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Bachelor Thesis Econometrics and Operational Research

Determining the underlying factors of perceived income adequacy

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Abstract

As the average age of the world population is increasing and incomes tend to decline in late life, it is essential for policymakers to have a good view of an elderly person's financial capacity. An increasingly important measure of financial capacity is someone's perceived income adequacy (PIA), i.e., the manner in which a person subjectively evaluates the sufficiency of his or her income to meet household expenses. This paper examines which factors determine perceived income adequacy and whether those factors suffice to validate PIA as a measure of economic status. This is done by replicating and extending the study of Litwin and Sapir (2009), using data from the Survey of Health, Ageing and Retirement in Europe (SHARE). For the extension, parameters of a simultaneous equation model (SEM) are estimated using a generalized estimation equation (GEE). As the results indicate that economic variables were the most important factors to determine PIA, this measure can be validated as a measure of economic status. However, other variables are also of importance when evaluating perceived income adequacy: the older people get, the more they perceive their income as adequate and the less healthy people are, the more they perceive their income as inadequate.

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1 Introduction

Due to increasing life expectancy and lower birth rates, the average age of the world population is rapidly increasing (Beard et al., 2016). As income tends to decline in late life due to retirement (Litwin and Sapir, 2009), elderly are more susceptible to poverty and may respond to lessened income by adjusting their living standards downward (Hooyman and Kiyak, 2008). Noting that economic status is a major dimension of their well-being (Chan et al., 2002), it is important for elderly to be financially stable. Especially when keeping in mind that health-related expenses tend to rise by age (Cook and Settersten Jr, 1995; Stoller and Stoller, 2003). So, to prevent health and financial issues of elderly, it is essential for policymakers to have a good view of an elderly person's financial capacity.

An increasingly important measure of financial capacity is perceived income adequacy (PIA) (Gildner et al., 2016). PIA refers to the manner in which a person subjectively evaluates the sufficiency of their income to meet household expenses. But, as this measurement is subjective, it can result in estimation bias (Grable et al., 2013). Formulated differently by Schwarz and Strack (1991), judgments of sufficiency or satisfaction can be sensitive to context, mood, measurement instrument and other factors. For instance, older people often tend to be financially satisfied, regardless of their financial capacity (George, 1992).

To make good policy using the perceived income adequacy of elderly, this measurement has to be reliable. This paper contributes to this topic by examining which factors determine whether the perception of individuals aged above 50 is to be financial adequate, and whether those factors suffice to validate PIA as a measure of economic status. It does so by taking Litwin and Sapir (2009) as a starting point: their research will be replicated and extended. Litwin and Sapir (2009) also *"sought to better understand the nature of perceived income adequacy among older adults and to confirm its validity"*. However, as Litwin and Sapir (2009) only utilizes data from the first wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) and thus is of a cross-sectional nature, this paper uses data from multiple waves of SHARE and will be a longitudinal study.

Furthermore, Litwin and Sapir (2009) did not find an association between consumption and PIA, even though indications exist that there could be. For instance, Litwin and Sapir (2009) found an association between age and PIA, and Banks et al. (1998) found correlation between age and consumption level. Together with the belief that elderly may respond to lessened income by adjusting their living standards downward (Hooyman and Kiyak, 2008), this could be an indication that consumption level and age are correlated. Because of those indications, this

paper will especially focus on the correlation between PIA, expenditures and age. In short, this study assesses the following questions for people aged above 50:

- Following longitudinal analysis, what are the determinants of perceived income adequacy and how do they compare to the results of Litwin and Sapir (2009)?
- Does an individual's level of consumption influence their perceived income adequacy?
- Do elderly assess their income as more adequate because they adjust their standard of living to their income level?

In the following section, relevant literature about perceived income adequacy is discussed. The used data are described in Section 3. Further, in Section 4, the methods used to answer the research questions are discussed. Moreover, this paper represents the final results in Section 5 and finishes this report with a conclusion in Section 6.

2 Literature

Perceived income adequacy is a concept which is associated with a large variety of terms. First of all, PIA is naturally associated with objective income. However, it has been stated early that it is not determined by income alone (Thompson and Streib, 1958; Hansen et al., 1965; Youmans, 1966; Peterson, 1972; Tissue, 1972; Hazelrigg and Hardy, 1997). Several studies underlined this statement more recently. Litwin and Sapir (2009) found that, besides the level of income, health status and education level have a direct effect on judgments of income adequacy. Furthermore, results of a study conducted by Sumarwan and Hira (1993) show that locus of control, an individuals' perception of their ability to control what happens to them (Rotter, 1966), and socio-demographic variables, such as gender and age, have a direct effect as well. A study of Chan et al. (2002) confirms these findings, and even clarifies them more deeply. They found that not only socio-demographic characteristics, but also socio-demographic transitions influence subjective measures of income. For instance, changes in marital status and work status turned out to be significant predictors of changes in perceived income adequacy.

Where Sumarwan and Hira (1993), Litwin and Sapir (2009) and Chan et al. (2002) agree about the effects of socio-demographic variables, their results about the influence of objective income differ. In particular, Sumarwan and Hira (1993) and Litwin and Sapir (2009) argue that household income and net worth affect perceived income adequacy directly, whereas Chan et al. (2002), supported by Veenhoven and Saris (1996) and Michalos (1985), argue that the objective level of income have little relationship to subjective measures of income. Liang and

Fairchild (1979) found the effect of income to be indirectly related through the feelings of relative deprivation. This means that it is not income itself, but the level of income compared to peers that affects the subjective measures of income.

Perceived income adequacy is also often associated with financial satisfaction. However, where in earlier mentioned studies PIA was the dependent variable, most existing literature about the relationship between PIA and financial satisfaction uses PIA as an explanatory variable. Grable et al. (2013) examined whether a PIA bias exists and whether that bias can be useful in explaining financial satisfaction. It turned out that people who perceive their income level to be below their living standard exhibit a lower financial satisfaction than people who perceive their income level to be in excess of their standard. Sumarwan and Hira (1993) hypothesized that perceived income adequacy, perceived locus of control and socio-economic characteristics directly influence satisfaction with financial status. Results confirmed this hypothesis: Not only perceived income adequacy, perceived locus of control and several socio-economic characteristics, such as age and employment status, have a significant effect, but perceived locus of control also has an indirect effect through PIA.

As earlier mentioned, Litwin and Sapir (2009) reported health to have a significant effect on perceived income adequacy: elderly who rate their functional health more positively, tend to assess their income to be more adequate. Functional health is the health one has for activities of daily living, physically and mentally. Chan et al. (2002); Pereira and Coelho (2013); Gildner et al. (2016) all underline this positive correlation. However, Pereira and Coelho (2013) turn around the causality: individuals who assess their income as adequate, tend to be more satisfied with their subjective well being. Besides functional health, self-rated health (SRH) is also linked to PIA in existing literature. For instance, Nummela et al. (2007) reported PIA to be a significant predictor of self-rated health.

Besides health, Litwin and Sapir (2009) also reported age to have a significant effect on perceived income adequacy. According to the existing literature, age appears to be an important predictor for perceived income adequacy. Hansen et al. (1965); Herzog and Rodgers (1981); Sumarwan and Hira (1993); Hazelrigg and Hardy (1997); Stoller and Stoller (2003) all observe older adults to report greater income adequacy compared to younger adults. However, Litwin and Sapir (2009) reported the effect of age of oldest-old[1] to be so excessive, that it almost is not credible. Furthermore, Gildner et al. (2016) argue this relationship to vary cross-culturally. Possible explanations given for this are differences in familial and governmental financial support.

