

# Analysis of capability deprivation of people with Alzheimer's disease using a structural equation model

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Martine Bungener.

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## Key points

- Aim: To assess the ability of elderly individuals to accomplish valued activities in life, in particular people with Alzheimer's disease (AD)
- Data: A representative sample from France's population, 2008
- Main steps:
  - Select capability dimensions
  - Gather information (indicators)
  - Derive capability measures and analyse them
  - Examine the influence of surrounding factors
  - Compare capabilities among different groups

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## Main findings

- Methodology : Structural equation latent variable model framework
- Results:
- Capability dimensions
  - Two fundamental capability dimensions chosen : ability to perform self-care and ability to participate in household activities
  - All selected indicators have significant loadings and hence are adequate representations of the corresponding latent abilities
  - All (standardized) loadings are almost equal for both dimensions, meaning a change in the latent ability reflects equally in all outcomes

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- Exogenous factors
  - They are grouped into five broad topics: general health status, human capital, family and social circumstances, economic resources, and government aid, with several variables for each.
  - All these factors are highly significant for both capabilities, though some variables are more relevant for self-care than for household activities, and vice versa.
- Capability comparisons
  - ADs have a systematically lower level of capabilities (freedom) compared to non-ADs even if the latter include people with many impairments such as visual, hearing, movement, speech, psychological and others
  - ADs have a much smaller range of capabilities than non-ADs

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## Motivation

- The number of elderly persons who have or will have Alzheimer's disease in France and other countries with aging populations, is rapidly increasing (Rép.franç. 2008, Brodaty *et al.* 2011) and governments are concerned about the consequences on the **well-being** of these individuals and their families.
- But what is well-being or quality of life?
- Most of the health economics literature on quality of life follows a traditional approach proposing health-related utility measures such as QALY, using information on preferences of different 'bundles' of health attributes.

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## Motivation

- While QALY-type measures are important, they are essentially confined to health and its *impact* on quality of life rather than the quality of life itself (Grewal *et al.* 2006). Very few studies in this area use broader well-being measures, such as capability-based ones i.e. measures based on what people are able to be and to do.
- This is one of the first attempts to provide such a capability measure for the elderly (Coast *et al.* 2008 is the only other study that we know of).
- And we go further to analyse the impact of the environment (family, social and economic) on their capabilities.

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## Latent variable approach

- The abilities are not directly measured (latent) but observed through appropriate indicators

$$\mathbf{y}_i = \alpha + \mathbf{A}\mathbf{f}_i + \varepsilon_i$$

- The abilities are affected by the social, economic and institutional circumstances in which the individuals live

$$\mathbf{f}_i = \mu + \mathbf{B}\mathbf{x}_i + \mathbf{u}_i$$

We consider two abilities in our study.

- Ability to perform self-care (F1) : bathe, dress, cut food, eat and drink, use toilet, take medicine
- Ability to participate in household activities (F2) : shopping, preparing meals, daily cleaning, occasional chores, administrative affairs



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# Construction of functionings

- We have information on three aspects for each outcome variable : whether the person has difficulty or not, whether the person does it alone or with help, whether the person wants more help or not
- So following five situations for *each* activity:
  - No difficulty, no help, does not want more
  - Has difficulty, has help, wants more
  - Has difficulty, has help, does not want more
  - Has difficulty, no help, wants more
  - Has difficulty, no help, does not want more

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# Construction of functionings

- How to order these 5 situations?
- First, Why order?
- How to combine the three types of information to arrive at 'valued' functionings?
- Three variants studied :
  - Variant I : Minimal assumptions
  - Variant II : Extra assumption (one way)
  - Variant III : Extra assumption (other way)

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## Variant I

Two intuitive or 'common sense' assumptions

- A1 : 'No difficulty' is better than or more valued than 'has difficulty', we write this as  $\text{No difficulty} > \text{Has difficulty}$
- A2 : Does not want (more) help  $>$  Wants (more) help

Based on A1 and A2 we get three ordered categories (from 'worst' to 'best')

- Category 1 : A person has difficulty, has help and wants more OR a person has difficulty, has no help and wants help
- Category 2 : A person has difficulty, has help and does not want more OR a person has difficulty, has no help and does not want help
- Category 3 : A person has no difficulty

