Credit Cards and Consumption

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Motivation

1. Dual-purpose CC use (US consumers)
   - Most have a card (77%) & use it (80% adopters)
   - Similar volume and value shares (15-20%)
   - Rewards: Yes (64%)
   - Interest: revolvers (14-16%), convenience (0%)
   - Debt puzzles: revolving ($5-6k) + liquid and/or illiquid
2. Mostly segregated theoretical modeling
   - Consumption-saving – debt, credit, smoothing
   - Money-payments – transactions costs, A/U, ACS, 2SMs
3. Incomplete data support/access
   - Debt OR payments, not both
   - Reliance on central moments & calibration
   - Subsets of revolving credit accounts not all
   - Insufficient longitudinal panels

Sources: Survey of Consumer Payment Choice, SCF, CFPB Making Ends Meet Survey.

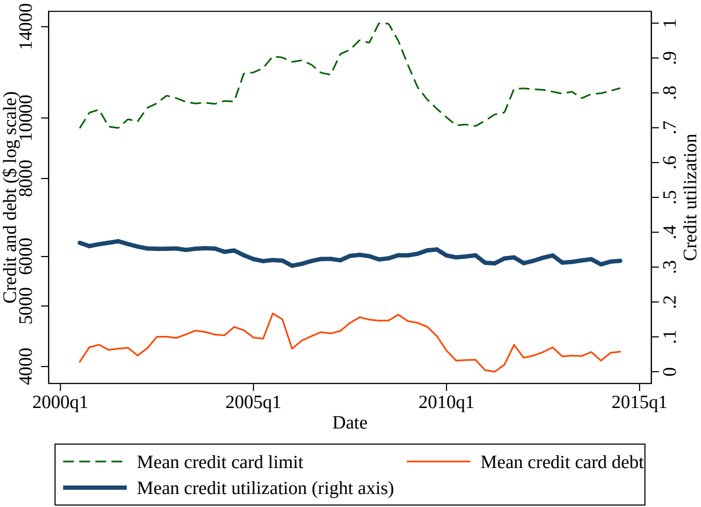
Related literature (partial)

- Consumption models with revolving credit and/or life-cycle behavior and/or hyberbolic discounting: Gourinchas and Parker (2002); Laibson, Repetto, and Tobacman (2003); Telukova (2013)
- Econometric studies with micro panel credit card data: Gross and Souleles (2002); Agarwal et al (2015); Fulford and Schuh (2015)
- Money demand/payment choice with cash, debit, and credit: Telukova and Wright (2008); Koulayev et al (2016); Wakmori and Welte (2017); Alvarez and Lippi (2017); Briglevics and Schuh (2018)
- Credit default: Chatterjee et al (2007); Livshits et al (2007)

Primary contributions

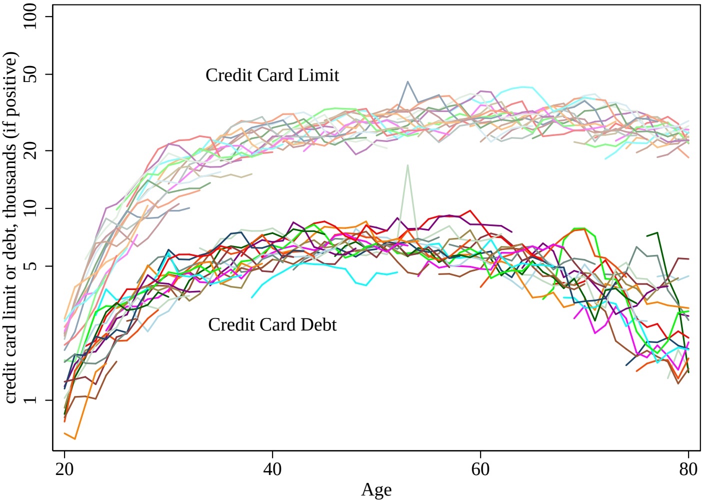
1. MODELING: Credit cards used for payment & debt
2. DATA: Rich longitudinal panel of micro data
   - NY Fed Consumer Credit Panel (CCP), 1999-2017
   - Diary of Consumer Payment Choice (DCPC)
   - SCF and CEX surveys
3. ESTIMATION: Method of Simulated Moments (McFadden 1989) rather than calibration
4. RESULTS: Estimated model reveals:
   - Mixed preferences (50-50 patient, impatient)
   - Persistent debt utilization over life & business cycle
   - Strong consumption reaction to liquidity shocks
   - Utility of CC payments (0.3% of expenditures) = $40b (merchant fees $60b)
   - But NOT life-cycle shift from revolving to convenience...

Business cycle: CC limit, debt, utilization



Notes: Observed individual debt may includes both convenience and revolving debt.
Source: Author's calculations from Equifax/CCP.

