Inattention and Inertia in Household Finance: Evidence from the Danish Mortgage Market

S. Andersen, J.Y. Campbell, K.M. Nielsen, and T. Ramadorai

Copenhagen, Harvard, HKUST, Oxford

March 20, 2014

Inertia in Household Finance

- Households often respond slowly to changed circumstances, e.g.
  - Participation, saving, and asset allocation in retirement savings plans (Agnew, Balduzzi, and Sunden 2003, Choi, Laibson, Madrian, and Metrick 2002, 2004, Madrian and Shea 2001)
  - Portfolio rebalancing in risky asset markets (Bilias, Georgarakos, and 2010, Brunnermeier and Nagel 2008, Calvet, Campbell, and Sodini 2009).
- Mortgage refinancing is an important example of this
  - "Woodheads" important in industry prepayment models for US FRMs
  - Random time-variation in inertia generates prepayment risk, important for pricing MBS (Gabaix, Krishnamurthy, and Vigneron 2007)
  - Inertia leads to cross-subsidies from sluggish refinancers to prompt refinancers, and may inhibit constructive financial innovation (Campbell 2006, Gabaix and Laibson 2006)
  - Similar phenomena in the UK system with ARM teaser rates (Miles 2004).

Understanding Mortgage Refinancing Inertia

- Do prompt refinancers look different from sluggish refinancers?
  - In the US, HMDA forms only tell us borrower characteristics at the time of mortgage origination, so we don't observe non-refinancers
  - Survey data, e.g. American Housing Survey, very noisy (Schwartz 2006)
- Is there evidence that some people also refinance too soon?
  - Agarwal, Driscoll, and Laibson (2013) present an approximate closed-form solution to the real options problem of optimally refinancing with fixed costs
  - Agarwal, Rosen, and Yao (2012) find evidence of both "errors of commission" (refinancing too soon) and "errors of omission" (refinancing too late), but they can only observe refinancers so the worst errors of omission are excluded
- To what extent is sluggish refinancing explained by constraints?
  - In the US, refinancing requires positive home equity
  - In the US, refinancing requires a sufficiently high credit score
  - Attempts to control for these constraints are inevitably imperfect (Archer, Ling, and McGill 1996, Campbell 2006, Schwartz 2006).

Mortgage Data from Denmark

- In this paper we use Danish data to surmount many of the problems of previous research
- Denmark has predominantly FRMs, like the US, but with important special features
  - Funding with covered bonds, fixed-rate maturity-matched bonds with integer coupons
  - Refinancing does not require positive home equity or a credit check provided the mortgage principal balance does not increase
  - Refinancing involves buying back the underlying mortgage bond, either at market value or face value
  - When buying back at face value, the refinancing incentive is the bond's coupon rate less the current mortgage yield.

Administrative Data from Denmark

- Denmark also has high-quality administrative data, which we match over the period 2008–12
  - All mortgages from 5 largest mortgage banks (out of 7) with a 94% market share
  - Demographic information from Civil Registration System
  - Income and wealth from the tax authority
  - Education from the Ministry of Education
  - Medical treatments from the National Board of Health
- We start with 2.7 million households
  - We match education and income for 2.5 million
  - We look only at households with a stable number of adults and a single address, 2.0 million
  - About 800,000 households have mortgages, 600,000 have a single mortgage, and 500,000 have a fixed-rate mortgage in two successive years (2009–2010 or 2010–2011).

Summary Statistics (Table 1)

Panel A: 2009- 2010

	3% Coupon	4% Coupon	5% Coupon	6% Coupon	>6% Coupon	Total
Fraction refinancing	0.023	0.022	0.081	0.389	0.323	0.106
Principal remaining (Millions DKK)	0.377	0.869	0.906	0.873	0.572	0.867
Years remaining on mortgage	7.528	20.648	23.797	24.288	21.777	22.343
Loan-to-value (LTV) on mortgage	0.221	0.479	0.548	0.562	0.445	0.516
# of observations	7,701	79,254	129,230	32,738	5,368	254,292

