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Domain-specific risk and public policy*

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Abstract

We develop a method to estimate domain-specific risk. We apply the method to sickness insurance by fitting a utility function at the individual level, using European survey data on life satisfaction. Three results stand out. First, relative risk aversion increases with income. Second, marginal utility is higher in the sick state conditional on income, due to an observed fixed cost of sickness. Third, the domain-specificity of risk shifts the focus on the smoothing of utility, not consumption. The optimal policy rule implies that the replacement rates should be non-linear and decrease with income.

Keywords: risk, risk aversion, state-dependence, social insurance, sickness absence
JEL classification: D02, H55, I13

Tiivistelmä

Kehitämme menetelmän, jolla voi tutkia alaominaista riskiä (domain-specific risk). Sovellamme menetelmää sairausvakuutukseen sovittamalla hyötyfunktion yksilötason aineistoon (EU-SILC). Mittaamme hyötyä elämäntyytyväisyydellä. Saamme kolme keskeistä tulosta. Ensinnäkin, suhteellinen riskiaversio kasvaa tulojen myötä. Toiseksi, sairaana olevien kulutuksen rajahyöty on korkeampi annetulla tulotasolla kuin työssäkäyvien. Ero johtuu havaitusta sairauden kiinteästä kustannuksesta, johon sisältyvät sekä sairauden rahalliset ja ei-rahalliset kustannukset. Tällä on huomattava vaikutus optimaalisen vakuutuskorvauksen arviointiin. Käyttämämme menetelmä osoittaa sen, että optimivakuutuksessa keskeistä on pyrkimys tilariippuvien rajahyötyjen eikä kulutustasojen tasoittamiseen.

Tutkimuksessa luonnehditaan saamiemme havaintojen perusteella optimaalista työtulovakuutusta. Ideaalitilanteessa optimaalinen vakuutuskorvaus asetetaan siten, että kulutuksen rajahyöty on yhtä suuri työssäkäyville ja sairaille. Todellisuudessa vakuutuskorvaus vaikuttaa käyttäytymiseen ja siihen liittyy kustannuksia, sillä parempi vakuutusturva pitkittää ja lisää sairausjaksoja. Tällöin optimaalinen politiikkasääntö (ns. Baily-Chetty -kaava) tasapainottelee mainitun hyödyn (hyödyn/kulutuksen tasaaminen) ja kustannuksen (käyttäytymisen vääristyminen) välillä. Estimoimiemme parametrien avulla arvioitu optimaalinen politiikkasääntö viittaa siihen, että yksilötasolla vakuutuksen korvausasteen tulisi olla epälineaarinen ja tulotason aleneva funktio.

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1. Introduction

The standard expected utility theory states that the utility gain of consumption smoothing stems from the curvature of the utility function, which governs all states of the world. However, a recent strand of the literature in psychology and behavioral economics argues that the value of insurance greatly varies, depending on the context (Weber et al., 2002).

We bridge the gap between these two seemingly incompatible approaches by employing a utility function in which risk is domain-specific. We specify a two-step characterization of income risk with respect to the realization of a domain-specific event. The first step involves studying the change in utility given the curvature of the utility function and a fall in consumption. The crucial new second step is the effect that results from the state-dependence of the utility function. To operationalize our approach, we study optimal sickness insurance schemes. We allow for a fixed cost of sickness that impacts utility directly and increases the relative risk aversion and marginal utility of the utility function. We show that our method leads to a novel, domain-focused view on risk that has important policy implications.

One can infer risk preferences and state-dependence empirically by studying individuals' revealed preferences (e.g., Cohen and Einav, 2007) or by analyzing subjective well-being in different states (Finkelstein et al., 2009; Mata et al., 2018). We take the latter approach. We use comprehensive survey data on life satisfaction in Europe (EU-SILC) to estimate state-dependent utility functions for the employed and sick leave states. Our analysis builds on the assumption that life satisfaction approximates utility. Our fitted functional form utilizes minimal restrictive assumptions and allows us to extract the relevant parameters of the utility function, including the fixed cost of the sickness term. The estimates show that the domain-specific fixed cost plays a fundamental role when characterizing optimal social insurance, particularly at the lower tail of the income distribution.

The empirical findings support our method of incorporating the standard utility theory and insights from recent behavioral economics research. The estimate of the utility function under the employment (i.e., non-sick) state conforms to the standard utility function. However, allowing for and empirically finding a significant difference in the utility curve for those who are on sick leave emphasizes the importance of state-dependence in risk.

The optimal policy rule in sickness insurance schemes constitutes a trade-off between benefits (i.e., the consumption smoothing effect) and costs (i.e., due to hidden actions or the moral hazard effect). The canonical Baily–Chetty formula is based on a state-independent utility function (Chetty, 2006, 2008; Baily, 1978). We relax this restriction and show that the standard measure of relative risk aversion is empirically lacking and that the fixed cost of sickness drives a substantial part of the effect of sickness leave on utility. It also implies that social insurance schemes need to be calibrated according to our best empirical understanding of utility and risk in each domain. We highlight the importance of smoothing utility rather than smoothing consumption across the states.

Our approach accounts for the core features related to public policy considerations. Augmenting the Baily–Chetty formula, we establish that the simple linear replacement rules that have been adopted in most European countries are generally not optimal.

Regarding sickness, the assumption of state-independence of the utility function has been challenged by previous contributions. The empirical literature provides conflicting results as to whether the marginal utility is higher or lower for the sick population (see Finkelstein et al., 2009, p. 117; see also Viscusi and Evans, 1990). Notably, Finkelstein et al. (2013) estimate that a one standard deviation increase in the incidence of chronic disease leads to a 10%–25%

drop in the marginal utility of consumption relative to the healthy population. The empirical economics literature on insurance choice in addition to psychological literature has found that risk taking is highly domain-specific (Einav et al., 2012; Weber et al., 2002).

The paper is structured as follows. Section 2 discusses the key theoretical aspects of an optimal sickness insurance system. Section 3 describes EU-SILC data, characterizes the utility function and empirical estimation methods. Section 4 reports the estimation results. The last section concludes.

2. Optimal sickness insurance

We apply and develop the static Baily–Chetty approach to sickness insurance (Baily, 1978; Chetty, 2006; Chetty and Finkelstein, 2013). The theoretical model describes a welfare-maximizing social planner's optimal choice of sickness benefits and taxes given the costs and benefits of higher sickness allowance. The costs of higher replacement rates consist of unobservable hidden actions, the effect of longer sickness spells at the intensive margin and more sickness spells at the extensive margin. The benefit is the utility smoothing that is provided by sickness insurance.[1]

We make two important departures from the standard theoretical model, as outlined by Chetty (2006). Both aspects are crucial for estimating and designing the optimal policy. On the cost side, we explore the relative contribution of the extensive and intensive margins by allowing

[1] Our approach is to emphasize the smoothing of utility rather than consumption across the states.

the probability of getting sick to vary in the model as a function of effort, which is unobserved to the social planner. On the benefit side, we allow for a fixed cost of sickness (θ in the model), i.e., we depart from the standard assumption of the state-independence of the utility function.[2]

The fixed cost of sickness, which fundamentally affects the utility gain of consumption smoothing, could in principle be of either sign. If the fixed cost of sickness is positive (negative), it implies a positive (negative) state-dependence, meaning that the marginal utility is higher (lower) in the sick state. The importance of state-dependence in optimal sickness insurance has been acknowledged since at least Zeckhauser (1970) and Arrow (1974). The prior evidence (see Finkelstein et al., 2009, for a review), however, focuses on the relationship between health (e.g., Finkelstein et al., 2013, study chronic disease) and marginal utility. Our focus is on the relationship between sickness absence status and marginal utility. We characterize and estimate θ.

The model gives an implicit equation for the optimal benefit, *b*, which is based on sufficient statistics approach (an augmented Baily–Chetty formula; see Appendix 2 for the detailed derivation of the model):

$$\varepsilon_{r,b} + \varepsilon_{D,b} = \frac{u'(c_s,1) - u'(c_e,0)}{u'(c_e,0)} \approx \gamma \frac{\Delta c + \theta}{c_e}\left[1 + \frac{1}{2}\rho \frac{\Delta c + \theta}{c_e}\right], \tag{1}$$

where $u'(c_s, 1)$ and $u'(c_e, 0)$ are the utility functions, where c_s and c_e are consumption in the sickness leave ($S = 1$) and employment ($S = 0$) states, respectively; $\frac{\Delta c}{c_e} = \frac{c_e - c_s}{c_e}$ is the proportional drop in consumption while on sick leave; $\gamma = -\frac{c_e u''(c_e)}{u'(c_e)}$ is the coefficient of

[2] See Chetty and Finkelstein (2013, pp. 155-156) for an alternative way to incorporate state-dependence.

relative risk aversion; $\rho = -\frac{c_e u'''(c_e)}{u''(c_e)}$ is the coefficient of relative prudence; $\varepsilon_{r,b} = \frac{d\log(\frac{p}{1-p})}{d\log(b)}$ is the elasticity of the odds ratio ($r = \frac{p}{1-p}$) of sickness leave with respect to the sickness benefit, i.e. the extensive margin; and $\varepsilon_{D,b} = \frac{d\log(D)}{d\log(b)}$ is the elasticity of the duration (D) of sick leave with respect to the sickness benefit, i.e. the intensive margin. The Envelope Theorem guarantees that all other behavioral responses can be ignored when setting the optimal benefit level, except for the elasticity parameters ($\varepsilon_{D,b}$ and $\varepsilon_{p,b}$) that enter the government budget constraint directly.

The model has an intuitive interpretation. The right-hand side of equation (1) defines the value of the insurance, i.e. the change in relative marginal utility, and the fixed cost of sickness under sick leave. The reduction in consumption is a function of the replacement rate, i.e. the rate at which pre-sickness income is covered by the sickness insurance scheme (for more details, see Section 3). We estimate the utility function parameters, including the fixed cost of sickness, allowing the value of insurance to vary as a function of income.

The left-hand side of the equality in equation (1) disentangles the extensive ($\varepsilon_{r,b}$) and intensive ($\varepsilon_{D,b}$) margins of the effect due to hidden actions. In our formulation, the extensive margin is expressed using the odds ratio $r = \frac{p}{1-p}$, following discrete choice models.

The Baily-Chetty formula is based on simplifying assumptions. The model does not account for possible preference for redistribution, the marginal cost of public funds, externalities on government budget or other externalities (Pichler and Ziebarth, 2017). Reference-dependence might play a role in the utility function in this context. However, the part of reference-dependence that is not captured by θ is not considered.

3. Empirical approach

3.1. Data

We use the EU Statistics on Income and Living Conditions (EU-SILC) data. The EU-SILC is a harmonized dataset on income, social inclusion and living conditions that covers the material and subjective aspects of well-being.[3] The EU-SILC data are based on a combination of survey and register-based information, depending on the source country. We use the data for all 27 countries that were members of the European Union in 2013 (see Appendix 3 for a description of sickness insurance institutions in Europe). In addition, we use data on Iceland, Norway and Switzerland, for a total of 30 countries.

Descriptive statistics are presented in Table 1. Figures A1–A2 display the histograms of the incomes and life satisfaction of the two subsamples (being on sick leave vs. employed), respectively. The subsample that is employed is large (~133,000), while the subsample for those on sick leave is substantially smaller (~1,400). Mean life satisfaction is ~0.8 points lower for the sick.

[Table 1 here]

We use four variables to construct our estimates. To define the working population, we restrict the sample to those who work above 30 hours per week (the variable PL060 in EU-

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[3] See http://ec.europa.eu/eurostat/web/income-and-living-conditions/overview. The data are readily available to other researchers and our method is replicable for sickness insurance and other domains.

SILC). We define the sick leave population as those who work less than 30 hours per week due to “disability or illness” (PL120). Our preferred measure of subjective well-being is life satisfaction, since it is the best available measure of decision utility (Benjamin et al., 2012; 2014a-2014b). We use the standard life satisfaction question (PW010): “Overall, how satisfied are you with your life nowadays?” The level of life satisfaction is measured on a scale from 0 to 10, where 0 is ‘not at all satisfied’ and 10 is ‘completely satisfied’. We give the life satisfaction variable a cardinal interpretation to accomplish our analyses, following e.g. Layard et al. (2008). For income, we use PPP-adjusted equivalized disposable household income per consumption unit (HX090).

3.2. A utility function compliant with data

We estimate the utility functions in the state of employment and sickness using life satisfaction as a measure of subjective well-being, allowing us to infer both the degree of risk aversion and state-dependence. There is no consensus on the sign of state-dependence, possibly due to varying contexts (see Finkelstein et al., 2009; Finkelstein et al., 2013; Figure 1).

[Figure 1 here]

For a non-parametric analysis of the relationship between income and life satisfaction in the data, we fit a spline. A visual inspection of the fit as shown in Figure 2 reveals that the utility on sick leave is lower with a higher slope, compared to those who are employed. To account for such a relationship, we utilize a function in the family of HARA (Hyperbolic Absolute Risk Aversion) utility functions, with relative risk aversion increasing, decreasing, or constant (see Merton, 1971; Meyer and Meyer, 2005, for a review):

$$u(c(y),S) = \frac{(y-\omega-\theta S)^{1-\gamma}}{1-\gamma}, \quad (2)$$

where S is an indicator for sickness leave and ω is a shift parameter that has been used in dynamic analyses incorporating stock effects, such as habit formation; see Phlips (1978). The HARA family offers a flexible and tractable functional form which encompasses the most commonly used functions in macroeconomics and finance and emerges from economic reasoning (Perets and Yashiv, 2016).

[Figure 2 here]

Inserting the functional form from equation (2) into equation (1) and assuming that equivalized disposable income is a near equivalent to consumption (but see equation (8) below), we are able to explicitly solve for the optimal replacement rate (RR),

$$RR = 1 - \frac{\Delta \text{y}}{y_e} = \left(\frac{\omega}{y_e} + \frac{\theta}{y_e}\right) + \left(1 - \frac{\omega}{y_e}\right)\left(1 + \varepsilon_{r,b} + \varepsilon_{D,b}\right)^{-\frac{1}{\gamma}}, \quad (3)$$

where $\Delta \text{y} = y_e - y_s$. Note that the presence of θ on the right-hand-side of equation (3) implies that pecuniary and non-pecuniary costs need to be considered when characterizing the total benefit of insurance. If $\theta > 0$, the state-dependence is positive and *vice versa*. However, in the current formulation of social sickness insurance, the true nature of θ is not relevant for optimal policy design.

