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A Discontinuity Approach with Linked Employer-Employee Data

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The economic incidence of social security contributions

A discontinuity approach with linked employer-employee data

Kai-Uwe Müller*, Michael Neumann‡

May 19, 2016

Abstract

We estimate economic incidence of social security contributions (SSC) on the basis of cross-sectional earnings distributions. The approach exploits discontinuities in earnings distributions at kinks in the budget set which are informative about tax incidence. Contrary to most research on SSC incidence, it does not rely on policy reforms, panel data, or hours information. When the location of kinks does not change significantly, estimates represent equilibrium incidence and are less affected by short-run adjustment frictions than results based on policy reforms. We refine the framework proposed by Alvaredo and Saez (2007), discuss identifying assumptions and related problems in empirical applications. We also suggest parametric and non-parametric estimators. The approach is applied to earnings caps of SSC in Germany where the marginal SSC rate drops to zero. The linked employer-employee data used provide precise measures of gross and net earnings. Utilizing two separate earnings distributions improves identification in the presence of measurement error. We find substantial negative discontinuities at most earnings caps of SSC in the distribution of observed net earnings. Together with smooth gross earnings distributions around the caps this provides consistent empirical evidence that legal and economic incidence of SSC coincide.

Keywords: incidence; social security contributions; discontinuities; linked employer-employee data

JEL classification: H22; J38; H55; J20

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1 Introduction

In many countries payroll taxes or social security contributions (SSC) account for a material part of total taxation. Their average contribution to government funding among OECD countries is similar to personal income taxation (around 9% of total tax revenues, OECD, 2016). With earnings from employment usually being the sole tax base, the potential of SSC to distort efficient allocations on the labor market is large. Who bears the burden of SSC is thus a crucial question for distributional or welfare analysis.

By contrast to income taxation SSC are formally shared between employers and employees. According to standard economic theory legal incidence does not matter for the effective sharing of the tax burden though (invariance of incidence proposition). The SSC burden is primarily borne by employees because labor demand is considered to be more elastic than supply (Fullerton and Metcalf, 2002). More recent empirical research challenges the standard view and finds economic incidence to be identical with formal incidence (Saez et al., 2012). Overall the evidence on the burden-sharing of SSC is inconclusive (Melguizo and Gonzalez-Paramo, 2013). This might be partly explained by the variety of estimation approaches and their underlying assumptions.

The majority of the empirical literature on the economic incidence of SSC relies on longitudinal variation. Most earlier observational regressions lack clean identification, though. More credible approaches exploit exogenous variation generated by policy reforms (Gruber, 1994, 1997; Bennmarker et al., 2009; Saez et al., 2012). Suitable SSC reforms are infrequent, however. Only one policy change occurred, for instance, in Germany which created sufficient institutional variation and provided a setting with a valid control group (Neumann, 2015). Except for Saez et al. (2012) estimates from these studies are based on a difference-in-differences framework. They rely on the common-trends assumption, depict short-term responses and are biased towards zero under optimization frictions. Data restrictions exacerbate these limitations. Should hours of work not be observed – which is common in administrative data sets – behavioral responses (of labor supply and demand) to SSC have to be assumed away to interpret estimates in terms of incidence. Given the incomplete information, this presumption cannot be tested.

In this paper we therefore follow a different approach suggested by Alvaredo and Saez (2007). The alternative framework is based on cross-sectional data and utilizes earnings caps in a given SSC schedule. The discontinuous drop of the marginal SSC rate generates a downward kink in the average tax schedule. Depending on how the SSC burden is shared, a positive or negative discontinuity emerges in the distribution of gross earnings at the cap. Only when statutory equals economic incidence, the gross earnings distribution is smooth around the cap. This can be exploited to estimate economic incidence.