Another aspect of perceived income adequacy is its dynamic nature. Kaya (2014) used a

[1]Litwin and Sapir (2009) define the oldest-old to be 80 years and older, this paper follows this definition.

dynamic probit model to examine the persistence of perceived income inadequacy. Results show that the history of perceptions is relevant to its current perceptions. Dominitz and Manski (1997) and Das and Donkers (1999) argue that not only history is relevant, but the expectation regarding future financial status also influences the current perceived income adequacy.

In contrast to all variables mentioned above, consumption is often overlooked as a determinant of perceived income adequacy. Litwin and Sapir (2009) even argue that there does not exist an association between consumption and perceived income adequacy. However, several connections imply that they are related. As mentioned in Section 1, Hooyman and Kiyak (2008) argue that elderly may respond to lessened income by adjusting their living standards downward, so lowering their consumption level. As income is an often used determinant, consumption level could also be correlated with PIA. Furthermore, as also mentioned in Section 1, observing the association Litwin and Sapir (2009) found between age and PIA, and the correlation Banks et al. (1998) found between age and consumption level, could imply that PIA and consumption are related. Not only could they be related, their relation could also be an explanation for the excessive significance of age among oldest-old, found by Litwin and Sapir (2009).

This paper will follow current literature (especially Litwin and Sapir (2009)) by analyzing the nature of perceived income adequacy. However, as most current literature uses cross-sectional data, this paper will increase the understanding of the underlying factors of perceived income adequacy by using longitudinal data. Furthermore, this paper also extends current literature by better examining the relationship between consumption level and perceived income adequacy and age.

3 Data

This study uses data from the Survey of Health, Ageing and Retirement in Europa, also known as SHARE[2]. According to the SHARE website, SHARE is "*a multidisciplinary and cross-national panel database of micro data on health, socio-economic status and social and family networks of about 140,000 individuals aged 50 or older (around 380,000 interviews). SHARE covers 27 European countries and Israel.*" Respondents are interviewed over seven waves during a period of approximately fifteen years, where not every respondent participated in every wave. Interviews are done in a computer-assisted face-to-face way.

The remainder of this section will discuss the variables and samples used in this research: this will be done for the replication in Section 3.1 and for the extension in Section 3.2.

[2]Information about SHARE comes from the SHARE website http://www.share-project.org (accessed May 25, 2019)

3.1 Replication

For the replication part of this study, only wave 1 of the SHARE database is used. Respondents of twelve different countries participated in this wave: Austria, Belgium, Denmark, France, Germany, Greece, Israel, Italy, Netherlands, Spain, Sweden and Switzerland. In the next subsection, the variables used for replication will be outlined. Further, this section shortly describes how the final sample is obtained.[3]

3.1.1 Variables used for replication

The dependent variable of this analysis is the perceived income adequacy. Respondents were asked the question, "*Thinking of your household's total monthly income, would you say that your household is able to make ends meet?*", on which they could answer with '*With great difficulty*'/'*With some difficulty*'/'*Fairly easily*'/'*Easily*'. Following Litwin and Sapir (2009), answers are recoded into a binary variable: Individuals who reported difficulty- i.e., responded one of the first two answers, are given a 1, others are given a 0.

Litwin and Sapir (2009) stated that the independent variables can be distinguished in four main groups: *socio-demographic background characteristics that shape economic capacity in older age, including employment status*; *objective measures of income and wealth, including absolute and relative indicators*; *functional health status as a reflection of need and possible dependency*; *subjective expectations regarding one's financial future.*

The first group includes the following variables: age, gender, employment status and level of education. Age is recoded in the categories '*50-59*'/'*60-69*'/'*70-79*'/'*80+*'. Besides, employment status is also categorized in several groups, namely '*Employed*'/'*Retired*'/'*Unemployed*'/'*Sick/Disabled*'/'*Housemaker*'. In contrast to the first three, variables level of education is not harmonized for international comparison. For this, the level of education computed by United Nations Educational, Scientific, and Cultural Organization (UNESCO) is used, called The International Standard Classification of Education (ISCED). After this harmonization, ISCED is recoded in three groups representing low, average and high education levels[4].

The second component is defined by measures of monthly individual income, individual net worth and relative income. Monthly individual income is computed using monthly household income, which is in turn based on self-reports of gross individual income from pensions, employment, transfers and long term care (Brugiavini et al., 2005). After adjusting for relative

[3]This section completely follows Litwin and Sapir (2009) in their selection of variables and choices regarding those variables, unless stated otherwise.

[4]ISCED 1997 levels of education is used here, which consists of the education levels 0 to 6. Respondents with education levels (0,1,2); (3,4); (5,6) are classified in groups of (low);(average);(high) education levels, respectively.

purchasing power parity (PPP) within country and standardizing for the household size square root, an individual income measure is computed. After also adjusting for purchasing power parity and household size, a net worth variable is computed based on primary residence, bank accounts, stock holdings, and other sources, after deducting financial liabilities (Christelis et al., 2005). Both the individual income measure and the individual net worth are classified in three groups of equal size, representing low, average and high income and net worth, respectively. Relative income consists of a dummy variable, where an 1 represents an income of an individual to be higher or equal to the sample median of individual incomes and a 0 represents otherwise. Here, the sample including respondents with missing values is used.

The functional health status component consists of two binary variables: one for representing physical health and one for mental health. Physical health is measured by asking respondents six questions about physical limitations regarding activities in their daily life, such as showering and getting out of bed. If a respondent reported to have at least one limitation, their binary variable is 1, 0 otherwise. Mental health is measured on the EURO_D scale (Castro-Costa et al., 2007). Respondents were given twelve questions about their health symptoms, such as irritability and trouble sleeping. Following Litwin and Sapir (2009), the binary variable is 1 if the respondent reports experiencing more than three symptoms.

The last component consists of two variables, optimism and pessimism. Respondents are asked the two questions "*What are the chances that five years from now your standard of living will be better/worse than today?*", in which the answer scale ranges from 0 to 100. If an individual reports a chance higher than 50% for improvement (worsening), a value of 1 is given for the optimism (pessimism) variable, 0 otherwise.

3.1.2 Final sample

In total, 30,424 individuals responded in SHARE wave 1. As this research focuses on people aged 50 or older, people under 50 years of age are deleted from the sample. Furthermore, in contrast to the variables for which imputations are used (monthly individual income; individual net worth; relative income (Brugiavini et al., 2005; Christelis et al., 2005)), almost all other variables contain missing values. After omitting all observations with missing values, the sample used consists of 26,050 respondents. The summary of all the observations deleted can be found in Appendix Table A1 and a table of descriptive statistics can be found in Appendix Table B1.

3.2 Extension

For the extension part of this study, longitudinal data are used. To make the sample representative, weights are calibrated using a report of De Luca and Rossetti (2018). That paper gives a description of how to obtain weights using data from Eurostat, the statistical office of the European Union. This database contains population figures and number of deaths by year, region, age and gender, for every country.

