Online Appendix for

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

by

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This appendix contains three parts:

A. Data appendix
- Details about refinancing in Denmark
  This appendix provides answers to FAQs about access to refinancing in Denmark, obtained from the Association of Danish Mortgage Banks. The answers suggest that refinancing is widely available, and largely unrestricted.

B. Guide to appendix tables and figures replicating our results assuming a constant moving probability of 10% across households. We model mortgage terminations that are driven by household-specific events, such as moves, death, or divorce, by predicting the probability of mortgage termination, and using the fitted probability as an input into the Agarwal, Driscoll, and Laibson (2013) model of optimal refinancing. Table B.1 reports the determinants of mortgage terminations, while Table B.2 through B.5 and Figure B.1 and B.2 reports estimates under the alternative assumption of a constant mortgage termination probability of 10% as in Agarwal, Driscoll, and Laibson (2013).

- Table B1: Determinants of Mortgage Termination
  This table shows results from simple probit specifications which seek to uncover the determinants of mortgage termination caused by moving, or other circumstances which result in full prepayment of the mortgage. The dependent variable takes the value of 1 if a household terminates its mortgage in a given month, and 0 otherwise. We use Model 3 to predict each household's mortgage termination probability, μ. For reference, Figure 2 in the paper shows a histogram of the predicted mortgage termination probability.

- Table B.2: Cross-sectional Variation in Incentives assuming a constant mortgage termination probability of 10%.
  This table shows the cross sectional variation in incentives when we assume a constant mortgage termination probability of 10% for all households, i.e. $\mu = 10\%$. In comparison Table 4 in the paper shows the cross sectional variation in incentives using the predicted moving probability of the household from Table B.1.

- Table B.3: Refinancing: Heterogeneous Baseline with Constant Attention, and Heterogeneous Attention with Constant Baseline.
  This table shows the determinants of mortgage refinancing when we assume a constant mortgage termination probability of 10% for all households, i.e. $\mu = 10\%$. In comparison Table 8 shows the heterogeneous baseline with constant attention, and heterogeneous attention with constant baseline using the predicted moving probability of the household from Table B.1.

- Table B.4: Heterogeneous Baseline with Heterogeneous Attention
  This table shows the determinants of mortgage refinancing when we assume a constant mortgage termination probability of 10% for all households, i.e. $\mu = 10\%$. In comparison Table 9 in the paper shows heterogeneous baseline with heterogeneous attention using the predicted moving probability of the household from Table B.1.

[1] We are grateful to the Association of Danish Mortgage Banks for providing data, and for facilitating dialogue with the Mortgage Banks. We are particularly grateful to the senior economists Bettina Sand and Kaare Christensen at the Association of Danish Mortgage Banks for providing us with valuable institutional details.

- Table B.5: Test of Proportionality of Heterogeneous Baseline with Heterogeneous Attention
  This table shows the determinants of mortgage refinancing when we assume a constant mortgage termination probability of 10% for all households, i.e. $\mu = 10\%$. In comparison Table 10 in the paper shows the test of proportionality using the predicted moving probability of the household from Table B.1.

- Figure B.1: Effects of Age, Length of Education, Income, Financial Wealth, and Housing Wealth on Refinancing Probability
  This figure shows the marginal effect of age, education, income, financial wealth, and housing wealth on probability of refinancing across the distribution of incentives when we assume a constant mortgage termination probability of 10%for all households, i.e. $\mu = 10\%$. In comparison Figure 4 in the paper shows the marginal effect of age, education, income, financial wealth, and housing wealth on probability of refinancing across the distribution of incentives using the predicted moving probability of the household from Table B.1.

- Figure B.2: Inertia and Inattention
  This figure shows the fitted relationship between our measures of inertia (baseline probability of refinancing) and inattention, when we assume a constant mortgage termination probability of 10%for all households, i.e. $\mu = 10\%$. In comparison Figure 5 in the paper shows the estimated relationship using the predicted moving probability of the household from Table B.1.

Appendix A:

The following is a list of questions and answers resulting from our discussions with the Association of Danish Mortgage Banks regarding constraints on Danish households' ability to refinance mortgages.

