MPRA

Munich Personal RePEc Archive

A Kink that Makes You Sick: the Effect of Sick Pay on Absence in a Social Insurance System

Petri Böckerman and Ohto Kanninen and Ilpo Suoniemi

30 December 2014

Petri Böckerman, Ohto Kanninen,
and Ilpo Suoniemi

A Kink that Makes you Sick: the Effect of Sick Pay on Absence in a Social Insurance System

Aboa Centre for Economics

Discussion Paper No. 97
Turku 2014

The Aboa Centre for Economics is a joint initiative of the economics departments of the University of Turku and Åbo Akademi University.

Petri Böckerman, Ohto Kanninen, and Ilpo Suoniemi

A Kink that Makes you Sick: the Effect of Sick Pay on Absence in a Social Insurance System

Aboa Centre for Economics
Discussion Paper No. 97
December 2014

ABSTRACT

We examine the effect of the replacement rule of a social insurance system on sickness absence. The elasticity of absence with respect to the benefit level is a critical parameter in defining the optimal sickness insurance scheme. A pre-determined, piecewise linear policy rule in which the replacement rate is determined by past earnings allows identification of the causal effect using a regression kink design. Using a large administrative dataset, we find a substantial and robust behavioral response. The statistically significant point estimate of the elasticity of the duration of sickness absence with respect to the replacement rate in a social insurance system is on the order of 1.

Contact information

Petri Böckerman (corresponding author)

Turku School of Economics, Labor Institute for Economic Research

and IZA

Pitkänsillanranta 3A, FI-00530 Helsinki, Finland.

Phone: +358-9-2535 7330. Fax: +358-9-2535 7332

E-mail: petri.bockerman@labour.fi

Ohto Kanninen

Labour Institute for Economic Research

Email: ohto.kanninen@labour.fi

Ilpo Suoniemi

Labour Institute for Economic Research

Email: ilpo.suoniemi@labour.fi

Acknowledgements

1. Introduction

Absenteeism causes a substantial loss of working time worldwide. In some OECD countries nearly 10% of annual working days are lost because of sickness absence (DICE Database, 2012).[1] The costs are considerable for the individual, employers, co-workers, and health and benefit systems. Sickness absence is also a source of major indirect costs, because it increases the risk of withdrawing from the labor force (e.g. Kivimäki et al. 2004).

A sickness insurance system protects individuals from earnings losses. Among cash benefits, sickness insurance is one of the most important social protection schemes in Europe (Eurostat, 2011). The key policy parameter is the replacement rate, i.e. the ratio of sickness insurance benefits to past earnings.

We examine the effect of the replacement rate of the Finnish sickness insurance on the duration of sickness absence. We find a substantial and robust behavioral effect. The statistically significant point estimate of the elasticity of the duration of sickness absence with respect to the replacement rate is 0.83 or 1.41, depending on the model specification.

The elasticity of the duration of sickness absence is a relevant parameter of an optimal sickness insurance system (Baily, 1978; Chetty, 2006). The replacement rate directly affects workers' financial incentives to be absent from work at the intensive margin of labor supply through a moral hazard effect.

---

[1] Treble and Barmby (2011) provide an overview.

We use Regression Kink Design (RKD, see Section 4) to identify the causal effect of the replacement rate. Unlike in most other countries (Frick and Malo, 2008, p. 510-511), the compensation level of sickness insurance in Finland is not a fixed fraction of past earnings, but it follows a piecewise linear scheme. This allows us to use RKD, in which the identification of the effect is based on a pre-determined, nonlinear policy rule (Nielsen et al. 2010; Card et al. 2012).[2]

Previous research has used policy reforms that provide exogenous variation in the replacement rates to examine the effect of sick pay level on absence. Several studies exploit legislative changes in the replacement rates and provide difference-in-difference estimates for Sweden (Henrekson and Persson, 2004; Johansson and Palme, 2005; Pettersson-Lidbom and Skogman Thoursie, 2013). There is also similar evidence for other countries (Puhani and Sonderhof, 2010; De Paola et al. 2014; Ziebarth and Karlsson, 2014; Fevang et al. 2014). Most other countries, including the U.S., have more fragmented sickness insurance schemes which complicate the analysis (cf. Gruber, 2000). In addition to studies that have exploited policy reforms within countries, there is cross-country evidence on the positive effect of the replacement rate of sickness insurance on absenteeism (Frick and Malo, 2008).

The elasticity of absence with respect to the replacement rate is positive, based on earlier research. However, the quantitative size of the effect varies substantially from study to study. Also, the comparison of the estimates is not straightforward, since the outcome

---

[2] See Table 1 in Ganong and Jäger (2014) for a list of RKD applications.

variables (duration of sickness absence or number of sickness absence days) are not identical in all studies.[3]

Empirical studies based on policy reforms suffer from a number of caveats. Reforms are aimed at specific groups, the causal impact takes time to take effect, agents anticipate the upcoming reform,[4] effects are confounded by simultaneous policy changes or other shocks, etc. Thus, the causal interpretation for the difference-in-difference estimates based on policy reforms is not straightforward (cf. Besley and Case, 2000; Pettersson-Lidbom and Skogman Thoursie, 2013, p. 487).

We improve upon previous literature by using a method that allows us to focus on all employees around the kink point in the benefit rule. The kink point provides policy-relevant exogenous variation in the neighborhood of the median income. A long-standing quasi-experiment is likely to reveal equilibrium behavior. We interpret our estimate as the Frisch elasticity. We recast the search models by Baily (1978) and Chetty (2006) of optimal unemployment insurance to interpret our results. The models compare universal sickness insurance to self-insurance.

The paper unfolds as follows. Section 2 discusses the theoretical aspects of an optimal mandatory sickness insurance system. Section 3 provides an overview of the Finnish sickness insurance system. Section 4 describes RKD. Section 5 introduces the data and the estimation results are presented in Section 6. The last section concludes.

---

[3] Ziebarth and Karlsson (2014, p. 209-210) summarize the existing estimates by noting that the elasticity of sick days with respect to the benefit level is ~0.9.
[4] De Paola et al. (2014, p. 349) highlight the fact that employees can adjust their sickness absence behavior in anticipation of the reform.

2. Optimal sickness insurance system

In the absence of private insurance, social planner faces a trade-off: an optimal social insurance system balances the costs of more generous payments to the sick with the welfare gain resulting from the consumption smoothing that the benefits allow (Baily, 1978; Chetty, 2006; Chetty and Saez, 2010). A critical input in defining the optimal replacement rate in a mandatory sickness insurance program is the elasticity of absence w.r.t. the generosity of benefits. The elasticity captures the relevant costs of a higher benefit level.

The search model of optimal unemployment insurance benefit compares unemployment insurance scheme which is financed by a budget-balancing tax while working to self-insurance using prior assets as a buffer-stock.[5] The unobserved cost of effort of an early return to work induces moral hazard to the model.[6]

In comparative statics it is important to separate effects that refer to shifts in a life-cycle wage profile (wealth effects) and movements along a given wage profile. The labor supply response to wage changes is generally a mixture of an intertemporal substitution effects, compensated wage elasticity and wealth effects. The intertemporal (i.e. Frisch) elasticities hold the marginal utility of wealth constant and compensated elasticities hold lifetime utility constant. Intertemporal responses are greater than compensated responses and they reduce to the same value only if income or wealth effects are zero (Macurdy, 1981, pp. 1070-1073).

---

[5] A mandatory insurance system prevents adverse selection out of insurance coverage. However, in the presence of heterogeneity, some workers have more to gain from insurance than others. We leave any heterogeneity effects out of the analysis.
[6] The unobserved cost of job search in the unemployment insurance model is reinterpreted in our setting as the cost of effort to an early return to work while on sick leave.

The MaCurdy (1981) critique maintains that studying a reform which changes the whole net-of-tax wage profile does not recover the Frisch elasticity, since the reforms affect wealth. In our setting, workers return to work with the same wage level as before the sickness leave. This is dictated by the Finnish labor law. In Baily's (1978, p. 389) analysis this is a simplifying assumption, but strictly holds in our application. In addition, the wealth effect on life-cycle labor supply is likely to be smaller in sickness insurance, since the spells of sickness leave (in our data the mean spell is 44 days) are considerably shorter than typical unemployment durations (over 15 weeks). Therefore, we ignore the wealth effects[7] and base the interpretation of the estimates on the simplified two-period search models by Baily (1978, pp. 383-390) and Chetty (2006, pp. 1882-1886).

The optimal benefit level of a social insurance system equates the marginal cost of financing the benefit to the marginal welfare gain from consumption while on sick leave. As a second order Taylor approximation, the optimal benefit condition is a function of four parameters (Chetty, 2006, p. 1883):

$$E_b^s = \frac{U'(C_s) - U'(C_w)}{U'(C_w)} \approx \gamma \frac{\Delta C}{C_w}(b^*) \left[1 + \frac{1}{2}\rho\frac{\Delta C}{C_w}(b^*)\right], \qquad (1)$$

where subscript w stands for being at work, b^* is the optimal benefit level, D signifies the duration of sickness leave , $\Delta C / C_w$ is the proportional drop in consumption while on sick leave, $\gamma = -\frac{u''(C_w)}{u'(C_w)}$ is the coefficient of relative risk aversion, $\rho = -\frac{u'''(C_w)}{u''(C_w)}$ is the coefficient of relative prudence and $E_b^s = \frac{d \log(D)}{d \log(b)}$ is the elasticity of the duration of sick leave with respect to the sickness benefit.

---

[7] This assumption predicts that post sickness leave consumption is, in a stationary environment, equal to that before sickness leave.

In the absence of a private sickness insurance market and lifetime wealth effects, agents' optimization allows us to assume that sickness benefits are spent solely on consumption while sick and that higher taxes are financed solely by reducing consumption while at work when computing welfare changes. The welfare change can be written in terms of marginal utilities of consumption in the two states, eliminating all other behavioral responses when setting the optimal benefit level except for the elasticity parameter (E_b^s) that enters the government budget constraint directly.

The reduced-form formula is quite robust (e.g. search costs and the value of leisure show up in the optimized level of consumption while sick) and the optimality condition captures a basic intuition that carries over to the general case (see Chetty, 2006). We exploit a kink in the policy rule to estimate the elasticity.

3. The Finnish sickness insurance system

Finland has a universal mandatory sickness insurance scheme that covers all (16-67 years old) permanent residents.[8] The scheme guarantees compensation for the loss of earnings owing to sickness and illness. Sickness allowances and reimbursements are defined in the Health Insurance Act and Decree. Sickness insurance is financed by both employers and employees. Insurance contributions are proportional to income and unrelated to the benefit rule. The state participates by financing the minimum allowance that is paid to those with no earnings.[9]

---

[8] The description of the system is based mainly on Toivonen (2012). Kangas et al. (2013) provide a historical account.

[9] Finland has the highest share of sickness absenteeism in Europe (Gimeno et al. 2004). Sickness absence has also increased significantly during the past 15 years. The average number of sickness absence days per wage and salary earner was 10 in 2008, according to the Quality of Work Life Survey (Lehto and Sutela, 2009).

The Social Insurance Institution of Finland (KELA) pays out a Sickness Allowance (SA) as compensation for the loss of earnings caused by an illness or injury. The SA includes two provisions: a minimum sickness benefit and an earnings-related benefit. The earnings-related benefit is relevant for most of employed and self-employed persons.

Before receiving the SA from KELA, the person must complete a waiting period. It includes the day of onset of work incapacity and the following nine working days.[10] The incapacity for work must be certified by a doctor. The employee is entitled to normal salary during the nine-day waiting period if the employment relationship has lasted at least a month.[11]

After the nine-day waiting period the employee is eligible to receive an earnings-related SA from KELA. The maximum period for SA is 300 working days (i.e. approximately a full calendar year). All SA days within the last two years are counted towards this sum. After the maximum has been reached, there is an assessment of eligibility for a disability pension. The person is eligible to receive the SA again only after having worked for at least a year.

The earnings-related SA has no ceiling. This feature distinguishes the Finnish scheme from those of the other Nordic countries and most other European sickness insurance systems. In 2012, for annual earnings of up to 34,496 euro, the replacement rate was 70% after which it decreased to 45% and at 53,072 euro to 30%.

---

[10] The waiting period includes Saturdays, but not Sundays or public holidays.
[11] The employer pays a full salary for at least the first nine days, depending on the collective labor agreement, if the employment has lasted at least a month. If the employment has lasted less than a month, the beneficiary receives 50% of the salary. KELA fully compensates employers for these payments.

For our purposes, the most important feature of the system is that the replacement rate of the earnings-related SA follows a pre-determined, nonlinear policy rule. First, the SA is determined by past taxable annual earnings. The relevant earnings are those earned two calendar years before the claim for sickness insurance is made. For example, in 2012, the SA was calculated on the basis of taxable earnings in 2010.[12] Work-related expenses are deducted from taxable earnings, and in addition a deduction is made to account for pension and unemployment insurance contributions.

The fact that the SA is determined by past earnings is particularly useful for our purposes, because applicants are arguably able to manipulate their current earnings. This would invalidate the identification of the causal effect using RKD. But this is highly unlikely regarding past earnings. Reassuringly, we are also able to check whether there is any bunching of the data points towards the kinks in the benefit rule (see Section 6.2).

The second important feature of the system is that the replacement level follows a piecewise linear policy rule in past earnings.[13] The determination of SA for 2012 is illustrated in Figure 1. There are four earnings brackets. The benefit formula for the earnings-related SA exhibits one discontinuity and two kink points, which we define as the lower and the upper kink point. The lower kink point allows one to use RKD to identify the causal effect of the replacement rate. The discontinuity point cannot be exploited, since those below the threshold receive no compensation and thus are not in our data.

---

[12] The amount of taxable earnings is based on the decision by the Finnish Tax Administration. An index is used to account for the rise in wage and salary earners' earnings (80 percent weight) and the cost of living index (20 percent weight).

[13] These kinks to the system were created in the early 1980s (see Kangas 2013, p. 283).

Figure 1 here

4. Regression Kink Design

4.1. Identification

Nielsen et al. (2010) propose a variant of the Regression Discontinuity Design (RDD) which they call RKD. Their method uses a kink or kinks in a policy rule to identify the causal effect of the policy rule on the outcome variable of interest. A valid RKD setting requires the explanatory variable (in our case, the replacement level) to be a deterministic and known function of an assignment variable (in our case, earnings from two years prior). The function also has to have at least one kink point. This means that the function has segments where it is (continuous and) differentiable, but in at least one point it is non-differentiable having unequal left and right derivatives (Condition 1).

The second condition for a valid RKD setting is that the assignment variable allocates the observations to the left and right segments of a kink point in a manner that is as good as random (Condition 2). Endogenous bunching of observations near kink points (i.e. discontinuities in the derivative of the density function) or nonlinearity of covariates would invalidate this smoothness condition (see Card et al. 2012 for these testable predictions). Additionally, regularity conditions are needed for a valid RKD.

In our setup, Condition 1 holds, since we know exactly how earnings from two years prior determine the replacement level. We also have data on the relevant earnings and the replacement level. Also, as Figure 1 shows, the relationship between the assignment

variable and the policy variable for the year 2012 is continuous for earnings above 1325 euro and has kinks at 34,496 and 53,072 euro. Other years in our data reveal a similar structure.

The random assignment of observations (Condition 2) is not directly verifiable in empirical applications. But it is unlikely that individuals manipulate the benefit level by altering their earnings in order to be assigned to another segment of the replacement function two years later. We can also ascertain that other benefit rules, such as the earnings-related unemployment benefit, do not have kinks or discontinuities at the same points as the sickness benefit and thus they do not affect the randomness of the assignment. Furthermore, we can test for whether the distribution of the control variables is smooth in relation to the kink point. If we find this not to be the case, Condition 2 fails, which invalidates the design. This procedure is very similar to what is usually done to validate RDD (for a review, see Imbens and Lemieux, 2008).

4.2. Formal model

Let S_i be sickness days in the year t, for individual i∈$\{1,2,...,n\}$, Y_i is earnings in the year t-2 and B_i is the sickness allowance, which follows the deterministic assignment function $B_i = b(Y_i)$ with a kink at $Y_i = y_k$. The parameter of interest is the change in the slope of the conditional expectation function $m(y) = E[S_i|Y_i = y]$, at y_k divided by the change in the slope of the deterministic assignment function $b(y)$ at $y = y_k$. The general model of interest is of the form:

$$S_i = s(Y_i, B_i, \varepsilon_i),$$

where ε_i is an error term.[14]

Card et al. (2012) show that τ, the average marginal effect of $b(y)$, is identified at

$y = y_k$ if $s(Y_i, B_i, \varepsilon_i)$ and its derivatives with respect to Y_i and B_i are continuous,

$s(Y_i, B_i, \varepsilon_i)$ has a kink (Condition 1) and the density of Y_i is smooth (Condition 2) at y_k.

Under these assumptions, $E(\varepsilon_i | Y_i = y_k)$ is a smooth function and

$$\tau = \frac{D_+ m(y_k) - D_- m(y_k)}{D_+ b(y_k) - D_- b(y_k)}, \tag{2}$$

where $D_j m(y_k) = \lim_{y \to y_k^j} \frac{\partial m(y)}{\partial y}, D_j b(y_k) = \lim_{y \to y_k^j} \frac{\partial b(y)}{\partial y}, j \in \{+,-\}$. τ is the weighted average

of marginal effects across the population. The weight is the relative likelihood that an

individual has $Y_i = y_k$, given ε_i (see Card et al. 2012, pp. 8–9 for a more detailed

discussion).