Initially, waves 3 and 7 are not suited for this research: in wave 3 respondents are asked different questions than in the other waves, and wave 7 is not suited due to representative purposes[5]. For analyzing purposes it is useful to use at least three waves, because in that case multiple differences regarding values of variables can be observed per individual, which increases validity of the research. Furthermore, only individuals who participated in all the waves used for this research, are included in the sample. This is because for respondents who do not respond in one or more waves of those waves, calibrating weights is computationally hard and goes beyond the extend of this research. For this, after comparing all possible combinations consisting of three waves or more, waves 4,5 and 6 turned out to contain the most individuals who responded in all of those waves: $29,457$. Combining those individuals with the calibrated weights, the sample used in this research will be representative for the population between 2011 and 2015 of people aged 50+ living in Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, Slovenia, Spain, Sweden and Switzerland.

In the next subsection, variables used for extension are discussed. Eventually, the remainder of this section describes how the final sample for the extension part is obtained.

3.2.1 Variables used for extension

In general, the variables used for extension are the same as the variables used for replication, i.e., the variables Litwin and Sapir (2009) used for their analysis and discussed in Section 3.1.1. However, a few variables are adjusted, deleted or added.

The first adjustment for the extension part is for monthly individual income. This variable is computed the same way as in the replication part. The only difference is that, after computing, instead of categorizing the monthly individual income into three equal-size groups, the logarithm of the monthly individual income is taken and used for the extension. In the remainder of this report the reason for this will become clear. Besides, a new category is added for the variable employment status, named '*Other*'. Litwin and Sapir (2009) perceived it as a missing value

[5]Data of the year of wave 7, 2017, is not yet included in the Eurostat database. For this, wave 7 cannot be used to compute weights and thus cannot be included in this research.

when respondents answered '*Other*' while asked about their employment status. However, as it is preferred to delete as less observations as possible, the extension analysis will treat '*Other*' as a category itself.

The variables used for replication, but not used for extension, are optimism and pessimism. From wave three on, respondents are not asked for their expectations regarding their standard of living. For this, it is not possible to use those variables in a regression.

The first variable added in the extension is self-rated health. The reason for this is that Nummela et al. (2007) reported a correlation between self-rated health and PIA. Respondents are asked how they rate their health in general, on which they can answer with '*Excellent*'/'*Very good*'/'*Good*'/'*Fair*'/'*Poor*'. On the basis of their responses, a binary variable is computed: an 1 is given when a respondent answered '*Fair*' or '*Poor*, 0 otherwise. Subsequently, because of results found by Chan et al. (2002), the marital status of respondents is added in the extension. This variable is categorized in the following six categories: '*Never married*'/'*Married, living with spouse*'/'*Registered partnership*'/'*Married, not living with spouse*'/'*Divorced*'/'*Widowed*'. Furthermore, the variable drinking is included in the extension. For this variable, an 1 indicates that a respondent drinks more than 2 glasses of alcohol almost everyday, 0 otherwise. This variable is included in this analysis for identification purposes, which will be made clear in Section 4.1. Lastly, as this research analyzes the correlation between expenditures and PIA, monthly individual expenditures are used in the extension. This variable is computed using monthly household expenditures, which in turn is based on rent and home-related expenditures, food consumption and home produced consumption (De Luca et al., 2015). After adjusting for relative purchasing power parity (PPP) within country and standardizing for the household size square root, the logarithm of this measure is taken and included in the extension.

3.2.2 Final sample

As earlier mentioned, 29457 individuals responded in SHARE waves 4, 5 and 6. Again, people under the age of 50 are not included in the sample. Subsequently, people who did not respond on the questions about making ends meet are omitted from the sample. As only one respondent of a participating household, the so-called household respondent, responded to this question, almost half of the sample is omitted[6]. This differs from Litwin and Sapir (2009), where respondents who did not answer this questions are assigned the answer given by the corresponding household respondent. This paper chooses not to follow Litwin and Sapir (2009) in this, because the goal of this study is to better understand the underlying factors of the answer people give on the 'making

[6]Note that this can be done because representativeness is still achieved due to the weights

ends meet question'. The results will be biased if one researches this with answers individuals in reality did not give. Furthermore, because almost half of the sample is already omitted, it is undesirable to delete more. For this, multiple imputations are used for all other variables (De Luca et al., 2015). Table 1 shows the descriptive statistics of the sample and a summary of all the observations deleted can be found in Appendix Table A1.

First of note in Table 1 are the high F-statistics, which indicate that every variable is significantly correlated with perceived income adequacy. One possible explanation for the high F-statistics is the use of multiple imputations, which increases the number of observations and thus increases the sum of residuals, what leads to a higher F-statistic. Another possible explanation is the use of weights: since all weights consist of a value bigger than 1 and the weights are taken into account when computing the F-statistic, the sum of residuals gets larger than it in reality is (without weights), which also leads to a higher F-statistic.

Second, it can be observed that proportionally 5% more of the women than of the men perceive their income as inadequate. Further, the oldest-old, who include only 9.59% of the sample, are more inclined to perceive their income as adequate than younger individuals. The same applies to education levels: individuals[7] with a high level of education perceive their income more as adequate than individuals with an average or low level of education. Regarding employment status, people who do not work are most likely to perceive their income as inadequate as 77.73% of all unemployed people, 60.6% of all sick/disabled people and 62.76% of all homemakers perceive their income to be inadequate.

Regarding marital status, the distribution of the sample across categories differs a lot. The category including most people, 'married, living with spouse', differs approximately 45% in size with the category including the least people, registered partnership. However, differences in numbers of individuals who perceive their income as inadequate are proportionally smaller, with a largest difference of 14 in terms of percentages.

Economic variables net worth and relative income both project the same effect: people with a higher net worth or an income above the sample median are more likely to perceive their income as adequate. Economic variables income and expenditures range from 0 to $1,231,103$ and from 640 to 39867.24, respectively. Because those variables are not categorical, percentages of difficulty in making ends meet are not computable.

Furthermore, in every of the three health variables, people belonging to the healthy categories are more represented compared to people belonging to the unhealthy categories, with percentages of 60% or higher. Further, there can be encountered that people with less health are more likely to

[7]Note that in this context this paper does not talk about real individuals, but about fictional individuals obtained by the use of weights. due to the use of weights.

Table 1: Descriptive statistics of the variables used in the extension, measured with the data of wave 4 and calibrated weights

		Univariate Statistics			Difficulty making ends meet	
Categorical variables	Category	%[a]			%[b]	F-statistic[c]
Gender	Men	45.46			38.95	258,667.27*
	Women	54.54			43.85	
Age (years)	50-59	38.12			46.76	256,813.29*
	60-69	30.34			38.27	
	70-79	21.95			40.12	
	80+	9.59			35.27	
Education	Low	40.45			55.65	2,900.82*
	Average	38.02			38.19	
	High	21.53			21.33	
Employment status	Employed	33.83			37.18	579273.92*
	Retired	47.79			36.06	
	Unemployed	3.72			77.73	
	Sick/disabled	3.68			60.6	
	Homemaker	9.57			62.76	
	Other	1.41			48.74	
Marital status	Never married	12.75			44.02	1126.3*
	Married, living with spouse	46.85			37.25	
	Registered partnership	1.19			51.28	
	Married, not living with spouse	2.7			47.33	
	Divorced	14.8			49.38	
	Widowed	21.72			43.14	
Net worth	Low	29.98			60.11	591.97*
	Average	33.1			43.95	
	High	36.92			24.53	
Relative income	<Median	61.18			55.48	534.36*
	>Median	38.82			19.79	
EURO-D	No	70.74			35.83	11,353.16*
	Yes	29.26			55.63	
Disability	No limitations	89.96			40	981,362.59*
	1+ limitations	10.04			56.17	
Self-rated health	Good	63.69			33.59	4,722,552.91*
	Not good	36.31			55.72	
Drinking	No	84			42.13	542.64*
	Yes	16			38.96	
Country	Austria	2.62			20.78	637,832.10*
	Belgium	3.43			30.85	
	Czech Rep.	3.23			55.36	
	Denmark	1.72			14.1	
	Estonia	0.41			55.61	
	France	20.29			35.82	
	Germany	27.85			34.63	
	Italy	20.32			58.09	
	Slovenia	0.66			62.78	
	Spain	13.98			55.07	
	Sweden	3			17.11	
	Switzerland	2.47			16.70	
Continuous variables		mean	min	max		
Income	$log(income)$	6.96	-2.48	14.02		365.86*
Expenditures	$log(expenditures)$	8.58	6.46	10.59		694.09*

