) indicates a dummy variable. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. P-Value 2-Year Chg Earn Quin k refers to the p-value for the sum of the coefficients 2-Year Chg. Earn and 2-Year Chg. Earn x Credit Score Quin k.*

Table 20: Earnings Losses and Debt Chargeoff by Credit Score In Year After Mass Layoff

	(1) Debt Chargeoff (d)	(2) Debt Chargeoff (d)	(3) Debt Chargeoff (d)
	(Year After Mass Layoff)		
Chg. Earning	3.88e-07***	-3.62e-07	-7.36e-07**
	(9.88e-08)	(3.42e-07)	(3.46e-07)
2 Yr. Chg. Earning x Credit Score Quin 2 (d)		-3.15e-09	-2.31e-08
		(4.71e-07)	(4.69e-07)
2 Yr.Chg. Earning x Credit Score Quin 3 (d)		2.85e-07	2.85e-07
		(4.20e-07)	(4.17e-07)
2 Yr. Chg. Earning x Credit Score Quin 4 (d)		3.75e-07	4.32e-07
		(3.78e-07)	(3.76e-07)
2 Yr. Chg. Earning x Credit Score Quin 5 (d)		3.09e-07	3.84e-07
		(3.59e-07)	(3.57e-07)
Constant	0.179***	0.249***	0.319***
	(0.00428)	(0.0117)	(0.0432)
Constant x Credit Score Quin 2 (d)		-0.0133	-0.0154
		(0.0159)	(0.0159)
Constant x Credit Score Quin 3 (d)		-0.0629***	-0.0625***
		(0.0151)	(0.0150)
Constant x Credit Score Quin 4 (d)		-0.150***	-0.146***
		(0.0137)	(0.0137)
Constant x Credit Score Quin 5 (d)		-0.195***	-0.189***
		(0.0129)	(0.0130)
Year FE	N	N	Y
Age and Wealth Controls	N	N	Y
R-Square	0.001	0.046	0.050
No of Indiv.	19000	19000	19000
P-Value 2-Year Chg Earn Quin 2		0.278	0.0263
P-Value 2-Year Chg Earn Quin 3		0.756	0.0767
P-Value 2-Year Chg Earn Quin 4		0.941	0.0893
P-Value 2-Year Chg Earn Quin 5		0.631	0.00478

Notes: Clustered SE in parenthesis, where the clustering is performed at the level of the firm where the worker was displaced. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. *The 2-year change in real annual earnings measures the change in earnings from the year after mass layoff relative to the year before mass layoff and is winsorized at the top and bottom at the 1 percent level. Earnings are measured in 2008 dollars. Credit Score Quin k refers to credit score quintile k, where credit score quintiles are based upon an individuals TransUnion bankruptcy score in the year prior to displacement. The symbol (d) indicates a dummy variable. Age and wealth controls include a quadratic in age, and deciles for lagged cumulative earnings. P-Value 2-Year Chg Earn Quin k refers to the p-value for the sum of the coefficients 2-Year Chg. Earn and 2-Year Chg. Earn x Credit Score Quin k.*