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

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Inertia in Household Finance

- Households respond slowly to changed circumstances.
  - 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 Haliassos 2010, Brunnermeier and Nagel 2008, Calvet, Campbell, and Sodini 2009).
- An important example: Mortgage refinancing.
  - Inertia ("woodheads") in prepayment models and MBS pricing (Stanton 1995, Deng, Quigley, and Van Order 2000, Gabaix, Krishnamurthy, and Vigneron 2007).
  - Cross-subsidies from sluggish to prompt refinancers (Miles 2004, Campbell 2006, Gabaix and Laibson 2006).

Mortgage Refinancing Inertia: Questions

- Do prompt refinancers look different from sluggish refinancers?
  - US HMDA tracks borrowers at origination, so we don't observe non-refinancers.
  - American Housing Survey and other survey data are very noisy (Schwartz 2006).
- Does the opposite of inertia (too-hasty refinancing) also exist?
  - Optimal refinancing solves a difficult real options problem (Agarwal, Driscoll, and Laibson 2013).
  - Errors of "commission" and "omission" when only refinancers are observed (Agarwal, Rosen, and Yao 2012).
- Can household constraints explain sluggish refinancing?
  - In the US, refinancing requires positive home equity and sufficiently high credit score: inevitably imperfectly measured (Archer, Ling, and McGill 1996, Campbell 2006, Schwartz 2006, Keys, Pope, and Pope 2014).

Mortgage Data from Denmark

- We use high-quality administrative data from Denmark to surmount many of these obstacles.
- 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 there is no cash-out.
  - 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

- 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 Customs and Tax Administration.
- Education from the Ministry of Education.
- Medical treatments from the National Board of Health.
- Start with 2.7 million households.
  - Match education and income: 2.5 million.
  - 953,000 households have mortgages in 2009 and 703,000 have a single mortgage.
  - 282,000 households have a fixed-rate mortgage in 2009 and 272,000 have one in 2010.
  - 60,000 households refinance in 2009 and 23,000 refinance in 2010.

Summary Statistics (Table 1)

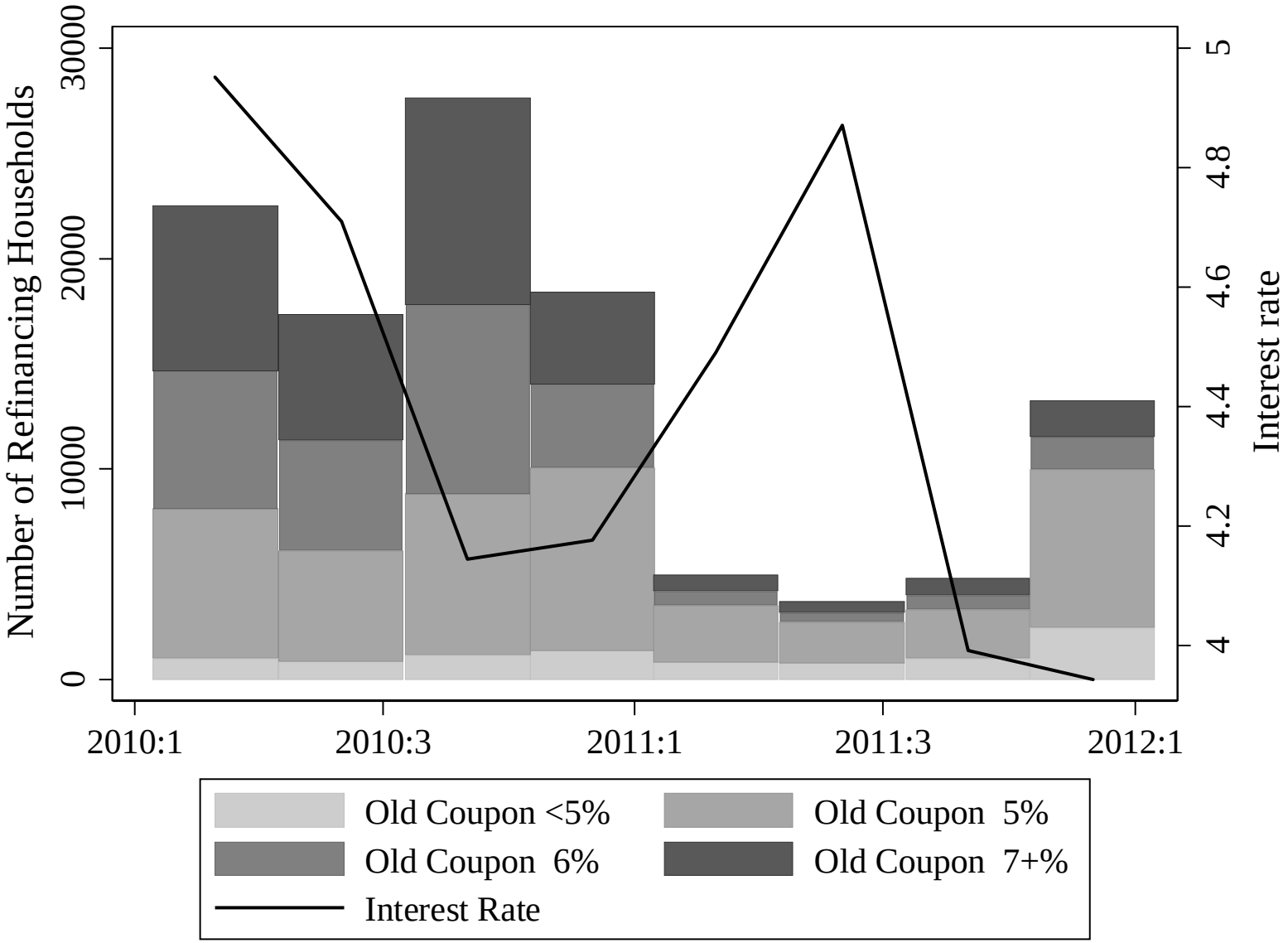
Panel A: 2010

	3% Coupon	4% Coupon	5% Coupon	6% Coupon	>6% Coupon	Total
Initial # of observations	8,054	79,929	141,610	44,590	7,515	281,698
Fraction refinancing	0.039	0.050	0.203	0.556	0.437	0.217
Fraction refinancing to ARM	0.013	0.024	0.108	0.218	0.153	0.100
Fraction refinancing to FRM	0.026	0.026	0.095	0.338	0.284	0.117
Principal remaining (Million DKK)	0.394	0.888	0.947	0.946	0.598	0.905
Years remaining on mortgage	7.849	21.425	24.552	25.371	22.281	23.256
Loan-to-value (LTV) ratio	0.242	0.506	0.595	0.640	0.462	0.563

