Savings and consumption responses to persistent income shocks

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Introduction

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  How does consumption react to persistent income shocks?

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- **Today:**
  1. **Data:** micro data on bank accounts and mortgage from Ireland
     a. Identify unexpected persistent shock to mortgage payments (=income shock)
     b. Estimate response of bank balances to shock
     b. Use budget constraint to back out consumption response to shock
     d. Explore heterogeneity by balances in bank account and shock length
  2. **Model:** Can standard consumption-savings explain the estimated responses?

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    d Explore heterogeneity by balances in bank account and shock length
  2 **Model:** Can standard consumption-savings explain the estimated responses?

- **Main findings:**
  1 Average MPC $\partial c_t / \partial \tau_t$ is high: 0.91
  2 By bank balance: 1.006 for lowest and 0.82 for highest balance quartiles
  3 By shock length: 0.84 for 6-10 year shock; 0.63 for $\leq$5 year shock
  4 Model matches average MPC with 62 quarter shock

Literature: MPCs

- **Covariance restrictions.** Hall & Mishkin (1982), Blundell, Pistaferri & Preston (2008)
- **Subjective expectations.** Hayashi (1985), Pistaferri (2001)
- **Quasi-experimental.**
  Expected one-time shock. Shapiro & Slemrod (1995, 2003, 2009), Souleles (1999, 2002), Hsieh (2003), Johnson, Parker & Souleles (2006), Kueng (2018), Baugh, Ben-David, Park & Parker (2021), Lewis, Melcangi & Pilossoph (2021)
  Unexpected one-time shock. Bodkin (1959), Agarwal & Qian (2014), Fagereng, Holm & Natvik (2020)
  Expected persistent shock. Bernheim, Skinner & Weinburg (2001), Aguiar & Hurst (2005, 2007)
  Unexpected persistent shock. Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, & Yao (2017), Baker (2018), Ganong & Noel (2019)
- **Model comparison.** Kaplan & Violante (2014)
- **Identification strategy.** Byrne, Kelly & O'Toole (2021)
- **Irish household finance.** Cussen, Lydon & O'Sullivan, (2018), Horan, Lydon & McIndoe-Calder (2020), Le Blanc, Lydon (2022)

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- **Our contribution**
  1. Estimate MPC using a quasi-experimental persistent income shock
  2. Heterogeneity by initial bank balance and by length of the shock
  3. Evaluate performance of standard consumption-savings model with persistent shocks

Message from the today

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  - By bank balance: matches covariance, errors ≤ 0.08
  - By shock length: matches covariance, errors > 0.27

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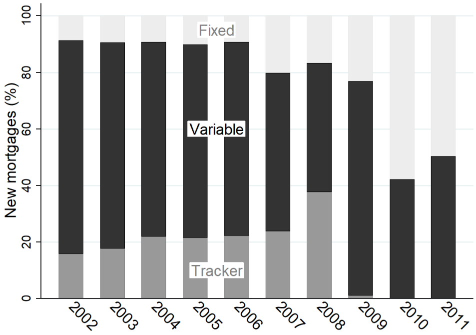
- **Comparison to literature:**
  - Higher MPC than literature (di Maggio et. al., MPC for cars=0.4; Baker elasticity = 0.33)
  - Literature: Data MPC (0.5) $>>$ Model MPC (0.05) for transitory shocks (Fagereng Holm & Natvik)
  - This paper: Data MPC $\approx$ Model MPC for persistent shocks
  - $\rightarrow$ Standard model performs comparatively well for persistent shocks

1. Data and consumption response
2. Model of consumption-savings

Payment shock: variable and tracker mortgage interest rates

(a) Share of new mortgages issued by interest rate



- Overlap in variable/tracker samples ▸ distributions

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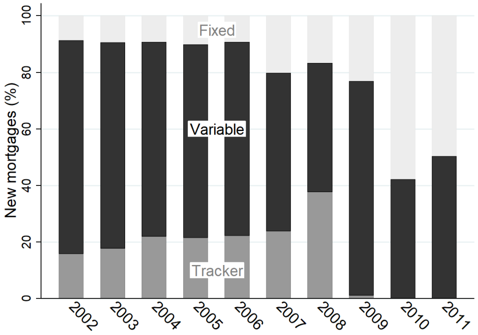
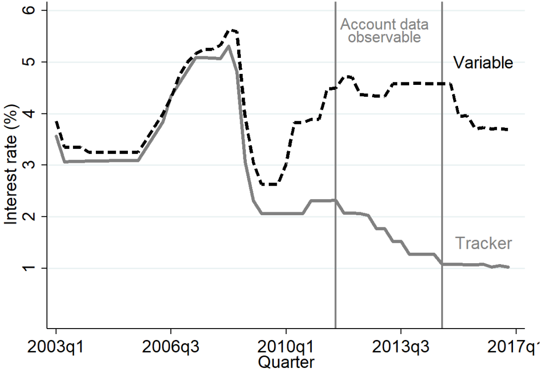


(b) Divergence in *ECB Tracker* and *Standard Variable*



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Data: mortgage and bank account data in Ireland

1. **Mortgage data**
   - *At origination:* age, income, county, house price, mortgage size, interest rate
   - *Over time:* outstanding balance, interest rate, days past due
   - Six monthly, 2000-2016 for origination data; 2012-2016 for over time
   - *Estimate:* current LTV w/ post code price index

2. **Bank account data**
   - Average balance over quarter (quarterly), balance at end date (6 monthly).
   - Checking and savings accounts
   - Quarterly, Q3 2011 - Q4 2014
   - Do not see accounts in multiple banks, or non-bank savings

3. **Cleaning**
   - **Household view:** Link all mortgages, bank accounts for household
   - Restrict to active (non-constant/zero) checking accounts (when using savings data)
   - Mortgages originated 2000-2008
   - Quarterly panel: Q3 2011 - Q4 2014
   - $N \approx 10,000$ households $\times$ 14 quarters $\approx 140,000$

Household finances in Ireland

How much of household savings are captured in our data:

1. How much of non-housing assets are in deposit savings
   - **Macro data:** 91% Quarterly Financial Accounts
   - **Micro data:** 55% HFCS, evidence of large ($\approx$ 66%) under reporting of deposits (Cussen, Lydon & O'Sullivan, 2018)

