A Theory of Credit Scoring and the Competitive Pricing of Default Risk

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Endlessly Preliminary

Why do people pay back rather than file for bankruptcy?

- Benefits of default:
  - Filing for Ch. 7 bankruptcy is cheap, protects the filer from creditors
    (Only restricts her to no wealth when filing).
  - New creditors are not obliged to punish at all, despite what all the literature assumes.
- But, in addition to these benefits, bankruptcy filing triggers:
  - Significantly lower credit scores.
  - Consumers with low credit scores face higher interest rates and restricted access to credit.
  - Perhaps other costs too (renting, getting jobs, relationships)
- Overall, there is too much unsecured credit (all quantitative work imposes some additional punishments)

We provide a "reputation with adverse selection" based theory of why

- People differ in privately observed characteristics that make some of them more prone to borrow a lot and to default now and later.
- People also differ in other privately observed characteristics that make them borrow and default today but do not make them more prone to default later.
- Excessive borrowing and bankruptcy filing signal being a bad type.
- This deters them from borrowing too much, which sustains credit.
- Our theory replicate key patterns in U.S. unsecured credit market data for bankruptcy under laws resembling those in the U.S.
- But credit-relevant reputation by itself only goes part of the way to account for the volume of borrowing and lending.
- We measure the additional value of a good reputation.

Technical Innovation that helps make the theory quantitative

- In private information environments with signal extraction, agents need to know the consequences of their actions even when they do not taken them (off-equilibrium path)
- We pose unobserved shocks as in the discrete choice (logit) literature (e.g. McFadden (1973), Rust (1987))
- This gives a theoretically sound way to provide the household with the market assessments of all its possible behaviors (No need to deal with off-path beliefs in our dynamic Bayesian posteriors since all feasible actions are taken with some probability.)
- Not unrelated to "Quantal response equilibrium" of McKelvey and Palfrey (1995,1996) to make sense of unpredicted outcomes.
- Actions only partially reveal information about type (semi-separating equilibrium). They are not supposed to play any real role: Can use the limit when variance goes to zero.

Taking the model to data

1. An Aiyagari-Bewley-Huggett-Imrohoroglu type model where households have unobservable a) persistent differences in discount factors and b) temporary differences in earnings which make some more prone to borrow and default.

2. Intermediaries use observable asset and default choices to try to infer borrower type in order to price loans.

3. Estimate type heterogeneity (U.S. income and wealth data, filing costs).

4. By using credit market data (volume), we assess the extent to which

    4.1 Filing costs alone account for unsecured credit market activity.

    4.2 The value of reputation for credit market purposes.

    4.3 The missing value of reputation to sustain credit.

5. Extremely preliminary findings are that half or more of the need for enforcement have to do with the punishment directly associated to the standing in the credit market.

Equilibrium Models of Bankruptcy

- Full info, Exogenous Punishment: Chatterjee et al. (2007), Livshits et al. (2007), and all the soveriegn default literature
- Asymmetric info, Static Signaling, Exogenous Punishment: Athreya et al. (2009, 2012), Livshits et al. (2015)
- Asymmetric info, Dynamic Signaling, Endogenous Punishment (Reputation): Chatterjee et al. (2008), Mateos-Planas et al. (2017).
- *Important Issue with Asym Info*: Off-Equilibrium-Path Beliefs

Discrete Choice Models

- Estimation of Micro Models *McFadden (1973), Rust (1987).*
- Make sense of behavior in experimental data. QRE. McKelvey and Palfrey (1995,1996)

Properties of Loans and Credit Scores: Han, Keys, and Li (2015), Jagtiani and Li (2015)

Unobserved Heterogeneity

- From Han, Keys, and Li (2015) (Table 3 and p.23):
  - The credit score clearly shapes positively credit limits and spreads.
  - Bankruptcy filing affects them negatively
- From Jagtiani and Li (2015)
  - Credit scores suffer upon filing for bankruptcy

Source: Han, Keys, and Li (2015), Table 3.