Panel B: 2011

	3% Coupon	4% Coupon	5% Coupon	6% Coupon	>6% Coupon	Total
Initial # of observations	10,168	110,709	125,369	21,205	4,442	271,893
Fraction refinancing	0.031	0.041	0.114	0.159	0.117	0.085
Fraction refinancing to ARM	0.012	0.019	0.060	0.062	0.045	0.037
Fraction refinancing to FRM	0.018	0.021	0.053	0.097	0.095	0.048
Principal remaining (Million DKK)	0.479	0.978	0.883	0.591	0.321	0.875
Years remaining on mortgage	8.662	22.542	23.686	21.785	17.389	22.407
Loan-to-value (LTV) ratio	0.290	0.557	0.564	0.486	0.299	0.541

Refinancing by Coupon (Figure 4)



Refinancers and Non-Refinancers (Table 3)

	Average	All
Single male household	0.128	-0.041***
Single female household	0.124	-0.029***
Married household	0.638	0.024***
Children in family	0.406	0.102***
Immigrant	0.072	-0.001
No educational information	0.006	-0.003***
Financially literate	0.046	0.006***
Family financially literate	0.129	0.016***
Getting married	0.010	0.009***
Change to health	0.036	-0.004***
Having children	0.042	0.032***
Rank of age	0.015	-0.087***
Rank of education	0.004	0.027***
Rank of income	0.008	0.056***
Rank of financial wealth	0.009	-0.094***
Rank of housing value	0.010	0.029***
Region North Jutland	0.124	0.000
Region Middle Jutland	0.241	0.023***
Region Southern Denmark	0.228	0.002
Region Zealand	0.187	-0.015***
Region Copenhagen	0.220	-0.011***
# of observations	2,146,395	2,146,395

Refinancing Types

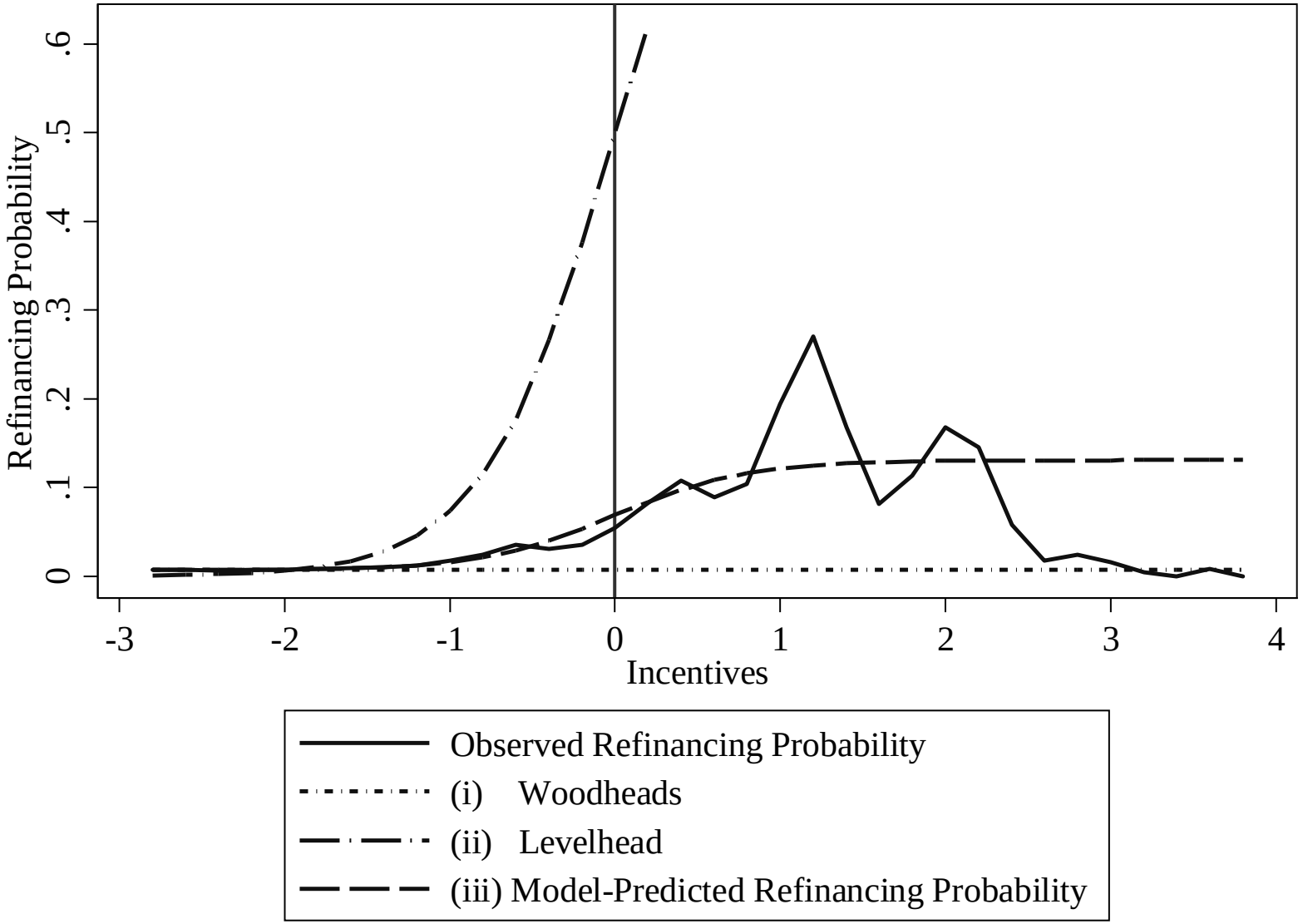
$$p^h_{i,t}(y_{i,t} = 1|\nu_h, \beta_h, \sigma_\epsilon) = p^h_{i,t}(\nu_h + e^{\beta_h} I_h(z_{i,t}) + \epsilon_{i,t} > 0).$$

