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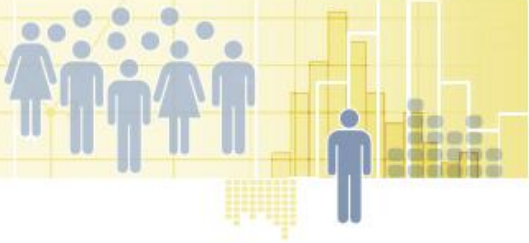

EQUALITAS Working Paper No. 4

Rethinking the Relative Income Hypothesis

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2012

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September 2012

Abstract

Income comparisons have been found to be important for individual health. However, the literature has so far looked solely at upward comparisons, disregarding the effects of comparisons with worse-off individuals. In this paper, I use a broad definition of relative income to test simultaneously for the effect of "upward" and "downward" income comparisons on health. Relative deprivation and relative satisfaction indexes are used to summarise upward and downward comparisons. Panel data models are used to correct for income endogeneity bias due to omitted variables. Using German Socio-Economic Panel data (SOEP), results show that relative deprivation has a positive effect, while relative satisfaction has a deleterious impact on health. These findings hold after correcting for unobserved heterogeneity and are robust to using quasi-objective health measures (but mental health) and to different reference groups.

JEL classification: I12; I14; I31
Keywords: relative deprivation; relative satisfaction; health

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†I started to write this paper while I was visiting DIW Berlin. I am very grateful for their hospitality and supportive facilities. I would like to thank Conchita D'Ambrosio, Sara Ayllón, Abel Brodeur, Johannes Martin, Therese Nilsson and Xavi Ramos for their comments. Furthermore, I am grateful for the comments received at XXXI Jornadas de Economía de la Salud (2011), IHEA conference in Toronto (2011), IZA summer school (2012), CRES seminars (2012), ECHE conference in Zurich (2012) and Universitat de Girona seminars (2012). Any errors or misinterpretations are my own. Financial support is greatly acknowledged from the Spanish project ECO2010-21668-C03-02 and XREPP (Direcció General de Recerca).

1 Introduction

There have been many attempts to disentangle the relationship between income distribution and health. The idea that income distribution matters appeared after finding an income gradient in health when analysing the *Absolute Income Hypothesis*, which states that income has a direct effect on health. Initial hypotheses suggested that more equal societies might have a protective effect for health. If it would be the case, redistribution could be a health enhancing policy (Wagstaff and Van Doorslaer, 2000; Deaton, 2003). However, empirical evidence is not conclusive about the validity of this relationship (Wilkinson and Pickett, 2006). Therefore, it is difficult to make recommendations to health policy makers.

A way of measuring income distribution is by means of income distances within a reference group, what is known as relative income. Relative income is expected to have a deleterious effect on health —*Relative Income Hypothesis*. As it is claimed in the literature, being or feeling deprived might cause psychosocial stress to the individuals. Stress might trigger psychosomatic diseases and individuals' health might worsen (Sapolsky, 1994; Deaton, 2003). However, while some studies find evidence of this negative effect of relative income on health, in others it is not significant, or even positive (Feng and Myles, 2005; Miller and Paxson, 2006; Theodossiou and Zangelidis, 2009).

These results disparities might be explained by the methodological caveats which have not been solved yet. First, the validity of the relative income measure used. As far as I know, previous empirical evidence focuses on "upward" income comparisons. In other words, what is relevant for health might be only the income distances with the better-off individuals in the reference group. In the health analysis this has been mainly measured by means of relative deprivation indexes. Nevertheless, new evidence on well-being shows that individuals also compare themselves with the worse-off, what is called, "downward" comparisons (Falk and Knell, 2004; Wunder and Schwarze, 2009).

Additionally, it is not so clear that a higher income distance with the better-off might generate psychosocial stress. For example, Hirschman and Rothschild (1973)

find evidence of a "tunnel effect". The tunnel effect is an analogy from a traffic jam on a road with two lanes. The stationary drivers anticipate the dissolution of the traffic jam when they observe cars moving in the other lane. In the income comparisons context, it would mean that individuals might use the information of individuals in comparable circumstances to predict their own future income situation. If it is the case, individuals might derive pleasure from having richer people in the group, because they consider it as a future opportunity to improve their own income.

Therefore, since income comparisons might generate both, positive and negative psychosocial effects, a deleterious effect might be expected on health when individuals feel deprived or suffer from psychosocial stress, and a protective effect when it is not so. Although some authors find evidence of those effects on well-being, such a distinction regarding income has not been considered to understand how relative income operates on health.

Second, the validity of the reference group. Again, there is no consensus in the literature about which is the relevant reference group. This might be different depending on the country or the population group considered (Karlsson, Nilsson, Hampus, and Leeson, 2010).

Last, the validity of the health measures used in previous studies. It is difficult to find datasets which include both a wide range of socioeconomic variables and health measures, particularly objective health. Therefore, most of the studies are based on self-assessed health. Although self-assessed health is a valid measure, it might present reporting bias, especially in cross-country analysis (Sadana, Mathers, Lopez, Murray, and Moesgaard, 2002).

Thus, the aim of this paper is to try to overcome the methodological caveats mentioned above when studying the *Relative Income Hypothesis*. First, the main contribution is to analyse the relationship between relative income and health based on a relative income measure, which allows to distinguish between the effect of "upward" and "downward" income comparisons on health. In this paper they are referred to as *Relative Deprivation* and *Relative Satisfaction* respectively.

To my knowledge, this is the first study to analyse this relationship tacking into

account the panel-dimension of the data to control for unobserved heterogeneity. This is important in order to correct for income endogeneity due to omitted variables. This seems to be the case, since the size and significance of the estimated coefficients in this paper are reduced once unobserved heterogeneity is included.

The analysis is based on the German Socio-Economic Panel (SOEP), which includes longitudinal income and health data for the period 1994-2010. Since this study is the first to use this data set to analyse the relationship between relative income and health, this paper also contributes to the empirical evidence for the German case. Additionally, SOEP includes "quasi objective" health measures, which allow to test the hypotheses using more objective health indicators, distinguishing between the mental and physical dimensions of health.

Finally, different reference groups are considered to find out which is the relevant reference group for Germans. New evidence suggests that Germans compare themselves with people in the same profession (Mayraz, Wagner, and Schupp, 2009). However, more traditional reference group definitions are used as a robustness check.

The results show that both upward and downward comparisons are statistically significant even after controlling for unobserved heterogeneity. Relative deprivation within the reference group generates a positive effect on health. And relative satisfaction affects health negatively. In the case of Germany psychosocial stress might not be derived from relative deprivation, but from relative satisfaction. These results might contradict the initial hypothesis and might explain some of the discrepancies found in the literature.

This paper is structured as follows. Section 2 presents the theoretical background. Section 3 summarizes previous empirical evidence regarding the relative income hypothesis. The employed data and the econometric specifications used in this paper are described in Section 4. Section 5 shows the empirical findings. And finally, Section 6 concludes.

2 Theoretical considerations

2.1 Income comparisons and well-being

Since Easterlin (1979) found a low correlation between income and well-being in richer countries, and suggested that a higher income does not make people happier once it rises above a 'subsistence level',[1] This has been dubbed the Easterlin Paradox. a great bulk of studies have focused on the implications of income comparisons on individual well-being. Especifically, empirical evidence shows that well-being is affected by the income gap between individual's income and her reference income (Easterlin, 1974; Ferrer-i Carbonell, 2005; Clark and Senik, 2010).

This idea stems from the assumption that the utility function of an individual i is determined by the interdependence of preferences and social status (Ferrer-i Carbonell, 2005 and Wunder and Schwarze, 2009). Accordingly, consumption and individuals' behaviour are influenced by other individuals' decisions and consumption.[2] Thus, individuals would feel deprived when they cannot reach others' consumption level, that is to say, that social comparisons are relevant for well-being. In this case, individual well-being might be affected not only by individual income y_i,[3] but also by individual relative income —denoted by y_j— within his reference group, as it is shown in the following equation:

$$U_i = (y_i, y_j, X) \tag{1}$$

where U_i stands for the utility or well-being level of individual i, and X includes a set of individual and household characteristics, which might also be relevant for individual well-being.

Additionally, income comparisons also provide individuals with information about their self-value and individual esteem within the reference group. In this sense, relative income would be a measure of the contentment derived from social status and

[1] Recent empirical work for selected European countries obtains similar results (e.g. Theodossiou and Zangelidis, 2006).

[2] Ferrer-i Carbonell (2005) suggests that if everybody were to drive a Rolls Royce, one would feel unhappy with a cheaper car.

[3] Note if this is the case absolute income might have a positive effect on health as it is claimed by the absolute income hypothesis.

would help individuals to assess their own success or failure (Dakin and Arrowood, 1981; Wunder and Schwarze, 2009).

Fehr and Schmidt (1999) propose the following utility function to capture the effects of individual income and income comparisons on well-being:

$$U_i = y_i - \frac{\alpha}{n-1} \sum_{y_j > y_i} (y_j - y_i) - \frac{\beta}{n-1} \sum_{y_j < y_i} (y_i - y_j) \tag{2}$$

They assume that $\alpha \geq \beta$ and $1 > \beta \geq 0$. Thus, individual's welfare might depend positively on his own income and upward and downward comparisons might have a negative effect. This effect might be higher for upward comparisons.

However, there is still controversy in the direction and the sign of income comparisons. For example, Duesenberry in 1949 pointed out that individuals compare themselves with richer individuals, namely, he suggested that in most cases social comparisons are upwards. Being worse-off might lower individual well-being, because individuals might feel deprived and would consider it as a signal for social failure. As a matter of fact, Duesenberry (1949) called it "envy" effect. Ferrer-i Carbonell (2005) using SOEP data also finds evidence of upward comparisons.

On the contrary, Hirschman and Rothschild (1973) were concerned about the existence of an "information effect" or "Tunnel effect" as it is pointed out in the previous section. In the social comparisons context, Hirschman and Rothschild (1973) claimed that individuals might use the information of individuals in comparable circumstances to predict their own future income situation. Following this line of thought, an increase in the average income of the reference group would be seen as an individual's own future income improvement, and individual well-being would be higher.[4] This is what D'Ambrosio and Frick (2012) find in Germany, when they analyse the effect of relative income on welfare.