	Having an offer	Credit limit	Spread
VantageScore bins			
550-600	0.100***	-208.749***	1.229***
	(0.009)	(34.383)	(0.181)
600-650	0.155***	-251.378***	2.249***
	(0.010)	(34.182)	(0.186)
650-700	0.223***	-208.157***	1.693***
	(0.011)	(32.610)	(0.203)
700-750	0.252***	-100.237***	0.436**
	(0.011)	(33.416)	(0.188)
750-800	0.285***	102.084***	-0.367*
	(0.011)	(31.987)	(0.191)
800-850	0.292***	326.984***	-0.871***
	(0.012)	(35.524)	(0.190)
850-900	0.264***	577.903***	-0.969***
	(0.012)	(31.360)	(0.185)
900-950	0.254***	714.265***	-0.865***
	(0.011)	(33.499)	(0.192)
> 950	0.267***	809.787***	-0.770***
	(0.010)	(40.664)	(0.178)
Yearly fixed-effects	yes	yes	yes
Monthly fixed-effects	yes	yes	yes
R^2 / pseudo R^2	0.061	0.115	0.341
N	169,692	148,656	217,920

	Having an offer	Credit limit	Spread
Credit hist. attr.			
Bankruptcy filer	-0.068***	-238.100***	0.834***
	(0.008)	(14.106)	(0.111)
Other derog rec.	-0.065***	-130.100***	0.153
	(0.009)	(13.166)	(0.106)
Deep del.	-0.027***	-26.073	0.091
	(0.010)	(19.841)	(0.113)
Recent del.	-0.004***	-31.710***	0.124***
	(0.001)	(2.115)	(0.015)
Num inquiries	0.001	-20.461***	0.011
	(0.001)	(2.610)	(0.011)
Debt-income ratio	-0.001	-9.194***	-0.030***
	(0.001)	(2.715)	(0.007)
Have credit card	0.065***	47.819***	-0.536***
	(0.004)	(12.860)	(0.044)
High util	-0.022***	-13.200	0.454***
	(0.006)	(16.002)	(0.043)
Yearly fixed-effects	yes	yes	yes
Monthly fixed-effects	yes	yes	yes
R^2 / pseudo R^2	0.061	0.115	0.341
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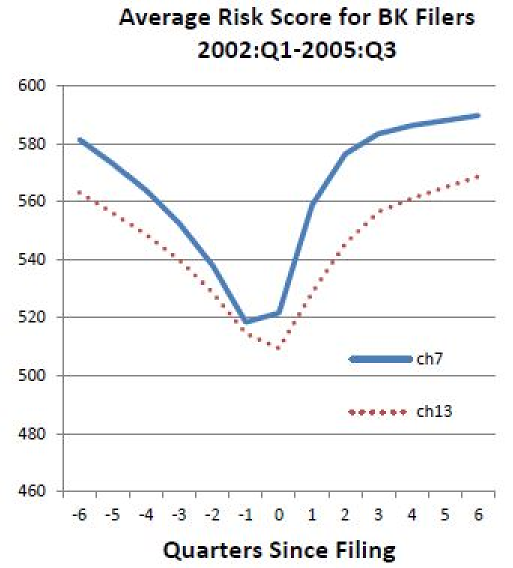
Credit Scores around Default in the Data (Jagtiani and Li (2015))



Households (Hholds)

- An Aiyagari-Bewley-Huggett-Imrohoroglu type model with preferences
$$E\left\{\sum_{t=0}^{\infty} \beta_i^t \, u(c_{it})\right\}$$
- Shocks to Preferences
  - **Persistent**: discount rate $\beta_{it} \in \{\beta_H, \beta_L\}$, $\beta' \sim \Gamma^{\beta}(\beta'|\beta)$
  - **Transitory**: additive, action-specific shocks $\epsilon_{it} \sim G(\epsilon_{it})$, i.i.d
  - (β, ϵ) **unobservable**, only β **persistent** $\rightarrow$ Hholds **type**
- Markov Shocks to Earnings, e, drawn from $\Gamma^e(e'|e)$.
- Each period, choose (d, a'):
  - $a' \in \mathcal{A} = \{a_1, ..., 0, ..., a_A\}$: asset position for next period
  - $d \in \{0, 1\}$. If $d = 1$ (Ch 7), face temporary exclusion and cannot save $[a' = 0]$, and income loss from default $[c = e - \kappa]$

- Risk neutral, perfectly competitive (free entry)
- Borrow at r, intermediation costs require spread ι on debt
- Observe earnings (e) and asset choices (d, a')