- Household i has type h, refinancing is event $y_{i,t} = 1$.
- Parameter ν_h governs base refinancing rate, β_h governs response to incentive $I_h(z_{i,t})$, z_{it} contains mortgage characteristics.
- Stochastic choice error $\epsilon_{i,t}$ is logistic (as in standard logit model).
- Woodheads: refinance at fixed rate ν_W, ignore incentives so $I_W(z_{i,t}) = 0$ and $\beta_W = 0$.
- Levelheads: respond rationally to incentives with some $\beta_L > 0$, but $\nu_L = 0$.

A Mixture Model

- Household i has mixing weight δ_i^h on type h, where $0 < \delta_i^h < 1$ and $\sum_h \delta_i^h = 1$.
- We model
$$\delta_i^h = e^{\xi_i^h} / \sum e^{\xi_i^h},$$
where ξ_i^h can be a function of household characteristics.
- We can capture dynamic effects using issuing quarter and current quarter dummies (interactions of these dummies have almost no explanatory power).
  - Pure time effects (e.g. from media coverage of refinancing opportunities).
  - Age effects (burn-in and burn-out).
  - Currently working on modeling the persistence of type assignments.

A Basic Mixture Model (Figure 1)



The Refinancing Incentive

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

- Interest saving is old bond coupon less new mortgage bond yield.
- Use Agarwal, Driscoll, and Laibson (2013) approximate closed-form solution for threshold:

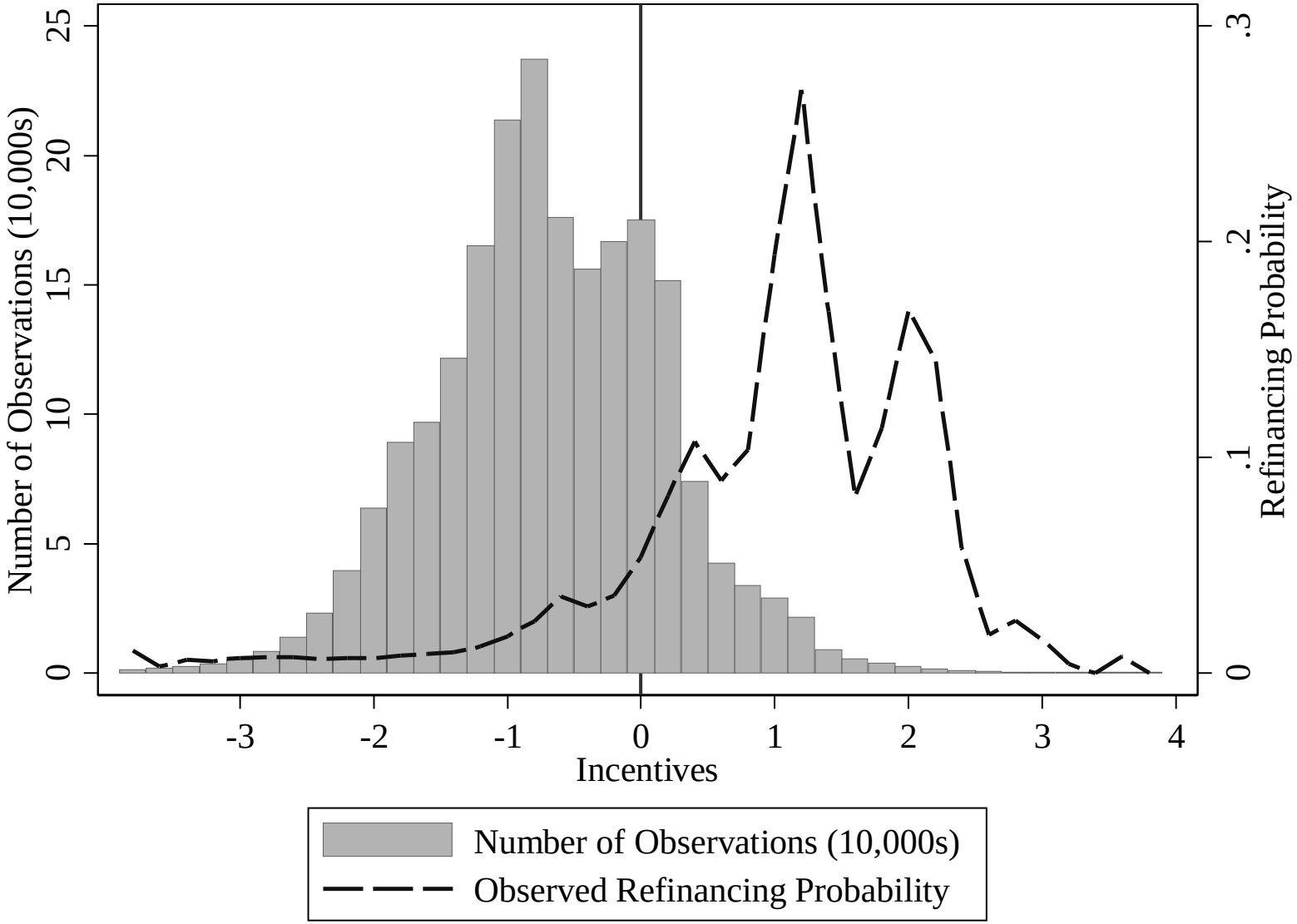
$$O(z_{it}) \approx \sqrt{\frac{\sigma \kappa_{it}}{m_{it}(1-\tau)} \sqrt{2(\rho + \lambda_{it})}}.$$

- σ interest rate volatility, τ mortgage interest tax deduction, ρ discount rate, κ_{it} fixed plus variable refinancing cost, $m_{i,t}$ size of mortgage, λ_{it} base rate of principal reduction, which includes termination probability.
  - We estimate termination probability: median 8.4%, mean 11.0%, standard deviation 8.7% (ADL suggest 10%).