The numerator in equation (2) is estimated semi-parametrically as β_1 using the following

local power series expansion:

$$E(S_i | Y_i = y) \approx \alpha_0 + \sum_{p=1}^{P} [\alpha_p (y - y_k)^p + \beta_p D_i (y - y_k)^p], \tag{3}$$

where P is the chosen polynomial order of the estimated function and D_i is the treatment

status, where 1 means treated and 0 means not treated ($D_i(z) = 1, if\ z > 0, D_i(z) = $

0 otherwise). The power series is a local approximation of the conditional expectation

function of S_i. Note that $|y - y_k| \leq h$, where h is the bandwidth chosen for the

estimation. The denominator in equation (2) is the change of the slope of the

deterministic $b(y)$ at the kink point.

---

[14] See Nielsen et al. (2010) for the model in the following additive form: $S_i = \tau B_i + g(y) + \varepsilon_i$, where g is a fixed function.

4.3. Fuzzy setting

Card et al. (2012, pp. 10–12) distinguish between sharp and fuzzy RKD. A fuzzy design arises when there is a significant difference between the theoretical and observed value of the kink in the policy rule. The difference stems from e.g. measurement errors or the fact that the kink in the policy rule is affected by some unobserved and observed variables in addition to the primary assignment variable. In our setting, a likely source of error is the manner in which variables are defined and classified in the original dataset (see Section 5 and Figure A1).

In a fuzzy RKD, $B_i = b(Y_i, \varepsilon_i^B)$. Thus, B_i is now determined by unobserved factors that might be correlated with the assignment variable. Additional assumptions are also required for identification. Along with some technical assumptions, monotonicity in the assignment function must hold (Condition 3). This condition states that the direction of the kink is either non-negative or non-positive for the entire population. B_i and Y_i are allowed to have specific types of measurement error.

When Conditions 1, 2 and 3 and the necessary technical conditions hold,

$$\tau = \frac{D_+ m(y_k) - D_- m(y_k)}{D_+ b(y_k) - D_- b(y_k)}, \tag{4}$$

where $D_j m(y_k) = \lim_{y \to y_k^j} \frac{\partial m(y)}{\partial y}, D_j b(y_k) = \lim_{y \to y_k^j} \frac{\partial E[B_i|Y_i=y]}{\partial y}, j \in \{+,-\}. \tau$, the average marginal effect of $b(y)$ at $y = y_k$, in equation (4) is weighted by the product of three components (see Card et al. 2012, p. 12). As in a sharp RKD, the first component is the relative probability of $Y_i = y_k$. The second is the size of the kink in the benefit rule for

individual i. The third component is the probability that the assignment variable is correctly measured at $Y_i = y_k$.

For estimation of the expected change of the policy rule, we use the following local power series expansion:

$$E(B_i|Y_i = y) \approx \delta_0 + \sum_{p=1}^{P} [\delta_p(y - y_k)^p + \gamma_p D_i(y - y_k)^p],$$

where γ_1 is the empirical counterpart of the policy rule. The elasticity of interest can be approximated as $\tau \approx \frac{\beta_1}{\gamma_1}$. To obtain the correct point estimate and standard errors for τ, we use instrumental variable (IV) regression, following Card et al. (2012, pp. 20–21). The instrument is the interaction term of past earnings and an indicator of earnings above the lower kink point, $D_i(y - y_k)$. The instrumented variable is B_i, the received compensation.

4.4. Bandwidth selector

The bandwidth selection is a trade-off between bias and precision. Card et al. (2012, pp. 32–33) use the "rule-of-thumb" bandwidth selector of Fan and Gijbels (1996, equation 3.20, p. 67; henceforth FG):

$$h = C_p \left\{ \frac{\hat{\sigma}^2(0)}{[\hat{m}^{(p+1)}(0)]^2 \hat{f}(0)} \right\}^{\frac{1}{2p+3}} n^{-\frac{1}{2p+3}},$$

where p is the order of the polynomial in the main specification, $\hat{\sigma}^2(0)$ and $\hat{m}^{(p+1)}(0)$ are, respectively, the estimated error variance and $(p+1)th$ order derivative of the

regression, using a wide-bandwidth polynomial regression of equation (3),[15] C_1 is 2.352

for the boundary case with a uniform kernel and $\hat{f}(0)$ is estimated from a global

polynomial fit to the histogram of earnings. Bandwidth choices which are too "large"

lead to a non-negligible bias in the estimator of the conditional expectation function. We

report the results for multiple bandwidths in the sensitivity analysis and we also use a

bandwidth selector proposed by Calonico et al. (2014; henceforth CCT). Calonico et al.

(2014) build the CCT bandwidth selector upon the FG bandwidth selector.

5. Data

We use total data on Finnish sickness absence spells over the period 2004–2012. This

comprehensive register-based data originate from KELA and they are derived from the

database that is used to pay out the SA compensations. Therefore, some measurement

error might arise from the aggregation of variables when converting the original register

for research purposes.[16] The administrative data cover both wage and salary earners and

self-employed persons. The data record the start and end dates for all sickness spells and

the total amount of SA paid for each person. Annual earnings are deflated to 2012 prices

by using the consumer price index.

Our data consist of absence spells that last for longer than the waiting period of nine full

working days. The distribution is right-skewed.[17] Thus, longer sickness absences

---

[15] We use the data for a very wide window of 0.8 log earnings for this regression, which contains 85% of the total sample. This is done in order to keep the polynomial order within reasonable limits. The polynomial order is chosen to minimize Akaike Information Criterion. Also, the polynomial in this context is allowed to be nonlinear up to the pth order. This is necessary in order for $\widehat{m}^{(p+1)}(0)$ to exist.

[16] In particular, consecutive absence spells that start within 300 days are counted as a single spell if the diagnosis remains the same.

[17] The skewness of the distribution is 2.5 and 2.9 for the total sample and for the window of 0.0796 log earnings around the lower kink point, respectively.

contribute disproportionately to the total days lost and absence costs. The data enable us to concentrate on those absences that are affected by the incentives of the sickness insurance system.

The data record a person's past taxable earnings that KELA obtains directly from the Finnish tax authorities. KELA uses the same information to calculate the SA for beneficiaries. The data also include useful background information such as a medical diagnosis for the reason for sick leave, which can be used to test for validity of the RKD. The initial diagnosis of individuals is documented according to the International Classification of Diseases (ICD-10).[18] We have also linked to the data the highest completed education from the Register of Completed Education and Degrees, maintained by Statistics Finland.

The estimations are restricted to those in the labor force who are eligible for sick pay and who are between 16 and 70 years of age. The final sample used in the analysis includes compensated absence spells which are above zero in duration and whose payment criteria and initial diagnoses are known for employees with a single employer during their sickness spell.[19] The final sample around the lower kink point consists of 37,000–41,000 individuals, depending on the year. Descriptive statistics is reported in Table 1 (duration of sickness absence and background characteristics for persons).[20]

---

[18] ICD is the standard diagnostic tool for clinical purposes. The classification is available at: http://www.who.int/classifications/icd/en/

[19] A part-time sickness benefit was introduced in Finland at the beginning of 2007. We exclude its recipients from the sample. Only 0.5% of the sample has no known diagnosis. Also, 146 observations with missing received compensation were excluded. We are able to identify entrepreneurs from 2006 onwards. We exclude the 2.3% of the original sample that entrepreneurs represent. In total, we exclude c. 3.0% of the original data to construct the final sample.

[20] A fraction of the insured (13.6%) are compensated according to an eligibility criterion other than prior earnings (e.g. if earnings have changed by more than 20%, the compensation can be claimed based on more recent earnings, see Toivonen 2012). Our results are robust to their exclusion from the sample (see Table A3).

Table 1 here

Figure 2 reveals that persons with low earnings have a longer duration of sickness absence. This pattern is consistent with the hypothesis that poor health erodes earning capacity (cf. Aittomäki et al. 2014, p. 86), assuming that the duration of sickness absence is a valid proxy for health.

Figure 2 here

We exploit the lower kink point to identify and estimate the effect of the replacement rule for two reasons. First, the lower kink point is located in the part of the earnings distribution which contains substantial mass to support the estimation of statistically significant effects (Figure A2). The large sample size around this kink point shows as smaller variability in the length of sickness absence within the 800 euro bins. Second, there is a large change in the benefit rule at the lower kink point (cf. Figure 1).[21]

6. Results

6.1. Baseline estimates

Figure 3 illustrates the duration of sickness absence and annual earnings around the lower kink point.[22] It suggests that there is a behavioral response at the kink.

---

[21] The estimated effects are insignificant at the upper kink point and thus omitted. There are multiple reasons for the insignificance of the estimate: fewer data points, smaller slope change and potentially heterogeneous treatment effects. The point estimate for the upper kink estimate is 0.426 (1.677). FG bandwidth is 0.086.

[22] The bandwidth in Figure 3 was chosen for illustrative purposes to mitigate excessive noise, following the methodological guidance of Lee and Lemieux (2010). The number of bins used coincides with the number

Using the FG bandwidth of 0.0796 log euro for annual earnings, we find clear evidence

for the incentive effects (see Table 2 and Table A1). The estimated change of the slope at

the lower kink point is -0.56. The weighted average of the marginal elasticities of the

duration of sickness absence (τ) with respect to the replacement rate is 1.41 [95% CI:

0.36, 2.46] using the linear specification. The point estimate implies a high elasticity. The

quadratic specification (i.e. when $p = 2$) gives a point estimate of 0.83 [0.27, 1.38] with

the FG bandwidth of 0.2953 also implying a significant behavioral response. Using the

CCT[23] (Calonico et al. 2014) bias-corrected estimator and bandwidth (0.1416), we

estimate the elasticity to be 1.16. The CCT was estimated using the triangular kernel.[24]

Figure 3 and Table 2 here

The wider the bandwidth used, the lower the point estimates get. This result is illustrated

in Figure 4. If functions $E(S_i|Y_i = y)$ and $E(B_i|Y_i = y)$ are piecewise linear and the

sample size is sufficiently large, then the point estimate would remain unchanged with all

bandwidths, i.e. the relationship depicted in Figure 4 would be a horizontal line. Thus,

deviations from the horizontal line are indicative of curvature in the conditional

expectation functions and consequently the presence of bias in the local linear estimator.

Figure 4 here

---

given by Sturges' rule (Sturges, 1926), which is a classic method for choosing the optimal number of bins for histograms. See Figure A3 for the same graph without the fit and confidence interval, but illustrating the sample size around the kink point. Figures A4 and A5 report the annual graphs.

[23] The CCT estimator is singularly compute-intensive in our setting.

[24] The FG bandwidth depends on the polynomial order. Under the same bandwidth sequence, the variance of the local quadratic estimator with a uniform kernel is 16 times as large as its local linear counterpart (see Card et al. 2012, pp. 15–16). Thus, we focus mainly on the linear specification. Asymptotically a local quadratic regression using its optimal bandwidth sequence is preferred to the local linear regression with its optimal bandwidth sequence. The asymptotic advantage, however, does not provide finite sample guarantees. We also report the results from the quadratic specification in Table 2. Following the recommendation of Gelman and Imbens (2014) for RDD, we omit reporting results with higher order polynomials.

The choice of bandwidth is a compromise between precision and bias. The main specification uses the FG bandwidth h, estimated to be 0.0796 log euro, which fulfils two criteria. First, covariates are linear, whereas they show nonlinearity at wider bandwidths (see Table A2) than 0.0796 log euro. Second, estimates are sufficiently precise, whereas a narrower band would increase standard errors.

Precision in regression analysis increases with sample size and variance in the explanatory variable. Both of these decrease as the bandwidth narrows. Note that the FG bandwidth that we use in our main specification is quite narrow in terms of monthly earnings (~460 euro in 2012).

6.2. Sensitivity analyses

We confirm the result from the main specification using different sets of controls (see Table 3). The results show a reassuring degree of robustness. Controlling for individual characteristics and the initial diagnosis at the one-letter level (21 different values) gives the same point estimate as the regression with no controls. The adjusted R^2 of the model increases from 0.0003 to 0.0781 once all the controls are included.

Table 3 here

We also run the main estimates by subsample to detect possible heterogeneity in the effect (see Table A3 and Figure A6). We show the results for subsamples according to sex, left censoring of sickness spells at 20 days, and most importantly by SA criterion and keeping only observations where the data year matches with the starting year of

sickness. When subsampled by diagnosis, sample sizes drop dramatically and all relevant estimates are insignificant (not reported). The heterogeneity of behavior by sex or other attributes is of no practical interest unless the policy parameters (i.e. the benefit and contribution rules) are conditioned on these variables.

To detect whether there might be any bias induced by possible non-randomness in the assignment, it is necessary to check for the linearity of covariates at the kink point. The covariates are all linear, with the exception of the female indicator and the indicator for tertiary education (Table A2, Figures A7 and A8). However, we run 101 placebo regressions, where the lower kink point is assumed to be off the correct location by -0.5 to 0.5 of log earnings at intervals of 0.01 log earnings and find nonlinearities in 56% and 49% of the specifications for the female indicator and the indicator for tertiary education, respectively (see Figures A9 and A10). This is encouraging, since the nonlinearity of these two variables at the lower kink point appears to be spurious, and the nonlinearities found reflect the location of females and higher educated in the earnings distribution, unrelated to the benefit rule.

The fact that the three most common one-letter level diagnoses are linear is particularly important, since the diagnoses are closely linked to the duration of sickness absence. This is evident in the R^2 of the estimated regressions with and without diagnoses (Table 3).

We test and find no evidence of non-smoothness in the density function of log earnings around the lower kink point (see Figures A11 and A12).[25] Neither is non-smoothness

---

[25] We use "non-smoothness" and "bunching" interchangeably. Smoothness implies no jump in the density or a kink in the density.

found if the densities for males or females are considered separately (not reported).[26] We conclude that the nonlinearity of the female indicator at the kink point is of minor concern for a causal interpretation of our response estimate.

To test robustness of our main specification in Table 2, we run 101 placebo regressions (see Figure 5).[27] We use the same FG bandwidth of the true (lower) kink point for all these regressions. Of the 94 regressions not around the true kink point, ~7 (7.4%) show a significant estimated effect. This lends strong support to the claim that the result is not spurious.

Figure 5 here

6.3. Economic interpretation

The response is affected in part by employer incentives (see Footnote 11 for details of the payment structure). Using the duration of the benefit period paid out to the employer (as opposed to the whole period, which consists periods of payments to the employer and employee) as the response variable, the estimated response is well within the confidence interval of our main specification. This suggests that employer incentives are aligned with those of the employees.

As discussed in Section 2, the response parameter E_b^s on the left-hand side of equation (1) is the elasticity of the duration of sick leave (D) with respect to the level of sickness

---

[26] See Appendix 2 for a decomposition of the density function by sex.
[27] Ganong and Jäger (2014) propose that researchers using RKD should present a distribution of placebo estimates in regions without a policy kink.

benefit ($B=by$). In the model, the sickness benefit is financed by contributions which are proportional to earnings, $T=ty$. Substituting rates for levels in the derivation of equation (1) has no effect on the government budget constraint nor any first-order effects on the optimal conditions and therefore the equation (1) is left unchanged (see, Chetty, 2006, p. 1884).[28]

In the Finnish nonlinear benefit rule, those in the higher earnings bracket receive both a lower marginal replacement rate and a fixed benefit unrelated to earnings and created by the nonlinear benefit rule (segment AB in Figure 6). In calculating the cost effects of reforming the mandatory sickness insurance using our elasticity estimate we assume that the benefit is proportionally adjusted in our policy simulation. To accomplish this we modify all benefit rates accordingly, unchanging the locations of the kinks and therefore proportionally adjusting also the fixed benefits (for details, see Appendix 3).

Figure 6 here

The impact of a proportional 5% increase in the benefit level for the year 2012 is a 0.06% [0.02%, 0.11%] reduction in GDP (cf. Figure 6). For this back-of-envelope calculation, we approximate productivity per working day by dividing annual earnings (in 2010) by 300 and adding 60% to account for indirect labor costs. The crucial (and strong) assumption is that the estimated elasticity is constant at 1.41 [0.36, 2.46][29] throughout the

---

[28] E.g. consider the elasticity: $E_b^s = \frac{dD}{dB}\frac{B}{D} = \frac{dD}{d(by)}\frac{d(by)}{db}\frac{b}{D} = \frac{dD}{db}\frac{b}{D}$.

[29] This estimate is based on the FG bandwidth. This is of course a local estimate for individuals at the kink and might differ from the average response for the whole population in the presence of heterogeneity. Specifically, our estimate corresponds to an average response weighted by the *ex ante* probability of being at the kink given the distribution of unobserved heterogeneity across individuals.

distributions of earnings, sickness benefits and sickness absence duration. We also assume that an increase of 5% is small enough for the constancy of the elasticity.[30]

We calculate the optimal replacement rate using equation (1) and assuming a Constant Relative Risk Aversion (CRRA) utility function (see Figure 7). Using elasticities of absence w.r.t. the benefit level of 1.41 and 0.83, we find that the replacement rate of the lowest bracket in the Finnish system (0.7) is optimal when the Coefficient of Relative Risk Aversion (CoRRA) is 2.95 and 1.92, respectively, implying that the optimal coefficient of relative prudence is 3.95 and 2.92 (see notes to Figure 7). Assuming a constant elasticity throughout the earnings distribution, the highest possible replacement rate of 0.25 is optimal only if CoRRA is low at around 1 (see Figure A13 for replacement rates at different earnings levels).

