Microfounding Household Debt Cycles with Extrapolative Expectations

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Introduction

- Rapid booms in HH debt $\rightarrow$ lower Δ GDP.

  Reuven and Lansing (2010), Mian and Sufi (2014), Martin and Philippon (2017), Mian, Sufi, and Verner (2017), etc.

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- The drivers and mechanisms?
  - supply-side: time-varying lending standard/funding costs.

    Agarwal et al. (2017), Mian, Sufi, and Verner (2019), Fishman, Parker, and Straub (2021), Yin (2022), etc.
  - demand-side: misbeliefs about fundamentals.

    Bianchi, Ilut, and Saijo (2021), Bordalo et al. (2021), Chodorow-Reich, Guren, and McQuade (2021), etc.

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- Lack of micro-level evidences.
- This paper: income shocks $\Rightarrow$ misbeliefs $\Rightarrow$ spending/debt.
  - survey and transaction-level data.

Results Preview

- Positive shocks to Y_t:
  - more over-optimistic about $E_t[Y_{t+1}]$.

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  - higher $default_{t+1}$.

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  - higher C_t and B_t.
  - higher $\textit{default}_{t+1}$.
  - higher subjective uncertainty at $t+1$.

A Simple Model

- An infinitely-living representative consumer with CARA utility.

$$\max_{c_t} E_0 \left[-\frac{1}{\gamma} \sum_{t=0}^{\infty} \beta^t e^{-\gamma c_t} \right].$$

- Budget constraint

$$a_{t+1} = R(a_t - c_t + y_t).$$

- Evolution of income

$$y_{t+1} = y_t + \epsilon_{t+1}$$

- $\epsilon_{t+1} \sim N(0, \sigma^2)$.

Diagnostic Expectation Over Income

- Overweighting the representative states as if

$$f_t^{\theta}(y_{t+1}) = f_t(y_{t+1}|y_t = \hat{y}_t) \cdot \left[\frac{f_t(y_{t+1}|y_t = \hat{y}_t)}{f_t(y_{t+1}|y_t = E_{t-1}[y_t])}\right]^{\theta} \frac{1}{Z}.$$

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- Given AR(1) structure of income,

$$E_t^{\theta}[y_{t+1}] = y_t + \theta\epsilon_t.$$

- $\theta > 0 \Rightarrow \frac{\partial E_t^{\theta}[y_{t+1}]}{\partial \epsilon_t} > 0.$

Consumption and Default Rate

- Euler Equation

$$e^{-\gamma c_t} = \beta R E_t \left[e^{-\gamma c_{t+1}} \right].$$

- Consumption rule

$$c_t = \frac{r}{R} a_t + y_t - \frac{\log(\beta R)}{r\gamma} - \frac{\gamma\sigma^2}{2r} + \frac{\theta}{r}\epsilon_t.$$

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- Defaults if $a_{t+1} + y_{t+1} < \psi$.

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- Defaults if $a_{t+1} + y_{t+1} < \psi$.

$$p_{d,t+1} = \Phi \left(\frac{\psi - R(a_t - c_t + y_t) - y_t}{\sigma} \right),$$

- $\theta > 0 \Rightarrow \frac{\partial c_t}{\partial \epsilon_t} > 0, \ \frac{\partial p_{d,t+1}}{\partial \epsilon_t} > 0.$

Data

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    - credit card holders
    - six month between the two waves.
    - each rounds cover the same participants.
    - spans Jan 2020 to Jan 2022.

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- Two rounds of two-wave surveys.
  - credit card holders
  - six month between the two waves.
  - each rounds cover the same participants.
  - spans Jan 2020 to Jan 2022.
- Requirements:
  - At least 15 account outflow every months.
  - Income is available at this bank.

  Ganong and Noel (2019)

Measurement of Income, Spending, and Borrowing

- Three types of income
  - salary (62.33%): deposited monthly income/social security insurance.
  - business income (26.11%): net inflow labeled as business operation.
  - financial investment (11.56%): net inflow from investment accounts.

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- Borrowing: outstanding interest-incurring credit card debt.

Check Income

Survey

- Surveys to elicit expectations about future income.

  *Q1/2: What is the lowest/highest possible level of **monthly income** you believe you would get over the next 6 months?*

  *Q3: What would your **monthly income** most likely be on average over the next 6 months?*

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- Future credit limit.