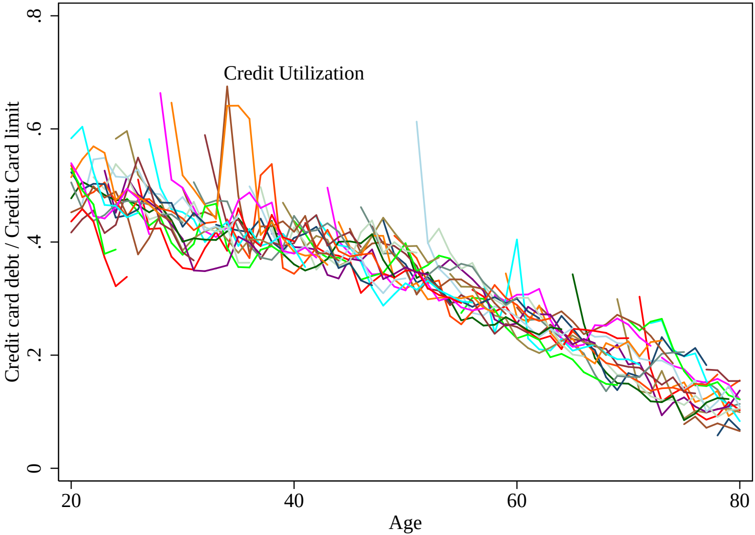
Life-cycle: CC limits and debt



Credit and debt largest changes early in life.
Biggest source of "saving" for those under 40.

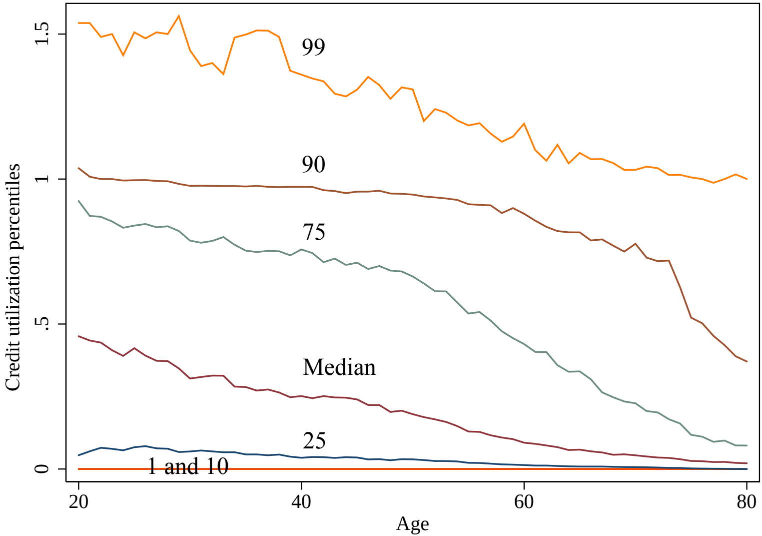
Compare to Attanasio, Banks, Meghir, and Weber (1999)

Life-cycle: CC utilization



Source: Author's calculations from Equifax/CCP

Life-cycle: CS distributions of utilization



Business cycle: Individual CC utilization

$$\text{Credit utilization}_{it} = \theta_t + \theta_a + \alpha_i + \beta \text{Credit utilization}_{i,t-1} + \epsilon_{it}$$

	CCP
Credit utilization$_{t-1}$	0.647***
	(0.00131)
Observations	347,642
R-squared	0.429
Fixed effects	Yes
Age and year effects	Yes
Number of accounts	10,451
Frac. Variance from FE	0.477

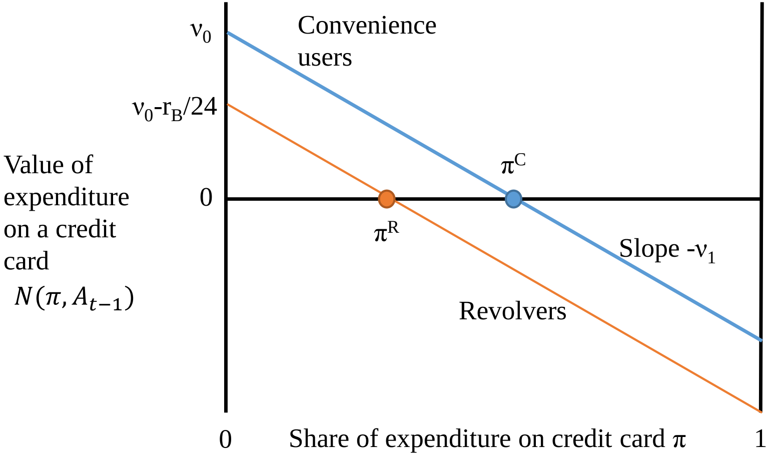
Only $0.647^4 = 0.175$ of a shock to utilization left after a year.

Model: Payments decision

- Each period consumer must decide how to pay for expenditure
- Model payments as a transaction cost driving a small wedge between expenditure X_t and consumption C_t
- For each fraction of expenditures (indexed by π) consumer chooses whether to pay by credit card or "cash"
- $N(\pi)$ is relative cost of cash
  - If $N(\pi) > 0$ prefer credit card
  - If $N(\pi) < 0$ prefer cash
- Key for identification: If revolving, lose "float" of free credit, makes using credit card for payments more expensive

Model: Payments decision

Simple linear function: $N(\pi) = \nu_0 - v_1\pi$



Estimating CC convenience value

	Fraction on Credit card	Std. error	Std. dev.
All consumers	0.172	0.0082	0.310
All revolvers	0.156	0.0130	0.283
All convenience users	0.182	0.0105	0.324
Model Estimates			
Level ν_0	0.035	0.0216	
Slope ν_1	0.194	0.1259	
Implied value of Credit Card use (in percent of consumption)			
Revolvers	0.235%	0.1512	
Convenience users	0.319%	0.0962	

Source: Authors' calculations from Federal Reserve Bank of Boston Diary of Dairy of Consumer Payment Choice