Notes: Because weights are used in this table, the number of observations n is not interpretable. For this, only percentages are given in the table.
%[a]: percentage of sample who belongs to the respective category.
%[b]: percentage of respective category who reports difficulty in making ends meets.
F-statistic[c]: H_o: all coefficients of regression from corresponding variable on making ends meet are equal to zero.
*$p < .001$

perceive their income as inadequate: approximately 55% of all people with depression, a physical limitation or a bad self-rated health have difficulties making ends meet. Lastly, most individuals

from Denmark and Slovenia report their income to be adequate and inadequate, respectively.

4 Methodology

In this section, first the replication part is being discussed. Subsequently, the extension part is being discussed.

4.1 Replication

Litwin and Sapir (2009) perform a multivariate logistic regression using all explanatory variables discussed in 3.1. In this way, the association of predictor variable and perceived income adequacy can be examined, considering all other variables. In this regression, the coefficients and the odds ratio of the explanatory variables are being discussed. Additionally, Litwin and Sapir (2009) perform four regressions where the samples correspond to the age groups: one for all individuals aged 50-59, one for all individuals aged 60-69, and so forth.

4.2 Extension

To investigate the determinants of perceived income adequacy, with focus on the relationship between PIA, age and expenditures, a simultaneous equation model (SEM) is used. This model consists of the lineair and logit functions

$$P(Y_{ij} = 1) = \frac{exp(X'_{ij}\beta + Z'_{ij}\omega)}{1 + exp(X'_{ij}\beta + Z'_{ij}\omega)} \tag{1}$$

$$E_{ij} = W'_{ij}\gamma + \eta_{ij}, \tag{2}$$

where Y_{ij} denote the binary variable indicating whether person i ($i \in 1, .., m$) experienced difficulty in making ends meet at time period j ($j \in \{1, ..., n\}$). The time period corresponds to the waves being used, so $n = 3$. Further, let X_{ij} denote a vector of exogenous variables and Z_{ij} a vector of endogenous variables used in Equation (1). In Equation (2), let E_{ij} denote the monthly expenditures and W_{ij} all (exogenous) variables of individual i on time period j. Additionally, let H_{ij} denote all exogenous variables in this simultaneous equation model.

In our analysis, X_{ij} consists of the following variables Litwin and Sapir (2009) used: gender, age, education, employment status, net worth, income, relative income, EURO-D, disability and country. In addition to this, the literature is followed (see Section 3.2.1) by including the variables marital status and self-rated health in X_{ij}. Z_{ij} consists of the variable expenditures, which is endogenous because it is the same as E_{ij} due to a correlation between income and

expenditures Hooyman and Kiyak (2008) reported. Furthermore, W_{ij} consists of the variables age, income[8] and drinking. Age is included because Banks et al. (1998) indicated a relationship between age and consumption level, income is included because this study examines whether the elderly adjust their consumption level to their income and drinking is included for identification purposes.

Note that wave dummies are also included in X_{ij} and W_{ij} to control for unexpected events between the waves. Besides, a constant is also included in both. Since both wave dummies and the constant are not relevant for this research, the remainder of this paper will ignore them. Additionally, note that all nominal variables mentioned above will use the same reference categories as used in the replication, to increase comparability.

4.2.1 Estimation

To estimate parameters β, ω and γ, a population-average model for longitudinal data is used. In contrast to person-specific models, population-average models estimate parameters on average for the entire population, which suits our research. An often used population-average model for longitudinal data is the Generalized Estimation Equation method (Hu et al., 1998). GEE has been first introduced in Liang and Zeger (1986), represented as a method to obtain consistent estimates of the parameters and their variance, without specifying the joint distribution of within-person observations. Assumed here is that observations across person are independent, which seems to be a reliable assumption in our case: only one respondent of a household answers the question about making ends meet, so the assumption holds if individuals from different households answer independently, which seems valid as the sample of households interviewed is picked at random (Börsch-Supan and Mariuzzo, 2005).

Despite not having to specify the joint distribution of within-person observations, the covariance structure must be specified. As the scientific focus here are the coefficient estimates and not the covariance structures, this study uses Huber-White standard errors (Huber et al., 1967; White et al., 1980). These standard errors are robust to misspecification of the covariance structures, so the estimates of the parameters and their variance will stay consistent.

Because no endogenous variables are included in Equation (2), the parameter vector γ can be estimated by solving generalized estimating equation (GEE)

$$\overrightarrow{S_\gamma}(\gamma) = \sum_{i=1}^{m} (\frac{\delta \overrightarrow{\mu_i^a}}{\delta \gamma})' Var(\overrightarrow{E_i})^{-1} (\overrightarrow{E_i} - \overrightarrow{\mu_i^a}) = 0, \tag{3}$$

[8]To better understand the relationship between expenditures and income in this regression, the logarithm is used instead of categorizing (Litwin and Sapir, 2009). One can also use the absolute incomes, but taking the logarithm decreases computation time.

where μ_i^a and E_i denote 3×1 vectors consisting of $W_{ij}\gamma$ and E_{ij} as given in Equation (2), respectively. Further, let m denote the number of respondents.

As Equation (1) does include an endogenous variable, parameters β and ω have to be estimated in a two stage approach. First, the endogenous variable expenditures is regressed on all exogenous variables in the system of equations (H_{ij}) using GEE, this comes down on solving

$$\overrightarrow{S_\theta}(\theta) = \sum_{i=1}^{m} (\frac{\delta \overrightarrow{\mu_i^b}}{\delta \theta})' Var(\overrightarrow{E_i})^{-1} (\overrightarrow{E_i} - \overrightarrow{\mu_i^b}) = 0, \tag{4}$$

where

$$\overrightarrow{\mu_i^b} = H_i \theta. \tag{5}$$

Let θ denote the parameter vector to be estimated when solving Equation (4).

Hereafter, Y_{ij} is regressed on X_{ij} and μ_{ij}^b using the logit model as specified in (1). This logistic regression is performed by solving the equation

$$\overrightarrow{S_\beta}(\beta) = \sum_{i=1}^{m} (\frac{\delta \overrightarrow{\mu_i^c}}{\delta \beta})' Var(\overrightarrow{Y_i})^{-1} (\overrightarrow{Y_i^1} - \overrightarrow{\mu_i^c}) = 0, \tag{6}$$

where μ_i^c denotes a 3×1 vector, consisting of $P(Y_{ij} = 1)$ as given in Equation (1), with Z_{ij} substituted for μ_{ij}^b.

When the discussed regressions are done, parameters γ and β and odds ratios will be considered to understand the nature of the perceived income adequacy and to determine whether it can be validated.