The answers to several of these queries provide perspective on the controversy surrounding a recent article in The Economist newspaper, which has engendered some debate in Denmark.[2] This article suggests that the ability to refinance mortgages in Denmark is limited due to legal restrictions: "*Refinancing is an option for many, but not for the most precarious borrowers, due to legal restrictions on loans of more than 80% of a property's value.*" However, in Denmark, the article has been rebuffed by economists and market participants. For instance, the largest commercial bank Danske Bank wrote in April 2014: "*The Economist has renewed the focus on Danish households' debt in a recent article entitled 'Something rotten, Denmark's property market is built on rickety foundations'. We have looked into the arguments in the article and we conclude that it is based more on myths than realities with regard to the financial stability in Denmark."* [3]

The original correspondence with the Association of Danish Mortgage Banks is in Danish, and has been translated into English by the authors. The original correspondence will be included in a later version of this appendix.

	Question (by the authors)	**Answer (from the Association of Danish Mortgage Banks)**
A.1	*Can households always refinance their mortgages?*	Households can always refinance if they do not increase their principal.
A.2	*Can households add the refinancing costs to their principal?*	Households have the right to refinance their mortgage, adding costs and capital loss to the new principal, as long as they stay within the same house associated with the mortgage.
A.3	*Does refinancing trigger a credit evaluation?*	No credit evaluation is done in the event of refinancing.
A.4	*Can households refinance in a situation in which the LTV has risen above 80% of the property's value, on account of declining house prices?*	Yes, households are allowed to refinance in such a situation because the value of the property is not re-assessed when households refinance. As long as the household does not increase the principal (beyond adding costs and capital loss to the new principal as described in Question A.2), the LTV will not be re-assessed and households therefore have the option to refinance.

[2] "Danish Mortgages: Something rotten, Denmark's property market is built on rickety foundations'", The Economist. April 19, 2014.
[3] "Research Denmark: Myths and realities about large household debt", Danske Bank, April 24, 2014.

Appendix B:

Table B1: Determinants of Mortgage Termination

This table shows results from simple probit specifications which seek to uncover the determinants of mortgage termination caused by moving, or other circumstances which result in full prepayment of the mortgage. The dependent variable takes the value of 1 if a household terminates its mortgage in a given month, and 0 otherwise. Model 1 estimates a probit, with no non-linear transformations of the independent variables. Models 2 and 3 include non-linear transformations, f(x), of several of the rank control variables in addition to their levels x. In Model 2, f(x) = |x|; and in Model 3, f(x) = $(\sqrt{2}x)^2$. As before, we estimate these specifications using all households in Denmark with an unchanging number of members, with a fixed rate mortgage in 2010 and 2011. The independent variables are indicated in the rows. The first set of variables is a set of dummy variables indicating the demographic status indicated in the row headers. The next set constitutes rank variables, which are normalized to take values between 0 and 1, and range between -0.5 and 0.5 once demeaned. All variables are described in greater detail in the header to Table 3. ***, **, and * indicate coefficients that are significant at the one, five, and ten percent level, respectively, using standard errors clustered at the municipality and year level.