Summary of the Evidence

- Danish mortgage rates have fallen substantially since their peak in 2008.
- About 23% of household-quarters have positive refinancing incentives.
- Almost 90% of these do not refinance (errors of omission).
- About 2% of the households with negative incentives do refinance, but about half of these cash out or extend maturity so only 1% appear to be mistakes (errors of commission).
- Most demographic characteristics shift refinancing up or down and therefore move these errors in opposite directions.

Incentives and Refinancing (Figure 6)



Errors of Omission and Commission (Table 5 Panel A)

Panel A: Incidence of errors of commission and omission

	Level of Cutoff						
	0	0.25	0.5	0.75	1	1.5	2.0
# Observations (Incentives < -Cutoff)	1,688,215	1,475,545	1,278,737	751,439	362,251	137,457	137,457
# Observations, refinancing	37,297	28,294	22,095	14,340	7,983	2,919	1,014
# Observations, cash out or extend maturity	15,743	12,224	9,715	7,356	4,878	1,921	791
# Observations, errors of commission	21,554	16,070	12,380	6,984	3,105	998	223
Fraction with error of commission	0.013	0.011	0.010	0.009	0.009	0.007	0.002
# Observations (Incentives > Cutoff)	458,180	252,336	152,097	100,844	61,309	17,434	6,287
# Observations, errors of omission	411,015	220,084	130,389	83,668	49,456	15,749	5,746
Fraction with error of omission	0.897	0.872	0.857	0.830	0.807	0.903	0.914

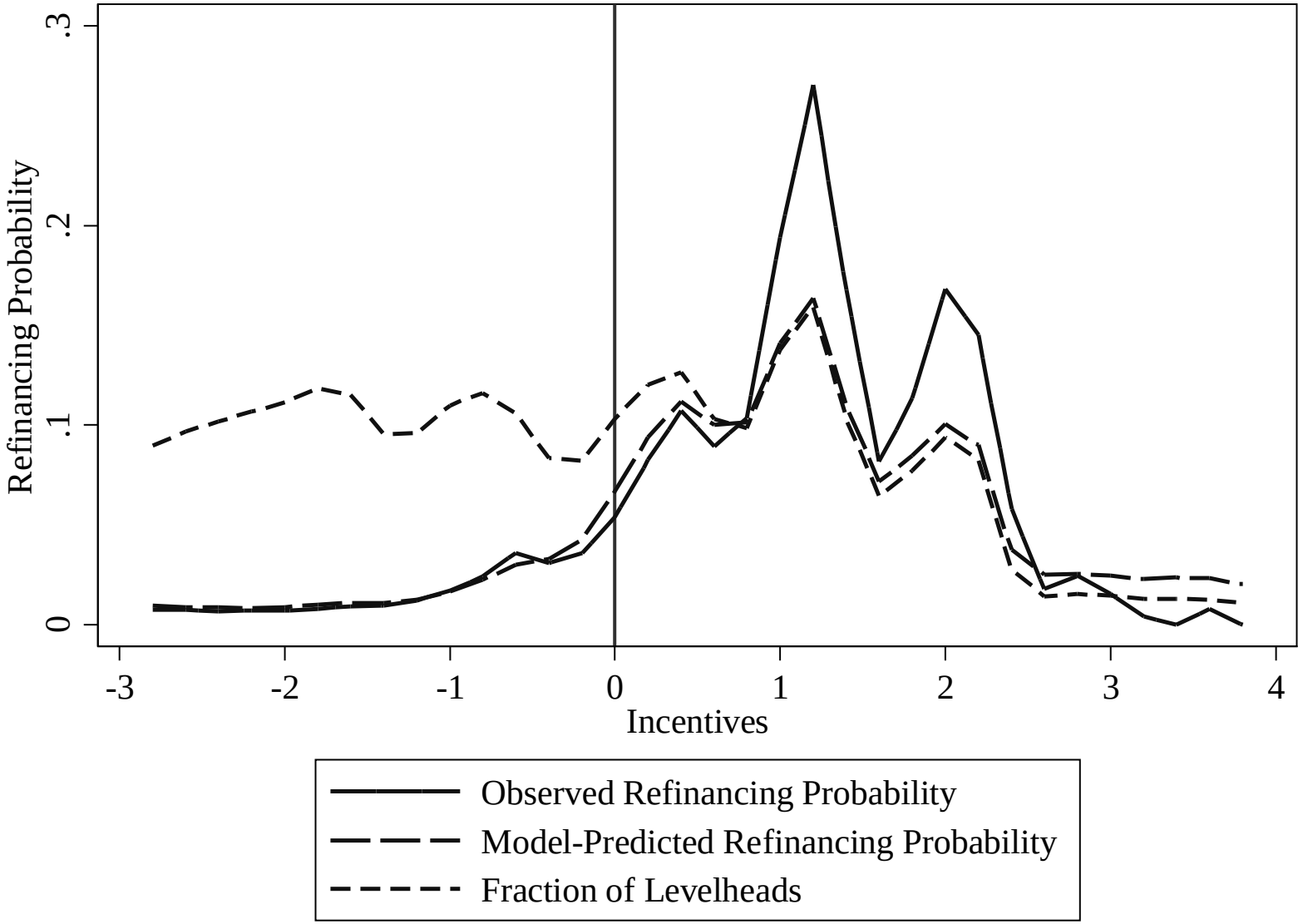
Who Makes These Errors?