With respect to small, temporary shocks such as non-disabling illness, the CoRRA may be much greater than w.r.t. large shocks such as disability. This difference stems from rigidities such as consumption commitments (Chetty and Szeidl, 2006). CoRRA may also vary with earnings level.

Figure 7 here

---

[30] In calculating the effects of reforming the mandatory sickness insurance by reducing the number of benefit brackets (or extending the result to a linear benefit system with zero fixed benefit), one should in principle take into account liquidity effects that operate through changes in non-zero fixed benefit created by the nonlinear benefit rule (see Chetty, 2008 and Landais, 2014).

7. Conclusions

Using administrative data on absence spells with a large sample size, we find a considerable incentive effect of the sickness benefit rule at the intensive margin in a quasi-experimental research setting. The point estimate of the elasticity of the duration of sickness absence with respect to the replacement rate is on the order of 1.

A large number of observations guarantee the robustness of our results even controlling for sickness diagnoses. Exogeneity is ensured by the fact that the sickness benefit is determined by earnings two years prior. An extensive battery of checks was run on a number of variables which might influence our results at the kink point.

Our contribution is to exploit a research design that delivers a compelling estimate with strong internal validity on a vital policy parameter in a social insurance system. Since the estimates are obtained at the earnings level close to the median earnings (within 1% in 2012), the response is likely to be similar for a large proportion of the population (see Figure A2). Previous literature has analyzed reforms, which are usually targeted at a specific subset of the population. The behavioral responses of the subset of the population might differ from that of the total population, which impairs the external validity of these research findings.

Our research provides a pioneering application of the regression kink design. The research design builds on exogenous variation that can be exploited for coherent causal inference in a manner that the regression discontinuity design rarely offers, since in our case the eligible persons have significantly weaker incentives to optimize their behavior with respect to the policy rule. However, to obtain statistically significant results, one has

to ensure sufficient sample sizes, since the changes in the policy rule and the responses tend to be noisy and are affected by sample heterogeneity.

The result we find might prove to be crucial for policy makers who aim to improve the cost effectiveness of the mandatory sickness insurance. Although the behavioral effect is only observed around the kink point, one would expect the benefit system to have strong behavioral effects elsewhere along the benefit rule as well. Future research should consider response at the extensive margin.

Figure 1. Relationship between prior annual earnings and daily sickness allowance in euro.
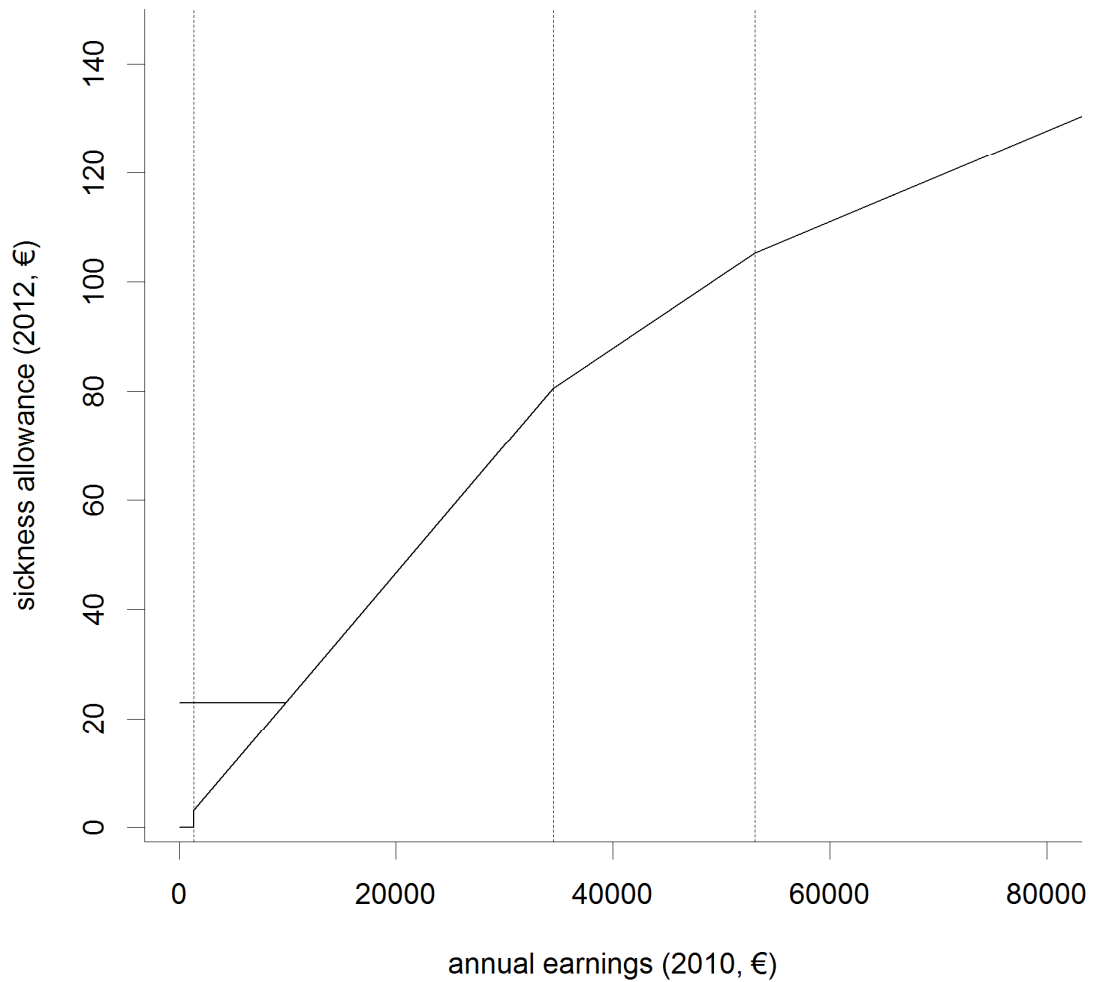
Notes: The vertical dashed lines represent the discontinuity point at 1325 euro and the lower and upper kink points at 34,496 and 53,072 euro in 2012.

Table 1. Descriptive statistics.

	Panel A: Total sample				Panel B: Sample around the lower kink point			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Duration of sickness absence (days)	43.76	70.73	1	575	36.36	60.94	1	454
Duration of sickness absence (log-days)	2.76	1.47	0	6	2.62	1.42	0	6.12
Earnings	26364.68	16119.64	0	6120738	33120.44	1923.67	29095	37897
Log earnings	10.07	0.67	-3.00	15.63	10.41	0.06	10.28	10.54
Age	45.13	11.35	16	70	46.53	10.01	17	69
Female	0.59	0.49	0	1	0.48	0.5	0	1
Tertiary level education	0.14	0.34	0	1	0.16	0.36	0	1
Helsinki Metropolitan Area	0.17	0.37	0	1	0.19	0.39	0	1
Sickness allowance per day (euro)	54.3	23.19	0.01	4600.56	69.16	8.26	0.02	136.21

Panel C: Sample size by year									
Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
Total sample	344,590	352,446	346,747	341,527	339,949	317,618	309,893	309,333	313,101	2,975,204
Sample around the lower kink point	39,887	41,275	41,380	40,617	40,693	38,368	37,875	37,068	37,652	354,815

Note: The sample around the lower kink point is defined within the FG bandwidth (0.0796 log euro of annual earnings). The diagnoses M, S and F represent respectively 34, 13 and 16 percent of the whole sample and 36, 14 and 14 percent of the sample around the lower kink point. Diagnosis M in ICD-10 refers to diseases of the musculoskeletal system and connective tissue. Diagnosis S refers to injury, poisoning and certain other consequences of external causes. Diagnosis F refers to mental and behavioral disorders.
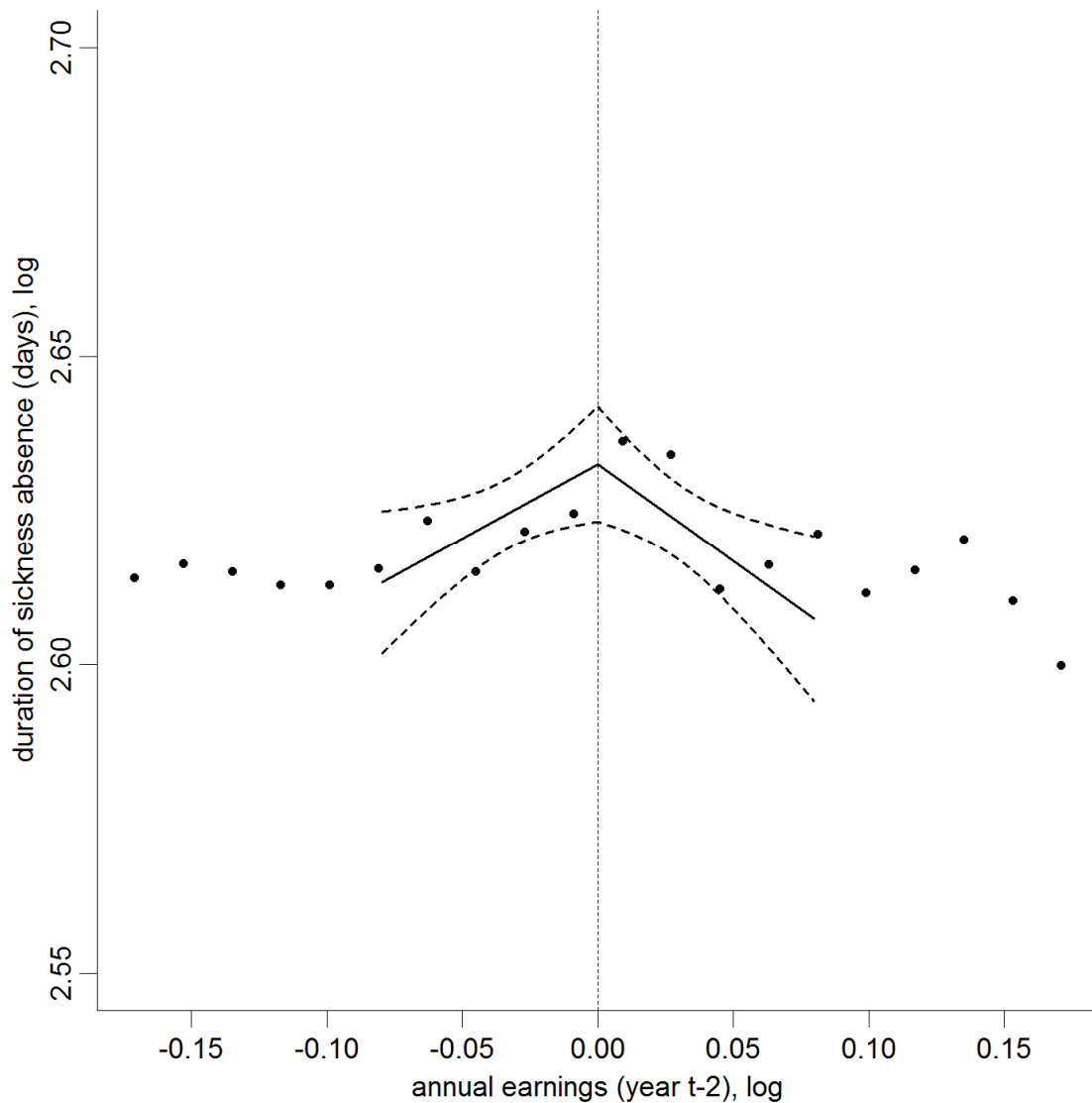
Figure 2. Duration of sickness absence in 2012 and annual earnings.
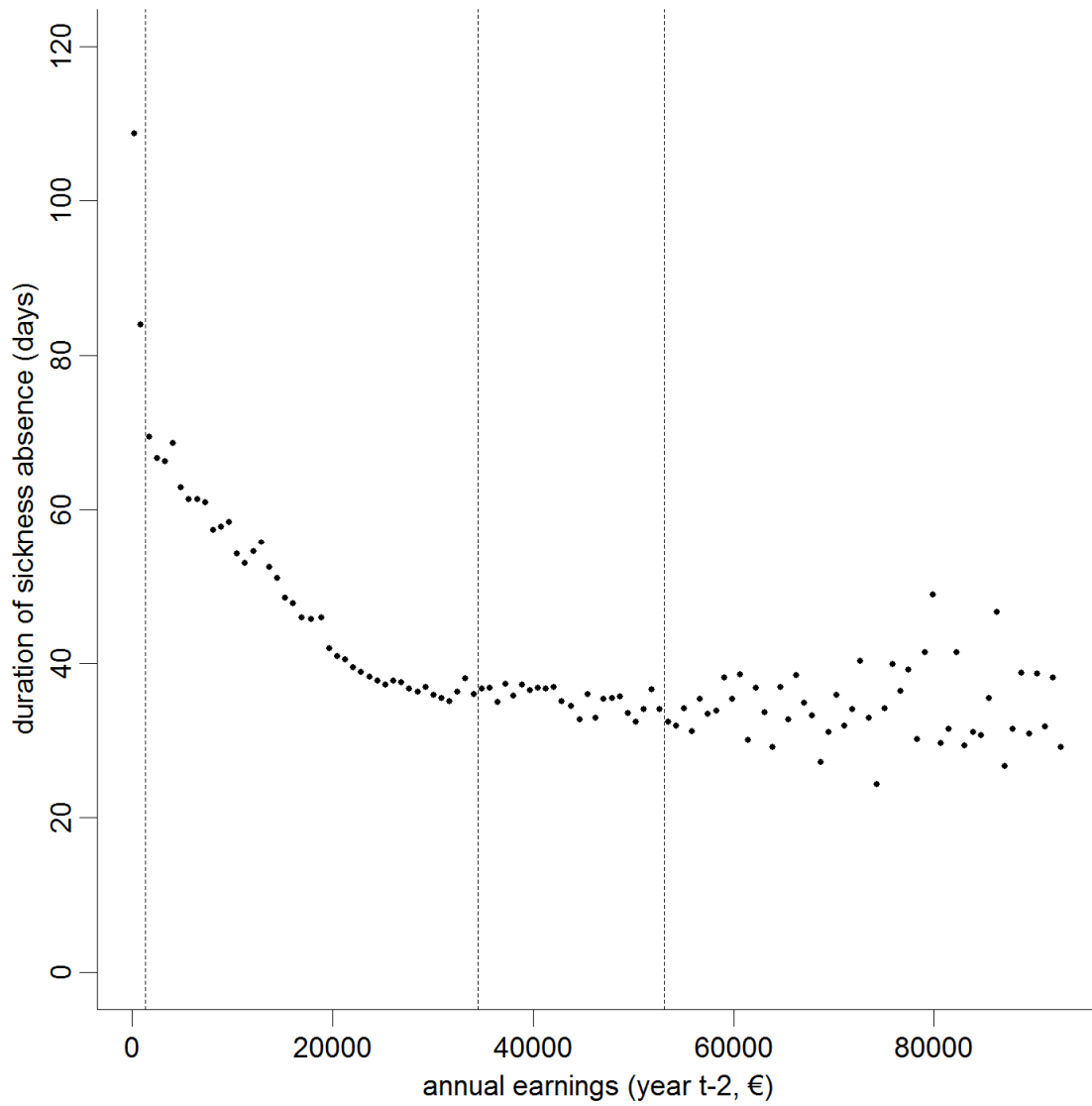
Notes: The vertical dashed lines represent the discontinuity point at 1325 euro and the kink points at 34,496 and 53,072 euro in 2012. The dots represent the mean duration of sickness absence in bins of 800 euro. One bin between each discontinuity and the kink point has been extended such that the discontinuity and the kink points are located at the bin cut-off points.

Figure 3. Duration of sickness absence (2004–2012) and annual earnings (two years prior) around the lower kink point.


Notes: *Annual earnings are deflated to 2012 prices by using the consumer price index. Earnings are in logs and normalized to zero at the lower kink point. The dots represent the mean duration of sickness absence in bins of 0.018 log euro. The regression fit and 95% confidence interval are shown for the FG bandwidth (0.0796 log euro of annual earnings), which is the main specification bandwidth used in the analysis (cf. Table 2).*

Table 2. Regression estimates.