The approach circumvents some of the aforementioned methodological issues. It neither requires exogenous policy reforms nor panel data or information on hours of work. Estimates represent long-term incidence effects as long as earnings caps do not change markedly. Adjustment frictions are thus less of a problem here. The first contribution of this paper is to refine the analytical framework: We elaborate on the identifying assumptions and discuss the empirical implementation using parametric as well as non-parametric estimators.

The second contribution is the application of linked employer-employee data (the German Structure of Earnings Survey, GSES). We argue that looking at distributions of other wage-related measures like net earnings or labor costs in addition to gross earnings densities produces more reliable results. Discontinuity estimates from a single earnings distribution are hard to interpret under measurement error. A small discontinuity might represent a substantial effect or result from noisy data. Besides providing precisely measured gross earnings, the GSES includes the exact amount of SSC paid by employees. We are therefore for the first time able to check whether incidence estimates at earnings caps are consistent across two different empirical densities.[1] This broader body of evidence allows to distinguish between the two competing interpretations.

We find at large small and insignificant discontinuities in empirical gross earnings distributions. Together with substantial negative discontinuities in net earnings this provides consistent empirical evidence that legal and economic incidence of SSC coincide in Germany. We demonstrate that the findings are robust with respect to methodological decisions, different caps and sample periods.

[1] Saez et al. (2012) also observe the exact amount of SSC in their data for Greece. They use a different framework based on a cohort-specific policy reform.

This finding is in line with recent evidence. Saez et al. (2012) evaluate a unique policy reform in Greece where a different SSC regime was implemented for employees who started working from 1993 onwards. They do not find gross earnings of otherwise similar workers, i.e of those who entered the labor market shortly before and after the reference date, to differ systematically. This implies that legal and economic incidence coincide. Skedinger (2014) finds small effects of payroll tax cuts for young Swedish workers. In Finland a similar reform targeted at older low-wage workers did not trigger any wage effects (Huttunen et al., 2013). These results contradict earlier studies for non-European countries which found economic incidence to be entirely with workers (Gruber, 1994, 1997). Our study provides further evidence that employers are hardly able to shift their SSC burden to employees under a more or less centralized wage setting regime as it exists in Germany and other European countries.

The remainder of this paper is organized as follows. Section 2 presents the methodological framework, discusses the underlying assumptions for identification and the empirical implementation of the approach. Section 3 applies the approach to German linked employer-employee data. Section 4 discusses the results in the light of previous findings and concludes.

2 Methodology

In this section we, first, introduce a refined version of the analytical framework developed by Alvaredo and Saez (2007). Second, we spell out the identifying assumptions. Third, we present parametric and non-parametric estimators to implement the discontinuity approach empirically.

2.1 Analytical framework

We start with a narrow framework centered around a general notion of economic incidence captured by a change in the hourly gross wage rate. The model does not describe any incidence mechanisms explicitly. Underlying labor supply and demand elasticities which drive economic incidence in the standard model are, for example, not included. Employees' and employers' taxes besides SSC are also not covered.

The latter does not (qualitatively) affect the analysis as long as additional taxes do not vary systematically around the SSC caps.

Let t denote the symmetric SSC rate which has to be paid by employers (r) and employees (e), i.e. $t = t_r = t_e$. Assume ability or preference for work n to follow a smooth cumulative (marginal) distribution function denoted by $P(n)$ ($p(n)$). For simplicity let realized gross earnings y equal ability, i.e. $y = n$, if either the SSC rate t is zero or legal and economic incidence coincide. Should legal and economic incidence differ, y is distorted such that

$$y = \frac{n}{1 + ts} \tag{1}$$

with s being a homogeneous shifting parameter which is positive (negative) if employers (employees) shift some burden to employees (employers). This framework can be generalized along several dimensions. Instead of using a symmetric SSC rate t, the rates might differ between employers and employees, i.e. $t_r \neq t_e$ (Appendix A.1). Likewise shifting s can be asymmetric between employers and employees (Appendix A.2), or s can be heterogeneous across different employees and employers (Appendix A.3). Finally, a change in the marginal SSC rate might induce behavioral reactions, for instance an adjustment of working hours. This is particularly relevant as underlying labor supply and demand elasticities might drive both behavioral responses as well as economic incidence (Appendix A.4). As shown in Appendix A neither of those extensions eliminates a discontinuity at an earnings cap.