Alternatively, income comparisons might also be downwards, and individuals would pay attention to the worse-off (Falk and Knell, 2004). Again, the effect of

[4]Note that a self-deception problem might arise in the long run once individuals experiment an income increase, and the average difference with the reference group disappears, in other words, the hope of further improvement vanishes and also the effect on well-being.

social comparisons might be positive or negative. Being richer might be interpreted as a "prestige or status effect", because it might be informative of individual social success (Frank, 1985). On the contrary, some individuals might feel "regret" for being richer, that is to say, individuals might have aversion to advantageous inequality (Hopkins, 2008). For example, Wunder and Schwarze (2009) using reference groups based on occupation and region in Germany find evidence of both downward and upward comparisons. However, they claim that the latter dominate in the absolute impact on well-being.

To sum up, relative income might generate satisfaction and discontent depending on which of these effects, informative, prestige, envy or regret are generated by income comparisons on individuals.

2.2 Income comparisons and health

Income comparisons might also affect health. The major concern is on the difficulties that an individual might face when he is situated at the bottom of the social ladder (Sapolsky, 1994; Wagstaff and Van Doorslaer, 2000). Previous evidence claims that health is affected by social status, rather than by absolute income, as is suggested by the non-linear relationship found between income and health (Preston, 1975; Rodgers, 1979; Wilkinson and Pickett, 2006). Accordingly, Deaton (2003) argues that social status is important in determining how much control individuals have over their own life and over their level of participation in society (Marmot, 2004). Firstly, a lower social position might threaten individuals' health by reducing the access to health enhancing goods –such as better housing or health services–, and secondly by the feeling of deprivation based on the fact that individual's cannot reach others' consumption level (Wilkinson, 2000; Deaton, 2003; Theodossiou and Zangelidis, 2009; Subramanyam, Kawachi, Berkman, and Subramanian, 2009). In both cases an individual might suffer from psychosocial stress.

It has been already proved by psychosomatic medicine that stress derived of psychosocial causes attack the immunological system. A psychosomatic disease is defined as a physical illness believed to be caused by psychosocial factors, such as recent or early life events, personality, psychological well-being and chronic or

daily stress. This medical discipline claims that psychosocial well-being helps to the immunological, endocrine and cardiovascular systems. For example, it plays an important role in coping with stress in transplant treatments. Moreover, it has a favorable impact on a disease course, implying a longer survival time (Sapolsky, 1994; Fava and Sonino, 2000). Following these arguments, income comparisons might determine psychosocial well-being due to its informative role about consumption possibilities, future income and self-value, and ultimately individual health.

Psychosocial stress might also be related to more health compromising behaviour. Individuals suffering from stress might eat and drink alcohol in excess, smoke more or even sleep less. Again, this might threaten individuals' health (Eibner and Evans, 2005).

3 Empirical evidence

3.1 Relative Income and health

Income comparisons are measured in health literature by means of the distance between individual's income and a reference income. Depending on the reference income considered, it is obtained a different measure of relative income. As it is highlighted in the previous section, relative income was expected to have a deleterious effect on health.

Three are the measures of relative income mainly used in previous studies (Wagstaff and Van Doorslaer, 2000). The first one is the average income of the reference group, which proxies the distance between individual income and the mean income of the reference group. This hypothesis —which is known as *relative income hypothesis* per se—suggests that the higher the distance, the more psychosocial stress might be experimented by individuals, and their health status would worsen. However, there are situations where average income of the reference group might vary without changing the distance between individuals' income, in other words, without changing relative income (Deaton, 2003). In this case, a negative effect of average income of the reference group on health might only reflect a negative effect of belonging to a poorer reference group, but not relative income. Thus, average income

of the reference group would not a be a good indicator of relative income, although it has been extensively used in the analysis of relative income and health.

Secondly, the *deprivation hypothesis* is based on a deprivation index. In this case, the distance between individual income and an income threshold –usually the poverty threshold— might be determinant for health. Again a higher distance would mean that it is more difficult for the individual to reach the desired consumption level. And finally, the *relative-position hypothesis* from which it can be drawn that it is the relative position in the income distribution that matters, which is measured by the rank of the individual in the income distribution (Deaton, 2003).

Although all these three measures have been vastly tested in the literature, there is still controversy about the effect of relative income on health. For example, Gerdtham and Johannesson (2004) do not find evidence of the effect of relative income measured by means of community average income for the Swedish population, but a protective effect at the county level. Following the same analysis, Hildebrand and Van Kerm (2005) find only weak evidence of the negative effect of relative income using ECHP data for 11 European countries. In this case, their relative income measure is also the mean income of the regional reference group. On the contrary, Feng and Myles (2005) after analysing US data state that living in richer neighbourhoods enhances health of the worse-off. They find a positive effect on health of the median neighbourhood income, showing that individuals might benefit from living with richer peers. Wealthier neighbourhoods might spend more on health-related public goods, and it may operate as a positive externality for the poor living there (Miller and Paxson, 2006). However, Pham-Kanter (2009) when analysing the effect of living with richer neighbours in the US using National Social Life, Health, and Aging Project (NSHAP) data finds that relative income is detrimental for health of those at the bottom and the top of the income distribution. In any case, the positive effect might contradict the initial hypothesis regarding the effect of relative income on health.

Similarly, the same disparity of results is found using deprivation as a relative income measure. Eibner and Evans (2005) analyse data from the National Health Interview Survey for Multiple Causes of death for the USA, considering reference

group based on individual characteristics. The relative deprivation indexes show a negative effect of relative income on health. But again, another study of Jones and Wildman (2008) on BHPS data from 1991 to 2002 and relative deprivation measures finds no effect of relative income on self-assessed health when allowing parametric and semiparametric models to asses the relationship between income and health. More recently, a clearer example of how difficult it is to determine the effect of relative income on health is the paper of Gravelle and Sutton (2009). They consider health records for Britain for the period 1979-2000, showing that the effect of relative income is sensitive to the reference group and to the relative income measures used. Finally, rank measures do not achieve either to shed light on this relationship, because there are also discrepancies in the empirical evidence (Subramanyam, Kawachi, Berkman, and Subramanian, 2009; Eibner and Evans, 2005).

In front of these results disparities one might think that "relatives income hypotheses" fail to capture the psychosocial stress caused by social status, or even that social status might not be significant for health. In my opinion, the main problem is that relative income measures used so far are unable to proxy the real mechanisms through which relative income might determine health, because they only focus on part of the story. Actually, new evidence regarding well-being presented in the previous section suggests that the relationship between relative income and well-being is very complex, and posits that being at the bottom of the social ladder does not always have a deleterious effect on psychosocial well-being. Following this vision, individuals might not only compare themselves with the better-off, as the average income of the reference group and the deprivation measures state, but also with the worse-off. In other words, income comparisons might be upwards and downwards and their effect on psychosocial well-being, might be positive or negative depending on individual's beliefs.

Thus, when income comparisons increase psychosocial well-being, as in the cases of a "tunnel effect" or "prestige", individual health status might improve, because positive psychosocial well-being helps to cope with daily stress. Alternatively, if what is relevant is the "envy" or the "regret" effect, individual psychosocial well-

being would decrease, and individual health is expected to worsen off through the psychosocial stress mechanism.

As far as I know, this is the first attempt to disaggregate the effect of income comparisons on health using panel data, when analysing relative income. At the beginning of this section I describe different studies which analyse social status using relative income, but all of them consider only upward comparisons. The study of Theodossiou and Zangelidis (2009) goes one step further, and analyses the effect of subjective social status, which shows the social position of the individual within a reference group. In the SOCIOLD dataset individuals are asked to compare their present income to that of other individuals of similar professional standing, with the same characteristics in terms of age, gender and educational level, in other words, using professional status as a reference group. Results for 2004 show that the ones who answer "much more than others" present a better health status compared to those who believe that their economic situations is "much less than others" within the reference group. Although this measure helps to evaluate the gradient between social status and income, it only considers that individuals compare mainly either with richer or with poorer, but not with both at the same time. Therefore, it does not allow us to understand all the effects of income comparisons on health explained previously, as the measure of relative income presented in this paper does. Specifically, the relative income measure used in this study differentiates between upward and downward comparisons and allows to test their effect on health.

Gravelle and Sutton (2009) use a "relative affluence measure" to consider that individuals care about being richer than the others. They find a positive effect of this measure on health only when they use a regional reference group. However, they do not considered unobserved heterogeneity, given than they based their analysis on cross-sectional data.

In front of the previous evidence in well-being, upward and downward comparisons are expected to be significant for Germany. It is not clear whether the effect will be positive or negative for individual health, because there is not previous evidence analysing this relationship.

3.2 Reference Group

Income comparisons take place within a reference group, which contains the subjects with whom an individual compares himself to (Runciman, 1966; Yitzhaki, 1979). Ferrer-i Carbonell (2005) suggests that the relevant group might be a set of people with similar observable characteristics such as age, occupation, education or location. However, this group might share other characteristics and might be diverse, such as family, friends, co-workers and it might even diverge between countries or individuals. The literature is not conclusive about which is the relevant reference group. Knight, Song, and Gunatilaka (2008) when analysing rural immigrants in China find that individuals compare with individuals in the same village. However, for post-transition European countries, Senik (2009) finds that people compare with individuals who they knew before the transitions started. The cross country differences are also highlighted in the paper of Karlsson, Nilsson, Hampus, and Leeson (2010), based on data for 21 countries in 2006, showing that the level of development in the country is relevant to establish the reference group. While individuals in middle/low income countries might compare with individuals living in the same community, the age reference group is significant for individuals in richer countries.

More recently, Clark and Senik (2010) analyse the third wave of the European Social Survey (ESS) covering 24 different countries and they find that different population groups have different reference groups. For instance, married people compare more with family and friends, as self-employed. And employees take colleagues as a reference group. They also note that there is divergence depending on the country. Thus, in central Europe individuals compare more with colleagues —which will be the case of Germany—, while the Spanish, Irish, Polish and Finnish compare more with family. And finally, those in Eastern Europe compare less with family than the others do.

Regarding the German case, a work of Mayraz, Wagner, and Schupp (2009) using a pretest module of the SOEP for 2008, shows that the more important income comparisons are work-related, for instance with other people in the same profession, and less with family and almost unimportant with neighbours. These results are similar to the conclusions found in Clark and Senik (2010).

4 Data and Methods

The data used in this paper is the German Socio-Economic Panel (SOEP). SOEP is a representative longitudinal study of private households in the Federal Republic of Germany which started in 1984. It includes data on 11,000 households with more than 20,000 individuals per year, covering a wide range of socioeconomic variables (see Wagner, Frick, and Schupp, 2007 for a detailed description of SOEP dataset).[5]

The final sample covers the period from 1994 to 2010 due to data availability. I focus on individuals aged 18 to 65, considering also two representative subsamples for females and males, with around 83,000 and 71,000 individuals observations respectively. The sample is split by gender to capture gender differences. Females usually report worst health than males. Moreover, Mayraz, Wagner, and Schupp (2009) suggest that the effect of income comparisons might differ by gender, since they find a significant effect of relative income on life satisfaction for men, but not for women.