- Most household demographic characteristics have offsetting effects on the two types of errors (Table 5 Panel B).
- Characteristics that are associated with increased refinancing in Table 3 increase errors of commission and reduce errors of omission.
- This suggests that a pure inattention model will not fit the data (since pure inattention would increase both types of error).
- Errors of omission are costly (Table 6): 1.9% of the outstanding mortgage balance for the average error-prone household, and about 0.25% of all outstanding mortgages (using 0.25 cutoff, across both years).

Mixture Model Results (1)

- Baseline model with no history dependence or demographic effects delivers sensible estimates (Figure 1):
  - 88% of household-quarters are woodheads who refinance with probability 0.8%.
  - 12% are levelheads who refinance with probability 10% when the incentive is -0.88%, 25% when the incentive is -0.43%, 50% when the incentive is zero, 75% when the incentive is 0.43%, and 90% when the incentive is 0.88%.
- History dependence and demographics greatly increase model's explanatory power from initial pseudo $R^2 = 8.5\%$.
- Issuing quarter effects are intuitive (Figure 8):
  - Woodhead refinancing probability increases initially, then remains flat on average (as in the PSA model used in the US).
  - Levelhead probability declines in mortgage age, except for mortgages with few lifetime chances to be refinanced at attractive rates.

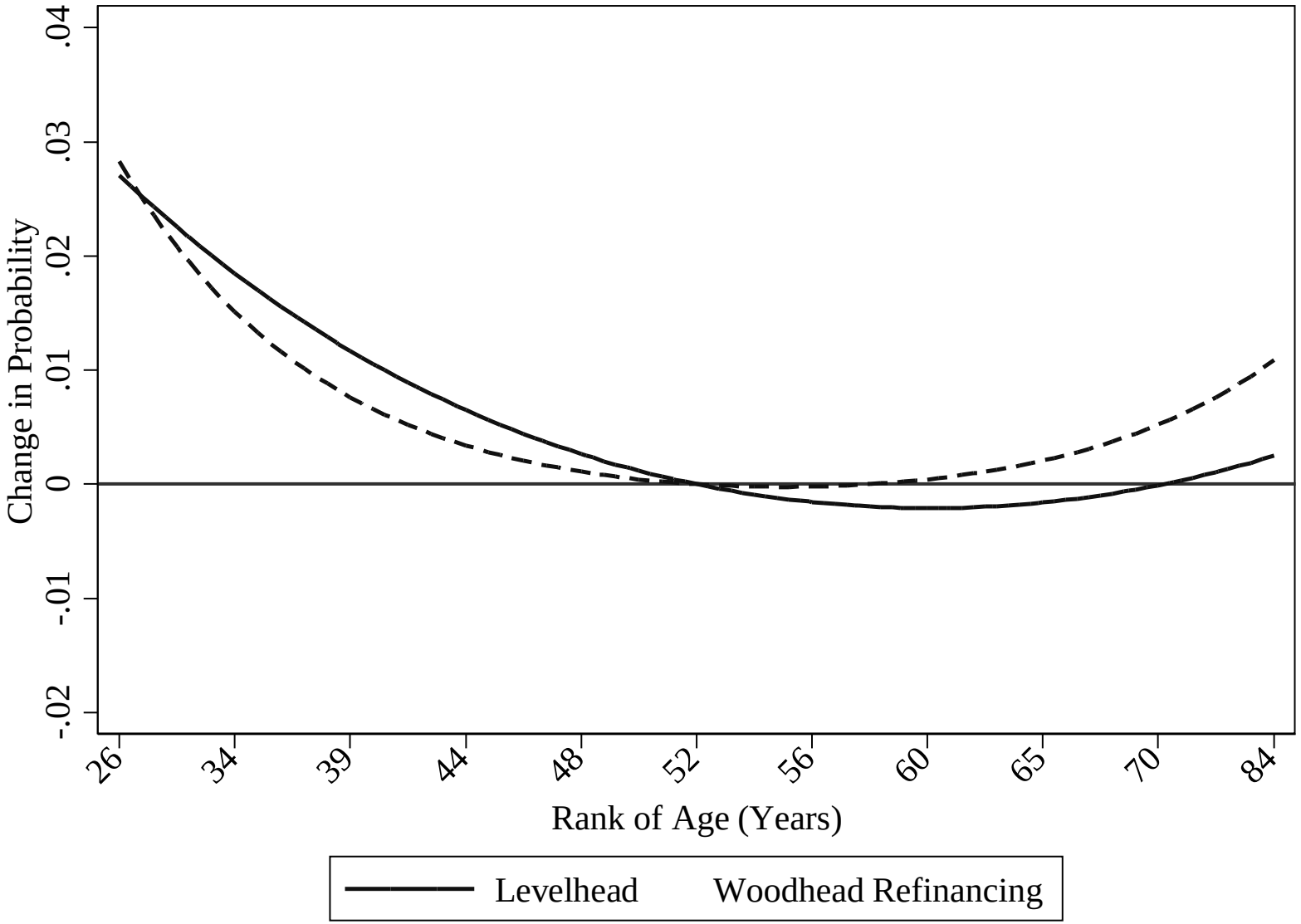
Mixture Model Fit (Figure 7)