	Panel A: Dependent variable: log duration of sickness absence (days)		
	Linear specification	Quadratic specification	Linear specification, bias-corrected (CCT)
Bandwidth	FG bandwidth	FG bandwidth	CCT Bandwidth
Kernel	Uniform	Uniform	Triangular
Change of slope at kink point (β_1)	-0.556*** (0.208)	-0.353*** (0.119)	..
Slope below kink point (α_1)	0.240** (0.112)	0.162*** (0.06)	..
Yearly fixed effects	Y	Y	N
Polynomial order	1	2	1 (bias correction: 2)
R^2 (Adj.)	0.0003	0.0002	..
N	354,800	1,326,992	635,548
	Panel B: Elasticity of the duration of sickness absence with respect to replacement rate		
Change in the replacement rate (γ_1)	-0.394*** (0.021)	-0.318*** (0.086)	-0.393*** (0.012)
Elasticity ($\tau \approx \frac{\beta_1}{\gamma_1}$)	1.411	0.830	..
	Panel C: Instrumental variable estimation of the elasticity of the duration of sickness absence with respect to replacement rate		
Estimated elasticity (τ)	1.411*** (0.536)	0.830*** (0.283)	1.155*** (0.359)
N	354,800	1,326,992	566,392

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Statistical significance: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The main specification is marked in light grey. The estimated model is equation (3). The FG bandwidth referring to the "rule-of-thumb" bandwidth described in Fan and Gijbels (1996) is estimated to be 0.0796 and 0.2953 for the linear and quadratic specification, respectively. The 95% confidence interval for the IV estimated elasticity with a point estimate of 1.41 is [0.36, 2.46], using the linear specification. CCT refers to the bandwidth (0.1416) and bias-corrected estimator proposed by Calonico et al. (2014). The 95% confidence interval for the IV estimated elasticity with a point estimate of 1.16 is [0.45, 1.86], using the linear CCT specification. The instrument is the interaction term of past earnings and an indicator of earnings above the lower kink point. The Angrist–Pischke first-stage F-statistic (see Angrist and Pischke 2009, pp. 217–218) for a test of the hypothesis that the coefficient of the instrument is zero in a regression of the received compensation on the instrument is higher (346) in the linear FG specification than the conventional threshold of 10 for a weak instrument. Clustering standard errors at the level of the individual increases the 95% CI only marginally (1.67%). In the main specification, the standard error with clustering is 0.545.

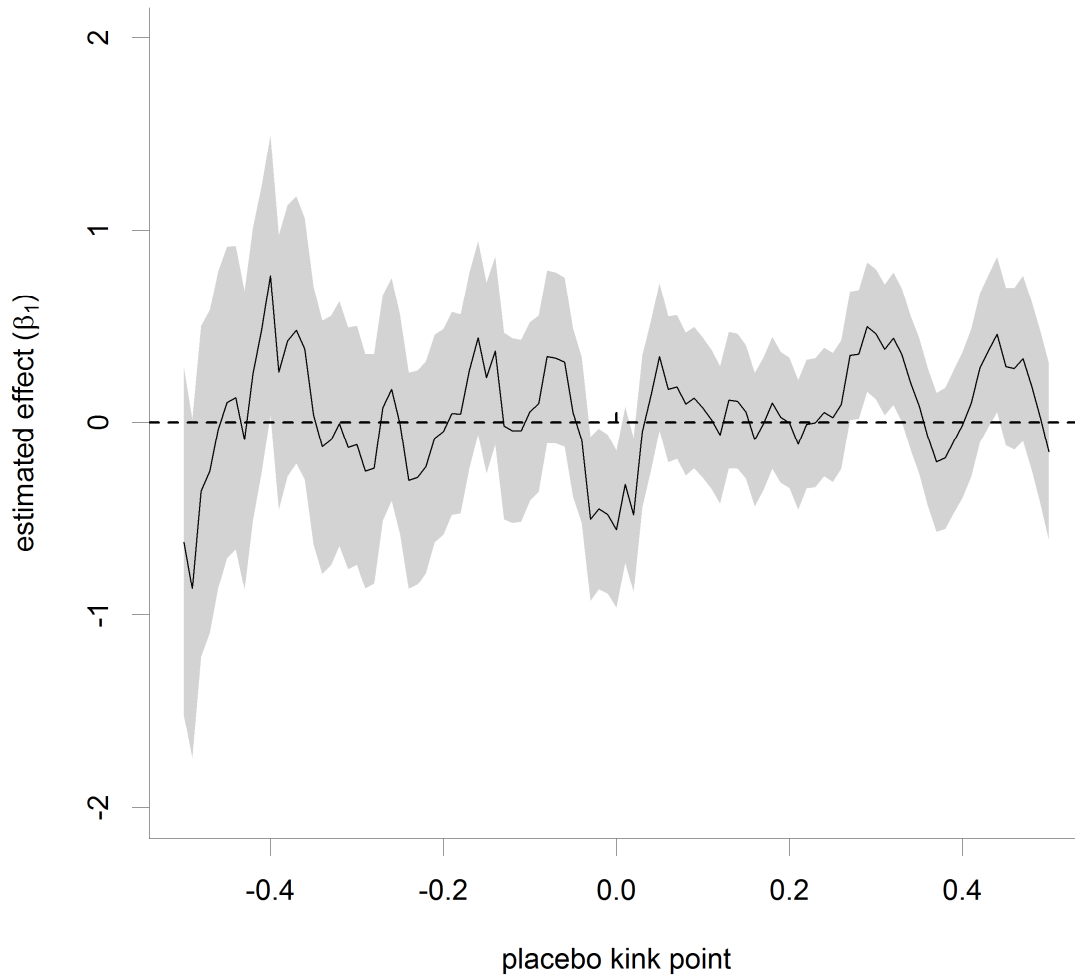Figure 4. Regression estimates with different bandwidths.
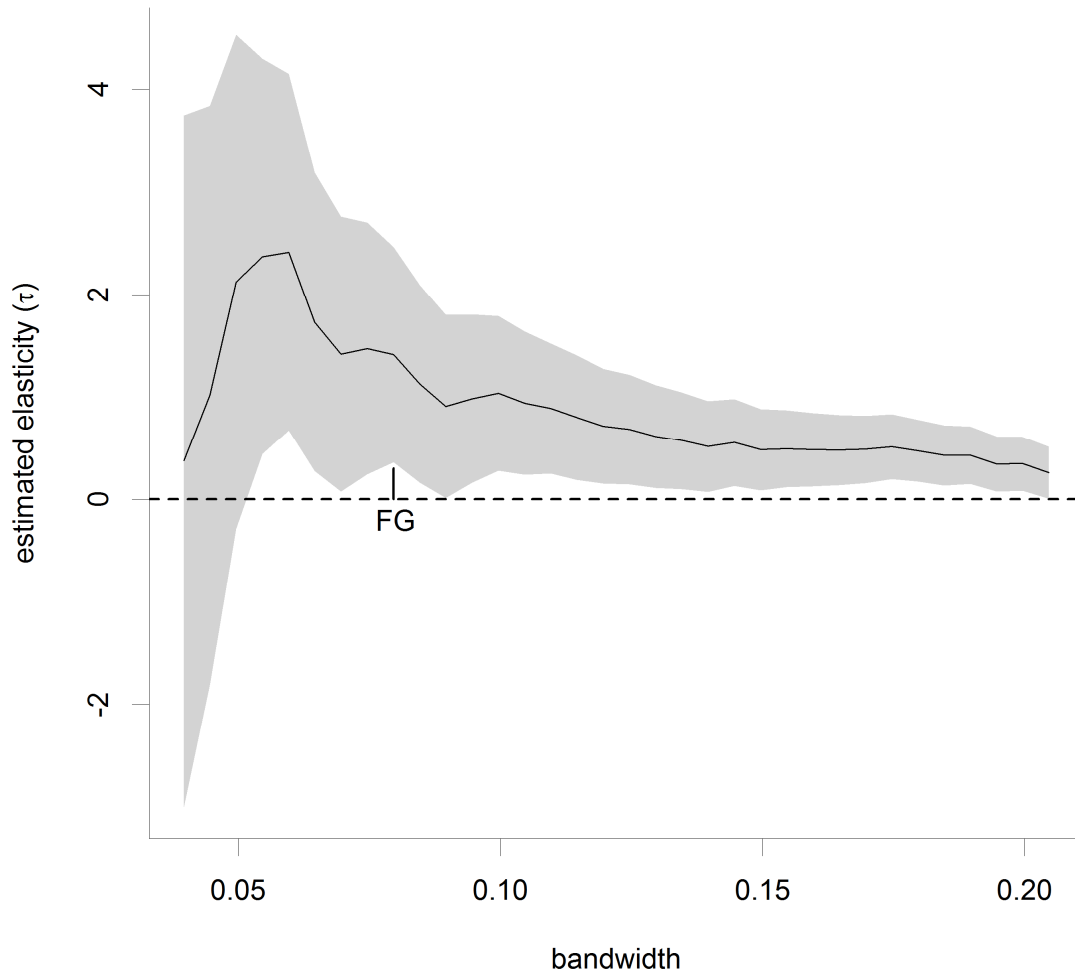
Notes: *The graph represents 33 estimates of the elasticity (τ) using the main specification (log sickness absence duration on log earnings with yearly fixed effects), between bandwidths of 0.0396 and 0.1996 at intervals of 0.05 log earnings. The point estimates are depicted in black and 95% confidence intervals in light gray. The FG bandwidth is marked by a short vertical line (cf. notes to Table 2).*

Table 3. Regression estimates of the main specification with controls.

| Panel A: Dependent variable: log duration of sickness absence (days)				
Change of slope at kink point (β_1)	-0.556*** (0.208)	-0.516** (0.206)	-0.502** (0.201)	-0.473** (0.199)
Slope below kink point (α_1)	0.240** (0.112)	0.055 (0.111)	0.208* (0.108)	0.034 (0.107)
Yearly fixed effects	Y	Y	Y	Y
Individual characteristics		Y		Y
Initial diagnosis (at one-letter level)			Y	Y
Polynomial order	1	1	1	1
R^2 (Adj.)	0.0003	0.0134	0.0661	0.0781
N	354,800	354,800	354,800	354,800
Panel B: Instrumental variable estimation of the elasticity of the duration of sickness absence with respect to replacement rate				
Estimated elasticity (τ)	1.411*** (0.536)	1.314** (0.533)	1.274** (0.517)	1.206** (0.516)
N	354,800	354,800	354,800	354,800

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Statistical significance: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The estimated model is equation (3). Individual characteristics are age, sex, the Helsinki Metropolitan Area indicator and tertiary education indicator. Initial diagnosis is denoted at the one-letter level, following the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10). The data have 21 different values for this variable. The FG bandwidth referring to the "rule-of-thumb" bandwidth described in Fan and Gijbels (1996) is estimated to be 0.0796. The instrument is the interaction term of past earnings and an indicator of earnings above the lower kink point. The lowest Angrist–Pischke first-stage F-statistic for a test of the hypothesis that the coefficient of the instrument is zero in a regression of the received compensation on the instrument is 344 in the second column regression with individual characteristics as the control variables (cf. notes in Table 2).

Figure 5. Placebo regressions.

Notes: The graph represents 101 estimates of the kink using the main specification (log sickness absence duration on log earnings with yearly fixed effects), where the lower kink point is assumed to be off the correct location by -0.5 to 0.5 of log earnings at intervals of 0.01 log earnings. The lower kink point is originally normalized to be at 0 of log earnings. The point estimates are depicted in black and 95% confidence intervals in light gray. Of the 94 regressions not around the kink point, 7.4% are significant at the 5% level.

Figure 6. A policy reform.
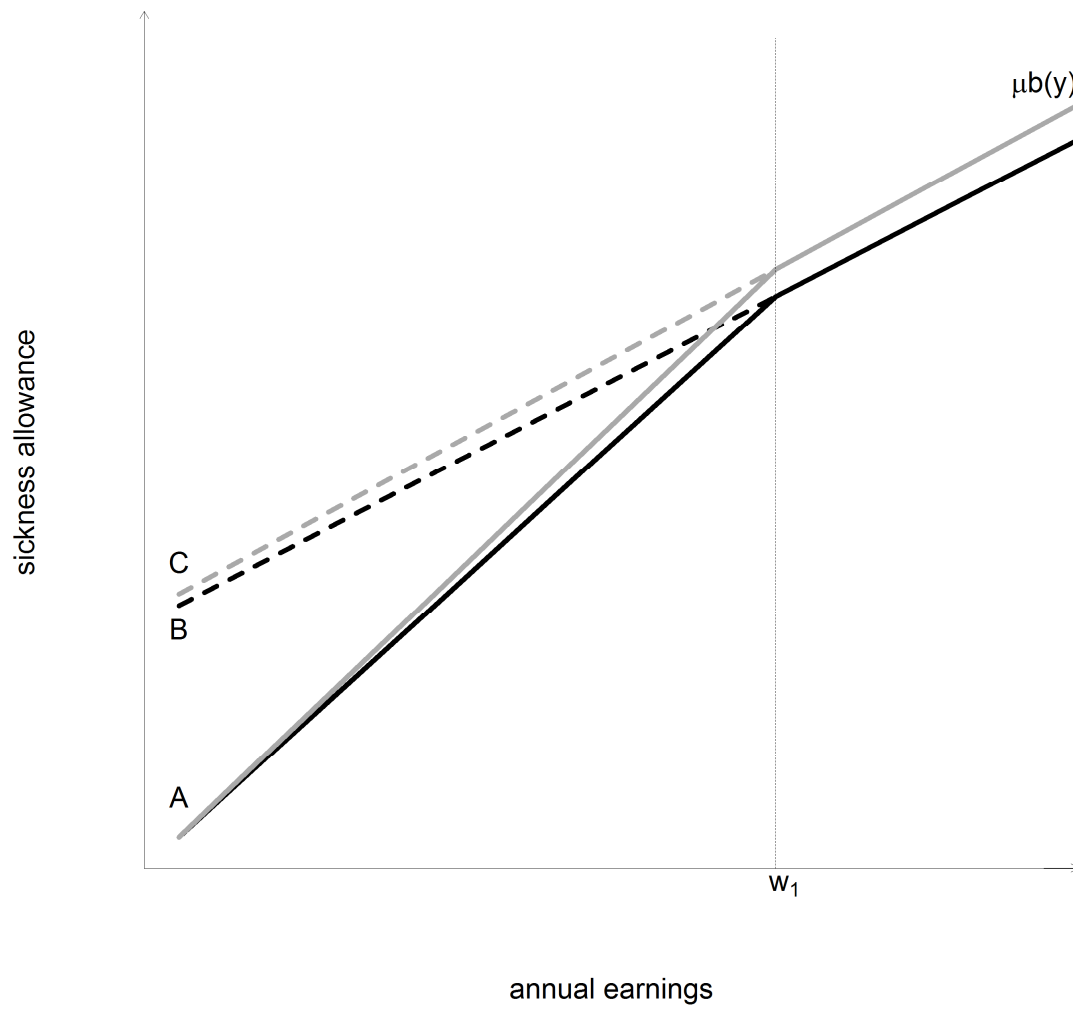
Notes: $b(y)$ is the benefit rule. $\mu = 1.05$.

Figure 7. Optimal consumption replacement rate.
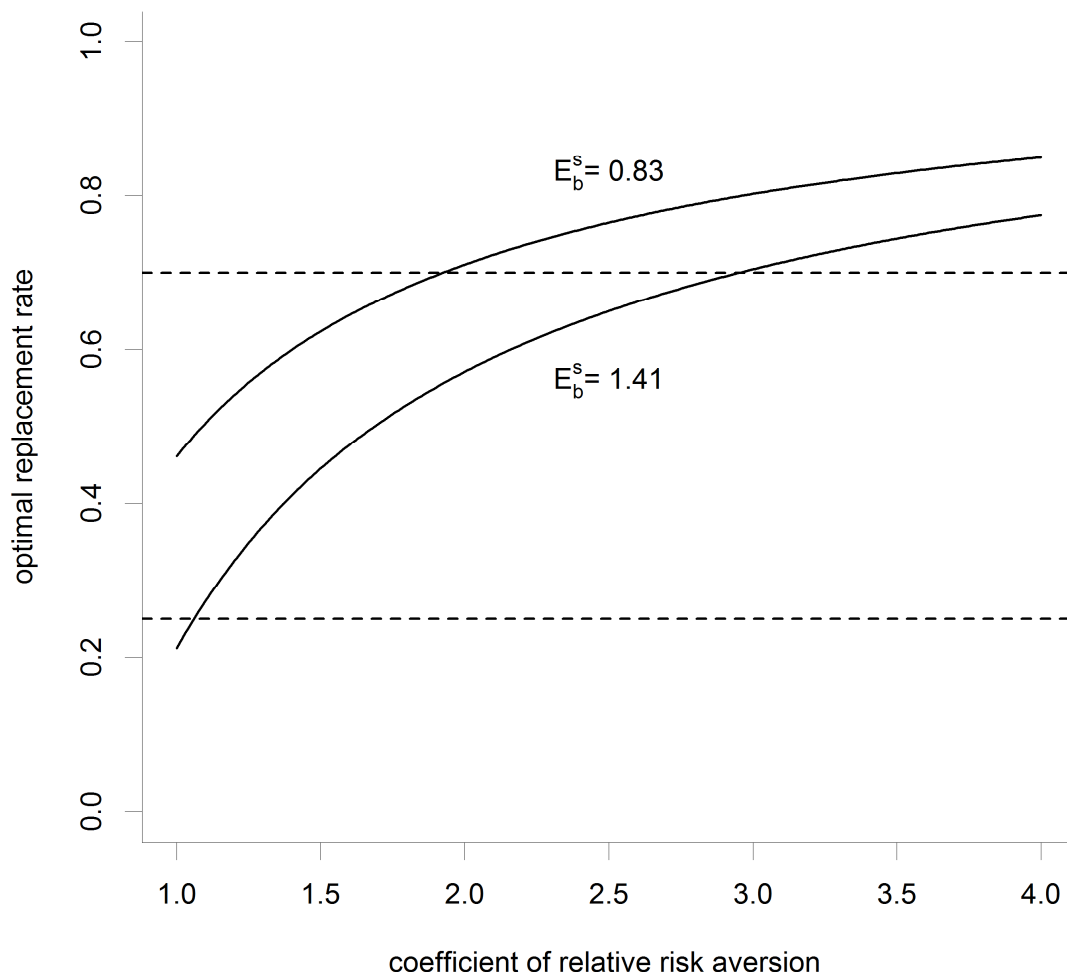
Notes: E_b^s is the elasticity of sickness absence w.r.t. the benefit level. The elasticities used in the calculation are taken from the linear and quadratic FG specifications as presented in Table 2 (columns 1 and 2). The optimal replacement rate is $1 - \frac{\Delta C}{C_w}$ and calculated based on equation (1). The horizontal lines at 0.7 and 0.25 represent the highest and lowest marginal replacement rates in the Finnish sickness insurance system, respectively. The coefficient of relative prudence is assumed to be one plus the Coefficient of Relative Risk Aversion (CoRRA). This is the value implied by the Constant Relative Risk Aversion (CRRA) utility function: $u(c) = \begin{cases} \frac{c^{1-\gamma}}{1-\gamma} & if \ \gamma \neq 1 \\ \log c & if \ \gamma = 1 \end{cases}$. The range of values of CoRRA are taken from Gruber (1997, p. 203).