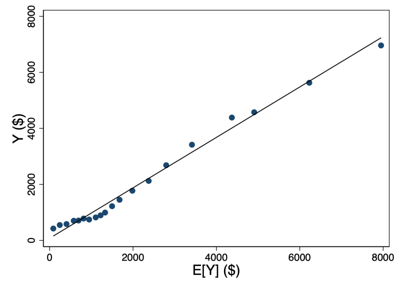
  *Q4/5: What is the lowest/highest possible level of **credit limit** you believe you would get over the next 6 months?*

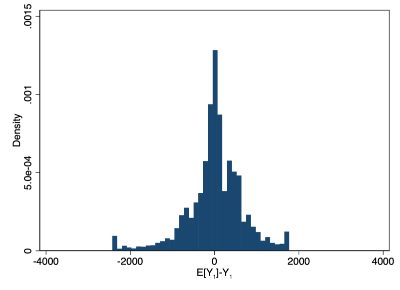
  *Q6: What would your **credit limit** most likely be on average over the next 6 months?*

Summary Statistics

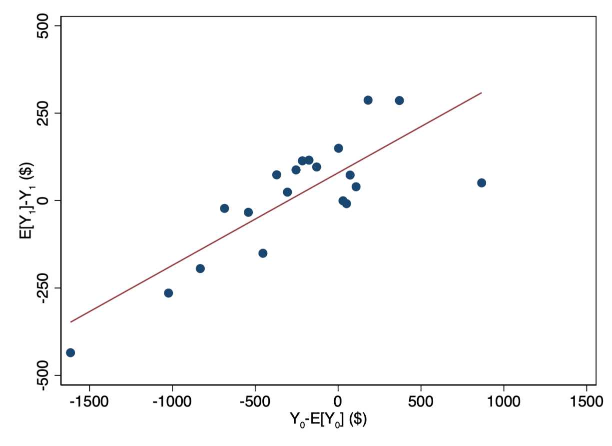
	(1) Mean	(2) SD	(3) p25	(4) Median	(5) p75	(6) N
Spending	1369.13	1971.73	258.74	506.09	1449.68	5732
Income	2000.61	1957.65	590.51	1141.15	2923.08	5732
Saving	18504.28	31176.05	1647.19	4425.99	19965.42	5732
Limit	12029.73	13147.11	2307.69	5414.54	21021.64	5732
Debt	1081.73	1899.69	0.00	0.00	1553.91	5732
Debt$\|$Debt>0	2582.61	2233.41	965.83	1969.91	3555.08	2417
Age	38.51	8.17	30	38	45	5732
Female	0.51	0.50	0	1	1	5732
E[Income]	2110.32	1729.50	793.32	1530.53	2923.08	5732
E[min. Income]	1543.25	1659.50	350.00	923.08	2153.85	5732
E[max. Income]	3374.65	3179.45	1133.85	2054.42	4615.39	5732
E[Limit]	14219.58	13362.47	4230.77	8461.54	21538.46	5732
E[min. Income]	9884.00	11014.66	2307.69	5452.22	14444.99	5732
E[max. Income]	16779.24	15849.98	4921.88	10366.29	24984.68	5732
E[Δ Limit]	1239.65	5379.57	-1195.91	769.23	2734.37	5732

Expectation and Realization of Income





Income Shocks and Misbeliefs about Future Income



Income Shocks and Misbeliefs about Future Income

- Proposition 1: misbeliefs about y_{t+1} increases with income shocks at t.

	(1)	(2)	(3)	(4)
	$E[Y_{t+1}] - Y_{t+1}$	$E[Y_{t+1}] - Y_{t+1}$	$E[Y_{t+1}] - Y_{t+1}$	$E[Y_{t+1}] - Y_{t+1}$
$Y_t - E[Y_t]$	0.322***	0.343***	0.324***	0.308***
	(0.027)	(0.061)	(0.059)	(0.055)
N	5,732	5,732	5,732	5,732
Industry FE $\times$ Round FE	No	No	No	Yes
City FE	No	No	Yes	Yes
Controls	No	Yes	Yes	Yes
R^2	7.10%	19.11%	22.06%	31.82%

Standard Errors Clustered at City Level in Parentheses
* $p<0.10$ ** $p<0.05$ *** $p<0.01$

$1 income shock $\Rightarrow$ $0.308 misbeliefs about future income.