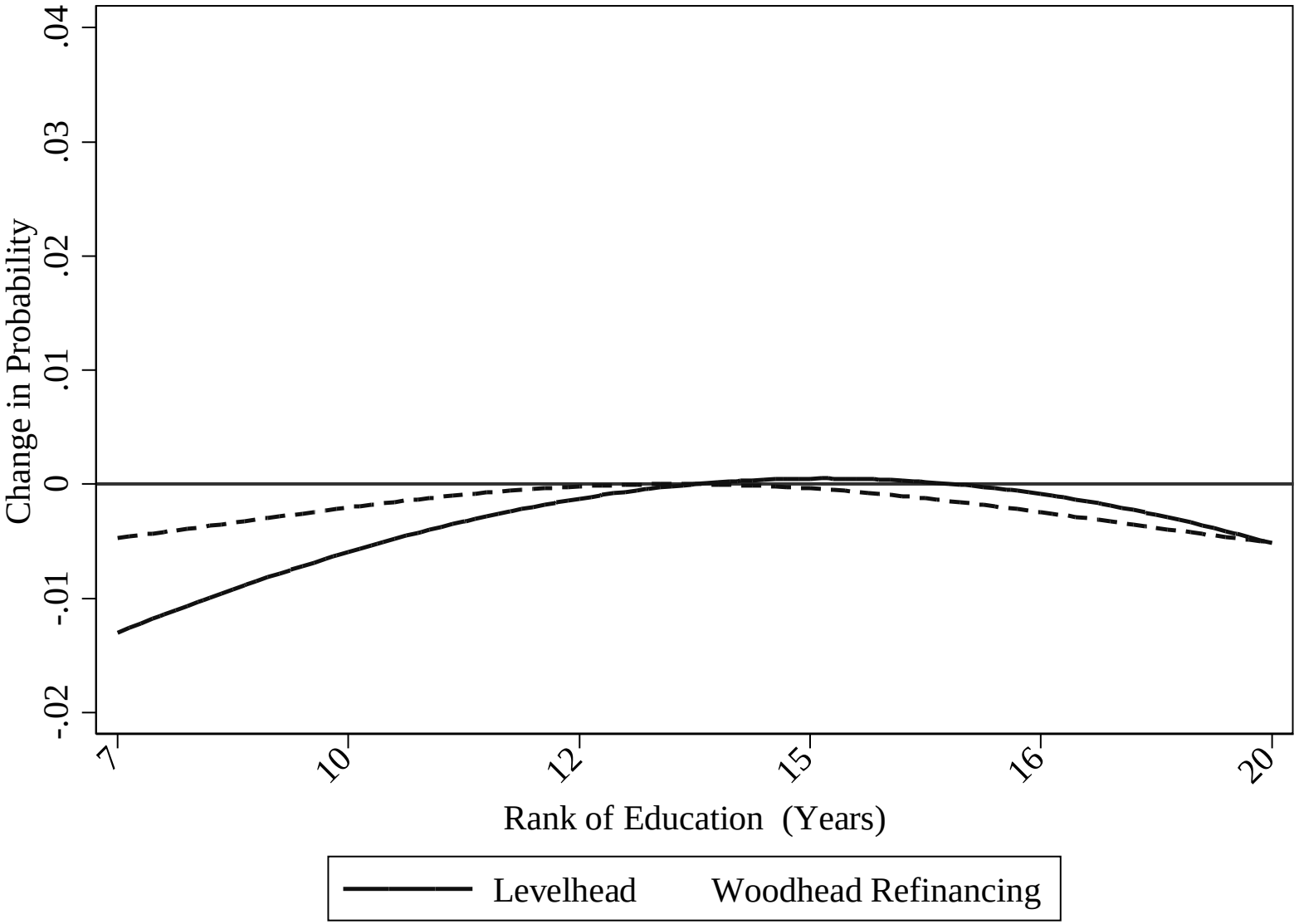
Mixture Model Results (2)

- Full mixture model has pseudo $R^2 = 15.7\%$.
- Most demographic variables move levelhead proportion and woodhead refinancing probability, or equivalently inattention and inertia, in the same direction.
  - Inertia and inattention as fitted from demographics have a cross-sectional correlation of 0.67; we can reject perfect correlation.
- Age reduces attention while education and income increase it among younger, less educated, and poorer households.
- Financial wealth and housing wealth have opposite effects
  - Highest attention for households with large houses relative to their financial wealth.

