Documentation
Predicted Cognition and Dementia Measures
Release 1

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January 24, 2023

Overview

This document describes the predicted cognition and dementia measures developed in the publication:

Hudomiet, P., Hurd, M. D., & Rohwedder, S. (2022). Trends in Inequalities in the Prevalence of Dementia in the U.S. *Proceedings of the National Academy of Sciences of the United States of America*. 119(46). https://doi.org/10.1073/pnas.2212205119. PMID: 36343247. PMCID: PMC9674270.

The program files that created these data are available in the HRS Data repository at https://hrsdata.isr.umich.edu/data-products/trends-inequalities-prevalence-dementia-us-replication-package.

The project's objective and the details of the statistical methods are discussed in the published article and its supplementary appendix. Please direct any questions to the corresponding author, Péter Hudomiet (Peter_Hudomiet@rand.org).

Below we list the developed measures and discuss their interpretation and basic properties.

Sample

- Person-year observations from the Health and Retirement Study
  - From waves 5 (year 2000) to 13 (year 2016).
  - Restricted to respondents age 65+.

Variable list

The file Dementia_HRS_2000-2016_Basic_Release1_2m.zip contains a Stata data file with the following seven variables:

1) **hhidpn:** HRS person identifier
2) **wave:** Survey wave identifier from 5 to 13
3) **PrDem:** Estimated probability of dementia of the person-year observation.
4) **PrCIND:** Estimated probability of "cognitive impairment, not dementia" (CIND).
5) **PrNorm:** Estimated probability of normal cognitive status (i.e., neither dementia nor CIND).
6) **Cog:** Expected value of latent cognitive ability
7) **CogSd:** The standard deviation of latent cognitive ability (i.e., the precision of the Cog estimate)

The "2m" in the filename indicates that the MCMC model was run using 2 million simulation draws. The first 10% burn-in draws were discarded.

Interpretation

The project assumed that individual i at wave t was endowed with latent cognitive ability c_{it}^* that developed over time according to equation

$$c_{it}^* = \beta x_{it} + \eta_{i0} + \eta_{i1} a_{it} + \varepsilon_{it}^c, \tag{1}$$

where x_{it} denotes observed covariates (such as age, calendar time, sex, and education), a_{it} is age, η_{i0} is a random person-specific intercept, η_{i1} a random slope with respect to age, and ε_{it}^c is a residual term. We normalized latent cognition in the following way:

- Person i in wave t has dementia if and only if $c_{it}^* < 0$.
- Person i in wave t has CIND if and only if $0 \le c_{it}^* < 1$.
- Person i in wave t has normal cognition if and only if $1 \le c_{it}^*$.

The HRS includes a set of cognitive measures, such as word recall and counting tests. We assumed that performance on these tests depended on latent cognitive function and other predictor variables:

$$y_{it}^s = \alpha^s x_{it} + \phi^s c_{it}^* + \varepsilon_{it}^s, \tag{2}$$

where s indexed the different cognitive measures available in the HRS.

After estimating the model, *Cog* was defined as the expected value of c_{it}^* of the person-year observation as a function of the model estimates and the data. *PrDem*, *PrCIND*, and *PrNorm* were defined as the probabilities that c_{it}^* fell into the appropriate intervals.

Basic properties of the measures

Tables 1-2 show weighted and unweighted descriptive statistics on the five cognition and dementia measures:

- About 10% of the sample have dementia, two-thirds have normal cognition, and the rest have CIND.
- The weighted average value of Cog is 1.3, which is in the normal range but not far from the CIND threshold (one).
- The standard deviation of cognition is non-trivial, 0.31, on average. This reflects both model uncertainty (i.e., the HRS cognition measures cannot predict dementia status with 100% accuracy) and calibration uncertainty (i.e., the ADAMS supplement dataset used for calibrating the HRS cognition measure had a moderate sample size of 856.)

Tables 3-4 show weighed and unweighted trends in the five measures:

- We see a slow and steady improvement in cognition over time.
- The weighted time series is smooth, and the unweighted series fluctuates more.

The two panels of Figure 1 show the histograms of predicted cognition and the wave-to-wave changes in cognition:

- Cognition has a smooth distribution, following a Bell-shape in the normal cognition range with a long left tail corresponding to CIND and dementia.
- The distribution of the wave-to-wave change in cognition is smooth. Most individuals experience a slow cognitive decline, a few experience faster descents, and a handful experiences minor improvements in cognition.

The two panels of Figure 2 show the histograms of predicted dementia probabilities and the wave-to-wave changes in these probabilities:

- The distribution of dementia probabilities has two peaks: a larger one at 0% dementia probabilities and a smaller one at 100%. A small fraction of the sample is in the middle range.
- The distribution of the wave-to-wave change in dementia probabilities is concentrated around 0% change, with a non-negligible mass above 0%, corresponding to a slight increase in the likelihood of dementia.

Table 1. Unweighted descriptive statistics about the five cognition and dementia measures

	mean	sd	p10	p50	p90
PrDem	0.107	0.275	0.000	0.000	0.518
PrCIND	0.226	0.306	0.000	0.040	0.787
PrNorm	0.667	0.400	0.000	0.916	1.000
Cog	1.248	0.963	-0.013	1.418	2.272
CogSd	0.310	0.060	0.244	0.301	0.380

Table 2. Weighted descriptive statistics about the five cognition and dementia measures

	mean	sd	p10	p50	p90
PrDem	0.097	0.262	0.000	0.000	0.386
PrCIND	0.217	0.301	0.000	0.037	0.774
PrNorm	0.686	0.392	0.001	0.932	1.000
Cog	1.298	0.937	0.089	1.461	2.290
CogSd	0.316	0.062	0.246	0.308	0.387

Table 3. Unweighted trends in the five cognition and dementia measures

	PrDem	PrCIND	PrNorm	Cog	CogSd
2000	0.120	0.203	0.678	1.270	0.346
2002	0.111	0.206	0.683	1.279	0.310
2004	0.104	0.214	0.681	1.278	0.293
2006	0.101	0.220	0.679	1.275	0.286
2008	0.102	0.223	0.674	1.267	0.283
2010	0.109	0.231	0.660	1.226	0.286
2012	0.111	0.237	0.652	1.208	0.298
2014	0.107	0.245	0.648	1.207	0.324
2016	0.101	0.256	0.643	1.212	0.375

Table 4. Weighted trends in the five cognition and dementia measures

	PrDem	PrCIND	PrNorm	Cog	CogSd
2000	0.118	0.196	0.686	1.285	0.345
2002	0.108	0.202	0.690	1.295	0.309
2004	0.100	0.210	0.689	1.297	0.291
2006	0.101	0.220	0.680	1.280	0.285
2008	0.097	0.221	0.682	1.294	0.286
2010	0.096	0.222	0.682	1.291	0.292
2012	0.091	0.222	0.687	1.302	0.305
2014	0.086	0.225	0.689	1.313	0.331
2016	0.085	0.229	0.686	1.310	0.380

Figure 1. Histograms of predicted latent cognition (*Cog*) and wave-to-wave changes in cognition.

Panel A: Predicted latent cognition
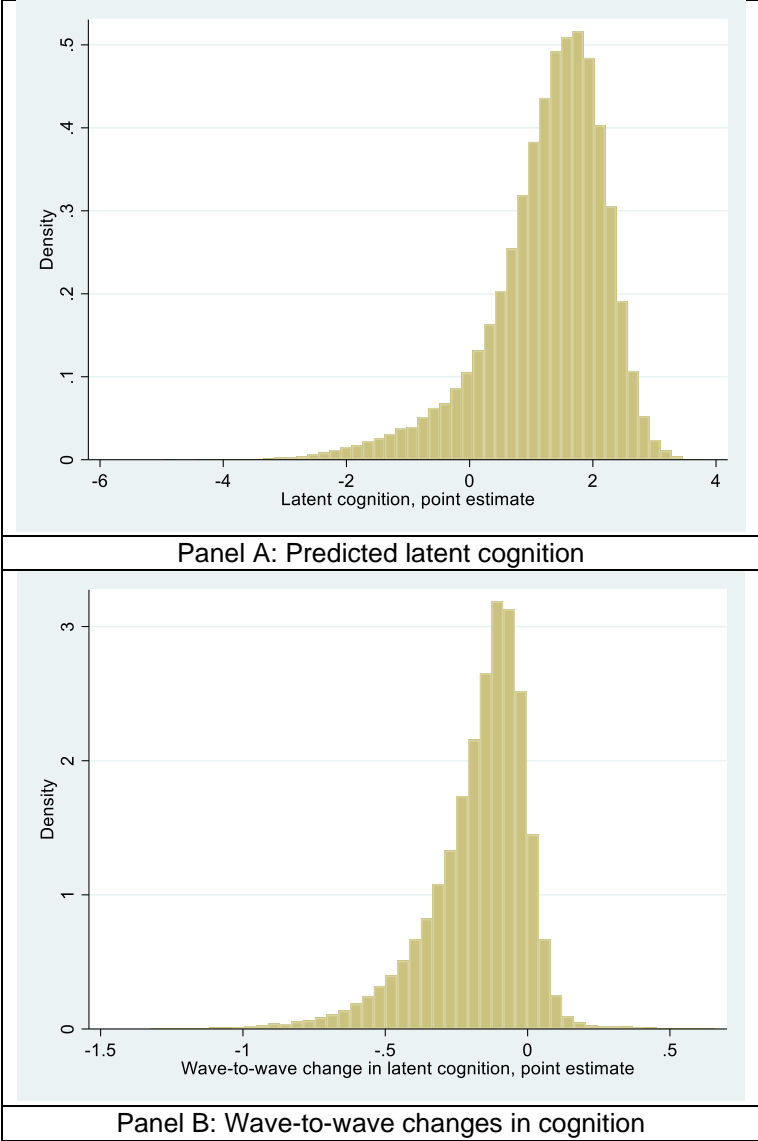
Panel B: Wave-to-wave changes in cognition

Figure 2. Histograms of dementia probability (*PrDem*) and wave-to-wave changes in dementia probabilities.

Panel A: Predicted dementia probability

Panel B: Wave-to-wave change in dementia probability