The dependent variable is a self-assessed health measure (SAH) constructed by means of the answers to the question 'How would you describe your current health?'. The reporting answers are five different categories ordered from very bad (value one) to very good (value five). Since true health perceptions may differ among individuals and also across countries, this subjective health measure might present reporting bias (Sadana, Mathers, Lopez, Murray, and Moesgaard, 2002). However, SAH has been found to be a good predictor of mortality and other health outcomes such as physicians' services and retirement in different countries. (Idler and Benyamini, 1997; Miilunpalo, Vuori, Oja, Pasanen, and Urponen, 1997; Dwyer and Mitchell, 1999; Deaton, 2003). This is also the case for Germany, as it is shown in the study of Schwarze, Andersen, and Anger (2000) using SOEP data.

Objective health measures have been also considered to test the main hypotheses of this paper and to check the robustness of the results. SOEP does not contain

[5]The data used in this paper were extracted using the Add-On package PanelWhiz v3.0 (Nov 2010) for Stata. PanelWhiz was written by Dr. John P. Haisken-DeNew (john@panelwhiz.eu). The following authors supplied PanelWhiz SOEP Plugins used to ensure longitudinal consistency, Markus Hahn and John P. Haisken-DeNew. The PanelWhiz generated DO file to retrieve the SOEP data used here and any Panelwhiz Plugins are available upon request. Any data or computational errors in this paper are my own. Haisken-DeNew and Hahn, (2010) describe PanelWhiz in detail.

objective data for the period 1994-2001. However, since 2002 SOEP respondents report information on "quasi-objective" health measures, based on the 12 health-related questions of the SF12 index. This SF12 index is a generic health measure, which was developed to accurately measure the objective health status of individuals, focusing on two dimensions, mental health, called *mcs*, and physical health, referred as *pcs* —more details on how the SF12 index is calculated can be found in Andersen, Mühlbacher, Nübling, Schupp, and Wagner, 2007. Unfortunately, these measures are only reported every two years. Therefore, the final sample with objective health includes only 5 waves, from 2002 to 2010.

Additionally, since weight has been proved to be a good predictor of health, individual body mass index, *bmi*, is also considered.[6] The *bmi* is included in the analysis as one minus the body mass index. Thus, a higher index indicates better health for the three objective health measures.

Table 1 presents the correlation between health variables, showing that the correlation between SAH and *pcs* is much higher than with the other two variables. One possible explanation might be that individuals are more conscious about their physical, rather than their mental health when they report their level of health.

Table 1: Correlation between SAH and the "quasi-objective" health measures, 2002-2010

	pcs	mcs	bmi
SAH	0.7296***	0.2644***	0.1906****
pcs	–	-0.0553***	0.2401****
mcs	–	–	-0.0472****

Note: Significance: *** 99% confidence level

Finally, a set of covariates such as age, age square, gender, individual's number of years of education, nationality, marital status, labour status, household composition and income are included to control for personal characteristics —see Table A.1. Namely, the income variable refers to the equivalised household post-government income which represents the combined income after taxes and government transfers

[6]SOEP also considers grip measures as an objective health indicator but data is only available since 2006.

in the previous year of all individuals in the household.[7] Any missing income information due to item-nonresponse has been imputed according to the longitudinal and cross-sectional imputation procedures (see Frick and Grabka, 2005 and Grabka, 2009 for a detailed description). Income variable has been deflated to 2006 prices. As suggested by Cowell and Victoria-Feser (2002), to avoid noise and bias in the estimation of the relative income indexes due to outliers and extreme incomes, income distribution has been trimmed 1% of the upper and lower tails of the income distribution. Equivalised household post-government income is included in logarithm. The income variable has also been used to calculate the average income of the reference group and the relative income measures.

4.1 The relative income measure

The relative income measure used in this paper, follows the deprivation index suggested by Yitzhaki (1979), which defines upward comparisons as the deprivation felt by a person with income x_i with respect to a person with income x_j.

$$\begin{aligned} d_i(x) &= (x_i - x_j)\ if\ x_i < x_j, \\ &= 0\ else \end{aligned}$$

(3)

Thus, the deprivation function of the person with income x_i is:

$$D_i(x) = \frac{\sum_{j \varepsilon B_i(x)} (x_j - x_i)}{n}, \tag{4}$$

Chakravarty (1997) proposes to look at a relative concept of deprivation felt by a person with income x_i with respect to a person with income x_j, namely, their income share differential $\frac{d_i(x)}{\lambda(x)}$. Now, the total relative deprivation function of the person

[7]The equivalence scaled used is the modified OECD scaled which sets a single adult to be 1.0, each additional adult to be 0.5, and each child to be 0.3 (Hagenaars, de Vos, and Zaidi,1994).

with income x_i is:

$$RD_i(x) = \frac{\sum_{j \varepsilon B_i(x)} (x_j - x_i)}{n\lambda(x)}, \tag{5}$$

where $\lambda(x)$ is the mean income of the reference group. B_i refers to the set of individuals that have a higher income than individual i in the reference group.

Regarding the downward comparisons, Chakravarty (1997) suggests a relative satisfaction function of the person with income x_i, $S_i(x)$ (see also D'Ambrosio and Frick (2012)). The function $S_i(x)$ is:

$$RS_i(x) = \frac{\sum_{j \varepsilon W_i(x)} (x_i - x_j)}{n\lambda(x)}, \tag{6}$$

W_i refers to the set of individuals that have a lower income than individual i in the reference group. In this case, deprivation and satisfaction indexes are also calculated for all the reference groups.

4.2 The relevant reference group

In front the empirical evidence presented in section 3, I define the reference group by means of individual's profession, using the ISCO-88 occupation codes available in SOEP, aggregated into 22 different categories as suggested in Pischke (2010) —refoccup.

Since the SOEP occupation variable is very wide, the geographical criteria is also included to allow for some proximity with people in the same profession. In this case it is considered that individuals might compare to individuals in the same occupation and living in the same area. Three different regional aggregation are used. First the traditional division between East and West —refoccup2—, the four region division —refoccup4: East-North-Central-South— and finally the 16 "Bundeslands" —refoccup16.

Reference groups only based on regional criteria are also considered to test for the positive externalities of living with richer individuals —region2, region4 and region16.

Finally, to test the robustness of the reference group, relative income is measured by means of a more traditional reference group definition: by age, educational level and geographical area —including the different geographical divisions mentioned above: refgrup2, refgrup4 and refgrup16. Table 2 shows the number of groups in each reference group.

Table 2: Number of reference groups by definition

Name	Definition	# of groups
region2	living in west or east Germany	2
region4	living in the 4 big areas in Germany: East-North-Central-South	4
region16	living in the 16 federal regions of Germany	16
refoccup	by occupation	22
refoccup2	by occupation and region2	44
refoccup4	by occupation and region4	88
refoccup16	by occupation and region16	330
refgrup2	by age, education and region2	18
refgrup4	by age, education and region4	36
refgrup16	by age, education and region16	135

4.3 The estimation procedure

A health production model is used in order to estimate the effect of relative income on self-assessed health:

$$h_{it}^{*} = X_{it}\beta + y_{it} + RD_{it} + RS_{it} + e_{it} \tag{7}$$

$$h_{it} = k \Leftrightarrow h_{it} \in [\lambda_k, \lambda_{k+1}\} \tag{8}$$

Where h_{it}^{*} is the latent health status of the individual i at time t. h_{it} is the individual observed health measured by means of the self-assessed health and λ_k i the kth cut-off point for the five different k categories. In the right-hand side, X_{it} is a set of control variables, y_{it} stays for the income variable and RD_{it} and RS_{it} are the relative income measures —relative deprivation and relative satisfaction respectively.

Given the ordinal nature of self-assessed health, it is difficult to apply traditional econometric techniques to estimate the model. For this reason, SAH is transformed

to a "pseudo" continuous variable following the "Probit OLS Method" (POLS), proposed by Van Praag and Ferrer-i Carbonell (2004). This econometric strategy estimates the conditional expectation $\overline{\mu}_{i_n} = E(\mu \,|\mu_{i-1} < \mu \leq \mu_i)$ of the true values of health, which cannot be directly observed, by means of the normal distribution as suggested by Maddala (1983):

$$\overline{\mu}_{i_n} = E(\mu \,\Big|\mu_{i-1} < \mu \leq \mu_i) = \frac{n(\mu_{i_n-1}) - n(\mu_{i_n})}{N(\mu_{i_n}) - N(\mu_{i_n-1})} \quad (9)$$

where $\overline{\mu}_{i_n}$ is a discrete random variable which is used as a proxy of the real individual health. N is the cumulative standard normal distribution and n is the standard normal density function.

Once the transformation is done, h_{it} from equation (7) works as a continuous variable, and the model can be estimated using traditional econometric strategies, allowing to interpret estimated coefficients as marginal effects, and directly to compare the results obtained with different models (Origo and Pagani, 2009) —B Appendix shows the alternative models used to test the validity of the health variable estimations after a POLS transformation.

Moreover, taking advantage of the panel structure of the data I also control for time-invariant unobserved individual effect, to correct for the existence of omitted variables:

$$h_{it} = X_{it}\beta + y_{it}\gamma_1 + RD_{it}\gamma_2 + RS_{it}\gamma_3 + u_i + \epsilon_{it} \quad (10)$$

where u_i is the time-invariant individual-level effect, and ϵ_{it} is the disturbance term.

In order to estimate equation (10), an assumption has to be done regarding the correlation between u_i and the regressors. When this correlation is zero, u_i is considered "an individual random effect", and parameters can be consistently estimated by OLS with robust variance matrix, what is named Pooled OLS, which do not require full strict exogeneity. However, u_i is a nuisance parameter and cannot be estimated. Given that Pooled OLS might be inefficient, the model could also be estimated by modeling the within-panel correlation to get more efficient estimates. This option is called Random Effects estimation (RE).