Inference problem: cannot observe β, or $\epsilon^{(d,a')}$ when pricing loans

- β persistent $\implies$ actions can signal type
- ϵ transitory $\implies$ adds confusion, allows all things to happen

Reputation: creditor's prior of HH's type $s = \Pr(\beta = \beta_H) \in \mathcal{S}$

- Posterior uses observables (d, a') and $\omega = (e, a, s)$ to revise type score $\psi^{(d,a')}(\omega)$
- Offer discount loans at prices $q^{(d,a')}(\omega)$

Timing

1. Hholds begin period with state $(\beta, e, a, s) = (\beta, \omega)$
2. Hholds receive transitory preference shocks
   - $\epsilon = \{\epsilon^{(d,a')}\}_{(d,a') \in \mathcal{Y}} \sim G^{\epsilon}(\epsilon)$, which is GEV with scale $1/\alpha_j$ in nest j (details next slide)
3. Given price schedule $q = \{q^{(0,a')}(\omega)\}$, agents choose (d, a')
4. Intermediaries revise type scores from $s \to s'$ via Bayes rule and the type scoring function $\psi^{(d,a')}(\omega)$
5. Next period states are drawn and $s' = \psi^{(d,a')}(e, a, s)$ is updated
   - $\beta' \sim \Gamma^{\beta}(\beta'|\beta)$
   - $e' \sim \Gamma^{e}(e'|e)$

Hholds Problem: Overview

- We divide the Hholds problem into 3 choices:
  1. default (D) vs no default (N)

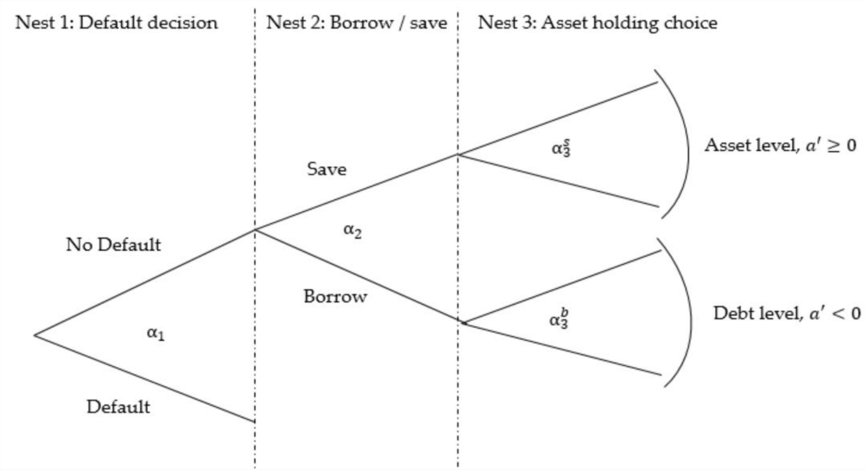
     $$D = \{1, 0\} \text{ and } N = \{B, S\}$$

  2. conditional on no default, borrow (B) vs save (S)

     $$B = \{(0, a')|a' < 0\} \text{ and } S = \{(0, a')|a' \geq 0\}$$

  3. conditional on borrow (save), choose specific debt (asset) level
- Why? To discipline the correlations b/w choices at each decision node
  - Extreme value preference shocks imply a **3-tier nested logit** structure
- We analyze this problem working backwards through these 3 decisions

Hholds problem: decision tree



- α parameters determine the correlation b/w the ϵ shocks (distributed GEV) associated with the alternatives within each nest

Hholds problem: fundamental value

The conditional value function for a given feasible action is

$$v^{(d,a')}(\beta,\omega) = u\left(c^{(d,a')}\right) + \beta \sum_{z',\beta',s',e'} \Gamma^{\beta}(\beta'|\beta)\Gamma^{e}(e'|e)\; W(\beta',\omega';\psi)$$

- $\mathcal{F}(\omega)$ is the set of feasible actions given state ω ▸ Details

and the expected value function $W(\cdot)$ integrates the extreme value shocks

$$W = \int V(\beta,\omega,\epsilon)\; dG^{\epsilon}(\epsilon)$$

The individual's decision problem is to solve

$$V(\beta,\omega,\epsilon) = \max_{(d,a')\in\mathcal{F}(\omega)} v^{(d,a')}(\beta,\omega) + \epsilon^{(d,a')},$$

where $\epsilon = \{\epsilon^{(d,a')}\}_{(d,a')\in\mathcal{Y}}$ is drawn from a Generalized Extreme Value distribution.