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Misbeliefs about Future Income – Heterogeneity Analysis

	(1) $E[Y_{t+1}] - Y_{t+1}$	(2) $E[Y_{t+1}] - Y_{t+1}$	(3) $E[Y_{t+1}] - Y_{t+1}$	(4) $E[Y_{t+1}] - Y_{t+1}$
$Y_t - E[Y_t]$	0.437***	0.141***	0.346***	0.350***
	(0.053)	(0.053)	(0.056)	(0.065)
$Y_H \times (Y_t - E[Y_t])$	-0.227***			
	(0.048)			
$SD_H \times (Y_t - E[Y_t])$		0.331***		
		(0.053)		
$Age_H \times (Y_t - E[Y_t])$			-0.078**	
			(0.037)	
$Degree_H \times (Y_t - E[Y_t])$				-0.092*
				(0.046)
N	5,732	5,732	5,732	5,732
Controls	Yes	Yes	Yes	Yes
Industry FE $\times$ Round FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
R^2	29.08%	33.15%	31.85%	31.96%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

- Extrapolation is larger for consumers with
  - lower income.
  - higher subjective uncertainty.
  - younger age.
  - lower schooling.

Misbeliefs about Income and Economic Behaviors

- Proposition 2: misbeliefs about y_{t+1} increases C_t, B_t, and $Default_{t+1}$.

	(1) ΔC_t	(2) ΔC_t	(3) ΔB_t	(4) ΔB_t	(5) $Default_{t+1}$	(6) $Default_{t+1}$
$E[Y_{t+1}] - Y_{t+1}$	0.154***	0.146***	0.076***	0.091***	1.002***	0.849***
	(0.028)	(0.030)	(0.009)	(0.012)	(0.246)	(0.302)
N	5,732	5,732	5,732	5,732	5,732	5,732
Industry FE $\times$ Round FE	No	Yes	No	Yes	No	Yes
City FE	No	Yes	No	Yes	No	Yes
Controls	No	Yes	No	Yes	No	Yes
R^2	3.66%	10.57%	2.33%	10.13%	0.36%	3.94%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

- \$1,000 misbeliefs about $Y_{t+1} \Rightarrow$
  - \$146 spending at t.
  - \$91 consumption debt at t.
  - 0.849 pp default rate at $t + 1$.

Income Shocks and Misbeliefs about Future Credit Limit

	(1) $E[L_{t+1}] - L_{t+1}$	(2) $E[L_{t+1}] - L_{t+1}$	(3) $E[L_{t+1}] - L_{t+1}$	(4) $E[L_{t+1}] - L_{t+1}$
$Y_t - E[Y_t]$	0.808***	0.816***	1.165***	1.180***
	(0.159)	(0.301)	(0.293)	(0.296)
N	5,732	5,732	5,732	5,732
Industry FE $\times$ Round FE	No	No	No	Yes
City FE	No	No	No	Yes
Controls	No	No	No	Yes
R^2	0.74%	4.11%	5.84%	6.39%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

- \$1 income shock $\Rightarrow$ \$1.180 misbeliefs about future borrowing capacity.

Misbeliefs about Credit Limit and Economic Behaviors

	(1) ΔC_t	(2) ΔC_t	(3) ΔB_t	(4) ΔB_t	(5) $Default_{t+1}$	(6) $Default_{t+1}$
$E[L_{t+1}] - L_{t+1}$	0.006***	0.006***	0.009***	0.010***	0.111***	0.132***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.038)	(0.042)
$E[Y_{t+1}] - Y_{t+1}$		0.146***		0.091***		0.861***
		(0.030)		(0.012)		(0.299)
N	5,732	5,732	5,732	5,732	5,732	5,732
Industry FE $\times$ Round FE	No	Yes	No	Yes	No	Yes
City FE	No	Yes	No	Yes	No	Yes
Controls	No	Yes	No	Yes	No	Yes
R^2	0.29%	10.87%	1.86%	12.34%	2.07%	4.29%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

- \$1 income shock $\Rightarrow$ total consumption through
  - income extrapolation: 0.31 × (0.146 + 0.091) = 0.073.
  - borrowing limit extrapolation: 1.18 × (0.006 + 0.010) = 0.019.
- \$1 income shock $\Rightarrow$ default rate $\sim$ 0.42 pp.

Panel Asymmetry Time-Varying Vol Long

Conclusion

- Micro evidences of consumer over-reaction to income shocks.
- Too optimistic for future earnings ability and debt capacity.
- Over-reaction leads to more spending and borrowing, eventually more default.
- Support demand-side story of credit-cycle dynamics.
- Future research:
  - GE macro models of HH credit cycles with extrapolative expectations. $\Rightarrow$ heterogeneous-agent.
  - HH non-standard belief-formation.