On the other hand, if the unobserved effect is suspected to be correlated with the X_{it}'s, "fixed-effects" (FE) is the most appropriate strategy to estimate coefficient consistently (Wooldridge, 2010). I think that it is the case, for example, genetics or ability are individual time invariant unobserved effect, which obviously affects health, but also could be correlated with other explanatory variables such as income or education. In this case the use of FE might solve part of the income endogeneity.[8]

Both techniques can be easily applied using traditional statistical packages. Nonetheless, one drawback of the FE approach is that it removes panel-level averages — $\overline{h}_i$, $\overline{y}_i$,$\overline{RD}_i$ and $\overline{RS}_{it}$— from each side of equation (10) to get rid off the fixed effect u_i from the model.

$$h_{it} - \overline{h}_i = (X_{it} - \overline{X}_{it})\beta + (Z_i - Z_i)\delta + (y_{it} - \overline{y}_i)\gamma_1(RD_{it} - \overline{RD}_i)\gamma_2 +$$

$$+(RS_{it} - \overline{RS}_{it})\gamma_3 + u_i - u_i + \epsilon_{it} - \overline{\epsilon}_i \tag{11}$$

obtaining:

$$\widetilde{h_{it}} = \widetilde{X_{it}}\beta + \widetilde{y_{it}}\gamma_1 + \widetilde{RD_{it}}\gamma_2 + \widetilde{RS_{it}}\gamma_3 + \widetilde{\epsilon_{it}} \tag{12}$$

Then, OLS can be applied to equation (12), and it will produce consistent estimates. However, note that Z_i variables from equation (11) are time-invariant covariates. This approach implies that any characteristic that does not vary over time cannot be estimated, because it disappears after the differences transformation, for instance individual's gender or origin. In order to avoid this, Mundlak (1978) recommends to include panel-level means of the time-varying regressors to capture its correlation with u_i. Moreover, estimated coefficients on time-varying variables are numerically identical to within estimates, in other words, to FE estimation. Thus, Mundlak's approach allows to estimate coefficients on time-invariant variables, and

[8]Nevertheless, if omitted variables are not time-invariant or if there is reverse causality between income and health, income will be still endogenous.

also to test the appropriateness of RE, conducting a Wald test on panel-level means coefficients. If the null hypothesis of "all panel-level means are 0" is rejected, it means that unobserved heterogeneity is correlated with the regressors. In that case, orthogonality assumption is violated, inconsistent RE estimates will significantly differ from their FE counterparts, and the latter model will be more appropriate. This can also be tested using a Hausman test, which considers the null hypothesis that extra orthogonality conditions imposed by the RE estimator are valid. Again if this null hypothesis is rejected, FE estimation is more appropriate (Baum, 2006).

5 Results

This section presents the results obtained for the estimation of the effect of relative deprivation and relative satisfaction on SAH using the econometric techniques described in the previous section.

5.1 Relative deprivation, relative satisfaction and SAH

Table 3 summarizes Pooled OLS estimations using the whole sample (TOTAL), and the two sub-samples for MALE and FEMALE. All the specifications include the control variables. The relative income measures are based on the reference group defined only by individual's occupation —Table A.2 in the A Appendix shows the estimated coefficients for all the variables included in the models.

Table 3: Pooled OLS estimations of relative income on SAH using occupation as reference group, 1994-2010

	TOTAL		MALE		FEMALE	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
income	0.0914***	0.2031***	0.0764***	0.2031***	0.0965***	0.2033***
mean income	0.1275***		0.1437***		0.1193**	
RD		0.2383***		0.2378***		0.2685***
RS		-0.0285		-0.0534**		0.0008
R-squared	0.0816	0.0815	0.0936	0.0932	0.0701	0.0703
Obs.	153,729	153,729	82,679	82,679	71,050	71,050

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%. Mean income, RD and RS are refered to Refoccup.

For the three samples income presents a positive and significant effect on SAH. In this case, the evidence suggests that the level of income might be relevant for health, as it is claimed by the *Absolute Income Hypothesis*.

When relative income is measured by means of the average income of the reference group, it has a positive sign (model 1). In other words, individuals who belong to a richer reference group report better health. According to the relative income hypothesis, when average income of the reference group increases, individuals might feel more deprived and health may worsen. Nevertheless, as it has been pointed out in section 3, a variation in average income does not always represent a relative income change. Therefore, I believe that average income might capture the effect of income differences between reference groups, rather than within.

In model 2 relative income is measured by means of upward and downward income comparisons. In this specification, RD presents a positive sign and is significant for the three samples. However, the RS coefficient is negative.

These results would suggest that there is no evidence of psychosocial stress when individuals compare to richer individuals, on the contrary, it would be the tunnel effect suggested by Hirschman and Rothschild (1973). Since reference group in Table 3 is occupation, RD gives positive expectations to individuals about their future income, and therefore it might not be negative for health. In this case, the initial relative income hypothesis might not be hold. This will be also the case when the reference group is defined by occupation and region, as shown in Table 4. Although in the literature of well-being it is mostly found that the effect of RD is negative for life satisfaction, new empirical evidence suggests that it is not always the case. D'Ambrosio and Frick (2012) claim in their study of dynamic relative income on well-being for Germany, that the tunnel effect explains individual well-being in stable societies, as it is the case in Germany.

On the other hand, RS is negative and significant for males and also for the TOTAL sample when *refoccup4* and *refoccup16* are considered. It means that a higher distance with the worse-off individuals in the reference group might worsen health. Thus, both relative income indexes are significant, showing that upward and downward income comparisons are relevant for health. Nevertheless, RS is not

Table 4: Pooled OLS estimations of relative income on SAH using occupation and region as a reference group, 1994-2010

	TOTAL	MALE	FEMALE
Refoccup2			
income	0.1911***	0.1942***	0.1872***
RD	0.2204***	0.2298***	0.2419***
RS	-0.0285	-0.0539**	0.0011
R-squared	0.0817	0.0937	0.0703
Refoccup4			
income	0.1968***	0.2023***	0.1885***
RD	0.2297***	0.2481***	0.2376***
RS	-0.0337**	-0.0585***	-0.0040
R-squared	0.0818	0.0939	0.0703
Refoccup16			
income	0.1681***	0.1788***	0.1512***
RD	0.1548***	0.1868***	0.1393***
RS	-0.0311**	-0.0570***	0.0000
R-squared	0.0814	0.0935	0.0698
Obs.	153,729	82,679	71,050

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%.

significant for females. This might confirm that there are gender differences on the effect of relative income comparisons in Germany as suggested in Mayraz, Wagner, and Schupp (2009).[9]

These findings are consistent with the study of Wunder and Schwarze (2009) with SOEP data, in which they find a positive effect of their measure of relative deprivation on well-being when using occupation to define reference group. They also find that the impact of upward comparisons is stronger than the effect of downwards

[9]Results regarding female and male samples are based on the assumption that females and males compare with both at the same time. I have conducted alternative estimations for the male and female samples considering that they compare only with individuals of the same gender. Results obtained under the latter assumption are similar to the ones presented in this paper and they are available upon request.

ones. The same is shown in the results of this study, where the positive impact of RD is much stronger than the one of RS —as it is suggested in the Fehr and Schmidt's utility function.

Thus, in the case of Germany it seems that the negative impact of RS might be compensated by the positive effect of RD. This might be one explanation for the results disparities in those studies using average income and not controlling for another measure of relative income. Depending on which of the two relative income indexes is stronger, average income might have a positive or a negative sign.[10]

Regarding the covariates, results are quite robust in all the specifications — covariates estimations for the four reference groups related to occupation and region are shown in the Table A.2 of the A Appendix).[11]

As expected age has a deleterious effect on health due to human capital depreciation —especially for MALE—, which increases with age as shown by the positive effect of age squared. In the TOTAL sample estimation females report worse SAH than males, being positive and significant the effect of household size and education. All these results coincide with the ones found in the previous literature.

Regarding civil status, being married but separated has a protective effect on health (with respect to married people), but only for females. The same happens for the case of widowed and divorced individuals for the TOTAL sample. Being single has no effect on SAH in the MALE and FEMALE samples. Europeans and non-Europeans report better SAH than Germans, but these variables are not significant for the case of females. However, stateless is positive and negative for males and females respectively. Finally, employment shows disparities in the results. Only being on training and sheltered working are negative and significant with respect to full-time employed for the three samples. Being part-time or marginal part-time working are negative and significant only for males. Finally, being not employed is negative for males, but not significant. In the case of females it is positive, but only significant for the specifications of *refoccup4* and *refoccup16* in the occupation

[10] In this analysis it is not possible to control for both, average income and RD and RS indexes, in the model, because the RD and RS are relative indexes. It means that they are corrected for the size of the reference group, dividing the indexes by the average income of the reference group.

[11] Covariates estimations with the rest of the reference groups present similar results. The tables are available upon request.

reference group. Actually, unemployment is believed to affect health negatively. However, in this case the not employed variable might content also females who have freely decided not to work, and that is why not working would not be negative for health. Thus, the unemployment effect might be offset by this positive situation.[12]

5.2 Panel effects with unobserved heterogeneity

This section presents the results when unobserved heterogeneity is considered. I focus on two possible scenarios. Firstly, when the time-invariant unobserved effect is assumed not to be correlated with the regressors and that model is estimated using RE. And secondly, when X are allowed to be correlated with u_i. In this case, the model is estimated using the Mundlak's approach, which is equivalent to estimate the model by FE (this correspondence is shown in Table A.5). However, Mundlak's approach allow us to estimate the effect of time invariant variables and to analyze the correlation between the omitted variables and the regressors through the panel-level means estimation.

Table 5 shows the effect of relative income on health, now estimated by RE and Mundlak's approach. Regarding income and the relative income variables, the results follow the same pattern as in the Pooled OLS estimations. Income is positive and significant, RD shows a positive effect on health, and RS has a deleterious effect. However, the estimated coefficients for those three variables are lowered after correcting for unobserved heterogeneity, especially in the Mundlak's specification. Thus, the Pooled OLS estimation might overestimate the effect of income and relative income on SAH. This result is reinforced by the significance of the panel-level means of income and RD, showing that part of effect of income on health is due to the correlation of income with omitted variables —panel-level means are shown in Table A.4 of the A Appendix. In addition, these results might also state that permanent income, or to be deprived recurrently, are more relevant for health than *current* absolute and relative income. Again, RS is not significant in the female sample.

What is clear is that unobserved heterogeneity still explains almost half of the

[12] An alternative estimation of the model defining labour status as being unemployed or not unemployed shows a negative and significant effect of unemployment on health for the three samples.

variability of SAH, as the rho coefficient shows in all the specifications. More research is needed to disentangle how much of this unobserved heterogeneity is due to socio-economic variables.