We therefore stick to the parsimonious specification in equation (1) which is not restrictive for SSC institutions in most countries, such as Germany. First, statutory SSC rates for employers and employees are often identical. This holds for the period under observation (1995-2010) in this paper, too. Second, earnings caps apply to employers as well as employees. Separate identification of s_r and s_e with varying SSC rates requires differential variation in employers' and employees' SSC rates. Third, strong labor supply reactions make identification more difficult. Yet, there is no evidence for behavioral adjustments at earnings caps in the literature (Liebman and Saez, 2006; Alvaredo and Saez, 2007; Saez, 2010). Neither does the observed distribution of gross earnings suggest any hours reactions in our application (Appendix A.4).

An earnings cap for SSC at $\bar{y}$ where t drops to 0 yields the following relationships between the distributions of ability and realized earnings $(F(y), f(y))$:

$$F(y) = P(n) = \begin{cases} P(y(1+ts)) & \forall y \leq \bar{y} \\ P(y+\bar{y}ts) & \forall y > \bar{y} \end{cases} \tag{2}$$

$$f(y) = \begin{cases} p(y(1+ts))(1+ts) & \forall y \leq \bar{y} \\ p(y+\bar{y}ts) & \forall y > \bar{y} \end{cases} \tag{3}$$

Considering the left and right limit of the density of realized gross earnings when y approaches $\bar{y}$:

$$f(\bar{y})_- = p(\bar{y}(1+ts))(1+ts) = p(\bar{y}+\bar{y}ts)(1+ts) = p(\bar{n})_-(1+ts) \tag{4}$$

$$f(\bar{y})_+ = p(\bar{y}+\bar{y}ts) = p(\bar{n})_+ \tag{5}$$

As $p(n)$ is assumed to be smooth, there will be some discontinuity in the density $f(y)$ as long as $s \neq 0$, i.e. economic differs from legal incidence. The density drops (jumps), if $s > 0$ ($s < 0$), that is if employers (employees) are able to shift some of their legal burden. Full shifting to employees (employers) implies $s = +(-)1$. The deviation between the actual and a counterfactual density without earnings cap is not uniform over the area above the cap. For a negative (positive) slope the gap diminishes (increases) slowly with the distance to $\bar{y}$ (see Appendix B for details). The size of the discontinuity at the cap is equivalent to the share of the SSC rate shifted (ts) in relative terms to (i.e. in per cent of) the density directly above:

$$\frac{f(\bar{y})_- - f(\bar{y})_+}{f(\bar{y})_+} = ts \tag{6}$$

Therefore s can be expressed as a function of observed measures. To put it more intuitively: Depending on their bargaining power and other factors like wage rigidities, employers or employees will shift some of their SSC burden. This manifests itself in a negotiated wage which is influenced by the average SSC rate. At an earnings cap the previously flat average SSC schedule features a downward kink. From that point the SSC burden decreases relative to earnings. Under constant shifting the wage rate is adjusted to a lesser degree with increasing distance of earnings to the cap. This implies that the gross earnings distribution expands (compresses) to the right of the cap when incidence is rather with employees (employers). A negative (positive) discontinuity emerges at the cap.

In theory analyzing gross earnings densities suffices to determine economic incidence. Discontinuities can be less clear-cut and hard to identify in empirical practice, however. Measurement error or other distorting factors lead to noisy data. Small or insignificant discontinuities, for instance, could be a substantial finding or simply result from such measurement problems. We argue here that the additional investigation of the net earnings and/or labor cost distribution(s) enhances the power of our estimation approach under those circumstances (see the two following sub-sections). Getting consistent estimates from two earnings distributions provides more robust evidence for actual economic incidence. Saez et al. (2012) show this for a different identification strategy.