Appendix

Time-Varying Income Volatility

- Time-varying income volatility at individual-level.

  Guvenen and Smith (2014); Fagereng et al. (2018); Chang et al. (2021), etc.

Time-Varying Income Volatility

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- Income evolution

$$y_{t+1} = y_t + \sigma_{t+1}\epsilon_{t+1}$$
$$\sigma^2_{t+1} = \alpha_0 + \alpha_1(\sigma_t\epsilon_t)^2$$

Time-Varying Income Volatility

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  Guvenen and Smith (2014); Fagereng et al. (2018); Chang et al. (2021), etc.

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$$y_{t+1} = y_t + \sigma_{t+1}\epsilon_{t+1}$$
$$\sigma^2_{t+1} = \alpha_0 + \alpha_1(\sigma_t\epsilon_t)^2$$

- Assume $\omega_t = 1 + \frac{\alpha_1}{\alpha_0}(\sigma_t\epsilon_t)^2 < \left(1 + \frac{1}{\theta}\right)^{\frac{1}{2}}$, then

$$E_t[y_{\theta,t+1}] = E_t[y_{t+1}] + \tilde{\theta}\left(y_t - E_{t-1}[y_t]\right)$$
$$\sigma^2_{\theta,t+1} = \sigma^2_{t+1}\frac{1}{1-\theta(\omega_t^2 - 1)}$$
$$\tilde{\theta} = \theta\frac{\omega_t^2}{1-\theta(\omega_t^2-1)}$$

- $\nearrow \sigma_t$, tails get thicker, diagnostic tails more over-weighted.

Optimality Condition

- Given AR(1) structure of income,

$$E_t^{\theta}[y_{t+1}] = y_t + \tilde{\theta}\epsilon_t.$$

- Consumption rule

$$c_t = \frac{r}{R}a_t + y_t - \frac{\log(\beta R)}{r\gamma} - \frac{\gamma\sigma^2_{\theta,t+1}}{2r} + \frac{\tilde{\theta}}{r}\epsilon_t.$$

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$$E_t^{\theta}[y_{t+1}] = y_t + \tilde{\theta}\epsilon_t.$$

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$$c_t = \frac{r}{R}a_t + y_t - \frac{\log(\beta R)}{r\gamma} - \frac{\gamma\sigma^2_{\theta,t+1}}{2r} + \frac{\tilde{\theta}}{r}\epsilon_t.$$

- Given $\theta > 0$, σ_t^2 increases $\tilde{\theta}$ and $\sigma^2_{\theta,t+1}$

  $\rightarrow$ negative shocks have larger effects.

Income Shocks and Subjective Income Uncertainty

	(1) $\Delta SD(E[\Delta \log Y_{t+1}])$	(2) $\Delta SD(E[\Delta \log Y_{t+1}])$	(3) $\Delta SD(E[\Delta \log Y_{t+1}])$	(4) $\Delta SD(E[\Delta \log Y_{t+1}])$
$abs(Y_t - E[Y_t])$	0.162***	0.221***	0.068***	0.097***
	(0.021)	(0.032)	(0.026)	(0.033)
$abs(Y_t - E[Y_t]) \times 1_{\{Y_t - E[Y_t] < 0\}}$			0.117***	0.210***
			(0.033)	(0.045)
$1_{\{Y_t - E[Y_t] < 0\}}$			0.006	0.018
			(0.032)	(0.034)
N	5,732	5,732	5,732	5,732
Industry FE $\times$ Round FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Controls FE	No	Yes	No	Yes
R^2	2.50%	11.72%	3.02%	12.21%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

- \$1,000 income shock $\Rightarrow$
  - 9.7% higher subjective uncertainty for positive shocks.
  - 30.7% higher subjective uncertainty for negative shocks.

Asymmetric Effects of Misbeliefs

	(1) ΔC_t	(2) ΔC_t	(3) ΔB_t	(4) ΔB_t
$Y_t - E[Y_t]$	0.059***	0.161***	0.129***	0.218***
	(0.018)	(0.047)	(0.016)	(0.026)
$(Y_t - E[Y_t]) \times 1_{\{Y_t - E[Y_t] < 0\}}$		0.122**		0.093**
		(0.060)		(0.039)
$1_{\{Y_t - E[Y_t] < 0\}}$		-0.075***		-0.056***
		(0.021)		(0.018)
N	5,732	5,732	5,732	5,732
Industry FE $\times$ Round FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes
R^2	12.30%	13.05%	10.06%	10.86%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Go Back

- Effects of over-extrapolation larger for negative shocks.