Appendix 1: Additional figures and tables.

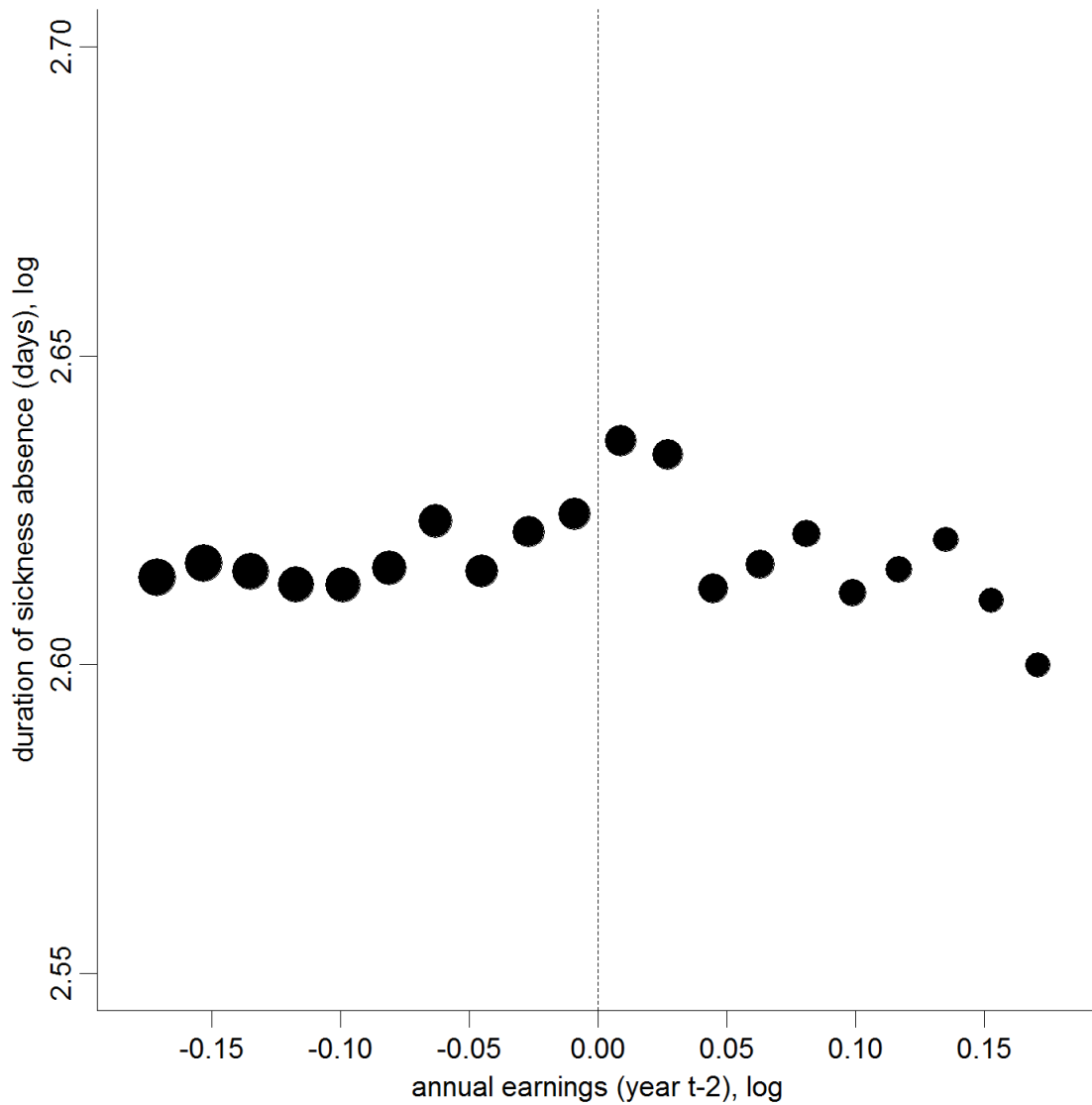Figure A1. Annual earnings and compensation level around the lower kink point in 2012.
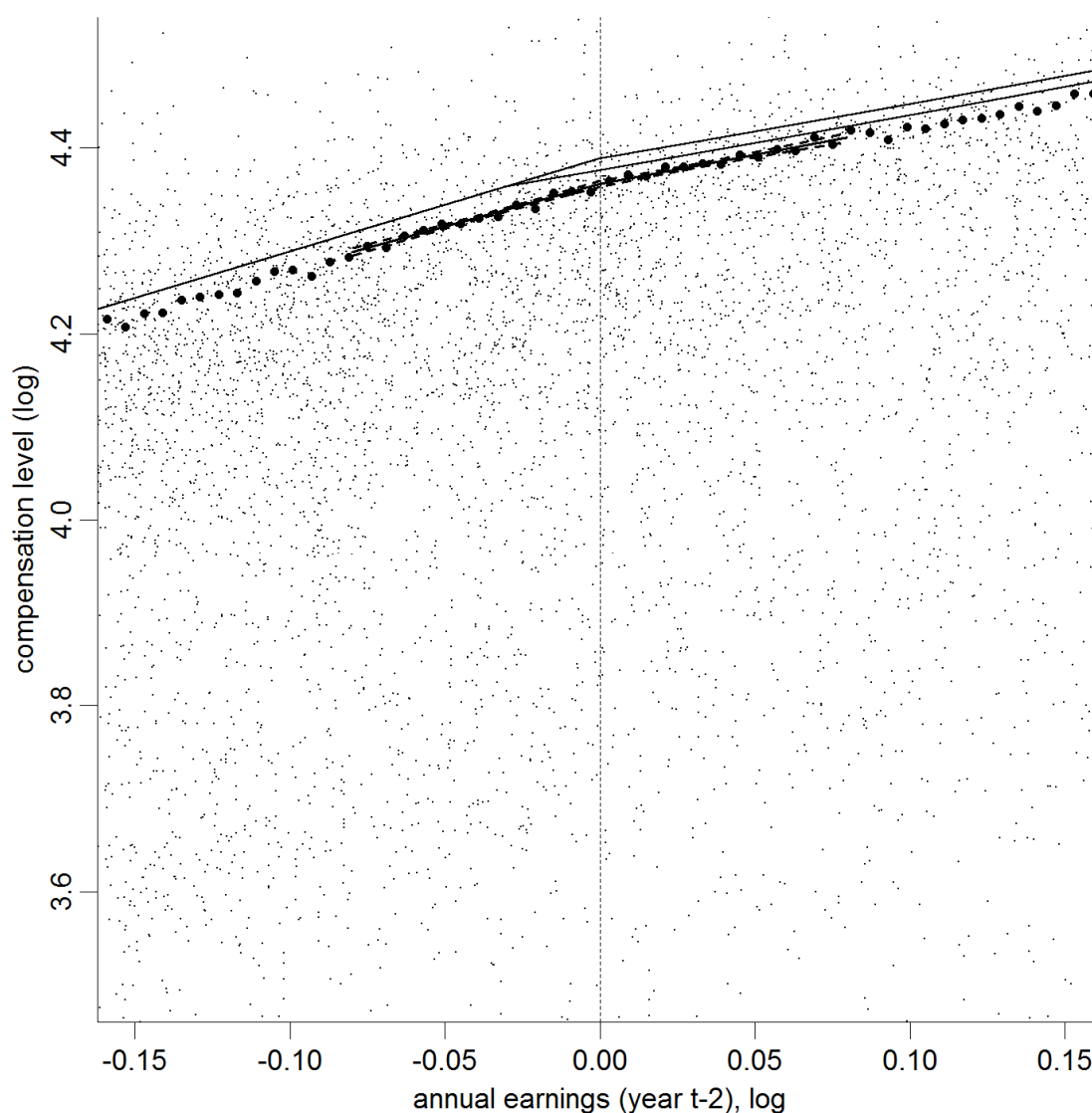
Notes: Earnings are in logs and normalized to zero at the lower kink point. The large dots represent the mean log compensation level in bins of 0.006 log euro. Each small dot represents one observation. The vertical axis has been cut at 4.5 for clarity. The regression fit and 95% confidence interval are shown for the FG bandwidth (0.0796 log euro of annual earnings), which is the main specification bandwidth used in the analysis. The double line that starts right below the lower kink point stems from the fact that some of the benefits in 2012 data follow 2011 replacement rates. This is a source of fuzziness in the data.

Figure A2. Kernel density estimates of the earnings distributions.
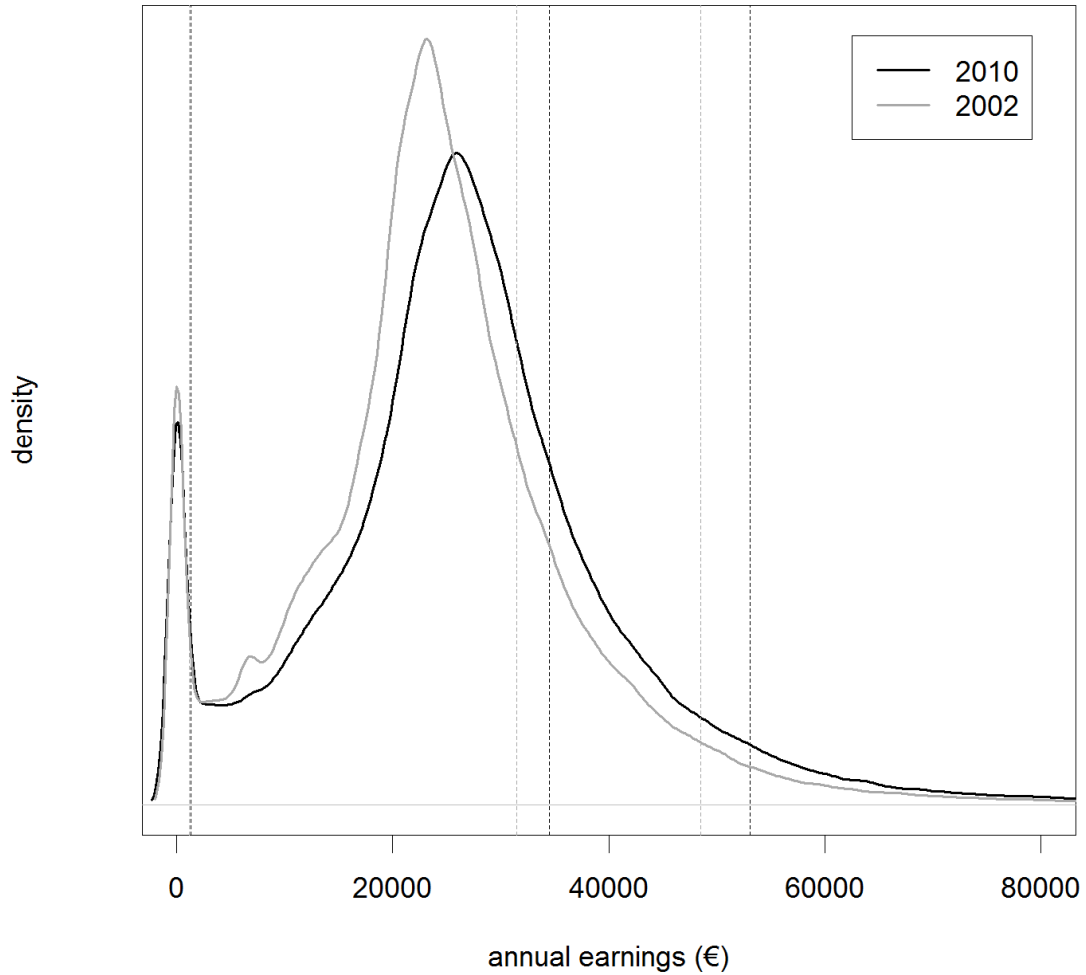
Notes: The vertical dashed lines represent the discontinuity points at 1,211 and 1,325 euro and the kink points at 31,506 and 48,473 euro in dark gray (2002) and 34,496 and 53,072 euro in black (2010). The kernel is Gaussian and the bandwidth is set at 675 and 769 euro, respectively.

Figure A3. Duration of sickness absence (2004–2012) and annual earnings (two years prior) around the lower kink point, with the dot size representing sample size within the bin.
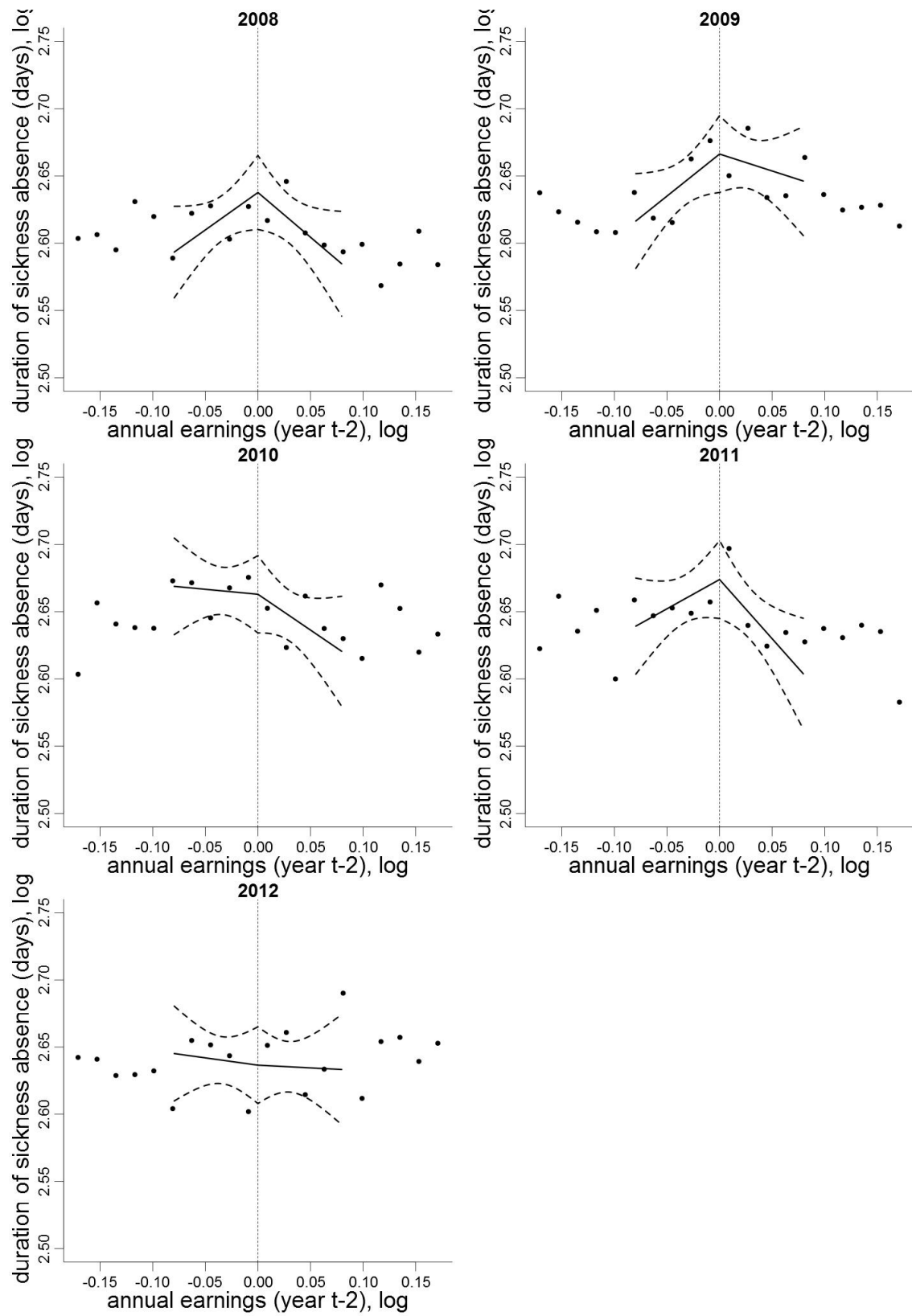

Notes: Annual earnings are deflated to 2012 prices by using the consumer price index. Earnings are in logs and normalized to zero at the lower kink point. The dots represent the mean duration of sickness absence in bins of 0.018 log euro. The dot size represents sample size within the bin, from the highest (57,341) to the lowest (25,194).

Figure A4. Annual earnings and duration of sickness absence around the lower kink point 2004–2007.
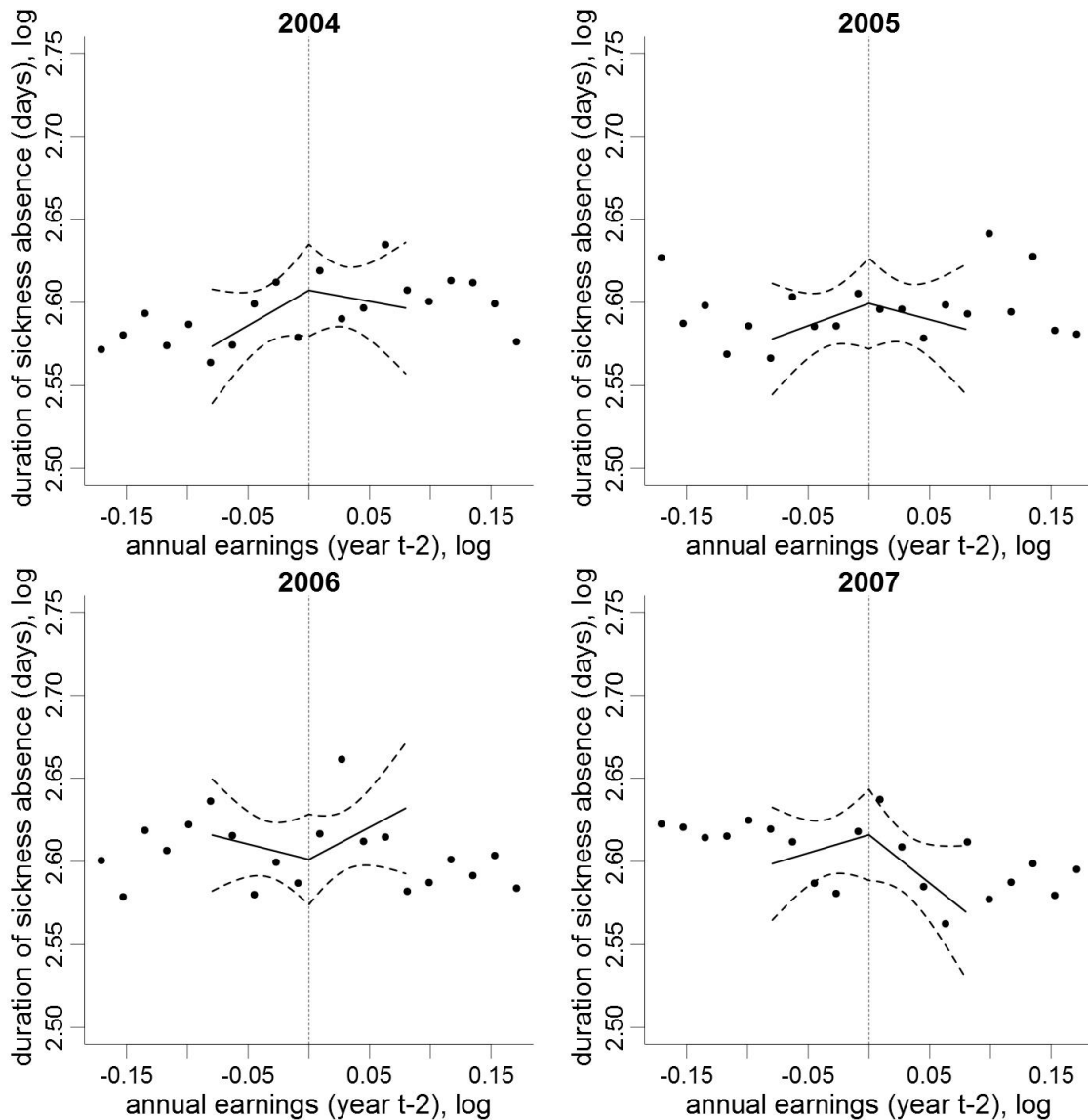
Notes: Annual earnings are deflated to 2012 prices by using the consumer price index. Earnings are also normalized to zero at the lower kink point. The dots represent the mean duration of sickness absence in bins of 0.018 log euro. The regression fit and 95% confidence interval are shown for the FG bandwidth (0.0796 log euro of annual earnings), which is the main specification bandwidth used in the analysis. It should be noted that the bandwidth was optimized for the aggregated data 2004–2012. The yearly estimates were not significant at the 5 % level for 2004–2007.

Figure A5. Annual earnings and duration of sickness absence around the lower kink point 2008–2012.

Notes: Annual earnings are deflated to 2012 prices by using the consumer price index. Earnings are also normalized to zero at the lower kink point. The dots represent the mean duration of sickness absence in bins of 0.018 log euro. The regression fit and 95% confidence interval are shown for the FG bandwidth (0.0796 log euro of annual earnings), which is the main specification bandwidth used in the analysis. It should be noted that the bandwidth was optimized for the aggregated data 2004–2012. The yearly estimates were significant at the 5 % level only for the years 2008 and 2011.

Table A1. Regression estimates with different bandwidths.

	Panel A: Dependent variable: log duration of sickness absence (days)				
	Linear specification				
Bandwidth	FG bandwidth - 0.04	FG bandwidth - 0.02	FG bandwidth	FG bandwidth + 0.02	FG bandwidth + 0.04
Change of slope at kink point (β_1)	-0.129 (0.593)	-0.908*** (0.321)	-0.556*** (0.208)	-0.402*** (0.149)	-0.286*** (0.114)
Slope below kink point (α_1)	0.236 (0.325)	0.451*** (0.174)	0.240** (0.112)	0.238*** (0.079)	0.149*** (0.060)
Yearly fixed effects	Y	Y	Y	Y	Y
Polynomial order	1	1	1	1	1
R^2 (Adj.)	0.0003	0.0003	0.0003	0.0003	0.0002
N	176,215	264,944	354,800	444,304	533,718
	Panel B: Elasticity of the duration of sickness absence with respect to replacement rate				
Change in the replacement rate (γ_1)	-0.346*** (0.061)	-0.377*** (0.033)	-0.394*** (0.021)	-0.390*** (0.015)	-0.402*** (0.012)
Elasticity ($\tau \approx \frac{\beta_1}{\gamma_1}$)	not sig.	2.409	1.411	1.031	0.712
	Panel C: Instrumental variable estimation of the elasticity of the duration of sickness absence with respect to replacement rate				
Estimated elasticity (τ)	0.373 (1.72)	2.408*** (0.886)	1.411*** (0.536)	1.033*** (0.386)	0.712** (0.285)
N	176,215	264,944	354,800	444,304	533,718

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Statistical significance: * p<0.1; ** p<0.05; *** p<0.01. The main specification is marked in light grey. The estimated model is equation (3). The FG bandwidth referring to the "rule-of-thumb" bandwidth described in Fan and Gijbels (1996) is estimated to be 0.0796 for the linear specification. The 95% confidence interval for the IV estimated elasticity with a point estimate of 1.41 is [0.36, 2.46], using the linear specification. The instrument is the interaction term of past earnings and an indicator of earnings above the lower kink point (cf. Table 2).

Table A2. Regression estimates from the main local linear specification, covariates.

Bandwidth	FG bandwidth - 0.04	FG bandwidth - 0.02	FG bandwidth	FG bandwidth + 0.02	FG bandwidth + 0.04
Diagnose M					
Change of slope at kink point (β_1)	0.007 (0.2)	-0.127 (0.108)	0.006 (0.07)	-0.021 (0.05)	-0.040 (0.038)
R^2 (Adj.)	0.0002	0.0003	0.0004	0.0004	0.0005
N	176,215	264,944	354,800	444,304	533,718
Diagnose S					
Change of slope at kink point (β_1)	-0.023 (0.145)	0.051 (0.079)	0.004 (0.051)	0.033 (0.037)	-0.018 (0.028)
R^2 (Adj.)	0.0002	0.0002	0.0002	0.0003	0.0004
N	176,215	264,944	354,800	444,304	533,718
Diagnose F					
Change of slope at kink point (β_1)	-0.050 (0.145)	-0.008 (0.079)	0.045 (0.051)	0.009 (0.036)	0.001 (0.028)
R^2 (Adj.)	0.0004	0.0003	0.0002	0.0002	0.0002
N	176,215	264,944	354,800	444,304	533,718
Diagnose M, S or F					
Change of slope at kink point (β_1)	-0.065 (0.2)	-0.085 (0.109)	0.055 (0.07)	0.021 (0.05)	-0.057 (0.039)
R^2 (Adj.)	0.0005	0.0005	0.0006	0.0005	0.0005
N	176,215	264,944	354,800	444,304	533,718
Age					
Change of slope at kink point (β_1)	3.403 (4.144)	-2.517 (2.262)	0.568 (1.464)	2.117** (1.046)	2.667*** (0.798)
R^2 (Adj.)	0.0008	0.0009	0.0009	0.0011	0.0012
N	176,215	264,944	354,800	444,304	533,718
Female					
Change of slope at kink point (β_1)	0.437** (0.208)	0.494*** (0.113)	0.312*** (0.073)	0.318*** (0.052)	0.353*** (0.04)
R^2 (Adj.)	0.0037	0.0057	0.0085	0.0118	0.0152
N	176,215	264,944	354,800	444,304	533,718
Female (quadratic specification)					
Change of slope at kink point (β_1)	-0.002 (0.829)	0.180 (0.450)	0.638** (0.291)	0.450** (0.207)	0.316** (0.157)
R^2 (Adj.)	0.0037	0.0057	0.0085	0.0118	0.0152
N	176,215	264,944	354,800	444,304	533,718
Highest Degree Tertiary Education					
Change of slope at kink point (β_1)	0.003 (0.151)	0.210** (0.083)	0.134** (0.054)	0.131*** (0.038)	0.152*** (0.029)
R^2 (Adj.)	0.0068	0.0076	0.0080	0.0087	0.0101

|					
N	176,215	264,944	354,800	444,304	533,718
Highest Degree Tertiary Education (quadratic specification)					
Change of slope at kink point (β_1)	-0.156 (0.605)	-0.404 (0.329)	0.062 (0.212)	0.135 (0.151)	0.104 (0.115)
R^2 (Adj.)	0.0068	0.0076	0.0080	0.0087	0.0101
N	176,215	264,944	354,800	444,304	533,718
Lives in Helsinki Metropolitan Area					
Change of slope at kink point (β_1)	-0.083 (0.164)	0.0270 (0.089)	-0.051 (0.058)	0.001 (0.041)	0.031 (0.032)
R^2 (Adj.)	0.0001	0.0004	0.0005	0.0007	0.0010
N	176,215	264,944	354,800	444,304	533,718

Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Statistical significance: * p<0.1; ** p<0.05; *** p<0.01. The estimated model is equation (3). Diagnosis M in ICD-10 refers to diseases of the musculoskeletal system and connective tissue. Diagnosis S refers to injury, poisoning and certain other consequences of external causes. Diagnosis F refers to mental and behavioral disorders. The FG bandwidth referring to the "rule-of-thumb" bandwidth described in Fan and Gijbels (1996) is estimated to be 0.0796.

Table A3. Regression estimates for different subsamples.

	Panel A: Dependent variable: log duration of sickness absence (days)				
Subsample	Females	Males	Left censoring at 20 days	SA criterion: annual earnings year t-2	Observations where the data year matches with the starting year of sickness
Change of slope at kink point (β_1)	-0.110 (0.293)	-0.779*** (0.294)	-0.705*** (0.177)	-0.488** (0.223)	-0.501** (0.227)
Slope below kink point (α_1)	0.077 (0.153)	0.059 (0.162)	0.350*** (0.095)	0.205* (0.120)	0.221* (0.122)
Yearly fixed effects	Y	Y	Y	Y	Y
Polynomial order	1	1	1	1	1
R^2 (Adj.)	0.0001	0.0011	0.0003	0.0003	0.0004
N	170,869	183,931	204,208	306,463	296,907
	Panel B: Elasticity of the duration of sickness absence with respect to replacement rate				
Change in the replacement rate (γ_1)	-0.406*** (0.030)	-0.384*** (0.030)	-0.386*** (0.032)	-0.380*** (0.022)	-0.415** (0.012)
Elasticity ($\tau \approx \frac{\beta_1}{\gamma_1}$)	0.271	2.029	1.826	1.284	1.207
	Panel C: Instrumental variable estimation of the elasticity of the duration of sickness absence with respect to replacement rate				
Estimated elasticity (τ)	0.271 (0.724)	2.032*** (0.790)	1.823*** (0.491)	1.286** (0.595)	1.206** (0.553)
N	170,869	183,931	204,208	306,463	296,907

*Notes: Heteroskedasticity-robust standard errors are reported in parentheses. Statistical significance: * p<0.1; ** p<0.05; *** p<0.01. The bandwidth is the FG bandwidth of the main specification (see Table 2 for more details).*

Figure A6. Left censoring of duration and the corresponding estimated elasticity.
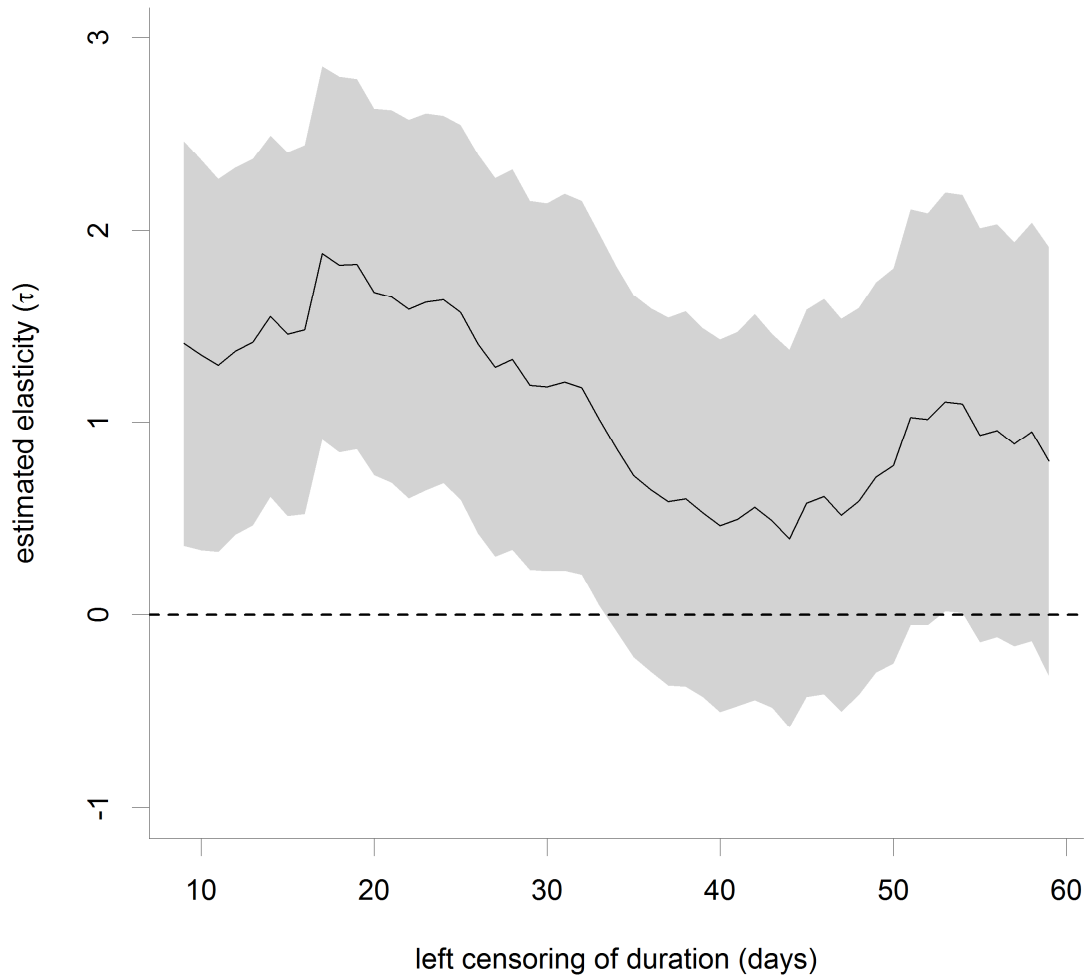
Notes: The graph represents 51 left censored regressions of the duration of sickness spells at 9 (i.e. the main specification in Table 2) to 59 days. Sample size decreases monotonically with censoring, reaching 62,578 at 59 days. The point estimates are depicted in black and 95% confidence intervals in light gray.