	Model 1 - 2009	*Model 1 - 2010*	*Model 2 - 2009*	*Model 2 - 2010*	*Model 3 - 2009*	*Model 3 - 2010*
Single male household	0.092***	0.084***	0.155***	0.140***	0.158***	0.144***
Single female household	0.002	-0.002	0.074***	0.064***	0.082***	0.070***
Married household	-0.231***	-0.245***	-0.213***	-0.226***	-0.201***	-0.214***
Children in family	-0.233***	-0.242***	-0.188***	-0.199***	-0.161***	-0.173***
Immigrant	0.133***	0.135***	0.145***	0.148***	0.148***	0.150***
Financially literate	-0.000	0.033***	-0.025***	0.007	-0.030***	-0.001
Family financially literate	0.025***	0.010**	0.002	-0.010*	0.004	-0.009
No education data	0.266***	0.258***	0.189***	0.200***	0.147***	0.162***
Getting married	0.126***	0.185***	0.095***	0.149***	0.093***	0.147***
Change to health	0.381***	0.427***	0.340***	0.379***	0.340***	0.380***
Having children	0.134***	0.173***	0.087***	0.124***	0.081***	0.119***
Region of Northern Jutland	-0.112***	-0.112***	-0.054***	-0.069***	-0.077***	-0.090***
Region of Middle Jutland	-0.081***	-0.106***	-0.042***	-0.071***	-0.043***	-0.072***
Region of Southern Denmark	-0.105***	-0.117***	-0.045***	-0.062***	-0.057***	-0.074***
Region of Zealand	-0.119***	-0.131***	-0.069***	-0.087***	-0.058***	-0.075***
Demeaned rank of:						
Age	-0.903***	-0.938***	-0.906***	-0.947***	-0.874***	-0.916***
Length of education	0.126***	0.170***	0.018**	0.051***	0.041***	0.078***
Income	-0.489***	-0.481***	-0.451***	-0.429***	-0.403***	-0.391***
Financial wealth	-0.046***	-0.068***	0.017***	-0.015***	0.050***	0.012**
Housing wealth	-0.149***	-0.101***	-2.370***	-2.700***	-1.934***	-1.968***
Non-linear transformation f(x),where x is the demeaned rank of:						
Age			0.505***	0.509***	0.701***	0.713***
Length of education			0.087***	0.144***	0.059***	0.119***
Income			-0.094***	-0.126***	-0.082***	-0.097***
Financial wealth			0.911***	0.842***	0.856***	0.787***
Housing wealth			2.853***	3.178***	2.347***	2.341***
Constant	-0.906***	-0.905***	-1.514***	-1.482***	-1.219***	-1.184***
Pseudo R^2	0.0581	0.0599	0.0835	0.0836	0.0826	0.0815
Log Likelihood	-404051	-400117.94	-393168.59	-390041.39	-393552.44	-390948.85
# of observations	1,243,247	1,242,540	1,243,247	1,242,540	1,243,247	1,242,540

Table B.2: Cross-sectional Variation in Incentives with Constant Moving Probability of 10%

The percentiles of the distribution reported in the column headings are calculated across all households in Denmark with an unchanging number of members, with a fixed rate mortgage, pooling data over 2010 and 2011, as well as separately by year. The blocks of statistics refer to the interest rate spread in percentage points (defined as the coupon rate on the old mortgage less the yield on a newly available mortgage of roughly the same maturity); the threshold level above which refinancing is sensible, taking into account the option value of waiting, reported in percentage points, and calculated using the second order approximation in the Agarwal et al. (2013) formula; and the total incentive in percentage points, measured as the interest rate spread less the computed threshold level. Within each block of statistics, percentiles are calculated for all households, and separately for the sub-populations of refinancing and non-refinancing households.

	Min	*5%*	*25%*	*Median*	*75%*	*95%*	*Max*
				Interest Rate Spread in Percentage Points			
All	-2.11	-1.06	-0.26	0.36	0.82	1.82	7.55
2010	-2.06	-0.68	-0.06	0.57	0.88	1.88	6.76
2011	-2.11	-1.07	-0.40	-0.06	0.74	1.76	7.55
				Threshold Level in Percentage Points			
All	1.02	1.22	1.36	1.53	1.77	2.40	5.12
2010	1.02	1.21	1.35	1.51	1.75	2.35	4.98
2011	1.02	1.23	1.37	1.54	1.79	2.45	5.12
				Incentives in Percentage Points			
All	-6.04	-2.62	-1.85	-1.31	-0.70	0.28	5.36
2010	-5.07	-2.46	-1.67	-1.04	-0.57	0.40	4.67
2011	-6.04	-2.71	-2.02	-1.51	-0.88	0.00	5.36

Table B.3: Refinancing: Heterogeneous Baseline with Constant Attention, and Heterogeneous Attention with Constant Baseline