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2. How much of deposit savings are in bank accounts
   - **Bank deposits:** 66%
   - **Non-bank deposits (e.g. credit unions, Post Office):** 34%

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3. How much of bank deposits are in a single bank
   - **Bank accounts per household in Ireland:** 5.2
   - **Bank accounts per household in our data:** 4

- We can check results for households with both checking and savings accounts
  - Checking account MPC = 0.93; Savings account MPC = 0.95

  $\rightarrow$ Results are similar

Size of payment savings

Payment savings:

$$
\begin{aligned}
m_t^{flow} &= \text{pay}_t^{\text{variable}} - \text{pay}_t^{\text{tracker}} > 0 \quad \text{if tracker} \\
&= 0 \quad \text{if variable} \\
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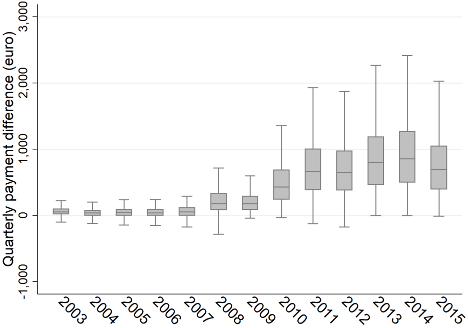

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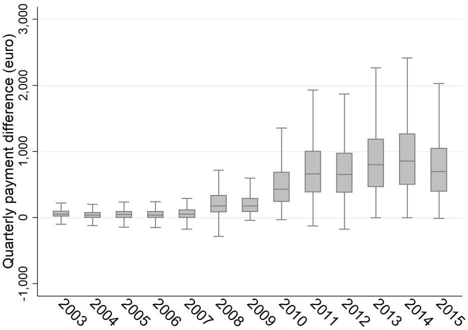
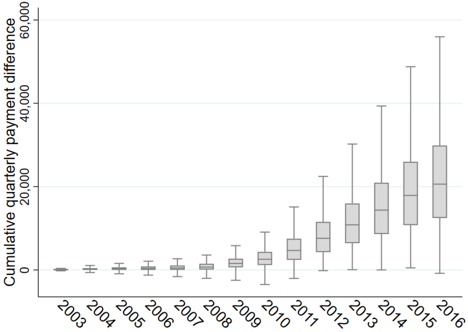
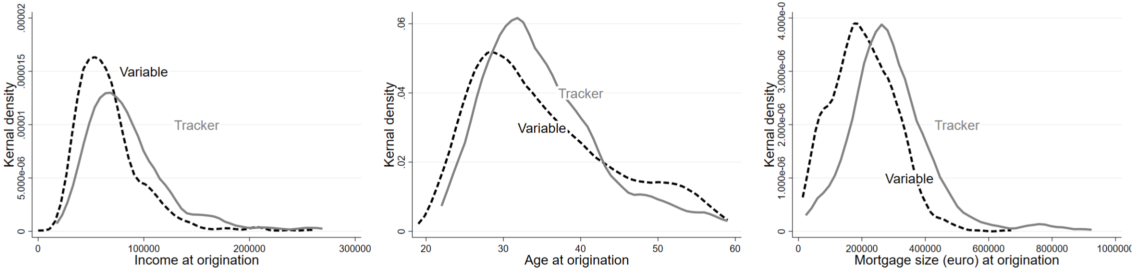




Median: 5% of income; 20% of payments

Comparing variable and tracker mortgage borrowers (ex-ante)



(a) Income at origination (b) Age at origination (c) Mortgage balance at origination

Comparing variable and tracker mortgage borrowers (ex-post)

Q. Were trackers more likely to get income shocks?

- Use survey of mortgage holders 2012Q2 – 2013Q1 (Byrne, Kelly, O'Toole, 2021)

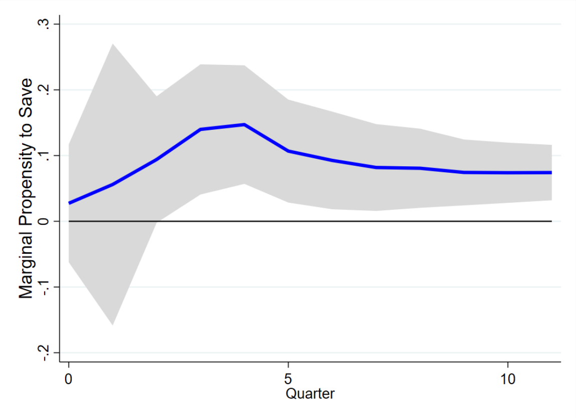
	Income Change			Unemployed		
	(1)	(2)	(3)	(4)	(5)	(6)
Tracker	-0.254***	-0.129	0.029	-0.029	0.001	0.005
	(0.0683)	(0.0774)	(0.0611)	(0.0215)	(0.0244)	(0.0256)
Observations	616	616	593	626	626	593
Adjusted R^2	0.020	0.044	0.464	0.001	0.026	0.006
Origin year and bank FE		Yes	Yes		Yes	Yes
Controls			Yes			Yes

Regression: savings response

$$\Delta b_{i,t+k} \quad = \quad \beta_0 + \beta_k \Delta m^{stock}_{i,t+k} + \eta \mathbf{X}_{it} + \gamma_{t+k} + u_{i,t+k} \qquad \text{for k=1 ,..., 12}$$

- $\Delta b_{i,t+k}$ is the change in bank balance of household i between quarter t and $t+k$
- $\Delta m^{stock}_{i,t+k}$ is change in stock payment savings between t and $t+k$
  - $\Delta m^{stock}_{i,t+k} > 0$ if tracker mortgage
  - $\Delta m^{stock}_{i,t+k} = 0$ if variable mortgage
- X_{it} is a vector of observable controls
- γ_{t+k} are time fixed effects
- Variations:
  - logs and levels
  - pooled and different time horizons

Result: Savings response at many horizons



- 12 quarter estimate
  - MPS_{t+12} = 0.074;
  - Implied MPC= 0.93
- $MPS_{t+h} = \sum_{s=0}^{h} (1+r)^{h-s}(1 - MPC)$
- Average pooled estimate
  - MPS = 0.087;
  - Implied MPC = 0.913