Figure A7. Linearity of covariates: initial diagnoses.
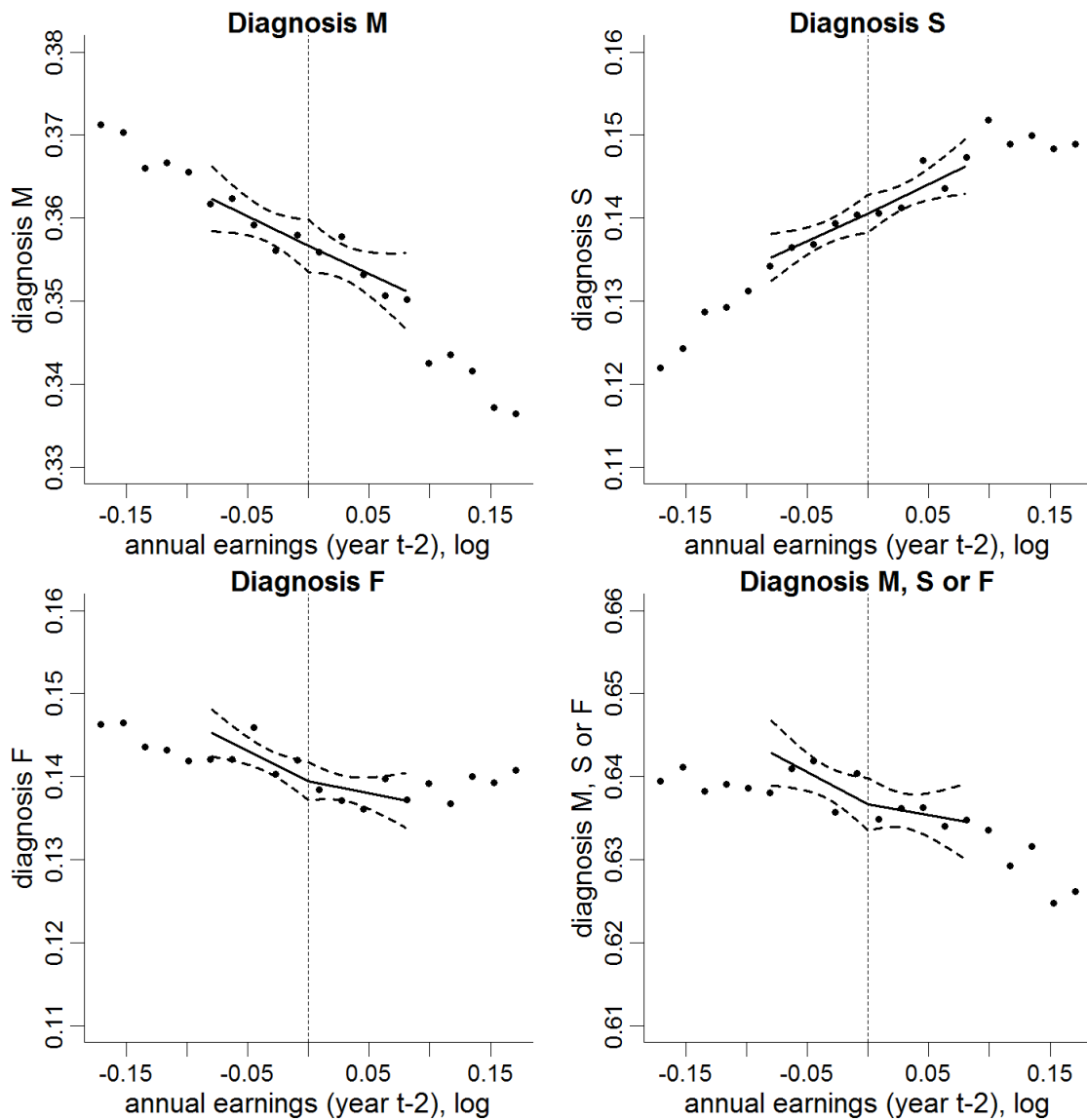
Notes: Annual earnings are deflated to 2012 prices by using the consumer price index. Earnings are in logs and normalized to zero at the lower kink point. The dots represent the mean duration of sickness absence in bins of 0.018 log euro. The regression fit and 95% confidence interval are shown for the FG bandwidth (0.0796 log euro of annual earnings), which is the main specification bandwidth used in the analysis. Diagnosis M in ICD-10 refers to diseases of the musculoskeletal system and connective tissue. Diagnosis S refers to injury, poisoning and certain other consequences of external causes. Diagnosis F refers to mental and behavioral disorders.

Figure A8. Linearity of covariates: age, sex (female indicator), having tertiary education and living in the Helsinki Metropolitan Area.
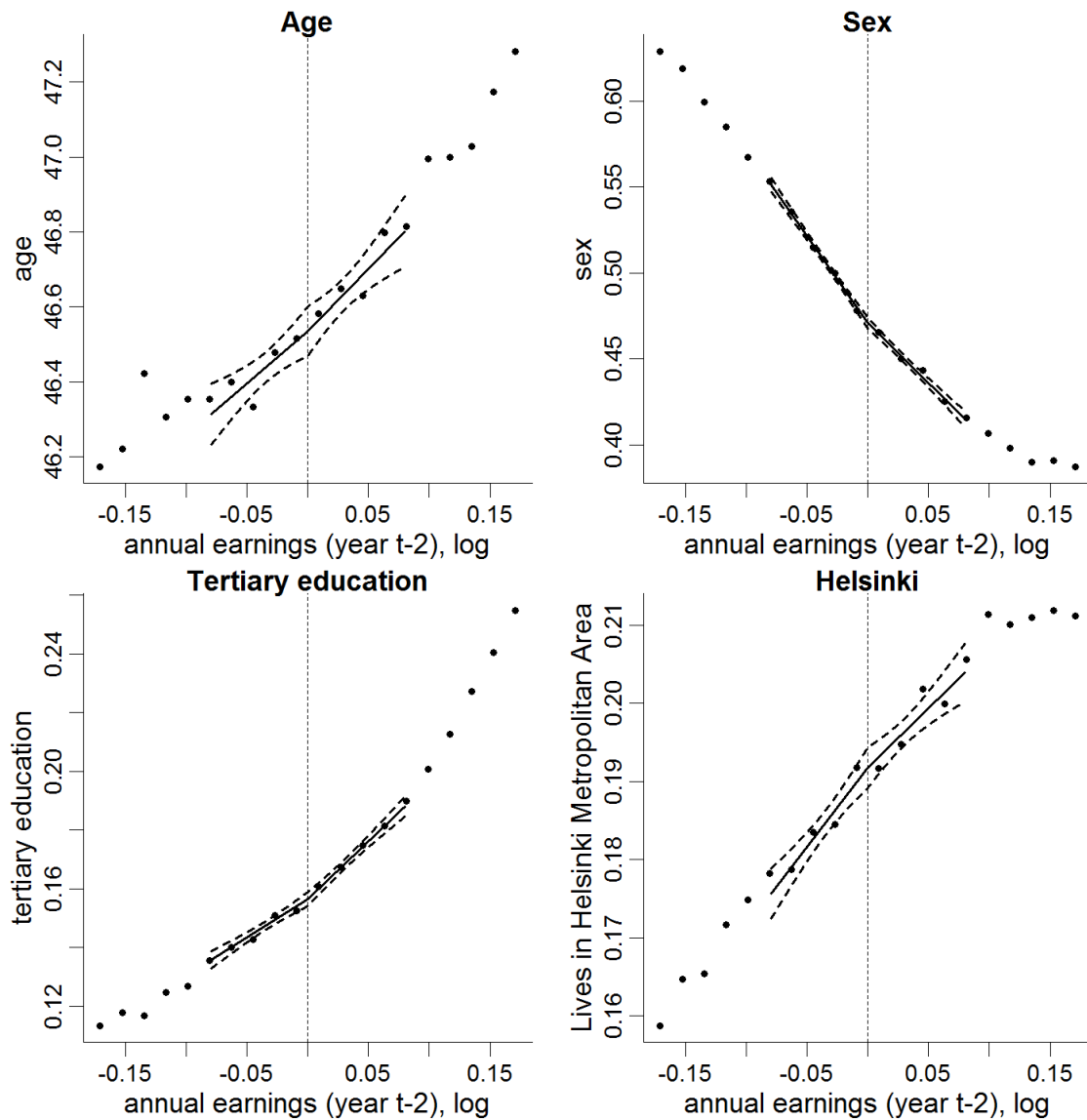

Notes: Annual earnings are deflated to 2012 prices by using the consumer price index. Earnings are in logs and normalized to zero at the lower kink point. The dots represent the mean duration of sickness absence in bins of 0.018 log euro. The regression fit and 95% confidence interval are shown for the FG bandwidth (0.0796 log euro of annual earnings), which is the main specification bandwidth used in the analysis.

Figure A9. Placebo regressions, female indicator.
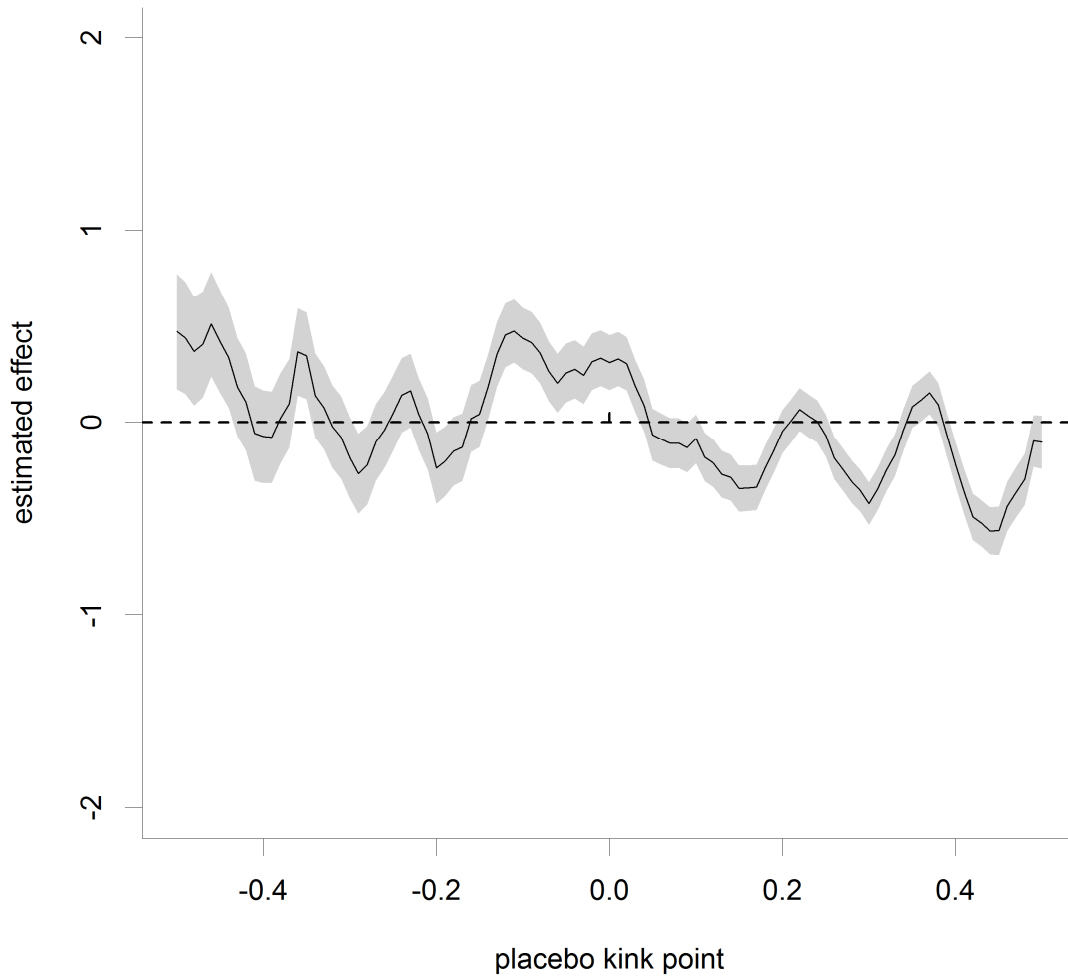
Notes: The graph represents 101 estimates of the kink using the main specification (log sickness absence duration on log earnings), where the lower kink point is assumed to be off the correct location by -0.5 to 0.5 of log earnings at intervals of 0.01 log earnings. The lower kink point is originally normalized to be at 0 of log earnings. The point estimates are depicted in black and 95% confidence intervals in light gray. Of the 94 regressions not around the kink point, 56% are significant at the 5% level.

