

# Credit, Bankruptcy, and Aggregate Fluctuations

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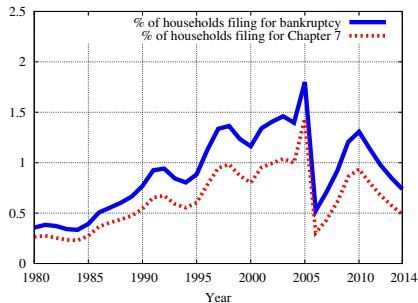
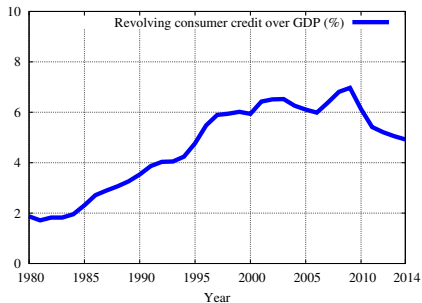
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# Motivation

- Expansion of unsecured consumer credit market.
  - Total credit card loans grew from 2% of GDP in 1980 to 7%.
  - Number of bankruptcies rose from 0.26% in 1980 to 1.00% in 2004.
- Attempts to answer why credit and bankruptcies increased.

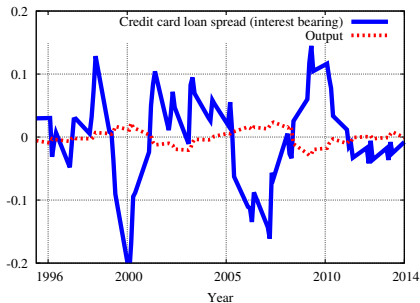
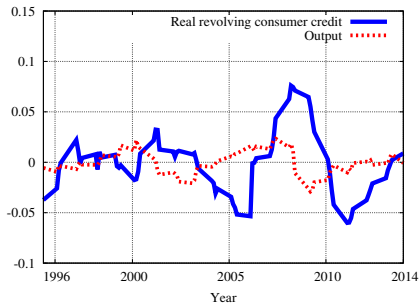
Livshits et al. (2010), Athreya et al. (2012), Drozd and Serrano-Padial (forthcoming)
- Less attention to cyclical properties of credit and bankruptcies.

# U.S. Data: Credit and Bankruptcy Filings



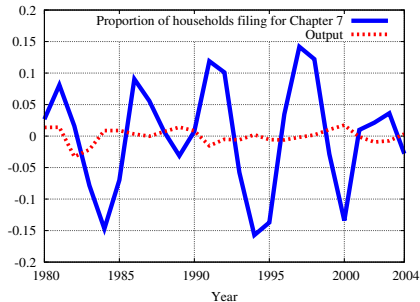
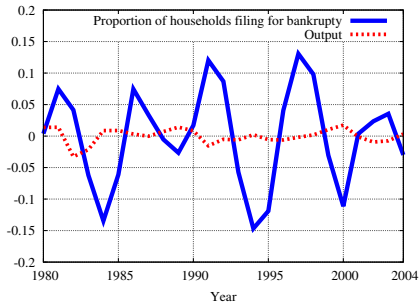
- Both credit/GDP (left) and the number of bankruptcy filings (right) increased since 1980.
- In 2005, bankruptcy Law reform (BAPCPA) was enacted.

# U.S. Data: Cyclicalities of Credit



- Credit (left) is more volatile than output ( $\times 3.4$ ) and mildly procyclical (0.4).
- Spread of credit card interest rate (right) is extremely volatile ( $\times 6$ ) and countercyclical ( $-0.85$ ).

# U.S. Data: Cyclicalities of Bankruptcies



- Number of Chapter 7 bankruptcies (right) is extremely volatile ( $\times 7$ ) and countercyclical ( $-0.2$ ).
- Cyclicalities of Chapter 7 filings (right) shape those of total bankruptcies (left).