The behavior of gross earnings around a cap has implications for labor costs (what employers effectively pay, denoted by z) and net earnings (what employees effectively receive, denoted by c). Both quantities are deterministically related to gross earnings:

$$z = \begin{cases} y(1+t) = \frac{n}{1+ts}(1+t) & \forall y \leq \bar{y} \\ y + \bar{y}t = n - \bar{y}ts + \bar{y}t & \forall y > \bar{y} \end{cases} \tag{7}$$

$$c = \begin{cases} y(1-t) = \frac{n}{1-ts}(1-t) & \forall y \leq \bar{y} \\ y - \bar{y}t = n - \bar{y}ts - \bar{y}t & \forall y > \bar{y} \end{cases} \tag{8}$$

It holds that $z = n$ ($c = n$) if $s = 1$ ($s = -1$), that is if the burden is shifted entirely to employees (employers). By similar arguments as above this implies that for $s = 1$ ($s = -1$) the density of labor costs (net earnings) is smooth, whereas the densities of gross earnings and net earnings (labor costs) are discontinuous. Should economic and legal incidence coincide, the gross earnings density is continuous while the density functions of net earnings and labor costs are not.

2.2 Identification

The emergence of a discontinuity in the density of gross earnings (net earnings or labor costs) which is proportional to the drop in the marginal SSC rate at an earnings cap requires a number of conditions to be met. A closer look at those assumptions is helpful to sort out different identification problems when we apply the framework to actual data. Assuming smoothly distributed abilities or preferences for work is a technical requirement. This is not restrictive in applications an will thus not be discussed further.

A first set of assumptions concerns different *shifting mechanisms*. The burden of SSC is shifted at the individual level. An alternative channel of incidence might be shifting to the workforce as a whole. Economic incidence at the aggregate level would invalidate the approach as individual earnings would not be affected by a cap and no discontinuity would emerge. Moreover, labor earnings subject to SSC are the exclusive item in negotiations about the sharing of SSC. The burden of SSC must not be shifted through other margins of employees' compensation (e.g. premia, non-pecuniary benefits, or paid/unpaid overtime). Finally, shifting may be heterogeneous but independent from the earnings level. Should s vary over individuals, the discontinuity at an earnings cap identifies average economic incidence of individuals located around the cap. Allowing for s and earnings to be correlated renders the estimate selective. (Appendix A.3)

A second set of assumptions comprises the (absence of) intervening factors which might distort incidence-induced discontinuities at earnings caps. There are no behavioral reactions in terms of labor supply or labor demand. Any adjustments at those margins would influence the shape of the density around an earnings cap (Appendix A.4) and therefore affect the identification of an incidence-induced discontinuity. Moreover, SSC rates and caps are perfectly salient. If this is not the case, (some) employers and employees might either ignore SSC when bargaining over wages, or perceived rates and earnings caps vary over individuals. In both instances a discontinuity would be blurred or even eliminated. And lastly, there are no optimization frictions. Wages can be adjusted according to SSC liabilities. By definition this also holds for re-negotiations of wages, e.g. after an institutional change in the earnings cap or an employee's promotion which implies a pay increase above an earnings cap. In addition, heterogeneous frictions across the earnings distribution render a discontinuity at an earnings cap and inference on economic incidence derived from it selective.

These assumptions seem very restrictive. However, all microeconometric evidence on economic incidence relies on them. Certain assumptions are less critical for the discontinuity approach where identification does no rely on policy reforms. Take optimization frictions as an example: If internalizing the reduced SSC liability at the cap is costly, it takes only place when benefits exceed those costs. The drop in the average SSC rate slightly above the cap and hence the benefits of a reaction are indeed relatively small. On the other hand, the framework captures long- and not merely short-term effects. Given that earnings caps are salient, wage negotiations – which for example lead to the crossing of the cap – can directly incorporate the drop of the marginal SSC rate. In that sense the discontinuity represents a long-run equilibrium which is hardly affected by optimization frictions in the short-term.