Unlike in the standard CRRA (Constant Relative Risk Aversion) model, the relative risk aversion (RRA) and relative prudence (RP) are functions of y and ω. Assuming that agents also know their utility function in the sick state and optimize their utility across the states, their relative risk aversion and relative prudence are also functions of θ:

$$RRA_S(y,1) = -y\frac{u''(y,1)}{u'(y,1)} = \frac{\gamma y}{y-\omega-\theta}, if\ c > \omega + \theta \quad (4)$$

$$RP_S(y,1) = -y\frac{u'''(y,1)}{u''(y,1)} = \frac{(\gamma+1)y}{y-\omega-\theta}, if\ c > \omega + \theta. \quad (5)$$

3.3. Estimation

For the empirical specification of the utility function, we estimate a least squares fit of the form:

$$SWB(c(y_i), S_i) = \alpha + \frac{\beta}{1-\gamma}(y_i - \omega - \theta S_i)^{1-\gamma} + \varepsilon_i, \quad (6)$$

where S_i is the sickness leave indicator, y_i is equivalized disposable income, and SWB_i is life satisfaction. Sickness ($S_i = 1$) is measured as the state of working under 30 hours per week due to sickness. Employment ($S_i = 0$) is measured as the state of working more than 30 hours per week.

We apply the R package "minpack-lm", which is based on a modified Levenberg–Marquardt-type algorithm to obtain our fit. We choose the fit with the lowest sum of squared errors, which is obtained with an above-one initial γ parameter value. The maximizing problem is strongly sensitive to having an initial value above or below one in the γ parameter. In addition, assuming $\gamma < 1$ gives an unbounded utility function, whereas the data have a natural upper bound of 10. We estimate the model once assuming that $\alpha = 10$, and once allowing α to vary. Note that parameters α and β do not affect the relative marginal utilities in equation (1). For completeness we could allow for α to be state-dependent to guarantee $SWB(S = 0) > SWB(S = 1)$ in the case of negative state-dependence, $\theta < 0$. We desire to keep the notation as simple as possible.

The functional form (6) is HARA $\left(U_{HARA}(c(y)) = \frac{\gamma}{1-\gamma}\left(\frac{\alpha_H}{\gamma}y + \beta_H\right)^{1-\gamma}\right)$, with the simplifying restriction that $\frac{\alpha_H}{\gamma} = \frac{1}{1000}$, i.e., we measure income in thousands of annual euros. The restriction slightly increases estimation robustness when scaling income to a similar order of magnitude as life satisfaction, due to particulars of the numeric estimation algorithm. The numerical values of the parameters of interest $\{\theta, \omega\}$ remain stable but are also scaled by $\frac{1}{1000}$ and qualitatively the estimation of the crucial parameter γ is not affected by the scale. The parameter β, whose value is not our focus, varies with scale.

3.4. Replacement rate: income vs. consumption

We use equivalized disposable income to approximate consumption as closely as possible with an income measure to explicitly solve for optimal replacement rates, see equation (3). Not using actual consumption levels induces a potential bias (see Gruber, 1997; Kolsrud et al., 2018).[4] However, assuming that our equation (6) uncovers marginal utilities conditional on income levels in the sick and employed states, we have

$$u'(y,S) = u'(c(y),S)c'(y,S) = SWB'(c(y),S)c'(y,S) = \beta(y-\omega-\theta S)^{-\gamma}. \qquad (7)$$

Note that equation (7) is a function of *y*, not *c*.

More generally, we can calibrate the optimum (equation 1) in terms of our observables using $u'(y,S) = u'(c(y),S)c'(y,S)$ and a linear approximation to $c'(y_s,1) - c'(y_e,0)$, to obtain

$$\varepsilon_{r,b} + \varepsilon_{D,b} = \frac{u'(c_s,1) - u'(c_e,0)}{u'(c_e,0)} = \frac{(c'(y_e,0)/c'(y_s,1))u'(y_s,1) - u'(y_e,0)}{u'(y_e,0)}$$

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[4] The bias is due to additional hidden effects, which affect consumption rates i.e. the increase in benefits crowding out savings (Engen and Gruber, 2001) or spousal labor supply (Cullen and Gruber, 2000). However, in the case of sickness insurance these costs are negligible in comparison with old age insurance and smaller than in the case of unemployment insurance For old age insurance, see Feldstein (1974).

$$\approx \gamma \frac{\Delta y + \theta}{y_e}\left[1 + \frac{1}{2}\rho \frac{\Delta y + \theta}{y_e}\right] - \frac{c''(y_s, 1)y_s}{c'(y_s, 1)}\frac{\Delta y}{y_s}\left[1 + \gamma \frac{\Delta y + \theta}{y_e}\right], \qquad (8)$$

where $c''(y_s, 1)y_s/c'(y_s, 1)$ is the elasticity of marginal propensity to consume. Assuming Keynesian consumption functions that allow for the constant term to be state-dependent, $c(y, S) = c_0(S) + c_1 y$, giving $c''(y_s, 1) = 0$; $c'(y_e, 0)/c'(y_s, 1) = 1$ and the last term on the RHS of (8) is equal to zero. Note that equation (6) estimates γ and ρ as risk parameters relative to income, not consumption. Chetty and Finkelstein (2013) argue that these parameters are likely to vary with b. This gives an alternative approximation to that of Gruber (1997) in terms of observable variables. Strictly speaking, our local recommendations regarding policy are based on the first order conditions (Appendix 2). Since parameters may vary with policy rule, they may not apply globally.

4. Results

4.1. Main specification and implications for policy

A spline fit of equivalized disposable income on life satisfaction, as shown in Figure 2, immediately reveals two qualitative results regarding the sickness absence state. First, life satisfaction is lower conditional on income, providing a rationale for insurance. Second, marginal utility is higher conditional on income (i.e. a positive state-dependence). There is a clear convergence in life satisfaction between the two states at high levels of income. However, the point of convergence is difficult to establish, due to wide confidence bands.

To obtain the numerical estimates of the parameters of the utility function, including the fixed cost of sickness, we fit equation (6). The estimated parameter values are documented in Table 2. The main specification is presented in column 2 of Table 2, where we assume that $\alpha = 10$. The assumptions imply that $\lim_{c \to \infty} LS(c) = 10$, where *LS(c)* is life satisfaction as a function of consumption. This specification is the most robust one, and all the parameter value estimates are statistically significant.

The resultant utility curves, overlaid on the spline fit, are presented in Figure 3. The parameters with policy significance, $\{\gamma, \theta, \omega\}$, are all statistically highly significant. The estimates confirm the visual observation that the association between life satisfaction and income is stronger conditional on income in the sickness absence state. Using our functional form, the positive state-dependence stems from the positive and significant fixed cost of the sickness parameter, θ.

Given the estimated utility function, we calculate the relative risk aversion and relative prudence parameters using equations (4) and (5), respectively. The estimated relative risk aversion increases with income, as presented in Figure A3 in the employed and sick states. This result challenges the conventional wisdom (see Meyer and Meyer, 2005). However, coupled with the fixed cost of sickness, the utility loss of sickness is higher for low-income earners. As argued above, in our application, the emphasis is on the estimate for the sick state, in which relative risk aversion is higher.

[Table 2 and Figure 3 here]

To complete the analysis, we assume that $\varepsilon_{r,b} + \varepsilon_{D,b} = 1.5$. Thus, the combined effect of the extensive and intensive margins adds up to 1.5. Böckerman et al. (2018) observe that $\varepsilon_{D,b} \approx$

1.1.[5] There are no comparable estimates for the extensive margin in the literature. We assume that $\varepsilon_{r,b} = 0.4$, giving a total of 1.5. We apply equation (3) to study the optimal replacement rates given the estimated and assumed parameter values. We are also interested in the role of θ in determining the optimal policy curve (Figures 4–5).

[Figures 4–5 here]

We find that the optimal replacement rate curve is non-linear and decreases with income. In Figure 4, we show that the fixed cost of sickness reshapes the replacement rate curve from increasing to decreasing, in spite of our estimate of an increasing relative risk aversion with income. A key feature is that relative risk aversion is higher in the sick state.

Figure 5 shows that the optimal policy curve is non-linear. Our estimated replacement rates for most income earners fall within a region between the current French and the German policies. Note, however, that the optimal curve is based on equivalized disposable income, whereas the current policy schemes are based on earnings. Therefore, our analysis follows the literature in abstracting from other sources of income than labor income and income of other family members. Similar observation holds true for any effects that operate through the savings rate.

[5] Echoing the estimate that we use in the calculations, Ziebarth and Karlsson (2014) argue that the consensus estimate of the literature is ~1.

4.2. Country-level analysis and other domains

We replicate the aggregate analysis at the country level. The fits are shown in Figure A4.1. See Appendix 4 for technical details. The functional fit follows the pattern of the aggregate fit remarkably well given the lower sample size for each country. The estimation of ω is robust to the exclusion of low-income individuals in the data, since the whole range of incomes is used for the estimation. However, the non-parametric spline is highly inaccurate for most countries.

We extract the ω parameter point estimates from the country-level fits and correlate them with measures of institutions (Figure A4.2). The ω parameter is equivalent to giving each citizen an equal increase in consumption, increasing utility at all consumption levels. The ω parameter, which measures this shared increase in utility, captures the value of *all* the characteristics of a country, including its institutions, social capital, culture, climate etc. For brevity, we call ω the institutions parameter. In contrast to Jones and Klenow (2016), ω parameter abstracts from consumption levels.

We find that the Nordic welfare states have a high ω. By contrast, high-income Southern European countries have a low ω. The high correlation coefficient between the institutions parameter and trust is notable, at 0.85 for interpersonal trust and 0.79 for the mean trust in the police, the legal system and the political system. Additionally, the Gini coefficient of equivalized disposable income has a highly significant correlation with the institutions parameter at -0.57.

The sickness benefit may affect the value of institutions and the functional form between income and life satisfaction across countries. However, the correlation coefficient between the replacement rate and the estimated value of institutions is modest at 0.21 and not statistically significant. Table A4.2. reports the estimated contribution of institutions and consumption to the mean utility by country.

The domain-specificity of risk implies that each domain needs to be studied separately for optimal policy design. To illustrate this, we extend the current analysis to the domain of unemployment cursorily in Figure A4. The figure shows that qualitatively the state-dependent utility looks similar to the case of sickness. An analysis of optimal unemployment insurance should thus follow steps similar to those taken in this paper.

5. Conclusions

To paint a data-driven picture of an important policy issue, we use comprehensive subjective well-being data to measure utility and characterize risk in a domain-specific manner and the implied optimal sickness insurance rules. The representative survey data cover 30 countries in Europe.

We establish three main results. First, relative risk aversion increases with income. Second, the marginal utility is higher in the sick state conditional on income (i.e. positive state-dependence), due to an observed fixed cost of sickness that has a larger effect at lower levels of income. Consequently, the augmented Baily–Chetty model with real-life parameter values implies that optimal policy design has higher replacement rates for low-income individuals than most policy rules in Europe. This provides *prima facie* evidence that linear rules are non-optimal.

Our third result is that the domain-specificity of risk implies that the gain from insurance is due to the smoothing of utility, not consumption, across states. The perspective of utility smoothing is indispensable due to the pecuniary and non-pecuniary costs related to sickness. Other applications could exhibit other forms of costs and benefits, which need to be accounted for when studying utility smoothing and insurance.

We propose the following procedure when assessing domain-specific risk. First, estimate the standard measure of relative risk aversion in the state where risk has been realized. Second, evaluate the utility cost or gain due to the state-dependence of the utility function.

Our result challenges the standard view of risk aversion. Based on our analysis, the relative marginal utility is domain-specific and is driven by the fixed costs of adverse events. The role of optimal public policy is to mitigate this sizable welfare cost, which is more pronounced at lower levels of income.

The estimated institutions parameter which has a marked influence on the shape of life satisfaction curves, captures the effects of predetermined stock variables, such as the value of institutions. We present country-specific estimates of the institutions parameter and report unconditional correlations lending credence to the value of institutions across European countries, such as interpersonal trust and trust in the police, the legal system and the political system.

To identify utility functions, we assume that life satisfaction is a sufficiently satisfactory measure of utility, and our fit of equation (2) guarantees a sufficiently good fit of relative marginal utilities and higher order derivatives. Furthermore, we assume that our regressions in essence compare 'same persons' across the income distribution and the two states. We also assume that the estimated relationship is not a result of reverse causality.

Our results apply to a European-wide sickness insurance. The estimates based on individual countries are qualitatively remarkably similar and offer a future avenue into the study of the value of different institutional settings. Future research should also consider other risks, such as unemployment and old age.