MPC heterogeneity

1. **Average** MPC = 0.913 (MPS= 0.087). ▸ table

2. **Split samples**

   a. Savings balances at 2011Q3: ▸ table
   - Lowest balance quartile: 1.006
   - Highest balance quartile: 0.82

   b. Mortage maturity at 2010Q1: ▸ table
   - $<=$ 5 year to maturity: 0.46 (imprecise)
   - 6-10 year to maturity: 0.84
   - $>$10 year to maturity: 0.93

1. Data & consumption response

2. Model of consumption-savings

Consumption-savings problem by households

Households solve infinite horizon problem

$$\max_{c,a} \sum_{t=0}^{\infty} \mathbf{E_0} \left[\beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right]$$

$$c_t + a_t = (1+r)a_{t-1} + e_t + \tau_t$$

$$a \geq 0$$

$$\ln e_t = \rho_e \ln e_{t-1} + \epsilon_t \qquad \epsilon_t \sim \mathcal{N}(0, \sigma_e^2)$$

Perfect foresight for path $\{\tau_s\}_{s\geq 0}$.

Compare to stationary distribution with $\tau_{ss} = 0$

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Policies $c_t^*(e_t, a_{t-1}; \boldsymbol{\tau})$ and $a_t^*(e_t, a_{t-1}; \boldsymbol{\tau})$
Distribution's law of motion $D_{t+1}(e_{t+1}, a_t) = \sum_{e_t} D_t(e_t, a_t^{*-1}(e_t, a_t; \boldsymbol{\tau}))\mathcal{P}(e_t, e_{t+1})$

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Calibration: $\sigma = 2, r = 0.01, \beta = 0.98, \rho_e = 0.966, \sigma_e = 0.5$ (Auclert, et. al.)
$\tau = 0.04, \tau/e = [0.15, 0.1, 0.07, 0.05, 0.03, 0.02, 0.01]$ interquartile range $\approx$ 3-7% income

▸ Bellman

Computing MPCs

Individual MPCs

$$MPC_t(e_t, a_{t-1}; \boldsymbol{\tau}) = \left[c_t^*(e_t, a_{t-1}; \boldsymbol{\tau}) - c_{ss}^*(e_t, a_{t-1}, 0)\right] / \tau$$

Computing MPCs

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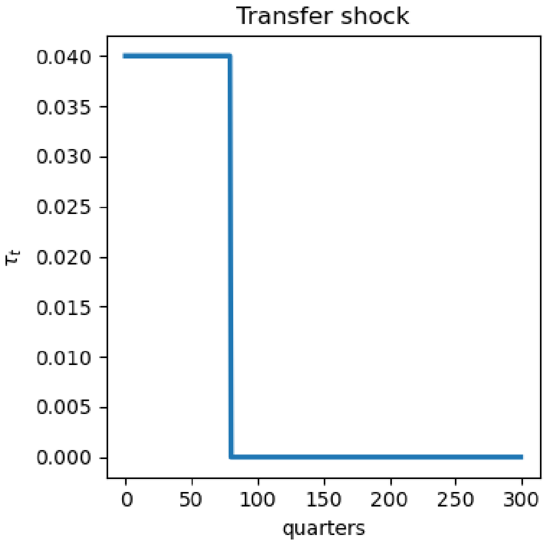
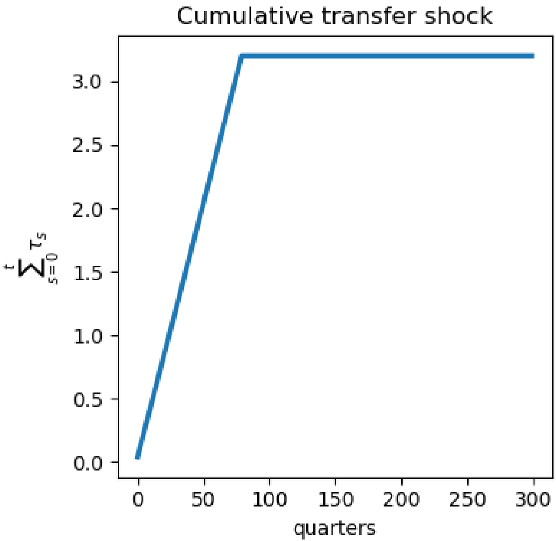
Average $C_t(\boldsymbol{\tau}) = \sum_e \int_a c_t^*(e_t, a_{t-1}; \boldsymbol{\tau}) D_t(e_t, a_{t-1})$

Average MPC

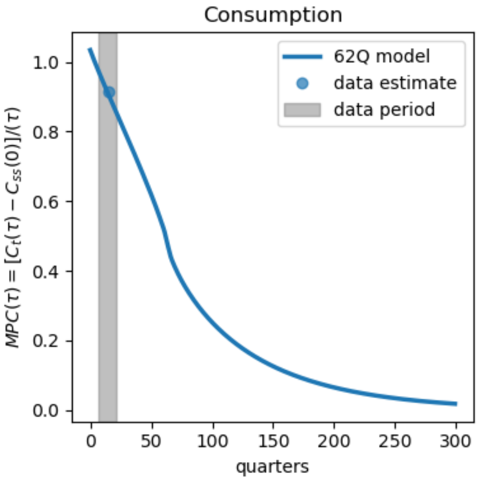
$$MPC_t(\boldsymbol{\tau}) \quad = \quad \left[C_t(\boldsymbol{\tau}) - C_{ss}(0)\right] / \tau$$

The model experiment





Comparing model and data



- MPC errors (data-model) = [-0.004, -0.021, 0.084, 0.071]
- Close quantitatively relative to 1 time shock

One period shock at quarter 0 One period shock at quarter 40 Savings response Permanent income hypothesis