Further arguments can be brought forward in support of certain assumptions. The salience assumption is underpinned by the fact that earnings caps are relevant for employers as well as employees. Employers should be particularly aware of their SSC liabilities when calculating labor costs, even more so when they have several employees with earnings above the cap. Salience is plausible for the German setting where earnings caps have been in existence for a long time and have rarely been changed significantly (sub-section 3.1). The persistence of SSC institutions also facilitates the no-frictions assumption, as SSC liabilities are incorporated into equilibrium wages. Caps are adjusted regularly according to the change in the average gross wage bill in the preceding year. These minor changes might make a complete internalization of legal SSC liabilities impossible but carry minor weight as they go along with the overall shift in the earnings distribution.

2.3 Estimation

It is straightforward to bring this framework to the data: The size of a potential discontinuity has to be determined at the cap of a given earnings distribution. We follow two estimation strategies, a non-parametric sorting test proposed by McCrary (2008) and a parametric approach where a polynomial is fitted to the distribution. The magnitude of the shifting ts is calculated by normalizing the discontinuity estimate by the density directly right of the cap.

In the first step of the McCrary test a histogram is estimated where no bin contains observations below and above a potential discontinuity. Then the density to the left and right of the cap is estimated by local linear regressions to avoid bias at the boundaries. The test statistic consists of the log difference in the prediction slightly left and right of the cap. The procedure is subject to the choice of the bin size for the underlying histogram estimates, the selection of the bandwidth for the local linear smoother as well as the earnings interval underlying estimation.

In an alternative parametric approach we also estimate initially a histogram of the earnings distribution. Then a polynomial of degree nine is fitted to the density values at the center of each histogram bin. The discontinuity is measured by an indicator variable differentiating between bins above and below the cap. We restrict the coefficients to be identical on both sides of the cap to increase the precision of the fit for values close to the cap. This is justifiable since the estimation window is rather small and our specification is flexible enough to fit the slight change of the curvature at the earnings cap:

$$d_j = \sum_{p=1}^{9} \beta_p y_j^p + \delta \mathbb{1}(y_j > \bar{y}) + \epsilon_j \tag{9}$$

Here d_j denotes the height of bin j, y_j are earnings in the middle of bin j, $\mathbb{1}$ is an indicator function, β and δ are parameters, and ϵ is an error term. While the non-parametric test is not subject to functional form assumptions about the earnings distribution, it might be more sensitive to outliers close to the discontinuity. By allocating the same weights to all bins in the estimation window the parametric approach is more robust in that respect. The fact that identification is less dependent on individuals very close to the cap also decreases the diluting effect of optimization frictions (sub-section 2.2). In the basic specification we use an estimation interval of 2000 € which is split into 100 bins on either side of the cap. This implies a bin size of 10 €.

We provide some Monte-Carlo evidence on the performance of these estimators (Appendix B). Gross earnings distributions $f(y)$ are simulated on the basis of equation (3) under the assumption of full shifting of employers' SSC to employees ($s = 1$). Given our assumptions the simulated earnings densities feature a negative discontinuity at $\bar{y}$ in the magnitude of the drop in the marginal SSC rate of roughly 7.6% (Fig. B1 in the Appendix). The McCrary test and the parametric test identify a discontinuity of -7.2% and -7.6%, respectively, which matches the underlying parameters s and t (Fig. B2 in the Appendix). The confidence interval of the McCrary estimate translates to an interval of $(-1.24, -0.64)$ for the shifting parameter s. The corresponding interval for s based on the parametric test is slightly narrower: $(-1.21, -0.79)$.