In these specifications, the dependent variable continues to take the value of 1 for a refinancing in 2010 or 2011, and 0 otherwise, using the same sample as in Table 5. In columns 1, 3, and 5, we estimate a simple "Baseline" probit specification as in Table 4, but with the addition of "Incentives", measured using the Agarwal et al. (2013) formula. This approach calculates refinancing incentives as the difference between the annuitized option value of taking on the new mortgage, less the interest paid on the old mortgage. Columns 2, 4, and 6 estimate a specification in which these incentives are interacted with an "attention" function, holding fixed a baseline probability of refinancing. The level of attention is calculated by the function $A(\Delta's) = \exp(\Delta's)$, where Δ is the vector of estimated coefficients on the covariates in the vector *s*, reported in the rows, and described more fully in the header to Table 3. As before, Models 2 and 3 include non-linear transformations, f(x), of several of the rank control variables in addition to their levels; in Model 2, $f(x) = |x|$; and in Model 3, $f(x) = (\sqrt{2}x)^2$. Pseudo R^2 is calculated using the formula $R^2 = 1 - L_1/L_0$, where L_1 (L_0) is the log likelihood from the unconstrained (constrained constant only) model. ***, **, and * indicate coefficients that are significant at the one, five, and ten percent level, respectively, using standard errors clustered at the municipality and year level.

	Model 1		**Model 2**		**Model 3**	
	Baseline Probability	*Attention*	*Baseline Probability*	*Attention*	*Baseline Probability*	*Attention*
Single male household	-0.070***	0.036**	-0.014**	-0.022	-0.017***	-0.015
Single female household	-0.003	0.035**	0.042***	-0.018	0.039***	-0.012
Married household	0.035***	-0.023**	0.038***	-0.029***	0.038***	-0.032***
Children in family	-0.023***	0.030***	-0.001	0.003	-0.003	0.008
Immigrant	-0.060***	0.077***	-0.051***	0.067***	-0.051***	0.068***
Financially literate	0.022***	-0.071***	0.033***	-0.074***	0.034***	-0.074***
Family financially literate	0.019***	-0.006	0.020***	-0.005	0.020***	-0.006
No education data	-0.111***	0.070	-0.161***	0.173***	-0.140***	0.138***
Getting married	0.087***	-0.119***	0.079***	-0.112***	0.079***	-0.114***
Change to health	-0.013*	0.015	-0.018**	0.019	-0.018**	0.018
Having children	0.065***	-0.133***	0.050***	-0.112***	0.052***	-0.117***
Region of Northern Jutland	0.061***	-0.033**	0.061***	-0.035***	0.061***	-0.034**
Region of Middle Jutland	0.071***	-0.064***	0.068***	-0.065***	0.067***	-0.064***
Region of Southern Denmark	0.058***	-0.092***	0.055***	-0.094***	0.054***	-0.093***
Region of Zealand	0.009**	0.019	0.004	0.017	0.004	0.019
Demeaned rank of:						
Age	-0.188***	0.019	-0.117***	-0.034*	-0.121***	-0.024
Length of education	0.020***	0.061***	0.033***	0.057***	0.029***	0.064***
Income	-0.013*	0.123***	0.077***	0.068***	0.071***	0.084***
Financial wealth	-0.288***	0.487***	-0.295***	0.500***	-0.294***	0.501***
Housing wealth	0.169***	-0.193***	0.172***	-0.174***	0.177***	-0.172***
Non-linear transformation f(x), x is the demeaned rank of:						
Age			0.241***	-0.238***	0.206***	-0.177***
Length of education			-0.170***	0.313***	-0.137***	0.267***
Income			-0.140***	0.071***	-0.141***	0.049*
Financial wealth			-0.047***	-0.225***	-0.043***	-0.266***
Housing wealth			-0.073***	-0.038	-0.078***	-0.022
Baseline Refinancing (Intercept)	-1.961***	-1.891***	-1.938***	-1.891***	-1.953***	-1.891***
Incentives (Intercept in Attention Function)	-1.032***	-0.982***	-1.029***	-0.923***	-1.030***	-0.928***
Pseudo R^2	0.010	0.002	0.011	0.003	0.010	0.003
Log Likelihood	-424074.45	-427097.52	-423648.21	-426943.51	-423688.79	-426945.07
Observations	6,718,668	6,718,668	6,718,668	6,718,668	6,718,668	6,718,668