Intertemporal model

$$\max_{\{X_s,\pi_s,f_s\}_{s=t}^{T}} \left\{ E\left[\sum_{s=t}^{T} \beta_j^{s-t} u(C_{is}) + \beta_j^{T+1} S(A_{iT}) \right] \right\} \text{ subject to}$$

$$
\begin{aligned}
&C_{is} = \nu_{is}(1 - f_{i,s}\phi_s^c)X_{is} && \text{(Consumption and expenditures)}\\
&X_{is} \leq W_{is} && \text{(Expenditures limited by liquidity)}\\
&W_{is} = R_{i,s}A_{i,s-1} + Y_{is} + B_{is} - K_{is} && \text{(Evolution of liquidity)}\\
&A_{i,s-1} = W_{i,s-1} - B_{is-1} - X_{is-1} && \text{(Assets and liquidity)}\\
&\nu_{is} = \nu(\pi_{is}; A_{i,s-1}) && \text{(Payment decision)}\\
&f_{is} = f(F_{i,s}, W_{i.s}) && \text{(Default decision)}\\
&F_{i,s} = H(F_{i,s-1}, f_{i,s-1}) && \text{(Evolution of default state)}
\end{aligned}
$$

- Key constraint: liquidity W_{it} from assets A_{it-1}, credit limit B_{it}, and income Y_{it}, minus expenditure shock K_{is}
- Expenditures X_{is} become consumption through payment choice ν_{is} and cost if default $f_{i,s}$

Shocks and Income

- Permanent-Transitory income:

$$Y_{i,t+1} = P_{i,t+1}(U_{i,t+1} - F_{i,t+1}\phi^{y}_{t+t})$$
$$P_{i,t+1} = G^{j}_{t+1}P_{it}M_{i,t+1},$$

  - G^{j}_{t} follows CEX income
  - Shocks $M_{i,t+1}$ and $U_{i,t+1}$ log normal
  - Allow for transitory unemployment/low-income shock
  - Income reduced by ϕ^{y}_{t+t} if in default state
- Transitory expenditure shocks
  - $K_{it} = kP_{i,t}$ with probability p^{k}
- Beginning and end of life ▸ Beginning and end of life
- Bequests ▸ Bequests

Borrowing

- Credit limit as fraction of permanent income

$$B_{it} = b_t P_{it} b_f^{F_{it}}$$

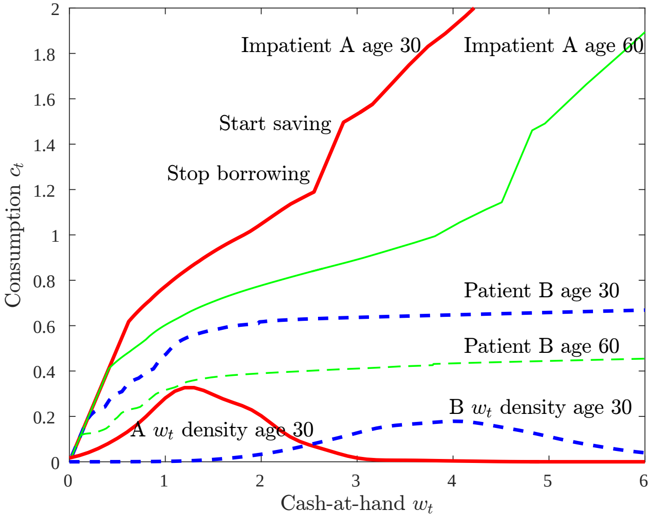
  - b_t grows so that $E_i[B_{it}]$ matches observed credit limits
  - Produces direct correspondence between income, credit, and consumption decisions
  - Distribution of credit and income match
- Borrowing and saving at different rates

$$R_{i,t} = R(A_{i,t-1}, F_{i,t}) = \begin{cases} R & \text{if } A_{i,t-1} \geq 0 \\ R_B & \text{if } A_{i,t-1} < 0 \\ R_D & \text{if } A_{i,t-1} < 0 \text{ and in default at t-1} \end{cases}$$

Default

- Default if:
  1. Expenditure shock pushes liquidity below 0 $\rightarrow$ consume $c^{min}P_{it}$.
  2. Decide to default $\rightarrow$ consume all liquidity, minus a penalty $(1-\phi_t^c)W_{it}$
- After default, enter default state
  - Assets in next period 0
  - Credit limit reduced to by multiple $b_f < 1$
  - Interest rate on borrowing increased to R_D
  - Income in each period reduced by $\phi_t^y = \phi^y(R^B-1)b_tP_{it}$
  - Exit default with constant probability each period, expected length of default 7 years

Consumption policy



▸ Consumption Policy with default by choice

Estimation with heterogeneity

- Allow for two sub-populations with different preferences
- Mix populations by estimating:
  - Fraction of population A: f^a
  - Fraction of mean life-cycle income earned by A: ζ^A
  - Hold population average life-cycle income equal CEX, so f^a and $\zeta^A \rightarrow f^B$ and ζ^B
- First stage: estimate payments decision, life-cycle income, credit limit, income volatility, interest rates First stage estimates
- Second stage: estimate 12 parameters jointly:

$$\theta = \{\gamma^A, \beta^A, \lambda_0^A, \lambda_1^A, \gamma^B, \beta^B, \lambda_0^B, \lambda_1^B, f^A, \zeta_0^A, p^k, k\}$$