Hholds problem: debt / asset choice

- Using discrete choice results, **conditional on not defaulting and on borrowing**, the probability of choosing a debt level $a' < 0$ is

$$\sigma^{(0,a')}(\beta, \omega | N, B) = \frac{\chi^{(0,a')}(\omega) \exp\{\alpha_3^B v^{(0,a')}(\beta, \omega)\}}{\sum_{\tilde{a}' \in B} \chi^{(0,\tilde{a}')}(\omega) \exp\{\alpha_3^B v^{(0,\tilde{a}')}(\beta, \omega)\}}$$

  - $\chi^{(0,a')}(\omega) = 1$ if $(0, a')$ is feasible in set $j \in \{B, S\}$ for an ω-agent
    - formally, $\chi^{(0,a')}(\omega) = 1 \iff (0, a') \in \mathcal{F}(\omega)$

- We can define the expected value of borrowing, then, via the inclusive value or logsum formula

$$W^B(\beta, \omega) = \frac{1}{\alpha_3^B} \ln \left[\sum_{a' \in B} \chi^{(0,a')}(\omega) \exp\{\alpha_3^B v^{(0,a')}(\beta, \omega)\} \right].$$

- The procedure is similar for savings levels, replacing $a' < 0$ with $a' \geq 0$ and B with S in the above formulas.

Hholds problem: borrow / save choice

- Similarly, **conditional on not defaulting,** the borrowing probabiliy is

$$\sigma^B(\beta,\omega|N) = \frac{\chi^B(\omega)\ \exp\{\alpha_2 W^B(\beta,\omega)\}}{\chi^B(\omega)\ \exp\{\alpha_2 W^B(\beta,\omega)\} + \chi^S(\omega)\exp\{\alpha_2 W^S(\beta,\omega)\}}$$

  - $\chi^j(\omega) = 1$ if $\exists$ feasible actions in set $j \in \{B, S\}$ for ω.
    - formally, $\chi^j(\omega) = 1 \iff j \cup \mathcal{F}(\omega) \neq \emptyset$ for $j \in \{B, S\}$
  - similar for saving, replacing B with S above
    - 2 choices $\implies \sigma^S(\beta,\omega|N) = 1 - \sigma^B(\beta,\omega|N)$

- Expected value of not defaulting via inclusive value or logsum formula

$$W^N(\beta,\omega) = \frac{1}{\alpha_2}\ln\left[\chi^B(\omega)\exp\{\alpha_2 W^B(\beta,\omega)\} + \chi^S(\omega)\exp\{\alpha_2 W^S(\beta,\omega)\}\right].$$

Hholds problem: default / no default choice

- Similarly, the probability of defaulting is

$$\sigma^D(\beta,\omega) = \frac{\chi^D(\omega)\exp\{\alpha_1 W^D(\beta,\omega)\}}{\chi^D(\omega)\exp\{\alpha_1 W^D(\beta,\omega)\} + \chi^D(\omega)\exp\{\alpha_1 W^N(\beta,\omega)\}}$$

  - $\chi^i(\omega)$ is an indicator equal to one if there is any feasible action in set $i \in \{D, N\}$ for an agent with observable state ω
    - formally, $\chi^i(\omega) = 1 \iff i \cup \mathcal{F}(\omega) \neq \emptyset$ for $i \in \{D, N\}$
    - $\chi^D(\omega) = 1$ if and only if $a < 0$
  - similar for no default, replacing D with N above
    - 2 choices $\implies \sigma^N(\beta,\omega) = 1 - \sigma^D(\beta,\omega)$
  - $W^D(\beta,\omega) = v^{(1,0)}(\beta,\omega)$
- Agent's total expected value via the inclusive value or logsum formula

$$W(\beta,\omega) = \frac{1}{\alpha_1}\ln\left[\chi^D(\omega)\exp\{\alpha_1 W^D(\beta,\omega)\} + \chi^N(\omega)\exp\{\alpha_1 W^N(\beta,\omega)\}\right].$$