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## Variant II

A3A : One additional assumption : Doing alone  $>$  Doing with help

Based on A1, A2 and A3 we get five ordered categories (from 'worst' to 'best')

- Category 1 : A person has difficulty, has help and wants more
- Category 2: A person has difficulty, has no help and wants help
- Category 3 : A person has difficulty, has help and does not want more
- Category 4: A person has difficulty, has no help and does not want help
- Category 5 : A person has no difficulty

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## Variant III

A3B : One additional assumption : Doing with help  $>$   
Doing alone

Based on A1, A2 and A3 we get five ordered categories  
(from 'worst' to 'best')

- Category 1 : A person has difficulty, has no help and wants help
- Category 2: A person has difficulty, has help and wants more
- Category 3 : A person has difficulty, has no help and does not want help
- Category 4: A person has difficulty, has help and does not want more
- Category 5 : A person has no difficulty

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In each variant, for each of the indicators, functionings are constructed depending on the individual's answers to the three questions (difficulty, help, want).

Thus our functionings combine the 'ability' aspect with the 'value' aspect and are the  $y_i$ 's in our measurement equations.

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Thus our functionings combine the 'ability' aspect with the 'value' aspect and are the  $y_i$ 's in our measurement equations.

The model is estimated by using Robust Weighted Least Squares (WLSMV):

- Calculation of the empirical moments: thresholds, correlations, conditional expectations and conditional variances.
- Calculation of the asymptotic variance-covariance matrix.
- Estimation of the parameters by minimizing the following fitting function:

$$[\hat{\rho} - \sigma(\theta)]' \mathbf{G}^{-1} [\hat{\rho} - \sigma(\theta)]$$

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## Measurement equations

Table: Measurement equation for F1 (1<sup>st</sup> variant)

	Estimate	Std. Error	Standardized	t value	Pr(> t )
FTOIL	1.000	-	0.908	-	-
FSHABI	1.024	0.020	0.918	51.508	***
FMEDIC	0.821	0.027	0.824	30.817	***
FNOURR	0.929	0.023	0.878	40.974	***
FMB	0.793	0.042	0.809	19.009	***
FSERTO1	0.924	0.029	0.876	31.976	***

- All functionings have significant loadings and hence are adequate representations of the corresponding latent abilities.
- All (standardised) loadings are almost equal for both dimensions, meaning a change in the latent ability reflects equally in all outcomes.



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## Measurement equations

**Table:** Measurement equation for F2 (1<sup>st</sup> variant)

	Estimate	Std. Error	Standardized	t value	Pr(> t )
FREPAS	1.000	-	0.918	-	-
FTMEN	1.011	0.014	0.923	70.179	***
FCOURS	0.917	0.015	0.883	62.859	***
FADMIN	0.751	0.016	0.796	47.174	***
FTRAV	0.934	0.014	0.891	65.968	***

- All functionings have significant loadings and hence are adequate representations of the corresponding latent abilities.
- All (standardised) loadings are almost equal for both dimensions, meaning a change in the latent ability reflects equally in all outcomes.

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## Exogenous variables

- *General health*: Chronic disease, Concentrating, Limitations due to health problems, Having memory loss, Health status, Learning, Notion of time, Problems of everyday life, Number of impairments by type.
- *Entourage, Family*: Household size, Children alive, Living in couple, Frequency of visits of family members, Know the neighbors, Having at least one daughter.
- *Social Awareness and Benefit*: Know the local center of gerontological information and coordination, Personal Autonomy Benefits.
- *Economic capital*: Equivalent income, Tenure.

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- *Human capital*: Highest degree, Occupational category.
- *Mobility and access to infrastructure*: Moving from home , Access to public services, Access to shops or local services, Access to supermarkets, Need of health services, Access to close friends or relatives houses, Walking, Car, Public transportation, Size of urban area.
- *Others*: Age, Gender.