3 Application to German data

3.1 Institutions

The German social security system consists of pension, unemployment, health, and long-term care insurance. The contribution rates are flat with daily gross earnings as tax base. SSC have formally been shared equally between employees and employers until the end of 2004. Since then a share of 0.9 pp. are paid exclusively by employees.[2] Most SSC rates have been quite constant. The total SSC rate varied around 40% with pension (around 20%) and health insurance (around 14%) as the most important branches (Fig. C1 in the Appendix). Marginal SSC rates only apply up to earnings caps. There is one threshold for pension and unemployment insurance, another one for health and long-term care insurance. For the sake of readability we do not separately refer to unemployment and long-term care insurance throughout the paper. Both caps differed between East and West Germany until 2001 when the health insurance cap in East Germany was adjusted to the level of West Germany (Fig. C2 in the Appendix).

SSC rates as well as earnings caps are subject to yearly gradual changes which are difficult to exploit for the identification of economic incidence. Considerable discontinuous changes are rare with the strong increases of the earnings cap of health insurance in East Germany in 2001 and pension insurance in 2003 as notable exceptions. While the former is evaluated by Neumann (2015), the latter is difficult to analyze because suitable German panel data is right-censored at the pension earnings cap. The cross-sectional approach outlined above does not rely on policy reforms and panel data. We are therefore able to draw on uncensored earnings data here. The caps are at different positions in the respective earnings distributions. The threshold for health insurance in West Germany is around the 75th quantile and by far the lowest (Tab. 1). The health cap in East Germany and the pension cap in West Germany come in second at around the 90th quantile. The pension cap in East Germany is up high in the earnings distribution above the 95th quantile.

One peculiarity of the German social security system which could affect our empirical analysis is the possibility to substitute public for private health insurance.

[2] This share increases by 0.25 pp. for childless employees.

Tab. 1: Quantiles of earnings caps

Wave	West Germany		East Germany	
	Pension / Unemployment	Health / Long-term care	Pension / Unemployment	Health / Long-term care
1995	.91	.76	.97	.89
2001	.90	.76	.96	.93
2006	.92	.75	.96	.91
2010	.90	.72	.95	.89

Source: GSES 1995, 2001, 2006, 2010; own calculations.

Eligibility for private health insurance depends on exceeding the income threshold for compulsory insurance (called *Versicherungspflichtgrenze*), except for the self-employed and civil servants who are excluded here. This threshold had been equal to the earnings cap of health insurance until both caps were decoupled in 2003. Since then the threshold for compulsory insurance lies between the earnings caps of health/care and pension/unemployment insurance. The employees' share of SSC does not depend on earnings but on personal characteristics under private insurance. Employers have to pay half of private contributions but only up to the maximum value of employers' SSC under public insurance.

Private health insurance interferes with our analysis of gross earnings when it affects the change in the marginal SSC rate at the analyzed earnings cap. This is only the case for the earnings cap of health insurance before 2003.[3] Being slightly below or above this earnings cap might change the insurance system applicable to the employee. Although we do not observe whether an employee is privately health insured, it is not obvious how severely this distorts a potential discontinuity at that cap. First, the cap for employers' SSC is in most cases identical under public and private insurance. Their incentives below vs. above the threshold are comparable as long as private is at least as expensive as public health insurance which normally holds (Neumann, 2015). Second, the switch to private health insurance usually occurs earliest in the first year after earnings increased above the threshold. A large fraction of employees with earnings very closely above the earnings cap, i.e. a large fraction of our estimation sample, are still publicly health insured in a given year.

[3]As contributions to private health insurance are included in the GSES' measure of employees' SSC, the impact on the analysis of observed net earnings is more severe. See sub-section 3.2 for a detailed discussion.

3.2 Data

We use the German Structure of Earnings Survey (GSES, *Verdienststrukturerhebung*) which consists of repeated cross-sections. The information is provided by employers and is part of the official labor cost statistics of the German Statistical Office. Firms are therefore obliged to cooperate and provide the information.