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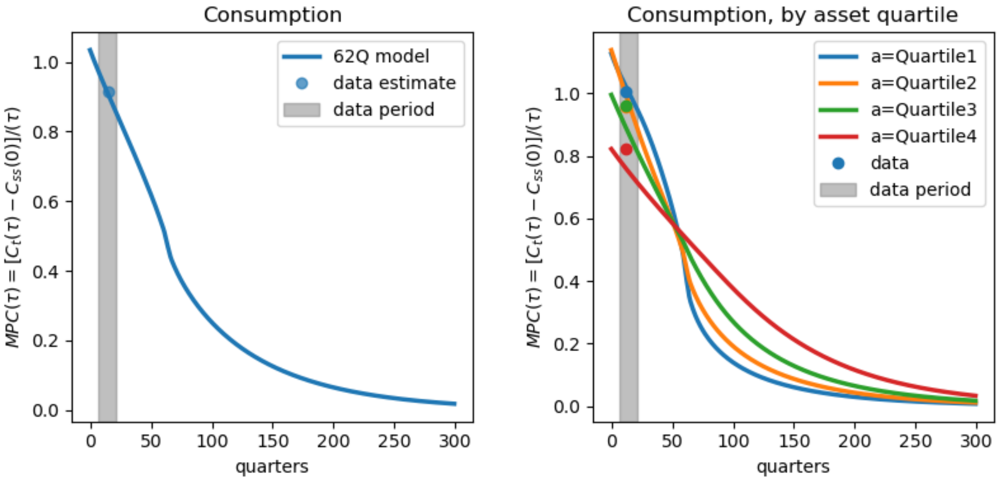

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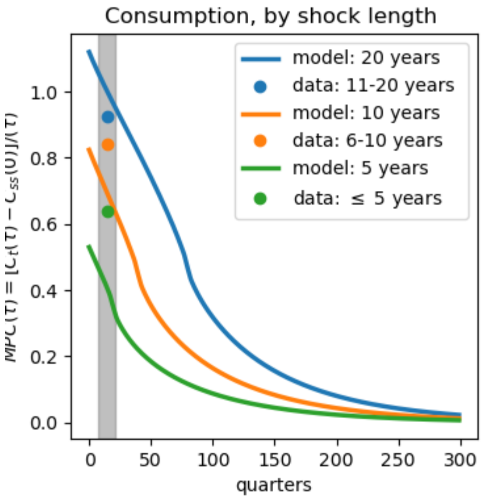
▸ One period shock at quarter 0 ▸ One period shock at quarter 40 ▸ Savings response ▸ Permanent income hypothesis

Comparing length of the shock



- Smaller MPC for less persistent shocks in both model and data
- Data $>$ model errors increase with less persistent shocks

Conclusions

- Compared savings responses in model and data with persistent shocks

1. **Data:** Average MPC is high 0.92
   - By bank balance: Lower MPC (0.82) for high bank balance consumers
   - By shock length: Lower MPC (0.84) for shorter (6-10 year) shocks
2. **Model:** matches average MPC with 62 quarter shock
   - By bank balance: matches covariance, error ≤ 0.08
   - By shock length: matches covariance, error > 0.27
3. **Takeaway:**
   - Literature: Data MPC $>>$ Model MPC for transitory shocks
   - This paper: Data MPC $\approx$ Model MPC for persistent shocks

   $\rightarrow$ Standard model performs comparatively well for persistent shocks

- **Bonus:**
  - How do defaults depend on balances? ▸ Defaults ▸ Tracker v variable

Thank you

Bellman

The value function at time t is

$$V_t(e, a_-) = \max_{c,a} \left\{ \frac{c^{1-\sigma}}{1-\sigma} + \beta \sum_{e'} V_{t+1}(e', a) \mathcal{P}(e, e') \right\}$$
$$c + a = (1 + r) a_- + e + \tau$$
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Perfect foresight for aggregate path $\{\tau_s\}_{s \geq 0}$.
Compare against stationary dist with $\tau_{ss} = 0$

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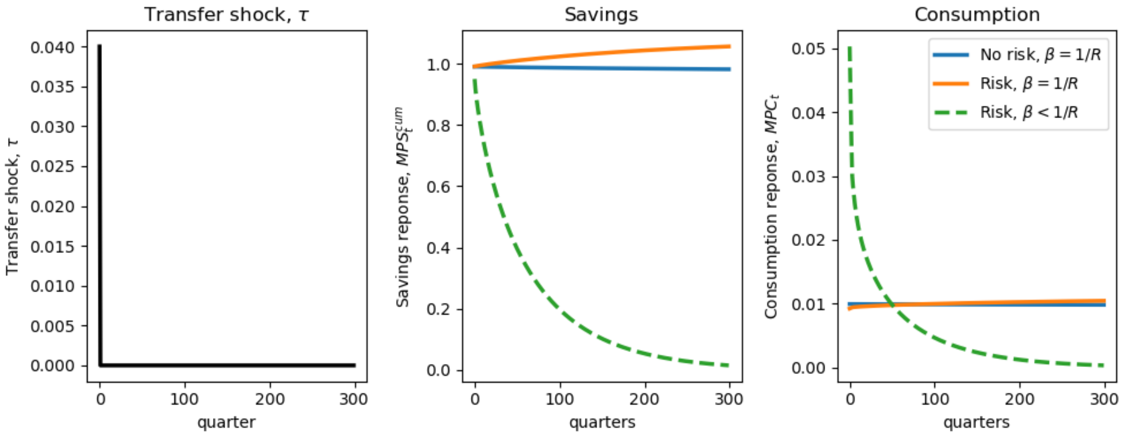
back