Table B.4: Heterogeneous Baseline with Heterogeneous Attention

In these specifications, the dependent variable continues to take the value of 1 for a refinancing in 2010 or 2011, and 0 otherwise, using the same sample as in Table 5. This table shows the results of estimating three models (Models 1, 2, and 3). In each model, we allow for heterogeneous baseline probabilities of refinancing, conditional on household attributes (the first column under each model), *as well as* heterogeneous attention to incentives (the second column under each model). That is, pairs of columns now show results from the estimation of a single model. As before, "Incentives" are measured using the Agarwal et al. (2013) formula, which calculates refinancing incentives as the difference between the annuitized option value of taking on the new mortgage, less the interest paid on the old mortgage. The level of attention is calculated by the function $A(\Delta's) = \exp(\Delta's)$, where Δ is the vector of estimated coefficients on the covariates in the vector *s*, reported in the rows, and described more fully in the header to Table 3. As before, Models 2 and 3 include non-linear transformations, f(x), of several of the rank control variables in addition to their levels x; in Model 2, $f(x) = |x|$; and in Model 3, $f(x) = (\sqrt{2}x)^2$. Pseudo R^2 is calculated using the formula $R^2 = 1 - L_1/L_0$, where L_1 (L_0) is the log likelihood from the unconstrained (constrained constant only) model. ***, **, and * indicate coefficients that are significant at the one, five, and ten percent level, respectively, using standard errors clustered at the municipality and year level.

	Model 1		**Model 2**		**Model 3**	
	Baseline Probability	*Attention*	*Baseline Probability*	*Attention*	*Baseline Probability*	*Attention*
Single male household	-0.072***	-0.042**	-0.017**	-0.029	-0.019**	-0.026
Single female household	0.023***	0.087***	0.065***	0.085***	0.062***	0.088***
Married household	0.050***	0.052***	0.049***	0.041***	0.049***	0.038***
Children in family	-0.016***	0.007	0.002	-0.004	-0.000	-0.003
Immigrant	-0.062***	-0.004	-0.054***	-0.007	-0.053***	-0.007
Financially literate	0.013	-0.042*	0.026***	-0.028	0.029***	-0.023
Family financially literate	0.030***	0.038***	0.031***	0.042***	0.032***	0.042***
No education data	-0.100***	0.008	-0.134***	0.059	-0.117***	0.046
Getting married	0.088***	0.019	0.079***	0.013	0.079***	0.012
Change to health	-0.016*	-0.017	-0.020**	-0.015	-0.019**	-0.013
Having children	0.053***	-0.036**	0.040***	-0.030*	0.043***	-0.029*
Region of Northern Jutland	0.084***	0.088***	0.086***	0.089***	0.086***	0.090***
Region of Middle Jutland	0.096***	0.089***	0.090***	0.077***	0.089***	0.075***
Region of Southern Denmark	0.061***	0.005	0.054***	-0.009	0.054***	-0.009
Region of Zealand	0.027***	0.067***	0.017***	0.047***	0.017***	0.047***
Demeaned rank of:						
Age	-0.295***	-0.418***	-0.220***	-0.392***	-0.221***	-0.380***
Length of education	0.067***	0.193***	0.075***	0.174***	0.073***	0.177***
Income	0.060***	0.262***	0.162***	0.332***	0.158***	0.343***
Financial wealth	-0.256***	0.109***	-0.271***	0.083***	-0.273***	0.076***
Housing wealth	0.199***	0.118***	0.212***	0.162***	0.220***	0.173***
non-linear transformation f(x), x is the demeaned rank of:						
Age			0.224***	-0.015	0.191***	-0.010
Length of education			-0.126***	0.152***	-0.098***	0.142***
Income			-0.191***	-0.227***	-0.200***	-0.260***
Financial wealth			-0.140***	-0.375***	-0.146***	-0.415***
Housing wealth			-0.130***	-0.240***	-0.135***	-0.236***
Baseline Refinancing (Intercept)	-1.995***		-1.923***		-1.949***	
Incentives (Intercept in Attention Function)		-1.141***		-0.950***		-0.997***
Pseudo R^2		0.012		0.013		0.013
Log Likelihood		-423173.5		-422651.27		-422658.93
# of observations		6,718,668		6,718,668		6,718,668

Table B.5: Test of Proportionality of Heterogeneous Baseline with Heterogeneous Attention

In these specifications, the dependent variable continues to take the value of 1 for a refinancing in 2010 or 2011, and 0 otherwise, using the same sample as in Table 6. This table shows the results of estimating two models (Models 1 and 3). Unlike the unconstrained estimation in Table B.4, here we estimate a constrained model in which all coefficients in the attention function are constrained to be proportional to the coefficients on the same variables in the baseline. The estimated coefficient of proportionality is reported in a row labeled as such towards the bottom of the table. The columns labeled "deviation" show the simple difference between the coefficients in the constrained model (reported in the first and third columns under each model) and the unconstrained model estimates from Table B.4. As before, "Incentives" are measured using the Agarwal et al. (2013) formula, which calculates refinancing incentives as the difference between the annuitized option value of taking on the new mortgage, less the interest paid on the old mortgage. The level of attention is calculated by the function $A(\Delta's) = \exp(\Delta's)$, where Δ is the vector of estimated coefficients on the covariates in the vector *s*, reported in the rows, and described more fully in the header to Table 3. As before, Model 3 includes non-linear transformations, f(x), of several of the rank control variables in addition to their levels x with $f(x) = (\sqrt{2}x)^2$. ***, **, and * indicate coefficients that are significant at the one, five, and ten percent level, respectively, using standard errors clustered at the municipality and year level.

	Model 1				**Model 3**			
	Baseline Probability	*Deviation*	*Attention*	*Deviation*	*Baseline Probability*	*Deviation*	*Attention*	*Deviation*
Single male household	-0.077***	-0.005	-0.056***	-0.014	-0.016**	0.004	-0.011**	0.015
Single female household	0.010	-0.013	0.007	-0.080	0.057***	-0.006	0.041***	-0.046
Married household	0.047***	-0.003	0.034***	-0.018	0.049***	-0.001	0.035***	-0.003
Children in family	-0.022***	-0.006	-0.016***	-0.023	-0.000	0.000	-0.000	0.003
Immigrant	-0.068***	-0.006	-0.049***	-0.045	-0.058***	-0.004	-0.042***	-0.036
Financially literate	0.023**	0.010	0.017**	0.058	0.039***	0.010	0.029***	0.052
Family financially literate	0.026***	-0.004	0.019***	-0.019	0.028***	-0.004	0.020***	-0.021
No education data	-0.115***	-0.016	-0.084***	-0.092	-0.143***	-0.027	-0.104***	-0.151
Getting married	0.095***	0.006	0.069***	0.049	0.085***	0.006	0.062***	0.050
Change to health	-0.016*	0.000	-0.012*	0.005	-0.021**	-0.002	-0.015**	-0.002
Having children	0.067***	0.013	0.048***	0.085	0.052***	0.009	0.038***	0.067
Region of Northern Jutland	0.075***	-0.009	0.055***	-0.033	0.075***	-0.011	0.055***	-0.035
Region of Middle Jutland	0.088***	-0.007	0.064***	-0.025	0.083***	-0.006	0.061***	-0.015
Region of Southern Denmark	0.064***	0.004	0.047***	0.042	0.059***	0.005	0.043***	0.052
Region of Zealand	0.016***	-0.011	0.011***	-0.056	0.008	-0.009	0.006	-0.042
Demeaned rank of:								
Age	-0.250***	0.044	-0.182***	0.236	-0.168***	0.053	-0.122***	0.258
Length of education	0.038***	-0.030	0.027***	-0.166	0.049***	-0.024	0.035***	-0.142
Income	0.018**	-0.042	0.013**	-0.249	0.117***	-0.041	0.085***	-0.258
Financial wealth	-0.317***	-0.062	-0.231***	-0.340	-0.330***	-0.057	-0.240***	-0.316
Housing wealth	0.204***	0.004	0.148***	0.030	0.218***	-0.001	0.159***	-0.014
non-linear transformation f(x), x is the demeaned rank of:								
Age					0.235***	0.043	0.171***	0.181
Length of education					-0.143***	-0.045	-0.104***	-0.246
Income					-0.186***	0.014	-0.135***	0.125
Financial wealth					-0.091***	0.055	-0.066***	0.349
Housing wealth					-0.109***	0.026	-0.080***	0.157
Intercept	-1.984***		-1.439***		-1.960***		-1.432***	
Coefficient of Proportionality	0.728***				0.727***			
Chi^2	1242.98				1440.53			
Likelihood ratio test p-value	0.000				0.000			