Measurement error

Similar to the literature on behavioral responses at kinks or notches of tax schedules (Kleven et al., 2011; Kleven and Waseem, 2013), identifying a discontinuity at an earnings cap is demanding in terms of data quality. In order to identify the precise location of the cap at $\bar{y}$, the exact amount of labor earnings subject to SSC has to be observed. Measurement errors in data on gross earnings y could arise as a result of imprecisely/erroneously reported information. Let ϵ_i be a random disturbance term for individual i, the observed gross earnings are $y_i^{obs} = y_i + \epsilon_i$. As we do not observe ϵ_i, the assumed location of the earnings cap is $\bar{y} - \epsilon_i$ which varies across individuals in an unknown way. As a result, a discontinuity estimate might be biased towards zero. This type of distortion is purely a data problem and independent of the identifying assumptions. The influence of ϵ_i is a function of the sample and decreases with the number of observations. It also depends on the data collection and is more problematic in self-reported earnings data.

Reliability of individual earnings information is better in administrative data like the GSES. Therefore measurement error arguably is not a big issue (although we cannot determine its magnitude) as documented in other applications (Fitzenberger et al., 2013; Antonczyk et al., 2010). We primarily use monthly earnings information that refers to the month of October. As the GSES separately includes all earnings components which are subject to SSC (like regular earnings and compensation for overtime hours) as well as some of those which are not (like tax-free premia for shift work, working on Saturdays/Sundays/holidays, or night employment), locating the earnings caps is neither an issue.

Multiple earnings measures

As argued multiple earnings measures are helpful in empirical applications with non-systematic measurement error. Using incidence estimates from different earnings distributions generates a more robust empirical foundation to draw policy conclusions. Consider the following example. The gross earnings distribution is found to be smooth around the cap. This could be explained by no shifting or measurement error. According to the first explanation the distributions of labor costs or net earnings should feature a discontinuity consistent with the drop of the marginal SSC rate. Under the alternative scenario of measurement error all three distributions would be found smooth around the cap. The results would be inconclusive as far as incidence is concerned.

To our knowledge this is the first paper using a discontinuity approach on SSC incidence that exploits separate measures of gross earnings and actually paid employees' SSC. The latter include an employee's contributions (also voluntary) to social insurance (i.e. the employee's share of contributions to the pension, unemployment, health and care insurance). This also entails contributions to private health insurance as well as occupational insurance schemes. Together with information on gross earnings y we can calculate actual individual net earnings c. There is no independent information on employers' SSC. Labor costs z are thus not considered separately here.

Explicit information on participation in public or private health insurance is not available. Identification of discontinuities in the distribution of net earnings could thus be affected: A privately health insured employee i with earnings between the health and pension earnings caps, i.e. $\bar{y}^h < y_i \leq \bar{y}^p$, has *observed* net earnings $c_{i,obs} = y_i - ssc_{i,obs} = y(1 - t_e^p) - ssc^h_{i,private}$. The location of the earnings cap in the net earnings distribution is $\bar{c}^h_i = \bar{y}(1 - t^p_e) - ssc^h_{i,private}$. However, as we do not observe, whether an employee is privately health insured, we approximate $\bar{c}^h_i$ by assuming public health insurance: $\hat{\bar{c}}^h = \bar{y}(1 - t^p_e) - t^h_e \bar{y}^h$. This might attenuate a potential discontinuity. The threshold for compulsory public insurance exceeds the earnings cap of health insurance since 2003, though (see section 3.2). The estimates based on the health insurance cap in 2006 and 2010 are therefore not distorted by private health insurance.

Sample

We use all four waves of data currently available to us, i.e. data for the years 1995, 2001, 2006, and 2010. For the wave 1995 more than 700,000 observations are available, about 640,000 for the wave 2001, more than 1.2 million for 2006, and more than 1 million employees for the wave 2010. We analyze the caps for *health/long-term care* and *pension/unemployment* insurance $\bar{y}^h, \bar{y}^p$. In order to increase the power of the estimation East and West Germany are pooled throughout the analysis. Waves are either analyzed pooled or separately. There is variation in caps $\bar{y}_{rt}$ over time t and by region r (i.e. between West and East Germany). We, therefore, index individual earnings y_{irt} in the following simple way: $y^{ind}_{irt} = y_{irt} - \bar{y}_{rt}$. The resulting y^{ind}_{irt} is measured in deviations from the threshold which allows us to pool data for different r and t. The indexation of net earnings c at the cap is a little more intricate since the SSC rates applied change due to the health insurance earnings cap $\bar{y}^h$.