Warm up: one period shock

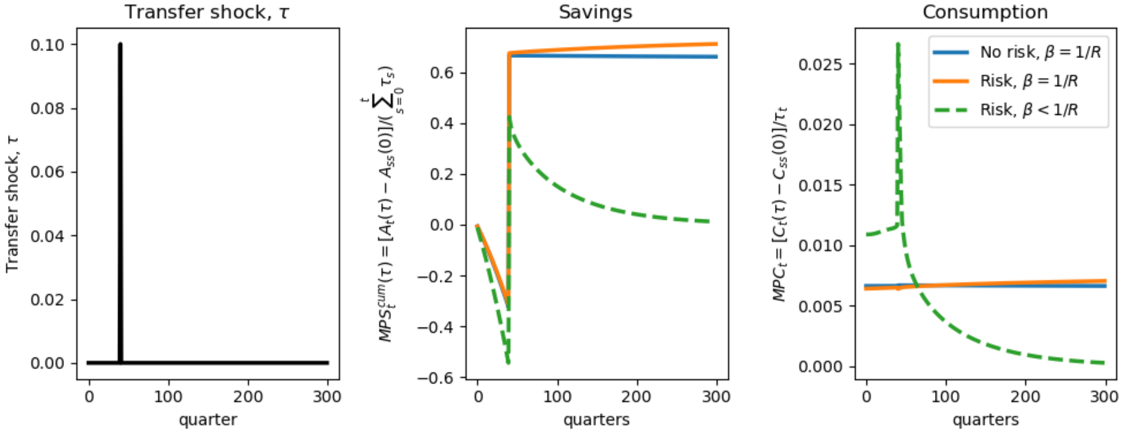
‣ Shock at quarter 40



- **Here:** $MPC_{t=0} = \frac{r}{1+r}$ when $\beta = 1/R$
  $MPC_{t=0}$ at impact 0.043 with risk and $\beta < 1/R$;
- **Kaplan Violante (2014)** One-asset: $MPC_{t=0} \approx 0.03$ (non-HtM), 0.15(HtM)
- **Data:** $MPC_{t=0} \approx 0.5$ Fagereng, Holm and Natvik (2020)

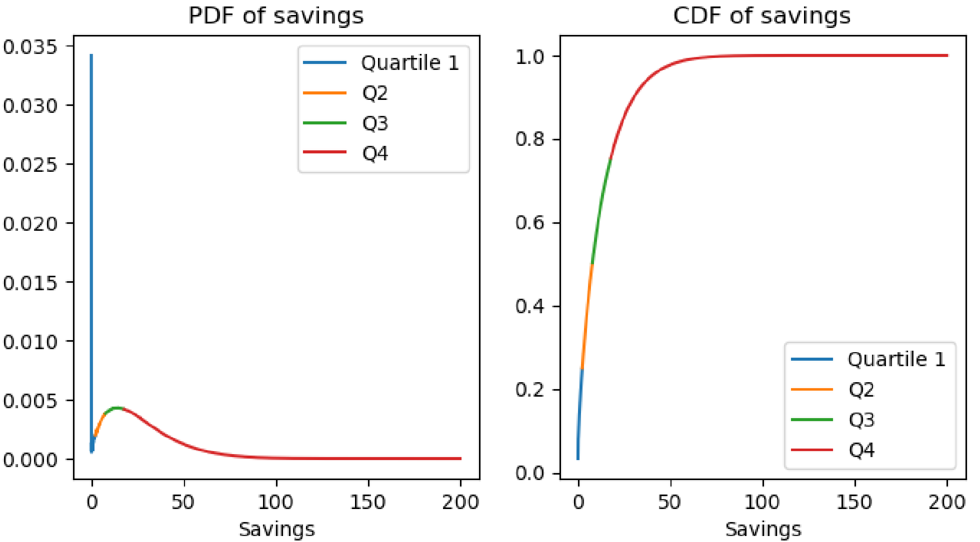
Warm up: one period shock

‣ back



Asset distribution in steady state

‣ back

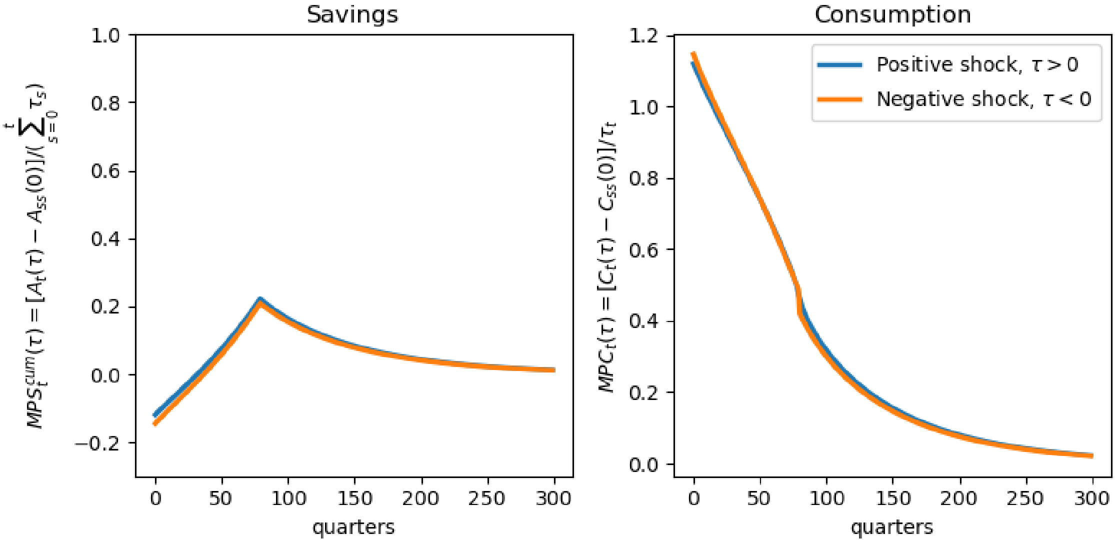


Other model experiments

- Responses are larger to negative shocks, though not by much for this shock size ‣ link