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## Structural model results : F1

Table: Structural Equation for F1 (1<sup>st</sup> variant)

	Estimate	Std. Error	Standardized	t value	Pr(> t )
AGE	-0.011	0.002	-0.068	-5.456	***
GENDER	-0.081	0.034	-0.029	-2.351	**
INDMEN	-0.113	0.020	-0.065	-5.505	***
CENF1	0.131	0.037	0.048	3.546	***
CENF2	0.111	0.041	0.037	2.691	***
TDHDOM	0.149	0.022	0.102	6.881	***
TLIEU3	0.267	0.068	0.072	3.908	***
TRANS1	0.127	0.038	0.046	3.301	***
TRANS5	0.105	0.036	0.036	2.909	***
TRANS6	0.346	0.064	0.091	5.371	***
STOC	0.040	0.015	0.030	2.616	***
RAL7	-0.194	0.022	-0.074	-8.856	***
CLIC	-0.321	0.080	-0.044	-4.017	***
BCONC	0.063	0.018	0.045	3.475	***
BLIMI	0.410	0.024	0.377	17.005	***
BSANTE	0.131	0.020	0.094	6.546	***
BSAVOIR	0.044	0.017	0.036	2.630	***
BTEMPS	0.067	0.017	0.044	3.897	***
BVIEQ	0.193	0.017	0.144	11.204	***
DEFTY	-0.096	0.016	-0.083	-6.162	***

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## Structural model results : Ability to perform self-care

All results are for Variant 1 (Variants 2 and 3 give similar results):

- **Positive and significant** coefficients for **F1**:  
Number of children alive, Moving from home, Access to shops or local services, Walking, Car, Public Transportation, Tenure, Concentrating, Limitations due to health problems, Health status, Learning, Notion of time, Problems of everyday life.
- **Negative and significant** coefficients for **F1**: Age, Gender, Household size, Personal Autonomy Benefits, Know the CLIC, Number of impairments by type.

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## Structural model results : Ability to participate in household activities

Table: Structural Equation for F2 (1<sup>st</sup> variant)

	Estimate	Std. Error	Standardized	t value	Pr(> t )
AGE	-0.021	0.002	-0.129	-12.863	***
GENDER	0.259	0.028	0.091	9.340	***
COUPLE	0.122	0.032	0.043	3.774	***
INDMEN	-0.041	0.019	-0.023	-2.103	**
CENF1	0.167	0.031	0.060	5.462	***
CENF2	0.115	0.034	0.037	3.405	***
TUU	-0.011	0.004	-0.025	-2.608	***
TDHDOM	0.237	0.018	0.158	12.902	***
TLIEU2	0.165	0.055	0.044	2.984	***
TLIEU3	0.158	0.061	0.042	2.592	***
TLIEU4	0.093	0.055	0.024	1.686	*
TRANS6	0.113	0.039	0.029	2.901	***
RUC	0.025	0.014	0.016	1.769	*
STOC	0.058	0.012	0.042	4.705	***
RAL7	-0.088	0.023	-0.033	-3.869	***
CLIC	-0.232	0.070	-0.031	-3.322	***
BLIMI	0.368	0.016	0.327	23.346	***
BSANTE	0.149	0.017	0.104	8.640	***
BSAVOIR	0.054	0.013	0.044	4.190	***
BTEMPS	0.029	0.015	0.018	1.927	**
BVIEQ	0.190	0.015	0.138	12.818	***
DEFTY	-0.112	0.013	-0.094	-8.821	***

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## Structural model results : Ability to participate in household activities

- **Positive and significant** coefficients for **F2**: Gender, Living in couple, Number of children alive, Moving from home, Access to public services, Access to shop or local services, Access to supermarkets, Public Transportation, Equivalent income, Tenure, Limitations due to health problems, Health status, Learning, Notion of time, Problems of everyday life.
- **Negative and significant** coefficients for **F2**: Age, Household size, Size of urban area, Personal Autonomy Benefits, Know the CLIC, Number of impairments by type.
- All **fit indices** and **R<sup>2</sup>s** are good.

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## General discussion

- Age decreases F1 and F2 : 'Older' means less capable
- Gender : negative for F1 (men less able to perform self-care than women) and positive for F2 (women less 'able' in household activities).
- Household size: negative for both. More people in the household means more things to do and 'less capable' to do all.
- Number of children : increases both abilities as more help or more confident that help is readily available.
- Combining the above two results  $\Rightarrow$  help is welcome but more people living in the household is not always helpful!