Table 5: RE and Mundlak estimations using occupation and regional reference groups, 1994-2010

	Refoccup		Refoccup2		Refoccup4		Refoccup16	
	RE	Mundlak	RE	Mundlak	RE	Mundlak	RE	Mundlak
TOTAL								
income	0.1455***	0.0717***	0.1507***	0.0730***	0.1505***	0.0750***	0.1270***	0.0631***
RD	0.1916***	0.0894***	0.2069***	0.0967***	0.2052***	0.1013***	0.1540***	0.0785***
RS	-0.0278**	-0.0251*	-0.0298***	-0.0228*	-0.0314***	-0.0234*	-0.0260**	-0.0203*
rho	0.470	0.470	0.470	0.470	0.470	0.470	0.470	0.470
Obs.	153,729	153,729	153,729	153,729	153,729	153,729	153,729	153,729
Num. of persnr	24,348	24,348	24,348	24,348	24,348	24,348	24,348	24,348
MALE								
income	0.1608***	0.0844***	0.1603***	0.0833***	0.1687***	0.0977***	0.1462***	0.0879***
RD	0.1960***	0.0803*	0.2004***	0.0827*	0.2226***	0.1182***	0.1790***	0.1055***
RS	-0.0514***	-0.0410**	-0.0510***	-0.0376**	-0.0523***	-0.0388**	-0.0439***	-0.0320**
rho	0.483	0.483	0.483	0.483	0.483	0.483	0.483	0.483
Obs.	82,679	82,679	82,679	82,679	82,679	82,679	82,679	82,679
Num. of persnr	12,710	12,710	12,710	12,710	12,710	12,710	12,710	12,710
FEMALE								
income	0.1331***	0.0550*	0.1441***	0.0634**	0.1319***	0.0465*	0.1075***	0.0408*
RD	0.1936***	0.0903	0.2206***	0.1103**	0.1880***	0.0710	0.1282***	0.0513
RS	-0.0029	-0.0030	-0.0080	-0.0040	-0.0085	-0.0017	-0.0068	-0.0072
rho	0.460	0.460	0.460	0.460	0.460	0.460	0.460	0.460
Obs.	71,050	71,050	71,050	71,050	71,050	71,050	71,050	71,050
Num. of persnr	11,638	11,638	11,638	11,638	11,638	11,638	11,638	11,638

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%.

The sign and statistical significance of the covariates under RE specification are similar to the Pooled OLS estimation. However, some of them such as *hsize* and *educ* lose their statistical significance when using Mundlak's approach (see Table A.3 of the A Appendix). One possible explanation might be that panel variation of both variables is low. Nevertheless, their panel-level means are significant, showing that the effect of these variables on health might be through omitted variables. Thus, once unobserved heterogeneity is taken into account their effect on health vanishes. At the same time, estimated coefficients are lower comparing to Pooled OLS estimations, especially in the Mundlak's approach. Again, panel-level means might capture part of their effect due to its correlation with unobserved heterogeneity.

Finally, after conducting a Wald test on panel-level means of the time variant variables for the three specifications, the null hypothesis is rejected. This result confirms that u_{it} are related with the regressors, and the FE specification is more convenient. Finally, a Hausman test also confirms this result —tests are shown in C Appendix.

5.3 The Relevant Reference Group

In order to check the validity of the reference groups defined by occupation, more traditional definitions of reference group have also been considered in the analysis. First, reference groups defined by age, educational level and the three different regional levels described in section 4.2. Second, reference groups defined only using the regional criteria.

The Pooled OLS estimations using the two sets of reference groups are shown in Table 6. In the case of the first set of reference groups, the statistical significance and the size of the coefficients of income and relative income indexes are similar to the ones defined by occupation. However, once unobserved heterogeneity is included in the analysis, the significance of the relative income measures vanishes, and only individual income is significant —Table 7 summarizes the results when Mundlak's approach is used. As it is shown in the previous section, this is not the case for *RD* and *RS* measured using occupational reference groups. Both are precisely estimated by Mundlak's approach, at least for the case of the TOTAL and MALE samples.

Table 6: Pooled OLS estimations of relative income on SAH using traditional reference group definitions, 1994-2010

Refgrup	TOTAL	MALE	FEMALE	Refgrup	TOTAL	MALE	FEMALE
Refgrup2				Region2			
income	0.1480***	0.1335***	0.1597***	income	0.1594**	0.1857**	0.1355*
RD	0.1585***	0.1206**	0.2182***	RD	0.1721	0.2308	0.1424
RS	-0.0205	-0.0379*	0.0003	RS	0.0023	-0.0257	0.0290*
R-squared	0.0810	0.0926	0.0698	R-squared	0.0811	0.0928	0.0698
Refgrup4				Region4			
income	0.1690***	0.1552***	0.1796***	income	0.2043**	0.2309**	0.1805*
RD	0.1174***	0.0790*	0.1786**	RD	0.2611*	0.3227**	0.2295
RS	-0.0091	-0.0256*	0.0111	RS	-0.0199	-0.0465	0.0048
R-squared	0.0811	0.0927	0.0700	R-squared	0.0812	0.0930	0.0699
Refgrup16				Region16			
income	0.1549***	0.1494***	0.1557***	income	0.1532*	0.1857**	0.1193
RD	0.1311**	0.1154	0.1648**	RD	0.1521	0.2290	0.0955
RS	-0.0144	-0.0330	0.0083	RS	0.0010	-0.0277	0.0294
R-squared	0.0811	0.0927	0.0698	R-squared	0.0810	0.0929	0.0697
Obs.	153,729	82,679	71,050	Obs.	153,729	82,679	71,050

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%.

When only region is used to define the reference group, income is positive and significant for the three resultant reference groups. *RD* is only significant in the case of the 4 big regions, and *RS* is never significant. The lost of significance is more pronounced when unobserved heterogeneity is considered, particularly, when it is allowed to be correlated with the regressors as is shown in Table 7. *RD* and *RS* are not significant in any of the three regional reference groups. This might suggest that relative income measured by regional criteria might capture the effect of omitted variables. Moreover, depending on the regional level considered the effect of *RD* and *RS* changes the sign. Again, these results might explain the disparities found in previous studies when regional reference groups were used and unobserved heterogeneity is not considered.

Table 7: Mundlak estimations of relative income on SAH using traditional reference group definitions, 1994-2010

Refgrup	TOTAL	MALE	FEMALE	Refgrup	TOTAL	MALE	FEMALE
Refgrup2				Region2			
income	0.0712***	0.0700**	0.0868**	income	0.0529	-0.0675	0.0717
RD	0.0943**	0.0509	0.1531**	RD	-0.0525	-0.2124	0.1315
RS	-0.0231	-0.0331	-0.0192	RS	0.0141	0.0295	-0.0080
rho	0.4704	0.4838	0.4597	rho	0.4702	0.4837	0.4597
Refgrup4				Region4			
income	0.0586**	0.0565*	0.0733**	income	-0.0067	-0.0706	0.1093*
RD	0.0673	0.0190	0.1277*	RD	-0.1068	-0.2242	0.0234
RS	-0.0192	-0.0309	-0.0126	RS	0.0231	0.0277	0.0379
rho	0.4703	0.4838	0.4597	rho	0.4702	0.4837	0.4594
Refgrup16				Refgrup16			
income	0.0582***	0.0804***	0.0501	income	-0.0326	0.0788	0.0474
RD	0.0632*	0.0667	0.0739	RD	0.0595	0.0669	0.0781
RS	-0.0218	-0.0413**	-0.0083	RS	-0.0148	-0.0372	-0.0010
rho	0.4703	0.4838	0.4597	rho	0.4703	0.4837	0.4598
Obs.	153,729	82,679	71,050	Obs.	153,729	82,679	71,050

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%.

These findings support the idea that Germans compare themselves with people in the same profession as it is shown in Mayraz, Wagner, and Schupp (2009), and these comparisons might be relevant for health.

Since individuals' reference group might differ between countries, the cross-country analysis of the impact of relative income on health will be difficult until data sets do include information to determine the relevant reference group.

5.4 Quasi-objective health measures

A set of alternative health measures are used to check the robustness of the results obtained with *SAH*.

In Table 8 are shown the results of the Pooled OLS estimations for the objectives

measures mentioned in the data section, referring to the physical dimension of health, *pcs*, the body mass index, *bmi*, and the mental dimension, *mcs*. The sign and significativaty of the estimated coefficients for income, RD and RS are similar to the SAH results in section 5 for *pcs* and *bmi*. However, the size of income and RD coefficients is much lower.

In the case of *mcs*, the effect of income is positive but it is not significant in most of the cases. The same happens with the relative income indexes, which change the sign of the effect depending on the reference group considered.

Thus, the physical health measures confirm the results obtained for SAH with Pooled OLS, but not mental health. One explanation might be that correlation between SAH and *pcs* is much higher, than with *mcs*, as it was shown in the data section. These findings point out that relative income might affect health through physical health.

Table 8: Pooled OLS estimations using "quasi-objective" measures of health and reference group defined by occupation, 2002-2010

	Refoccup			Refoccup2			Refoccup4			Refoccup16		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
PCS												
income	0.0357***	0.0367***	0.0319***	0.0334***	0.0353***	0.0284***	0.0340***	0.0360***	0.0290***	0.0298***	0.0332***	0.0233***
RD	0.0568***	0.0590***	0.0527***	0.0531***	0.0572***	0.0471***	0.0549***	0.0599***	0.0477***	0.0441***	0.0525***	0.0336***
RS	-0.0031	-0.0053**	0.0005	-0.0031	-0.0059**	0.0013	-0.0034	-0.0056**	0.0006	-0.0030	-0.0059**	0.0018
R-squared	0.1288	0.1465	0.1131	0.1290	0.1471	0.1131	0.1293	0.1475	0.1131	0.1286	0.1470	0.1124
MCS												
income	0.0030	0.0019	0.0037	0.0122***	0.0086	0.0169**	0.0108**	0.0086	0.0135**	0.0119***	0.0087*	0.0156***
RD	-0.0186**	-0.0131	-0.0222	0.0007	0.0007	0.0057	-0.0026	0.0003	-0.0018	-0.0036	-0.0012	-0.0024
RS	0.0091**	0.0091*	0.0095	0.0049	0.0058	0.0037	0.0056*	0.0057	0.0054	0.0030	0.0047	0.0009
R-squared	0.0309	0.0177	0.0262	0.0306	0.0174	0.0258	0.0306	0.0174	0.0258	0.0305	0.0174	0.0257
BMI												
income	0.0136***	0.0072*	0.0232***	0.0120***	0.0059**	0.0201***	0.0116***	0.0058**	0.0193***	0.0107***	0.0054***	0.0171***
RD	0.0208**	0.0164**	0.0331***	0.0183***	0.0141**	0.0279***	0.0172***	0.0135**	0.0259***	0.0143***	0.0118***	0.0201***
RS	-0.0009	-0.0035*	0.0012	-0.0003	-0.0032**	0.0023	-0.0002	-0.0034**	0.0027	-0.0006	-0.0040**	0.0028
R-squared	0.1315	0.0924	0.1004	0.1315	0.0923	0.1001	0.1313	0.0923	0.0999	0.1312	0.0923	0.0995
Obs.	49,198	25,939	23,259	49,198	25,939	23,259	49,198	25,939	23,259	49,198	25,939	23,259

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%.