Panel B: 2010- 2011

	3% Coupon	4% Coupon	5% Coupon	6% Coupon	>6% Coupon	Total
Fraction refinancing	0.017	0.014	0.034	0.078	0.078	0.028
Principal remaining (Millions DKK)	0.550	1.011	0.855	0.565	0.345	0.889
Years remaining on mortgage	9.526	22.665	22.820	20.960	18.165	22.081
Loan-to-value (LTV) on mortgage	0.345	0.608	0.589	0.491	0.357	0.579
# of observations	9,054	112,640	106,522	16,738	3,059	248,013

Do Refinancers and Non-Refinancers Look Different? (Table 3)

	Average	All
Single male household	0.130	-0.041***
Single female household	0.126	-0.033***
Married household	0.642	0.042***
Children in family	0.396	0.104***
Metropolitan property	0.127	0.000
Getting married	0.012	0.010***
Change to health	0.108	-0.015***
Having children	0.034	0.022***
Rank of age in years	0.000	-0.076***
Rank of education in years	0.003	0.038***
Rank of income	0.000	0.061***
Rank of financial wealth	0.000	-0.033***
# of observations	502,304	502,304

A Model of Inattention and Inertia

$$\Pr(\text{Refinancing}) = \Pr(\gamma' b_{it} + A(\delta' s_{it}) I(z_{it}) + \epsilon_{it}) > 0,\ \epsilon_{it} \sim N(0, \Sigma).$$

- Vectors b_{it} and s_{it} contain characteristics of household i at time t.
  - b_{it} determines baseline probability of refinancing
  - s_{it} shifts attention to incentives
- Vector z_{it} contains characteristics of household i's mortgage at time t
- $I(.)$ is the refinancing incentive function
- $A(.)$ is the attention function for household i at time t
  - We use the exponential form $A(\delta' s_{it}) = \exp(\delta' s_{it})$.
  - As $A(s_{it}) \to 0$ the household ignores the incentive, and refinancing probability goes to the baseline.

The Refinancing Incentive

$$I(z_{it}) = C_{it}^{old} - Y_{it}^{new} - O(z_{it}).$$

- In the Danish system the interest saving is given by old bond coupon less new mortgage bond yield.
- $O(z_{it})$ is a threshold determined by refinancing costs.
- We use the Agarwal, Driscoll, and Laibson (2013) approximate closed-form solution:

$$O(z_{it}) \approx \sqrt{\frac{\sigma \kappa_{it}}{m_{it}(1-\tau)} \sqrt{2(\rho + \lambda_{it})}}.$$