• Combine the conditional (or nest-level) decision rules computed above into a single decision probability function $\sigma^{(d,a')}(\beta,\omega)$ for all $(d,a') \in \mathcal{Y}$, $\beta \in \mathcal{B}$, and $\omega \in \mathcal{E} \times \mathcal{Z} \times \mathcal{S} \times \mathcal{A}$ by combining conditional probabilities:

$$\begin{aligned}
\sigma^{(1,0)}(\beta,\omega) &= \sigma^{D}(\beta,\omega) \\
\sigma^{(0,a')}(\beta,\omega) &= \begin{cases} \sigma^{N}(\beta,\omega)\sigma^{B}(\beta,\omega|N)\sigma^{(0,a')}(\beta,\omega|N,B) & \text{if } a' < 0 \\ \sigma^{N}(\beta,\omega)\sigma^{S}(\beta,\omega|N)\sigma^{(0,a')}(\beta,\omega|N,S) & \text{if } a' \geq 0 \end{cases}
\end{aligned}$$

- can substitute in for σ formulas to get expressions that are functions of only conditional values and α parameters

• This is the decision rule used in the intermediary/credit scoring agency problem, as well as in the computation of the stationary distribution

Type Scoring and Debt Pricing by Intermediaries

It updates the assessment of a Hholds's type given its actions and observable characteristics using Bayes' rule, ▸ Details

$$\psi^{(d,a')}(\omega) = \Pr(\beta' = \beta_H | d, a', \omega)$$

Perfect competition, deep pockets $\implies$ breakeven pricing:

$$q^{(0,a')}(\omega) = \begin{cases} \frac{p^{(0,a')}(\omega|f)}{1+r+\iota} & \text{if } a' < 0 \\ \frac{1}{1+r} & \text{if } a' \geq 0 \end{cases}$$

where $p(\cdot)$ is the **assessed repayment probability** using both the type score ψ and decision rules σ:

$$p^{(0,a')}(\omega) = \int_{s',e'} \Gamma^s(s'|\psi^{(d,a')}(\omega)) \cdot \Gamma^e(e'|e) \cdot$$
$$\cdot \left[s'(1-\sigma^{(1,0)}(\beta_H,\omega')) + (1-s')(1-\sigma^{(1,0)}(\beta_L,\omega')) \right]$$

Actual definition of the "data relevant" credit score

- It is the probability that an agent defaults the following period conditional on today's observables

$$\xi_1(\omega) = \sum_{(d,a')\in\mathcal{Y}} \left[p^{(0,a')}(\omega) \cdot \sum_{\beta\in\mathcal{B}} \sigma^{(d,a')}(\beta,\omega) \cdot \frac{\overline{x}(\beta,\omega)}{\sum_{\hat{\beta}\in\mathcal{B}} \overline{x}(\hat{\beta},\omega)} \right]$$

Equilibrium Definition

A **stationary recursive competitive equilibrium** is a vector-valued pricing function q^*, a vector-valued type scoring function ψ^*, a vector-valued quantal response function σ^*, and a steady state distribution $\overline{x}^*$ such that:

- $\sigma^{(d,a')*}(\beta,\omega|f^*)$ satisfies household optimization,
- $q^{(0,a')*}(\omega)$ implies lenders break even with objective likelihood of repayment $p^{(0,a')*}(\omega|f^*)$,
- $\psi_{\beta'}^{(d,a')*}(\omega)$ satisfies Bayes', and
- $\overline{x}^*(\beta,\omega|f^*)$ is stationary.

Theorem

There exists a stationary recursive competitive equilibrium.