Figures and Tables

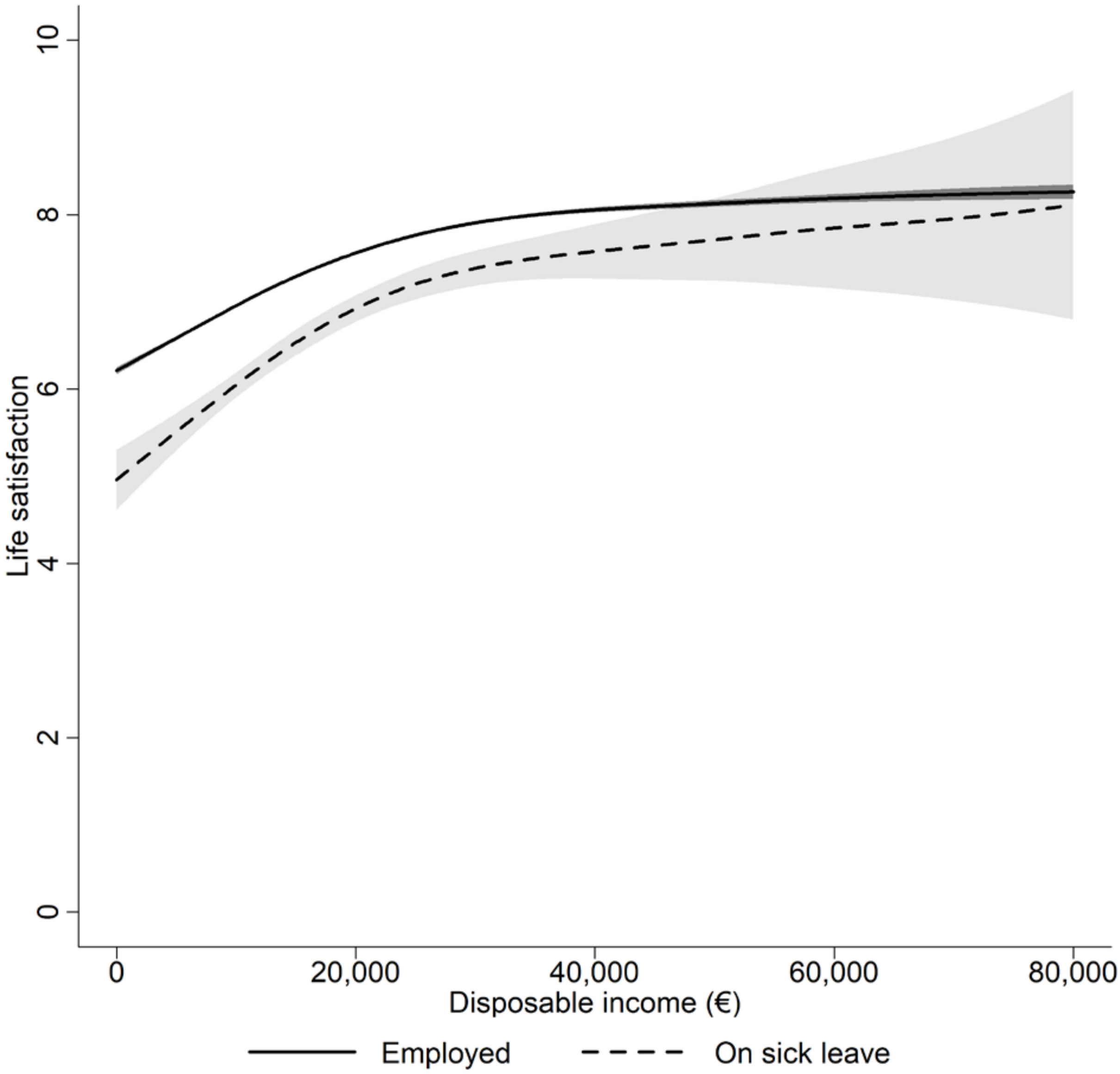
Table 1. Descriptive statistics.

	Employed		On sick leave	
	Mean	SD	Mean	SD
Life satisfaction	7.37	1.8	6.54	2.18
Equivalized disposable income (€)	19780.42	15680.63	17805.93	11684.36
Age	44.09	11.18	52.76	10.29
Female	0.45	0.50	0.69	0.46
Tertiary education	0.67	0.47	0.43	0.51
N	133,163		1,423	

Figure 1. Theoretical patterns of marginal utilities.

Notes. Adapted from Finkelstein et al. *(2013).* ***Panel A.*** *The panel presents a utility function with positive state-dependence*, i.e., *a utility function with higher marginal utility at each consumption level when on sick leave.* ***Panel B.*** *The panel presents a utility function with negative state-dependence,* i.e., *a utility function with lower marginal utility at each consumption level when on sick leave.*

Figure 2. Spline fit of life satisfaction and income in Europe, employed vs. sick.



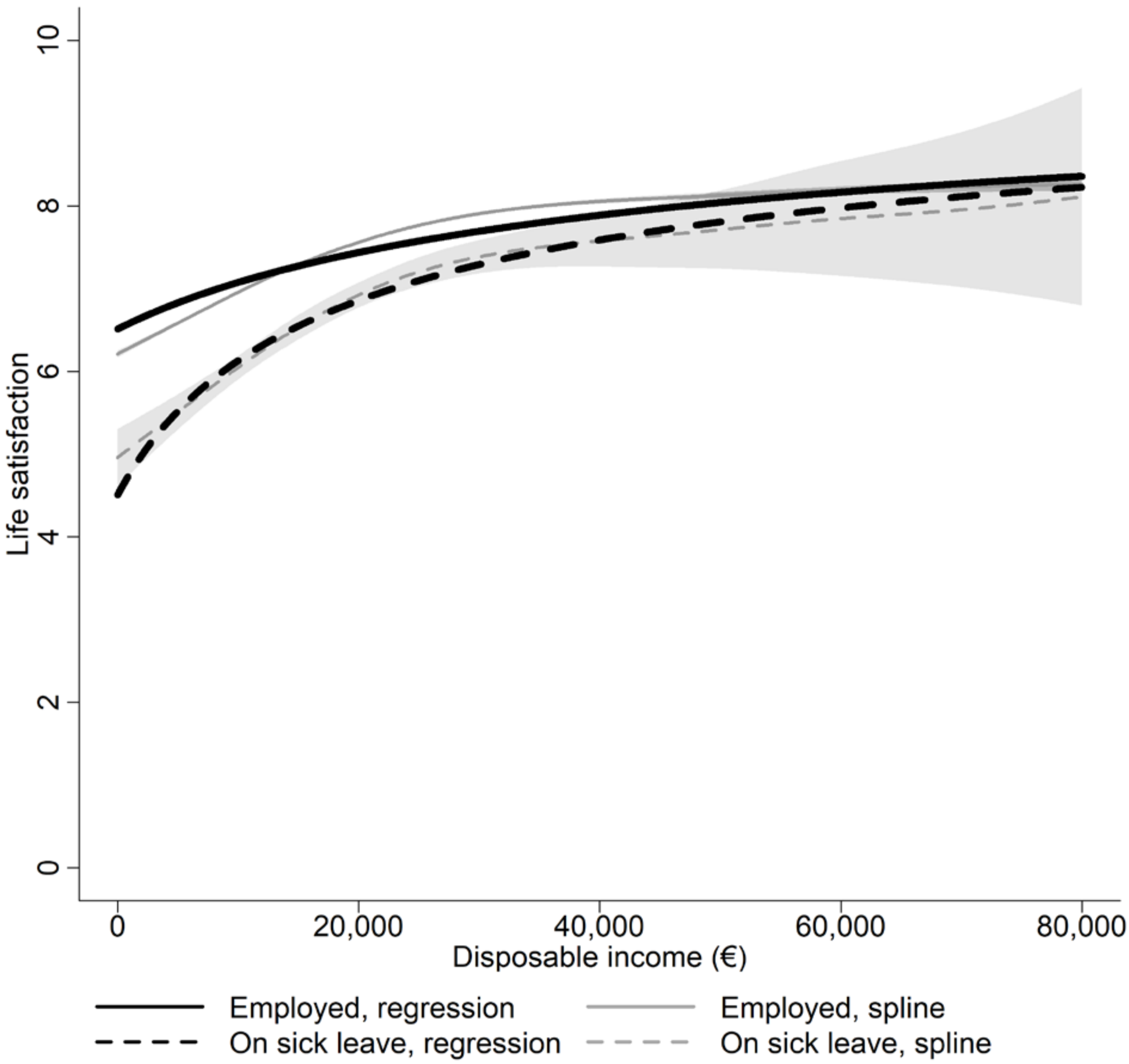
Notes. The estimate is a cubic spline with six knots estimated with the R package "bigsplines" using the default parameter values. The gray area around the curves represents the 95% confidence interval. Sample size: 133,207 in employment, 1,423 on sick leave.

Table 2. Estimates.

	Model 1: Estimated α	Model 2: Assume $\alpha = 10$
Constant: α	9.21*** (0.37)	-
Scale parameter: β	44.13 (75.78)	9.55** (2.36)
Relative risk aversion parameter: γ	1.86*** (0.34)	1.52*** (0.04)
Institutions parameter: ω	-31.16*** (9.85)	-24.99*** (2.97)
Fixed cost of sickness: θ	14.12*** (0.86)	14.27*** (0.79)
N	134,586	134,586

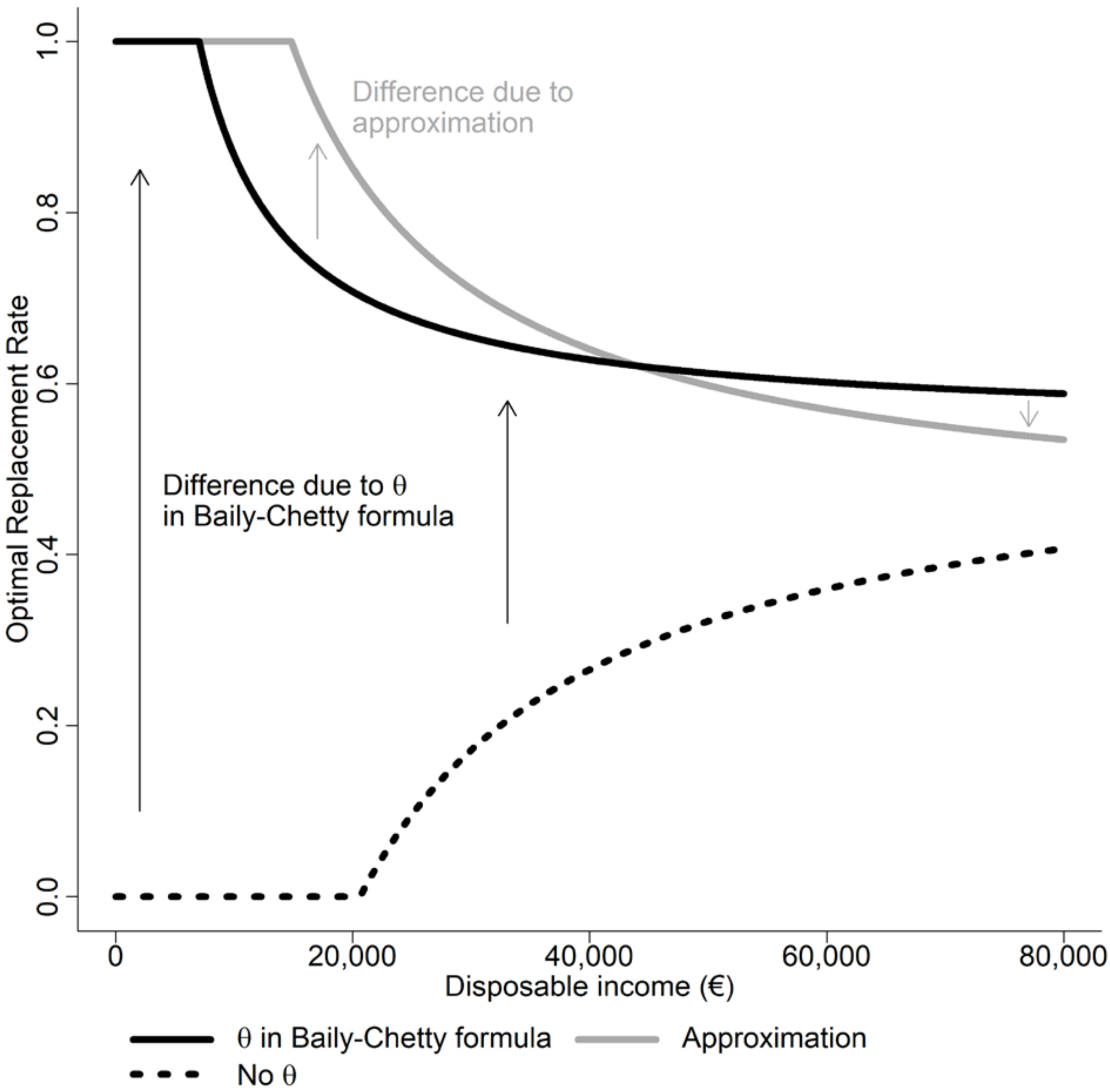
*Notes. Statistical significance: * p<0.1; ** p<0.05; *** p<0.01. The non-linear regression is the fit with a modified Levenberg–Marquardt-type algorithm with sampling weights. The standard errors are in parentheses. The residual standard error of the fit is 52.71 for columns 1 and 2. The starting values, where applicable, for both models, are:* $\{\alpha = 0,\ \beta = 0,\ \omega = -15,\ \theta = 15,\ \gamma = 1.4\}$. *The starting values in the set* $\{\gamma\ |\gamma < 1\}$ *yield a fit with higher residual standard errors and insignificant parameter estimates. Model 2 is our preferred specification. For the estimation, the income variable is in thousands of annual euros, which affects the estimated ω, and* θ *in particular.*

Figure 3. Spline and non-linear regression fit of life satisfaction and income in Europe, employed vs. sick.