5 Results

In this section, the results of the longitudinal study will be given and compared to the results of the replication of the study conducted by Litwin and Sapir (2009). First, the estimated parameters of Equation (1) are given in Table 2.

First of note is the significance of all categories of age. Although not all categories are as significant as the results of the replication, where all categories are significant on a 0.001 level, an obvious pattern can be observed regarding age and perceived income adequacy: the older people get, the more they perceive their income to be adequate.

Further, the economic variables are a few of the most significant among all variables. So can be seen that if the income of a respondent increases with 10%, the probability of perceiving their income as adequate increases with with approximately 0.5%. Not only the absolute level of income is significant, but relative income also: results indicate that if an individual's income is below the median, the probability of perceiving their income as inadequate is 134% times

Table 2: Results of Equation (1)

Variable	Category	β/ω	Odds ratio	95% C.I. Odds Ratio
Gender[a]	Women	0.2	1.22	0.88-1.69
Age[b] (years)	60-69	-0.42**	0.66	0.50-0.86
	70-79	-0.57***	0.57	0.41-0.78
	80+	-0.94***	0.39	0.28-0.54
Education[c]	Low	1.15***	3.15	1.65-5.98
	Average	0.69**	1.99	1.20-3.31
Employment status[d]	Retired	0.11	1.12	0.77-1.62
	Unemployed	1.5***	4.48	2.02-9.95
	Sick/disabled	0.29	1.33	0.73-2.41
	Homemaker	0.6*	1.83	1.03-3.25
	Other	0.78	2.19	0.95-5.02
Marital status[e]	Married, living with spouse	-0.22	0.8	0.62-1.03
	Registered partnership	0.24	1.27	0.52-3.07
	Married, not living with spouse	-0.24	0.79	0.41-1.52
	Divorced	0.33	1.39	0.90-2.15
	Widowed	-0.3	0.74	0.51-1.06
Net worth[f]	Low	0.71**	2.02	1.29-3.18
	Average	0.48***	1.61	1.26-2.06
Income	$log(income)$	-0.12***	0.89	0.84-0.94
Relative income[g]	<median	0.85***	2.34	1.76-3.12
Consumption	$log(expenditures)$	2.98	19.77	0.07-5703.49
EURO-D[h]	Yes	0.31***	1.36	1.19-1.56
Disability[i]	1+ limitations	0.24**	1.27	1.07-1.51
Self-rated health[k]	Not good	0.39***	1.47	1.26-1.73
Country	Austria	0.84	2.31	0.37-14.28
	Belgium	1.3	3.67	1.24-10.87
	Czech Rep.	2.53	12.59	0.52-302.79
	Denmark	1.08	2.95	0.20-43.86
	Estonia	2.95	19.03	0.87-417.40
	France	1.95	7.01	0.84-58.52
	Germany	1.42	4.14	0.67-25.62
	Italy	2.73*	15.41	1.59-149.32
	Slovenia	3.57*	35.42	1.21-1035.88
	Spain	2.38	10.8	0.93-125.00
	Sweden	1.07	2.92	0.23-37.79

Notes: Odds Ratio = $exp(\beta)$ or Odds Ratio = $exp(\omega)$
[a]Reference: men.
[b]Reference: 50-59 years.
[c]Reference: high education.
[d]Reference: employed.
[e]Reference: never married.
[f]Reference: high net worth.
[g]Reference: >median.
[h]Reference: no depression.
[i]Reference: no physical disability
[j]Reference: good self-rated health
[k]Reference: Switzerland
*p<.05; **p<.01; ***p<.001

bigger than when that person's income is above the median. The last economic variable, net worth, turns also out to have a significant effect on PIA: individuals with a low (medium) net worth, have a probability of reporting their income as inadequate which is 102% (61%) higher than individuals with a high net worth. The results of the three previous mentioned economic variables are in agreement with the results of the cross-sectional study, where the economic variables are also significant. The only difference between the two studies is that the category of low net worth is less significant in the longitudinal studies than in the cross-sectional study: in the cross-sectional study it was significant on a respectively 0.001 level, in the longitudinal study on a 0.01 level.

The outcomes of the health variables also underscore the findings of Litwin and Sapir (2009): the better the health of an individual, the less likely that person is to perceive their income as inadequate. Depressive people are 36% times as likely to perceive their income as more adequate than people who are not depressive. Further, people who rate their own health as good, are 32% less likely to rate their income adequacy as inadequate. Additionally, where disability was significant a 0.001 level in the cross-sectional study, in the longitudinal study it is of less significance, namely at a 0.05 level. A possible explanation for this is that self-rated health was not present in the cross-sectional study, and a part of the effect of disability on PIA in the longitudinal study goes indirectly through self-rated health.

Where in the cross-sectional study both categories of education have a significant effect on PIA on a 0.001 level, the effect of average education is in the longitudinal study significant on a 0.01 level and thus less significant. Apart from the differences in significance, the implications of the coefficients stay the same: in both the cross-sectional and longitudinal studies applies that people with higher education levels have higher probabilities of reporting their income as adequate. In the longitudinal study, people with an average (low) education level are 99% (215%) more likely to report their income as adequate than people with a high education level.

The least significant variables in the longitudinal study are gender, employment status, marital status, country and expenditures. For gender and employment status these results are unexpected, as both have significant effects on PIA in the cross-sectional study. The effect of gender even changed: in the longitudinal study women are more likely to perceive their income as inadequate whereas in the cross-sectional study men are more likely[9]. For employment status, only unemployment is of significance when evaluating perceived income adequacy as unemployed people are approximately 350% as likely to perceive their income as inadequate relative to employed individuals. Further, the influence found by Chan et al. (2002) of marital status on PIA,

[9]After performing regressions without weights or with only one of the three waves, they all confirm the finding that women are more likely to perceive their income as inadequate.

cannot be confirmed by this research: all categories of marital status result to be insignificant. Subsequently, results of the cross-sectional analysis indicate that seven out of eleven parameters representing the countries have an significant effect on PIA, whereas in the longitudinal study only three parameters are of significance. Although it must be noted that in both studies different countries are present, which makes it harder to compare results.

Although the coefficient and odds ratio of expenditures are strikingly high, this variable does not have a significant effect on perceived income adequacy. When looking at the estimates of Equation (2), as shown in Table 3, it can be observed that income has a significant effect on expenditures and age has not, thus that elderly do adjust their expenditures to their income: the less income one has, the less one spends in a regular month, regardless their age. However, as expenditures do not have a significant effect on PIA, lower or higher expenditure levels will not influence the perception of making ends meet, this can be seen as that elderly do not perceive their income as more adequate because of adjustment of their standard of living to their income level. Because we use a two-stage approach for estimating Equation (1) and we observe that income has a significant effect on expenditures, it could be possible that the effect of expenditures on PIA is represented through the effect of income on PIA. For this, an additional regression of Equation (2) is performed, without the income variable. The coefficient of expenditures is then estimated to be -4.33, with an p-value of 0.12, and thus is still not significant.

Table 3: Results of Equation (2)

Variable	Category	γ	Odds Ratio	95% C.I. Odds Ratio
Age[a] (years)	60-69	0.02	1.02	0.99-1.06
	70-79	0	1	0.96-1.04
	80+	-0.03	0.97	0.93-1.02
Income	$log(income)$	0.02***	1.02	1.02-1.03
Drinking[b]	Yes	0.05**	1.05	1.01-1.08

Notes: Odds Ratio = $exp(\gamma)$
[a]Reference: 50-59 years.
[b]Reference: ≤ 2.
*$p < .05$; **$p < .01$; ***$p < .001$

All results from the replication of Litwin and Sapir (2009), can be found in appendix C.

