The Costs and Benefits of Employer Credit Checks

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Abstract

Credit agencies sell credit reports to employers for use in hiring. We build a model that rationalizes these products through adverse selection in credit and labor markets. Workers differ in their patience, with more patient workers repaying debts more frequently and accumulating more human capital. In equilibrium, a better credit history correlates with higher productivity. A poverty trap may arise: an unemployed agent with a low credit score has a low job finding rate, but cannot improve her credit score without a job. A policy that bans employer credit checks must balance their benefits (labor market efficiency and improved credit repayment incentives) against their costs (idiosyncratic poverty trap risk).

Very preliminary, comments welcome.

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1 Introduction

According to a Survey by the Society for Human Resource Management (2010), 60% of human resource representatives who were interviewed in 2009 indicated that the companies they worked for ran credit checks on potential employees. The three primary consumer credit agencies (Equifax Persona, Experian Employment Insight, and TransUnion PEER) market credit reports to employers, which include not only personal information (such as addresses and social security numbers) and previous employment history but also any public record (such as bankruptcy, liens and judgments) as well as credit history. The Federal Trade Commission[1] published a consumer alert in May 2006 entitled "Negative Credit Can Squeeze a Job Search" warning consumers about the possibility of adverse employment actions due to a bad credit history. Further, the FTC writes "As an employer, you may use consumer reports when you hire new employees and when you evaluate employees for promotion, reassignment, and retention as long as you comply with the Fair Credit Reporting Act (FCRA)."[2]

Since 2005, numerous state and federal laws with the goal of limiting or banning employer credit checks have been introduced and, as of 2017, eleven states have enacted such laws. Legislators often express concern of a "poverty trap" arising due to employer credit checks: a worker loses her job, cannot pay her debts, which negatively impacts her credit report and thereby makes her unable to find a job. We assess the welfare consequences of these policies in a general equilibrium model of unsecured credit and labor market search with adverse selection.

Our model features heterogeneously patient households and has three main components: an initial human capital investment, labor search frictions, and unsecured credit with endogenous default. Credit scores are useful because of private information in the labor market, here modeled as exoge-

[1] http://www.ftc.gov/bcp/edu/pubs/consumer/alerts/alt053.shtm
[2] http://www.ftc.gov/bcp/edu/pubs/business/credit/bus08.shtm

nous differences in productivity that affect revenue generated by employees. In equilibrium, high productivity workers are also less likely to default, ceteris paribus, which means that workers with a high credit score are more valuable as employees. The labor market is modeled with search frictions, which generates both wage and employment differences across credit scores, with high score workers enjoying both higher job finding rates and higher wages conditional upon finding a job.

We then use this model as a laboratory to assess the effect of a policy that forces employers to ignore the credit score. This has both direct and indirect effects on the equilibrium. First, as expected by policy makers, there is a redistribution of wages from high to low credit score workers, which in equilibrium also translates into a redistribution of wages from high to low productivity workers. However, there is also an indirect effect on incentives that lowers welfare for everyone. When credit scores are not used in the labor market, workers lose some of their incentives to repay debts. This leads to higher interest rates and less consumption smoothing. In our calibrated economy, the negative effect on credit markets dominates across the board and everyone loses in welfare terms from the policy. This cost of the policy has not been considered, even by those who advocate on behalf of lower income households with bad credit.

We proceed as follows. In section two we describe the economic environment, then define and characterize equilibrium. In section three we calibrate the economy and conduct policy experiments. We then conclude.

2 Environment

There are four agents in our economy. The first and primary agent is the worker, which we assume can be one of two types: patient or impatient. Workers can either be unemployed or employed, which means they work for a firm, which is the second agent. Each period is split into two sub periods and only in the second sub period is a worker's product available for sale, which means that her earnings are only paid at that point. We assume she prefers to consume in both sub periods, which she accomplishes by borrowing from a lender, which is the third agent. When a worker borrows, she promises to repay once she is paid, but may choose not to do so because of unexpected expenditure shocks. Her choice of whether to repay is recorded by the fourth agent, which we call the credit agency.

A newborn worker draws $\beta_i \in \{\beta_L, \beta_H\}$, which denotes her discount factor. We call a worker patient if her discount factor is $\beta_H > \beta_L$ and we assume that the population share of patient workers is π_H. A newborn worker makes a one-time choice of her human capital at cost $\phi(h)$. This will be observed only by the agent and her eventual employer, but not by the lender or credit agency. The worker's remaining decisions are described recursively.

- In any period t, a worker's states are her employment status, human capital h, history of repayment decisions (which we will summarize by a type score, s_t) and type i. When unemployed, her period t unfolds as:
  - Receive unemployment benefit z in the first sub-period. The total flow of utility equal to z
  - With probability $1 - \delta$ the worker survives into $t + 1$, otherwise she dies and a newborn replaces her in the economy
  - The worker matches with a firm with probability $f\big(\theta(s)\big)$. Labor markets are frictional, so that the finding rate depends on the equilibrium market tightness $(\theta(s))$. The tightness may depend on s because the worker's human capital is only observed after the match, but affects profits of the firm ex-post. We will assume that all matches have a positive surplus, so all matches turn into jobs in equilibrium.
  - With probability $1 - f\big(\theta(s)\big)$ the worker does not match

- Denoting the value of being employed as W and unemployed as U, we write the value function:

$$U_i(h,s) = z + \beta_i^2(1-\delta)\Big[f\big(\theta(s)\big)W_i(h,s) + \Big(1 - f\big(\theta(s)\big)\Big)U_i(h,s)\Big]$$