▸ Proof

Detour: Nastiness of problem

- Hholds need to know the derivative of the Bayesian updating function, which in turn is an equilibrium function.
- This is particularly hard.
- Perhaps we can use less stringent equilibrium/rationality conditions
    - Explicitly Approximating Agents

Mapping the Model to Data

How to Estimate a Particular Economy

- We estimate (pedestrian exactly identified GMM) a five parameter model $\{\beta_L, \Gamma_{Hholds}, \Gamma_{LL}, \alpha_1, \alpha_3^b\}$.
  - We normalize β_H Not clear if we should
  - We normalize also 2 irrelevant α's (so no errors on the savings borrowing margin and o errors on the savings margin conditional on other choices)
- We target 17 moments:
- 12 of the SCF joint earnings and wealth including distribution of the 95% age 20-60 poorest households.
- We add 5 credit type targets (default, interest rates, volume of credit)
- We use direct measurements (monetary cost of bankruptcy filing).
- This is a particularly hard model to solve

We estimate various models and compare them

1. The baseline model with Dynamic Punishment.
2. A Model with only Static Punishment.
3. A Static Punishment model with the same amount of Extreme value noise but partially reestimated.
4. The static Punishment Model with the Dynamic Parameters.
5. A Dynamic Punishment Model with additional punishment to being thought of as a bad guy.

Targeted model moments: Distributional Moments

Earnings → / Wealth ↓	Data			Model		
	T1	T2	T3	T1	T2	T3
T1	0.20	0.10	0.03	0.15	0.13	0.05
T2	0.09	0.14	0.10	0.07	0.11	0.15
T3	0.03	0.09	0.22	0.04	0.09	0.20

Table 1: Joint distribution of earnings and wealth tertiles

Wealth, $t+2$ → / Wealth, t ↓	Data			Model		
	T1	T2	T3	T1	T2	T3
T1	0.76	0.22	0.02	0.84	0.11	0.05
T2	0.20	0.62	0.18	0.09	0.68	0.24
T3	0.04	0.14	0.82	0.03	0.07	0.91

Table 2: Wealth tertile transitions

Targeted model moments: Credits and aggregates

	Moment	Data	Dynamic Model
Credit	Default rate (%)	0.99	0.68
	Average interest rate (%)	12.89	18.24
	Fraction of HH in debt (%)	6.50	4.82
	Debt to income ratio (%)	0.49	0.11
	Interest rate dispersion (%)	6.58	12.21
Wealth	Mean wealth to mean earnings	3.22	2.40
	Correlation b/w wealth and earnings	0.52	0.49

Table 3: Credit market and wealth moments

- Equal percentage weights.
- Sum of Squared Errors (MSE) for dynamic model is: 2.011

Summary of Findings

- In sufficient Default (20% missing)
- Excessive Interest Rates (5%)
  - These two may be incompatible. In the model all debt is voluntary and defaultable. Not so in the data.
- Slightly too few borrowers.
- Very little debt (75% missing)
- Interest rates too dispersed
- A bit too little wealth

Parameterization: For what is worth

	Parameters	Notation	Value
Selected	CRRA	ν	3
	Risk-free rate (%)	r	1
	Filing costs to mean income (%)	κ	2
	EV scale parameter, borrow / save	α_2	600
	EV scale parameter, $a \geq 0$ level	α_3^s	550
	High type discount factor	β_H	0.99
Estimated	Low type discount factor	β_L	0.91
	$\beta_L \rightarrow \beta_H$ transition prob	$\Gamma^\beta(\beta_H' \vert \beta_L)$	0.04
	$\beta_L \rightarrow \beta_H$ transition prob	$\Gamma^\beta(\beta_L' \vert \beta_H)$	0.09
	EV scale parameter, default	α_1	448
	EV scale parameter, $a < 0$ level	α_3^b	470

What is the value of Dynamic Punishments?

- For this we will pose three models with only Static Punishments
    - All parameters Reestimated (Stat 1)
    - Same noise model, but reestimation of others (Model 3)
    - Same parameters as Dynamic Model (Stat 3)

Static Punishment Economies: Moments

Moment	Data	Dyn	Stat 1
Default rate (%)	0.99	0.68	0.68
Average interest rate (%)	12.89	18.24	20.59
Fraction of HH in debt (%)	6.50	4.82	6.39
Debt to income ratio (%)	0.49	0.11	0.13
Interest rate dispersion (%)	6.58	12.21	8.75
Mean wealth to mean earn	3.22	2.40	2.42
Correl b/w wealth and earn	0.52	0.49	0.53
Credit MSE		1.67	1.06
All MSE		2.01	2.31

Table 4: Credit market and wealth moments

- Credit in Stat 1 better than in Dyn.