When the model is estimated using RE and Mundlak's approach, the impact and significance of *RD* and *RS* on *pcs* are similar to the POOLED OLS estimations, showing that *RD* and *RS* are relevant for health in the case of males. For females only *RD* is significant —see Table 9. In the case of *mcs*, *RD* is negative, and *RS* is positive for males and negatives for females, but in both cases are not significant. Finally, the coefficients of *RD* and *RS* are not precisely estimated for *bmi* when using RE. Around 90% of the variability on *bmi* is due to unobserved heterogeneity. It indicates that *bmi* might be explained by variables not included in this analysis.

Table 9: RE and Mundlak estimations using "quasi-objective" measures of health and reference group defined by occupation, 2002-2010

	TOTAL		MALE		FEMALE	
	RE	Mundlak	RE	Mundlak	RE	Mundlak
PCS						
income	0.0260***	0.0017	0.0303***	0.0183***	0.0198***	0.0041
RD	0.0451***	0.0107	0.0461***	0.0260***	0.0412***	0.0253**
RS	-0.0014	0.0024	-0.0053*	-0.0075**	0.0034	0.0046
rho	0.493	0.493	0.487	0.487	0.491	0.491
MCS						
income	0.0040	-0.0009	0.0017	-0.0078	0.0069	0.0039
RD	-0.0124*	-0.0134	-0.0051	-0.0109	-0.0176	-0.0200
RS	0.0047*	-0.0011	0.0071**	0.0053	0.0018	-0.0075
rho	0.469	0.469	0.478	0.478	0.457	0.457
BMI						
income	0.0025***	-0.0014	0.0009	-0.0008	0.0050***	0.0005
RD	0.0047**	-0.0012	0.0014	-0.0020	0.0095***	0.0033
RS	0.0005	0.0010	-0.0001	0.0004	0.0008	0.0005
rho	0.881	0.881	0.871	0.871	0.888	0.888
Obs.	49,198	49,198	25,939	25,939	23,259	23,259

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%. RD and RS are refered to Refoccup.

In front of these findings, *RD* and *RS* might be only relevant for *pcs*, but not for the mental dimension of health and *bmi*. It might be important to use more accurate objective measures of health to disentangle how relative income operates on physical and mental health.

6 Concluding Remarks

The aim of this paper is to shed light on the relationship between relative income and health. Previous research only takes into account upward income comparisons. Nevertheless, the findings of this paper show that both upward and downward comparisons might be relevant for health.

Relative income is measured by means of a relative deprivation and a relative satisfaction index in this study. Both are significant for the TOTAL and MALE samples —for females only upward comparisons are precisely estimated. As a matter of fact, *RD* might have a positive effect on health through an "informative or tunnel effect". In the case of Germany, being deprived might not generate psychosocial stress as the relative income hypothesis states. Alternatively, *RS* presents a negative impact on health. However, the effect of *RD* is much stronger.

These findings might be an explanation for the result disparities found in the literature when relative income is measured by the average income of the reference group. Depending on which of the two dimensions of relative income dominates, average income might take a positive or a negative sign.

Once unobserved heterogeneity is considered, the relative income indexes coefficients are lowered, especially with Mundlak's approach, but they are still significant. This would suggest that there are omitted variables correlated with relative income, which might explain the remaining variability of the proposed model. As the value of rho indicates it is almost 50%. Thus, future research might be focus on finding which are these omitted variables.

Although final estimations are not affected by omitted variables endogeneity, reverse causality between income and health has not been considered in this paper.

It has been also confirmed that reference groups are based on occupation for Germany. *RD* and *RS* indexes lose their significance when more traditional definitions of reference group are used to measure relative income.

Finally, the findings of this paper point out that *RD* and *RS* are relevant for physical health, but not for mental health. Estimations using the physical dimension of the SF12 index, *pcs*, support the results obtained with SAH, but not *mcs* and

bmi. Thus, more research is needed to understand how relative income operates in health using more accurate objective health measures.

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A Appendix.

Table A.1: Variable labels and descriptives for the TOTAL sample

Variables	Definition	Mean
Health measures		
SAH	Self-Assessed Health	3.587135
mcs	Mental health	0.4992533
pcs	Physical health	0.5238817
bmi	Body mass index	0.7449622
age	Age in years of the individual	41.05497
agesq	Age squared	1814.168
sex	1 if male, 2 if female	.4622456
	(reference group of sex is male)	
Civil status		
married_sep	1 if married but separated, 0 otherwise	0.0197489
single	1 if single, 0 otherwise	0.2625919
divorced	1 if divorced, 0 otherwise	0.0764466
widow	1 if widow, 0 otherwise	0.0137496
	(reference group of civil status is married)	
Labour status		
part-time	1 if part-time employed, 0 otherwise	0.1703239
training	1 if vocational training, 0 otherwise	0.0417355
mg_working	1 if marginal or irregular part-time, 0 otherwise	0.0547058
not_working	1 if not employed, 0 otherwise	0.0037187
sheltered_working	1 if sheltered workshop, 0 otherwise	0.0013476
	(reference group of labour status is full-time employed)	
Origin		
European	1 if European, 0 otherwise	0.0531073
non-European	1 if Non-European 0 otherwise	0.0314888
state-less	1 if state-less, 0 otherwise	0.0000715
	(reference group of origin is German)	
hsize	Number of members of the household	2.943862
educ	Number of years of education	12.42869
income	Log of equivalised total net household income	9.904644
mean income	Log of average income of the reference group	9.973518
RD	Relative Deprivation	.2051115
RS	Relative Satisfaction	.2074072

Source: Own calculation on the SOEP, 1994-2010. Mean income, RD and RS are referred to Refoccup.

Table A.2: POOLED OLS estimations with occupation and occupation-regional reference groups, 1994-2010

	Refoccup			Refoccup2			Refoccup4			Refoccup16		
	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE
age	-0.0273***	-0.0347***	-0.0230***	-0.0273***	-0.0347***	-0.0229***	-0.0273***	-0.0347***	-0.0229***	-0.0274***	-0.0348***	-0.0229***
	(0.0027)	(0.0022)	(0.0039)	(0.0025)	(0.0023)	(0.0035)	(0.0020)	(0.0022)	(0.0027)	(0.0020)	(0.0025)	(0.0027)
agesq	0.0002***	0.0002***	0.0001**	0.0002***	0.0002***	0.0001***	0.0002***	0.0002***	0.0001***	0.0002***	0.0002***	0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
female	-0.0440***			-0.0416***			-0.0421***			-0.0411***		
	(0.0050)			(0.0047)			(0.0052)			(0.0067)		
married_sep	0.0395***	0.0247	0.0518*	0.0381**	0.0246	0.0487*	0.0388***	0.0256	0.0497*	0.0399***	0.0256	0.0524**
	(0.0122)	(0.0202)	(0.0257)	(0.0149)	(0.0235)	(0.0264)	(0.0132)	(0.0182)	(0.0252)	(0.0132)	(0.0179)	(0.0223)
single	0.0165*	0.0168	0.0166	0.0159*	0.0169	0.0144	0.0161*	0.0172	0.0149	0.0162*	0.0169	0.0161
	(0.0092)	(0.0112)	(0.0149)	(0.0086)	(0.0108)	(0.0122)	(0.0083)	(0.0117)	(0.0115)	(0.0086)	(0.0120)	(0.0117)
divorced	0.0300***	0.0278*	0.0301*	0.0292***	0.0282*	0.0278	0.0295***	0.0283*	0.0287*	0.0301***	0.0284*	0.0304**
	(0.0073)	(0.0147)	(0.0153)	(0.0103)	(0.0143)	(0.0179)	(0.0095)	(0.0150)	(0.0164)	(0.0091)	(0.0162)	(0.0131)
widow	0.0642**	0.0347	0.0676**	0.0639**	0.0363	0.0666**	0.0640***	0.0366	0.0666***	0.0642***	0.0366	0.0668***
	(0.0245)	(0.0477)	(0.0278)	(0.0260)	(0.0533)	(0.0253)	(0.0207)	(0.0497)	(0.0220)	(0.0234)	(0.0456)	(0.0250)
euro	0.0535***	0.0834***	0.0193	0.0478***	0.0776***	0.0129	0.0481***	0.0776***	0.0134	0.0481***	0.0777***	0.0133
	(0.0135)	(0.0195)	(0.0176)	(0.0137)	(0.0199)	(0.0179)	(0.0150)	(0.0197)	(0.0212)	(0.0127)	(0.0184)	(0.0183)
non-euro	0.0410**	0.0686***	0.0094	0.0352**	0.0628***	0.0027	0.0362***	0.0641***	0.0034	0.0355**	0.0635***	0.0025
	(0.0168)	(0.0148)	(0.0238)	(0.0146)	(0.0154)	(0.0202)	(0.0133)	(0.0155)	(0.0209)	(0.0150)	(0.0179)	(0.0207)
stateless	0.0106	0.1330***	-0.3053***	0.0033	0.1243***	-0.3181***	0.0073	0.1239	-0.2964***	0.0064	0.1249	-0.3059***
	(0.0772)	(0.0112)	(0.0175)	(0.0774)	(0.0163)	(0.0221)	(0.1139)	(0.1206)	(0.0218)	(0.1123)	(0.1159)	(0.0185)
part-time	0.0058	-0.0780***	0.0049	0.0029	-0.0801***	0.0008	0.0034	-0.0791***	0.0015	0.0040	-0.0782***	0.0027
	(0.0072)	(0.0181)	(0.0074)	(0.0075)	(0.0179)	(0.0077)	(0.0079)	(0.0194)	(0.0087)	(0.0075)	(0.0192)	(0.0092)
training	-0.0570***	-0.0660***	-0.0681***	-0.0553***	-0.0637***	-0.0672***	-0.0551***	-0.0636***	-0.0667***	-0.0542***	-0.0633***	-0.0647***
	(0.0110)	(0.0125)	(0.0112)	(0.0170)	(0.0203)	(0.0175)	(0.0146)	(0.0160)	(0.0175)	(0.0132)	(0.0175)	(0.0170)
mg_working	-0.0092	-0.0630***	-0.0046	-0.0134*	-0.0647***	-0.0109	-0.0125	-0.0640***	-0.0096	-0.0129	-0.0641***	-0.0097
	(0.0068)	(0.0162)	(0.0092)	(0.0070)	(0.0181)	(0.0092)	(0.0091)	(0.0191)	(0.0095)	(0.0093)	(0.0180)	(0.0104)
not_working	0.0332	-0.0180	0.0731	0.0321	-0.0193	0.0715	0.0319	-0.0202	0.0717*	0.0329	-0.0189	0.0728*
	(0.0283)	(0.0408)	(0.0433)	(0.0256)	(0.0369)	(0.0444)	(0.0273)	(0.0391)	(0.0361)	(0.0307)	(0.0449)	(0.0421)
sheltered_working	-0.5228***	-0.4833***	-0.5839***	-0.5244***	-0.4843***	-0.5874***	-0.5240***	-0.4841***	-0.5870**	-0.5240***	-0.4835***	-0.5891***
	(0.0990)	(0.0666)	(0.1347)	(0.0888)	(0.0723)	(0.1591)	(0.1021)	(0.1248)	(0.2329)	(0.0810)	(0.1234)	(0.1735)
hsize	0.0200***	0.0136***	0.0270***	0.0200***	0.0132***	0.0275***	0.0198***	0.0130***	0.0272***	0.0200***	0.0133***	0.0271***
	(0.0018)	(0.0021)	(0.0032)	(0.0018)	(0.0025)	(0.0030)	(0.0024)	(0.0027)	(0.0037)	(0.0025)	(0.0032)	(0.0039)
educ	0.0122***	0.0138***	0.0119***	0.0130***	0.0145***	0.0128***	0.0129***	0.0143***	0.0128***	0.0139***	0.0153***	0.0139***
	(0.0015)	(0.0016)	(0.0026)	(0.0013)	(0.0014)	(0.0023)	(0.0014)	(0.0019)	(0.0022)	(0.0013)	(0.0016)	(0.0019)
income	0.2031***	0.2031***	0.2033***	0.1911***	0.1942***	0.1872***	0.1968***	0.2023***	0.1885***	0.1681***	0.1788***	0.1512***
	(0.0340)	(0.0305)	(0.0430)	(0.0260)	(0.0234)	(0.0344)	(0.0215)	(0.0252)	(0.0269)	(0.0218)	(0.0267)	(0.0247)
RD	0.2383***	0.2378***	0.2685***	0.2204***	0.2298***	0.2419***	0.2297***	0.2481***	0.2376***	0.1548***	0.1868***	0.1393***
	(0.0705)	(0.0671)	(0.0878)	(0.0459)	(0.0434)	(0.0654)	(0.0393)	(0.0448)	(0.0528)	(0.0408)	(0.0541)	(0.0458)
RS	-0.0285	-0.0534**	0.0008	-0.0285	-0.0539**	0.0011	-0.0337**	-0.0585***	-0.0040	-0.0311**	-0.0570***	0.0000
	(0.0225)	(0.0253)	(0.0262)	(0.0175)	(0.0209)	(0.0238)	(0.0139)	(0.0198)	(0.0185)	(0.0156)	(0.0199)	(0.0201)
Rsquared	0.0815	0.0934	0.0703	0.0817	0.0937	0.0703	0.0818	0.0939	0.0703	0.0814	0.0935	0.0698
Obs.	153,729	82,679	71,050	153,729	82,679	71,050	153,729	82,679	71,050	153,729	82,679	71,050