6 Conclusion

This paper studied the determinants of perceived income adequacy. First, the research conducted by Litwin and Sapir (2009) is replicated. This replication used data from SHARE wave 1 and is done by performing a logistic regression. In this way, people from Austria, Belgium, Denmark, France, Germany, Greece, Israel, Italy, Netherlands, Spain, Sweden and Switzerland are analyzed. Subsequently, this research is extended in a longitudinal way by using waves 4, 5 and 6 of SHARE. This extension analysis used a simultaneous equation model (SEM), of which one equation consisted of a lineair model and the other of a logit model. The parameters of these equations are estimated by a generalized estimating equations (GEE) model using multiple imputations and weights. This part of the study is representative for people aged 50 or older from Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Italy, Slovenia, Spain, Sweden and Switzerland are analyzed.

The variables with the most significant effect on perceived income adequacy were the economic variables income, relative income and net worth. This confirms the findings of Litwin and Sapir (2009) that perceived income adequacy has a economic basis, and thus that reporting difficulty in making ends meet reflects lower financial capacity. Because of this, perceived income adequacy is validated and could be used to make policy about the elderly. However, there are other (non-economic) factors that are also significant, and thus should be also taken into account when evaluating perceived income adequacy.

Corresponding to results of Litwin and Sapir (2009), the effect of age on PIA is also significant: the older people get, the less they perceive their income to be inadequate. However, our research also found that age does not have a significant effect on the level of expenditures, so the effect of age on PIA has to be explained by other phenomenona, e.g., older people tend to worry less about their financial status or older people have saved enough money throughout their life. The latter could be reflected through net worth, but as the correlation between net worth and age is not studied in this paper, this can be done in further research.

Besides age, health also have a significant on PIA. Individuals with less health are more likely to perceive their income as inadequate, which could be possible explained by noting that unhealthy people are forced to spend more money on health care. Furthermore, the level of education of an individual also reported to have a significant effect on PIA and thus should be also taken into account when making policy. Both significances of health and education are underscored by the findings of Litwin and Sapir (2009).

This research also found several factors to have less significant effects on PIA, consisting of

gender, employment status, marital status, country and expenditures. These variables are thus of less importance when evaluating perceived income adequacy. However, results indicate that lower incomes result in lower expenditures and thus elders adjust their standard of living to their income level. As this study did not look into the effect of individual's adjustment of expenditure behaviour, but only at whether lower expenditure levels result in a better perception of income adequacy in general, the effect of adjusting this behaviour on PIA cannot be completely ruled out, but the first indications are that this adjustment does not effect the PIA.

To make more bold statements about the correlation between expenditures and perceived income adequacy, further research has to be done. This could be done by dividing an individuals' expenditures in several groups, such as expenditures for food, health care and clothing. In this way, the correlation between both variables could be better investigated. Furthermore, the variable relative income could be computed otherwise. Instead of taking the sample median as reference point, could the median of a specific country also be the reference point for people of the corresponding country. Finally, the topic of household respondents could be better analyzed. In this research, only household respondents answered the question about perceived income adequacy. Although this paper adjusted for this by using weights, it could also be the case that household respondents answer differently than non household respondents, due to non-measurable variables. For instance, household respondents could be more financially conscious than non household respondents.

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A Sample selection

Table A1: Sample selection of the replication and extension

	Variable	Replication	Extension
Total sample		30424	29457
	Age (< 50)	-1059	-495
Subtotal		29365	28962
	PIA	-491	-14088
Subtotal		28874	14874
	Gender		
	Age	-2	
	Education	-278	
	Employment status	-464	
	Marital Status		
	Net worth		
	Income		
	RelInc		
	Expenditures		
	EURO-D	-570	
	Disability	-5	
	Self-rated Health		
	Pessimism	-1505	
	Optimism		
	Drinking		
	Country		
Final sample		26050	14874

Note: this table shows the number of omitted observations per variable.

B Descriptive statistics replication

Table B1: Descriptive statistics from all variables used in the replication

	Univariate statistics			Difficulty making ends meet	
Variable	Category	n	$\%^a$	$\%^b$	$\chi^{2\ c}$
Gender	Men	12046	46.2	35.3	39.37*
	Women	14004	53.8	39	
Age (years)	50-59	9791	37.6	37.3	5.94
	60-69	8419	32.3	36.8	
	70-79	5607	21.5	38.5	
	80+	2237	8.6	35.9	
Education	Low	13144	50.5	47.6	1320.9*
	Average	7900	30.3	30.1	
	High	5006	19.2	21.7	
Employment status	Employed	7676	29.5	29.1	707.63*
	Retired	12678	48.7	36.1	
	Unemployed	827	3.2	57.7	
	Sick/disabled	858	3.3	56.4	
	Homemaker	4011	15.4	48.3	
Net worth	Low	8683	33.3	50.2	1480.53*
	Average	8683	33.3	39.2	
	High	8684	33.3	22.5	
Income	Low	8683	33.3	59.8	3219.08*
	Average	8682	33.3	32.7	
	High	8685	33.3	19.3	
Relative income	< Median	12735	48.9	53	2671.25*
	≥ Median	13315	51.1	22.3	
EURO-D	No	19603	75.3	32.3	823.14*
	Yes	6447	24.8	52.4	
Disability	No limitations	16401	63	32.3	469.17*
	1+ limitations	9649	37	45.8	
Pessimism	No	19029	73.1	35.2	127.68*
	Yes	7021	27	42.9	
Optimism	No	22586	86.7	37.1	3.34*
	Yes	3464	13.3	38.7	
Country	Austria	1450	5.6	25.2	4122.37*
	Belgium	3401	13.1	28.9	
	Denmark	1482	5.7	18.6	
	France	2417	9.3	33.6	
	Germany	2710	10.4	25.9	
	Greece	2429	9.3	70	
	Israel	1751	6.7	59.2	
	Italy	2310	8.9	66.2	
	Netherlands	2497	9.6	19.3	
	Spain	1937	7.4	58.1	
	Sweden	2797	10.7	19.6	
	Switzerland	869	3.3	17.6	

Notes: $\%^a$: percentage in corresponding category, relative to the whole sample.
$\%^b$: percentage reporting difficulty in making ends meets, relative to the corresponding category.
$\chi^{2\ c}$: H_o: all coefficients of regression from corresponding variable on making ends meet are equal to zero.
*$p < .001$

C Code for computing weights

```
*-------------------------------------------------------------------------------
* Set Stata
*-------------------------------------------------------------------------------
clear
set linesize 100
*cd "...."              // set your working directory here
*adopath ++ "...."      // set your adopath directory here
*local SHARE_w1 "..."   // set the SHARE data directory here
*-------------------------------------------------------------------------------




*-------------------------------------------------------------------------------
* Select country, initial wave and final wave
*-------------------------------------------------------------------------------
global wi 4                             // initial wave //
global wf 6                             // final wave //
global cc "CH"                          // country label //
global cc_num "20"                      // country number //
global pop_time 2011                    // reference year //
global mort_time 2015                   // final year //
global w "l_`wi'_`wf'"
global age_groups 4                     // number of age groups
global age_thr_low "80 70 60 50"        // lower thresholds of age groups
global age_thr_upp "130 79 69 59"       // upper thresholds of age groups
*-------------------------------------------------------------------------------


*-------------------------------------------------------------------------------
local wi            ${wi}               // initial wave //
local wf            ${wf}               // initial wave //
local cc            ${cc}               // country label //
local cc_num        ${cc_num}           // country number //
local w             ${w}
*-------------------------------------------------------------------------------
```