The Agarwal-Driscoll-Laibson Threshold

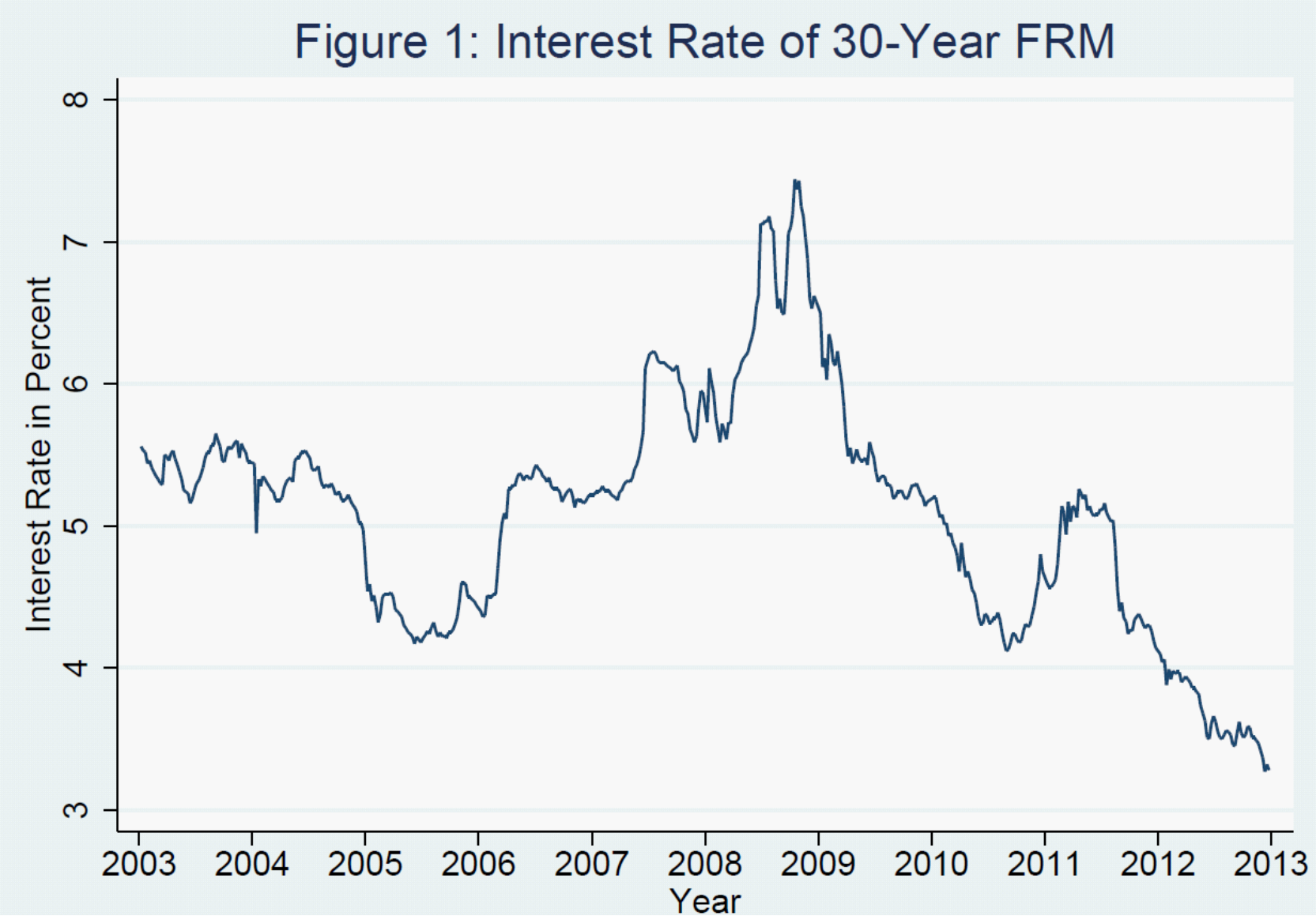
$$O(z_{it}) \approx \sqrt{\frac{\sigma\kappa_{it}}{m_{it}(1-\tau)}\sqrt{2(\rho+\lambda_{it})}}.$$

- $\sigma = 0.0109$ is interest rate volatility, $\tau = 0.33$ is tax rate (for mortgage interest deduction), $\rho = 0.06$ is discount rate
- $m_{i,t}$ is the size of the mortgage in DKK
- λ_{it} is the base rate of principal reduction:

$$\lambda_{it} = \mu_{it} + \frac{Y_{it}^{old}}{\exp(Y_{it}^{old} T_{it}) - 1} + \pi_t$$

- $\mu_{it} = \mu = 0.1$ (in this version of the paper)
- $\kappa_{it} = f + \theta m_{it}$ is the refinancing cost in DKK
- $f = 10,000$, $\theta = 0.01$.

Recent History of Danish Mortgage Rate (Figure 1)



Variation in Refinancing Incentives (Table 4)

	Min	*1%*	*5%*	*10%*	*25%*	*Median*	*75%*	*90%*	*95%*	*99%*	*Max*
						Interest Rate Spread in Percentage Points					
All	-1.20	-1.20	-0.20	-0.20	0.10	0.80	1.10	1.80	2.10	2.80	6.80
2010	-1.20	-1.20	-0.20	-0.20	-0.20	0.80	0.80	1.80	1.80	2.80	6.80
2011	-0.90	-0.90	0.10	0.10	0.10	1.10	1.10	1.10	2.10	3.10	6.10
						Threshold Level in Percentage Points					
All	1.03	1.17	1.23	1.28	1.38	1.56	1.81	2.17	2.48	3.10	4.51
2010	1.03	1.17	1.23	1.28	1.39	1.56	1.81	2.17	2.48	3.10	4.51
2011	1.04	1.17	1.23	1.28	1.38	1.55	1.81	2.17	2.48	3.11	4.48
						Incentives in Percentage Points					
All	-5.38	-3.62	-2.34	-1.95	-1.55	-0.98	-0.49	-0.14	0.37	0.88	3.93
2010	-5.27	-3.72	-2.43	-2.04	-1.66	-0.90	-0.55	0.08	0.43	1.09	3.69
2011	-5.38	-3.44	-2.25	-1.80	-1.43	-1.12	-0.41	-0.18	0.16	0.81	3.93

Errors of Commission and Omission (Table 5)

- Define commission as refinancing when $I(z_{it}) = C_{it}^{old} - Y_{it}^{new} - O(z_{it}) < -k$.
- Define omission as refinancing when $I(z_{it}) = C_{it}^{old} - Y_{it}^{new} - O(z_{it}) > k$.