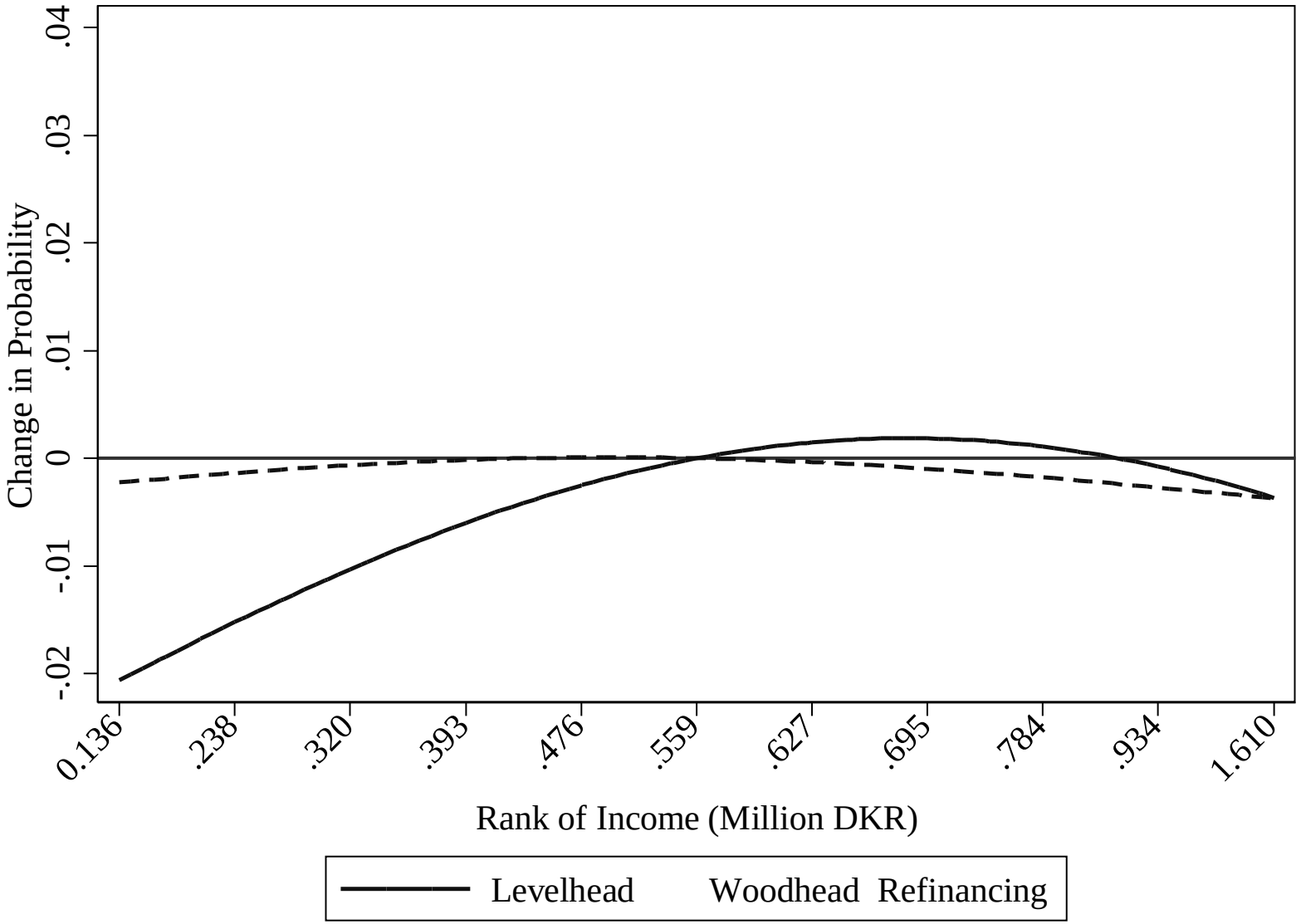
Effects of Age (Figure 9A)



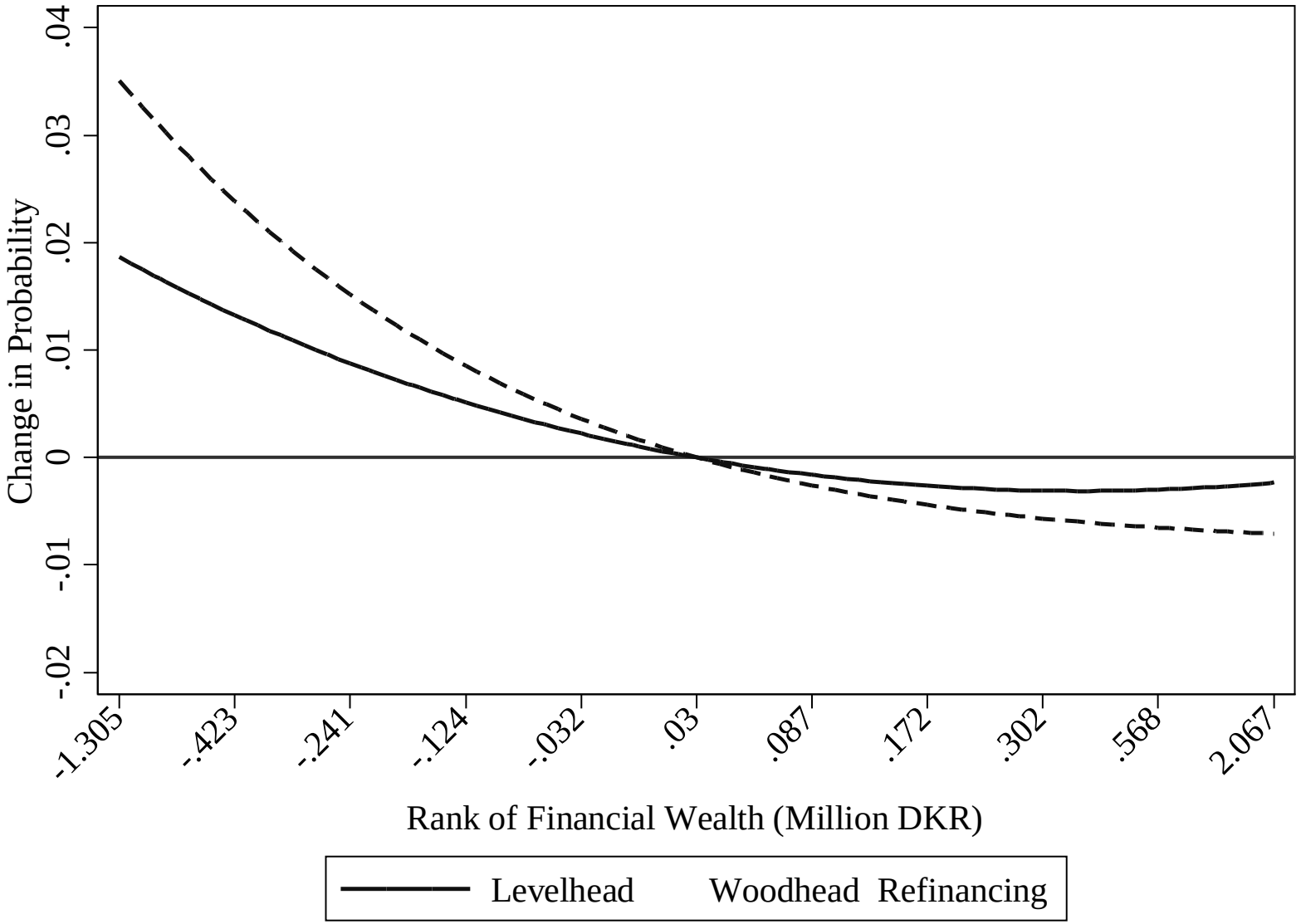
Effects of Education (Figure 10A)