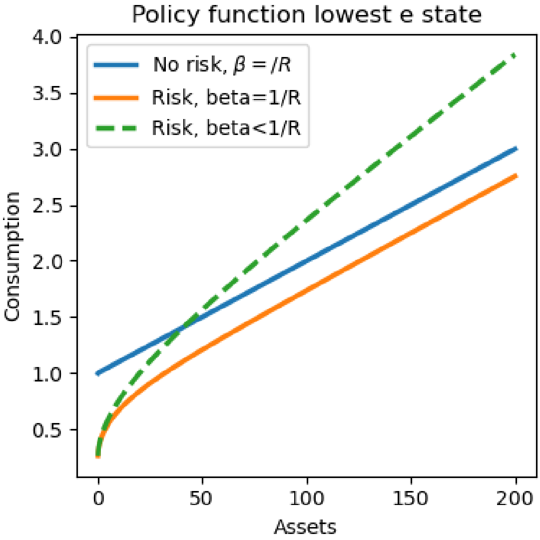
Positive versus negative shocks

▸ back



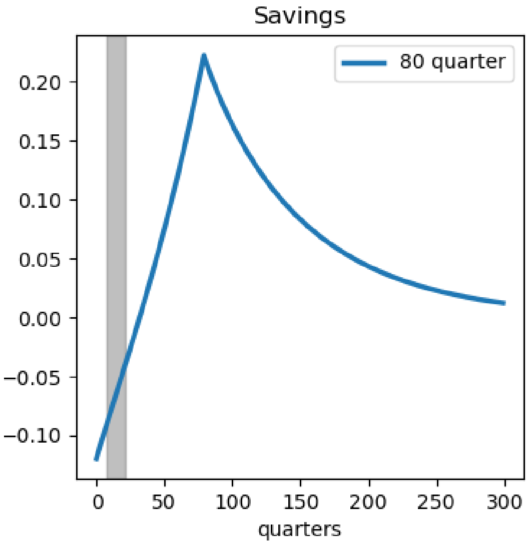
Policy functions

‣ back

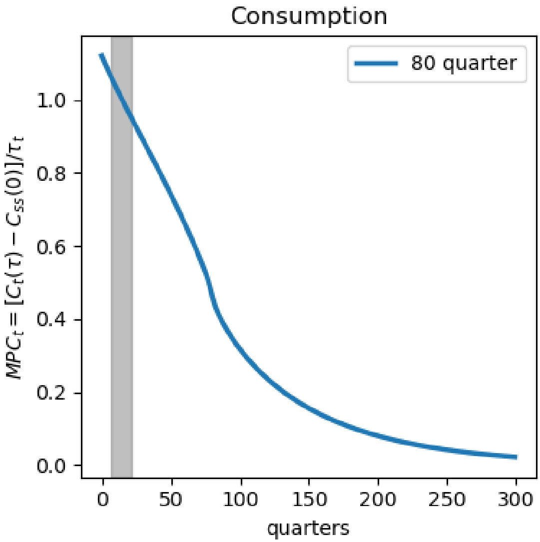


Average savings responses

- back



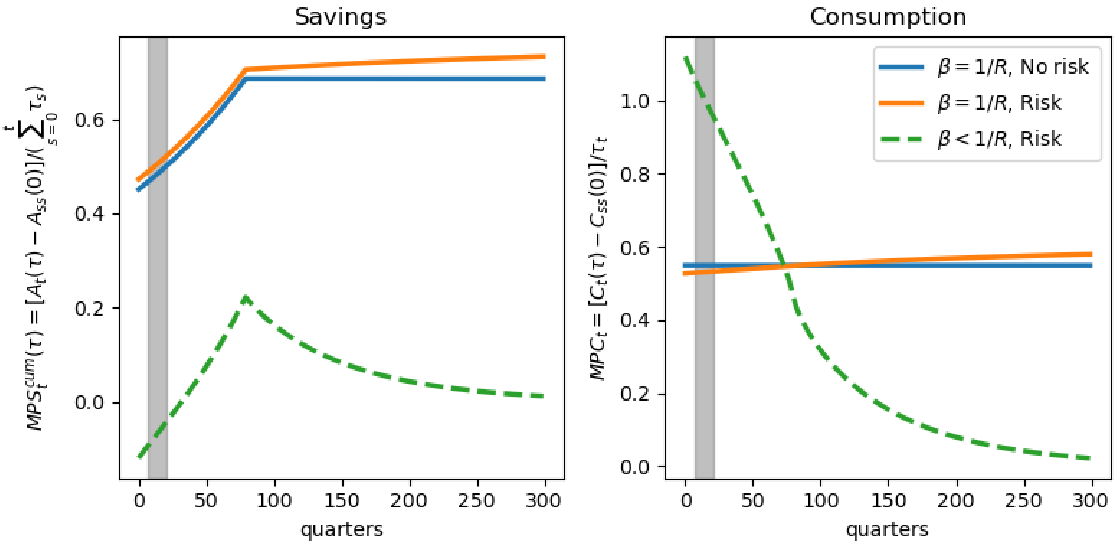
Average consumption responses



‣ One period shock at quarter 0 ‣ One period shock at quarter 40 ‣ Savings response ‣ Permanent income hypothesis

Average responses

‣ back

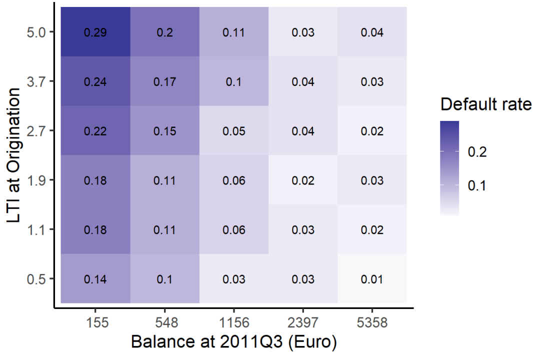


‣ One period shock at quarter 0 ‣ One period shock at quarter 40

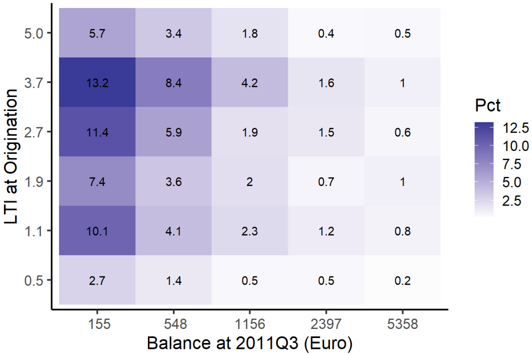
Tracing out the default threshold: LTI-balance space

back

(a) Default propensity



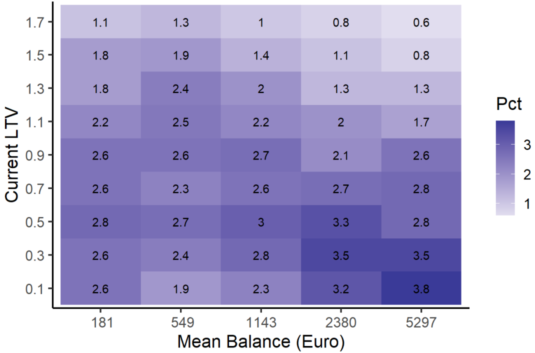
(b) Defaults



Distribution of observations

- back

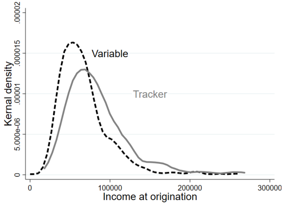
(a) Distribution of observations



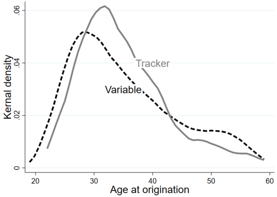
Distribution of variable and tracker mortgage borrowers