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%. Standard Errors in brackets.

Table A.3: RE and Mundalk estimations using occupation and occupation-regional reference groups, 1994-2010

	Refoccup		Refoccup2		Refoccup4		Refoccup16	
	RE	Mundlak	RE	Mundlak	RE	Mundlak	RE	Mundlak
age	-0.0201***	-0.0219***	-0.0201***	-0.0220***	-0.0201***	-0.0219***	-0.0201***	-0.0221***
	(0.0017)	(0.0025)	(0.0017)	(0.0025)	(0.0017)	(0.0025)	(0.0017)	(0.0025)
agesq	0.0001***	-0.0000	0.0001***	-0.0000	0.0001***	-0.0000	0.0001***	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
female	-0.0524***	-0.0382***	-0.0517***	-0.0362***	-0.0519***	-0.0368***	-0.0509***	-0.0357***
	(0.0062)	(0.0070)	(0.0062)	(0.0069)	(0.0062)	(0.0069)	(0.0062)	(0.0069)
married_sep	0.0543***	0.0599***	0.0541***	0.0599***	0.0543***	0.0599***	0.0545***	0.0599***
	(0.0122)	(0.0136)	(0.0122)	(0.0136)	(0.0122)	(0.0136)	(0.0122)	(0.0136)
single	0.0107	0.0126	0.0105	0.0123	0.0106	0.0123	0.0107	0.0124
	(0.0078)	(0.0106)	(0.0078)	(0.0106)	(0.0078)	(0.0106)	(0.0078)	(0.0106)
divorced	0.0245***	0.0395***	0.0245***	0.0396***	0.0245***	0.0394***	0.0247***	0.0395***
	(0.0092)	(0.0121)	(0.0092)	(0.0121)	(0.0092)	(0.0121)	(0.0092)	(0.0121)
widow	0.0346	-0.0088	0.0346	-0.0090	0.0346	-0.0090	0.0346	-0.0089
	(0.0215)	(0.0297)	(0.0215)	(0.0297)	(0.0215)	(0.0297)	(0.0215)	(0.0297)
euro	0.0459***	0.0583***	0.0412***	0.0529***	0.0416***	0.0534***	0.0413***	0.0532***
	(0.0131)	(0.0130)	(0.0131)	(0.0130)	(0.0131)	(0.0130)	(0.0131)	(0.0130)
non-euro	0.0512***	0.0659***	0.0470***	0.0601***	0.0479***	0.0612***	0.0471***	0.0611***
	(0.0154)	(0.0154)	(0.0153)	(0.0154)	(0.0153)	(0.0154)	(0.0153)	(0.0154)
stateless	-0.0097	0.0769	-0.0155	0.0668	-0.0105	0.0736	-0.0156	0.0707
	(0.1463)	(0.1451)	(0.1467)	(0.1452)	(0.1428)	(0.1409)	(0.1448)	(0.1410)
part-time	0.0121**	0.0133**	0.0112*	0.0131*	0.0114**	0.0131*	0.0114**	0.0131*
	(0.0058)	(0.0067)	(0.0058)	(0.0067)	(0.0058)	(0.0067)	(0.0058)	(0.0067)
training	-0.0086	-0.0022	-0.0081	-0.0020	-0.0081	-0.0020	-0.0072	-0.0015
	(0.0103)	(0.0115)	(0.0102)	(0.0115)	(0.0103)	(0.0115)	(0.0102)	(0.0115)
mg_working	0.0073	0.0107	0.0062	0.0104	0.0066	0.0106	0.0057	0.0102
	(0.0082)	(0.0093)	(0.0082)	(0.0093)	(0.0082)	(0.0093)	(0.0082)	(0.0093)
not_working	0.0561**	0.0666***	0.0555**	0.0666***	0.0555**	0.0665***	0.0557**	0.0666***
	(0.0233)	(0.0233)	(0.0232)	(0.0233)	(0.0232)	(0.0233)	(0.0232)	(0.0233)
sheltered_working	-0.4715***	-0.1265	-0.4714***	-0.1265	-0.4724***	-0.1273	-0.4724***	-0.1254
	(0.0969)	(0.1652)	(0.0968)	(0.1652)	(0.0969)	(0.1653)	(0.0972)	(0.1654)
hsize	0.0083***	0.0003	0.0084***	0.0005	0.0083***	0.0005	0.0084***	0.0004
	(0.0020)	(0.0026)	(0.0020)	(0.0026)	(0.0020)	(0.0026)	(0.0020)	(0.0026)
educ	0.0154***	0.0029	0.0154***	0.0029	0.0154***	0.0029	0.0162***	0.0031
	(0.0012)	(0.0029)	(0.0012)	(0.0029)	(0.0012)	(0.0029)	(0.0012)	(0.0029)
income	0.1455***	0.0717***	0.1507***	0.0730***	0.1505***	0.0750***	0.1270***	0.0631***
	(0.0150)	(0.0175)	(0.0135)	(0.0169)	(0.0131)	(0.0161)	(0.0116)	(0.0141)
RD	0.1916***	0.0894***	0.2069***	0.0967***	0.2052***	0.1013***	0.1540***	0.0785***
	(0.0295)	(0.0337)	(0.0269)	(0.0325)	(0.0261)	(0.0308)	(0.0228)	(0.0264)
RS	-0.0278**	-0.0251*	-0.0298***	-0.0228*	-0.0314***	-0.0234*	-0.0260**	-0.0203*
	(0.0114)	(0.0130)	(0.0111)	(0.0129)	(0.0110)	(0.0128)	(0.0107)	(0.0122)

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Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%. Standard Errors in brackets.

Table A.4: Table Continued from previous page

	Refoccup		Refoccup2		Refoccup4		Refoccup16	
	RE	Mundlak	RE	Mundlak	RE	Mundlak	RE	Mundlak
		-0.0123***		-0.0122***		-0.0122***		-0.0123***
age_m		(0.0034)		(0.0034)		(0.0034)		(0.0034)
		0.0003***		0.0003***		0.0003***		0.0003***
$agesq_m$		(0.0000)		(0.0000)		(0.0000)		(0.0000)
		0.0253***		0.0250***		0.0248***		0.0251***
$hsize_m$		(0.0039)		(0.0039)		(0.0039)		(0.0039)
		0.0107***		0.0116***		0.0115***		0.0122***
$educ_m$		(0.0032)		(0.0032)		(0.0032)		(0.0032)
		-0.0591*		-0.0609*		-0.0599*		-0.0580
$married\_sep_m$		(0.0359)		(0.0360)		(0.0360)		(0.0360)
		0.0087		0.0085		0.0089		0.0090
$single_m$		(0.0154)		(0.0154)		(0.0154)		(0.0154)
		-0.0241		-0.0249		-0.0242		-0.0237
$divorced_m$		(0.0186)		(0.0186)		(0.0186)		(0.0186)
		0.1083***		0.1084***		0.1085***		0.1087***
$widow_m$		(0.0394)		(0.0394)		(0.0394)		(0.0394)
		-0.0065		-0.0093		-0.0085		-0.0079
$part\text{-}time_m$		(0.0140)		(0.0140)		(0.0140)		(0.0140)
		-0.1304***		-0.1283***		-0.1278***		-0.1285***
$training_m$		(0.0277)		(0.0277)		(0.0277)		(0.0277)
		0.0006		-0.0053		-0.0037		-0.0027
$mg\_working_m$		(0.0259)		(0.0259)		(0.0259)		(0.0259)
		-0.1874***		-0.1880***		-0.1869***		-0.1881***
$not\_working_m$		(0.0155)		(0.0155)		(0.0155)		(0.0155)
		-0.5769**		-0.5785***		-0.5767**		-0.5783***
$sheltered\_working_m$		(0.2244)		(0.2243)		(0.2244)		(0.2244)
		0.1230***		0.1074***		0.1113***		0.0981***
$income_m$		(0.0242)		(0.0222)		(0.0219)		(0.0206)
		0.1757***		0.1487***		0.1497***		0.1007**
RD_m		(0.0513)		(0.0479)		(0.0476)		(0.0441)
		0.0382		0.0400		0.0326		0.0302
RS_m		(0.0245)		(0.0246)		(0.0245)		(0.0244)
Rho	0.470	0.470	0.470	0.470	0.470	0.470	0.470	0.470
Obs.	153,729	153,729	153,729	153,729	153,729	153,729	153,729	153,729

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%. Standard Errors in brackets.