Misbeliefs – Asymmetry

	(1)	(2)	(3)	(4)
	wave 1	*wave 1*	*wave 2*	*wave 2*
	$Y_t - E[Y_t] < 0$	$Y_t - E[Y_t] \geq 0$	$Y_t - E[Y_t] < 0$	$Y_t - E[Y_t] \geq 0$
	$E[Y_{t+1}] - Y_{t+1}$	$E[Y_{t+1}] - Y_{t+1}$	$E[Y_{t+1}] - Y_{t+1}$	$E[Y_{t+1}] - Y_{t+1}$
$Y_t - E[Y_t]$	0.479***	0.280**	0.128	0.491***
	(0.117)	(0.123)	(0.135)	(0.100)
N	1,960	1,438	1,312	992
Industry FE $\times$ Round FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
R^2	40.48%	48.80%	36.42%	42.80%

Standard Errors Clustered at City Level in Parentheses

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Go Back

Longer Horizon

$$Y_{i,t+1} = \alpha_i + \rho_{j,k,a} Y_{i,t} + \Gamma X_{i,t} + \epsilon_{i,t+1}.$$

	(1) ΔC_t	(2) ΔC_t	(3) ΔB_t	(4) ΔB_t	(5) *Default*	(6) *Default*
$E[Y_{t+1}] - Y_{t+1}$	0.096***	0.139***	0.084***	0.098***	1.123**	0.975***
	(0.035)	(0.021)	(0.020)	(0.023)	(0.006)	(0.007)
N	5,309	21,397	5,309	21,397	5,309	21,397
Individual FE	No	Yes	No	Yes	No	No
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
City FE	Yes	No	Yes	No	Yes	Yes
Longer Sample	No	Yes	No	Yes	No	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
R^2	22.38%	61.76%	5.34%	21.87%	4.76%	3.89%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

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Panel Analyses – Misbeliefs

	(1) $E[Y_{t+1}] - Y_{t+1}$	(2) $E[Y_{t+1}] - Y_{t+1}$	(3) $E[L_{t+1}] - L_{t+1}$	(4) $E[L_{t+1}] - L_{t+1}$
$Y_t - E[Y_t]$	0.259***	0.288***	0.768***	0.852***
	(0.059)	(0.059)	(0.232)	(0.234)
N	2,552	2,552	2,552	2,552
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Individual FE	No	Yes	No	Yes
R^2	79.87%	80.82%	80.90%	81.15%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

Panel Analyses – Consumption

	(1) ΔC_t	(2) ΔC_t	(3) ΔB_t	(4) ΔB_t	(5) *Default*	(6) *Default*
$E[Y_{t+1}] - Y_{t+1}$	0.096***	0.162***	0.078***	0.089***	0.819***	0.724**
	(0.021)	(0.034)	(0.009)	(0.016)	(0.129)	(0.141)
$E[L_{t+1}] - L_{t+1}$	0.021**	0.013***	0.016***	0.022*	0.129**	0.107**
	(0.005)	(0.013)	(0.004)	(0.011)	(0.052)	(0.047)
N	2,552	2,552	2,552	2,552	2,552	2,552
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	1.80%	24.60%	0.86%	23.94%	6.53%	36.48%

Standard Errors Clustered at City Level in Parentheses
* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$

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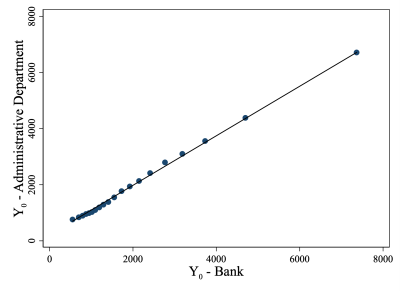
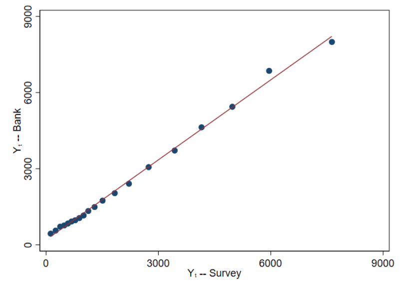
Sanity Check of Income Data





- R^2 respectively 78.26% and 72.56%.

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