Static Punishment Economies: Moments

Moment	Data	Dyn	Stat 1	Stat 2
Default rate (%)	0.99	0.68	0.68	1.10.
Average interest rate (%)	12.89	18.24	20.59	7.76
Fraction of HH in debt (%)	6.50	4.82	6.39	6.82
Debt to income ratio (%)	0.49	0.11	0.13	0.17
Interest rate dispersion (%)	6.58	12.21	8.75	17.71
Mean wealth to mean earn	3.22	2.40	2.42	2.26
Correl b/w wealth and earn	0.52	0.49	0.53	0.56
Credit MSE		1.67	1.06	4.63
All MSE		2.01	2.31	7.10

Table 5: Credit market and wealth moments

- The better performance of Stat 1 was due to higher noise.

Static Punishment Economies: Moments

Moment	Data	Dyn	Stat 1	Stat 2	Stat 3
Default rate (%)	0.99	0.68	0.68	1.10.	0.68
Average interest rate (%)	12.89	18.24	20.59	7.76	25.90
Fraction of HH in debt (%)	6.50	4.82	6.39	6.82	6.11
Debt to income ratio (%)	0.49	0.11	0.13	0.17	0.13
Interest rate dispersion (%)	6.58	12.21	8.75	17.71	14.61
Mean wealth to mean earn	3.22	2.40	2.42	2.26	2.40
Correl b/w wealth and earn	0.52	0.49	0.53	0.56	0.49
Credit MSE		1.67	1.06	4.63	3.15
All MSE		2.01	2.31	7.10	10.47

Table 6: Credit market and wealth moments

- The performance suffers in Stat 3.

Conclusions so far

- Dynamics give a better match but not necessrily one that means more credit.
- There is some sense in which static punishment economies are very useful anaway as means of revealing type
- we are now working in developing measures of market revelation

What if a Bad Credit Score is Costly for other Reasons

- Let utility be

$$u(c) - \lambda(1 - s).$$

- Add λ as a parameter.
- Can we obtain more credit or better estimates?
- The results are still hot from the oven (fresh is longer)

Targeted model moments w/ Utility Cost

	Moment	Data	Model
Credit	Default rate (%)	0.99	0.99
	Average interest rate (%)	12.89	27.80
	Fraction of HH in debt (%)	6.50	6.06
	Debt to income ratio (%)	0.49	0.16
	Interest rate dispersion (%)	6.58	20.08
Wealth	Mean wealth to mean earnings	3.22	2.19
	Correlation b/w wealth and earnings	0.52	0.47

Table 7: Credit market and wealth moments

- There is more default but not a hell of a lot more credit.
- The estimation is not a lot better (the current value for the MSE is 6.0) (which I do not understand).

Dynamic Model w/ Utility Cost: $u(c) - \lambda(1 - s)$

	Parameters	Notation	Value
Selected	CRRA	ν	3
	Risk-free rate (%)	r	1
	Filing costs to mean income (%)	κ	2
	EV scale parameter, borrow / save	α_2	600
	EV scale parameter, $a \geq 0$ level	α_3^s	550
	High type discount factor	β_H	0.99
Calibrated	Low type discount factor	β_L	0.88
	$\beta_L \rightarrow \beta_H$ transition prob	$\Gamma^\beta(\beta_H' \vert \beta_L)$	0.033
	$\beta_L \rightarrow \beta_H$ transition prob	$\Gamma^\beta(\beta_L' \vert \beta_H)$	0.076
	EV scale parameter, default	α_1	450
	EV scale parameter, $a < 0$ level	α_3^b	373
	utility cost of bad reputation	λ	0.0063

Conclusion

Conclusion

- Developed model of unsecured consumer credit in which
  - Agents have option to **default**, and do so in equilibrium
  - Unobservable preference shocks impose an **inference problem** on intermediaries who price debt
  - **Credit scoring** helps solve this problem
- There are two temporary conclusions about the empirical implementation
  1. Maybe the data is inconsistent (interest rates are insufficient to pay for default)
     - Reinterpret the data at the light of the model
  2. Maybe the static model (those where the inference is not based on history as represented by s, the credit score, but only by current actions the amount of borrowing) reveals a lot, and the marginal value of the credit scoring is low.
- In any case, the estimation is not good enough yet.