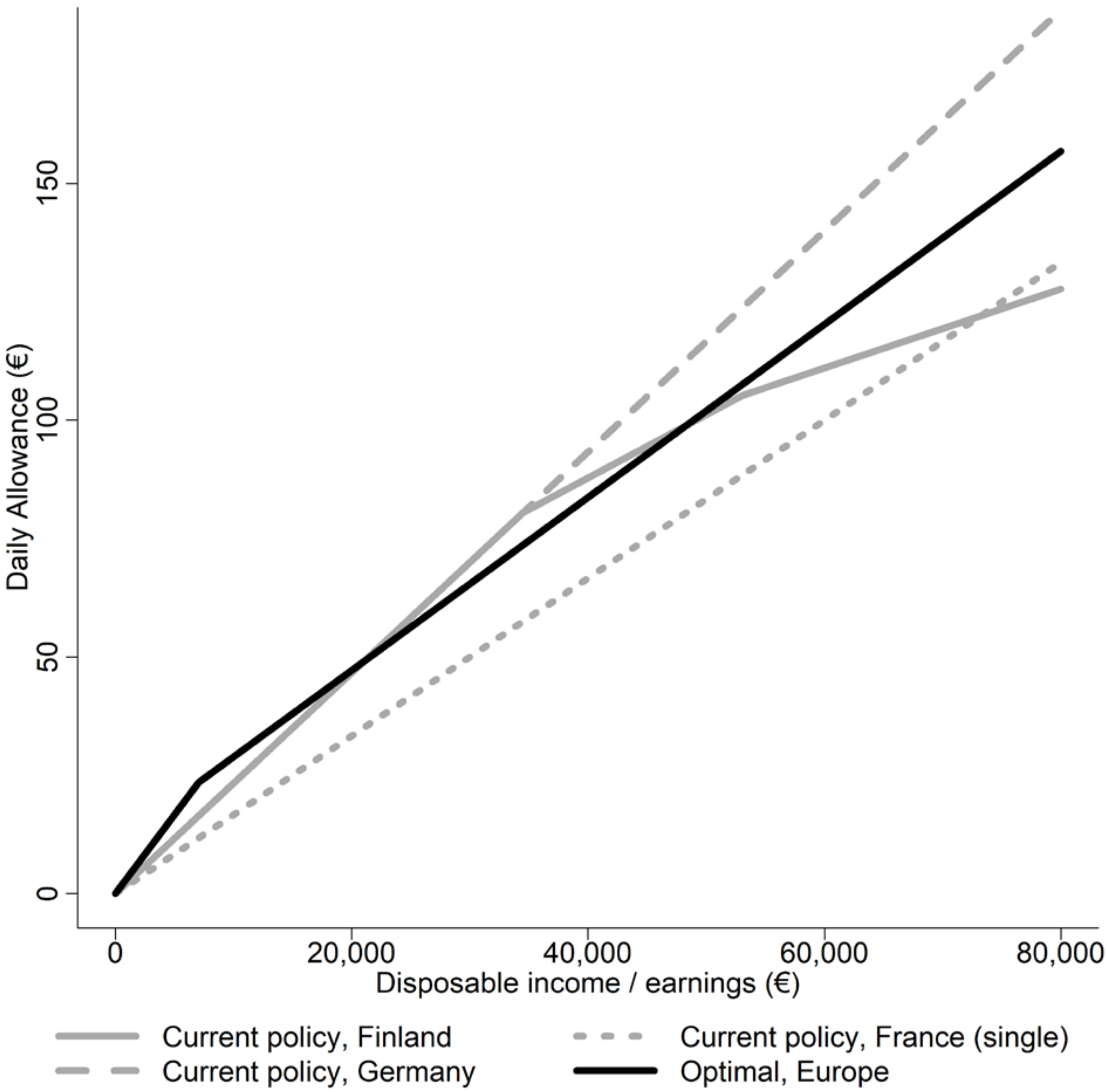
Notes. The estimate is a spline fit. The fit is estimated using the whole income distribution, although the x-axis in the figure is truncated at 80,000 euros. Sample size: in employment 133,207, on sick leave 1,423.

Figure 4. Optimal replacement rates.



Notes. The optimal replacement rates are calculated with the augmented Baily-Chetty formula (equation 1). The relative risk aversion values are from a generalized CRRA utility function with the parameter values of $\{\gamma,\ \omega,\ \theta\} = \{1.52, -25.0, 14.3\}$ *at different levels of consumption.* θ *is the fixed cost of sickness, which affects the optimal replacement rate through relative risk aversion (RRA) and the augmented Baily-Chetty formula. An identifying assumption is that disposable income equals consumption at each period. Additionally, we assume that* $\varepsilon_{r,b} + \varepsilon_{D,b} = 1.5$. *The approximation is performed using equations (1), (4), (5) and (6).*

Figure 5. The prevailing universal sickness insurance policy curves and estimated optimal curves.



Notes. The optimal replacement rates are calculated with the augmented Baily-Chetty formula (equation 1). The relative risk aversion values are from a generalized CRRA utility function with the parameter values of $\{\gamma,\ \omega,\ \theta\} = \{1.52, -25.0, 14.3\}$ *at different levels of consumption.* θ *is the fixed cost of sickness, which affects the optimal replacement rate through relative risk aversion (RRA) and the augmented Baily-Chetty formula. An identifying assumption is that disposable income equals consumption at each period. Additionally, we assume that* $\varepsilon_{r,b} + \varepsilon_{D,b} = 1.5$. *"Single" refers to a one-member household. The optimal curve is based on equivalized disposable income, whereas the current policy curves are based on earnings.*

References

Baily, M.L. (1978). Some aspects of optimal unemployment insurance. Journal of Public Economics, 10, 379–402. doi: 10.1016/0047-2727(78)90053-1

Benjamin, D.J., Heffetz, O., Kimball, M.S. and Rees-Jones, A. (2012). What do you think would make you happier? What do you think you would choose? The American Economic Review, 102, 2083–2110. doi: 10.1257/aer.102.5.2083

Benjamin, D.J., Heffetz, O., Kimball, M.S. and Rees-Jones, A. (2014a). Can marginal rates of substitution be inferred from happiness data? Evidence from residency choices. The American Economic Review, 104, 3498–3528. doi: 0.1257/aer.104.11.3498

Benjamin, D.J., Heffetz, O., Kimball, M.S. and Szembrot, N. (2014b). Beyond happiness and satisfaction: Toward well-being indices based on stated preference. The American Economic Review, 104, 2698–2735. doi: 10.1257/aer.104.9.2698

Böckerman, P., Kanninen, O. and Suoniemi, I. (2018). A kink that makes you sick: The effect of sick pay on absence. Journal of Applied Econometrics, doi: 10.1002/jae.2620

Chetty, R. (2006). A general formula for the optimal level of social insurance. Journal of Public Economics, 90, 1879–1901. doi: 10.1016/j.jpubeco.2006.01.004

Chetty R. (2008). Moral hazard versus liquidity and optimal unemployment insurance. Journal of Political Economy, 116, 173–234. doi: 10.1086/588585

Chetty, R. and Finkelstein, A. (2013). Social insurance: Connecting theory to data. In Handbook of Public Economics, Volume 5, Amsterdam: Elsevier, 111–193. doi: 10.1016/B978-0-444-53759-1.00003-0

Cohen, A. and Einav, L. (2007). Estimating risk preferences from deductible choice. The American Economic Review, 97, 745–788. doi: 10.1257/aer.97.3.745

Cullen, J.B. and and Gruber, J. (2000). Does unemployment insurance crowd out spousal labor supply? Journal of Labor Economics, 18, 546–572. doi: 10.1086/209969

Einav, L., Finkelstein, A., Pascu, I., and Cullen, M. (2012). How general are risk preferences? Choices under uncertainty in different domains. The American Economic Review, 102, 2606–2638. doi: 10.1257/aer.102.6.2606

Engen, E.M. and Gruber, J. (2001). Unemployment insurance and precautionary saving. Journal of Monetary Economics, 47, 545–579. doi: 10.1016/S0304-3932(01)00051-4

Feldstein, M. (1974). Social security, induced retirement, and aggregate capital accumulation. Journal of Political Economy, 82, 905–926. doi: 10.2307/1829174

Finkelstein, A., Luttmer, E.F.P., and Notowidigdo, M.J. (2009). Approaches to estimating the health state dependence of the utility function. The American Economic Review, 99, 116–121. doi: 10.1257/aer.99.2.116

Finkelstein, A., Luttmer, E.F.P., and Notowidigdo, M.J. (2013). What good is wealth without health? The effect of health on the marginal utility of consumption. Journal of the European Economic Association, 11, 221–258. doi: 10.1111/j.1542-4774.2012.01101.x

Geary, R.C. (1950). A note on "A constant-utility index of the cost of living". The Review of Economic Studies, 18, 65–66. doi: 10.2307/2296107

Gruber, J. (1997). The consumption smoothing benefits of unemployment insurance. The American Economic Review, 87, 192–205. doi: 10.3386/w4750

Jones, I.J., and Klenow, P.J. (2016). Beyond GDP? Welfare across countries and time. The American Economic Review, 106, 2426–2457. doi: 10.1257/aer.20110236

Kolsrud, J., Landais, C., Nilsson, P., and Spinnewijn, J. (2018). The optimal timing of unemployment benefits: Theory and evidence from Sweden. The American Economic Review, 108, 985–1033. doi: 10.1257/aer.20160816

Layard, R., Mayraz, G., and Nickell, S. (2008). The marginal utility of income. Journal of Public Economics, 92, 1846–1857. doi: 10.1016/j.jpubeco.2008.01.007

Mata, R., Frey, R., Richter, D., Schupp, J., and Hertwig, R. (2018). Risk preference: A view from psychology. Journal of Economic Perspectives, 32, 155–72.

Merton, R.C. (1971). Optimum consumption and portfolio rules in a continuous time model. Journal of Economic Theory, 3, 373–413. doi: 10.1016/0022-0531(71)90038-X

Meyer, D.J. and Meyer, J. (2005). Relative risk aversion: What do we know? Journal of Risk and Uncertainty, 31, 243–262. doi: https://doi.org/10.1007/s11166-005-5102-x

MISSOC (2017). Mutual Information System on Social Protection in the Member States of the European Union. European Commission.

Perets, G. and Yashiv, E. (2016): The Fundamental Nature of HARA Utility. Working paper.

Phlips, L. (1978). The demand for leisure and money. Econometrica, 46, 1025–1043.

doi: 10.1016/b978-0-444-86531-1.50017-2

Pichler, S. and Ziebarth, N.R. (2017). The pros and cons of sick pay schemes: Testing for contagious presenteeism and noncontagious absenteeism behavior. Journal of Public Economics, 156, 14–33. doi: 10.1016/j.jpubeco.2017.07.003

Viscusi, W.K., and Evans, W.N. (1990). Utility functions that depend on health status: Estimates and economic implications. The American Economic Review, 80, 353–374.

Weber, E.U., Blais, A.R. and Betz, N.E. (2002). A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors. Journal of Behavioral Decision Making, 15, 263–290. doi: 10.1002/bdm.414

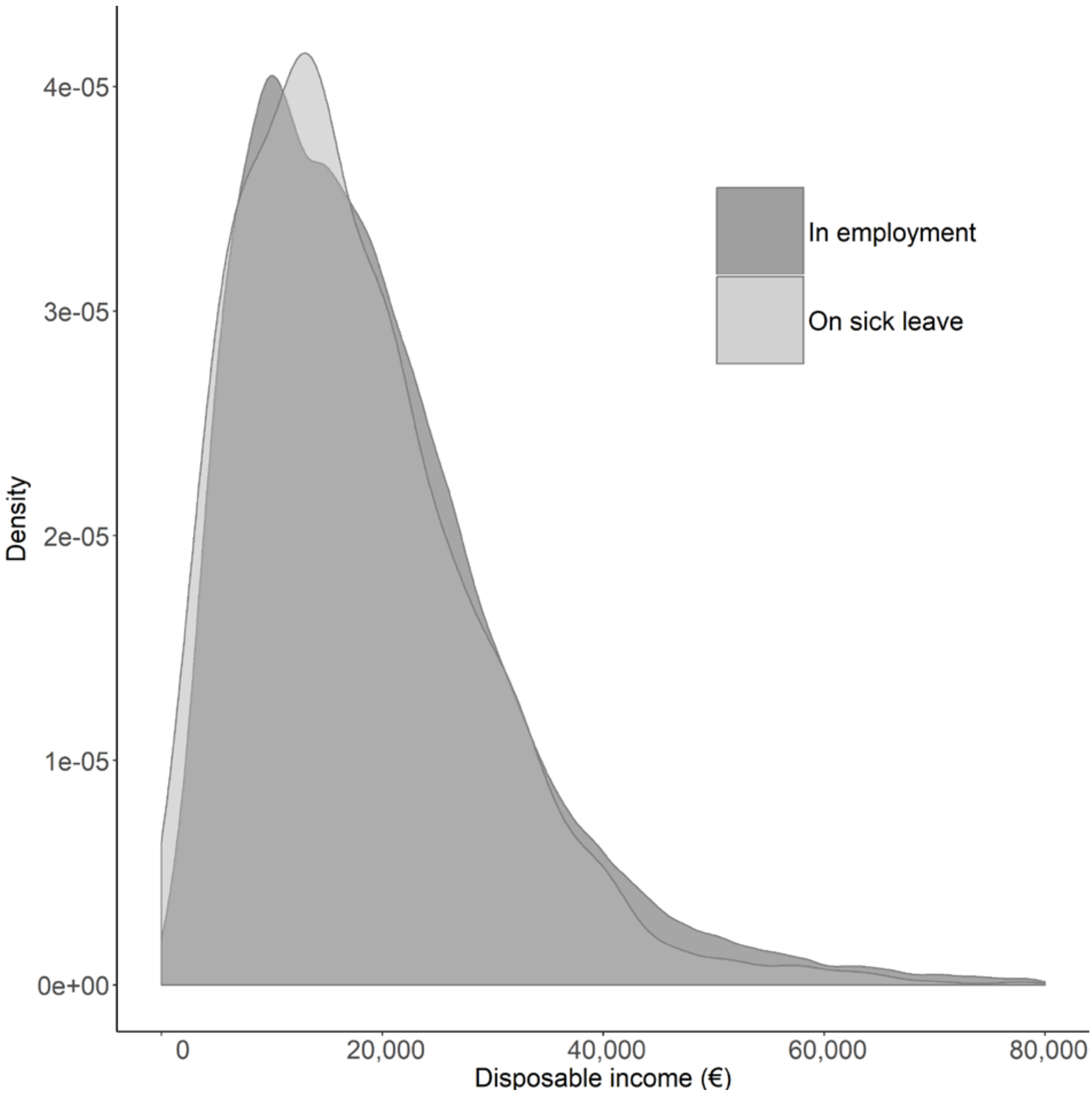
Zeckhauser, R. (1970). Medical insurance: A case study of the tradeoff between risk spreading and appropriate incentives. Journal of Economic Theory, 2, 10–26. doi: 10.1016/0022-0531(70)90010-4

Ziebarth, N.R. and Karlsson, M. (2014). The effects of expanding the generosity of the statutory sickness insurance system. Journal of Applied Econometrics, 29, 208–230. doi: 10.1002/jae.2317