(a) Part 1 of 4

```
*-------------------------------------------------------------------------------
* Run CalMar_long.do
*-------------------------------------------------------------------------------
noi run CalMar_long.do
*-------------------------------------------------------------------------------


*-------------------------------------------------------------------------------
* Number of calibration equations
*-------------------------------------------------------------------------------
* No NUTS1 for longitudinal weights
matrix ${cc}_w${w}_P_MARG = ${cc}_w${w}_P_SA
noi mat li ${cc}_w${w}_P_MARG

mata: st_matrix("C1",rows(st_matrix("${cc}_w${w}_P_SA")))
local C1 = C1[1,1]
mata: st_matrix("C",rows(st_matrix("${cc}_w${w}_P_MARG")))
local C = C[1,1]
local C2 = `C' - `C1'
local nag = `C1' / 2

assert `C1'==8
assert `C2'==0
*-------------------------------------------------------------------------------


*-------------------------------------------------------------------------------
* Load my SHARE dataset and select the country-data
* - `long_weights_x_co007_wi_x_all_resp_without_imp' is the datafile consisting
*    of all used data.
* - ResCo007I_w`wi'_`wf' is a dummyvariable indicating whether an individual
*   responded to the making ends meet question from wave `wi' till wave `wf'.
*-------------------------------------------------------------------------------
qui use long_weights_x_co007_wi_x_all_resp_without_imp, clear
qui keep if country_w`wi' ==`cc_num' & ResCo007I_w`wi'_`wf' == 1
*-------------------------------------------------------------------------------
```

(b) Part 2 of 4

```
*-------------------------------------------------------------------------------
* Calibration variables
*-------------------------------------------------------------------------------
sum age_w`wi' gender_w`wi' dw_w`wi'
*-------------------------------------------------------------------------------


*-------------------------------------------------------------------------------
* Binary indicator for missing weights
*-------------------------------------------------------------------------------
// qui gen nowi=(dw_w`wi'==.|gender==.|age==.|region==.|age<50)
qui gen nowi = (dw_w`wi'==.|gender_w`wi'==.|age_w`wi'==.|age_w`wi'<50)
noi tab nowi, mis
*-------------------------------------------------------------------------------


*-------------------------------------------------------------------------------
* Binary indicators for calibration groups
*-------------------------------------------------------------------------------
local t = 1
forvalues ss=1(1)2 {
  forvalues aa=1(1)`nag' {
    local lb = ${cc}_w${w}_P_AGE_THR[`aa',1]
    local ub = ${cc}_w${w}_P_AGE_THR[`aa',2]
    if `aa'==1 qui gen xi_`t'=(age_w`wi'>=`lb')*(age_w`wi'!=.   )*(gender_w`wi'==`ss') if nowi!=1
    else       qui gen xi_`t'=(age_w`wi'>=`lb')*(age_w`wi'<=`ub')*(gender_w`wi'==`ss') if nowi!=1
    local t = `t' + 1
  }
}
forvalues i=1(1)`C2' {
  local i2 = `C1' + `i'
  qui gen xi_`i2' = (region==`i' & age_w`wi'>=50 & age_w`wi'!=. & gender_w`wi'!=.) if nowi!=1
}
list mergeid gender_w`wi' age_w`wi' xi_1-xi_8 if _n<=5, noobs
// list mergeid region xi_9-xi_23       if _n<=5, noobs
*-------------------------------------------------------------------------------
```

(c) Part 3 of 4

```

*-------------------------------------------------------------------------------
* Compute calibrated weights (distance function: chi2 - case 6)
*-------------------------------------------------------------------------------
local list_CVar ""
forvalues i=1(1)`C' {
  local list_CVar `list_CVar' xi_`i'
}
sreweight `list_CVar' if nowi!=1 & dw_w`wi'!=.,   ///
    nweight(my_wgt) sweight(dw_w`wi')             ///
    total(${cc}_w${w}_P_MARG)                  ///
    dfunction(chi2) upbound(10) lowbound(.01)     ///
    niter(1000)
*-------------------------------------------------------------------------------
```

(d) Part 4 of 4

Figure 1: Main program for calibrating weights (example obtained from the SHARE data and specified for this research)

```
qui {
//------------------------------------------------------------------------------------------------------------
// Set macros
//------------------------------------------------------------------------------------------------------------
local cc            ${cc}              // country
local cc_num        ${cc_num}          // country number //
local pop_time      ${pop_time}        // reference year
local mort_time     ${mort_time}       // final year
local w             ${w}
local age_groups    ${age_groups}      // number of age groups
local age_thr_low   ${age_thr_low}     // lower thresholds of age groups
local age_thr_upp   ${age_thr_upp}     // upper thresholds of age groups
//------------------------------------------------------------------------------------------------------------


//------------------------------------------------------------------------------------------------------------
    *-----------------------------------------------------------------------------
    * `margin_nuts1' is the database containing all population figures from Eurostat
    *-----------------------------------------------------------------------------
    use "margins_nuts1", clear
    keep if country=="`cc'"

    gen age_mort = age - (year-`pop_time')
    local age_min: word `age_groups' of `age_thr_low'
    local age_max: word 1            of `age_thr_upp'
    drop if age<`age_min'
    assert age>=`age_min'&age<=`age_max'

    * Joint age-sex classification
    local rname ""
    local t=1
    matrix `cc'_w`w'_P=0
    cap matrix drop `cc'_w`w'_P_AGE_THR
    cap matrix drop `cc'_w`w'_P_SA
    forvalues ss=0(1)1 {
        if `ss'==0 local slab "M"
```

(a) Part 1 of 3

```
        if `ss'==1 local slab "F"
        forvalues aa=1(1)`age_groups' {
            local age_upp: word `aa' of `age_thr_upp'
            local age_low: word `aa' of `age_thr_low'
            sum pop     if year==`pop_time'                                          & (sex==`ss') & (age>=`age_low' & age<=`age_upp')
            local marg_`t'=r(sum)
            sum deaths  if year>=`pop_time' & year<`mort_time'  & (sex==`ss') & (age_mort>=`age_low' & age_mort<=`age_upp')
            local marg_`t'=`marg_`t''-r(sum)
            assert `marg_`t''>0
            matrix `cc'_w`w'_P = `cc'_w`w'_P + `marg_`t''
            matrix `cc'_w`w'_P_SA = nullmat(`cc'_w`w'_P_SA) \ (`marg_`t'')
            if `aa'==1  local rname "`rname' `slab'-`age_low'+"
            else            local rname "`rname' `slab'-`age_low'-`age_upp'"
            if `ss'==0  matrix `cc'_w`w'_P_AGE_THR = nullmat(`cc'_w`w'_P_AGE_THR) \ (`age_low',`age_upp')
            local t=`t'+1
        }
    }
    matrix coln     `cc'_w`w'_P_SA      =POP
    matrix rown     `cc'_w`w'_P_SA      =`rname'
    matrix coln     `cc'_w`w'_P         =POP
    matrix rown     `cc'_w`w'_P         =TOT
    matrix coln     `cc'_w`w'_P_AGE_THR = "age_thr_low age_thr_upp"
    noi matrix list `cc'_w`w'_P
    noi matrix list `cc'_w`w'_P_SA

    * NUTS1 classification
    tab nuts1
    local nreg=r(r)
    if `nreg'>1 {
        cap matrix drop `cc'_w`w'_P_NUTS1
        local rname ""
        local t=1
        encode nuts1, gen(REG)
        forvalue nn=1(1)`nreg' {
```