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## General discussion

- Living in couple: better for F2 as participation in household activities is easier and probably has more value when living in couple.
- Mobility is good for both. Only public transport is significant for household activities.
- Infrastructure (access to public services, shops, local markets) enhance both capabilities, especially the second one.
- Living in a smaller urban area is good for F2 (proximity to shops etc.)
- Economic resources (equivalent income, property tenure) positive but the (standardised) coefficient is not big. So economic capital is not the most important factor for these capabilities.

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## General discussion

- Getting public allowances and knowledge of a gerontology centre have negative influences. Here it is more an association: that is people getting allowances are people with less capabilities (highly dependent people, with severe problems).
- Social status (education, occupational category) are not significant : all have similar status in our sample, so no variability
- Health status is good for both: all the health variables (concentration, physical limitations, self-reported health, learning problems, notion of time, everyday problems, impairments) have a significant impact for both F1 and F2

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## Differences between the two capabilities

Factors that are important for F1 but not for F2:

- Walks regularly
- Drives regularly
- Can concentrate more than 10 minutes

As mentioned earlier, a person who can walk or drive regularly should be good in self-care.

Factors that are important for F2 but not for F1:

- Living in couple
- Lives in a small urban area
- Can access public services
- Can access supermarkets
- Equivalent income

These are basically access factors and hence particularly useful for accomplishing household activities, except the first one which we already discussed earlier.

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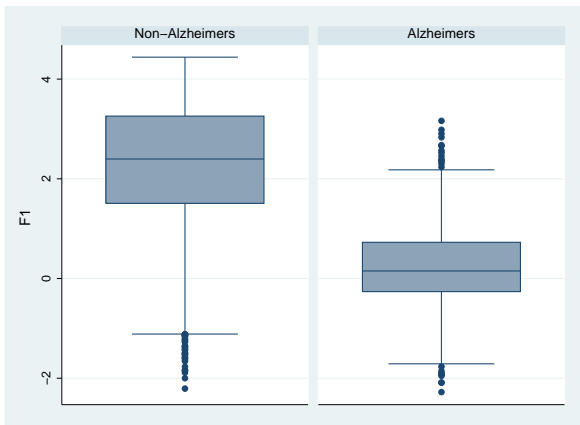
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## Distribution of capabilities - Box plots

Figure: Boxplots of F1 for Non-Alzheimers and Alzheimers (1<sup>st</sup> variant)



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## Comparison between ADs and non-ADs

### Distribution of capabilities (Figures of box-plots)

- Range of capability values much bigger for non-ADs
- Inter-quartile range (variability) is also greater for non-ADs
- There are outliers in both groups
- Some top outliers in AD are even above the median value for non-ADs
- But even the top most outlier is below Q3
- The bottom most outliers are almost the same for both, though the AD Q1 value is much below the non-AD Q1 value.
- Similar picture for both capabilities except that there are practically no outliers for non-ADs

The Kolmogorov-Smirnov test of equality of distributions is rejected.

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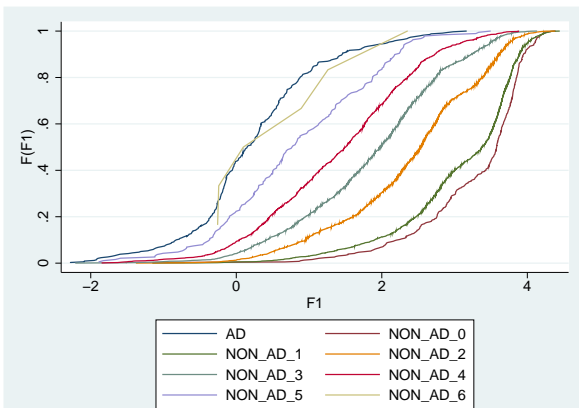
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## Cumulative distributions

**Figure:** Cumulative distribution function of F1 for Non-Alzheimers by number of impairments by type and Alzheimers (**1<sup>st</sup>** variant)



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## Comparison between ADs and non-ADs

Cumulative distributions for different groups: ADs, persons with one impairment, with 2 impairments,....., with 6 impairments

- AD is at the top of all and only overlaps with persons with all 6 impairments
- So capabilities of ADs are systematically lower than all other groups (i.e. all elderly people with up to 5 serious impairments)

ADs need special attention in policy-making.

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