	Level of Error Threshold					
	0	0.25	0.5	0.75	1	1.5
Error of commission	0.041	0.040	0.035	0.026	0.021	0.021
# of observations	460,831	435,232	373,707	295,455	240,445	137,191
Error of omission	0.635	0.584	0.603	0.683	0.601	0.713
# of observations	41,473	31,550	16,165	6,681	4,326	1,247

Who Makes These Errors? (Table 6)

Mistake

Mistake

Threshold = 0.25

Incentives < Threshold		*Incentives > threshold*	
Refinance	*No Refinance*	*Refinance*	*No Refinance*
0.189	0.083	0.090	0.131
0.162	0.083	0.093	0.127
0.525	0.673	0.714	0.644
0.351	0.552	0.452	0.385
0.135	0.138	0.120	0.124
0.014	0.027	0.015	0.011
0.111	0.103	0.102	0.108
0.036	0.069	0.042	0.031
-0.019	-0.134	-0.016	0.010
-0.053	0.058	0.024	0.000
-0.082	0.091	0.038	-0.004
-0.040	-0.074	0.014	0.006
18,440	13,110	17,378	417,854

Estimating the Full Linear Model (Table 9)

	Model 1	
	Baseline Probability	*Attention*
Single male household	-0.158***	-0.113***
Single female household	-0.036	0.130***
Married household	0.057***	-0.040
Children in family	0.034**	-0.006
Metropolitan property	-0.071	0.030
Getting married	0.058	0.094
Change to health	-0.062***	0.007
Having children	0.054***	0.092***
Demeaned rank of:		
Age	-0.350***	-0.706***
Length of education	0.146***	0.366***
Income	0.291***	0.565***
Financial wealth	-0.024	-0.460***
non-linear transformation f(x), x is the demeaned rank of:		
Age		
Length of education		
Income		
Financial wealth		
Constant baseline probability	-1.071	
Constant attention		-0.466***
Pseudo R^2		0.024
Log Likelihood		-104939.33
# of observations		502,304

Nonlinear Effects (Table 9)

Demeaned rank of:						
Age	-0.350***	-0.706***	-0.256***	-0.502***	-0.251***	-0.477***
Length of education	0.146***	0.366***	0.160***	0.288***	0.161***	0.289***
Income	0.291***	0.565***	0.389***	0.699***	0.378***	0.727***
Financial wealth	-0.024	-0.460***	-0.036***	-0.473***	-0.040	-0.477***
non-linear transformation f(x), x is the demeaned rank of:						
Age			0.155***	0.594***	0.104***	0.612***
Length of education			-0.062	0.163**	-0.027	0.172***
Income			-0.237***	-0.205***	-0.244***	-0.263***
Financial wealth			-0.479***	-0.079	-0.479***	-0.112
Constant baseline probability	-1.071		-0.921***		-0.969***	
Constant attention		-0.466***		-0.595***		-0.551***
Pseudo R^2		0.024		0.027		0.028
Log Likelihood		-104939.33		-104939.33		-104559.77
# of observations		502,304		502,304		502,304