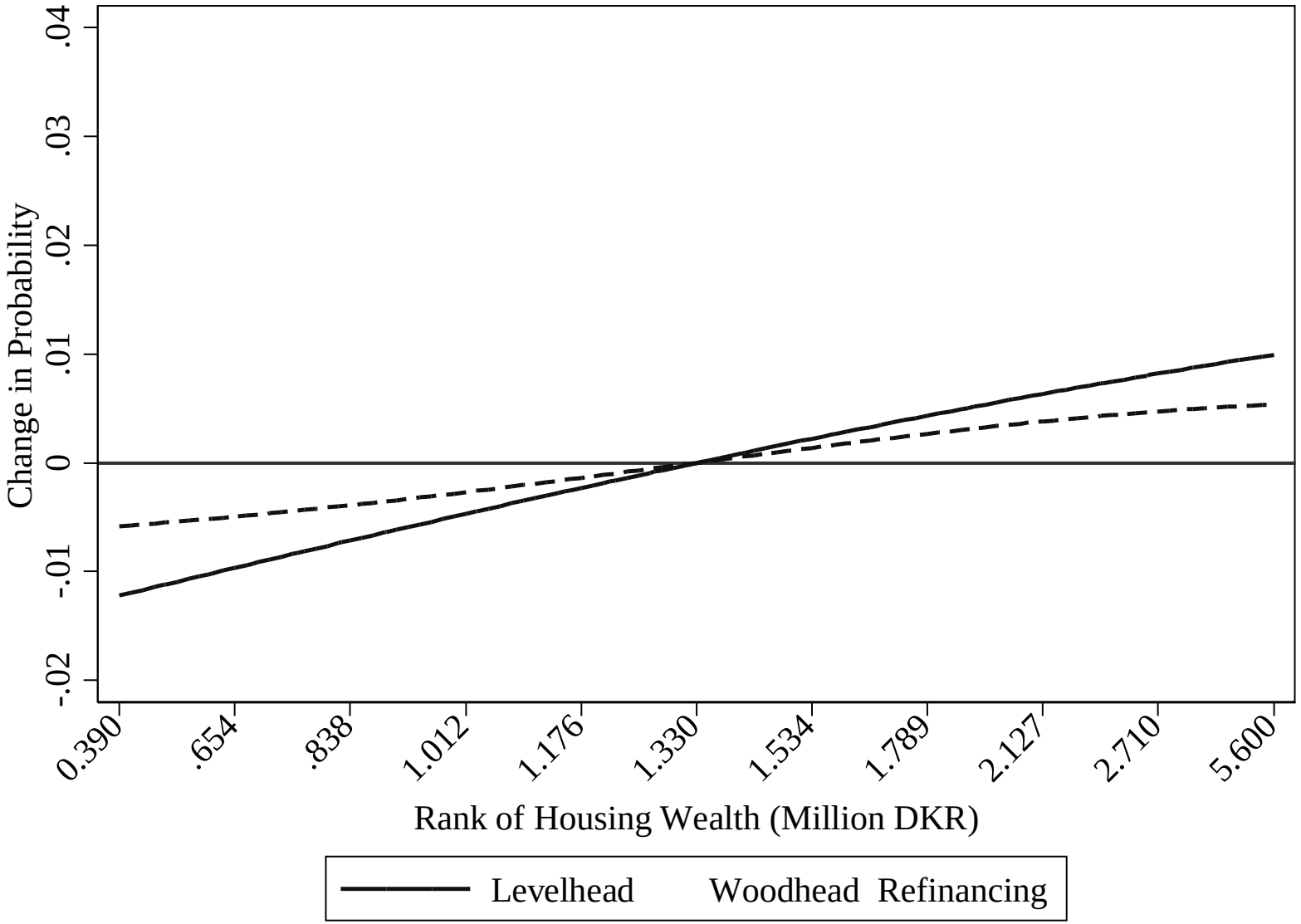
Effects of Income (Figure 11A)



Effects of Financial Wealth (Figure 12A)



Effects of Housing Wealth (Figure 13A)



Refinancing in Household Finance

- We propose a mixture model of household types to capture heterogeneity in propensity to refinance.
  - Distinguish inattention (low levelhead probability) and inertia (low woodhead refinancing probability).
  - Household characteristics generally move inertia and inattention in the same direction.
- Demographic effects are intuitive.
  - Inertia and inattention increase with age, decrease with education and income.
  - Financial wealth (proxy for cost of time?) and housing wealth have opposite effects.

Next Steps

- Enriching the set of household types, looking for active behavioral patterns.
- For example, "roundheads" refinance when interest saving or coupon reduction reaches a round number.
  - We find some evidence for a "new bond available with 2% lower coupon" effect.
  - But the improvement in the overall model fit is modest, because few households reach this point.
  - Demographic patterns discussed above are robust to this change in model specification.
- Also working on a better model of type persistence. Ultimate goal is a richer dynamic characterization of multiple household types.

Some Thoughts on Mortgage Policy

- The Danish mortgage system is impressively well designed.
- But it still places the burden of the refinancing decision on households.
  - Many people, particularly poorer and less educated people, get this wrong.
  - Errors of omission can be expensive for these people.
- Errors of omission increase the value of mortgage bonds, lowering yields in equilibrium.
  - Thus, sophisticated borrowers gain at the expense of the less sophisticated.
  - A troublesome phenomenon in an age of inequality.
- This cross-subsidy makes it harder for individual mortgage lenders to introduce new products (Gabaix and Laibson 2006).
  - An automatically refinancing "ratchet" bond would help the unsophisticated but hurt the sophisticated, who would otherwise be the natural early adopters.
  - In this situation there is a case for public policy to force the issue.