- Default costs identified only up to inequality

Identification of Default Costs

Method of Simulated Moments Estimation

1. Given preferences θ and first stage χ, numerically find
   - Consumption $C_t(W_t, P_t, F_t, I^R_{t-1}; \theta, \chi)$ at each age, liquidity, permanent income, default, revolving status
   - Default liquidity at which $V^D > V^{ND}$
2. Simulate consumption/savings/debt/default at every age for large population
3. Compare simulated and actual consumption and debt profiles
4. Go back to 1 with new θ, stop when find θ that minimizes difference between simulated and actual life-cycle profiles

Technical Details

Estimates

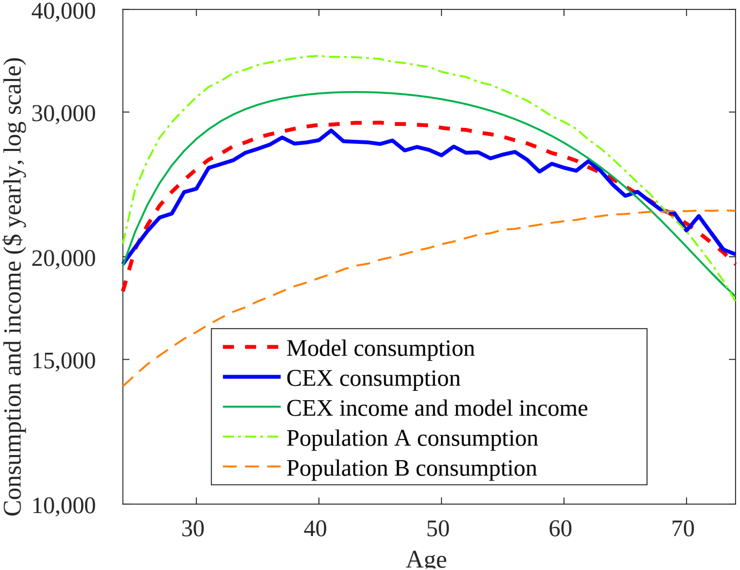
Population A	
CRRA γ^A	0.089
	(0.027)
Discount β^A	0.890
	(0.001)
Initial wealth λ_0^A	1.106
	(0.080)
Late life inc. λ_1^A	0.602
	(0.060)

Population B	
CRRA γ^A	1.735
	(1.045)
Discount β^B	0.964
	(0.015)
Initial wealth λ_0^B	3.551
	(7.180)
Late life inc. λ_1^B	0.207
	(0.443)

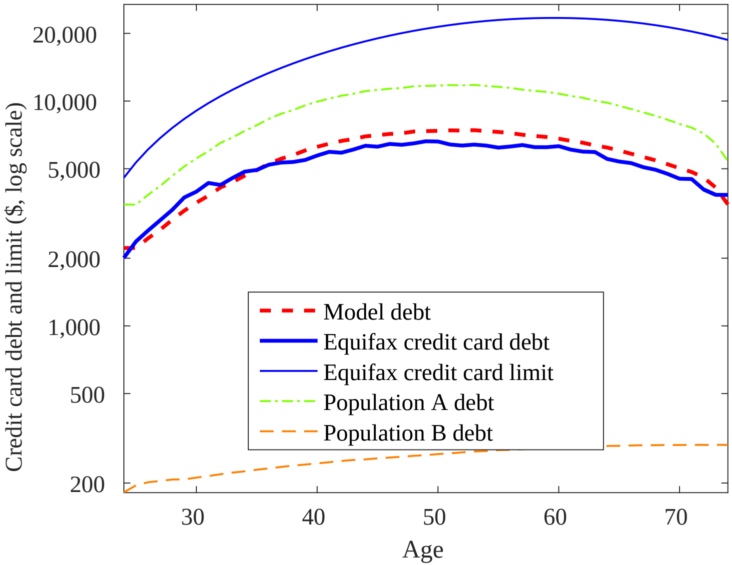
Mix	
Share A f^A	0.621
	(0.012)
Inc. mult. A ζ^A	1.131
	(0.100)

Expenditure Shock	
Prob. of exp. shock	0.044
	(0.015)
Size of exp. Shock	0.635
	(0.125)