ONLINE SUPPLEMENTARY APPENDIX

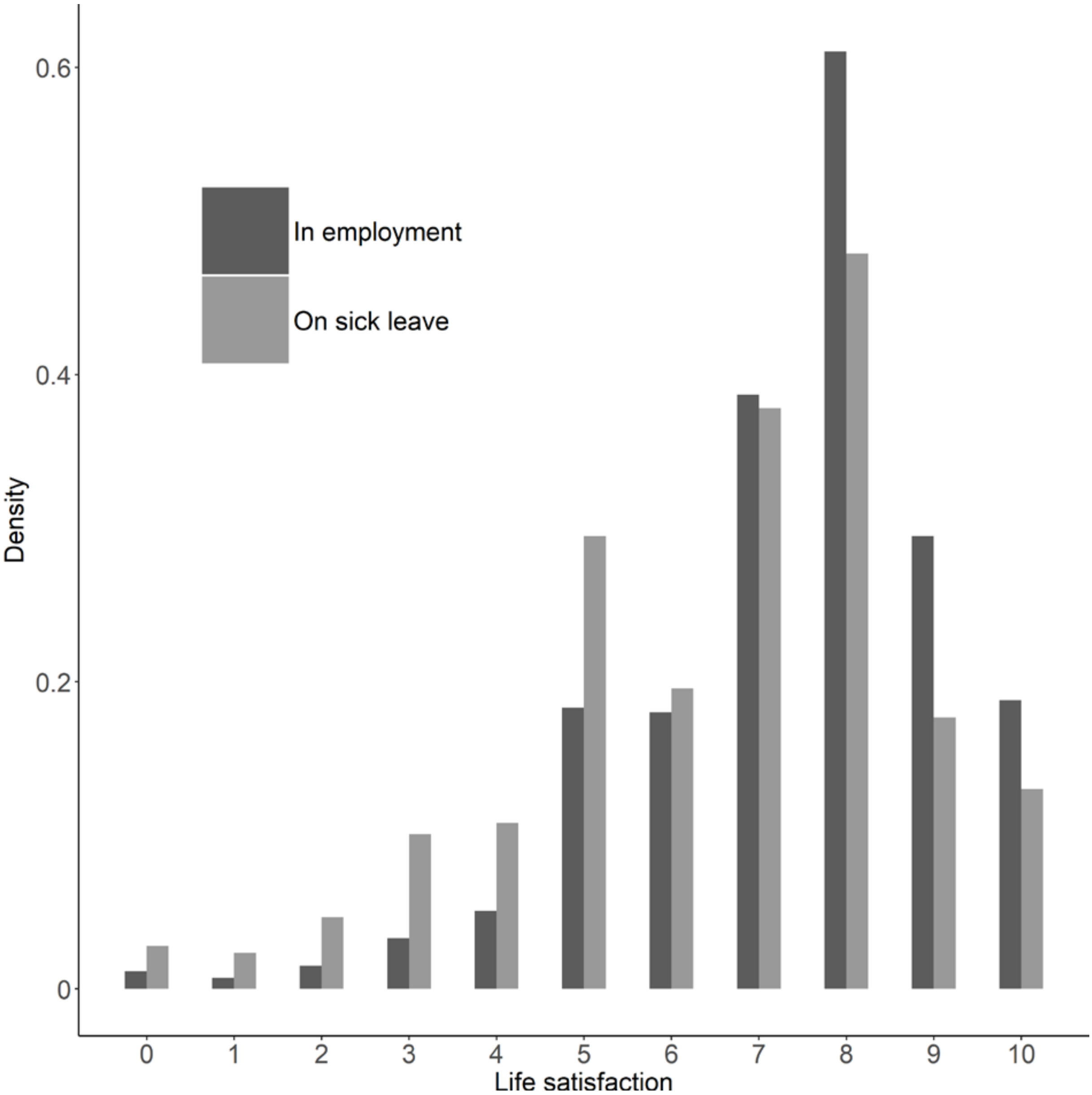
Appendix 1: Additional figures and tables.

Figure A1. Histogram of incomes of the employed and sick leave samples.



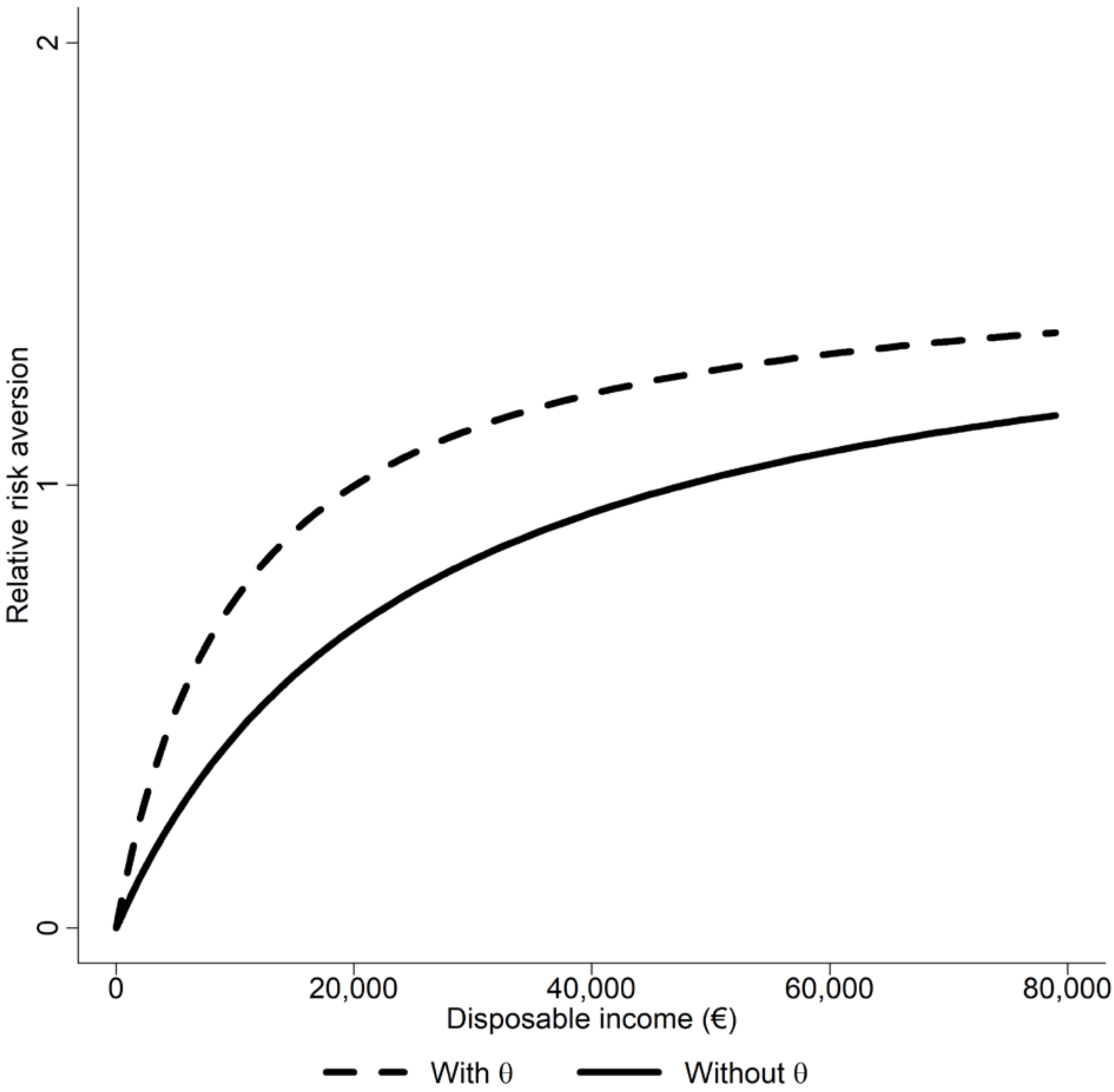
Notes. Sample size: in employment 133,207, on sick leave 1,423.

Figure A2. Histogram of life satisfaction of the employed and sick leave samples.



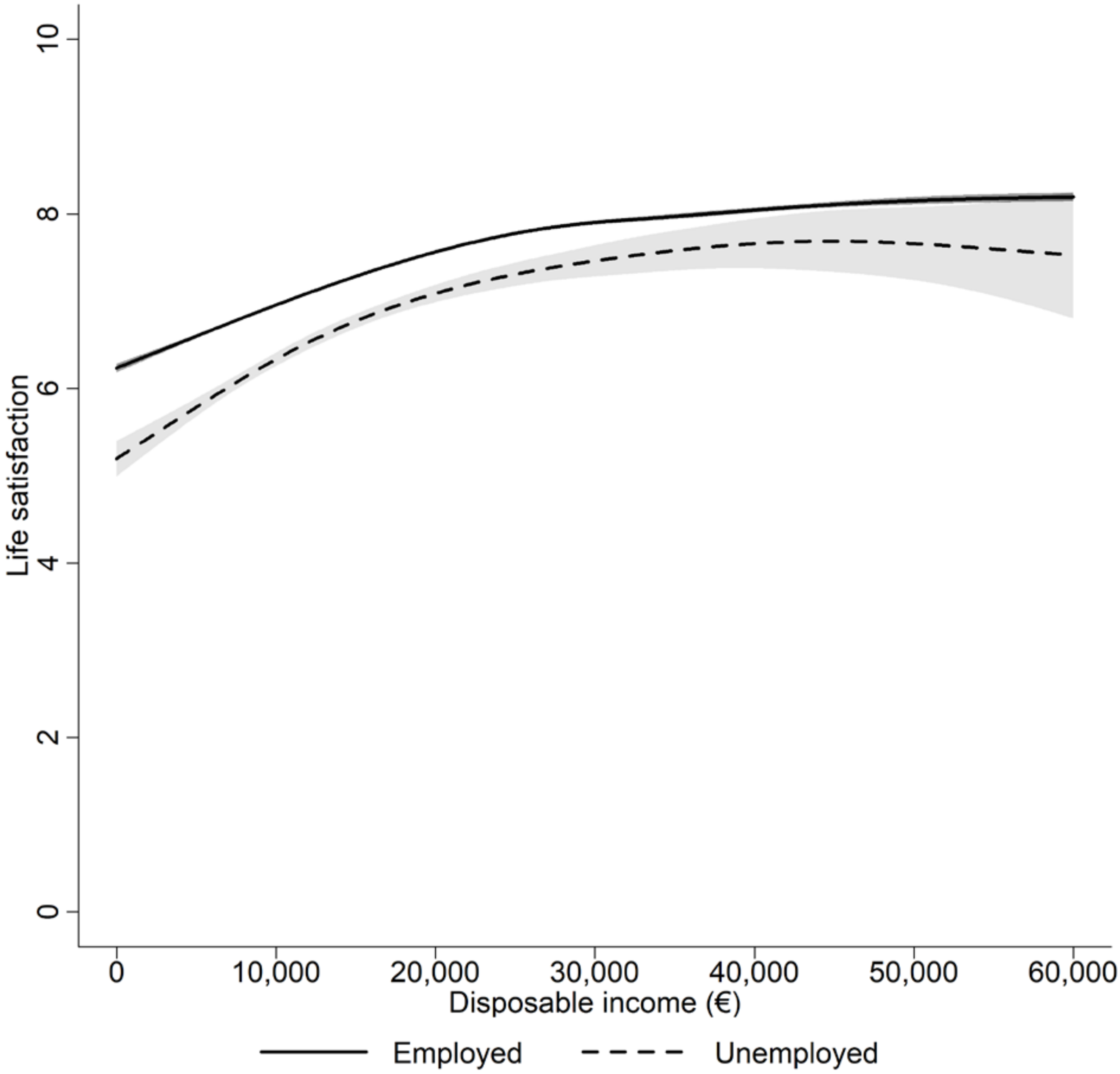
Notes. Sample size: in employment 133,207, on sick leave 1,423.

Figure A3. Estimated relative risk aversion.



Notes. The relative risk aversion values are from a generalized CRRA utility function with parameter values of $\{\gamma,\ \omega,\ \theta\} = \{1.52, -25.0, 14.3\}$ *at different levels of consumption. An identifying assumption is that disposable income equals consumption at each period.*

Figure A4. Spline of life satisfaction and income in Europe, employed vs. unemployed.



*Notes. The estimate is a cubic spline with six knots estimated with the R package "bigsplines" with default parameter values. The gray area around the curves represents the 95% confidence interval. Sample size: 133,163 in employment, 4,713 in unemployment. The constant (α) is assumed to be 10. A fit similar to Figure 3 yields the following parameter values: the scale parameter (β) is 7.98*** (1.57), the relative risk aversion parameter (γ) is 1.49*** (0.03), the institutions parameter (ω) is -22.78*** (2.29), and the fixed cost of unemployment (θ) is 11.03*** (0.49).*

Appendix 2: Augmented Baily–Chetty model

We adapt the canonical Baily-Chetty model of unemployment insurance to the sickness insurance (Baily, 1978; Chetty, 2006; Chetty and Finkelstein, 2013). Consider a representative worker who has an initial level of assets A_0 and wage w. Assume that the agent gets injured or ill at work with a probability $p(E)$, denoted p most of the time. $p(E)$ is a decreasing function of E, his chosen sickness-avoidance effort level, with convex effort cost $\psi_E(E)$. If the agent gets injured or ill, he takes sick leave. In the sick state, there is no risk of repeated sickness or unemployment, and the agent makes no labor supply choices. In the sick state, the agent must be rehabilitated to come back to work.