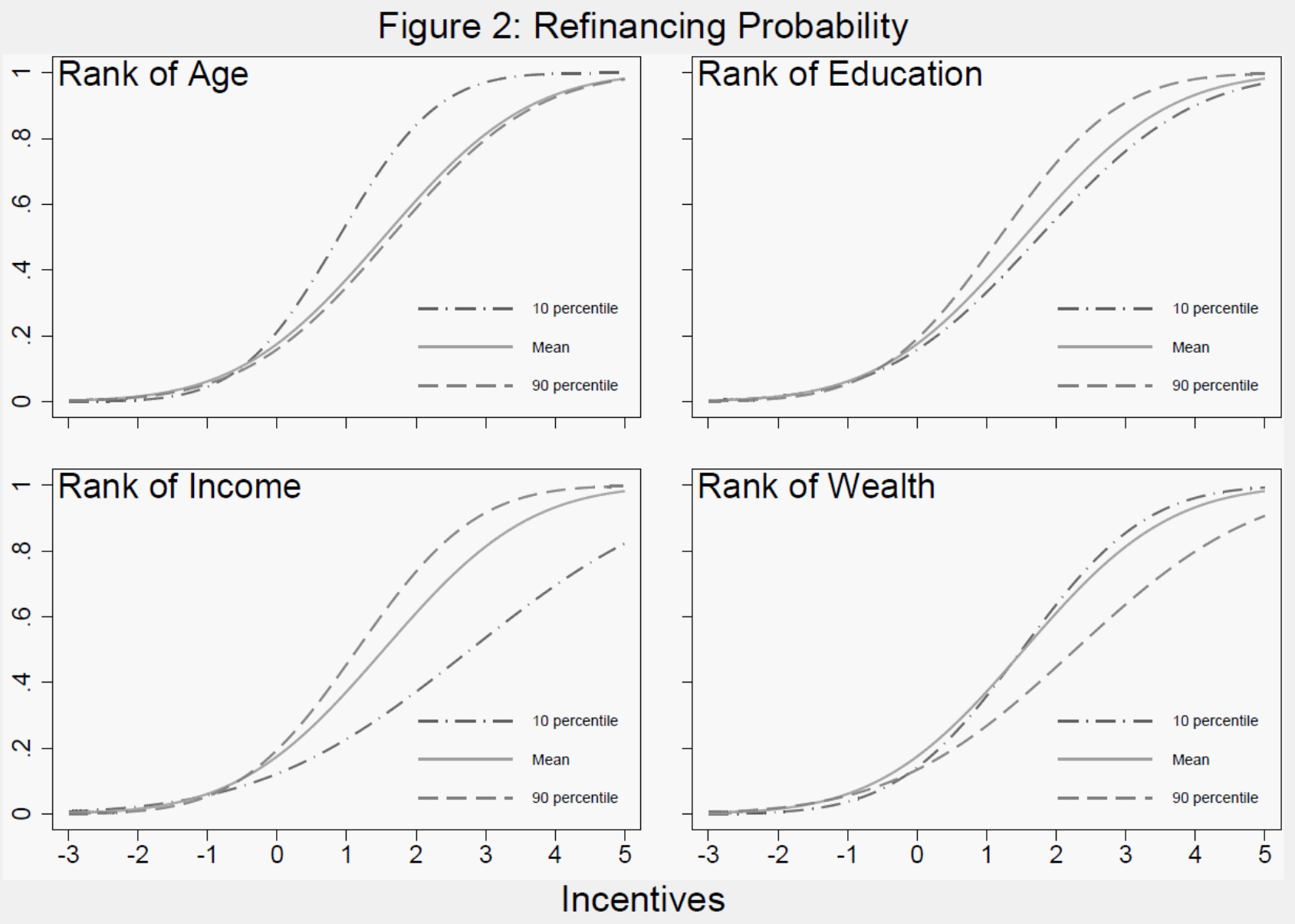
Model 2

Abs value

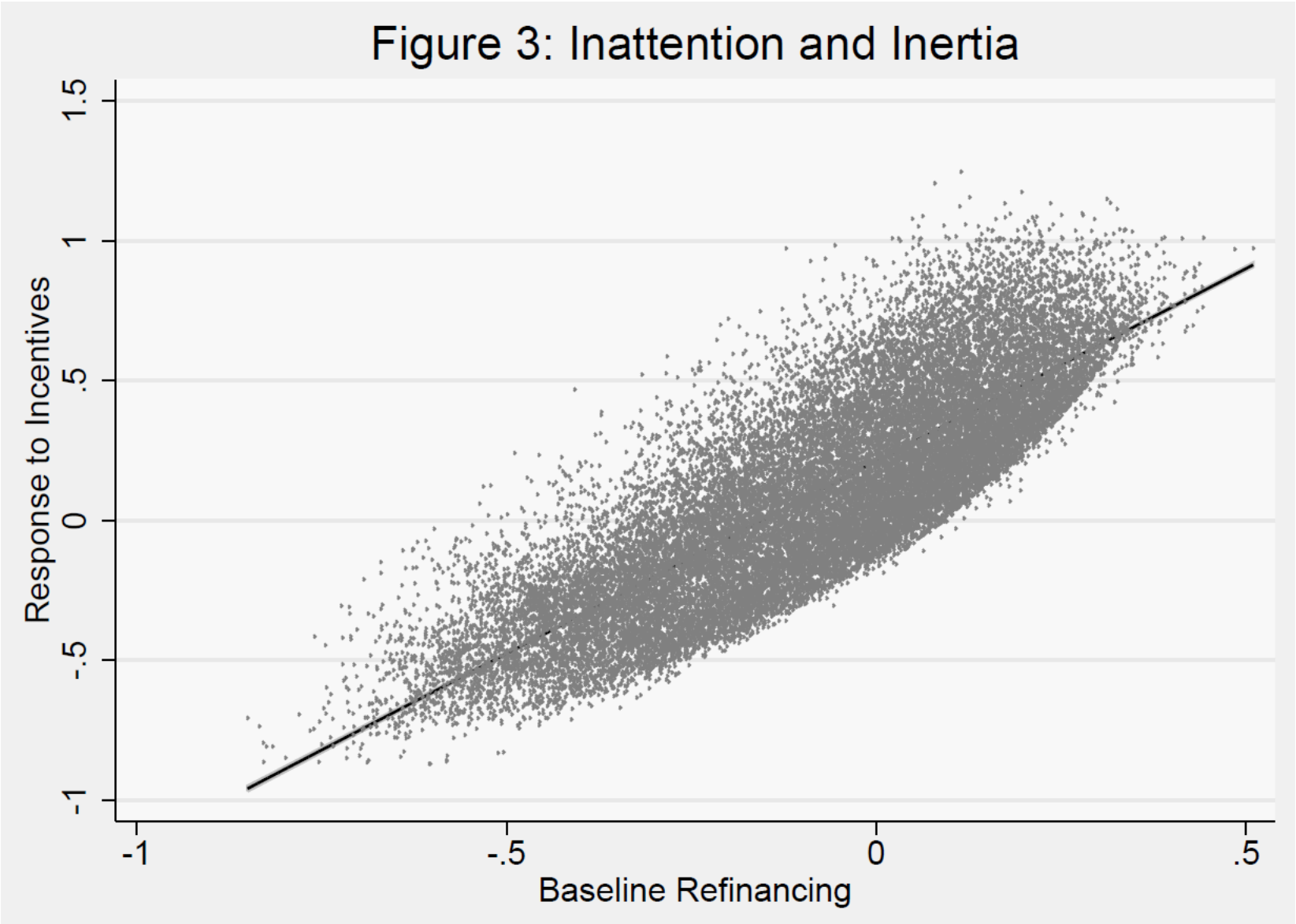
Model 3

2x square

Nonlinear Effects (Figure 2)



Proportional Inertia and Inattention? (Table 10, Figure 3)



Conclusion

- Household characteristics generally move inertia (low baseline refinancing probability) and inattention (insensitivity to refinancing incentive) in the same direction
  - The unconditional correlation of inertia and inattention is 0.82
  - But we can reject a deterministic linear relationship between these variables
- Middle-aged and older households have more inertia and inattention than younger households
- Education reduces inertia and inattention, particularly among more educated households
- Income reduces inertia and inattention, particularly among poorer households
- Wealth increases inertia and inattention, particularly among wealthier households
  - Could this result from a high cost of time, or less attention paid when mortgage is relatively less important?

Caveats and Next Steps

- This is a highly preliminary first draft, with several methodological weaknesses that we hope to address in future versions
- We assume equal moving probability for all households
  - Would be better to estimate moving probability as a function of household characteristics
- We focus on interest-rate reduction as the motivation for refinancing
  - Maturity extension may be another relevant motive (Danish system imposes no barriers to this)
- We do not use information on the exact timing of refinancing within the year
- We do not use the fact that errors of commission must have occurred before the start of our sample if households have old mortgages with high interest rates.