Consumption path

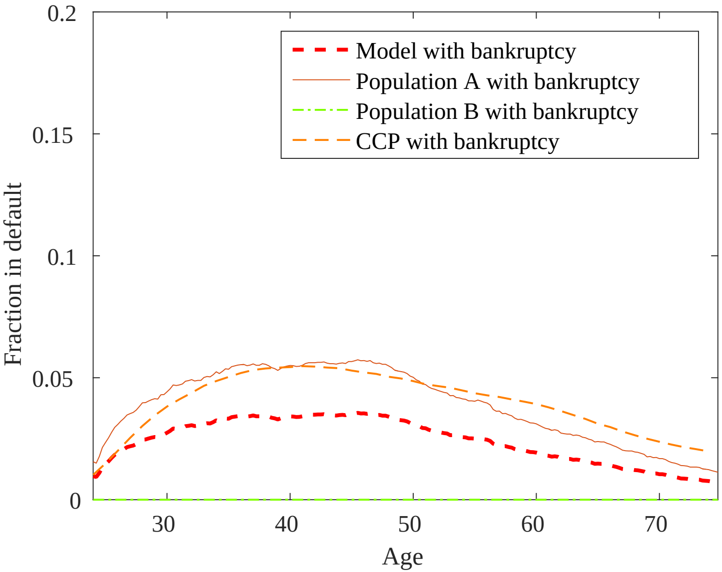


Debt path

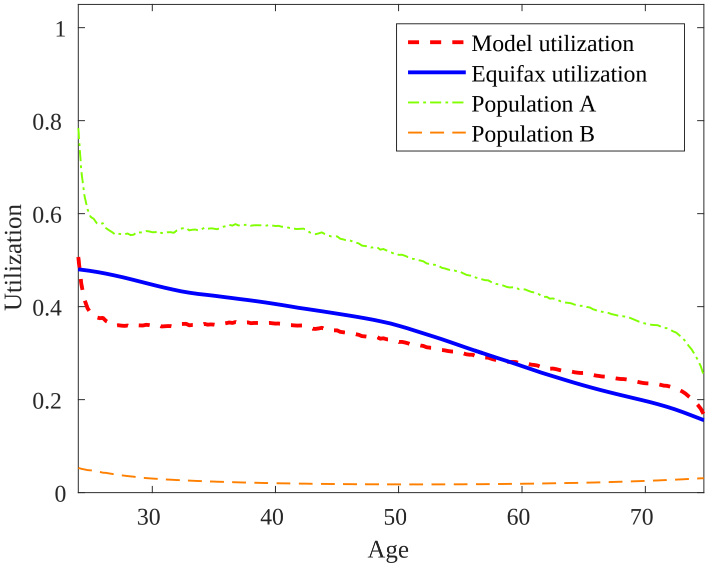


Credit card debt and limit ($, log scale)
20,000
10,000
5,000
2,000
1,000
500
200
30
40
50
60
70
Age
Model debt
Equifax credit card debt
Equifax credit card limit
Population A debt
Population B debt

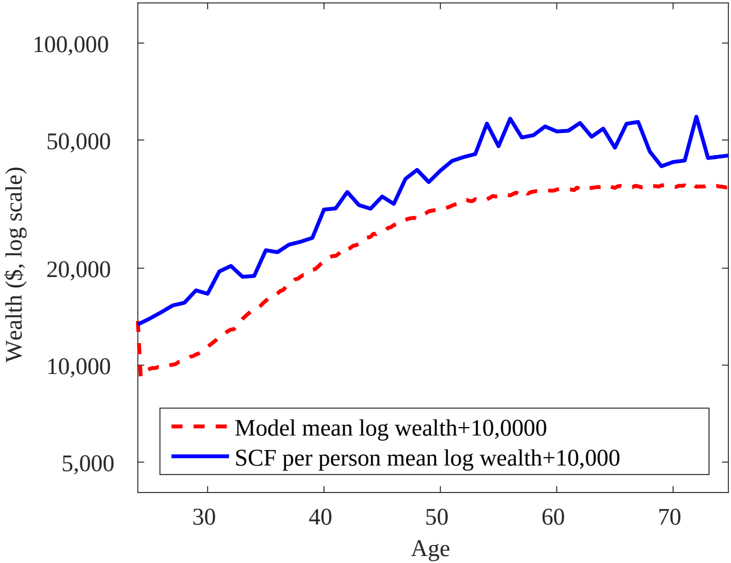
Default path



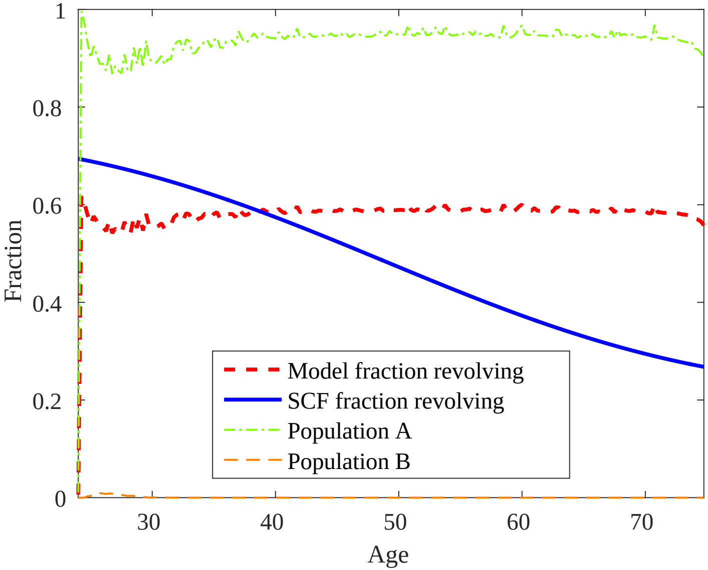
Model prediction: Utilization path



Model prediction: Wealth path

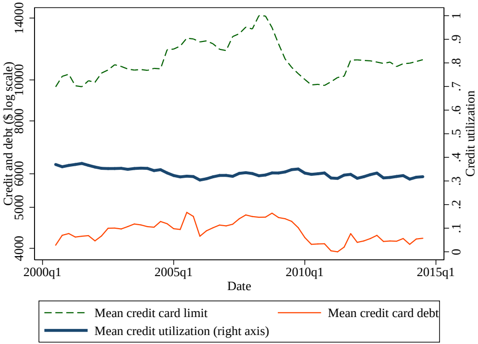


Model prediction: Fraction revolving

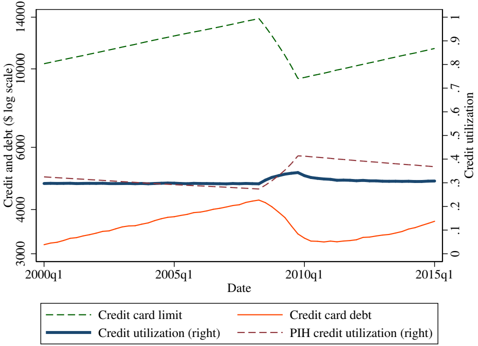


Out of sample predictions

- Three tests:
  1. Aggregate credit falls 35% to match 2008-2009
  2. Micro reduced-form utilization dynamics
  3. Response to randomly allocated income shock
- Each experiment incorporates full model heterogeneity:
  - Life-cycle
  - Heterogeneous agents with different histories (utilization, consumption)
  - Different preferences (patient, impatient)