- Now for the employed worker:
  - People work throughout the period, but their output is only available for their employer to sell at the end. They are therefore paid at the end of each period, but require a credit line in order to smooth consumption throughout. The employed household indexed by β_i, s, h has the following period t:
    - Determine earnings w via Generalized Nash Bargaining with firm
    - Choose debt contract (Q,b) from a menu offered by lenders to employed workers. We will describe the determination of the set of contracts, which are indexed by worker repayment histories.
    - Receive first sub-period utility Q
    - Draw expenditure shock τ from CDF $F(\tau)$
    - Choose default $d \in \{0,1\}$. This means that they stop paying in period t (i.e. go delinquent) and in the second subperiod of the following period $t+1$ pay a bankruptcy filing cost of ϵ.
    - Consume $c_2 = w - (1-d)(b+\tau)$, which is flow second subperiod utility. That is:
      - Utility function is given by $c_1 + \beta_i c_2$
    - Keep job with probability $1-\sigma$
      - Discounted continuation $\beta_i\big(W_i(h, s'(s,d)) - d\epsilon\big)$ The reason that ϵ enters linearly is because the bankruptcy cost

is incurred in the second subperiod, which assumes linear utility.[3]

  * Separate with probability σ
    · Discounted continuation $\beta_i\big(U_i(h, s'(s,d)) - d\epsilon\big)$

- Defines:

$$W_i(h,s) = Q + \beta_i \int_0^\infty \max_d \left[w - (1-d)(b+\tau) + \beta_i(1-\delta)\left(\mathcal{V}_i\big(h, s'(s,d)\big) - d\epsilon \right) \right] dF(\tau)$$

- Where we have used an intermediate value functions to save space:

$$\mathcal{V}_i\big(h, s'(s,d)\big) = \left[(1-\sigma) W_i\big(h, s'(s,d)\big) + \sigma U_i\big(h, s'(s,d)\big) \right]$$

- Notice that we keep track of a worker's type score even while employed, even though the firm observes the worker's productivity. This is for two reasons: first, the score will affect their credit market contracts and is therefore a state variable. Second, the score will affect their outside option and therefore the bargaining outcome with their employer.

This requires a credit score updating function $s'(s,d)$. By starting with a finite economy and then taking the limit we expect a unique equilibrium with $s'(s,0) > s'(s,1)$. A patient household who avoided the death shock for an infinite time would have $s_t \to 1$ (β_L types would have $s_t \to 0$). In principle we can make this take a really long time by putting small enough differences in β. Note that the assumption that unemployed do not borrow means that the scoring function does not need to take employment status as an argument.

[3] The expenditure cost is in utils since ϵ is paid in the second sub period of $t+1$. An equivalent way of modeling the cost would be to add d_t as a state variable and subtract ϵd_t in period $t+1$. Our specification is equivalent and economizes on state variables.

We now describe the profits for a firm. Before matching with a worker, firms post vacancies. These vacancies can condition on a worker's type score, which represents the employer credit check, but not the unobservable human capital. After hiring the firm observes their employee's human capital, so Nash Bargaining ensues under full information. The expected discounted profit for paying w to a worker of type i with score s and human capital h is:

$$J_i(w,h,s) = \int \Big[h - w + R^{-1}(1-\sigma)J_i\big(w_i^*(h,s'),h,s'\big)\Big]dF(\tau)$$

Where arguments have been suppressed for $s' = s'\big(s, d_i^*(\tau,h,s,w)\big)$ to save space. To solve for $w_i^*(h,s)$ using Nash Bargaining we have to determine the worker's outside option. Since the worker walks away at the beginning of the period, she is simply unemployed at that point and so receives value $U_i(h,s)$ as defined above.

The credit market determines a menu of contracts indexed by s through the Netzer and Scheuer game as in Corbae & Glover (2015).

Free entry for firms determines market tightness as a function of s. By definition, the fraction of patient households with score s is exactly s. The cost of posting a vacancy is κ and q is the job-filling rate. Thus:

$$\kappa = R^{-1}q\big(\theta(s)\big)\Big[sJ_H\big(w_H^*(h_H^*,s),s\big) + (1-s)J_L\big(w_L^*(h_L^*,s),s\big)\Big]$$

Finally, we solve for human capital of the new born:

$$\phi'\left(h_i^*\right) = \frac{\partial U_i}{\partial h}\left(h_i^*, \pi_H\right)$$

2.1 Worker Decisions

We start by characterizing the worker's default choice, taking all other objects as given. Quasi-linear utility of consumption in the second sub period facilitates characterization. Apparently, the worker defaults if and only if:

$$\tau > \tau_i^*(h,s,b) \equiv \beta_i(1-\delta)\Big[\epsilon + \mathcal{V}_i\big(h, s'(s,0)\big) - \mathcal{V}_i\big(h, s'(s,1)\big)\Big] - b$$

This allows us to evaluate the integral in $W_i(h,s)$ for given values of (w,Q,b):

$$W_i(h,s) = Q + w + \beta_i(1-\delta)\mathcal{V}_i\big(h, s'(s,1) - \epsilon\big) + \int_0^{\tau_i^*(h,s,b)} F(\tau)d\tau$$

We can then write the worker's surplus evaluated at the equilibrium $(Q_i^*(s), b_i^*(s))$:

$$\begin{aligned} S_i^w(w;h,s) \quad = \quad & \beta_i w + Q_i^*(s) - z + \\ & \beta_i(1-\delta)\Big[\mathcal{V}_i\big(h, s'(s,1)\big) - \epsilon - f(s)W_i(h,s) - \big(1-f(s)\big)U_i(h,s)\big)\Big] + \\ & \int_0^{\tau_i^*\left(h,s,b_i^*(s)\right)} F(\tau)d\tau \end{aligned}$$

The firm's surplus is given by:

$$\begin{aligned} S_i^f(w;h,s) \quad = \quad & h - w + \\ & R^{-1}(1-\delta)(1-\sigma)F\big(\tau_i^*(h,s,b)\big)\Pi_i\big(w_i^*(h,s_0'), h, s_0'\big) + \\ & R^{-1}(1-\delta)\Big(1 - F\big(\tau_i^*(h,s,b)\big)\Big)\Pi_i\big(w_i^*(h,s_1'), h, s_1'\big) \end{aligned}$$

Where $s_d' = s'(s,d)$ is used to save space.