Table A.5: FE and Mundalk estimations using occupation and occupation-regional reference groups, 1994-2010

	Refoccup		Refoccup2		Refoccup4		Refoccup16	
	FE	Mundlak	FE	Mundlak	FE	Mundlak	FE	Mundlak
TOTAL								
income	0.0693***	0.0717***	0.0732***	0.0730***	0.0744***	0.0750***	0.0654***	0.0631***
	(0.0191)	(0.0175)	(0.0185)	(0.0169)	(0.0175)	(0.0161)	(0.0150)	(0.0141)
RD	0.0865**	0.0894***	0.0987***	0.0967***	0.1019***	0.1013***	0.0836***	0.0785***
	(0.0359)	(0.0337)	(0.0347)	(0.0325)	(0.0326)	(0.0308)	(0.0274)	(0.0264)
RS	-0.0233*	-0.0251*	-0.0217	-0.0228*	-0.0220*	-0.0234*	-0.0201	-0.0203*
	(0.0134)	(0.0130)	(0.0134)	(0.0129)	(0.0131)	(0.0128)	(0.0125)	(0.0122)
Obs.	153,729	153,729	153,729	153,729	153,729	153,729	153,729	153,729
Num. of persnr	24,348	24,348	24,348	24,348	24,348	24,348	24,348	24,348
rho	0.565	0.470	0.565	0.470	0.565	0.470	0.565	0.470
MALE								
income	0.0838***	0.0844***	0.0827***	0.0833***	0.0973***	0.0977***	0.0878***	0.0879***
	(0.0248)	(0.0247)	(0.0246)	(0.0245)	(0.0231)	(0.0231)	(0.0205)	(0.0205)
RD	0.0784*	0.0803*	0.0809*	0.0827*	0.1168***	0.1182***	0.1051***	0.1055***
	(0.0468)	(0.0466)	(0.0459)	(0.0457)	(0.0433)	(0.0432)	(0.0374)	(0.0374)
RS	-0.0412**	-0.0410**	-0.0377**	-0.0376**	-0.0389**	-0.0388**	-0.0321**	-0.0320**
	(0.0175)	(0.0174)	(0.0174)	(0.0173)	(0.0171)	(0.0170)	(0.0162)	(0.0162)
Obs.	82,679	82,679	82,679	82,679	82,679	82,679	82,679	82,679
Num. of persnr	12,710	12,710	12,710	12,710	12,710	12,710	12,710	12,710
rho	0.574	0.483	0.574	0.483	0.574	0.483	0.574	0.483
FEMALE								
income	0.0635**	0.0550*	0.0707**	0.0634**	0.0532**	0.0465*	0.0460**	0.0408*
	(0.0300)	(0.0297)	(0.0284)	(0.0282)	(0.0268)	(0.0266)	(0.0219)	(0.0218)
RD	0.1046*	0.0903	0.1226**	0.1103**	0.0823*	0.0710	0.0597	0.0513
	(0.0563)	(0.0559)	(0.0531)	(0.0528)	(0.0497)	(0.0494)	(0.0402)	(0.0400)
RS	-0.0069	-0.0030	-0.0071	-0.0040	-0.0045	-0.0017	-0.0093	-0.0072
	(0.0210)	(0.0209)	(0.0209)	(0.0208)	(0.0205)	(0.0205)	(0.0194)	(0.0194)
Obs.	71,050	71,050	71,050	71,050	71,050	71,050	71,050	71,050
Num. of persnr	11,638	11,638	11,638	11,638	11,638	11,638	11,638	11,638
rho	0.555	0.460	0.555	0.460	0.555	0.460	0.555	0.460

Note: Control variables and year dummies are included in all the specifications. Significance: *** 99% confidence level, ** 95% and * 90%. Standard Errors in brackets.

B Appendix. POLS transformation validity

In order to test the robustness of the findings obtained in section 5 and the validity of the POLS transformation for SAH, equation (7) is estimated considering the ordinal nature of self-assessed health using an ordered probit model. Table B.1 shows the results for Table 3 now estimated using an ordered probit model.

In an ordered probit model the estimated coefficients cannot be directly interpreted, but the sign is informative about whether the effect is positive or negative. In the case of the ordered probit model, coefficients for absolute and relative income measures present the same sign as the ones estimated by Pooled OLS.[13]

Table B.1: Ordered probit estimations using reference group defined by occupation, 1994-2010

	TOTAL		MALE		FEMALE	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
income	0.1786***	0.3878***	0.1510***	0.3880***	0.1866***	0.3877***
	(0.0165)	(0.0659)	(0.0215)	(0.0601)	(0.0230)	(0.0808)
mean income	0.2382***		0.2691***		0.2234**	
	(0.0780)		(0.0756)		(0.0918)	
RD		0.4435***		0.4427***		0.5002***
		(0.1387)		(0.1364)		(0.1662)
RS		-0.0550		-0.1011**		-0.0023
		(0.0435)		(0.0496)		(0.0490)
cut1	0.6068	0.3945	0.2672	0.0138	0.9001	0.7762
	(0.6419)	(0.6247)	(0.6372)	(0.6172)	(0.8348)	(0.7923)
cut2	1.6249**	1.4126**	1.2654**	1.0119*	1.9407**	1.8169**
	(0.6416)	(0.6238)	(0.6289)	(0.6080)	(0.8396)	(0.7969)
cut3	2.7276***	2.5153***	2.3942***	2.1406***	3.0182***	2.8945***
	(0.6472)	(0.6294)	(0.6366)	(0.6161)	(0.8407)	(0.7977)
cut4	4.2845***	4.0720***	3.9781***	3.7244***	4.5475***	4.4239***
	(0.6475)	(0.6297)	(0.6374)	(0.6167)	(0.8414)	(0.7979)
Obs.	153,729	153,729	82,679	82,679	71,050	71,050

Note: Control variables and year dummies are included in all specifications Significance: *** 99% confidence level, ** 95% and * 90%. Mean income, RD and RS are refered to Refoccup.

[13]Results are also similar when using reference groups defined by occupation and region, tables are available upon request.

Again, the sign and significance of income, RD and RS is the same to the results obtained with RE and FE after the POLS transformation –see Table B.2.

These findings might support the use of POLS transformation for SAH.

Table B.2: Reoprobit estimations using reference group defined by occupation, 1994-2010

	TOTAL		MALE		FEMALE	
	RE	Mundlak	RE	Mundlak	RE	Mundlak
income	0.3990***	0.1844***	0.4681***	0.2417***	0.3376***	0.1154*
	(0.0352)	(0.0403)	(0.0465)	(0.0540)	(0.0545)	(0.0672)
RD	0.5047***	0.2153***	0.5690***	0.2268**	0.4607***	0.1745
	(0.0698)	(0.0786)	(0.0918)	(0.1043)	(0.1080)	(0.1295)
RS	-0.0813***	-0.0736**	-0.1465***	-0.1320***	-0.0090	-0.0038
	(0.0268)	(0.0300)	(0.0358)	(0.0406)	(0.0408)	(0.0465)
cut1	-0.6615*	0.4022	-0.4541	0.0403	-0.7198	1.2617
	(0.3484)	(0.5400)	(0.4573)	(0.7487)	(0.5427)	(0.9428)
cut2	0.7780**	1.8452***	0.9755**	1.4751**	0.7300	2.7142***
	(0.3483)	(0.5400)	(0.4572)	(0.7486)	(0.5426)	(0.9428)
cut3	2.3618***	3.4318***	2.6150***	3.1182***	2.2576***	4.2446***
	(0.3484)	(0.5401)	(0.4572)	(0.7487)	(0.5426)	(0.9429)
cut4	4.5746***	5.6458***	4.8766***	5.3821***	4.4182***	6.4063***
	(0.3484)	(0.5402)	(0.4574)	(0.7489)	(0.5427)	(0.9430)
rho	0.5190	0.5145	0.5281	0.5242	0.5090	0.5041
Obs.	153,729	153,729	82,679	82,679	71,050	71,050

Note: Control variables and year dummies are included in all specifications. Significance: *** 99% confidence level, ** 95% and * 90%. RD and RS are refered to Refoccup.

C Appendix. Wald and Hausman Tests

This appendix summarizes the Wald and Hausman tests conducted to test whether unobserved heterogeneity is correlated with the regressors.

The null hypothesis of the Wald test is whether the coefficients of the panel-level means introduced in the Mundlak's estimations are jointly equal to 0. Table C.1 shows that this null hypothesis is rejected for the three samples of this study and all the reference groups based on occupation.

Additionally, the Hausman test analyses the difference between the RE and FE estimations. Again, the null hypothesis that there are not systematically differences is rejected.

Both tests confirm that unobserved heterogeneity might be correlated with the control variables.

Table C.1: Wald and Hausman Tests, 1994-2010

	Refoccup		Refoccup2		Refoccup3		Refoccup4	
	Wald	Hausman	Wald	Hausman	Wald	Hausman	Wald	Hausman
TOTAL								
Chi2	469.41	388.81	458.36	378.02	454.70	372.85	454.42	372.75
Prob $\succ$ *chi*2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Null Hypothesis	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
MALE								
Chi2	240.78	206.00	233.55	195.04	235.45	199.22	194.57	232.69
Prob $\succ$ *chi*2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Null Hypothesis	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
FEMALE								
Chi2	212.33	251.55	215.57	251.44	207.51	243.75	211.57	247.82
Prob $\succ$ *chi*2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Null Hypothesis	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected