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What Do Happiness and Health Satisfaction Data Tell Us about Relative Risk Aversion?[1]

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Abstract

In this paper we provide estimates of the coefficient of relative risk aversion using information on self-reports of subjective personal well-being from multiple datasets, including three cross-sectional surveys and two panel surveys, namely the Gallup World Poll, the European Social Survey, the World Values Survey, the British Household Panel Survey for the United Kingdom, and the General Social Survey for the United States. We additionally consider the implications of allowing for health-state dependence in the utility function on the estimates of risk aversion and examine how the marginal utility of income changes in poor health states. Our estimates of relative risk aversion with cross-section data vary closely around 1, which corresponds to logarithmic utility, while the estimates with panel data are slightly larger. We find that controlling for health dependence generally reduces these estimates. In contrast with other studies in the literature, our results also suggest that the marginal utility of income *increases* when satisfaction with health deteriorates, and this effect is robust across the various datasets analyzed.

JEL codes: D80, G00, I10, I31.

Keywords: relative risk aversion; marginal utility of income; happiness; health dependence.

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1. Introduction

Attitudes toward risk are a central issue in almost every economic problem involving decision making. Surprisingly, there is not yet a commonly accepted estimate of the coefficient of relative risk aversion. Many economists think that the coefficient of relative risk aversion probably lies between 1 and 3, but estimates vary widely in the literature, from as low as 0.2 to 10 or higher, particularly in the literature that uses inferences from behavioral choices to elicit risk aversion.[1]

In this paper, we use data on subjective self-reports of personal well-being to estimate the coefficient of relative risk aversion. Additionally, using data on subjective self-reports of satisfaction with personal health, we examine how the estimates of risk aversion and the curvature of the utility function are affected by considering health-state dependence.

The literature on the application of happiness or subjective well-being data to address economic issues originated with Easterlin's (1974) seminal paper, and since the late 1990s the amount of research that uses happiness and satisfaction databases has increased considerably; Frey and Stutzer (2002) and Di Tella and MacCulloch (2006) are two examples of reviews of the use of such data in economics.

In our analysis, we build primarily on Layard, Mayraz, and Nickell (2008) by applying their analysis to various cross-sectional and panel datasets not considered in their study. These authors use happiness data to estimate how fast the marginal utility of income declines as income increases, an elasticity that corresponds to the parameter of relative risk aversion under a constant relative risk aversion utility function. The authors stress the importance of this interpretation of the parameter of interest for analyzing normative public economic issues, such as optimal taxation. The estimation of the association between survey based measures of personal well-being and income has been analyzed extensively in the

[1] Among the studies based on behavioral choices, Friend and Blume (1975), studying the demand for risky assets, estimate that the coefficient of relative risk aversion generally exceeds 1. Weber (1975), using expenditure data, and Szpiro (1986), using data on property insurance, estimate relative risk aversion in the range of 1.3 and 1.8. Using consumption data, Hansen and Singleton (1983) report lower estimates: between 0.68 and 0.97. Also using data on consumption, Mankiw (1985) finds much larger estimates in the range of 2.44 to 5.26. More recent studies continue to show a great disparity of estimates. Using a consumption-based capital asset pricing model with state-dependent risk aversion, Gordon and St-Amour (2004) find estimates in the range of 0 to 10. Garcia, Luger, and Renault (2003) using a generalization of a Black-Scholes option pricing model to S&P 500 call option prices report estimates of relative risk aversion in the range of 0.83 to 3.28. Chetty (2006), studying the links among labor supply, risk aversion, and the curvature of the utility over consumption, finds a mean estimate of relative risk aversion of 0.71 with a range of 0.15 to 1.78. Campo, Guerre, Perrigne, and Vuong (2011) estimate a first-price auction model semiparametrically and report an estimate of relative risk aversion of 0.61. Kapteyn and Teppa (2011) estimate different measures of risk aversion based on subjective indicators.

literature. Clark, Frijters, and Shields (2008) provide a survey of recent results on the estimation of the relationship specifically between happiness scores and personal income.[2]

Our paper also extends the framework of Layard, Mayraz, and Nickell (2008) by considering health-state dependence in the utility function, as in Finkelstein, Luttmer, and Notowidigdo (2008), who stress the interpretation of the parameter of interest as a measure of risk aversion for analyzing financial problems, such as determining the optimal amount of health insurance.

While the interpretation of the parameter of interest as either the elasticity of the marginal utility of income or as the coefficient of relative risk aversion may conceptually rely on whether one assumes that happiness scores are ordinal or cardinal in nature, Ferrer-i-Carbonell and Frijters (2004) argue that one can practically assume that happiness scores are both cardinally and ordinally interpersonally comparable, as findings suggest that individuals, especially in the same language community, have a common understanding of happiness and of how to translate subjective notions of well-being into a numerical scale (van Praag, 1991). In this paper, we follow the literature and explicitly assume that happiness scores are cardinally comparable to provide estimates based on linear least squares regressions and we interpret the estimated coefficient as relative risk aversion.

First, we consider data sets that provide only cross-sectional observations for various countries in one or more time periods. In other words, these surveys do not follow individual respondents over time, but they may provide information for the same country in different years. The cross-section estimates use data from the Gallup World Poll (GWP), the European Social Survey (ESS), and the World Values Survey (WVS). The Gallup dataset only recently became available for applied research and covers a larger set of people than most subjective well-being surveys: about 70,000 individuals in more than 140 countries.[3] The largest dataset used by Layard, Mayraz, and Nickell (2008), for example, includes only about 50 countries. We also use data from the ESS covering 27 countries and from the WVS covering 41 countries. We classify the various individual countries in these surveys using five groups of countries categorized by the World Bank in terms of income per capita, and provide estimates for these categories. We also provide estimates for the United States with data from the GWP and the WVS. For each of these surveys, we provide overall estimates that use pooled observations from all countries.

[2] In a related approach, Plug, van Praag, and Hartog (1999) use survey-based measures of *welfare from income* in an analysis of optimal taxation.

[3] Deaton (2008), Gandelman and Hernández-Murillo (2009), and Rojas (2011) are among the first published papers using this data.

Second, we consider panel data sets that follow individuals over multiple time periods. We use data from the British Household Panel Survey (BPHS) for the United Kingdom and data from the General Social Survey (GSS) for the United States. In the samples we consider, the BPHS provides data for about 6,400 individuals in up to 7 waves, while the GSS provides data for about 940 individuals in up to 3 waves. The panel studies allow for the inclusion of time-invariant individual effects, which has been shown to be relevant for analyzing the effect of income on reported happiness (see Clark, Frijters, and Shields, 2008).

The estimates of relative risk aversion using the cross-sectional or panel surveys are largely similar in magnitude. In the cross-sectional surveys, the estimates with the GWP data are slightly lower than 1, whereas the estimates with the ESS and the WVS were slightly larger than 1. When we analyze the effect of controlling for health-state dependence on the estimates of relative risk aversion, we find that the estimated relative risk aversion coefficients generally decline. We also find in contrast to Finkelstein, Luttmer, and Notowidigdo (2008) that the marginal utility of income *increases* when health deteriorates. These patterns are robust across all the different datasets we analyzed.

In the Section 2 we describe the datasets used in the analysis. In Section 3 we present the estimated equations. We discuss the results in Section 4 and provide concluding comments in Section 5.

2. Data

2.1 Cross-Section Surveys.

We use data from the 2006 GWP, the 2002 to 2006 waves of the ESS and the 1981 to 2008 waves of WVS. The main variables of interest are self-reports of happiness or satisfaction with life, self-reports on the assessment of personal health, and self-reports on household income. We also use additional information on age, gender, marital status, employment status, and residence in urban areas.

2.1.1 The Gallup World Poll

The GWP is probably the world's most comprehensive database of behavioral economic measures. It surveys individuals in more than 140 countries representing about 95 percent of the world's adult population. In our study we use data on about 55,000 individuals from 103 countries.

While the GWP does not have a specific question on personal happiness (e.g., "*How happy are you?"*), it has a question on satisfaction with life that corresponds to a personal assessment of general well-being. The question in the survey reads "*Please imagine a ladder/mountain with steps numbered from zero at the bottom to ten at the top. Suppose we say that the top of the ladder/mountain represents the best possible life for you and the bottom of the ladder/mountain represents the worst possible life for you. If the top step is 10 and the bottom step is 0, on which step of the ladder/mountain do you feel you personally stand at the present time?"* We use the ordered responses to this question as our measure of reported well-being, and henceforth we do not distinguish it from happiness.

As an indicator of health status we use the question on satisfaction with personal health, *"Are you satisfied or dissatisfied with your personal health?"* "Yes" or "No" are the possible answers.

Household income data are reported in 29 brackets. We use the midpoint of the bracket as the measure of income, and for the top bracket we use a value equal to double the previous midpoint value. Because some countries report this variable in local currency (see Gasparini and Gluzmann, 2009), we express the income measure in deviations from the country's average.[4] We also eliminate outlier observations from the analysis (see Section 3).

2.1.2 European Social Survey

The first three rounds of the ESS conducted from 2002 to 2006 contain data on 27 countries. In our study we use data on 32,951 individuals.

The ESS asks respondents separate questions about their happiness and satisfaction with life. We use the happiness question that reads "*Taking all things together, how happy would you say you are?*" Respondents are asked to select a number from 0 (corresponding to *extremely unhappy*) to 10 (corresponding to *extremely happy*). We use the ordered responses to this question as our measure of reported well-being.

The health status indicator is derived from the ESS question that reads "*How is your health in general? Would you say it is…?*" Respondents are asked to select one of five responses: *very good, good, fair, bad, very bad*. We create an indicator that distinguishes *fair*, *bad*, and *very bad* responses from *good* and *very good* responses.

Household total net income data are reported in 12 brackets. The survey provides bracket intervals in Euros and when necessary, inserts corresponding national currencies.

[4] This normalization also addresses the issue of making the measures comparable across countries, as there is no clear indication of which countries report income in local currency.

We use the midpoint of the bracket as the measure of income. For the bottom and top brackets we use a value equal to two-thirds of the bottom-code value and one and a half times the top-code value, respectively. Similar to the procedure used with the Gallup data, the income measure is expressed in deviations from the country's average and outlier observations are excluded from the analysis.

2.2.3 World Values Survey

The WVS aggregated files contain data across 5 waves from 1981 to 2008 for 87 countries. In our study we use data on 38,500 individuals from 41 countries.[5]

The WVS asks respondents separate questions about their happiness and satisfaction with life. The responses to the satisfaction with life question are provided on an ordinal scale comparable to the measures of well-being used in the other surveys so we use this as our measure of reported well-being. The life satisfaction question reads "*All things considered, how satisfied are you with your life as a whole these days?*" Respondents are asked to select a number from 1 (corresponding to *dissatisfied*) to 10 (corresponding to *satisfied*).

The health status indicator is derived from the WVS question that reads "*All in all, how would you describe your state of health these days? Would you say it is…?*" Respondents are asked to select one of five responses: *very good, good, fair, bad, very bad*. We create an indicator that distinguishes *fair*, *bad,* and *very bad* responses from *good* and *very good* responses.

Household gross income data are reported in 10 brackets. Specific bracket intervals in national currencies are not provided for all country-wave combinations. Therefore, we exclude data from the analysis when the country-specific bracket values are not known. We use the midpoint of the bracket as the measure of income. For the bottom and top brackets we use a value equal to two-thirds of the bottom-code value and one and a half times the top-code value, respectively.[6] Again, similar to the procedure used with the Gallup data, the income measure is expressed in deviations from the country's average and outlier observations are excluded from the analysis.

[5] The number of observations used in our study is substantially limited by the lack of country-specific values for the income variable.

[6] The recoding of the top and bottom brackets of the income scales across the different datasets attempts to provide reasonable values for the extremes, but it is unlikely to alter the results because we eliminate outlier observations from the sample.

2.2 Panel Surveys

2.2.1 British Household Panel Survey

The BHPS is a panel study that followed a sample of individuals in the United Kingdom over the years 1991 to 2008. In 2009 the BHPS was integrated into the *Understanding Society* longitudinal study. The survey is conducted by the Institute for Social and Economic Research of the University of Essex. The first wave surveyed 10,300 individuals from Great Britain. After 1999, additional samples from both Wales and Scotland were added, and in 2001 individuals from Northern Ireland were included. In our sample we consider about 27,300 observations, corresponding to about 6,000 individuals in up to 7 waves, starting in wave 12.

This panel survey does not have a specific question on personal happiness, but it does have one on overall life satisfaction. The individual is asked "*How dissatisfied or satisfied are you with your life overall*?" on a scale from 1 to 7, with 1 indicating *not satisfied at all* and 7 indicating *completely satisfied*. The question on health satisfaction is phrased as "*Please think back over the last 12 months about how your health has been. Compared to people of your own age, would you say that your health has on the whole been ...*" The possible responses range from *very poor* to *excellent* in a scale of 1 through 5. We coded a dummy dissatisfaction with health as 1 for responses corresponding with *fair* or *poor*, and 0 in other cases. Finally, the income variable represents annual household income and is measured in nominal British pounds before taxes and deductions.

2.2.2 General Social Survey

The GSS is a survey administered in the United States to national samples of the National Opinion Research Center (NORC) at the University of Chicago. Data come from the 2006, 2008, and 2010 waves of the survey. In 2008, the survey was transitioned to a rotating 3-wave panel and included the first re-interviewed cross-section from the 2006 wave and a new cross-section. In our study we use 1,962 observations corresponding to 943 individuals in up to 3 waves.

The happiness question in this survey is phrased as *"Taken all together, how would you say things are these days—would you say that you are very happy, pretty happy, or not too happy?"* We dropped non-responses and recoded the scale from 1 (*not too happy)* to 3 (*very happy)*. The health status indicator was derived from the question *"Would you say that in general your health is Excellent, Very good, Good, Fair, or Poor?"* We coded an

indicator for dissatisfaction with health as in the BHPS. In contrast with the previous surveys, the GSS provides a variable for total family income that has already been adjusted for inflation and imputed based on the midpoints of the categorical midpoints from 25 income brackets. As with the cross-section data, for both the BHPS and the GSS we express the income measure in deviations from the respective overall average.

2.3 Summary Statistics

Table 1 presents summary statistics for the cross-sectional surveys. The top panel reports summary statistics from the Gallup World Poll for the key variables in our estimations. In the baseline estimations we used data from 103 countries and 54,625 individual observations. The average individual reported a happiness level of 5.5 in the 0-10 scale with a standard deviation of 2.2. About 22% of individuals in the GWP reported dissatisfaction with their personal health. The database is composed of adult individuals with an average age of 42.2 years and a slightly larger presence of women (55%) than men (45%). About 70% of individuals in our sample are married or in a partnership relation, fewer than half live in an urban setting (44%), and 60% are employed.

The middle panel presents similar summary statistics computed among individuals in the ESS. In the baseline estimations we used data from 27 countries and 32,951 individuals. The average reported happiness was 7.4 in the 0-10 scale with a standard deviation of 1.8. About 23% of individuals in the ESS reported dissatisfaction with personal health. The average age is 42.1 years, with a smaller presence of women (48%) than in the Gallup data. About 66% of individuals in the sample are married, 68% live in an urban setting, and 92% are employed.

The bottom panel presents the corresponding statistics in the WVS. This dataset has information on 38,504 individuals in 41 countries. The average reported happiness was 6.8 in the 1-10 scale with a standard deviation of 2.4. A larger proportion than in the GWP and ESS report dissatisfaction with personal health (33%), while the average age of 41.2 years is similar, as is the proportion of women (52%). However, the proportion of married individuals is somewhat higher (79%) and the proportion of employed individuals is slightly larger than in the GWP (68%).

In these tables the income variable is expressed in deviations from the country's average, and because we trimmed outlier observations, the reported means in each dataset may differ from 100%.

[Table 1 (summary statistics for GWP, ESS, and WVS) about here]

Table 2 presents the summary statistics for the two panel surveys. The top panel presents the BPHS. We have 27,299 observations corresponding to 5,938 individuals in up to 7 annual waves. The average happiness score is 5.1 in the 1-7 scale, with a standard deviation of 1.2. The proportion of individuals who report dissatisfaction with personal health (17%) is similar but slightly lower than in the cross-sectional surveys. Most other statistics are comparable. The average age is 43.8 years of age; the proportion of women is 53%; the proportion of married individuals is 79%; and the proportion of employed individuals is 80%.[7]

Finally, with the GSS we analyze 1,962 observations representing 1,962 individuals in up to 3 waves in the United States. The average happiness score is 2.2 in the 1-3 scale, with a standard deviation of 0.6. All other statistics are comparable to the previous surveys. Average age is 44.9 years of age; the proportion of women is 58%; the proportion of married individuals is 56%; and the proportion of urban residents is 75.7%.[8]

[Table 2 (summary statistics for BHPS and GSS) about here]

3. Methodology

3.1 Utility function

In this paper we follow a common assumption in theoretical and applied work and assume a constant relative risk aversion utility function with respect to income (a proxy for consumption):

$$u(y) = \begin{cases} \dfrac{y^{1-\rho}}{1-\rho} & \text{if} \quad \rho \neq 1 \\ \log(y) & \text{if} \quad \rho = 1 \end{cases}, \qquad (1)$$

where y represents income and ρ corresponds to the Arrow-Pratt coefficient of relative risk aversion r_R (Arrow, 1965):

[7] The British Household Survey Panel does include an indicator for urban or rural, and provides instead an indicator for geographic regions, but it was missing for several observations.

[8] We left the dummy for employment status out of the analysis because including this variable in the regression prevented the procedure from finding a coefficient of relative risk aversion in the interior of the interval considered.

$$r_R = -y\frac{u''(y)}{u'(y)} = \rho. \qquad (2)$$

3.2 Estimation methodology: happiness and utility

To use the happiness data we need to hypothesize on the nature of the relation between reported happiness, h_i, and the individual's experienced utility, $u_i = u(y_i)$. For simplicity, as in Layard, Mayraz, and Nickell (2008) we assume that the relation $h_i = f_i(u_i)$ is linear and that the relation f is common to all individuals. The linearity assumption corresponds to assuming a cardinality interpretation of the happiness scores and justifies the estimation with ordinary least squares (OLS).[9]

The estimated equation is therefore:

$$h_i = \gamma u_i + X_i\beta + v_i \qquad (3)$$

where v_i represents an error term that is independent of experienced utility u_i.

The last problem is how to estimate γ and ρ separately. We follow an iterative maximum likelihood procedure as in Layard, Mayraz, and Nickell (2008). First, we compute $u_i = u(y_i)$ for values of ρ between 0 and 5 in steps of 0.1. Second, for each of these computations we estimate γ and the vector of parameters β with an ordinary least squares regression and save the resulting log-likelihood of the estimation. In the vicinity of the maximum likelihood estimator we repeat this procedure in steps of 0.01.

To ensure that our results are not affected by outliers in the income reports we trim observations corresponding to the bottom 5% and the top 5% of the distribution of residuals of a regression of the log of relative income on individual controls, as in Layard, Mayraz, and Nickell (2008).

Clearly, according to the above specification, income enters in the utility function as a proxy for consumption. Furthermore, in order to interpret the estimation results we have to assume that the effect of income on reported happiness correspond to the causal effects of

[9] Our results do not vary significantly if we estimate the model with ordered logit instead of OLS when using cross-sectional data. Both the magnitude of the coefficients of interest and the directions of the effects are very similar under either methodology. Ferrer-i-Carbonell and Frijters (2004) note that while it makes little practical difference to estimate similar regressions with cross-sectional data using OLS or ordered logit, in the case of panel data when time-invariant individual effects are important estimating ordered response models requires more complex methods.

consumption on utility. In making this assumption, we follow previous studies, but we recognize that it is not trivial and we acknowledge it as a potential limitation. Further discussion on this topic can be found in Clark, Frijters, and Shields (2008) and the references therein.

3.3 Health state dependence

The previous estimation strategy can be easily extended to analyze the effect of health status on the utility function. We denote by S_i (for sick) a dummy variable that takes the value of 1 if individuals provide an affirmative answer to the question on dissatisfaction with personal health and rewrite the equation for the utility function over income and health status as:

$$\tilde{u}(y,S) = \gamma_1 u(y_i) + \gamma_2 u(y_i) \times S_i + \eta S_i. \tag{4}$$

The coefficient η reflects shifts in utility from dissatisfaction with personal health which do not modify the marginal utility income, whereas the coefficient γ_2 represents changes in the marginal utility of income from changes in health status. We use the same iterative procedure previously described to estimate the modified model.

4 Results

4.1 Cross-sectional surveys

The cross-sectional studies we analyze contain observations from different countries. So, in addition to providing global estimates by pooling all the observations, we also conduct the estimations for five different sets of countries categorized in terms of income using the World Bank's income classifications. The classes are high income OECD, high income non-OECD, upper-middle income, lower-middle income, and low income. Additionally, whenever we pool data from several countries we include country dummies in the estimation, and whenever the survey contains more than one wave we include wave dummies as well.

Table 3 reports the estimates of the relative risk aversion coefficient with and without health dependence. The table also reports likelihood ratio tests for the null hypothesis of log utility (ρ=1); the bold coefficients indicate statistical significance at the 10% confidence level. The top panel of Table 3 reports the estimates using the Gallup data. The reported

coefficients are for the five income country classifications, the United States, and the overall pooled estimation. The estimates of the relative risk aversion coefficient in the Gallup data for the various income groups and the overall estimate without controlling for health dependence range from 0.66 to 0.82. We do not observe a monotonic relation between income groups and the estimated relative risk aversion coefficient. The estimate with all countries, the estimate for high-income OECD countries, and the estimate for low income countries are statistically different from 1 (which corresponds to log utility), while the estimates for high-income non-OECD and lower- and upper-middle income countries are not statistically different from 1 at a 10% confidence level. The estimate for the United States without health dependence is much higher than the group estimates at 1.37, but it is not statistically different from 1. Adding health status in the utility function tends to reduce the estimates of the relative risk aversion coefficients across all groups and the United States.

The middle panel of Table 3 reports the estimates of relative risk aversion in the ESS. In this dataset, most countries fall in either the upper-middle income or high-income OECD classifications. The overall estimate without health dependence is 1.54 and is significantly different from 1. Similarly, the estimate for high-income OECD countries is 1.53 and it is also significantly different from 1. The estimate for upper-middle income countries is 1.13 and it is not significantly different from 1. Adding health dependence to the utility function reduces the point estimates for the overall estimates and for high-income OECD countries, but they remain significantly different from 1.

The estimates with the WVS, reported in the bottom panel of Table 3, present a picture similar to that of the ESS estimates. The overall estimate (1.17) and those for high-income OECD (1.52) and upper-middle income countries (1.32) are greater than 1 in magnitude and statistically significantly different from 1. The estimates for high-income non-OECD (0.51) and for lower-middle income countries (1.47), on the other hand, are not significantly different from 1.[10] The estimates also generally decline when controlling for health dependence. The estimates for the United States with (0.81) or without health dependence (0.96) were not significantly different from 1.

[Table 3 (LR tests for GWP, ESS, and WVS) about here]

The estimates of relative risk aversion using the Gallup data are somewhat smaller than the reported range for the elasticity of the marginal utility with respect to income (1.19-1.34)

[10] The low-income category in the WVS included only two countries with very few observations, and we dropped it from the analysis.

of Layard, Mayraz, and Nickell (2008) and smaller than the estimates with the ESS and WVS, especially for high-income OECD countries. The estimates using the ESS and WVS are, in contrast, slightly larger. A possible explanation for the disparities among our findings is the composition of countries in the different surveys that were used. The lower estimates with Gallup data are also below previous estimations of relative risk aversion that use inferences based on behavioral choices (Friend and Blume, 1975, Weber 1975, Szpiro 1986, Mankiw 1985). The reliability of the income data in the Gallup survey may also play a role in explaining the differences in the magnitude of the estimates. Our estimates are, however, closer to the results of Hansen and Singleton (1983), Cox and Oaxaca (1996), and Bartunek and Chowdhury (1997). The results with Gallup data are also in line with Gandelman and Porzecanski (2013), who also use Gallup data and find that the only way to reconcile happiness inequality with income inequality is with a relative risk aversion coefficient lower than 1. Finally, most studies using experimental data also find low levels of risk aversion.[11]

Tables 4 through 6 report the estimated coefficients of the individual controls and the coefficients of the income and health variables controlling for health dependence in the utility function. The reported OLS estimations correspond to the maximum likelihood estimator of the coefficients of relative risk aversion reported in Table 3. Most individual regressors have the expected direction of effect across all datasets.

In Table 4, corresponding to the estimates using the GWP, women are more likely than men to report higher levels of life satisfaction ("All countries" column). Similarly, happiness responds positively to living in partnership: married individuals are more likely to report higher levels of happiness than non-married individuals (especially in the United States). Age has a negative effect on the likelihood of higher happiness reports, while its square has a positive effect. This is consistent with other studies in the literature that find a U-shaped relation between age and happiness scores. Residence in an urban setting has a statistically negative effect for the United States, high-income OECD countries, and low-income countries (although not statistically significant in the latter case) and a positive effect in other cases. The effect of employment status is also positive whenever it is statistically significant; employed individuals are more likely to report higher levels of happiness than unemployed individuals.

In terms of health dependence, individuals reporting dissatisfaction with personal health are less likely to report higher levels of happiness, and the effect is statistically

[11] Holt and Laury (2002) report relative risk aversion between 0.3 and 0.5 and Andersen, Harrison, Lau, and Rutström (2008) report an estimate of relative risk aversion of 0.74.

significant. More importantly, the interaction of health status with the utility of income, *Sick*u(y)*, has a positive effect and is statistically significant in the specifications for all countries (0.14), high income OECD countries (0.32), low income countries (0.13), and upper-middle income countries (0.14) and suggests that the marginal utility of income increases when satisfaction with health declines. These results are in contrast with those of Finkelstein, Luttmer, and Notowidigdo (2008). Our findings indicate that controlling for health dependence would suggest that the optimal amount of health insurance or the optimal amount of life cycle savings is *higher* than when not controlling for health dependence. A potentially important methodological difference between our paper and Finkelstein, Luttmer and Notowidigdo (2008) is that, although we both use a subjective utility proxy, Finkelstein, Luttmer, and Notowidigdo use an *objective* indicator of health status, measured by the number of diagnosed chronic diseases, while we use a *subjective* self-reported indicator of dissatisfaction with personal health. Another difference between our approaches is that their data consists of elderly or near-elderly individuals with no labor income, while in our sample we restrict observations to working-age individuals.

[Table 4 (regression with health for GWP) about here]

Table 5 presents similar coefficient estimates for the ESS. All individual controls are statistically significant for the estimation with all countries and for high-income OECD countries, but some coefficients are not statistically significant in the case of upper-middle income countries. Women and married individuals are more likely to report higher happiness levels in all three specifications (although the female coefficient is not statistically significant in the case of upper-middle income countries). Residence in an urban setting and employment status also have a positive effect on reported happiness. The direct effect of age is negative, while its square has a positive effect. Similarly, the variable indicating dissatisfaction with health (*Sick*) has a negative effect. Individuals dissatisfied with personal health (*Sick=1*) are less likely to report higher levels of happiness. The interaction of the *Sick* dummy with the utility of income, *u(y)*, also has a positive sign when it is statistically significant, suggesting that individuals dissatisfied with personal health experience a higher effect from income on reported happiness than individuals who are satisfied with their personal health.

[Table 5 (regression with health for EES) about here]

Finally, Table 6 presents the estimations using the WVS. Again, the magnitude and direction of the effects of the various controls are similar to those reported in Tables 4 and 5. The results regarding health dependence are also robust. In the overall estimate, for example,

the *Sick* dummy has a negative effect and suggests that individuals dissatisfied with personal health are less likely to report higher levels of happiness than healthier individuals. The interaction of the health status indicator with the utility of income is also positive and suggests that individuals dissatisfied with personal health have a larger effect from income on reported happiness (than individuals who are satisfied with personal health) in the estimation with all countries and much higher for individuals in high-income countries.

[Table 6 (regression with health WVS) about here]

4.2 Results with panel surveys

Table 7 presents the estimated coefficients of relative risk aversion for the BHPS and the GSS. In the United Kingdom, the estimate without accounting for health dependence is 1.89 and it is not statistically significantly different from 1. The estimate for the United States is similar in magnitude, at 1.71, and it is also not significantly different from 1. Controlling for health dependence reduces the coefficient in the BHPS to 1.71 while the estimate in the GSS increases to 1.74 but in neither case can we reject the null hypothesis of log utility.

[Table 7 (LR tests for BHPS and GSS) about here]

Table 8 presents the regression results corresponding to the maximum likelihood estimators. While the estimated relative risk coefficients are similar using panel and cross-sectional data, the regression results regarding the effect of income are somewhat different. Specifically, the coefficient for the utility of income is negative for the BHPS (although not statistically significant) and positive for the GSS (and statistically significant). While the happiness scores scales are not directly comparable across surveys (the cross-sectional surveys are mostly in the 0-10 scale, the BHPS is in a 1-7 scale, and the GSS is in a 1-3 scale) the measures of relative income are comparable and the panel results suggest a much smaller magnitude of the effect of income on happiness than in the cross section results, once time and individual effects are taken into account.

[Table 8 (regression with health BHPS and GSS) about here]

The panel results concerning the notion of health dependence in the utility of income are, however, consistent with the cross-sectional results. The coefficients for the direct effect of dissatisfaction with health (*Sick*) are negative in both the BHPS and GSS, but only statistically significant in the BHPS. Furthermore, the estimated coefficients for the

interaction of dissatisfaction with health and the utility of income are positive in both cases, similar to the cross-sectional estimates, but they are not statistically significant.

In the panel regressions we control for time-invariant individual effects (the indicator for female is dropped as a consequence) and we also include wave dummies. Therefore, the direct effect of age in the BHPS and the GSS case is not comparable to the cross-section estimates. As in the cross-section estimates, the indicators for married individuals is positive and statistically significant. Finally, the urban indicator in the GSS is not statistically significant, and the employment indicator in the BHPS is positive and statistically significant.

5 Conclusion

A significant volume of literature on the implications of behavioral choices for attitudes toward risk yields varying estimates of the coefficient of relative risk aversion. The reported estimates range from nearly linear utility on income (a relative risk aversion coefficient of zero) to estimates implying much greater concavity than log utility (corresponding to a relative risk aversion coefficient larger than 1).

In this paper, we extend the analysis of the estimation of the coefficient of relative risk aversion using happiness data by Layard, Mayraz, and Nickell (2008) and the analysis of health-state dependence in the utility function by Finkelstein, Luttmer, and Notowidigdo (2008). We use data from three large cross-sectional surveys and two large panel surveys that include information on self-reports of subjective well-being, dissatisfaction with personal health, and household income. Happiness data, although extensively used in recent years to analyze the effects of inflation and unemployment, among other macroeconomic variables, have only recently begun to be used to study risk aversion or the links with personal health, and our studies are among the first in this area.

In contrast to Layard, Mayraz, and Nickell (2008), who report estimates of relative risk aversion that generally exceed a value of 1, we obtain estimates that are greater or smaller than 1, depending on the set of countries and surveys analyzed. More importantly, we find that controlling for health dependence tends to reduce the estimates of relative risk aversion, even in the cases for which we obtain coefficients of relative risk aversion greater than 1.

Controlling for health-state dependence in the specification of the utility function indicates that individuals who are dissatisfied with their personal health are more likely to

report lower levels of subjective well-being. Our findings also indicate that the marginal utility of income is *higher* for individuals who are dissatisfied with their health. This result is robust across all the surveys analyzed and is in contrast with that of Finkelstein, Luttmer, and Notowidigdo (2008), who find the opposite effect. From a policy perspective, these results may prove relevant for future analysis of the implications of risk attitudes and health status on the optimal amount of health insurance benefits.

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Table 1. Summary Statistics

Variable	Mean	Std. Dev.	Observations	Countries
Gallup World Poll				
Happiness	5.5	2.2	54,625	103
Sick	22.2%	41.6%	54,625	103
Income	90.5%	55.2%	54,625	103
Age	42.2	11.3	54,625	103
Female	54.9%	49.8%	54,625	103
Married	70.1%	45.8%	54,625	103
Urban	43.5%	49.6%	54,625	103
Employed	60.1%	49.0%	54,625	103
European Social Survey				
Happiness	7.4	1.8	32,951	27
Sick	22.6%	41.8%	32,951	27
Income	95.2%	46.1%	32,951	27
Age	42.1	7.2	32,951	27
Female	48.0%	50.0%	32,951	27
Married	65.6%	47.5%	32,951	27
Urban	68.2%	46.6%	32,951	27
Employed	92.4%	26.5%	32,951	27
World Values Survey				
Happiness	6.8	2.4	38,504	41
Sick	32.6%	46.9%	38,504	41
Income	86.9%	58.4%	38,504	41
Age	41.2	7.3	38,504	41
Female	52.0%	50.0%	38,504	41
Married	79.4%	40.5%	38,504	41
Urban	--	--	--	--
Employed	67.6%	46.8%	38,504	41

Note: In the WVS urban was missing for several countries.

Table 2. Summary Statistics

Variable	Mean	Std. Dev.	Observations
British Household Panel Survey			
Happiness	5.1	1.2	27,299
Sick	17.1%	37.6%	27,299
Income	95.4%	60.6%	27,299
Age	43.8	11.4	27,299
Female	52.6%	49.9%	27,299
Married	78.7%	41.0%	27,299
Employed	79.9%	40.0%	27, 299
General Social Survey			
Happiness	2.2	0.6	1,962
Sick	20.4%	40.3%	1,962
Income	96.6%	67.5%	1,962
Age	44.9	11.3	1,962
Female	58.4%	49.3%	1,962
Married	55.5%	49.7%	1,962
Urban	75.7%	42.9%	1,962

Table 3. Relative risk aversion estimation results

	Without health dependence			With health dependence		
		Likelihood ratio			Likelihood ratio	
	Rho	**Chi-squared**	**p-value**	**Rho**	**Chi-squared**	**p-value**
Gallup World Poll						
All countries	0.82	**12.98**	0.000	0.75	**22.82**	0.000
High-income OECD	0.76	**7.22**	0.007	0.62	**16.12**	0.000
High-income non-OECD	0.95	0.06	0.804	0.84	0.52	0.470
Upper-middle income	0.91	1.39	0.239	0.84	**3.34**	0.068
Lower-middle income	0.86	1.46	0.227	0.85	1.53	0.217
Low-income	0.66	**7.91**	0.005	0.59	**10.51**	0.001
United States	1.37	1.32	0.251	1.13	0.14	0.711
European Social Survey†						
All countries	1.54	**33.44**	0.000	1.51	**23.36**	0.000
High-income OECD	1.53	**27.26**	0.000	1.49	**18.54**	0.000
Upper-middle income	1.13	0.21	0.648	1.19	0.37	0.543
World Values Survey‡						
All countries	1.17	**4.35**	0.037	1.12	1.42	0.234
High-income OECD	1.52	**12.39**	0.000	1.26	2.39	0.122
High-income non-OECD	0.51	1.08	0.298	0.74	0.27	0.605
Upper-middle income	1.32	**7.26**	0.007	1.35	**6.17**	0.013
Lower-middle income	1.47	2.92	0.088	1.44	1.90	0.168
United States	0.96	0.03	0.871	0.81	0.35	0.552

Bold chi-squared test statistics indicate statistical significant at the 10% level.

The null hypothesis is log utility (relative risk aversion (rho) equal to 1).

†The "Low-income", "Lower-middle income", and "High-income non-OECD" country classifications contain one or zero countries and are omitted.

‡ The "Low-income" country classification contains just two countries and is omitted.

Table 4. Regression with health dependence: Gallup World Poll.

	All countries		United States		High-income OECD		High-income non-OECD		Low-income		Lower-middle income		Upper-middle income	
Sick	-0.5618	***	-0.6005	***	-0.6917	***	-0.6793	***	-0.3712	***	-0.5387	***	-0.6026	***
	(0.0218)		(0.1954)		(0.0388)		(0.0990)		(0.0413)		(0.0507)		(0.0469)	
u(y)	0.6542	***	0.4770	***	0.7570	***	0.6792	***	0.4666	***	0.5666	***	0.6918	***
	(0.0160)		(0.1221)		(0.0352)		(0.0729)		(0.0283)		(0.0340)		(0.0333)	
Sick* *u(y)*	0.1358	***	0.1984		0.3151	***	0.1269		0.1300	**	0.0666		0.1359	**
	(0.0309)		(0.1880)		(0.0671)		(0.1433)		(0.0598)		(0.0642)		(0.0598)	
Female	0.1781	***	0.1024		0.2742	***	0.2071	***	0.0234		0.0869	**	0.2309	***
	(0.0157)		(0.1357)		(0.0273)		(0.0662)		(0.0298)		(0.0381)		(0.0350)	
Age	-0.0706	***	-0.0854		-0.1209	***	-0.0082		-0.0369	***	-0.0540	***	-0.0914	***
	(0.0057)		(0.0522)		(0.0104)		(0.0249)		(0.0110)		(0.0132)		(0.0126)	
Age^2	0.0008	***	0.0012	**	0.0013	***	0.0001		0.0004	***	0.0006	***	0.0010	***
	(0.0001)		(0.0006)		(0.0001)		(0.0003)		(0.0001)		(0.0002)		(0.0001)	
Married	0.1771	***	0.7505	***	0.2991	***	0.0288		-0.0105		0.1277	***	0.1731	***
	(0.0174)		(0.1631)		(0.0318)		(0.0813)		(0.0330)		(0.0426)		(0.0380)	
Urban	0.0291	*	-0.2709	*	-0.0791	***	0.1883	**	-0.0172		0.1226	***	0.1137	***
	(0.0172)		(0.1404)		(0.0282)		(0.0760)		(0.0362)		(0.0405)		(0.0391)	
Employed	0.1489	***	-0.0240		0.1943	***	-0.0487		-0.0143		0.0977	**	0.2695	***
	(0.0177)		(0.1810)		(0.0353)		(0.0827)		(0.0318)		(0.0397)		(0.0389)	
	8.6990	***	8.3071	***	9.6820	***	6.8066	***	5.1353	***	6.1353	***	7.1345	***
	(0.1371)		(1.1874)		(0.2334)		(0.5226)		(0.2248)		(0.2778)		(0.2716)	
No. of Obs.	54,625		610		14,976		2,646		12,181		10,713		14,122	
No. of Countries	103		1		28		5		23		20		27	
Log-likelihood	-108,033.8		-1,157.7		-28,257.1		-5,035.8		-22,762.7		-21,675.5		-29,642.3	
R2	0.358		0.197		0.282		0.164		0.154		0.172		0.219	

Standard errors in parentheses.

* Significant at 10%, **Significant at 5%, ***Significant at 1%.

Regressions include country and wave dummies.

Table 5. Regression with health dependence: European Social Survey.

	All countries		High-income OECD		Upper-middle income	
Sick	-0.7196	***	-0.7165	***	-0.8743	***
	(0.0250)		(0.0253)		(0.1487)	
u(y)	0.3265	***	0.3180	***	0.7080	***
	(0.0194)		(0.0199)		(0.1344)	
Sick* *u(y)*	0.1491	***	0.1464	***	-0.0248	
	(0.0313)		(0.0329)		(0.1689)	
Female	0.1415	***	0.1436	***	0.1624	
	(0.0178)		(0.0179)		(0.1316)	
Age	-0.0860	***	-0.0911	***	-0.0818	
	(0.0154)		(0.0155)		(0.1051)	
Age^2	0.0009	***	0.0010	***	0.0009	
	(0.0002)		(0.0002)		(0.0012)	
Married	0.4821	***	0.4830	***	0.5986	***
	(0.0206)		(0.0207)		(0.1451)	
Urban	0.1279	***	0.1196	***	0.3482	**
	(0.0195)		(0.0197)		(0.1394)	
Employed	0.4304	***	0.4436	***	0.3358	*
	(0.0378)		(0.0386)		(0.2000)	
No. of Obs.	32,951		31,344		1,324	
No. of Countries	27		23		3	
Log-likelihood	-62,290.4		-58,673.3		-2,930.8	
R2	0.214		0.191		0.137	

Standard errors in parentheses.
* Significant at 10%, ** Significant at 5%, *** Significant at 1%.
Note: The "Low-income", "Lower-middle income", and "High-income non-OECD" country classifications contain one or zero countries and are omitted.

Regressions include country and wave dummies.

Table 6. Regression with health dependence: World Values Survey.

	All countries		United States		High-income OECD		High-income non-OECD		Lower-middle income		Upper-middle income	
Sick	-0.8925	***	-1.1513	***	-1.0138	***	-0.5875	***	-0.7776	***	-0.8934	***
	(0.0298)		(0.1753)		(0.0454)		(0.1422)		(0.0933)		(0.0427)	
u(y)	0.3635	***	0.5507	***	0.3873	***	0.6875	***	0.2239	***	0.3135	***
	(0.0201)		(0.1125)		(0.0383)		(0.1332)		(0.0474)		(0.0234)	
Sick* *u(y)*	0.0629	*	0.1591		0.2709	***	0.7300	**	0.0090		0.0238	
	(0.0324)		(0.2384)		(0.0625)		(0.3107)		(0.0725)		(0.0370)	
Female	0.2519	***	0.3137	***	0.1897	***	0.1832	*	0.1404	*	0.3000	***
	(0.0238)		(0.1034)		(0.0338)		(0.1045)		(0.0826)		(0.0350)	
Age	-0.0852	***	-0.1242		-0.0770	***	-0.0338		0.0518		-0.1388	***
	(0.0187)		(0.0912)		(0.0281)		(0.0832)		(0.0608)		(0.0271)	
Age^2	0.0011	***	0.0014		0.0009	***	0.0003		-0.0005		0.0017	***
	(0.0002)		(0.0011)		(0.0003)		(0.0010)		(0.0007)		(0.0003)	
Married	0.5006	***	0.3094	***	0.5230	***	0.3847	***	0.3508	***	0.5102	***
	(0.0282)		(0.1188)		(0.0435)		(0.1252)		(0.1134)		(0.0398)	
Employed	0.1317	***	-0.0569		0.0281		0.2891	**	0.1666	*	0.1286	***
	(0.0274)		(0.1356)		(0.0443)		(0.1246)		(0.0875)		(0.0388)	
No. of Obs.	38,504		1,087		10,222		1,821		5,354		20,522	
No. of Countries	41		1		14		3		6		16	
Log-likelihood	-83,925.1		-2,090.6		-19,548.1		-3,799.9		-12,619.9		-45,859.2	
R2	0.226		0.143		0.200		0.122		0.122		0.221	

Standard errors in parentheses.

* Significant at 10%, **Significant at 5%, ***Significant at 1%.

Note: The "Low-income" country classification contains just two countries and is omitted.

Regressions include country and wave dummies.

Table 7. Relative risk aversion panel estimation results

	Without health dependence			With health dependence		
		Likelihood ratio			Likelihood ratio	
	Rho	**Chi-squared**	**p-value**	**Rho**	**Chi-squared**	**p-value**
British Household Panel Survey						
UK	1.89	1.61	0.205	1.71	0.75	0.388
General Social Survey						
US	1.71	1.11	0.292	1.74	0.45	0.504

Bold chi-squared test statistics indicate statistical significant at the 10% level.

The null hypothesis is log utility (relative risk aversion (rho) equal to 1).

Table 8. Regression with health dependence: Panel data sets

	British Household Panel Survey		GSS	
Sick	-0.5847	***	-0.0923	
	(0.0196)		(0.0638)	
u(y)	-0.0137		0.0407	*
	(0.0085)		(0.0235)	
Sick* *u(y)*	0.0026		0.0025	
	(0.0122)		(0.0351)	
Age	-0.5395	**	0.7074	***
	(0.2612)		(0.2339)	
Age^2	0.0007	***	-0.0001	
	(0.0001)		(0.0003)	
Married	0.2680	***	0.1242	*
	(0.0303)		(0.0730)	
Employed	0.1422	***	--	
	(0.0270)			
Urban	--		-0.0034	
			(0.1149)	
No. of Obs.	27,299		1,962	
No. of Groups	5,938		943	
Log lik.	-28119.8		-528.6	
R2	0.057		0.029	
F(all u_i=0)	5.21		2.59	
Prob > F	0.000		0.000	

Standard errors in parentheses.
* Significant at 10%, **Significant at 5%, ***Significant at 1%.
Regressions include individual fixed effects and wave dummies.