# U.S. Data: Cyclicity of Credit and Default

	S.D.%	Rel. S.D.%	Corr(Y)
<b>U.S. Quarterly Data: 1980-2014<sup>1</sup></b>			
Output	1.33	1.00	1.00
Unsecured credit	4.00	3.01	0.35
Chapter 7 bankruptcy <sup>2</sup> (1995-2004)	28.68 9.55	24.14 10.40	-0.46 -0.41
Default premium <sup>2</sup>	7.19	6.05	-0.71
<b>U.S. Annual Data: 1980-2014<sup>1</sup></b>			
Output	1.20	1.00	1.00
Unsecured credit	4.04	3.36	0.40
Chapter 7 bankruptcy (1980-2004)	20.69 8.69	17.20 7.37	-0.33 -0.18
Default premium <sup>2</sup>	6.24	5.86	-0.85

[1] H-P filtered with 6.25 (annual) or 1600 (quarterly). [2] 1995-2014.

- Similar cyclical properties between annual and quarterly data.
- Similar with H-P parameter of 100 for annual data.

## Motivation 1: Cyclicity of Credit and Default

- Consumer credit is quite **volatile** (3.4 times output) and mildly **procyclical** (correlation 0.40).
- Bankruptcies are **extremely volatile** (7 times output) and **countercyclical** (correlation  $-0.18$ ).
- Can the standard model with equilibrium default, extended with aggregate shocks, replicate those cyclical properties? How?

## Motivation 2: Credit and Default and Business Cycles

- How do financial markets and, in particular, unsecured consumer credit, interact with business cycles?
  - Development of financial sectors causes [The Great Moderation?](#) (Campbell and Hercowitz (2006), Jermann and Quadrini (2007)).
  - Development of financial sectors destabilizes macroeconomy? Seems to be in the air since [The Great Recession](#).
  - Secured credit (home mortgages): next project.



# What We Do

- We construct, calibrate, and simulate a model with:
  - **Unsecured credit and equilibrium bankruptcies**  
Chatterjee et al. (2007), Livshits et al. (2007)
  - **Aggregate uncertainty.**  
Krusell and Smith (1998), Krusell and Smith (1997)  
Nakajima and Ríos-Rull (2005), Fieldhouse et al. (2014), Gordon (2015)
  - **Countercyclical earnings risk (CER).**  
Storesletten et al. (2004), Guvenen et al. (2014)
- Study its cyclical properties:
  - Baseline model.
  - Model without CER/Credit/Default.
- Interaction between heterogeneity and aggregate dynamics?
  - No interaction in a typical heterogeneous-agent model.

## Contribution

- Introduce aggregate uncertainty to the model with defaults.
- First to replicate the cyclicality of credit and default.
- Introduce countercyclical earnings risk into the model.
  - Will introduce countercyclical skewness (Güvönen et al. (2014)).

# Findings

- 1 Our model can replicate cyclicalities of credit and defaults, with:
  - Endogenous cyclical dynamics of the default risk premium.
  - Countercyclical earnings risk (CER).
- 2 Unsecured credit has little effects on the cyclical properties of labor supply and output.
- 3 Unsecured credit amplifies volatility of aggregate consumption.  
(Neumeyer and Perri (2005))
- 4 Welfare gain (+0.2%) associated with *commitment to repay*.
  - As large as welfare gain of having unsecured credit.

## Model: Overview

### Households

- Can borrow at interest rate  $r_b(X, x, a') = 1/q(X, x, a') - 1$ .
- $r_b(X, x, a')$  = “risk-free” rate + default risk premium
- Households can default on debt, if optimal to do so.
- Optimal default decision:  $g^h(X, x, a)$ .

### Credit Card Companies

- Take  $g^h(X, x, a)$  as given.
- Offer borrowers  $r_b(X, x, a')$  to make zero profit in expectation.
- Realized profits can be nonzero because of aggregate uncertainty.

### In a Recession...

- TFP ( $Z$ ) goes down.
- Risk of individual productivity rises (CER).
- $r_b(X, x, a')$  rises, reflecting a higher risk of unsecured credit.

## Model: Consumer Bankruptcy

- Focus on Chapter 7 bankruptcy.
  - Abstract from Chapter 13 (rescheduling) and informal default.
- With a good credit history ( $h = 0$ ):
  - A household can save or borrow, and file for bankruptcy.
  - Consumption smoothing against income fluctuations.
- Upon filing for bankruptcy:
  - Its debts disappear; its creditors lose any future claims to debts.
  - A fraction  $\xi$  of the current income is garnished.
  - In the filing period, the household cannot save ( $a' = 0$ ).
  - Its credit history turns bad ( $h' = 1$ ).
- With a bad credit history ( $h = 1$ ):
  - The household cannot borrow but can save.
  - After the punishment period (10 years), credit history turns good.
- Bankruptcy provides an option of partial state-dependency.

## Model: Default Decision

Optimal default decision:  $h' = g^h(z, K, m, x, a) \in \{0, 1\}$

$$V(z, K, m, x, 0, a) = \max\{V_0(z, K, m, x, 0, a), V_1(z, K, m, x, 0, a)\} \quad (1)$$

- With good credit history ( $h = 0$ ), household can borrow, in addition to save, to smooth consumption.
- Household optimally chooses to default on debt borrowed.
- Credit card company can calculate default prob when lending.
- Default premium is charged based on the default prob.

## Case 1: Good Credit History and No Default

$$V_0(z, K, m, x, 0, a) = \max_{c, \ell, a'} \{u(c, 1 - \ell) + \beta \pi \gamma \mathbb{E}_{z', x' | z, x} V(z', K', m', x', 0, a')\} \quad (2)$$

$$c + a' \pi q(z, K, m, x, a') = a[1 + r(z, K, L, m) \mathbb{1}_{a \geq 0}] + eptlw(z, K, L, m) \quad (3)$$

$$L = \phi_L(z, K, m) \quad (4)$$

$$m' = \phi_m(z, z', K, m) \quad (5)$$

$$K' = \phi_K(z, K, m) \quad (6)$$

## Case 2: Good Credit History and Default

$$V_1(z, K, m, x, \mathbf{0}, a) = \max_{c, \ell} \{u(c, 1 - \ell) + \beta\pi\gamma\mathbb{E}_{z', x'|z, x} V(z', K', m', x', \mathbf{1}, \mathbf{0})\} \quad (7)$$

$$c = ept\ell w(z, K, L, m)(1 - \xi) \quad (8)$$

- Chapter 7 bankruptcy: Debts are wiped out (no  $a'q(\cdot)$ ).
- Cannot save during the filing period ( $a' = 0$ ).
- Fraction  $\xi$  of the current earnings is garnished.
- Credit history turns bad ( $h' = 1$ ).



### Case 3: Bad Credit History

$$V(z, K, m, x, \mathbf{1}, a) = \max_{c, \ell, a'} \{u(c, 1 - \ell) + \lambda \beta \pi \gamma \mathbb{E}_{z', x' | z, x} V(z', K', m', x', \mathbf{0}, a') + (\mathbf{1} - \lambda) \beta \pi \gamma \mathbb{E}_{z', x' | z, x} V(z', K', m', x', \mathbf{1}, a')\} \quad (9)$$

$$c + a' \pi = a [1 + r(z, K, L, m)] + eptlw(z, K, L, m) \quad (10)$$

$$a' \geq 0 \quad (11)$$

- Cannot borrow ( $a' \geq 0$ ) and thus do not default.
- With probability  $\lambda$ , credit history becomes clean ( $h' = 0$ ).

## Unsecured Credit Industry

$$- a'q(z, K, m, x, a')\mathbb{E}_{z'|z}[1 + r(z', K'L', m')] = \mathbb{E}_{z',x'|z,x}[g'^h\xi e'p't'g'^l w(z', K', L', m') + (1 - g'^h)(-a')] \quad (12)$$

Or

$$q(z, K, m, x, a') = \mathbb{E}_{z',x'|z,x} \frac{1 - g'^h + g'^h\xi e'p't'g'^l w(z', K', L', m')/(-a')}{[1 + r(z', K'L', m')]} \quad (13)$$

- Credit card company determines lending interest rate ( $1/q(\cdot)$ ) based on the default probability of the borrower.
  - Lower-income and higher-debt  $\rightarrow$  higher default premium.
  - Recession  $\rightarrow$  higher default premium.
- *Expected* profits of any loan is zero.

## Production Firms and Mutual Funds

- Standard representative firm with CRS technology:

$$w(z, K, L, m) = zF_L(K, L) \quad (14)$$

$$r_K(z, K, L, m) = zF_K(K, L) - \delta \quad (15)$$

- Average returns of consumer credit industry:  $r_D(z, K, L, m)$ .
- Representative mutual funds own both capital and unsecured credit firms. The return from the mutual fund is:

$$r(z, K, L, m) = \frac{Kr_K(z, K, L, m) + Dr_D(z, K, L, m)}{K + D} \quad (16)$$

- Aggregate risk of unsecured credit industry is absorbed by savers.
  - In other words, credit firms are like banks with 100% reserves.
  - No risk generated by the financial sector.

# Equilibrium

- 1 Household optimization:  $V(\cdot), g^c(\cdot), g^l(\cdot), g^a(\cdot), g^h(\cdot)$ .
- 2 Expected zero profit condition for unsecured credit industry:  
 $q(z, K, m, x, a')$
- 3 Competitive factor prices:  $w(z, K, L, m)$  and  $r_K(z, K, L, m)$ .
- 4 Mutual funds return:  $r(z, K, L, m)$ .
- 5 Market clearing:  $\phi_L(z, K, m), \phi_K(z, K, m)$
- 6 Consistency:  $\phi_m(z, z', K, m)$

## Calibration: Strategy

There are three stages:

- 1 Many parameters for the steady-state model can be calibrated independent of the model, using outside evidence.
- 2 Six parameters for the steady-state model are calibrated to match the close-related six targets.
  - K/Y, Avg hours, % defaulting, % in debt, Avg debt, Var of earnings
- 3 Introduce aggregate shocks to the calibrated steady-state model
  - Standard TFP shock (little distributional effect).
  - Countercyclical earnings risk (CER) (Storesletten et al. (2004))

## Calibration (Stage 1): Parameterization

- Non-separable CRRA utility function.

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

- Cobb-Douglas production function.

$$Y = zF(K, L) = zK^\theta L^{1-\theta}$$

## Calibration (Stage 1): Idiosyncratic Shocks

- Individual productivity shocks: Storesletten et al. (2004):
  - Permanent shocks are log-normally distributed:  $N(0, (\eta\sigma_e)^2)$ .
  - Persistent productivity shocks follow log-AR(1):
    - Persistence:  $\rho_p$ .
    - Variance:  $(\eta\sigma_p)^2$ .
  - Transitory shocks are log-normally distributed:  $N(0, (\eta\sigma_t)^2)$ .
- Preference (discount-factor) shocks are i.i.d:
  - Capture expenditure shocks (medical expenses, divorces, etc.)
  - Either *normal*  $\gamma_1 = 1$  or *desperate*  $\gamma_2 < 1$ .
  - Probability of  $\gamma_2$  is  $\Gamma_2^Y$ .

## Calibration (Stage 2): Moment Matching

- Six parameters:  $\beta$ ,  $\alpha$ ,  $\gamma_2$ ,  $\Gamma_2^Y$ ,  $\eta$ ,  $\xi$  are calibrated to (successfully) match the following six targets.

Target Statistics	Data	Model
Capital-to-output ratio	3.0000	3.0004
Proportion of hours spent working	0.3300	0.3301
Proportion of bankruptcy filers	0.0084	0.0086
Proportion in debt	0.0840	0.0860
Debt-to-income ratio	0.1986	0.2016
Earnings coefficient of variation	0.8148	0.8194



## Calibration (Stage 3): Aggregate Shocks

- TFP shock is either good ( $z_1$ ), bad ( $z_2$ ), or disaster ( $z_3$ ).
  - Productivity levels are  $z_1 = 1 + \nu$ ,  $z_2 = 1 - \nu$ ,  $z_3 = 1 - 2\nu$ .
  - $\nu$  is calibrated to match output volatility (S.D.=1.2%).
  - Persistence of  $z_1$  and  $z_2$  is  $\gamma_{11}^z = \gamma_{22}^z = 2/3$ .
  - Persistence of  $z_3$  is  $\gamma_{33}^z = 1/3$ .
  - Probability of a disaster is  $\gamma_{13}^z = \gamma_{23}^z = 1/50$ .
  
- Countercyclical earnings risk: Storesletten et al. (2004).
  - Countercyclical volatility of persistent productivity shocks.
  - $\sigma_{p|z=1} = 0.088$ .
  - $\sigma_{p|z=2} = 0.162$ .
  - Alternative: Guvenen et al. (2014).

# Calibration: Summary of Parameters 1/2

	Value	Description	Calibration Strategy
1. Parameters Determined Ex-Ante			
$\pi$	0.9800	Survival probability	Average life of 50 years.
$\sigma$	3.7167	Curvature of utility func	Coefficient of RRA = 2.
$\gamma_1$	1.0000	Good pref shock	Normalization.
$\theta$	0.3600	Curvature of prod func	Labor share is 0.64.
$\delta$	0.0800	Depreciation rate	Depreciation rate is 0.08.
$\lambda$	0.1000	Prob. of default history erased	Avg. punishment is 10 years.
$\sigma_e$	0.4400	S.D. of perm shock	Storesletten et al. (2004).
$\rho_p$	0.9630	Pers of productivity shock	Storesletten et al. (2004).
$\sigma_p$	0.1300	S.D. of pers shock (acyclical)	Storesletten et al. (2004).
$\sigma_t$	0.3500	S.D. of trans shock	Storesletten et al. (2004).
2. Parameters that Require Solving the Model			
$\xi$	0.3395	Income garnishment rate	Bankruptcies = 0.84% per year.
$\beta$	1.0011	Discount factor	K/Y=3.0.
$\alpha$	0.3681	Avg. hours worked	33% disposable time.
$\Gamma_2^\gamma$	0.0310	Prob. of bad preference shock	8.4% are in debt.
$\gamma_2$	0.0000	Bad preference shock	Avg. debt over income is 20%.
$\eta$	0.7500	Adj factor for prod shock	Earnings coeff of variation is 0.815.

# Calibration: Summary of Parameters 2/2

	Value	Description	Calibration Strategy
3. Parameters Related to Business Cycles			
$\sigma_{p 1}$	0.0880	S.D. of pers shock in expansions	Storesletten et al. (2004).
$\sigma_{p 2}$	0.1620	S.D. of pers shock in recessions	Storesletten et al. (2004).
$\nu_1 = \nu_2$	0.0134	Size of TFP shock (normal)	S.D. of output = 1.2%.
$\nu_3$	0.0267	Size of TFP shock (disaster)	TFP drops twice as much.
$\gamma_{1,1}^z$	0.6667	Pers of good TFP shock	Avg. expansion = 3 years.
$\gamma_{2,2}^z$	0.6667	Pers of bad TFP shock	Avg. recession = 3 years.
$\gamma_{3,3}^z$	0.3333	Pers of disastrous TFP shock	Avg. disaster = 1.5 years.
$\gamma_3^z$	0.0200	Freq of disastrous TFP shock	Disaster happens every 50 years.

## U.S. and the Model: Macro Aggregates

	U.S. Data: 1980-2014		Baseline Model	
	S.D.%	Corr(Y)	S.D.%	Corr(Y)
Output	1.20	1.00	1.20	1.00
Consumption	0.95	0.91	0.47	0.98
Investment	5.65	0.92	3.52	1.00
Aggregate hours	1.74	0.90	0.63	1.00

The model looks like the standard RBC w.r.t. macro aggregates.

- Consumption fluctuates less than output and is procyclical.
- Investment is much more volatile than output and procyclical.
- Hours is strongly procyclical. Fluctuate less than in data though.

## U.S. and the Model: Credit and Bankruptcies

	U.S. Data: 1980-2014		Baseline Model	
	S.D.%	Corr(Y)	S.D.%	Corr(Y)
Output	1.20	1.00	1.20	1.00
Consumer credit	4.04	0.40	1.28	0.80
Bankruptcy filings	20.69	-0.33	19.98	-0.90
Default risk premium	6.24	-0.85	7.19	-0.76

- Model replicates cyclical properties of credit and bankruptcies.
  - The number of bankruptcies is significantly more volatile than output, and countercyclical.
  - Consumer credit is more volatile than output and procyclical.
- Countercyclical movement of default risk premium is the key.
  - In a recession, probability of default rises.
  - Credit card companies increase default risk premium.
  - A higher borrowing interest rate discourages borrowing.

# Credit and Bankruptcies: Role of Credit Industry

	Baseline Model		Model w/o Default	
	S.D.%	Corr(Y)	S.D.%	Corr(Y)
Output	1.20	1.00	1.19	1.00
Consumer credit	<b>1.28</b>	<b>0.80</b>	<b>0.73</b>	<b>-0.80</b>
Bankruptcy filings	19.98	-0.90	-	-
Mutual fund return ( $1 + r$ )	0.16	0.99	0.16	0.98
Capital return ( $1 + r_K$ )	0.16	0.99	0.15	0.98
Loan return ( $1 + r_D$ )	1.35	0.95	0.03	0.35
Default risk premium	7.19	-0.76	-	-

- In the model without default (HHs borrow at the risk-free rate).
  - Households borrow more in recessions to smooth consumption.
  - Consumer credit balance becomes **countercyclical**.

# Role of Countercyclical Earnings Risk (CER)

	Baseline Model		Model w/o CER	
	S.D.%	Corr(Y)	S.D.%	Corr(Y)
Output	1.20	1.00	1.20	1.00
Consumer credit	<b>1.28</b>	<b>0.80</b>	<b>0.85</b>	<b>-0.63</b>
Bankruptcy filings	19.98	-0.90	9.25	-0.35
Mutual fund return ( $1 + r$ )	0.16	0.99	0.16	0.98
Capital return ( $1 + r_K$ )	0.16	0.99	0.16	0.98
Loan return ( $1 + r_D$ )	1.35	0.95	0.43	0.72
Default risk premium	7.19	-0.76	6.25	0.04

- Without CER, default risk does not increase much in recessions.
  - HHs can borrow more in recessions → Countercyclical credit.
  - HHs borrow more and default more in recessions.
- CER is also crucial in replicating cyclicity of credit and defaults.

## Credit and Business Cycles

	Baseline Model		w/o Default		w/o Credit	
	S.D.%	Corr(Y)	S.D.%	Corr(Y)	S.D.%	Corr(Y)
Output	1.20	1.00	1.19	1.00	1.19	1.00
Consumption	0.47	0.98	0.38	0.98	0.40	0.98
Investment	3.52	1.00	3.81	1.00	3.71	1.00
Aggregate hours	0.63	1.00	0.61	1.00	0.61	1.00
Credit	1.28	0.80	0.73	-0.80	-	-
Bankruptcy filings	19.98	-0.90	-	-	-	-

- Does credit affect cyclical properties of output? → **Little**
  - Cyclical properties of hours and output are not significantly affected by credit sector.
- Does credit affect consumption smoothing? → **Yes**
  - With default, credit **amplifies** consumption volatility (+20%).
  - Without default, credit **dampens** consumption volatility.



## Remark: Comparison with Sovereign Default Literature

- Also in the sovereign default literature, countercyclical spreads amplify consumption (and net exports) volatility.
  - Neumeyer and Perri (2005)
- In the sovereign default models (Arellano (2008))
  - **Output fluctuations** generate countercyclical spreads.
- Our model:
  - Volatility of output is small.
  - **CER** amplifies countercyclicality of spreads.

## Remark: On Modeling Recessions

- Our results underscore the importance of modeling recessions properly.
  - More households than normal fare very poorly, instead of all households fare slightly worse than normal.
  - Storesletten et al. (2004) and Guvenen et al. (2014).
- Some (desperate) HHs always want to borrow more if possible.
  - They borrow more in expansions, generating procyclical credit.
  - In Fieldhouse et al. (2014), households default without borrowing.

## Credit and Welfare

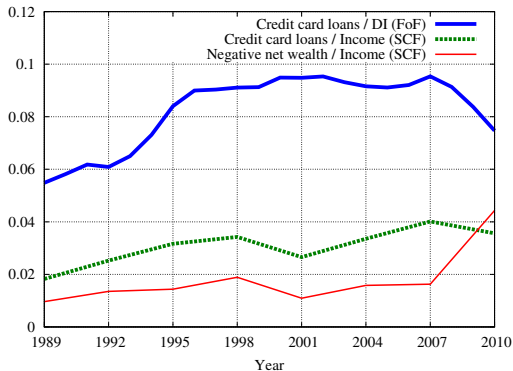
	Change in Welfare Relative to Baseline Model	
	Model without Default	Model without Credit
<b>CEV with Aggregate Uncertainty (Average) (%)</b>		
All households	0.175	-0.179
High- <i>e</i> households	0.273	-0.177
Low- <i>e</i> households	0.009	-0.182
<b>CEV in Steady-State (%)</b>		
All households	0.171	-0.180
High- <i>e</i> households	0.272	-0.177
Low- <i>e</i> households	0.000	-0.185

- Model without credit generates welfare loss of 0.18% in CEV.
- Model without default generates welfare gain of 0.17% in CEV.  
→ Cost of lack of commitment.
- Changes in welfare are mostly associated with idiosyncratic (not aggregate) uncertainty.

# Ongoing Extension

- Introduce countercyclical skewness (Guvenen et al. (2014)).
  - Replacing countercyclical variance (Storesletten et al. (2004)).
  - Estimating *quarterly* stochastic process with countercyclical skewness.
  - Same mechanism works as long as default risk increases in recessions.
- Gross vs. net credit card debt.
  - A large part of credit card debt is purely for transaction purpose.
  - Carries no default risk.
  - Introduce credit goods (purchased with credit card) and cash goods.
  - Procyclicality of credit will be strengthened ( $\leftarrow$  Procyclical  $C$ ).

# U.S. Data: Gross and Net Credit Card Debt



- Blue line is the gross credit card loans, incl. debt for transaction purpose.
- Red line is the net debt (which the current model captures).

## Concluding Remarks

- Can the model with equilibrium bankruptcy replicate cyclical properties of credit and bankruptcies? → **Yes!**
- Key elements:
  - Cyclical dynamics of equilibrium default risk premium.
  - Countercyclical earnings risk (CER).
- Does access to credit affect cyclical output? → **Little**
- Does access to credit affect consumption smoothing? → **Yes**
  - With default, credit amplifies consumption volatility (+20%).
  - Without default, credit dampens consumption volatility.
- What is a recession?
  - More households than normal fare very poorly (CER).
  - Instead of all households fare slightly worse than normal (TFP).

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