The wage is then determined by generalized Nash Bargaining in which the worker's bargaining weight is λ. Given that worker utility and firm profits are linear in earnings, this amounts to a simple splitting rule for the total surplus:

$$S_i^w(w;h,s) = \lambda\Big(S_i^w(w;h,s) + S_i^f(w;h,s)\Big)$$

Note that the right hand side is actually independent of w since it enters as a positive for the worker and a negative for the firm.

2.2 Credit Market Determination

The credit market in this model is identical to Corbae and Glover (2015), except that we have linear utility over first sub period consumption. The t period credit contracts for workers with type score s are separating allocations, but may be cross-subsidizing. They solve the following programming problem:

$$\max_{Q_H,b_H,Q_L,b_L} Q_H + \beta_H \int_0^{\tau_H^*(h,s,b_H)} F(\tau)d\tau$$

$$\text{s.t.}$$

$$s\Big[-Q_H + R^{-1}F(\tau_H^*(h,s,b_H))b_H\Big] + (1-s)\Big[-Q_L + R^{-1}F\big(\tau_L^*(h,s,b_L)\big)b_L\Big] \geq 0$$

$$Q_L + \beta_L \int_0^{\tau_L^*(h,s,b_L)} F(\tau)d\tau \geq Q_H + \beta_L \int_0^{\tau_L^*(h,s,b_H)} F(\tau)d\tau$$

$$Q_L + \beta_L \int_0^{\tau_L^*(h,s,b_L)} F(\tau)d\tau \geq \max_b R^{-1}F\big(\tau_L^*(h,s,b)\big)b + \beta_L \int_0^{\tau_L^*(h_L,s,b)} F(\tau)$$

In words, this says to maximize the patient borrower's utility subject to the lender's participation constraint, that the impatient household chooses the correct contract, and that the impatient lender chooses to participate when her outside option is an actuarially fair contract. The lender's participation constraint allows for cross-subsidization. When the last constraint is binding the impatient borrower is getting his reservation utility, which is associated with his Q, b breaking even for the lender (there is no cross-subsidization). This contract thus corresponds to the least-cost separating (LCS) and is independent of s. When the last constraint is slack then the impatient households is receiving strictly more utility than if his contract broke even on its own, therefore she must be getting cross-subsidized. Even when this is the case, however, the impatient household's necessary conditions imply that her contract is undistorted:

$$R^{-1}\Big[F\big(\tau_L^*(h_L, s, b_L)\big) - F'\big(\tau_L^*(h_L, s, b_L)\big)b_L\Big] = \beta_L F\big(\tau_L^*(h_L, s, b_L)\big) \quad (1)$$

This equation is independent of Q_L, Q_H, and b_H, which means that the optimal b_L is independent of these variables as well and take the unsubsidized, least-cost separating value. Call this b_L^{LCS}, then we can simplify the programming problem to:

$$\max_{Q_H, b_H, Q_L} Q_H + \beta_H \int_0^{\tau_H^*(h,s,b_H)} F(\tau)d\tau$$

s.t.

$$s\Big[-Q_H + R^{-1}F(\tau_H^*(h, s, b_H))b_H\Big] + (1-s)\Big[-Q_L + R^{-1}F\big(\tau_L^*(h, s, b_L^{LCS})\big)b_L^{LCS}\Big] \geq 0$$

$$Q_L + \beta_L \int_0^{\tau_L^*(h,s,b_L^{LCS})} F(\tau)d\tau \geq Q_H + \beta_L \int_0^{\tau_L^*(h,s,b_H)} F(\tau)d\tau$$

$$Q_L \geq Q_L^{LCS}$$

We can now prove a useful result: if $F''(\tau) \leq 0$ then the above is a concave programming problem, which means that the value is continuous in s.

2.3 Equilibrium

In general, an equilibrium consists of the following objects:

1. An updating function, $s'(s, d)$.
2. Credit market contracts, $(Q_i(h, s), b_i(h, s))_{i\in\{H,L\}}$
3. Wage $w_i(h, s)$
4. Market tightness $\theta(s)$
5. Human capital investment h_i

3 A Computed Example

To demonstrate how a poverty trap may arise and how markets respond to a policy banning employer credit checks, we compute an equilibrium of the economy and then change the determination of market tightness so that it is independent of type score.[4] We use a Cobb-Douglas matching technology so that the job-finding and filling rates are given by $f(\theta) = M\theta^{\alpha}$ and $q(\theta) = M\theta^{\alpha-1}$. We assume that expenditure shocks have an exponential CDF: $F(\tau) = 1 - e^{-\gamma\tau}$. Once these functional forms are set, we must only choose parameters, which can be found in Table (1). While these parameters have not been calibrated or estimated to match moments, we have relied on previous literature where appropriate and attempted to generate realistic outcomes.

3.1 The Poverty Trap

We use two figures to understand how a poverty trap may arise. Figure (1) plots the job-finding rate of an unemployed household as a function

[4]The algorithm used for computing the equilibrium can be found in the appendix.

Parameter	Value	"Target"
β_H	0.994	Risk free rate, default rate
β_L	0.987	Risk free rate, default rate
δ	0.005	50 Years in Market
ϵ	0.33	Cost of filing bankruptcy
γ	10	Default rate
ξ	0.10	Job-finding rate 0.91 (Shimer)
α	0.5	Literature
M	4.0	Job-finding rate 0.91
κ	0.2	Avg $\theta = 1$ (normalized)
R	1.005	Annual rate
σ	0.076	Separation Rate (Shimer)
h_H	1	Normalization
h_L	0.95	Conservative Heterogeneity
z	0.4	Shimer

Table 1: Parameter Values

of her score s. It is rising with score, reflecting the fact that patient workers are more productive in equilibrium and tend to have higher scores. This is the first part of the poverty trap: a worker with a bad credit history has a harder time finding a job than one with a good credit history.

