Measuring expectations from household surveys:

New results on subjective probabilities of future house prices

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Introduction

- **A talk on the measurement of subjective expectations of households**

- **Two purposes**

  1. **Selective review of recent work on eliciting and using household subjective expectations**

  2. **Present new evidence on probabilistic expectations on house price change from the Spanish Survey of Household Finances (EFF)**

Introduction

- **Measurement of individual expectations is an active topic in economics**
- **Expectations play a fundamental role in explaining behavior**
- **but standard practice in 20th century economics was to infer preferences and expectations from data on choices alone (strong assumptions)**
- **Seminal work by Manski (2004) advocates for collecting self reported expectation data and using them for economic analysis together with choice data**
- **Improve economists' credibility and ability to explain behavior**

Introduction

Some important distinctions when considering subjective expectations

1. Expectations about
   - *Outcomes concerning the individual (e.g. your own death or the increase in the price of your house)*
   - *Aggregate outcomes (e.g. inflation, nationwide house price change)*

2. Point expectations vs. probabilistic expectations
(e.g. expected nº of children vs. probability of having 0, 1, 2, … children)

3. Qualitative vs. quantitative questions

Introduction

Binary outcomes

- **Qualitative questions:**

  "Thinking about the next 12 months how likely do you think it is that you will lose your job?

  Possible answers: Very likely, fairly likely, not too likely, not at all likely"

- **Probabilistic (quantitative) question on the same topic:**

  "Using a scale from 0 to 100 what is the percent chance that you lose your job in the next 12 months?"

  - *In the binary situation distributional and point expectation questions coincide*

Introduction

- **Limitations of qualitative questions**
  - different respondents may interpret them differently
  - they convey limited information
- **Advantages of probabilistic questions**
  - comparable across persons and over time
  - algebra may be used to examine consistency
- **But potential added difficulty for the respondent**

Introduction

Continuous outcomes: probabilistic expectations

Italian households (SHIW, 1989):

"We are interested in knowing your opinion about labor earnings or pensions twelve months from now. Suppose now that you have 100 points to be distributed between these intervals (a table is shown to the person interviewed). Are there intervals which you definitely exclude? Assign zero points to these intervals. How many points do you assign to each of the remaining intervals?"

Rural Indian villagers (Attanasio and Augsburg, 2011)

"How likely do you think it is that your income in the coming year will be higher than ___ (A/B/C) Rupees?", where A, B, and C are different income thresholds.

- **The information is elicited in the form of a *probability density* in the first case and of a *cumulative distribution* in the second**

Introduction

Continuous outcomes: point expectations

- **Bank of England/NOP survey uses the following question:**

  "How much would you expect prices in the shops generally to change over the next 12 months?"

- **Advantage of probabilistic expectations compared to point expectations:**
  - measure uncertainty, asymmetry, tail weight, etc.
  - individual distributions are needed to analyse behaviour under uncertainty
  - note that disagreement in point expectations across individuals is different from individual uncertainty

Introduction

- **Most of the evidence concludes that respondents are**
  - willing to answer probabilistic questions
  - responses generally sensible and internally consistent

… provided the questions concern well defined events that relate to respondents' lives

(Manski, 2004, van der Klaauw et al., 2008)

- **Some controversy remains over the state-of-the-art in elicitation of probability beliefs**
  - inherent difficulty to induce subjects to provide thoughtful answers (Tversky and Kahneman, 1974)
  - difficulty to allow for (partial) ambiguity or ignorance about the probabilities themselves in non-binary situations.

Introduction

House price expectations of Spanish households

- **Study evidence from a new question in the EFF where households are asked to assign probabilities to different scenarios of house price changes**
- **Use these answers to fit subjective probability distributions about future HP for each household from which I calculate individual quantiles**
- **I use the quantiles to study household-level and location-level determinants of heterogeneity in distributions**
- **There is heterogeneity in the position of the distributions but there is also heterogeneity in the amount of uncertainty**
- **Economic and demographic individual factors play a significant role, specially gender.**

Outline

1. **Elicitation methods**

2. **Validation diagnostics**

3. **Using subjective probability distributions**
   - -Mortality
   - -Stock market returns
   - -Inflation
   - -Expectation formation

4. **Subjective probabilities of future house prices in the EFF**

5. **Some results**

1. Elicitation methods

- **Asking for uncertainty requires a process of elicitation (it is not like asking for your age)**

- **Elicitation methods matter to what gets elicited**

Wording

- **Substantial amount of work devoted to minimize bias by refining the way information is elicited**

- **Minimal differences in wording may produce different interpretations of the question**

  e.g. question on inflation expectations New York Fed "prices in gral" vs. inflation (Bruine de Bruin et al. 2011, 2012). The former leads to higher reported expectations than the latter.

1. Elicitation methods

Conveying the concept of probability

- **Alternative formulations: “Percent chance”, “how likely”, beans/balls to distribute, (Delavande et al. 2011)**
  - if beans/balls, their number (e.g. 10, 100) is an issue (trade-off between precision and complexity)
- **Visual aids (e.g. ruler with scale from 0 to 100)**
- **Training subjects by providing examples about probability statements and/or using preliminary familiar questions (e.g. probability of rain tomorrow)**
  - In case of ignorance due to lack of knowledge on the subject matter as opposed to limited skills in expressing beliefs in probabilistic form (e.g. stock market return expectations) the question should be changed

1. Elicitation methods

Choosing the intervals

- **Range of variation**
  - Respondent to report min and max possible outcome: standard when outcome is individual specific (e.g. own income) to avoid reference values provided influence the answers (anchoring)
  - Predetermined ranges: predominant when eliciting expectations about aggregate outcomes (e.g. inflation)

- **Number of intervals**
  - A finer grid allows for more precise statistics but is cognitively more demanding for respondent

1. Elicitation methods

cdf vs. pdf

- **Density: assessing probabilities that the outcome lies in each interval**
- **Cumulative distribution: probabilities that the outcome is above (or below) a sequence of thresholds**
- **Experimental evidence: easier to deal with pdfs (visualization of location and symmetry); traditionally, larger probabilities in cdfs was thought helpful (Morgan and Henrion, 1990)**
- **Asking for quantiles (inverse cdf): there is evidence that probabilities assessed this way match less well empirical frequencies (Dominitz and Manski, 1997)**

2. Validation diagnostics

Response rates

- **Non-response varies depending on matter being elicited:**
  US HRS expected survival probability 4% but expected gain in stock market 24% (11% among stockholders, 29% rest)
- **Provide an indication of the extent of ignorance (mixed with unwillingness to respond)**

Bunching in the middle

- **Tendency to choose towards the middle of a scale when respondent not able to provide an answer or does not understand the question**
- **But such answer could also reflect genuine belief in that outcome**
- **Sometimes follow up question in case of such answer e.g.**
  "Do you think that it is about equally likely that these mutual fund shares will increase in worth as it is that they will decrease in worth by this time next year or are you just unsure about the chance?" (HRS)

2. Validation diagnostics

Coherence

- **Sometimes compliance with probability laws is achieved with help of automatic prompting in case of violation**

- **Fraction of people who put probability mass in more than one bin, in non-contiguous bins…**

- **Compliance with prior beliefs about correlation with other survey variables**

  e.g. positive correlation between expected rain and expected income is found, but only for rural Indian households whose main income comes from agriculture (Attanasio and Augsburg, 2012)

3. Using subjective probability distributions

Motivation

- **Help explain household decisions**
- **Constructing economic statistics about individual beliefs and their heterogeneity**
- **To date a lot of effort has gone into establishing properties and validity**
- **Predictive power: desirable for credibility but not a necessary condition**
- **If individuals use all public information and in addition have private information we would expect:**

$$\hat{E}(y-y^e)^2 < \hat{E}(y-\hat{y})^2$$

where y^e is a subjective expectation and $\hat{y}$ is a statistical predictor based on public information available at the time y^e was elicited

3. Using subjective probability distributions

Examples

- **Subjective mortality**
  - Introduced early on in the 1992 HRS

    "What is the percent chance that you will live to be 75 or more?"

    (age-elegible respondents were about 51-61)
  - Average survival probability similar to 1990 life table survival rate
  - Good predictor of mortality
  - We learn a lot about private information and inequality in expected mortality
  - Subjective survival probabilities explain delay claiming Social Security benefits (Hurd et al. 2004)
  - and predict of out-of-sample wealth better than life tables in a structural life-cycle model of consumption (Gan et al. 2004)

3. Using subjective probability distributions

- **Subjective expectations about stock market returns**
  - Useful in helping resolve the stock holding puzzle
  - Low rates of stockholding may be traced to expectations as opposed to high risk aversion
  - Elicited data show large heterogeneity, which helps explain participation in the stock market; Dominitz and Manski (2007), Hurd et al. (2011) …
    - *People with more optimistic beliefs about returns are more likely to hold stocks*
    - *Men are consistently more optimistic than women*
  - Heterogeneity in stock market expectations raises an important question about how beliefs are formed, given that information about stock market is public

3. Using subjective probability distributions

- **Inflation expectations**
  - Important role in the monetary transmission mechanism
  - A number of household surveys have been asking for a while about a point forecast of expected inflation (e.g. Michigan Panel, Bank of England) but without eliciting related uncertainty
  - 2007 New York Fed started a survey (every 6 weeks) eliciting full subjective distribution in the next 12 months

What do you think is the percent chance that, during the next 12 months, the following things will happen?
Prices in general will:

go up by 12% or more _____ percent chance
go up by 8% to 12% _____ percent chance
go up by 4% to 8% _____ percent chance
go up by 2% to 4% _____ percent chance
go up by 0% to 2% _____ percent chance
go down by 0% to 2% _____ percent chance
go down by 2% to 4% _____ percent chance
go down by 4% or more _____ percent chance
(100 % Total)

  - Higher expectations among those who thought more about how to cover expenses and those with low financial literacy

3. Using subjective probability distributions

- But do individuals act on their inflation beliefs? Specially relevant in a low inflation environment
- In an experiment within the NYFed survey, respondents were asked to chose among investment options whose payoffs depended on future inflation
- There was a clear association between reported beliefs and investment behavior on average (Armantier et al., 2011)
- Individuals whose behavior was difficult to rationalize tended to be less educated and had lower scores on financial literacy

3. Using subjective probability distributions

- **Expectation formation**
  - Testing for rational expectations: by testing that differences in expectations in successive periods cannot be forecast (Benitez-Silva et al. 2008, Pesaran and Weale 2006, Case et al. 2012)

    Accepted for retirement and mortality in the HRS
  - Analysing revisions to expectations in association with interim events may provide information about how people form expectations (Manski 2004, Armantier et al. 2012)
  - Differences in inflation experiences generate differences in beliefs about future inflation; heterogeneity between young and old (Malmendier and Nagel, 2013)

4. Subjective probabilities of future house prices in the EFF

- **The EFF contains detailed information on household assets, debts, income, and consumption (and demographics)**
- **Has been conducted on 4 occasions (2002, 2005, 2008, 2011) to around 6,000 households**
- **Two distinctive characteristics**
  - Oversampling of wealthy households
  - Panel component with refreshment to maintain representativity

4. Subjective probabilities of future HPs

- **New question to elicit household price expectations in the EFF2011**

- **Importance of real estate in household wealth**
  - 80% of the value of household assets
  - all along the wealth distribution: 88% bottom quartile 68% top decile
  - 83% of owner occupiers, 36% of Spanish households hold other real estate property

- **Aggregate expectations about rates of return on housing have been found to be an important determinant of house purchase (Bover, 2011)**

- **Uncertainty about these returns has also been found to play a role**

- **Learning about house price expectations at the individual level may be useful in understanding portfolio composition and consumption**

4. Subjective probabilities of future HPs

- **Other surveys eliciting probabilistic expectations about HP**
  - HRS, the NYFed survey and the American Life Panel
  - Introduced very recently (2010, 2011)

4. Subjective probabilities of future HPs

- **Subjects answering the 2011 EFF questionnaire were asked the following:**

  "We are interested in knowing how you think the price of your home will evolve in the next 12 months:

  Distribute 10 points among the following 5 possibilities, assigning more points to the scenarios you think are more likely (assign 0 if a scenario looks impossible)

  Large drop (more than 6%)

  Moderate drop (around 3%)

  Approximately stable

  Moderate increase (around 3%)

  Large increase (more than 6%)

  DK

  NA"

4. Subjective probabilities of future HPs

Comments about the formulation of the EFF question

- **Small test pilot conducted beforehand**
- **Refers to price of household main residence**
  - Households have better information about their own house
  - Sentiment about HP nationwide could be inferred by aggregating individual expectations
- **Numerical answers are linked with verbal expressions (Juster, 1966)**
- **The respondent is offered 10 points to distribute as opposed to 100 because it is cognitively less demanding**
- **For the same reason we chose to elicit a density formulation rather than a cumulative distribution formulation**
- **Automatic prompt appears on the screen in case answers do not add up to 10**

4. Subjective probabilities of future HPs

PRELIMINARY

- **Fieldwork finished before summer 2012**
- **In the process of cleaning the data**
- **No imputations yet, so we cannot use certain variables (e.g. income)**
- **No population weights yet**
- **Highly preliminary results**

4. Subjective probabilities of future HPs

Item non-response

- **Only 4.3% of EFF2011 participants did not answer the question**
  10.5% if non-owner, 3.4% if owner
- **Men are more prone to answering this question than women 2.8% vs. 6.4% non-response**
- **Non-response rates decrease with education (7.1%, 2.5%, 1.5%)**
- **Non-response of over 64 stands out (6.3%)**
- **Significantly negative correlation with the fraction of monetary questions answered**

4. Subjective probabilities of future HPs

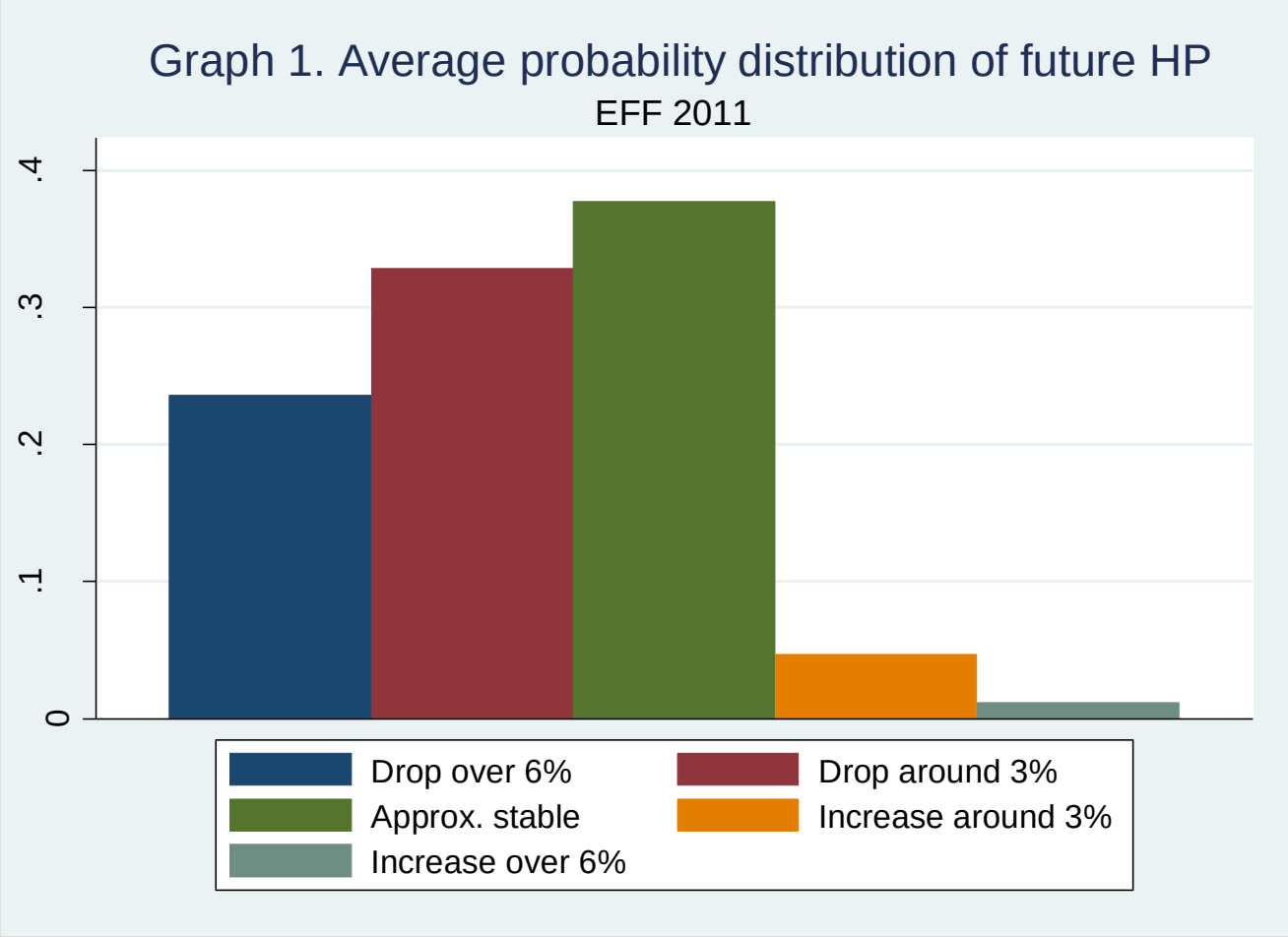
Coherency analysis

- **Number of intervals used**
  - 60% of respondents express uncertainty and put probability mass in more than one interval; 25% use more than two; 2.5% use all five
  - Bruine de Bruin et al. (2011) report 70% using more than two bins in answering about their own wage expectation in the NYFed survey

- **Very small fraction assigning non-zero probabilities to non-adjacent bins**
  - 1.68%

- **Bunching in the middle of the scale (all 10 points to middle interval) 19.6%**
  - In principle, this group may mix ignorants and strong believers
  - Lack of specific characteristics in this group suggests that it is not dominated by ignorants

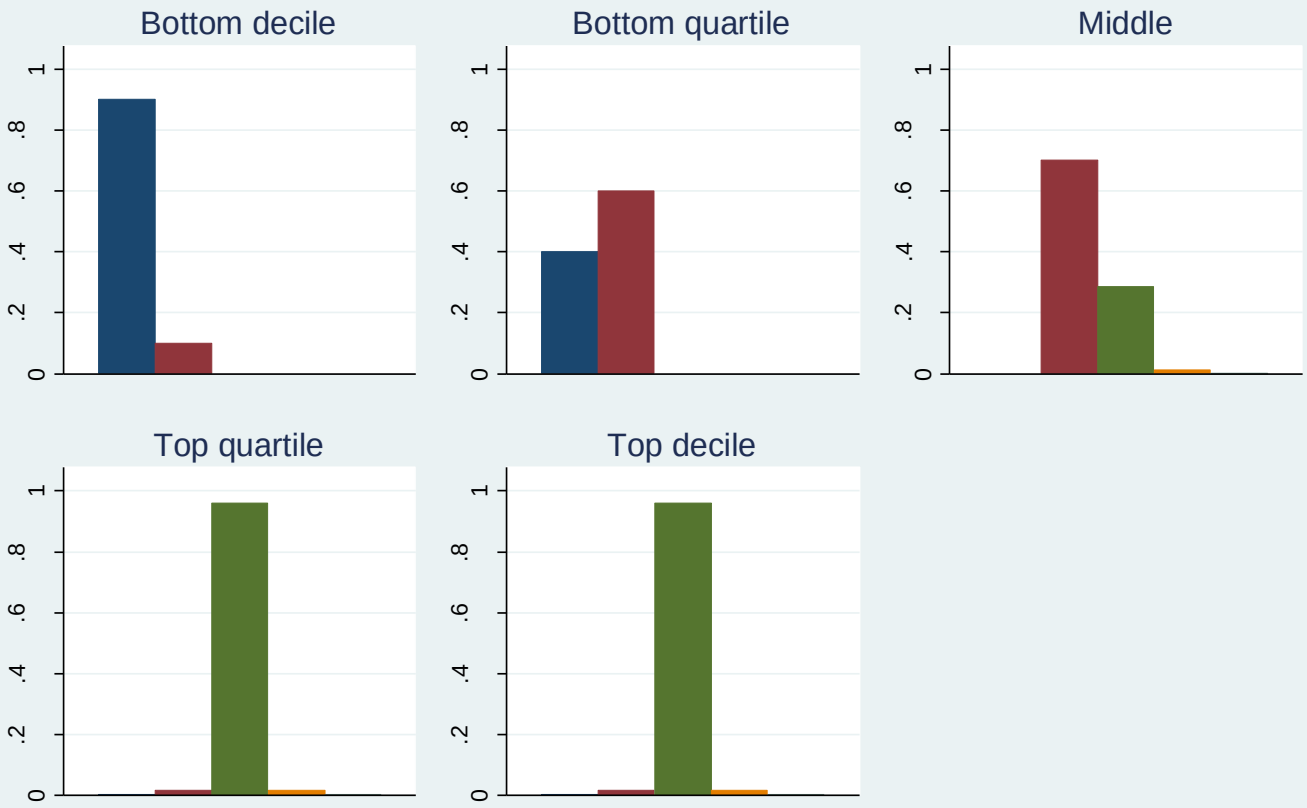
4. Subjective probabilities of future HPs



4. Subjective probabilities of future HPs

Graph 2. Ordering individual distributions by their median

Probability distributions for specific quantiles of the median



5. Fitting a probability distribution for each respondent

Table 5. Quantiles of subjective probability distributions of house prices (within postal codes estimates)

VARIABLES	q10	q25	q50	q75	q90
Log(price/m2)	0.265	0.314**	0.268**	0.192*	0.154
Age 45 to 64	-0.241	-0.299	-0.291	-0.345**	-0.451***
Age over 64	0.278	0.030	-0.090	-0.258	-0.451**
Blue collar	0.308	0.271	0.263*	0.191	0.224*
Self-employed	-0.378	-0.403*	-0.350**	-0.358**	-0.317**
Secondary education	-0.569**	-0.619**	-0.482**	-0.362**	-0.300
University education	-0.588*	-0.512*	-0.359	-0.251	-0.131
Woman*Below secondary educ.	0.059	0.100	0.167	0.152	0.098
Woman*Secondary educ.	0.831**	0.865***	0.788***	0.601***	0.518**
Woman*University educ.	0.375	0.413	0.310	0.228	0.164
Own other housing	-0.110	-0.137	-0.206	-0.230**	-0.233**
Bought main residence recently	0.470	0.454*	0.339	0.340*	0.332*
Constant	-8.775***	-6.583***	-4.404***	-2.282	-0.879
Observations	4515	4515	4515	4515	4515
Adjusted R-squared	0.160	0.147	0.165	0.198	0.213

5. Fitting a probability distribution for each respondent

Table 6. Uncertainty in subjective probability distributions of house prices (within postal codes estimates)

	(1)	(2)
VARIABLES	q75-q25	q90-q10
Log(price/m2)	-0.122	-0.111
Age 45 to 64	-0.046	-0.209
Age over 64	-0.289**	-0.729***
Blue collar	-0.080	-0.084
Self-employed	0.045	0.061
Secondary education	0.258*	0.269
University education	0.261*	0.457*
Woman*Below secondary educ.	0.052	0.040
Woman*Secondary educ.	-0.264	-0.313
Woman*University educ.	-0.185	-0.211
Own other housing	-0.093	-0.124
Bought main residence recently	-0.114	-0.137
Constant	4.302***	7.897***
Observations	4515	4515
Adjusted R-squared	0.211	0.229

5. Fitting a probability distribution for each respondent

- **P/m2**
  - positive shift in the distribution: more expensive housing is associated with smaller declines in HP
- **Age**
  - 45-64 also shift in the distribution: predict higher declines than the younger (reference group)
  - over 64: higher declines than the young but with lower uncertainty
  - young are more optimistic
- **Occupation (relative to white collar)**
  - Blue collar workers: positive shift all over the distribution
  - Self-employed: negative shift all over the distribution; less optimistic
- **Education**
  - low educated are more optimistic and more certain about their more optimistic beliefs
  - not much difference between secondary and university educated
  - size of the effect is around half a point

5. Fitting a probability distribution for each respondent

- **Result on gender stands out**
  - large positive shift all across the distribution
  - difficult to explain in terms of differences in information as one may do with education, occupation, age
  - An Abadie-Imbens matching estimator of the gender average treatment effect, which uses the controls in a non-parametric way, produces similar results (both in magnitude and significance)
  - need more research to see if due to self-selection (in unobservables) of the women who answer the survey despite the controls used so far
- **Own other housing**
  - an indicator of wealth
  - similarly to the elder, predict significantly lower values for the quantiles above the median
- **Bought recently (last 6 years)**
  - more optimistic; shift all over the distribution
  - same results if “House built in the last 6 years” so does not seem to reflect reverse causality

6. Discussion of results and extensions

Importance of location of the house

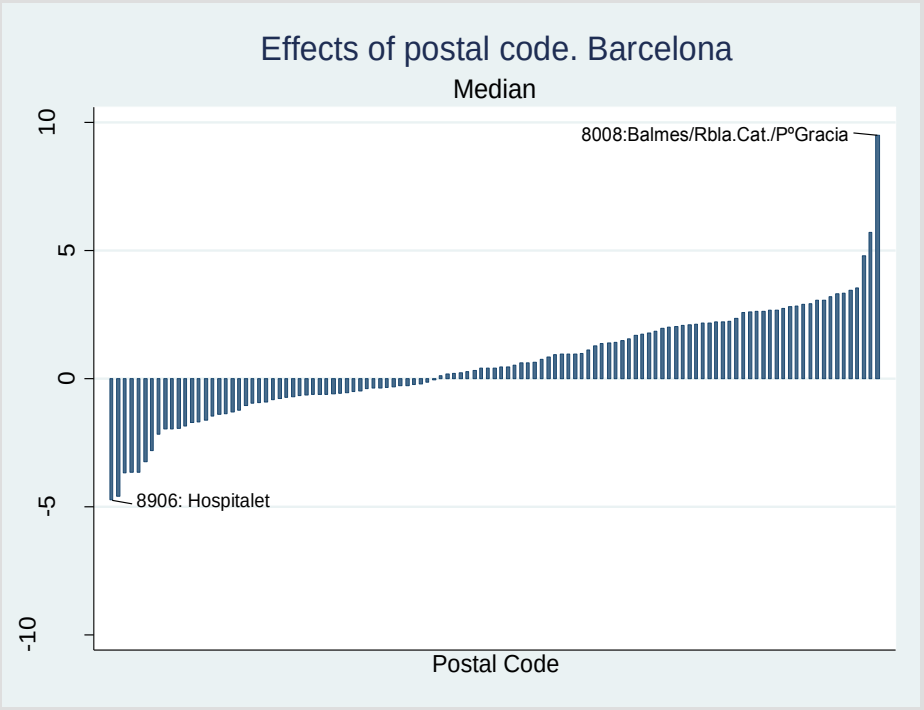
On q50

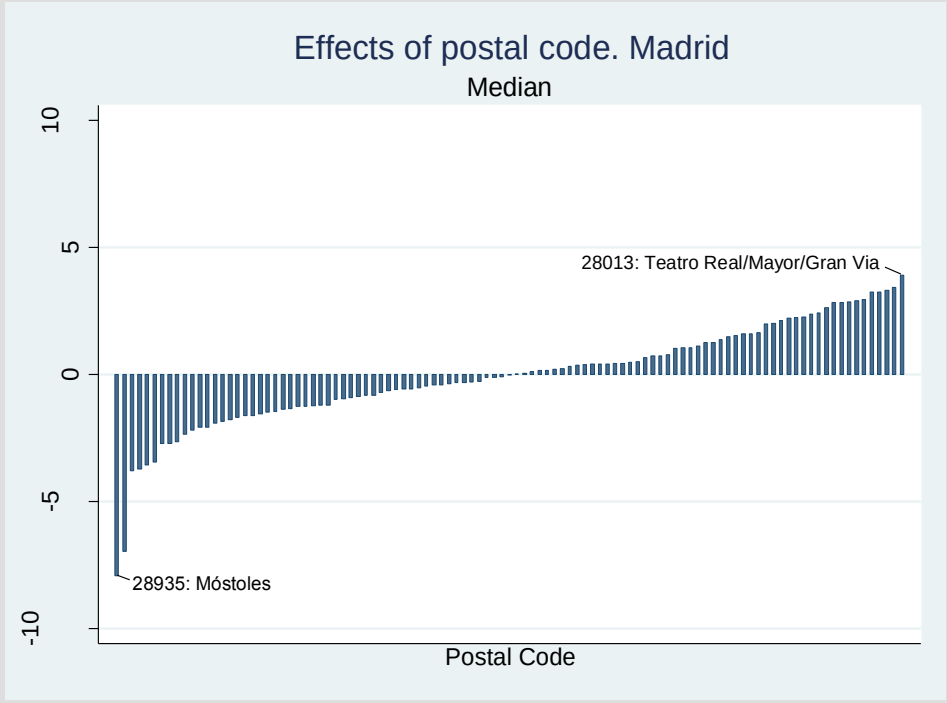
- **% of explained variation due to postal code dummies 93.3%**
- **% of postal code variation explained**
  - by municipality dummies 81.2%
  - by province dummies 43.5%

On q75-q25

- **% of explained variation due to postal code dummies 99%**
- **% of postal code variation explained**
  - by municipality dummies 87%
  - by province dummies 26%

6. Discussion of results and extensions





Conclusions

- **Measurement of individual expectations through survey collection is still in its infancy but it is a fascinating topic**
- **By learning how to collect better measures of expectations we learn about the nature of expectations themselves**
- **A lot of progress has been made since the work by Manski (2004) but much remains to be done**
- **The production of individual expectations data offers countless opportunities for research and policy analysis (study effect on decisions, understand how subjects form expectations, introduce longer term expectations etc.)**
- **The evidence on the HP question in the EFF is very encouraging since an important fraction of people seems to understand it and provide meaningful answers**