Figure B.1: Effects of Age, Length of Education, Income, Financial Wealth, and Housing Wealth on Refinancing Probability

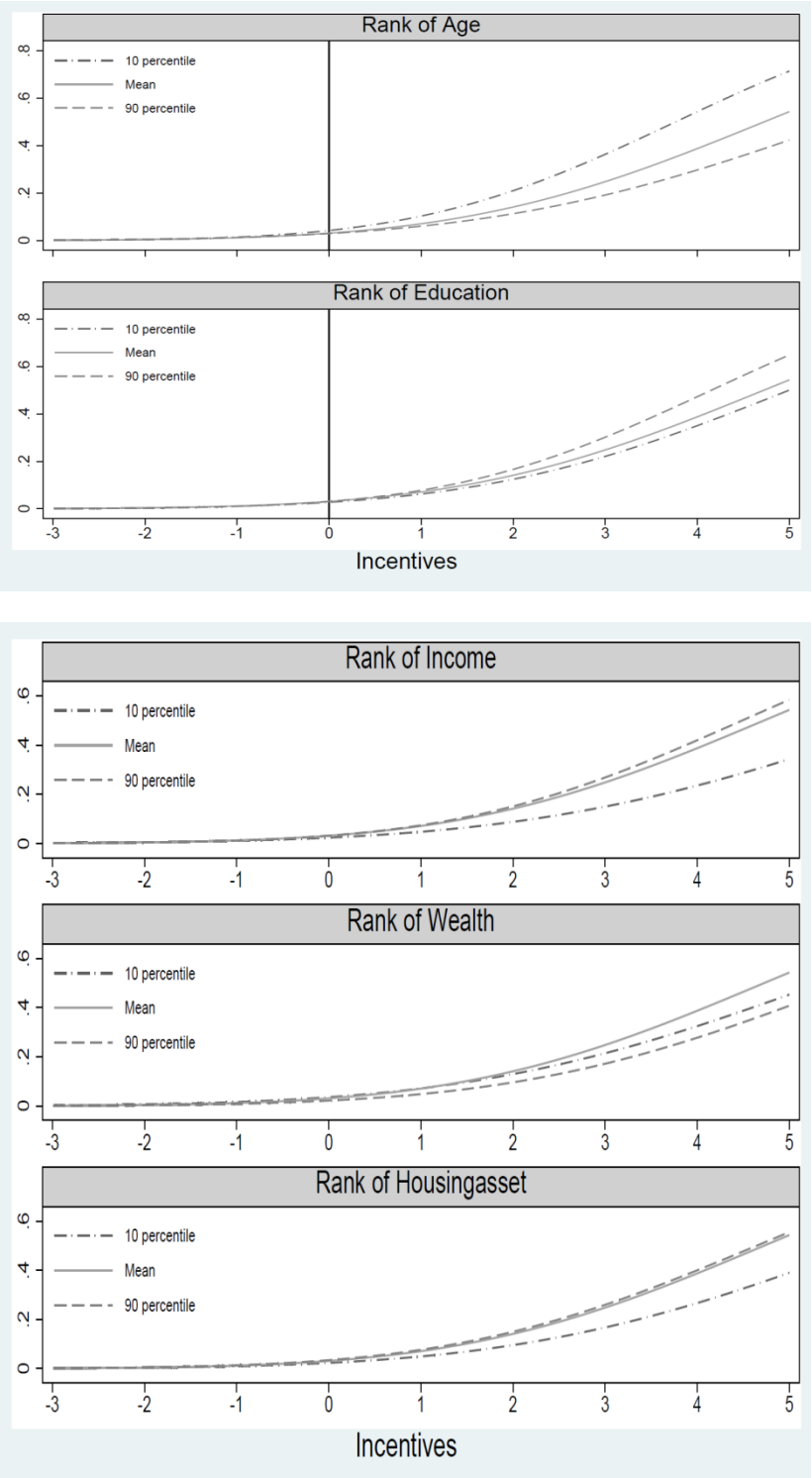


Figure B.2: Inertia and Inattention