- back

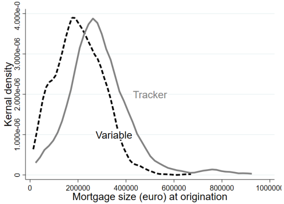
(a) Income



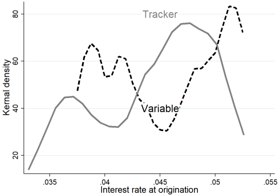
(b) Age



(c) Mortgage balance



(d) Annual interest rate



Note: All variables are at origination for new mortgages for house purchases originated in 2006 and 2007. Plots

Pooled Marginal Propensity to save (MPS)

▸ back

$$\Delta b_{i,t+1} = \beta_0 + \beta_1 m_{it} + \eta X_{it} + \gamma_t + u_{it} \quad (1)$$

	(1) Savings	(2) Log Savings	(3) Δ Savings	(4) Δ Log Savings	(5) Savings	(6) Log Savings	(7) Δ Savings	(8) Δ Log Savings
Cumulative Payment Savings	0.086**				0.078**			
	(0.0218)				(0.0249)			
Log Cumulative Payment Savings		0.078**				0.081*		
		(0.0242)				(0.0275)		
Δ Cumulative Payment Savings			0.089**				0.087**	
			(0.0225)				(0.0225)	
Δ Log Cumulative Payment Savings				0.060***				0.057**
				(0.0121)				(0.0134)
Observations	138516	138501	128622	128607	138450	138435	128561	128546
Adjusted (R^2)	0.902	0.922	0.001	0.001	0.902	0.922	0.002	0.002
Individual FE	Yes	Yes			Yes	Yes		
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls $\times$ Quarter FE					Yes	Yes	Yes	Yes
Prob($\beta = 1$)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

MPS heterogeneity: by balance quartiles

back

	Savings				Log Savings			
	(1) Lower	(2) Quartile 2	(3) Quartile 3	(4) Upper	(5) Lower	(6) Quartile 2	(7) Quartile 3	(8) Upper
Cumulative Payment Difference	-0.006	0.043	0.038	0.176*				
	(0.0071)	(0.0204)	(0.0431)	(0.0660)				
Log Cumulative Payment Difference					0.039	0.123*	0.161**	0.083
					(0.0441)	(0.0525)	(0.0510)	(0.0428)
Observations	34118	32116	33936	38346	34117	32115	33932	38337
Adjusted (R^2)	0.516	0.403	0.469	0.854	0.813	0.537	0.571	0.769
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls $\times$ Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prob($\beta = 1$)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

MPS heterogeneity: by quarters to maturity

back

- Compute time to maturity when shock starts 2010Q1

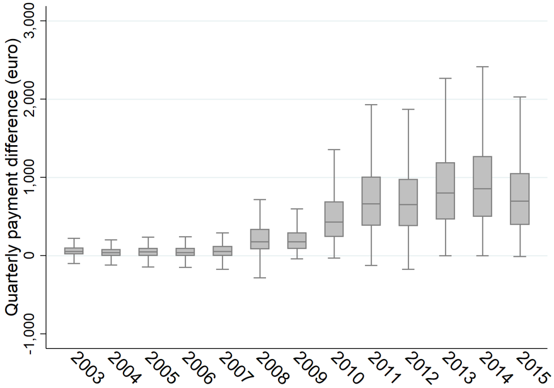
	Δ Savings			Δ Log Savings		
	(1)	(2)	(3)	(4)	(5)	(6)
	$\leq 5 years$	$6-10 years$	$>$ 10 years	$\leq$ 5 years	6-10 years	$>$ 10 years
D.Cumulative Payment Difference	0.394	0.161*	0.076*			
	(0.2059)	(0.0651)	(0.0268)			
D.Log Cumulative Payment Difference				0.130***	0.022	0.031
				(0.0206)	(0.0332)	(0.0313)
Observations	10634	23153	94835	10632	23149	94826
Adjusted R^2	-0.004	0.003	0.003	-0.005	-0.006	0.003
Individual FE						
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls $\times$ Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Prob($\beta = 1$)	0.012	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses.

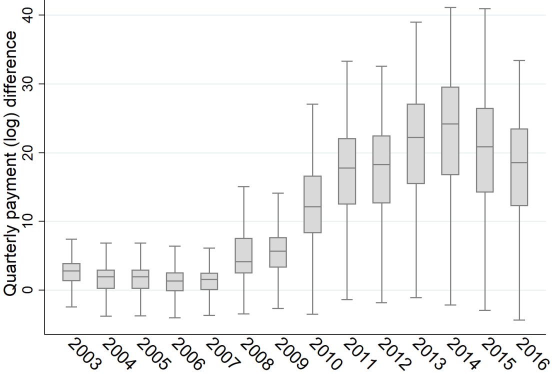
Size of payment shock

Figure: Box plot of size of payment difference

(a) Euro value



(b) Percent difference (relative to variable payment)

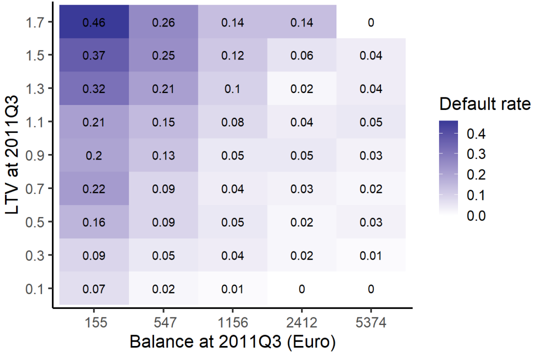


Note: Percent is relative to the first lien only.