THANK YOU

4. Subjective probabilities of future HPs

- **Subjects answering the 2011 EFF questionnaire were asked the following:**

  "Estamos interesados en conocer cómo cree usted que evolucionará el valor de su vivienda en los próximos doce meses:

  Reparta 10 puntos entre las cinco posibilidades siguientes, asignando más puntos a los escenarios que crea más probables (asigne cero puntos si alguno le parece imposible):

  Caída grande (más de 6%)

  Caída moderada (en torno a 3%)

  Aproximadamente estable

  Subida moderada (en torno a 3%)

  Subida grande (más de 6%)

  No sabe

  No contesta"

Non-response and focal answers, by demographic characteristics

	Nº of respondents	Non-response rate (%)	All points to middle interval (%)
Total sample	6,215	4.28	19.6
Men	3,731	2.84	18.70
Women	2,484	6.44	21.00
Up to primary education	2,820	7.13	20.96
Secondary education	1,486	2.49	19.32
University degree	1,883	1.49	17.95
Age $<$ 35	286	3.15	17.69
35 $\leq$ Age 45	774	2.97	19.04
45 $\leq$ Age $<$ 55	1,200	2.92	18.11
55 $\leq$ Age $<$ 65	1,296	2.47	18.43
Age $\geq$ 65	2,659	6.28	21.27
Owner of main residence	5,431	3.35	19.05
Non owner of main residence	741	10.53	23.38

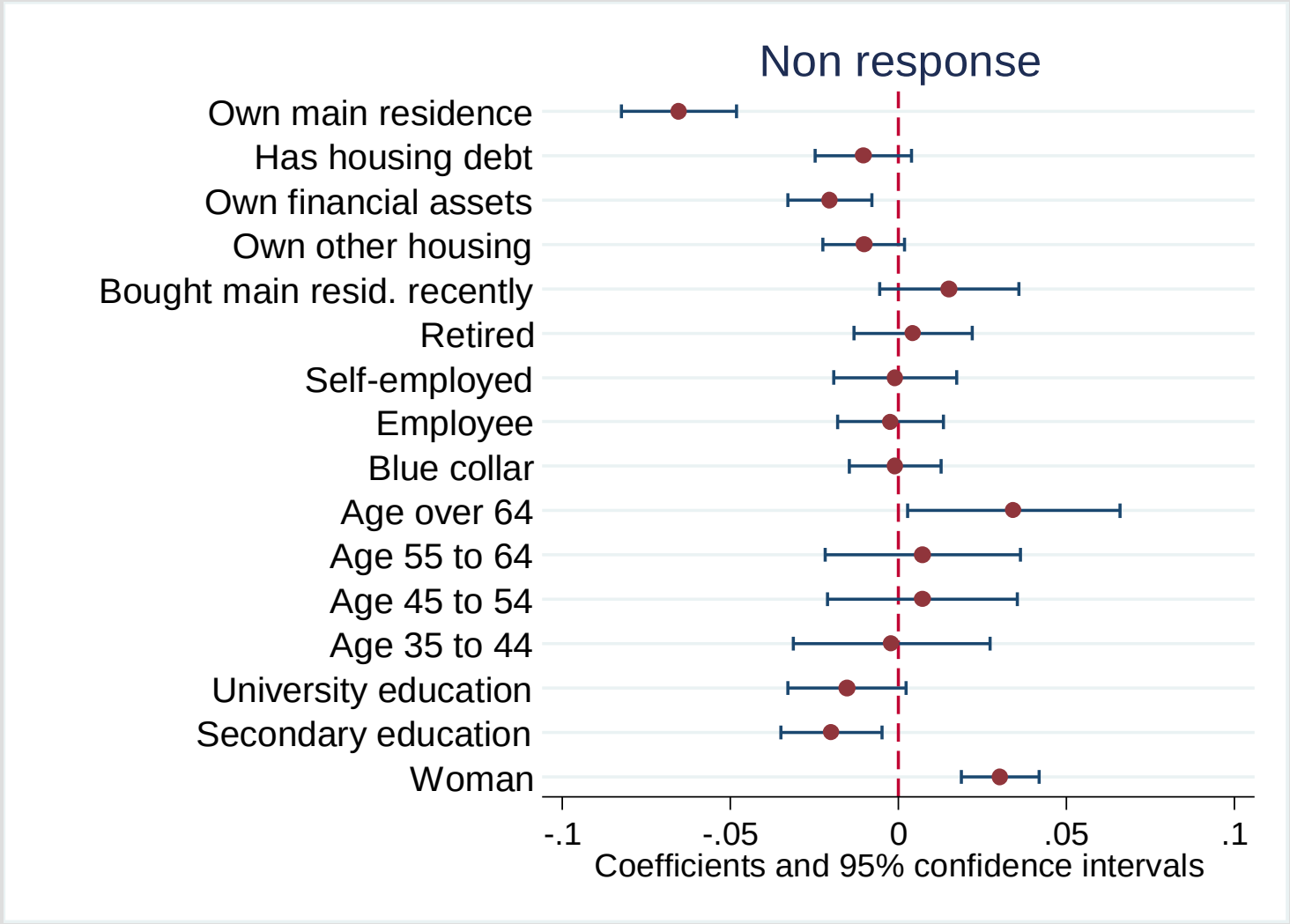
Number of bins used

Nº of bins	% of respondents
1	40.26
2	35.05
3	17.87
4	4.57
5	2.25

Ten most frequent answers

Drop over 6%	Drop around 3%	Approx. stable	Increase around 3 %	Increase over 6%	% of respondents
0	0	10	0	0	19.6
0	10	0	0	0	10.0
10	0	0	0	0	9.6
0	5	5	0	0	6.6
5	5	0	0	0	5.5
8	2	0	0	0	2.1
0	3	7	0	0	2.0
0	2	8	0	0	1.9
6	4	0	0	0	1.5
3	7	0	0	0	1.4

4. Subjective probabilities of future HPs



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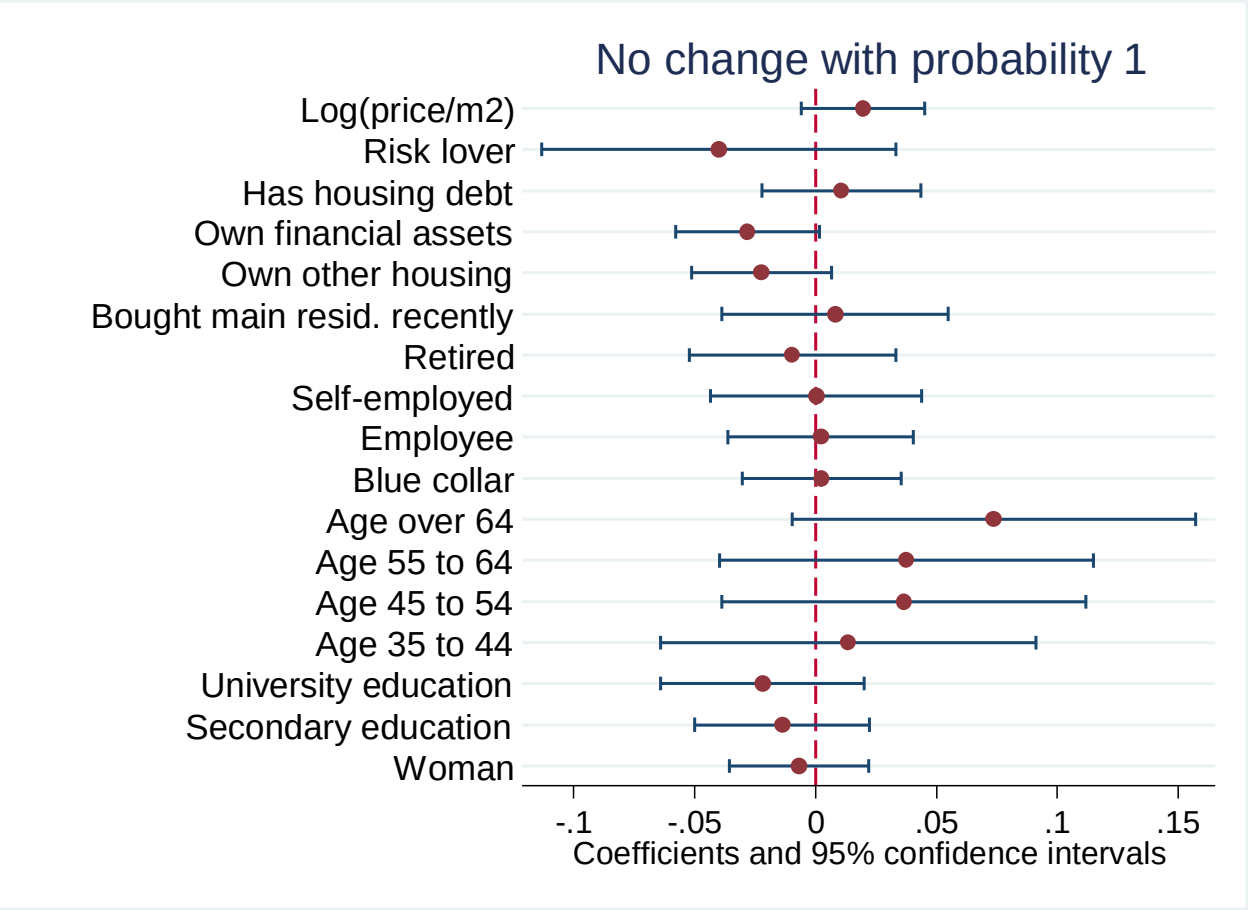

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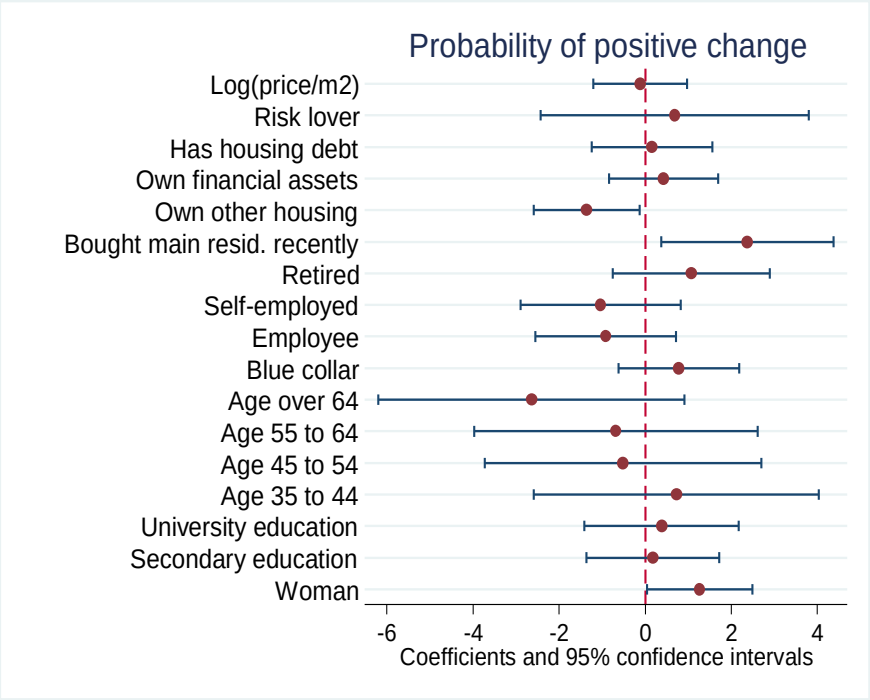
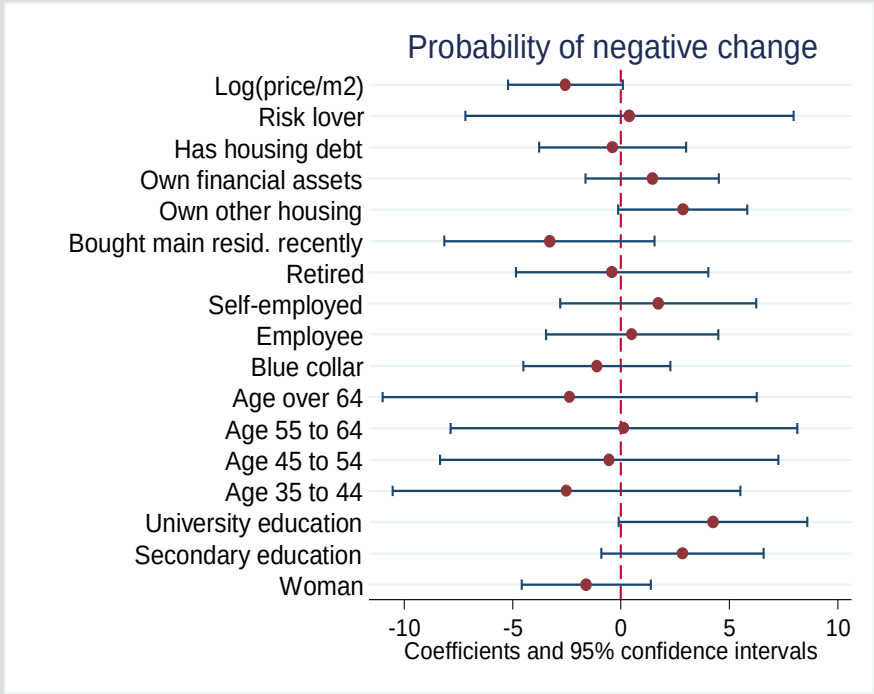
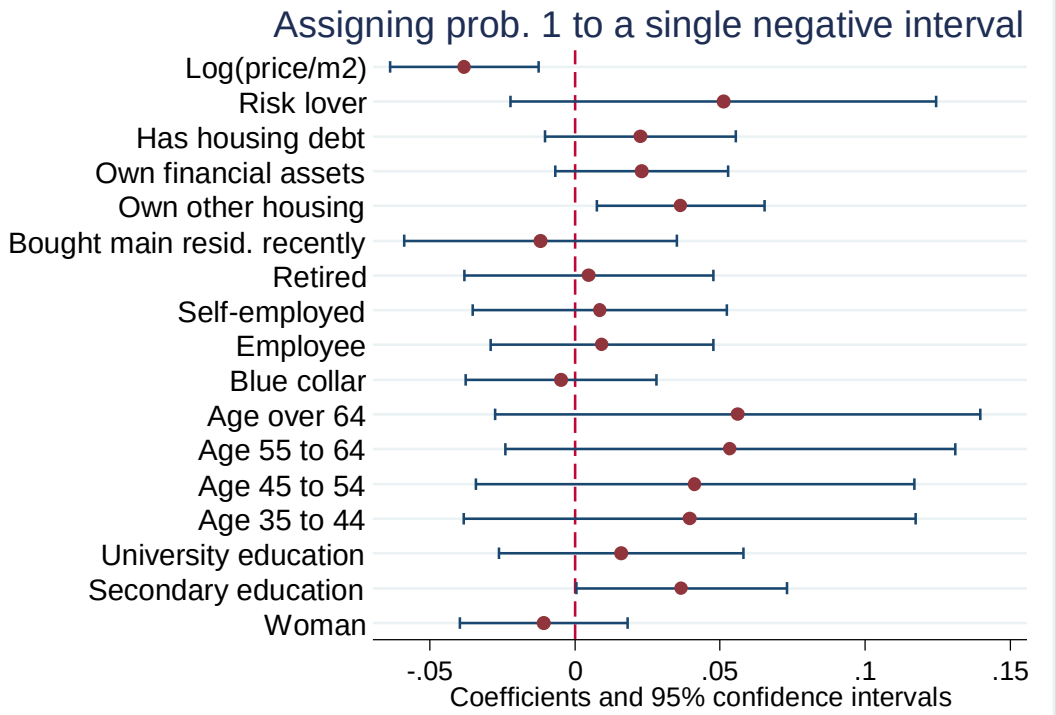




4. Subjective probabilities of future HPs

- **Large fraction of respondents hold their beliefs with certainty:**
  - 19.6% bunching in the middle
  - 10% drop around 3% with certainty
  - 9.6 % drop over 6% with certainty



5. Fitting a probability distribution for each respondent

- Subjects are asked to distribute 10 points among 5 possible changes to the price of their homes over the next year
- We use the subject responses to fit a saturated probability distribution
- This is useful because it facilitates the calculation of comparable measures of position, uncertainty, and quantiles for all individuals
- Using a saturated distribution avoids placing restrictions in the form of the distribution relative to the information in the data
- We assume that the probability distributions have a pre-specified support and a pre-specified neighbourhood around zero for the no change category

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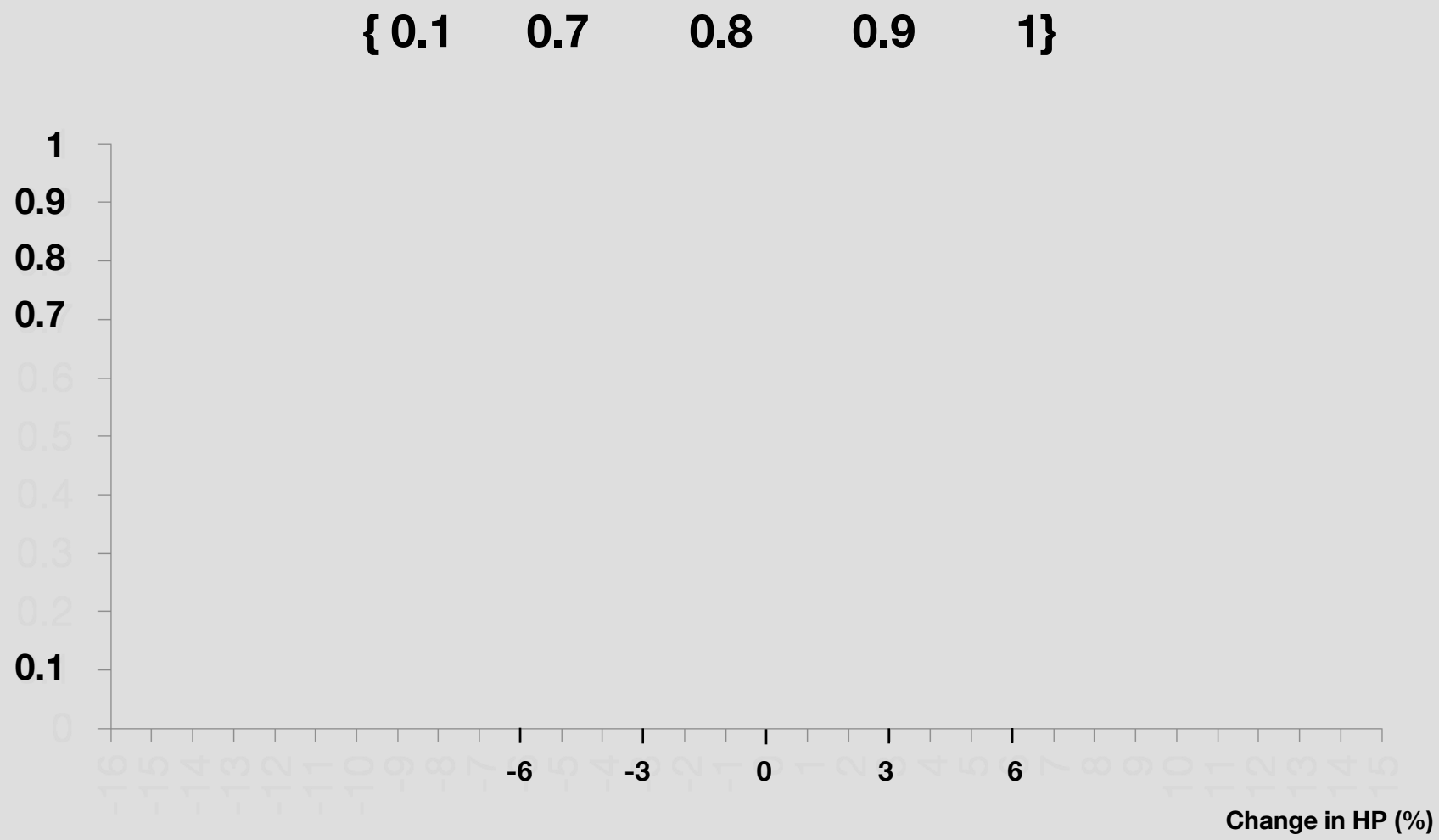

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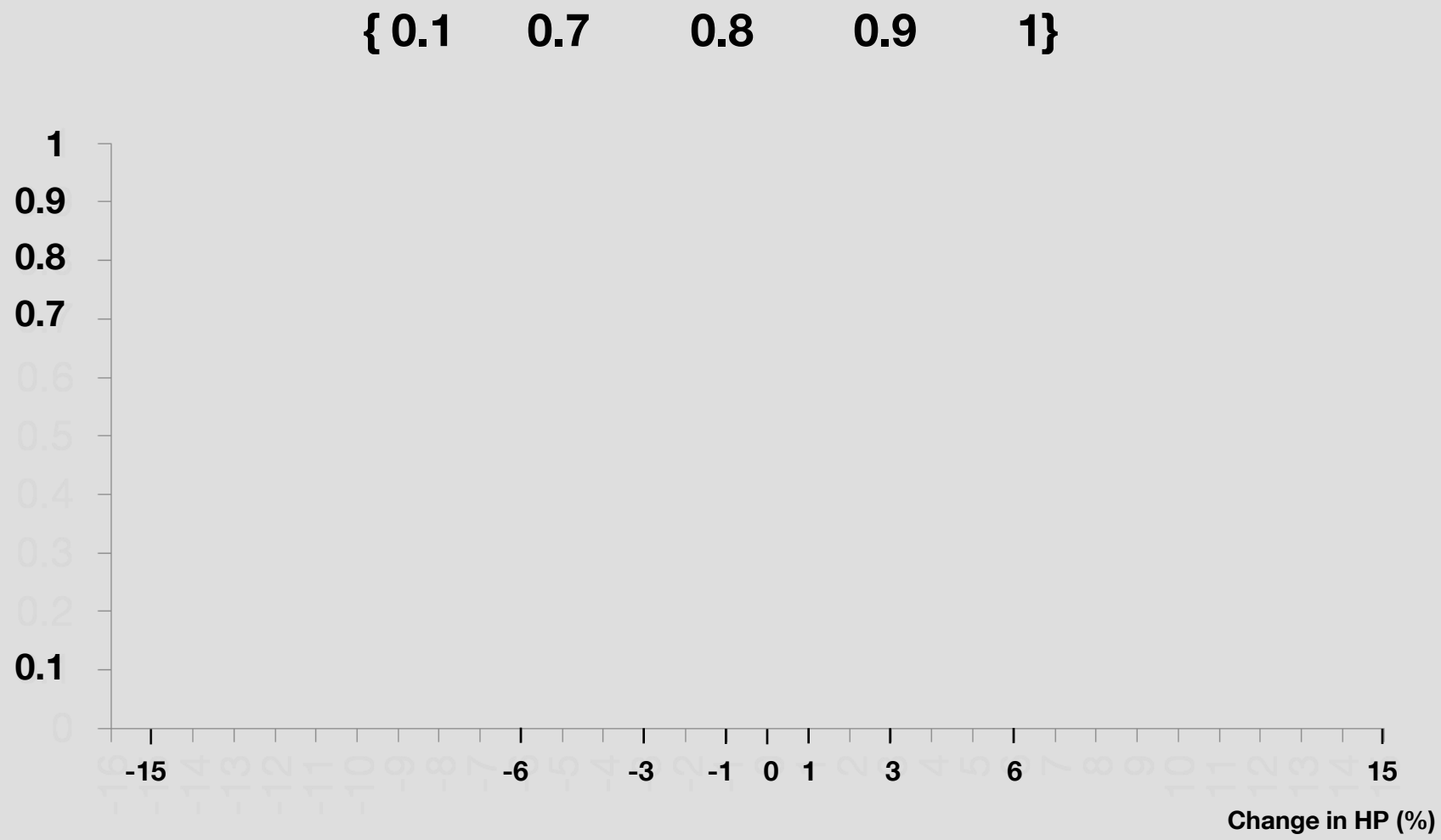

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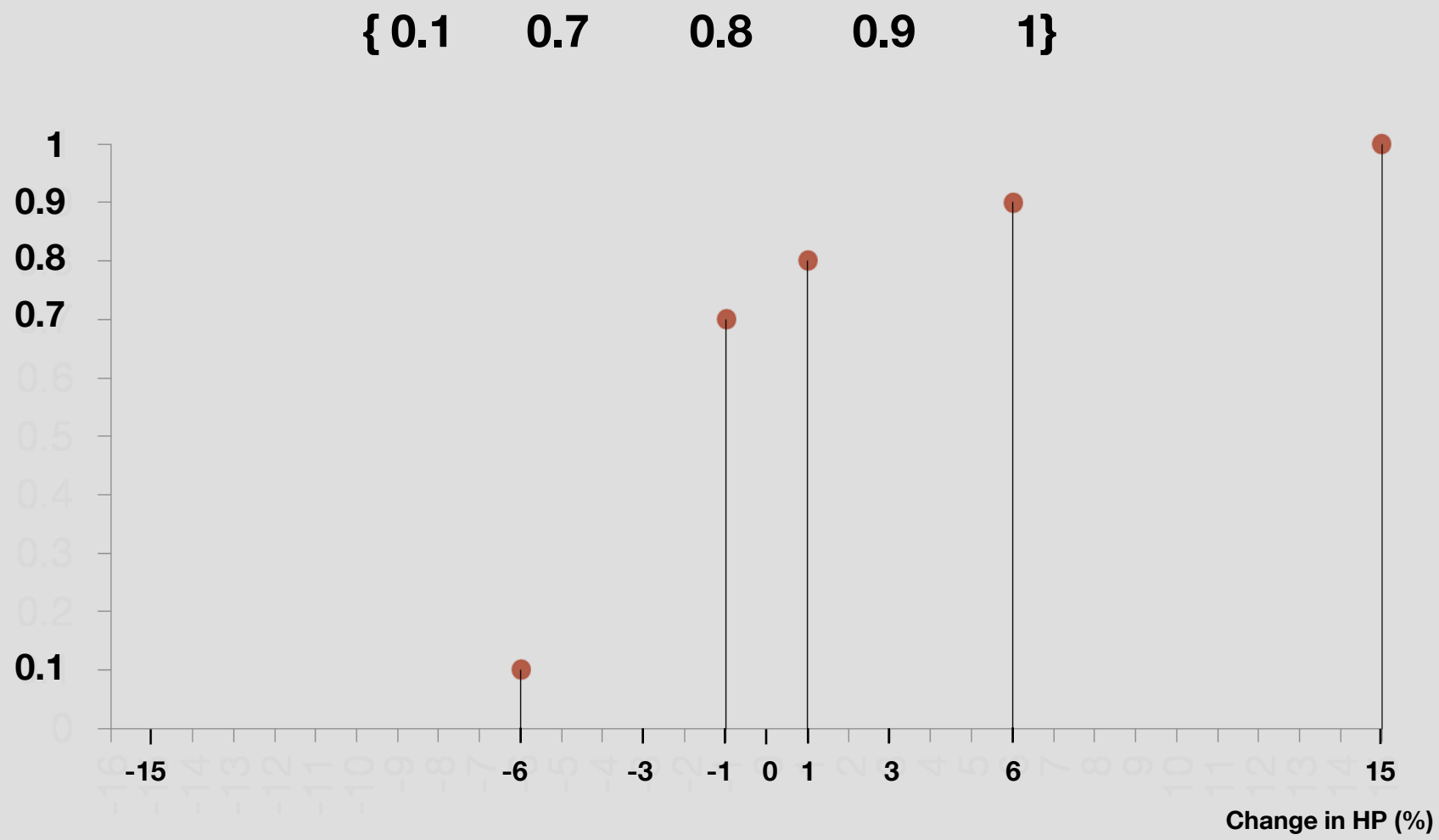
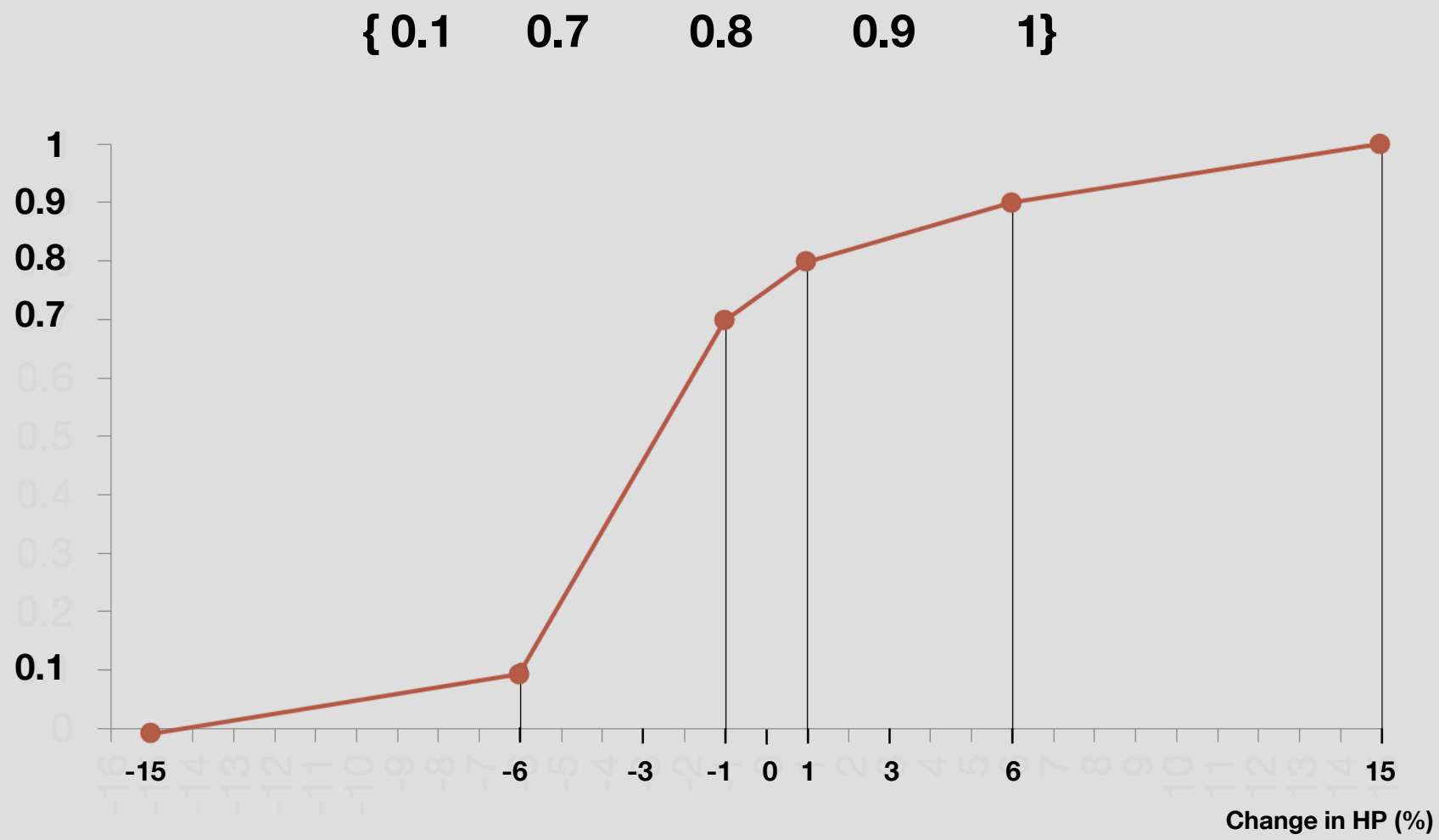
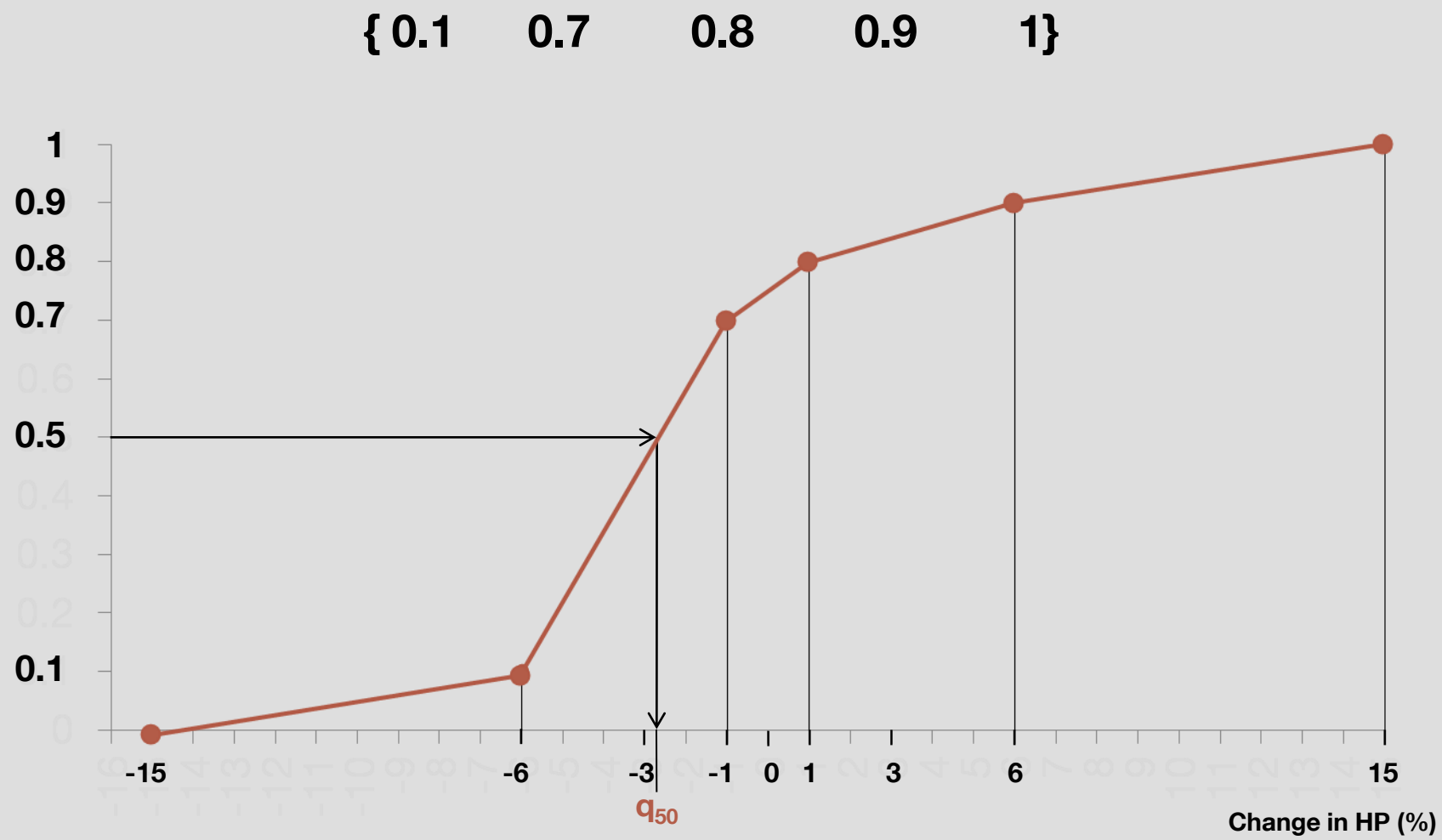


5. Fitting a probability distribution for each respondent

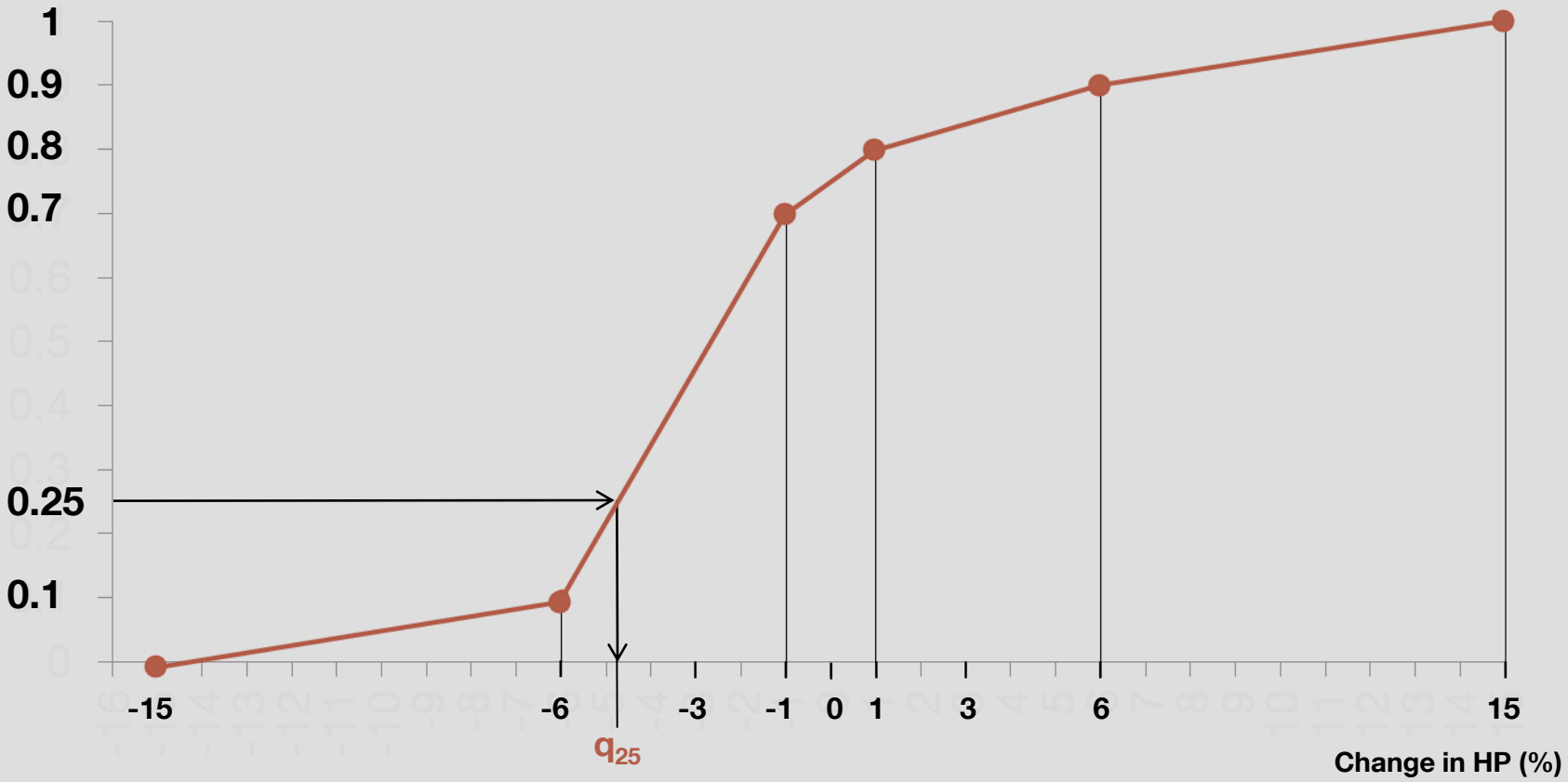


5. Fitting a probability distribution for each respondent



5. Fitting a probability distribution for each respondent

{ 0.1 0.7 0.8 0.9 1}



5. Fitting a probability distribution for each respondent

- Having specified end-points and an interval around zero, to get a full cdf we simply connect the points we observe using straight lines
- so that the cdf is piece-wise linear and the density is flat within segments
- This allows to calculate all quantiles by simple linear extrapolation
- To obtain $q_{\ i}$ for some $\in (z_{li}, z_{(l+1)i})$ we use

$$q_{\ i} = q_{zli} + [(\ - z_{l\mathrm{i}})/(z_{(l+1)i} - z_{li})](q_{z(l+1)i} - q_{zli})$$

where the z_{li} are cumulative probabilities and q_{zli} the corresponding quantiles given by (-15, -6, -1, 1, 6, 15) for $l = 0, 1, \ldots, 5$

5. Fitting a probability distribution for each respondent

Quantile regressions from subjective quantile variables

- **Measured quantiles q_i are to be interpreted as conditional quantiles given characteristics of the individual and the house, both observable and unobservable**

- **To look at the variability in these distributions, we estimate LS regressions of individual quantiles on measured characteristics and postal code dummies (within-postal code quantile estimates)**

- **These quantile regressions are very different from ordinary QR where one fits a quantile model to data that are sample draws from the distribution**

- **Here the left hand side variable consists of direct measures of the conditional quantiles**

5. Fitting a probability distribution for each respondent

A factor model for unobserved heterogeneity in subjective quantiles

- The quantile regression errors capture unobservable heterogeneity in the subjective probability distributions (except for functional form approximation errors)
- We estimate a random effects model for the errors of different quantiles to see to what extent a single factor captures the unobserved heterogeneity in the distributions
- Consider for example regressions for $q_{.25i}$, $q_{.50i}$, $q_{.75i}$

$$q_{.25i} = x'_{.25} + u_{.25i}$$
$$q_{.50i} = x'_{.50} + u_{.50i}$$
$$q_{.75i} = x'_{.75} + u_{.75i}$$

- The factor model is

$$u_{i} = \quad _{i} + \quad _{i} \qquad = 0.25, 0.5, 0.75$$

- We estimate the variance of the common factor $_{i}$, the variances of the random errors $_{i}$ and the factor loadings subject to $_{0.5} = 1$ and the assumption that $_{i}$ and the $_{i}$ are mutually independent

Table 5 b. Quantiles of subjective probability distributions of house prices (no postal code dummies)

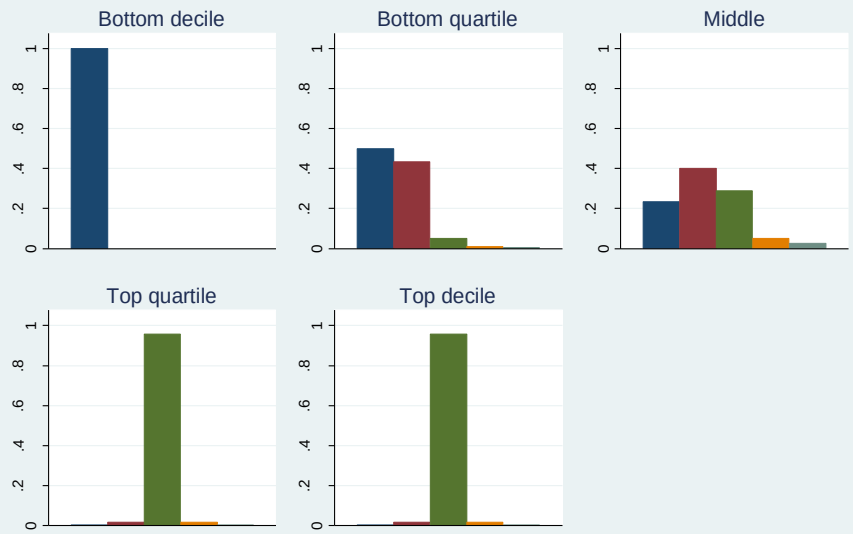
VARIABLES	(1) m1_q_10	(2) m1_q_25	(3) m1_q_50	(4) m1_q_75	(5) m1_q_90
Log(price/m2)	-0.038	0.060	0.066	0.040	0.031
Age 45 to 64	-0.320	-0.399*	-0.392**	-0.434***	-0.494***
Age over 64	0.182	-0.098	-0.255	-0.431***	-0.605***
Blue collar	0.246	0.219	0.204	0.154	0.154
Self-employed	-0.276	-0.370*	-0.374**	-0.389***	-0.361**
Secondary education	-0.376	-0.498**	-0.464**	-0.419**	-0.402**
University education	-0.310	-0.329	-0.349*	-0.324*	-0.266
Woman*Below secondary educ.	0.148	0.187	0.205	0.149	0.053
Woman*Secondary educ.	0.626*	0.672**	0.612***	0.457**	0.351
Woman*University educ.	0.440	0.480*	0.447**	0.350*	0.215
Own other housing	-0.086	-0.137	-0.258**	-0.269**	-0.282**
Bought main residence recently	0.601**	0.499**	0.288	0.233	0.243
Constant	-6.801***	-5.422***	-3.120***	-1.080**	0.327
Observations	4515	4515	4515	4515	4515
Adjusted R-squared	0.005	0.007	0.011	0.013	0.012

5. Fitting a probability distribution for each respondent

Men

Graph 2. Ordering individual distributions by their median: Men

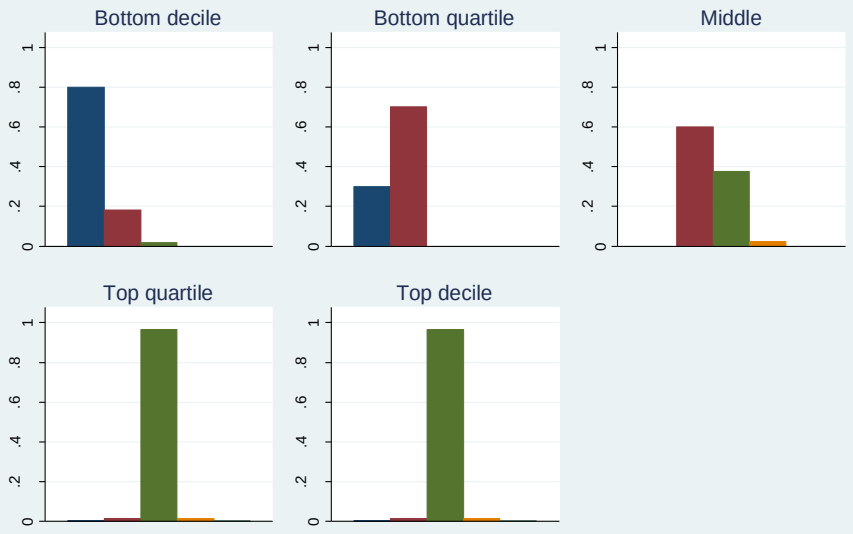
Probability distributions for specific quantiles of the median



Women

Graph 2. Ordering individual distributions by their median: Women

Probability distributions for specific quantiles of the median



6. Discussion of results and extensions

Table 8. Postal code dummies on housing and labour market variables (province). Quantiles

VARIABLES	(1) cp_10	(2) cp_25	(3) cp_50	(4) cp_75	(5) cp_90
Rate of return on housing 2010	-0.027	0.009	0.047	0.072	0.084
Rate of return on housing 2009	0.150**	0.180***	0.160***	0.135***	0.104**
Change in unemployment rate 2010	-0.303***	-0.249***	-0.190***	-0.147**	-0.096
Constant	1.617**	2.000***	1.938***	1.790***	1.539***
Observations	1070	1070	1070	1070	1070
Adjusted R-squared	0.011	0.012	0.012	0.010	0.005

- Change in unemployment rate in 2010 wrt 2009 of +1 pp implies -0.19 pp on expected median HP change
- Rate of return on housing in 2009 of -1% implies -0.1pp on expected median HP change

6. Discussion of results and extensions

Table 9. Postal code dummies on housing and labour market variables (province). Uncertainty

VARIABLES	(1) cp_7525	(2) cp_9010
Change in rate of return on housing 2010	0.049**	0.075*
Change in unemployment rate 2010	0.105***	0.220***
Constant	-0.280***	-0.479**
Observations	1070	1070
Adjusted R-squared	0.008	0.010

- Change in unemployment rate in 2010 wrt 2009 of +1 pp implies +0.10pp on expected interquartile HP change

- Change in rate of return on housing in 2009 wrt 2009 of +1pp implies 0.05pp on expected interquartile HP change

6. Discussion of results and extensions

Quantile error structure

- The first principal component of the (.1, .5, .9) quantile residuals explains 98% of total variation in a model with postal code dummies, and 96% with province dummies
- When five residuals are used (.1, .25, .5, .75, .9) the variation captured by the first principal component is 90% with postal code dummies and 89% with province dummies

- Estimation of the random effects model produces an estimated residual variance at the zero boundary (a Heywood case), which is not surprising given the high correlation among residuals
- The estimated factor loadings for 0.25 and 0.75 in the 3 error specification are close to unity (0.94 and 0.95) with corresponding residual variances in the 0.10 range
- Relative to those residuals the single common factor explains 97% of total variation

6. Discussion of results and extensions

- **Unobserved heterogeneity in the previous quantile models is large but not explained by any other observables**
  - e.g. other indicators of wealth, risk aversion
- **Results are qualitatively robust to the way of fitting the distribution**
  - e.g. alternative cut-off points

6. Discussion of results and extensions

Table 7. Some robustness checks

	Adding variables		Alternative cut-off points	
VARIABLES	q50	q75-q25	q50	q75-q25
Log(price/m2)	0.279**	-0.121	0.341**	-0.209*
Age 45 to 64	-0.297	-0.089	-0.346	0.019
Age over 64	-0.118	-0.375***	-0.114	-0.274
Blue collar	0.268*	-0.096	0.318*	-0.143
Self-employed	-0.339*	0.061	-0.429**	0.148
Secondary education	-0.488**	0.269**	-0.616**	0.416**
University education	-0.334	0.275*	-0.446*	0.391**
Woman*Below secondary educ.	0.166	0.039	0.184	0.058
Woman*Secondary educ.	0.790***	-0.263	0.971***	-0.459**
Woman*University educ.	0.272	-0.182	0.419	-0.323
Own other housing	-0.187	-0.096	-0.229	-0.078
Bought main residence recently	0.325	-0.065	0.372	-0.138
Own financial assets	-0.084	-0.009		
Has housing debt	0.000	-0.182*		
Risk lover	-0.253	0.092		
Constant	-4.463***	4.405***	-5.239***	5.447***
Observations	4499	4499	4515	4515
Adjusted R-squared	0.164	0.213	0.169	0.186