Figure A10. Placebo regressions, indicator for tertiary education.
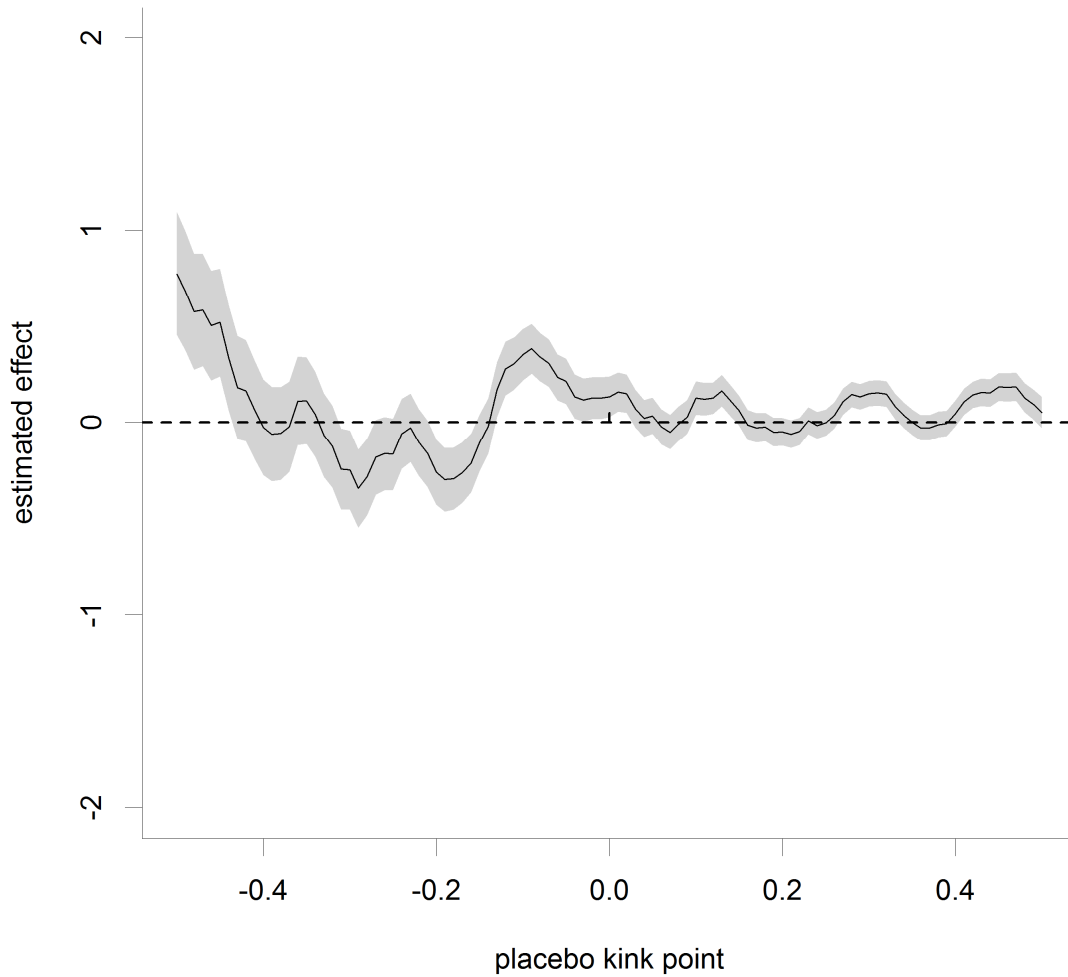
Notes: The graph represents 101 estimates of the kink using the main specification (log sickness absence duration on log earnings), where the lower kink point is assumed to be off the correct location by -0.5 to 0.5 of log earnings at intervals of 0.01 log earnings. The lower kink point is originally normalized to be at 0 of log earnings. The point estimates are depicted in black and 95% confidence intervals in light gray. Of the 94 regressions not around the kink point, 49% are significant at the 5% level.
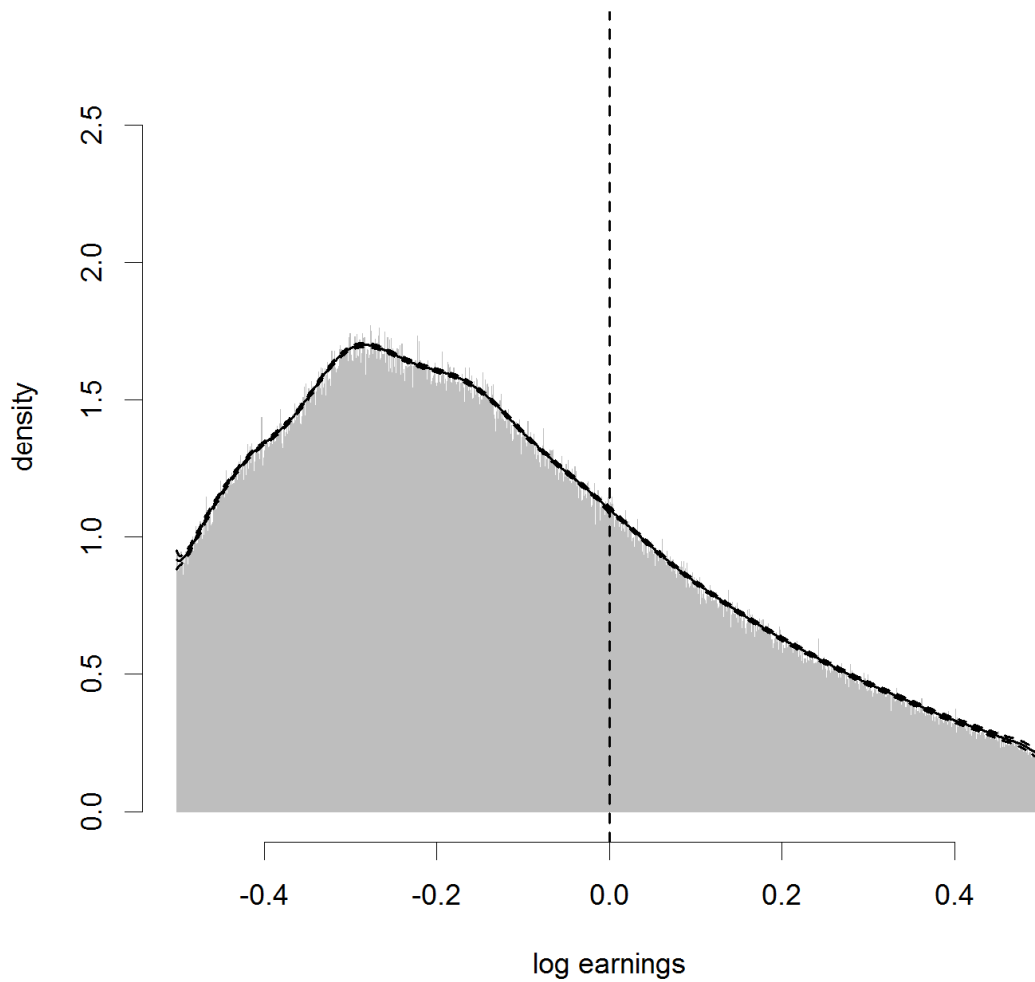
Figure A11. McCrary test for discontinuity of density at the lower kink point.
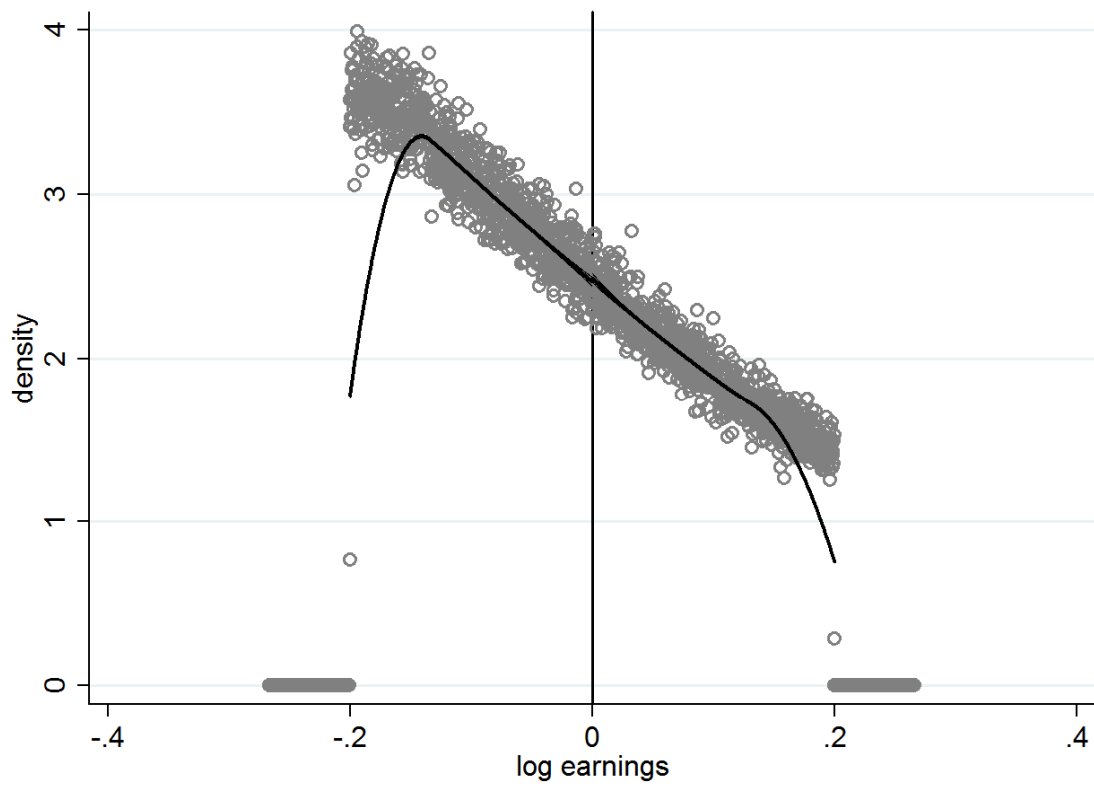
Notes: The McCrary (2008) test for discontinuity of the density function at the kink point shows no discontinuity for log earnings of -0.2 to 0.2 around the lower kink point in bins of 0.00024 and bandwidth of 0.0659.
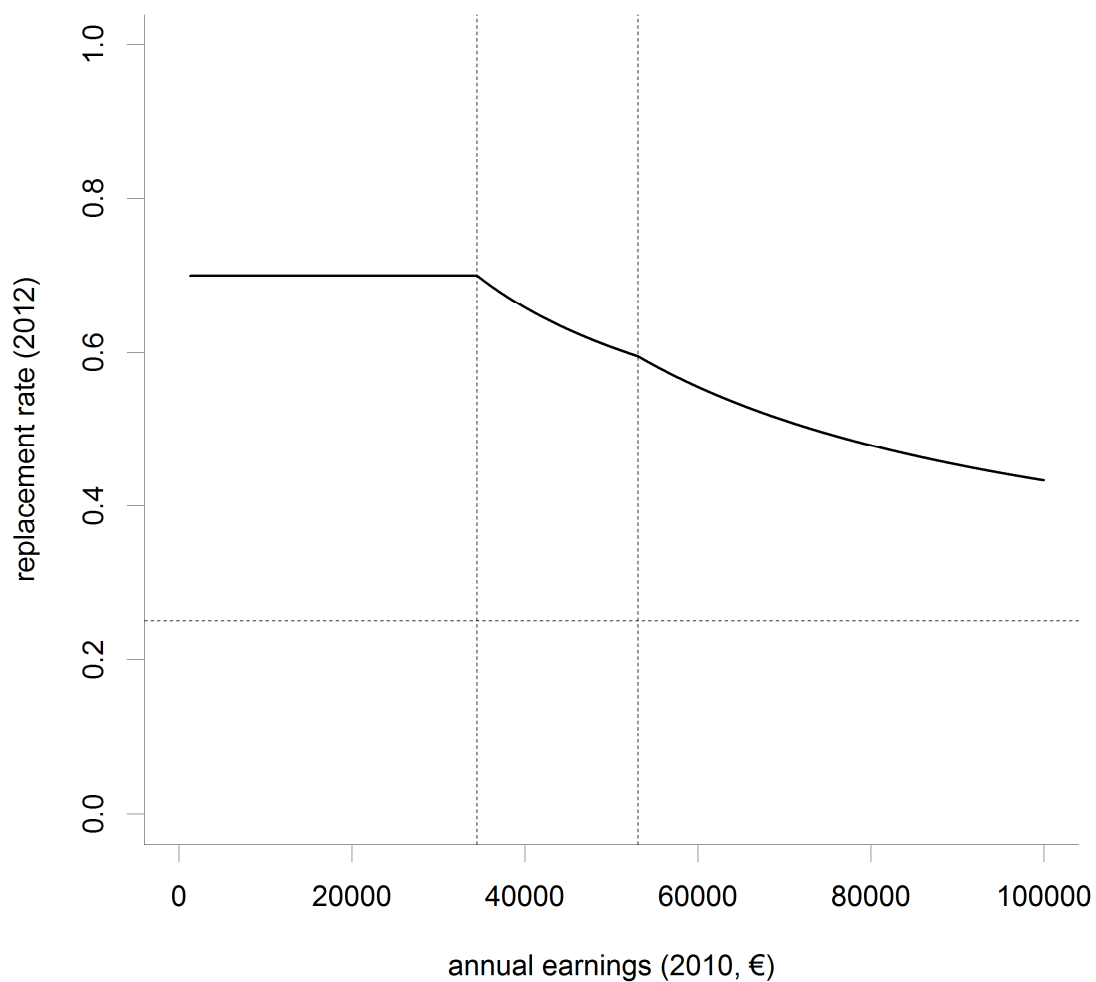
Figure A12. An adapted McCrary test for discontinuity of the slope of the density at the lower kink point.

Notes: *A test for a kink (i.e. a discontinuity in the slope) of the density function at the kink point shows no discontinuity in the slope, adapting the McCrary test for slopes using bins of 0.00024 and bandwidth of 0.0659.*

Figure A13. Replacement rates in 2012.

Notes: The vertical dashed lines represent the lower and upper kink points at 34,496 and 53,072 euro in 2012. The horizontal line represent the highest marginal replacement rate of 0.25.

Appendix 2: The density function by sex.

Consider a mixed density by sex $f(y) = p_m f_m(y) + (1 - p_m) f_f(y)$, and probability

$P_m(y) = P(sex = m \mid y) = p_m f_m(y) \big/ \big(p_m f_m(y) + (1 - p_m) f_f(y) \big)$, then

$p_m f_m(y) = P_m(y) f(y)$.

By differentiation, $D_{(j)} \big(p_m f_m(y) \big) = D_{(j)} P_m(y) f(y) + P_m(y) D_{(j)} f(y), j \in \{+, -\}$. If

$D_{(+)} f(y) \big|_{y_k} = D_{(-)} f(y) \big|_{y_k}$ and $\lim\limits_{y \to y_k^-} f(y) = \lim\limits_{y \to y_k^+} f(y)$ $(p_m > 0)$, then

$D_{(+)} f_m(y) \big|_{y_0} = D_{(-)} f_m(y) \big|_{y_0} \Leftrightarrow D_{(+)} P_m(y) \big|_{y_0} = D_{(-)} P_m(y) \big|_{y_0}$.

Appendix 3: A policy simulation.

In a nonlinear benefit rule those in the higher earnings bracket receive both a lower marginal replacement rate and the fixed benefit created by the nonlinear benefit rule (segment AB in Figure 6). However, this does not correspond to a lump-sum benefit since total benefit depends on the duration of sick leave. In calculating the cost effects of reforming the mandatory sickness insurance by changing the number or locations of the benefit brackets, one should take into account the effect that operates through changes in non-zero fixed benefit created by the nonlinear benefit rule.

$$B = (b_2(w - w_1) + b_1 w_1) 1(w - w_1) + b_1 w_1 1(w_1 - w)$$

On the upper segment, $w > w_1$, agent receives benefit $B_2 D, B_2 = b_2(w - w_1) + b_1 w_1 = b_2 w + (b_1 - b_2)w_1$ with fixed rate benefit $B_0 = (b_1 - b_2)w_1$. The consumption while on sick leave, $C_s = A + BD + w(1 - D)$, and A is the prior level of assets which affects the liquidity constraint. Similarly, the agent pays tax to finance benefits according to a linear schedule $T = tw$, while working. The consumption while working, $C_w = A + w - T$. The above formulae hold in the lower segment, $w \leq w_1$ with $b_2 = b_1$.

A proportional increase in all marginal replacement rates in the benefit system gives $\mu B = (\mu b_2(w - w_1) + \mu b_1 w_1) 1(w - w_1) + \mu b_1 w_1 1(w_1 - w)$, resulting in a proportional increase in the fixed rate benefit on the upper segment (segment AC in Figure 6): $\mu B_2 = (\mu b_2 w + \mu(b_1 - b_2)w_1) 1(w - w_1)$, and $\mu B_1 = \mu b_1 w 1(w_1 - w)$.

References

Aittomäki, A., Martikainen, P., Rahkonena, O. and Lahelma, E. (2014). Household income and health problems during a period of labour-market change and widening income inequalities – a study among the Finnish population between 1987 and 2007. Social Science and Medicine, 100, 84–92.

Angrist, J.D. and Pischke, J.S. (2009). Mostly Harmless Econometrics: An Empiricist's Companion. Princeton University Press, Princeton.

Baily, M.L. (1978). Some aspects of optimal unemployment insurance. Journal of Public Economics, 10, 379–402.

Besley, T. and Case, A. (2000). Unnatural experiments? Estimating the incidence of endogenous policies. Economic Journal, 110, F672–F694.

Calonico, S., Cattaneo, M.D. and Titiunik, R. (2014). Robust nonparametric confidence intervals for regression-discontinuity designs. Econometrica, 82, 2295–2326.

Card, D., Lee, D., Pei, Z. and Weber, A. (2012). Nonlinear policy rules and the identification and estimation of causal effects in a generalized regression kink design. NBER Working Paper No. 18564.

Chetty, R. (2006). A general formula for the optimal level of social insurance. Journal of Public Economics, 90, 1879–1901.

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

Chetty, R. and Saez, E. (2010). Optimal taxation and social insurance with endogenous private insurance. American Economic Journal: Economic Policy, 2, 85–114.

Chetty, R. and Szeidl, A. (2007). Consumption commitments and risk preferences. Quarterly Journal of Economics, 122, 831–877.

De Paola, M., Scoppa, V. and Pupo, V. (2014). Absenteeism in the Italian public sector: The effects of changes in sick leave policy. Journal of Labor Economics, 32, 337–360.

DICE Database (2012). Lost working time due to sickness, 2000-2009. Ifo Institute, Munich, online available at http://www.cesifo-group.de/DICE/fb/3Sb8mxDdU

Eurostat (2011). The European System of integrated Social Protection Statistics (ESSPROS). Methodologies and Working papers.

Fan, J. and Gijbels, I. (1996). Local Polynomial Modelling and Its Applications. Chapman and Hall, London.

Fevang, E., Markussen S. and Røed, K. (2014). The sick pay trap. Journal of Labor Economics, 32, 305–366.

Frick, B. and Malo, M.A. (2008). Labor market institutions and individual absenteeism in the European Union: The relative importance of sickness benefit systems and employment protection legislation. Industrial Relations, 47, 505–529.

Ganong, P. and Jäger, S. (2014). A permutation test and estimation alternatives for the regression kink design. IZA Discussion Paper No. 8282.

Gelman, A. and Imbens, G. (2014). Why high-order polynomials should not be used in regression discontinuity designs. NBER Working Paper No. 20405.

Gimeno, D., Benavides, F.G., Benach, J. and Amick, III B.C. (2004). Distribution of sickness absence in the European Union countries. Occupational and Environmental Medicine, 61, 867–869.

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

Gruber, J. (2000). Disability insurance benefits and labor supply. Journal of Political Economy, 108, 1162–1183.

Henrekson, M. and Persson, M. (2004). The effects on sick leave of changes in the sickness insurance system. Journal of Labor Economics, 22, 87–113.

Imbens, G. W. and Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. Journal of Econometrics, 142, 615–635.

Johansson, P. and Palme, M. (2005). Moral hazard and sickness insurance. Journal of Public Economics, 89, 1879–1890.

Kangas, O., Niemelä, M. and Varjonen, S. (2013). Politics in the making of sickness insurance in Finland. In Haggrén, H., Rainio-Niemi, J. and Vauhkonen, J. (Eds.): Multi-layered Historicity of the Present: Approaches to Social Science History. University of Helsinki, Helsinki, pp. 271–296.

Kivimäki, M., Forma, P., Wikström, J., Halmeenmäki, T., Pentti, J., Elovainio, M., and Vahtera, J. (2004). Sickness absence as a risk marker of future disability pension: the 10-town study. Journal of Epidemiology and Community Health, 58, 710–711.

Landais, C. (2014). Assessing the welfare effects of unemployment benefits using the regression kink design. American Economic Journal: Economic Policy, Forthcoming.

Lee, D.S., and Lemieux, T. (2010). Regression discontinuity designs in economics. Journal of Economic Literature, 48, 281–355.

Lehto, A-M and Sutela, H. (2009). Three Decades of Working Conditions. Findings of Finnish Quality of Work Life Surveys 1977–2008. Statistics Finland, Helsinki.

MaCurdy, T.E. (1981) The empirical model of labor supply in a life-cycle model. Journal of Political Economy, 89, 1059–1085.

McCrary, J. (2008). Manipulation of the running variable in the regression discontinuity design: A density test. Journal of Econometrics, 142, 698–714.

Nielsen, H. S., Sørensen, T. and Taber, C. (2010). Estimating the effect of student aid on college enrollment: Evidence from a government grant policy reform. American Economic Journal: Economic Policy, 2, 185–215.

Pettersson-Lidbom, P. and Skogman Thoursie, P. (2013). Temporary disability insurance and labor supply: Evidence from a natural experiment. Scandinavian Journal of Economics, 115, 485–507.

Puhani, P.A. and Sonderhof, K. (2010). The effects of a sick pay reform on absence and on health-related outcomes. Journal of Health Economics, 29, 285–302.

Treble, J. and Barmby, T. (2011). Worker Absenteeism and Sick Pay. Cambridge University Press, Cambridge.

Sturges, H. (1926). The choice of a class-interval. Journal of the American Statistical Association, 21, 65–66.

Toivonen, L. (2012). Statutory and occupational sickness benefits in Finland in 2011. Kela Online Working Paper No. 34/2012.

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.

The **Aboa Centre for Economics (ACE)** is a joint initiative of the economics departments of the Turku School of Economics at the University of Turku and the School of Business and Economics at Åbo Akademi University. ACE was founded in 1998. The aim of the Centre is to coordinate research and education related to economics.

Contact information: Aboa Centre for Economics, Department of Economics, Rehtorinpellonkatu 3, FI-20500 Turku, Finland.

www.ace-economics.fi