14000
10000
8000
6000
5000
4000
Credit and debt ($ log scale)
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
Credit utilization
2000q1
2005q1
2010q1
2015q1
Date
Mean credit card limit
Mean credit card debt
Mean credit utilization (right axis)



14000
10000
6000
4000
3000
Credit and debt ($ log scale)
1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
Credit utilization
2000q1
2005q1
2010q1
2015q1
Date
Credit card limit
Credit card debt
Credit utilization (right)
PIH credit utilization (right)

Reduced-form micro utilization dynamics

	CCP	Model
Credit utilization$_{t-1}$	0.647***	0.699***
	(0.00131)	(0.000492)
Observations	347,642	2,168,011
R-squared	0.429	0.491
Fixed effects	Yes	Yes
Age and year effects	Yes	Yes
Number of accounts	10,451	46,607
Frac. Variance from FE	0.477	0.217

Policy: Effect of cash stimulus

- Giving people cash one way to increase consumption, useful for counter-cyclical policy
  - Tax-rebate literature (Kaplan and Violante, 2014; Parker et al., 2013) suggests around 25% of rebate spent within one quarter
  - Much too large for standard models: PIH says spend annuity, buffer-stock with standard preferences very low as well
  - Kaplan and Violante (2014) suggest explanation is wealthy hand-to-mouth
- Our explanation simpler, but complementary: Because more than half of population revolving, more than half must have pretty high marginal propensity to consume

Policy: Effect of cash stimulus

$$\Delta C_{it} = \alpha + f(age_{it}) + \beta Cash_{it} + \epsilon_{it}$$

	Full pop.	Pop. A	Pop B.	Full pop.	Pop. A	Pop B.
	Δ Expenditure from previous quarter					
Transitory income increase	0.226***	0.270***	0.0904***			
	(0.0250)	(0.0334)	(0.0333)			
Permanenent credit limit increase				0.296***	0.340***	0.162***
				(0.0248)	(0.0330)	(0.0337)
Observations	533,288	329,560	203,728	533,288	329,560	203,728
R-squared	0.000	0.001	0.000	0.001	0.001	0.000
Age effects	Yes	Yes	Yes	Yes	Yes	Yes

Tax rebate literature: ≈ 0.25

Summary: Why is utilization so stable?

- Stability from three interacting sources
  - Liquidity constraint: Impatient want to spend more, increase in credit allows to do so
  - Payments: Credit card use a fraction of consumption, which is determined by income. Increase in permanent income increases both credit limit and credit cards
  - Precaution: Increase in credit increases buffer, allows spend more (Fulford, 2013)

Conclusions and insights

1. Need heterogeneous preferences to fit the data
   - Plausible *estimated* discount rates
2. Need CC payments to identify impatience
   - Margin between convenience and revolving
3. Need life-cycle credit dynamics to understand constraints
   - Large changes in early life are important
4. Model generally fits and predicts data well
   - Exception: life-cycle decline in share of revolvers

References I

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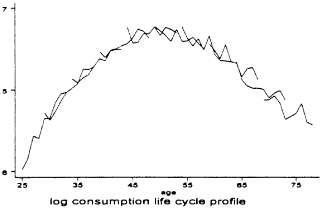
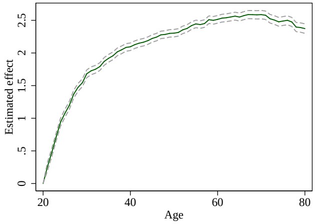
Parker, Jonathan A., Nicholas S. Souleles, David S. Johnson, and Robert McClelland. 2013. "Consumer Spending and the Economic Stimulus Payments of 2008." *American Economic Review* 103 (6):2530–53.

Credit is a **BIG** life-cycle change

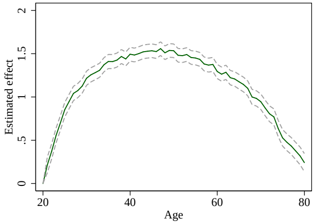
Attanasio, Banks, Meghir, and Weber (1999)



Comparable estimates from the CCP



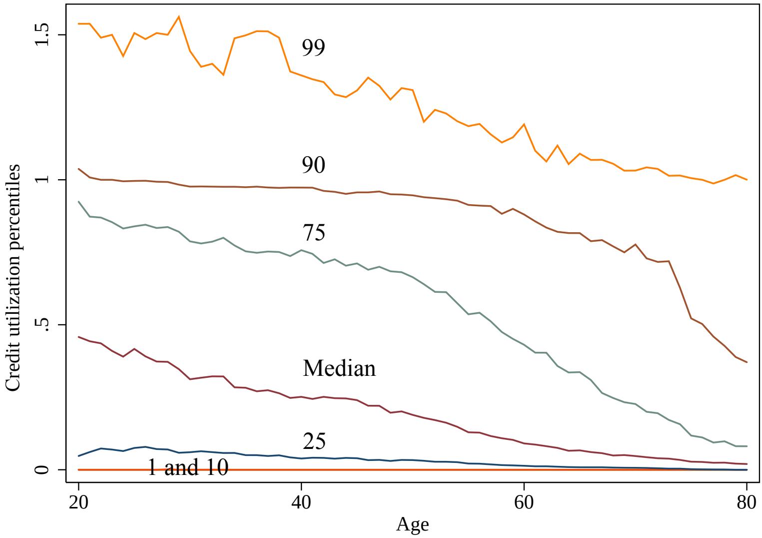
log Credit card limit



log Credit card debt

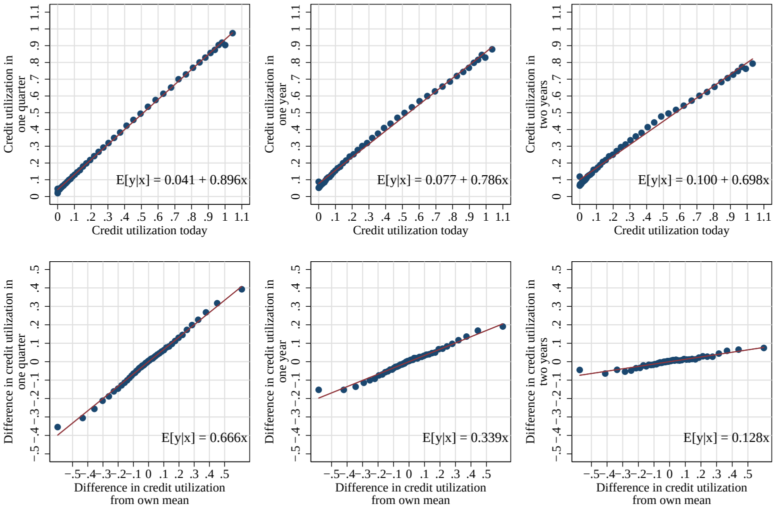
Back to presentation

Distribution of utilization



Distributions of Credit, Debt, and Utilization

Credit utilization: non-parametric



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Credit and Debt

$$\text{Log Debt}_{it} = \theta_i + \theta_t + \theta_a + \alpha \text{Log Limit}_{i,t-1} + \beta \text{Log Debt}_{i,t-1} + \epsilon_{it}$$

	Log Debt_t	Log Limit_t
Log Debt_{t-1}	0.505***	0.00687***
	(0.00157)	(0.000561)
Log Credit Limit_{t-1}	0.414***	0.848***
	(0.00262)	(0.000933)
Observations	296,369	307,805
R-squared	0.432	0.778
Accounts	10,028	10,149
Fixed effects	Yes	Yes
Zero included	No	No
Age effects	Yes	Yes
Long term credit impact	0.862	
Credit salience σ	0.443	

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First stage estimates of other parameters

- Income profile 5-degree age polynomial estimated from CEX
- Income volatility estimates from Gourinchas and Parker (2002) and Carroll and Samwick (1997) calculated from PSID, adjusted for quarterly
- $r_B = 14.11\%$ (average of Fed G19 adjusted for default using Edelberg (2006)).
- $r = 5.4\%$ (average return on an all bond portfolio 1926-2015)
- Adjust for inflation 2.15% from 2000-2015
- Allow for expected aggregate growth of 1.5% (average 1947-2015)

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Beginning and end of life

- Initial wealth/income log normal, mean λ_0, variance matching permanent income
- At T^{Ret}, no more income uncertainty, disposable income $\lambda_1 P_{T^{Ret}-1}$ income every period
- Die with some probability before 94, certainly at 94
- Bequest: annuity of assets left to heirs

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Bequests

- Have to allow for "negative" bequests of credit card debt that must be payed out of other assets
- Don't want marginal utility to be infinite $\rightarrow$ implies strong counterfactual preference to never hold debt
- Utility of giving annuity to heirs with their own income

$$S(A_t) = \left(\sum_{s=0}^{\tilde{T}} \beta^s \frac{(\zeta P_t + r(A_t)A_t)^{1-\gamma}}{1-\gamma} \right)$$

- Strength of bequest motive ζ: how much more income heirs have, value of rest of the estate

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Estimation using Method of Simulated Moments

- At each age find difference between empirical and simulated moment:

$$g_t^D(\theta;\chi) = \frac{1}{\bar{D}}\left((1/K_t)\sum_{k=1}^{K_t} D_{k,t} - (1/N)\sum_{i=1}^{N} \hat{D}_{i,t}(\theta;\chi) \right)$$

  - Scale so that percentage deviations in debt same weight as deviation in consumption
- Search for minimum weighted squares difference from empirical moments:

$$\min_{\theta\in\Theta} g(\theta;\chi)' W g(\theta;\chi)$$

- Generally use $W = \Omega_g^{-1}$, robust to alternatives

Estimation using Method of Simulated Moments

$$\min_{\theta \in \Theta} g(\theta; \chi)' W g(\theta; \chi)$$

- Also use "optimal" W where first estimate θ consistently using $W = \Omega_g^{-1}$, then take into account how first stage estimates might improve efficiency of weighting
- Use equal weighting, where normalize each block of block diagonal $W = \Omega_g^{-1}$ by trace, given exactly equal weight to consumption and debt moments
- Calculate variance-covariance of $\hat{\theta}$ following Laibson, Repetto, and Tobacman (2007) to allow K_t to vary
- Only know local optimum and loss function has multiple peaks
  - Start search grid of 10 dimensional space. Present best result, characterize other peaks in paper

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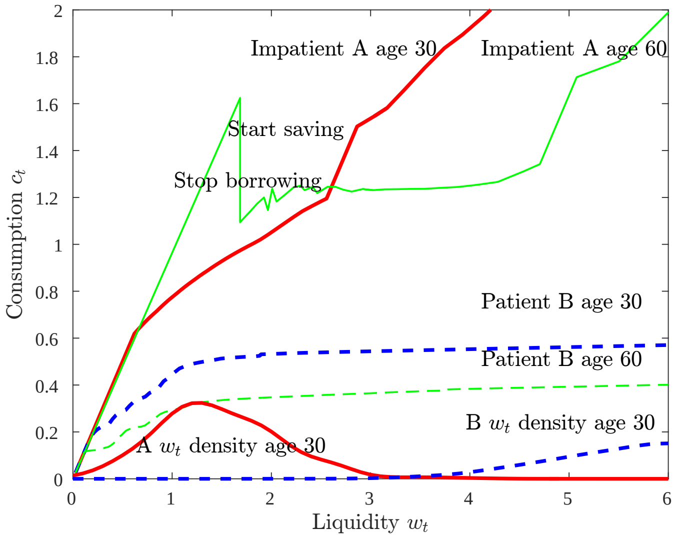
Identification of Default Costs



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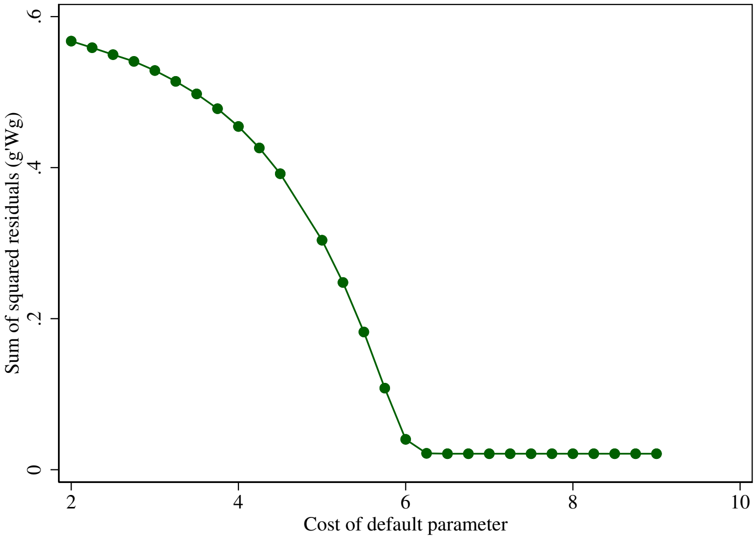
Identification of Default Costs



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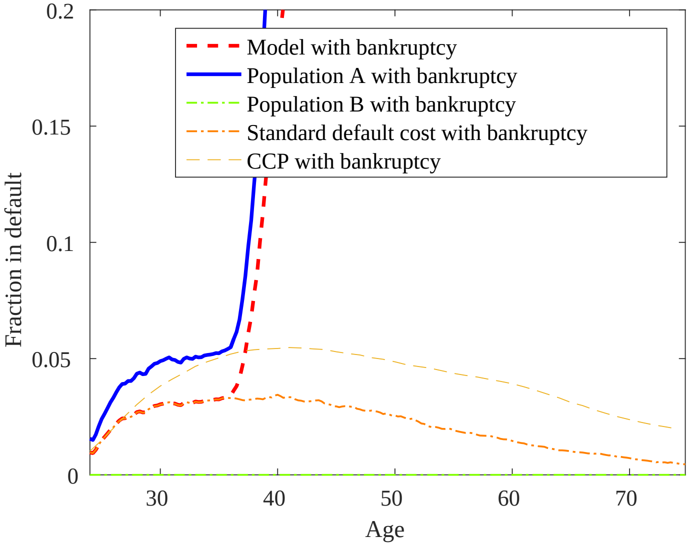
Identification of Default Costs



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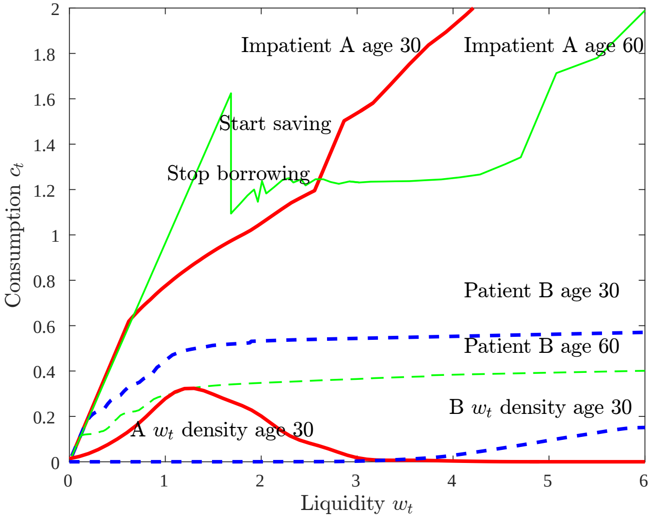
Consumption policy with voluntary default



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