In the sick state, the agent receives a benefit, b, for the duration of the sickness benefit and subsequently goes back to work. The sickness duration, D, is assumed to be a choice variable. Non-pecuniary costs and benefits of sickness duration and effort are captured by concave increasing functions $\psi_D(D)$ and $\psi_E(E)$. Let $k \in \{e, s\}$ and $U_k(c_k)$ be strictly concave utility over consumption, where subscripts *e* and *s* stand for being at work and on sick leave, respectively. The utility is assumed to be state-dependent, specifically with a fixed cost of sickness, $u(c, 1) = u(c - \theta)$, $\theta > 0$. The agent chooses c_e, c_s, *E* and *D* at time 0 to solve,

$$max\ (1 - p(E))u(c_e, 0) + p(E)\big(u(c_s, 1) + \psi_D(D)\big) - \psi_E(E)$$

$$s.t. A_0 + (w - \tau) - c_e \geq 0$$

$$A_0 + bD + w(1 - D) - c_s \geq 0.$$

while taking $(b,\ \tau)$ as fixed. This is a critical assumption. The social planner chooses the benefits, *b*, that maximize the agent's indirect utility under the condition that taxes collected (τ) equal benefits paid. The taxes here are modeled to be lump-sum, so they do not affect the labor supply choices under no sickness.[6] The social planner's problem, with p*(E)*, written as *p*, is:

[6] If modelled, they would add a component on the cost side.

$$\max_{\tau,b,E} V(b,\tau,E)$$

$$s.t.(1-p)\tau \geq pbD.$$

At the optimum, the optimal benefit rate, b*, must satisfy:

$$\frac{dV(b,\tau,E)}{d(b^*)} = 0,$$

where τ and E are functions of b.

$$V(b) = \max_{c_e,c_s,D,E,\lambda_e,\lambda_s} (1-p)u(c_e,0) + p\big(u(c_s,1) + \psi_D(D)\big) - \psi_E(E) + \lambda_e[A_0 + w - \tau - c_e]$$
$$+ \lambda_u[A_0 + bD + (w-\tau)(1-D) - c_s].$$

The function is optimized over $\{c_e, c_s, D, E, \lambda_e, \lambda_s\}$. We assume that the value function $V(b)$ is differentiable such that the Envelope Theorem applies. Thus, following the Envelope Theorem, changes in them have no first-order impact. Specifically, $\frac{dE}{db} = 0$, giving the interior optimum:

$$\frac{dV(b,\tau,E)}{Db(b^*)} = -\lambda_e \frac{d\tau}{db} + \lambda_s D = 0. \quad \text{(A1)}$$

From the agent optimization, we know that

$$\lambda_e = (1-p)u(c_e,0) \text{ and } \lambda_s = pu(c_s,1). \quad \text{(A2)}$$

From the social planner budget constraint, where the change in effort does have a first-order effect:

$$\frac{d\tau}{db} = \frac{\mathrm{p}}{1-\mathrm{p}}\left(\mathrm{D} + \frac{\mathrm{bdD}}{\mathrm{db}}\right) + \frac{\mathrm{Db}}{(1-p)}\frac{\mathrm{d}\log(\frac{p}{1-p})}{\mathrm{db}} \quad \text{(A3)}$$

Substituting (A3) and (A2) in to (A1) yields an implicit equation for the optimal policy (an augmented Baily–Chetty formula):

$$\varepsilon_{D,b} + \varepsilon_{r,b} = \frac{u'(c_s,1) - u'(c_e,0)}{u'(c_e,0)} = \frac{u'(c_s-\theta,1) - u'(c_e,0)}{u'(c_e,0)} \approx \gamma \frac{\Delta c + \theta}{c_e}\left[1 + \frac{1}{2}\rho\frac{\Delta c + \theta}{c_e}\right], \quad \text{(A4)}$$

where $\frac{\Delta c}{c_e}$ is the proportional drop in consumption while on sick leave; $\gamma = -\frac{C_e u''(C_e,0)}{u'(C_e,0)}$ is the coefficient of relative risk aversion; $\rho = -\frac{C_e u'''(C_e,0)}{u''(C_e,0)}$ is the coefficient of relative prudence; $\varepsilon_{r,b} =$

$\frac{d\log(\frac{p}{1-p})}{d\log(b)}$ is the elasticity of the odds ratio ($r = \frac{p}{1-p}$) of sickness leave with respect to the sickness benefit, i.e., the extensive margin; and $\varepsilon_{D,b} = \frac{d\log(D)}{d\log(b)}$ is the elasticity of the duration of sick leave with respect to the sickness benefit, i.e., the intensive margin. The right-hand side of the formula approximates the increase in relative marginal utility given the drop in consumption under sick leave, and gives an implicit equation for the optimal benefit, b, which is based on sufficient statistics, $\left(\varepsilon_b, \frac{\Delta c+\theta}{c_e}, \gamma\right), \varepsilon_b = \varepsilon_{D,b} + \varepsilon_{r,b}$ approach.

The welfare change can be written in terms of relative marginal utilities of consumption in the two states. If individuals' behaviors were not distorted by the provision of insurance, the social planner would achieve the first best by setting b to perfectly smooth utilities, $u'_s(c_s, 1) = u'_e(c_e, 0)$. Note that the equation (A4) is an implicit one. But the Envelope Theorem guarantees that one does not need to fully characterize all the margins to which individuals may respond, in order to calculate the net welfare gain of social insurance. In particular, all other behavioral responses can be ignored when setting the optimal benefit level, except for the elasticity parameters ($\varepsilon_{D,b}$ and $\varepsilon_{r,b}$) that enter the government budget constraint directly. However, the social planner cannot directly choose observed consumption levels or Δc, (hidden savings), but it determines the benefit level which influences income replacement rates which are observable. Kolsrud et al., (2018) find that the consumption drop increases with the duration of an unemployment spell and that savings and credit play a limited role in smoothing consumption. Equating consumption with income, we can directly solve for the optimal $\frac{\Delta y}{y_e}$ using equation (2):

$$RR = 1 - \frac{\Delta y}{y_e} = \left(\frac{\omega}{y_e} + \frac{\theta}{y_e}\right) + \left(1 - \frac{\omega}{y_e}\right)\left(1 + \varepsilon_{r,b} + \varepsilon_{D,b}\right)^{-\frac{1}{\gamma}}, \qquad \text{(A5)}$$

We employ the form $u(y, S) = u(c(y) - \theta S)$ as a simple parametrization of state-dependent utility of the qualitative type we have observed in Figure 2. The social planner now has to consider θ in addition to the standard Baily–Chetty parameters $\{\varepsilon_b, \gamma, \rho\}$ for optimal policy b. The relationship observed by Finkelstein et al., (2013) would require an alternative functional form.

The Envelope Theorem plays a critical role in generalizing (A4) with minor modifications to more realistic dynamic models with endogenous savings and borrowing constraints (Chetty and Finkelstein, 2013). One could also complement the model following Kolsrud et al. (2018), who model the effect of duration-dependent benefit rates in unemployment.

In the standard Baily-Chetty formula, it is possible that a non-linear benefit rule is optimal if risk aversion or the incentive effect varies significantly according to the income level. Additionally, if the aim of the insurance scheme is to contribute to the redistribution of income from rich to poor households, a non-linear benefit rule might be well-motivated.

Appendix 3: Sickness insurance in Europe

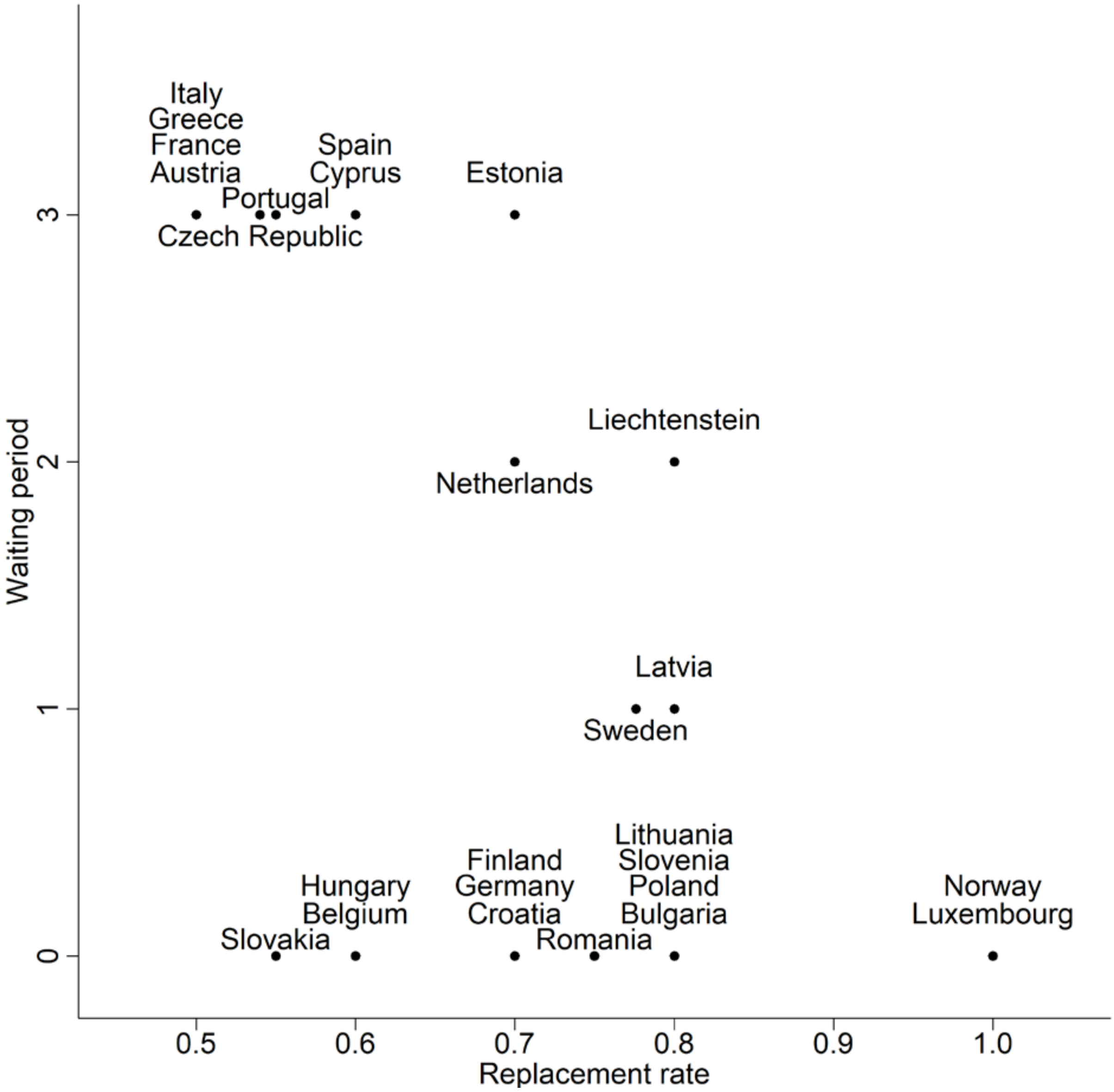
MISSOC (2017) comparative tables describe the European sickness insurance schemes (cf. Frick and Malo, 2008). The tables distinguish at least five dimensions, in which the schemes differ. Two of the key dimensions are depicted in Figure 1. The crucial aspect in any social insurance system is the replacement rate, i.e., the rate at which pre-sickness income is covered by sickness insurance. The replacement rates vary in Europe from 50% (Italy, Greece, France and Austria) to 100% (Luxembourg and Norway). However, some European countries (Iceland, Ireland, Malta and the UK) have a lump-sum benefit. Lump-sum benefits imply highly regressive replacement rates and are therefore not shown in Figure A2.1.

The other important dimension presented in Figure A2.1 is the waiting period. A waiting period is the amount of time the person has to pass on sick leave before being eligible for the benefit. The waiting periods vary between 0 and 3 days in the countries with proportional replacement rates. Three-day waiting periods are found in Southern Europe, the Czech Republic and Estonia. Northern European countries tend to have no waiting periods at all. The waiting period plays a large role in short sickness spells.

The other three dimensions in which European sickness insurance schemes differ are coverage, maximum duration and qualifying period. Coverage is broad for full-time employees in all countries in Europe and varies mainly in terms of how the self-employed are treated. Maximum durations vary slightly between countries such that the mode is at one year. The qualifying periods, that is, the time required at the job before eligibility, vary between none to 6 months.

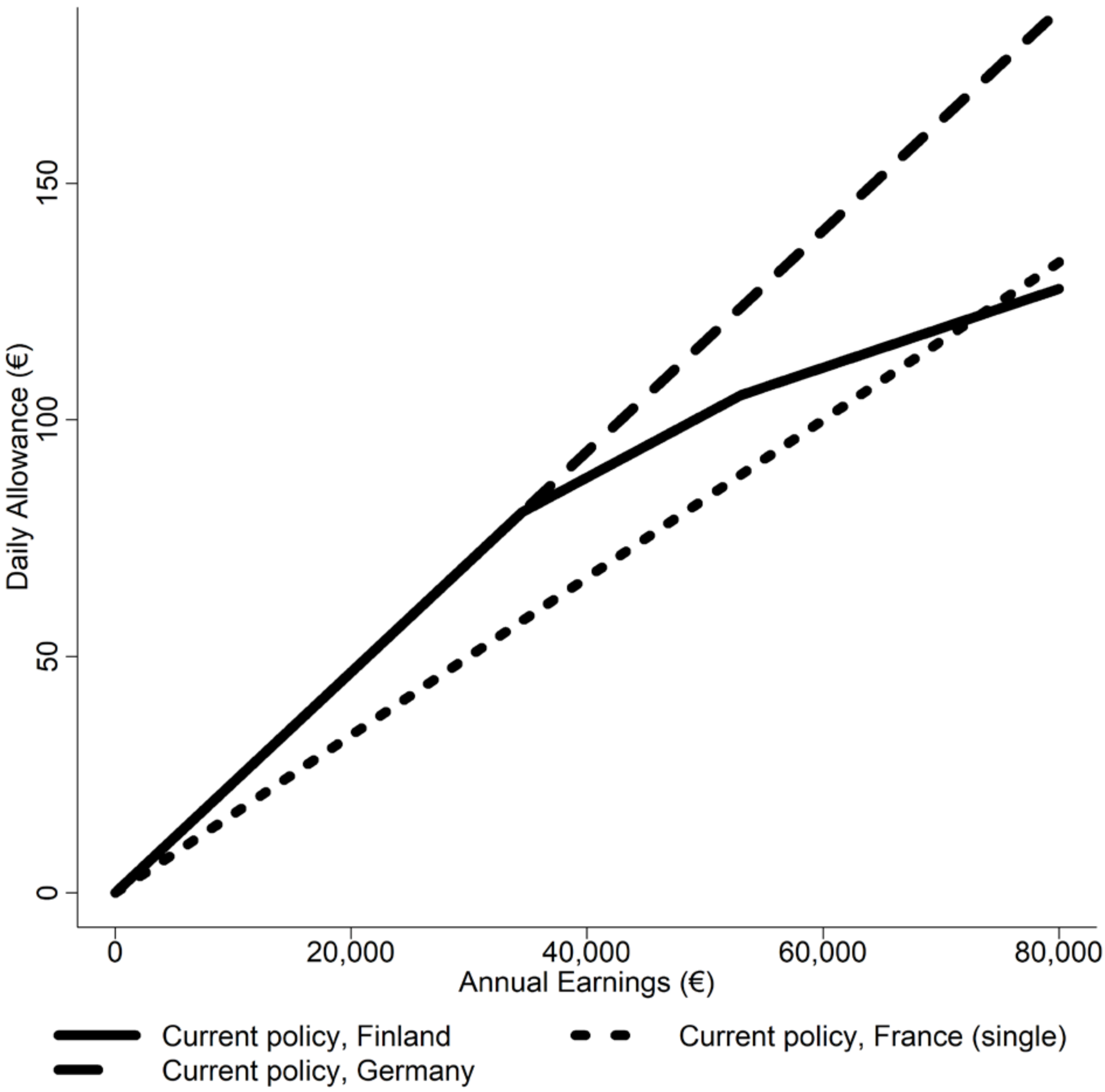
To capture within-country heterogeneity in the replacement rates, Figure A2.1 is insufficient. Some countries, such as Finland, have notably non-linear benefit rules. The benefit curves for Germany, France and Finland are depicted in Figure A2.2.

Figure A2.1. The characteristics of sickness insurance schemes in Europe.



Notes. Single, lowest income bracket, initial benefit level, and the general case for long-term employment. Denmark: not defined in the table. Iceland, Ireland, Malta and the UK: lump sum benefit. Switzerland: varies by individual contract. Source: MISSOC comparative table, 2017/07/01.

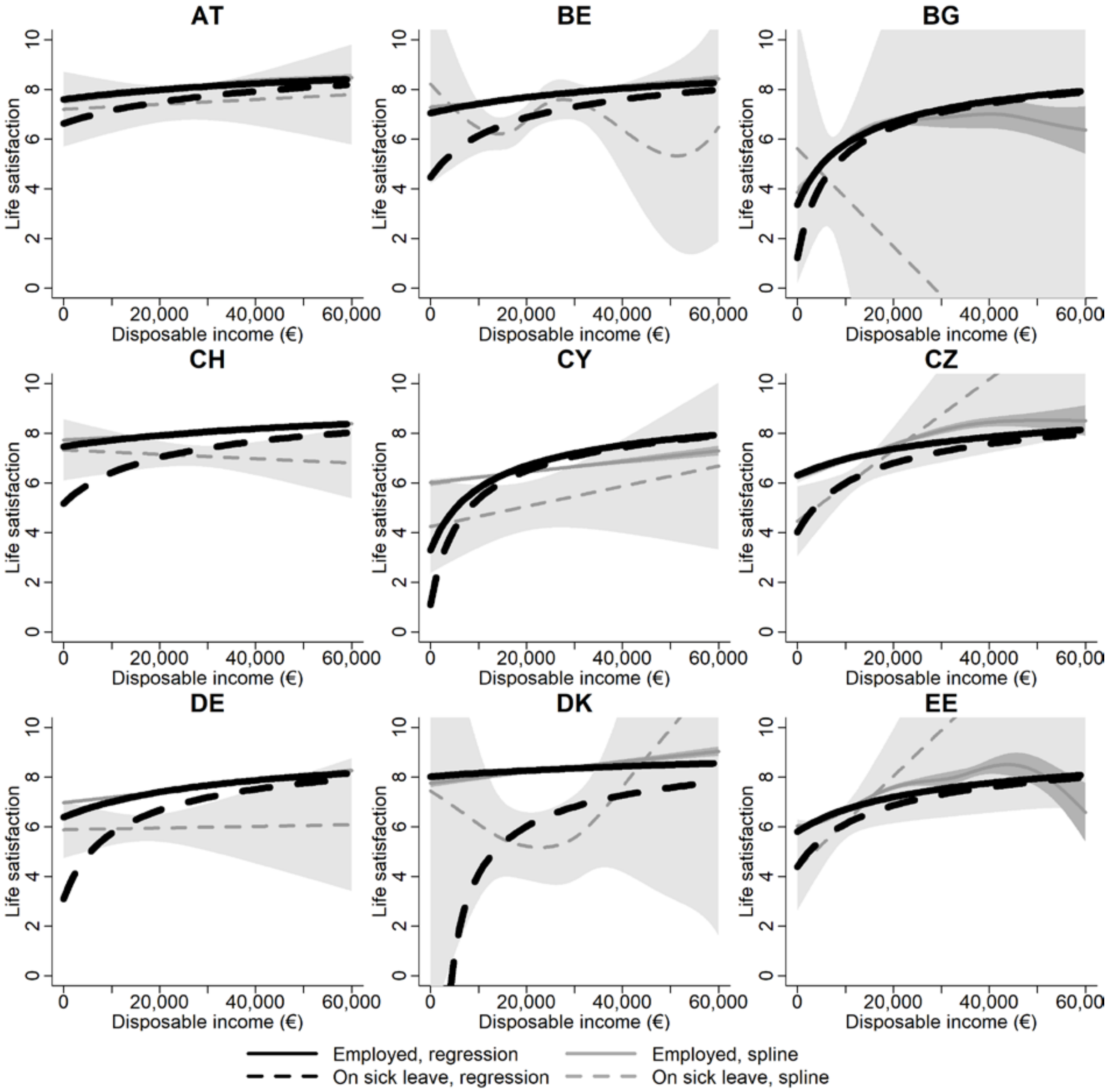
Figure A2.2. The generosity of sickness insurance schemes in three European countries.



Appendix 4. Country-specific estimates of ω (i.e., the value of institutions).

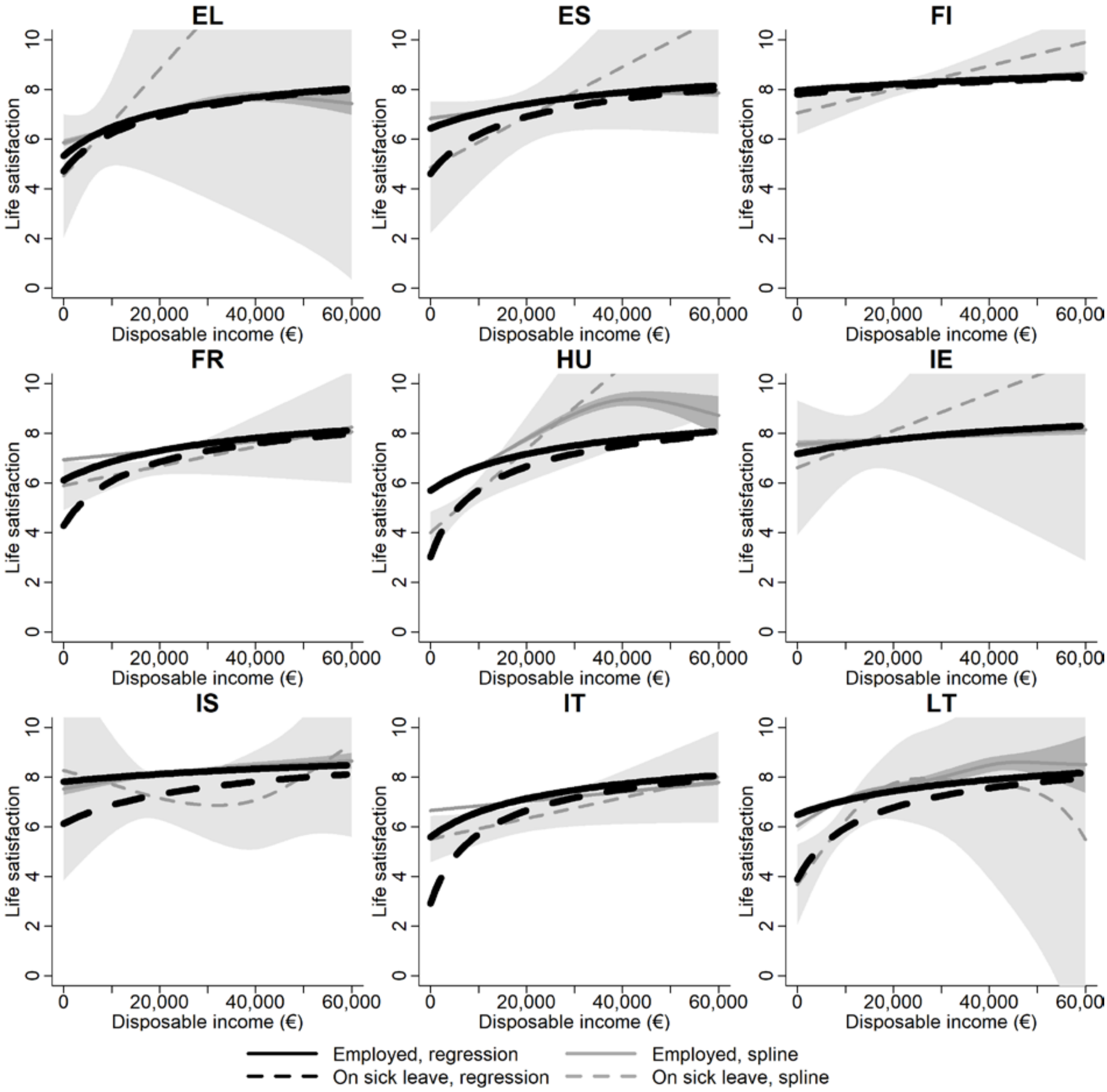
Figure A4.1 presents country-level profiles for the relationship between disposable income and life satisfaction as a spline fit. The figures also show the fit of equation (6), where only ω and θ are allowed to vary and all other parameters are held constant at values presented in Table 2, column 2. Table A4.1. shows the sample size by each country. Figure A4.2 shows the values of ω at the country level plotted against covariates.

Figure A4.1. Spline and non-linear regression fit of life satisfaction and income by country, employed vs. sick.



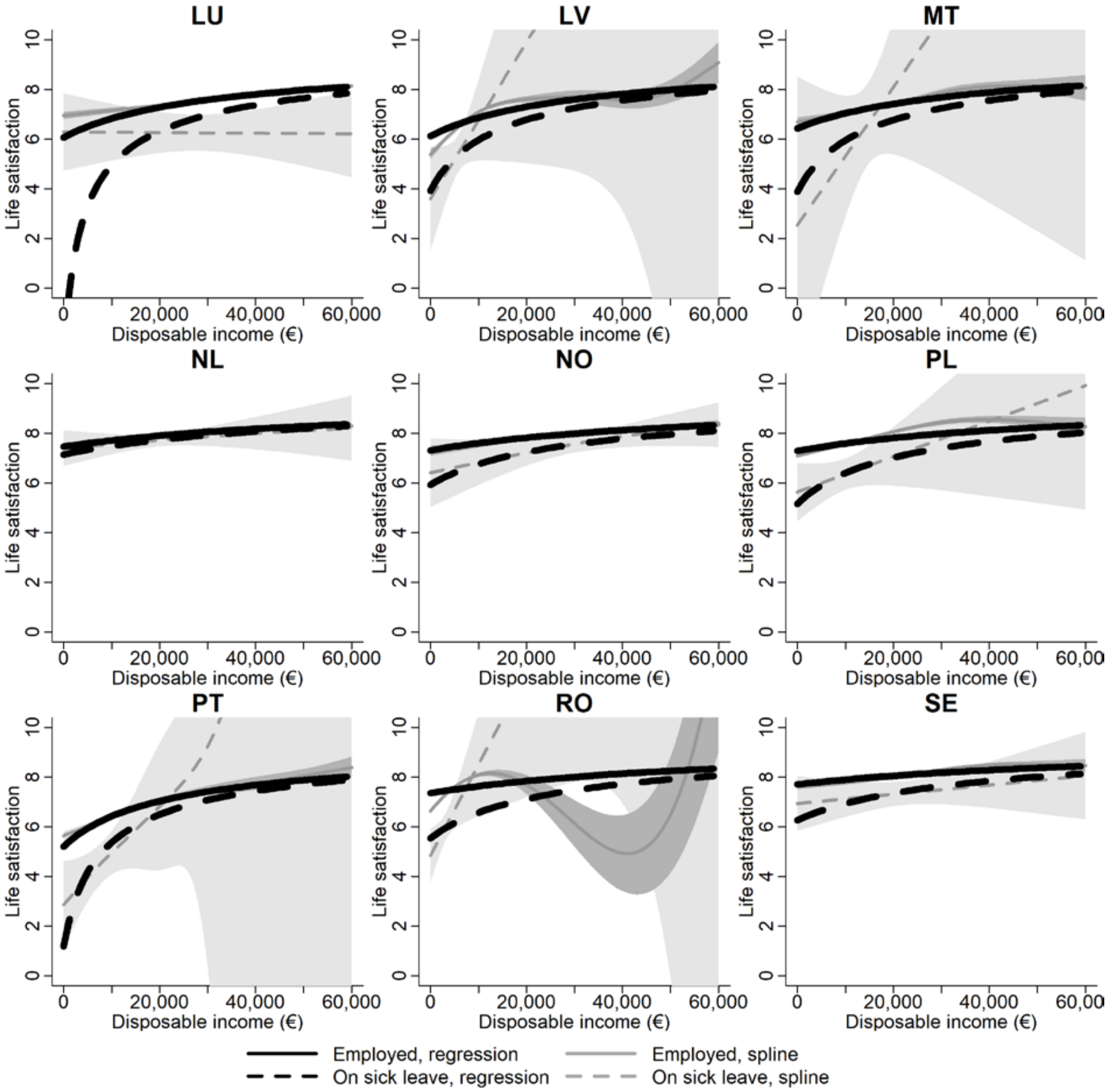
Notes. The estimate is a spline fit. The fit is performed using the whole income distribution, although the x-axis in the figure is truncated at 60,000 euros. Country codes: AT=Austria, BE=Belgium, BG=Bulgaria, CH=Switzerland, CY=Cyprus, CZ=Czech Republic, DE=Germany, DK=Denmark, EE=Estonia.

Figure A4.1 (cont.). Spline and non-linear regression fit of life satisfaction and income by country, employed vs. sick.



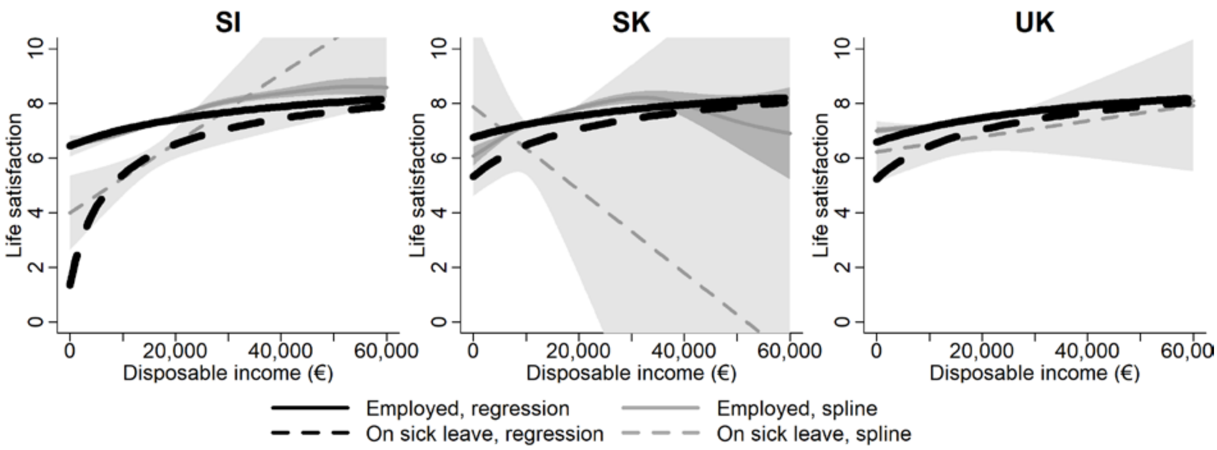
Notes. The estimate is a spline fit. The fit is performed using the whole income distribution, although the x-axis in the figure is truncated at 60,000 euros. Country codes: EL=Greece, ES=Spain, FI=Finland, FR=France, HU=Hungary, IE=Ireland, IS=Iceland, IT=Italy, LT=Lithuania.

Figure A4.1 (cont.). Spline and non-linear regression fit of life satisfaction and income by country, employed vs. sick.



Notes. The estimate is a spline fit. The fit is performed using the whole income distribution, although the x-axis in the figure is truncated at 60,000 euros. Country codes: LU=Luxembourg, LV=Latvia, MT=Malta, NL=Netherlands, NO=Norway, PL=Poland, PT=Portugal, RO=Romania, SE=Sweden.

Figure A4.1 (cont.). Spline and non-linear regression fit of life satisfaction and income by country, employed vs. sick.

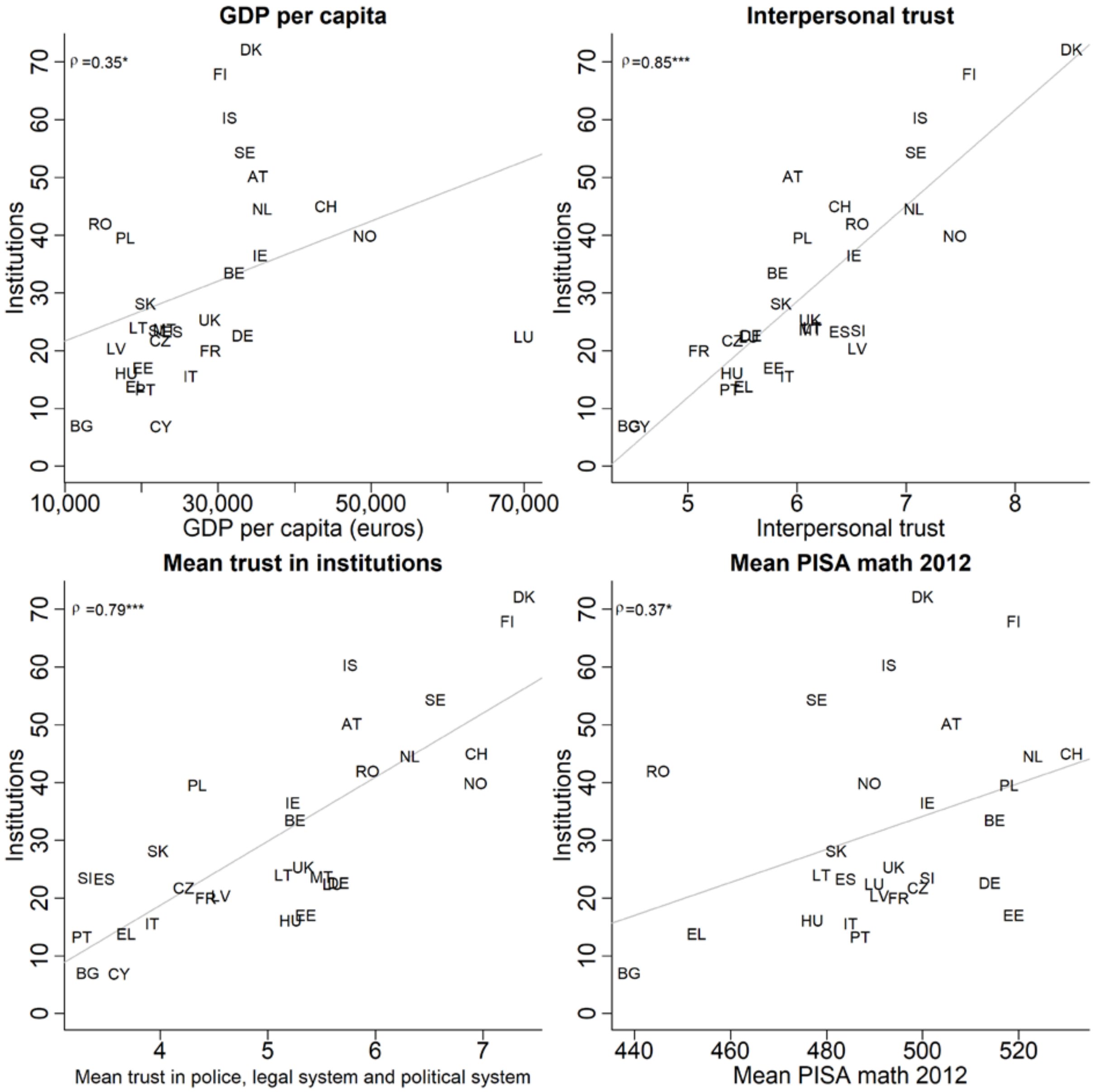


Notes. The estimate is a spline fit. The fit is performed using the whole income distribution, although the x-axis in the figure is truncated at 60,000 euros. Country codes: SI=Slovenia, SK=Slovakia, UK=United Kingdom.

Table A4.1. Sample size by country and subset.

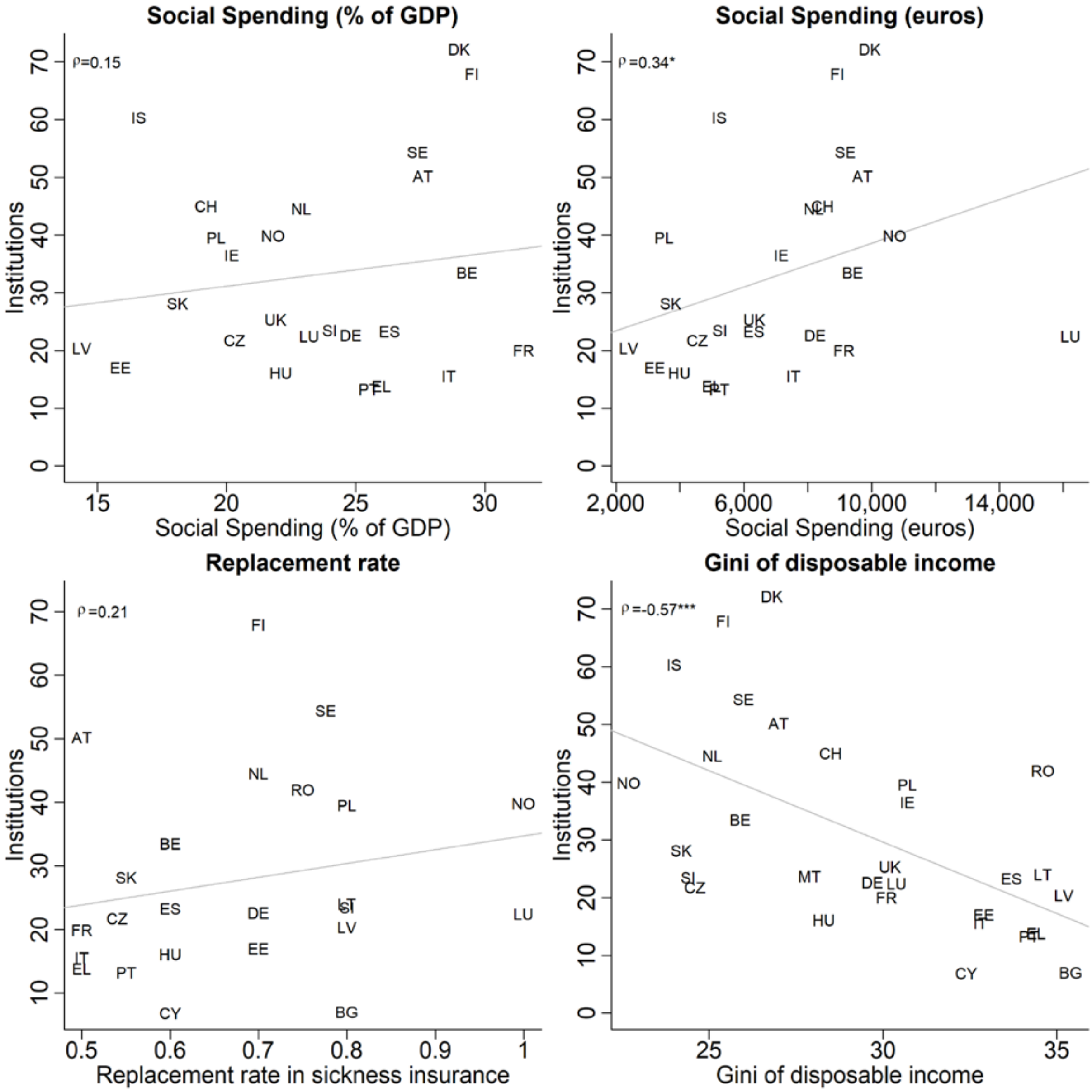
	Employed	On sick leave
Austria	3,860	36
Belgium	3,544	39
Bulgaria	2,820	4
Switzerland	5,290	97
Cyprus	4,010	22
Czech Republic	4,422	45
Germany	6,926	55
Denmark	2,498	14
Estonia	4,195	38
Greece	3,832	16
Spain	7,862	17
Finland	4,883	40
France	5,634	89
Hungary	6,459	110
Ireland	1,703	14
Iceland	1,518	17
Italy	8,190	40
Lithuania	2,912	42
Luxembourg	1,956	32
Latvia	3,362	18
Malta	2,191	7
The Netherlands	3,768	102
Norway	3,163	114
Poland	7,663	37
Portugal	3,713	27
Romania	4,865	40
Sweden	2,658	59
Slovenia	3,732	84
Slovakia	4,742	16
United Kingdom	4,905	75

Figure A4.2. Country-level scatter plots.



*Notes. Statistical significance of correlation: * p<0.1; ** p<0.05; *** p<0.01. All figures show a scatter plot and correlations for 30 countries except the top left panel, which is for 25 countries, and the bottom right panel, which is for 28 countries. Source. Income: Eurostat ppp GDP per capita. PISA math: PISA. All other sources: own calculations using EU-SILC.*

Figure A4.2 (cont.). Country-level scatter plots.



*Notes. Statistical significance of correlation: * p<0.1; ** p<0.05; *** p<0.01. All figures show a scatter plot and correlations for 25 countries in the top panels and 24 and 30 countries in the bottom left and right panels, respectively. Source. Social spending: OECD, GDP and Gini: Eurostat. Replacement rate: MISSOC (2017). All other sources: own calculations using EU-SILC.*

Table A4.2. The estimated relative contribution of the institutions parameter (ω) and consumption at mean income by country.

Country	Mean life satisfaction (EU-SILC)	Estimated utility at mean GDP	Estimated utility at zero income	Contribution of consumption to utility	Relative contribution of institutions to utility (%)
Austria	8.1	8.2	7.6	0.6	92.9
Belgium	7.8	7.9	7.0	0.9	89.0
Bulgaria	5.5	6.1	3.3	2.7	55.3
Switzerland	8.1	8.2	7.5	0.8	90.8
Cyprus	6.5	6.8	3.3	3.6	47.8
Czech Republic	7.2	7.4	6.3	1.1	84.7
Germany	7.5	7.7	6.4	1.4	82.4
Denmark	8.3	8.4	8.0	0.4	95.7
Estonia	6.8	7.2	5.8	1.4	80.5
Greece	6.6	7.0	5.3	1.7	75.7
Spain	7.4	7.5	6.4	1.1	85.4
Finland	8.3	8.3	8.0	0.4	95.7
France	7.4	7.6	6.1	1.4	81.0
Hungary	6.6	7.1	5.7	1.4	80.3
Ireland	7.8	8.0	7.2	0.8	89.5
Iceland	8.2	8.2	7.8	0.4	94.8
Italy	7.1	7.4	5.6	1.8	76.0
Lithuania	7.1	7.4	6.5	0.9	87.4
Luxembourg	7.7	8.3	6.4	1.9	77.0
Latvia	6.9	7.2	6.2	1.0	85.8
Malta	7.4	7.5	6.5	1.1	86.0
The Netherlands	8.0	8.1	7.5	0.7	91.7
Norway	8.0	8.2	7.3	0.9	88.8
Poland	7.6	7.8	7.3	0.5	93.8
Portugal	6.6	7.1	5.2	1.8	73.9
Romania	7.5	7.7	7.4	0.4	95.1
Sweden	8.1	8.2	7.7	0.5	93.8
Slovenia	7.3	7.5	6.4	1.0	86.2

Slovakia	7.3	7.6	6.8	0.8	89.4
United Kingdom	7.5	7.7	6.6	1.1	85.5

Notes. The values presented in Columns 3–6 are based on a fit of equation (6), where only ω and θ are allowed to vary and all other parameters are held constant at values presented in Table 2, column 2.