We next look at the average change in a worker's score while employed. This depends on the worker's patience as well as her current score, and can be seen in Figure (2). On average, an employed patient worker experiences a rising score over time, while her score remains constant during an unemployment spell. This is the second part of the poverty trap: a patient unemployed worker with a bad credit score would improve her credit if she could find a job (even faster than if she had a high credit score), but has a hard time finding one. The impatient worker, on the other hand, has a falling score on average. So, while she would rather be employed than unemployed, she is not subject to the

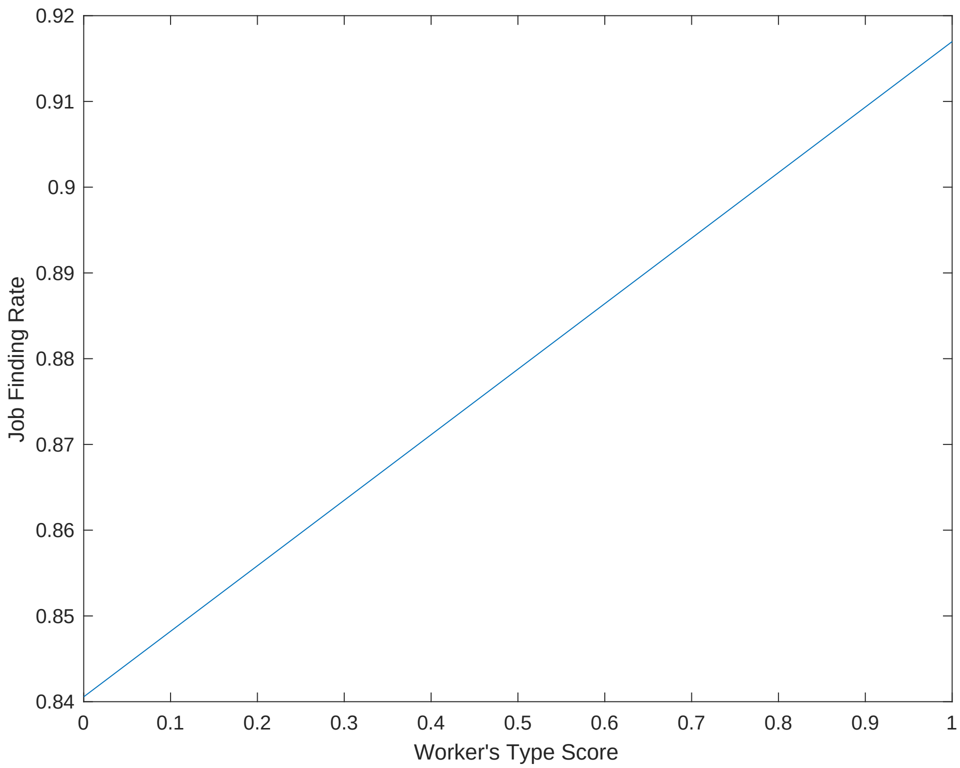

Figure 1: Job Finding Rate Rises With Score

same type of poverty trap (i.e., her lower productivity is exactly the reason for lower finding rates for workers with bad credit histories).

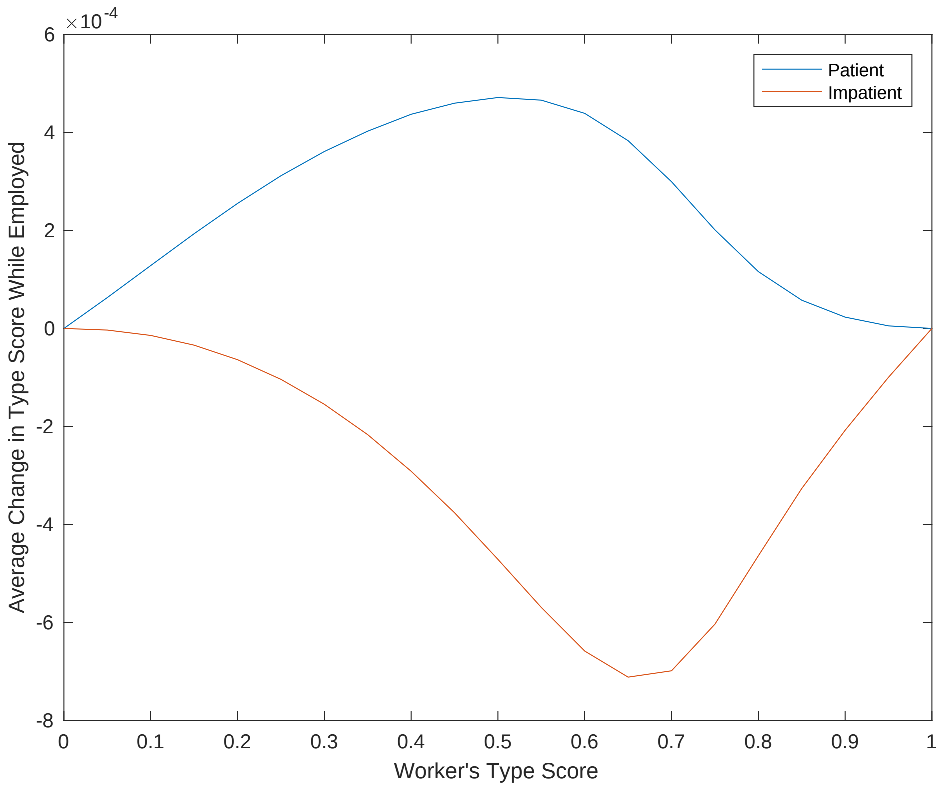

Figure 2: Expected Change in Score by Patience Level

3.2 Effect of Banning Employer Credit Checks

We now solve the economy with the same parameters, except that we change the free entry condition for vacancy postings to be:

$$\kappa = R^{-1}q(\theta)\Big[\pi_H J_H(\pi_H) + (1-\pi_H)J_L(\pi_H)\Big]$$

Notice that this says that the vacancy cannot condition on a worker's score and that vacancies must be posted as if the firm expects the eventual employee's score to be π_H. Once the match occurs and the worker is employed then the wage will still depend on the score, but at the matching stage the law forbids any dependence. The labor market effect comes through the job finding rate and can be seen in Figure (**??**).

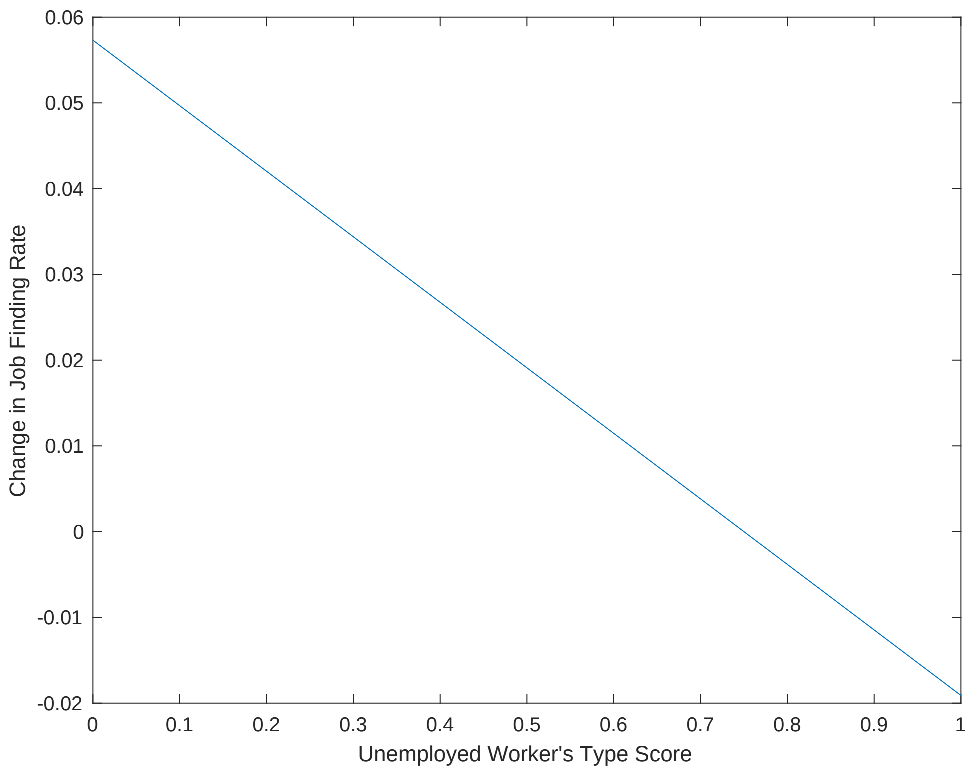

Figure 3: Effect of Employer Credit Ban: Job Finding Rates

We show the credit market effect of eliminating employer credit checks in Figures (4) and (5). The reduction in repayment incentives causes an increase in default and an interest rates rise. The amount of lending falls in response.

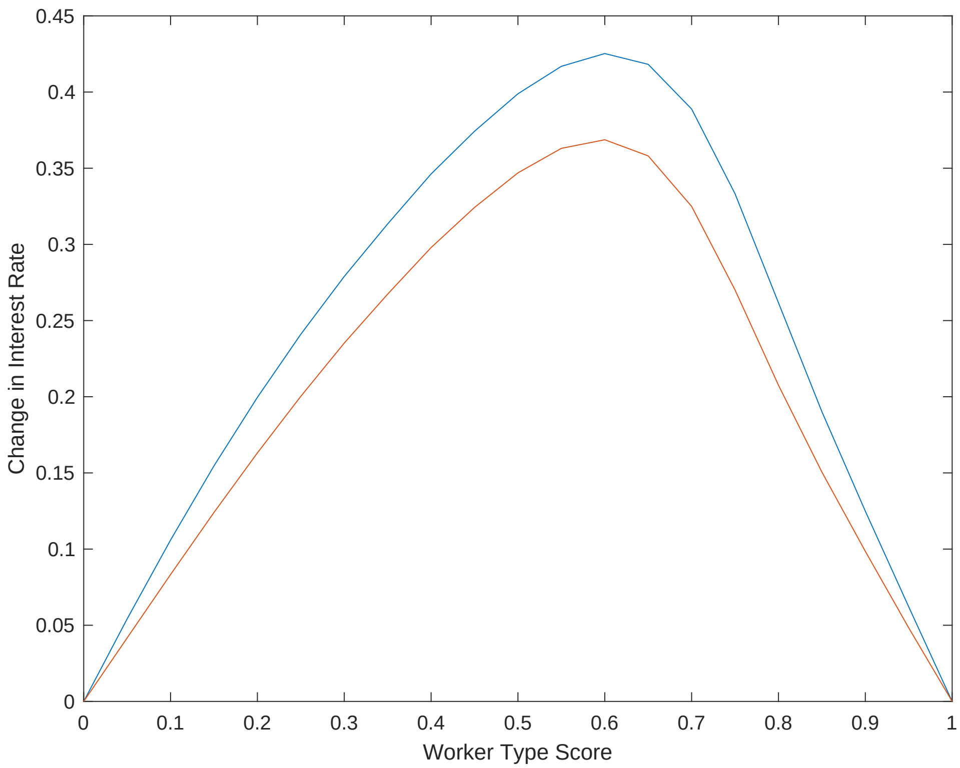

Figure 4: Effect of Employer Credit Ban: Interest Rates

The net effect of labor markets and credit markets can be calculated in consumption equivalent welfare units. Figure (6) shows the welfare losses/gains of eliminating employer credit checks for unemployed households and Figure (7) shows the equivalent measures for employed households.

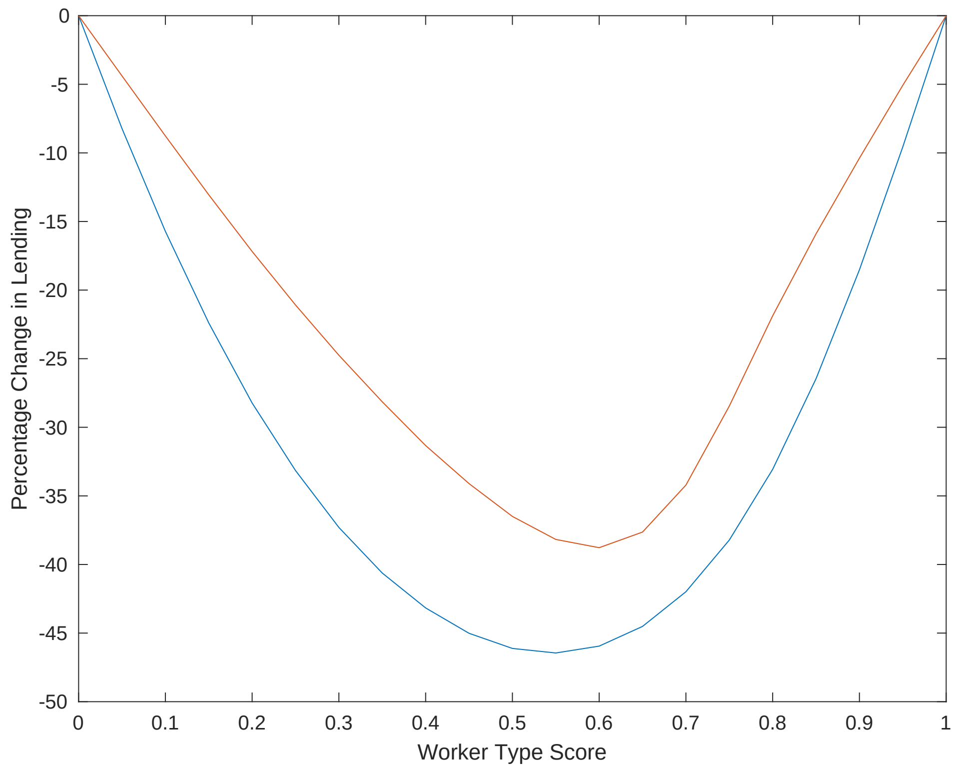

Figure 5: Effect of Employer Credit Ban: Amount Lent

4 Conclusion

To be written.

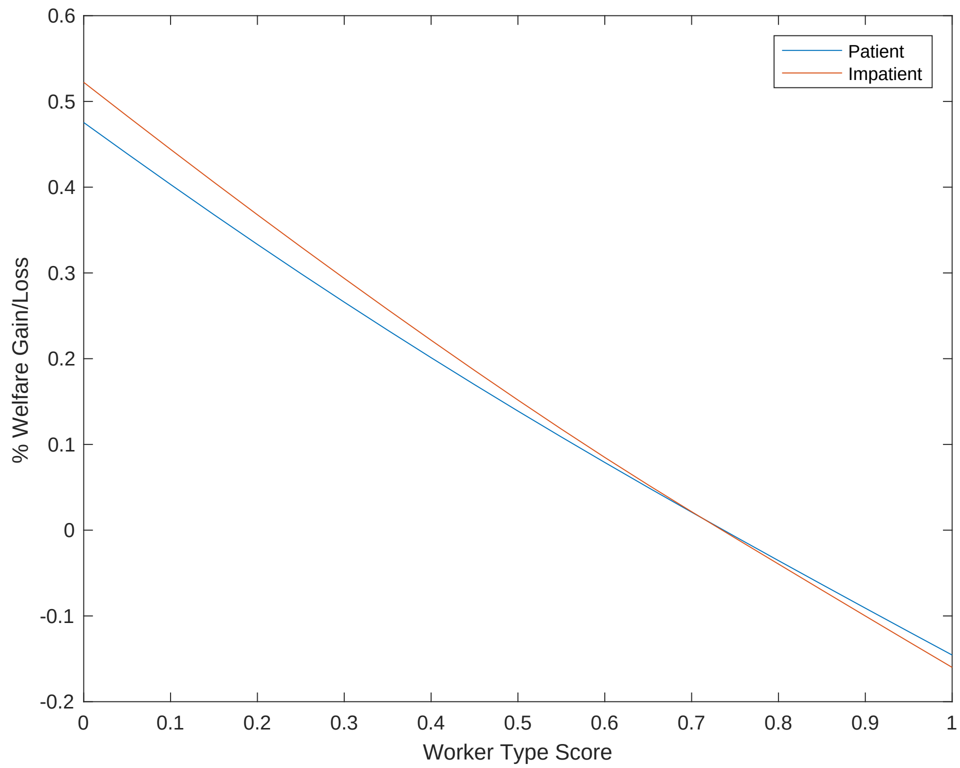

Figure 6: Effect of Employer Credit Ban: Welfare of Unemployed

References

[1] Athreya, K., X. Tam & E. Young, 2011. "A Quantitative Theory of Information and Unsecured Credit",*American Economic Journal: Macroeconomics*, vol. 4(3), pages 153-83, July.