(b) Part 2 of 3

```
    * NUTS1 classification
    tab nuts1
    local nreg=r(r)
    if `nreg'>1 {
        cap matrix drop `cc'_w`w'_P_NUTS1
        local rname ""
        local t=1
        encode nuts1, gen(REG)
        forvalue nn=1(1)`nreg' {
            local nn_lab: label REG `nn'
            sum pop     if year==`pop_time'                     & sex==2 & nuts1=="`nn_lab'"
            local marg_`t'=r(sum)
            sum deaths  if year>=`pop_time' & year<`mort_time'  & sex==2 & (age_mort>=`age_min') & nuts1=="`nn_lab'"
            local marg_`t'=`marg_`t''-r(sum)
            assert `marg_`t''>0
            matrix `cc'_w`w'_P_NUTS1 = nullmat(`cc'_w`w'_P_NUTS1) \ (`marg_`t'')
            local rname "`rname' `nn_lab'"
            local t=`t'+1
        }
        matrix coln     `cc'_w`w'_P_NUTS1   =POP
        matrix rown     `cc'_w`w'_P_NUTS1   =`rname'
        matrix `cc'_w`w'_P_N = `cc'_w`w'_P_NUTS1[2..`nreg',1]
        * Margins
        matrix `cc'_w`w'_P_MARG=`cc'_w`w'_P_SA \ `cc'_w`w'_P_N
    }
    else {
        matrix      `cc'_w`w'_P_NUTS1   =`cc'_w`w'_P
        matrix      `cc'_w`w'_P_MARG    =`cc'_w`w'_P_SA
    }
    noi matrix list `cc'_w`w'_P_NUTS1
    noi matrix list `cc'_w`w'_P_MARG

//-----------------------------------------------------------------------------------------------
}
```

(c) Part 3 of 3

Figure 2: Subprogram for calibrating weights (example obtained from the SHARE data and specified for this research

D Results replication

Table D1: Results of the logistic regression done for the replication

Variable	Category	B	Odds ratio	95% Confidence interval
Gender[a]	Women	-0.07*	0.93	0.87-0.99
Age[b] (years)	60-69	-0.21***	0.81	0.74-0.89
	70-79	-0.41***	0.66	0.59-0.74
	80+	-0.79***	0.45	0.40-0.52
Education[c]	Low	0.47***	1.6	1.45-1.75
	Average	0.19***	1.21	1.10-1.33
Employment status[d]	Retired	0.14***	1.15	1.04-1.27
	Unemployed	0.86***	2.36	1.99-2.80
	Sick/disabled	0.72***	2.05	1.72-2.44
	Homemaker	0.09	1.1	0.98-1.23
Net worth[e]	Low	1.21***	3.36	3.06-3.69
	Average	0.56***	1.74	1.60-1.89
Income[f]	Low	0.8***	2.22	1.85-2.68
	Average	0.25***	1.28	1.14-1.44
Relative income[g]	< Median	0.31***	1.36	1.20-1.55
EURO-D[h]	Yes	0.48***	1.61	1.50-1.73
Disability[i]	1+ limitations	0.31***	1.36	1.27-1.46
Pessimism[j]	Yes	0.5***	1.65	1.53-1.76
Optimism[k]	Yes	0	1	0.91-1.10
Country[l]	Austria	0.07	1.07	0.85-1.35
	Belgium	0.48***	1.62	1.31-2.00
	Denmark	-0.08	0.92	0.72-1.17
	France	0.66***	1.93	1.56-2.40
	Germany	0.27*	1.31	1.06-1.62
	Greece	2.14***	8.52	6.86-10.57
	Israel	1.99***	7.32	5.87-9.13
	Italy	1.92***	6.8	5.49-8.42
	Netherlands	-0.02	0.98	0.79-1.22
	Spain	1.37***	3.93	3.15-4.90
	Sweden	0.01	1.02	0.82-1.26

Notes: B denotes the regression coefficient
Odds Ratio = $exp(\beta)$ or Odds Ratio = $exp(\gamma)$
[b]Reference: men.
[c]Reference: 50-59 years.
[d]Reference: high education.
[e]Reference: employed.
[f]Reference: high net worth.
[g]Reference: high income.
[h]Reference: >median.
[i]Reference: no depression.
[j]Reference: no physical disability.
[k]Reference: no pessimism.
[l]Reference: no optimism.
[m]Reference: Switzerland.
*p<.05; **p<.01; ***p<.001

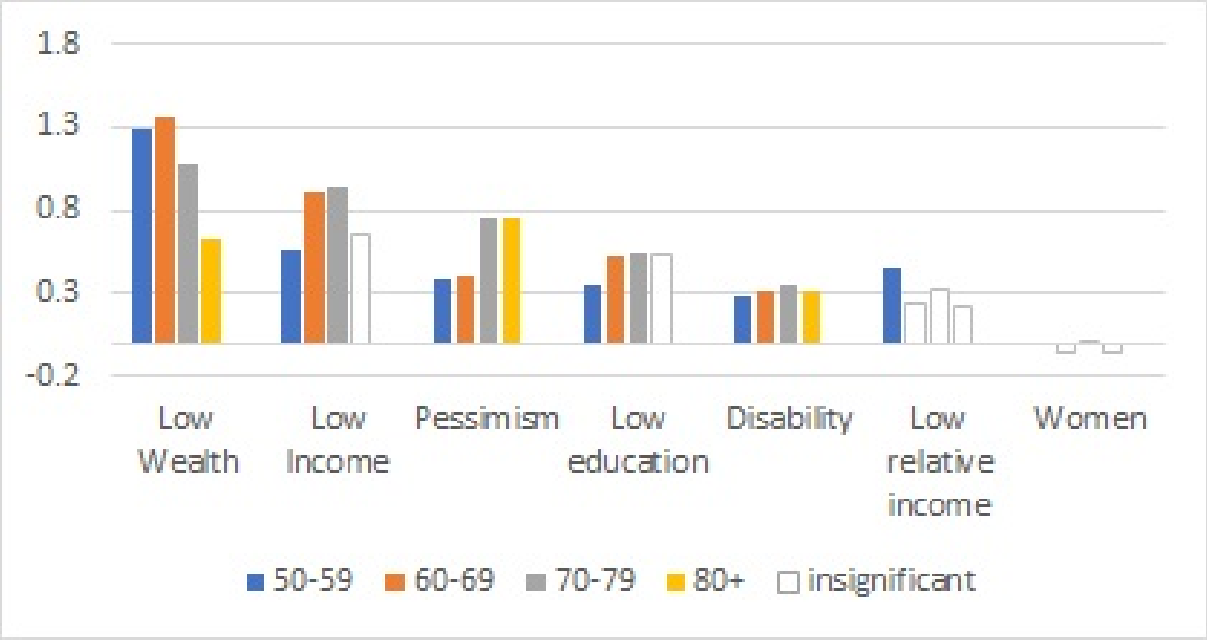

Figure 3: Coefficients of the logistic regressions done by age groups, for the replication

Note: Additional variables in the analyses (but not shown in the figure) included country, medium education, employment status, medium wealth, medium income and optimism