Tracing out the default threshold: LTV-balance space

- Stylized default decision: $V_t(y, b, \frac{m}{p}) = \max\{V_t^{pay}(y, b, \frac{m}{p}), V_t^{default}(y, b, \frac{m}{p})\}$

(a) Default propensity

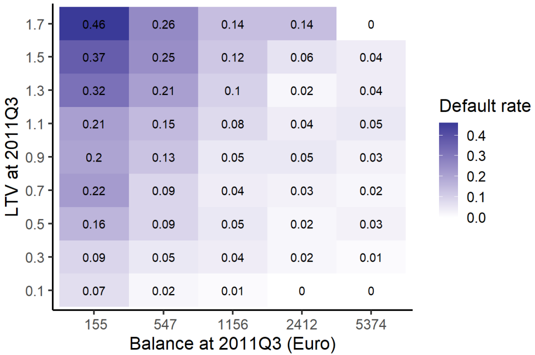


- Many other dimensions of heterogeneity: ▸ Balance-LTI-space ▸ Distribution ▸ Mean balances
- Do not observe income, but can use our “disposable income” shocks ▸ back

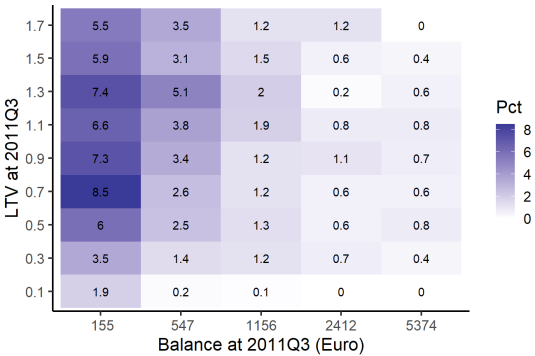
Tracing out the default threshold: LTV-balance space

- Stylized default decision: $V_t(y, b, \frac{m}{p}) = \max\{V_t^{pay}(y, b, \frac{m}{p}), V_t^{default}(y, b, \frac{m}{p})\}$

(a) Default propensity



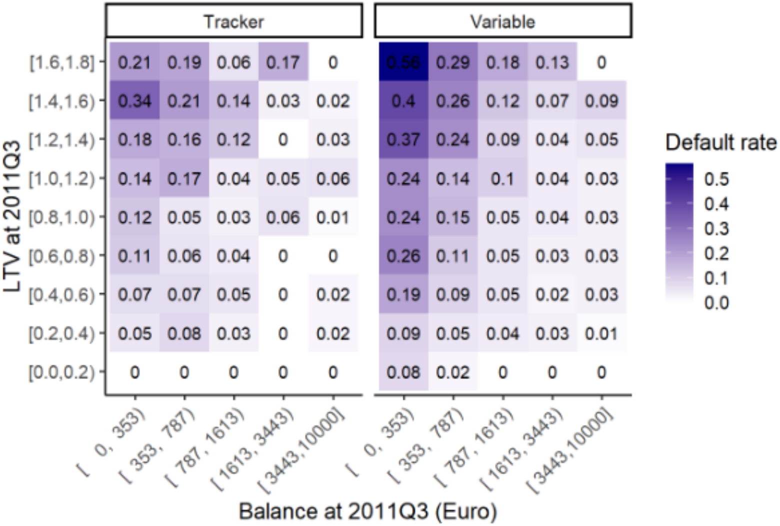
(b) Defaults



- Many other dimensions of heterogeneity: ▸ Balance-LTI-space ▸ Distribution ▸ Mean balances
- Do not observe income, but can use our "disposable income" shocks ▸ back

Comparing tracker and variable mortgages

‣ back



Tracing out the default threshold: LTV-balance space

‣ back

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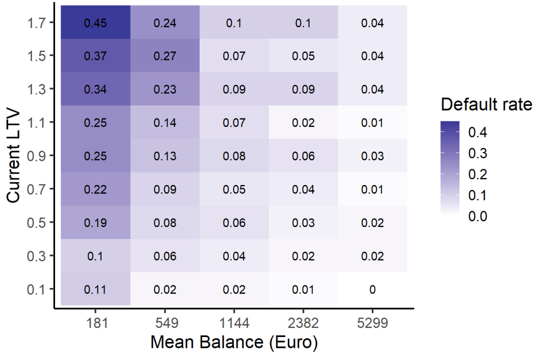
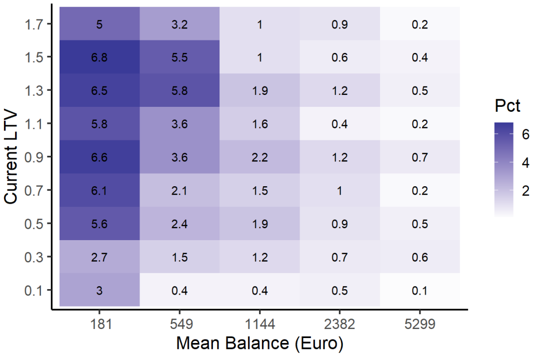
(a) Default propensity



(b) Defaults



Summary statistics

	Mean	P10	P25	P50	P75	P90
No of liens	1.69	1	1	1	2	3
No of deposit accounts	3.97	3	3	3	5	6
Dublin (%)	51					
Borrower Age	46.32	35	40	46	52	59
Total Account Balance	8346	42.25	565.17	2230.16	8531.59	25823.85
Total Quarterly Average Account Balance	8060	245.53	619.77	2093.94	8315.22	24498.02
Current Loan-to-Value	72	7	23	59	109	156
Oustanding Balance	137508	16104	44148.76	109519.28	203884.44	300785.29
Quarterly Mortgage Payments	3050.06	973.3	1637.15	2642.15	3913.48	5656.83
Current Interest Rate (%)	4	2	5	5	5	5
Income at Origination	69796.72	31400	44632	62500	87562.18	120146.41
Quarters to Maturity	56.95	13	27	54	85	105
Tracker Rate (%)	18					
SVR Rate (%)	79					
Primary Dwelling Home (%)	83					

Comparing across asset quartiles

- Split SS distribution by asset quartiles ▸ distribution