[2] Chatterjee, S., D. Corbae, & V. Rios-Rull, 2008. "A finite-life private-information theory of unsecured consumer debt," *Journal of Economic Theory*, vol. 142(1), pages 149-177, September.

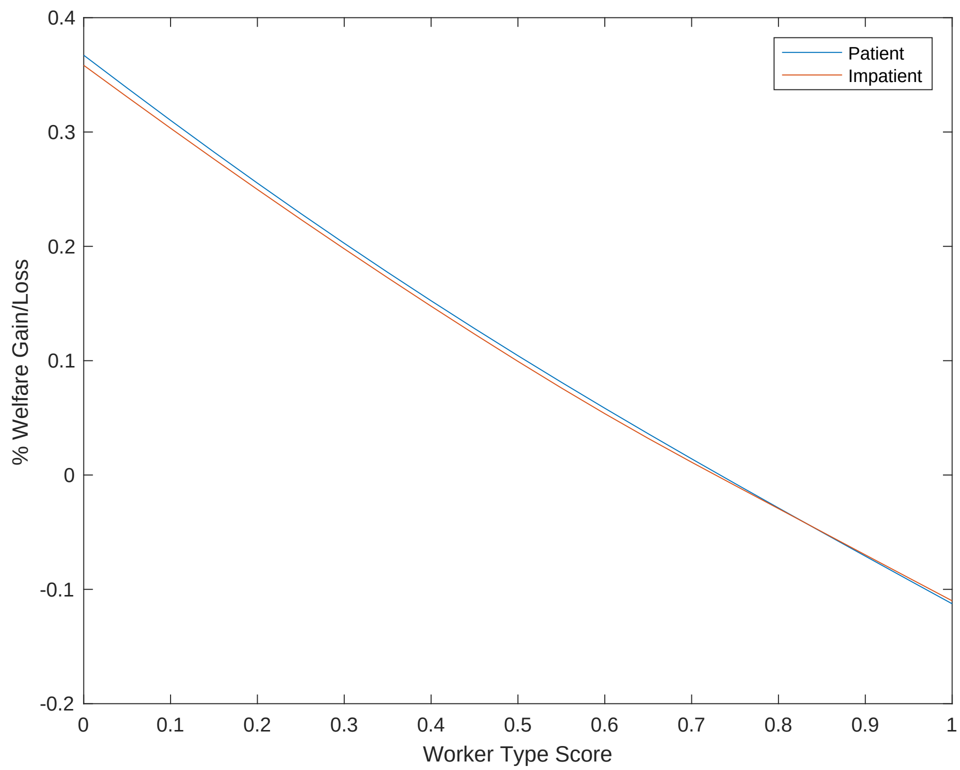

Figure 7: Effect of Employer Credit Ban: Welfare of Employed

[3] Chatterjee, S., D. Corbae, K. Dempsey, & V. Rios-Rull, 2016. “A Theory of Credit Scoring and the Competitive Pricing of Default Risk,” mimeo

[4] Cortes, K., A. Glover & M. Tasci, 2016. “The Unintended Consequences of Employer Credit Check Bans on Labor and Credit Markets ”,mimeo.

[5] Herkenhoff, K., G. Phillips & E. Cohen-Cole, 2016. “The Impact

of Consumer Credit Access on Employment, Earnings, and Entrepreneurship ",mimeo.

[6] Livshits, I., J. MacGee, and M. Tertilt (2014) "The Democratization of Credit and the Rise in Consumer Bankruptcies", forthcoming *Review of Economic Studies.*

[7] Lagos, R. & R. Wright, 2005. "A Unified Framework for Monetary Theory and Policy Analysis," *Journal of Political Economy*, vol. 113(3), pages 463-484, June.

[8] Mortensen, D. & C. Pissarides, 1994. "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies*, vol. 61(3), p. 397-415.

[9] Netzer, N. and F. Scheuer (2014) "A Game Theoretic Foundation of Competitive Equilibria with Adverse Selection", *International Economic Review*, 55, p. 399-422.

[10] Society for Human Resource Management, 2010. *Background Checking: Conducting Credit Background Checks.*

5 Appendix: Computational Algorithm

The algorithm to solve the model proceeds as follows:

- In outer loop iteration n we have a vector of positive and negative score updates on a grid of type scores. This gives us an updating function $s'_n(s,d)$ through interpolation.
- In inner loop iteration m we have vectors of worker value functions, which define $W^i_{m,n}(s), U^i_{m,n}(s)$. With these in hand we can perform the following steps:
  * Solve for the credit contracts $(Q^i_{m,n}, b^i_{m,n})_{i\in\{L,H\}}$. This is done in routine one, described below.
  * We can then solve for $w^i_{m,n}$ from the definition of the worker's value function. This is done in routine two, described below.
  * We can then solve for $\Pi^i_{m,n}(s)$. This involves a fixed point problem, but is done via iteration. Routine three describes this.
  * We can then solve for $\theta_{m,n}(s)$ as described in routine four below.
  * We finally finish the inner loop using the definition of U and Nash Bargaining, described in routine five below, which gives updated $W^i_{m,n+1}$ and $U^i_{m,n+1}$. We check the distance between the n and $n+1$. If they are close enough we exit the inner loop and update s', otherwise we begin at the beginning of the inner loop.
- We construct the new updating function $s'_{n+1}(s,d)$ from the converged value functions and credit contracts. If it is close enough to s_n then we have computed an equilibrium, otherwise we re-enter the inner loop with the new updating function

5.1 Routine One

The first routine takes as inputs $s'_n, W^i_{n,m}, U^i_{n,m}$. It returns $(Q^i_{n,m}(s), b^i_{n,m}(s))_{i\in\{L,H\}}$ for each value of s in the grid. We follow these steps:

- Loop over scores, s, and compute the following endogenous stigmas:

$$\lambda^i(s) = \beta_i(1-\delta)\Big[\epsilon + (1-\sigma)\Big(W^i_{n,m}\big(s'(s,0)\big) - W^i_{n,m}\big(s'(s,1)\big)\Big) + ... \\ \sigma\Big(U^i_{n,m}\big(s'(s,0)\big) - U^i_{n,m}\big(s'(s,1)\big)\Big)\Big]$$

- For each score s compute the least-cost separating credit market allocation. This is done by first solving the equation:

$$(1-\beta_L R)F(\lambda^L(s) - \hat{b}^L) = F'(\lambda^L(s) - \hat{b}^L)\hat{b}^L$$

  This gives the least-cost separating debt promise for impatient households, which is also the amount promised for cross-subsidizing contracts. The least-cost separating amount lent is then just $\hat{Q}^L = R^{-1}F(\lambda^L(s) - \hat{b}^L)\hat{b}^L$. We then solve for the debt of patient households from the incentive compatibility constraint:

$$R^{-1}F(\lambda^H(s)-\hat{b}^H)\hat{b}^H+\beta_L\int_0^{\lambda^L(s)-\hat{b}^H} F(\tau)d\tau = \hat{Q}^L+\beta_L\int_0^{\lambda^L(s)-\hat{b}^L} F(\tau)d\tau$$

  And finally the amount lent to patient households is $\tilde{Q}^H = R^{-1}F(\lambda^H(s) - \hat{b}^H)\hat{b}^H$. This give indirect utilities for each household of $I\hat{U}^L(s)$ and $I\hat{U}^H(s)$.

- Loop over scores, s, and compute the cross-subsidized credit market allocations. We solve for variables with $\tilde{.}$ above them from:

$$\tilde{Q}^L = \hat{Q}^L + \tilde{Q}^H + \beta_L \int_0^{\lambda^L(s)-\tilde{b}^H} F(\tau)d\tau - \hat{IU}^L(s)$$

$$\tilde{b}^L = \hat{b}^L$$

$$\tilde{Q}^H = sR^{-1}F(\lambda^H(s) - \tilde{b}^H)\tilde{b}^H - (1-s)\beta_L \int_0^{\lambda^L(s)-\tilde{b}^H} F(\tau)d\tau + (1-s)\hat{IU}^L(s)$$

$$s\Big[(1-\beta_H R)F(\lambda^H(s) - \tilde{b}^h) - f(\lambda^H(s) - \tilde{b}^H)\tilde{b}^H\Big] +$$

$$(1-s)R\Big[\beta_H F\big(\lambda^H(s) - \tilde{b}^H\big) - \beta_L F\big(\lambda^L(s) - \tilde{b}^H\big)\Big] = 0$$

Notice that the debt promise is for the patient household is independent of other variables. We take the allocations and use them to compute utilities $\tilde{IU}^H(s), \tilde{IU}^L(s)$

– We loop over s and choose the cross-subsidizing ($\tilde{.}$) allocations whenever both the patient and impatient indirect utilities are higher under cross-subsidization than the least-cost separating.

5.2 Routine Two

This routine takes $s_n', W_{n,m}^i, U_{n,m}^i, \lambda_{n,m}^i, Q_{n,m}^i, b_{n,m}^i$ and finds the wage that would be consistent with these. That is, we loop over s and solve for $w_{n,m}^i(s)$ in the equation:

$$W_{n,m}^i(s) = Q_{n,m}^i(s) + \beta_i w_{n,m}^i(s) + \beta_i \int_0^{\lambda^i(s)-b_{n,m}^i(s)} F(\tau)d\tau +$$

$$\beta_i^2(1-\delta)\Big[(1-\sigma)W_{n,m}^i\big(s'(s,1)\big) + \sigma U_{n,m}^i\big(s'(s,1)\big) - \epsilon\Big]$$

5.3 Routine Three

We now take $s'_n, W^i_{n,m}, U^i_{n,m}, \lambda^i_{n,m}, Q^i_{n,m}, b^i_{n,m}, w^i_{n,m}$ as inputs and solve for $J^i_{n,m}(s)$ from:

$$J^i_{n,m}(s) = R^{-1}\Bigg[h^i - w^i_{n,m}(s) + \\ R^{-1}(1-\sigma)\Bigg(F\big(\lambda^i_{n,m}(s) - b^i_{n,m}(s)\big)J^i_{n,m}\big(s'_n(s,0)\big) + \\ \Bigg(1 - F\big(\lambda^i_{n,m}(s) - b^i_{n,m}(s)\big)\Bigg)J^i_{n,m}\big(s'_n(s,1)\big)\Bigg)\Bigg]$$

Notice that this requires solving for a fixed point for the $J^i_{n,m}$ function.

5.4 Routine Four

This takes $s'_n, J^i_{n,m}$ as inputs and solves for $\theta_{n,m}(s)$ by looping over s and solving:

$$\kappa = R^{-1}q(\theta)\Big[sJ^H_{n,m}(s) + (1-s)J^L_{n,m}(s)\Big]$$

5.5 Routine Five

This routine updates $W^i_{n,m+1}, U^i_{n,m+1}$. It takes all of the above computed n, m indexed functions as inputs and solves the following equations:

$$W^i_{n,m+1}(s) = \frac{\xi}{1-\xi}J^i_{n,m}(s) + U^i_{n,m+1}(s)$$
$$U^i_{n,m+1}(s) = \beta_i z + \beta_i^2(1-\delta)\frac{\xi}{1-\xi}f\big(\theta_{n,m}(s)\big)J^i_{m,n}(s)$$

The first equation uses the solution to Nash Bargaining and the second one uses the definition of $U^i(s)$.