We exclude civil servants and self-employed as they do not contribute to the general SSC scheme. Home workers are also not included in the sample. We also exclude part time and marginally employed persons to limit behavioral adjustments. The majority of these employees has earnings below the caps, anyway. Small firms (below ten employees) are exempted from the GSES because of the administrative burden. Few branches are also missing for certain waves. Neither of those omissions is systematically related to SSC and earnings caps and affecting our estimates.

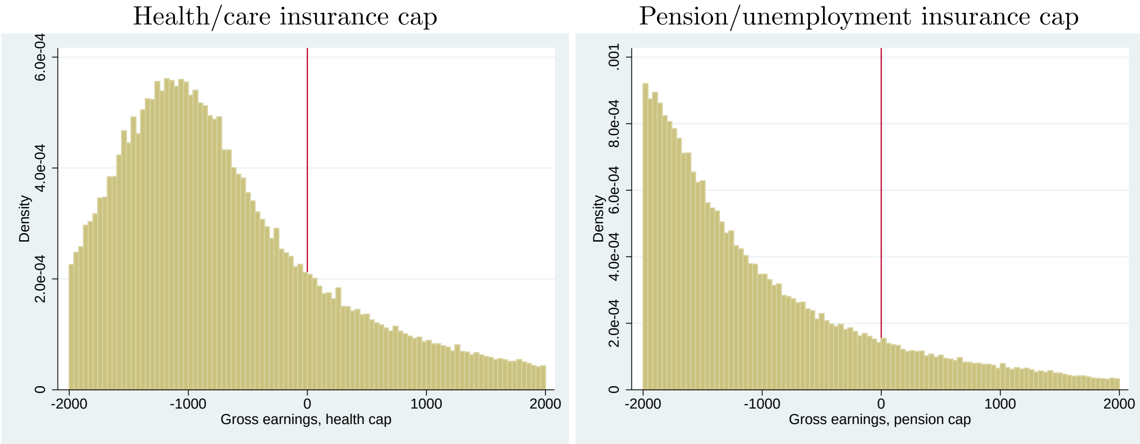
3.3 Empirical results

We first present results for the empirical gross earnings distribution. Results from gross earnings are in principle conclusive in terms of incidence. Yet, these estimates might be distorted by a number of factors as discussed above. The subsequent analysis of observed net earnings allows for plausibility and robustness checks.

Gross earnings

There is no clear-cut discontinuity in histograms of the monthly gross earnings distribution at the pension or the health cap based on pooled data for all years (Fig. 1). Although being indexed at earnings caps and based on a sizeable data set, the histograms are not completely smooth. There are some minor spikes at various points of the distribution. One of those visible spikes is located directly above the pension insurance cap. To a lesser degree this is also true for the health insurance cap which becomes more visible in histograms for single waves (Fig. C3 in the Appendix).

Fig. 1: Distribution of monthly gross earnings, all years pooled



Source: GSES 1995, 2001, 2006, 2010; own calculations.

The majority of those spikes can be explained by round number bunching as documented exemplarily in the non-normalized earnings distribution for West Germany in 2006 (Fig. C4 in the Appendix). In similar fashion it is conceivable that contracted earnings are oriented towards prominent numbers like an earnings threshold. In addition, in some years the earnings threshold was a round number. We therefore exclude individuals with $y \in [\bar{y}, \bar{y} + 10]$ from the estimation of discontinuities, in order to avoid bias driven by non-substantive factors, i.e. things not related to economic incentives. We adjust each histogram for the missing observations by moving the remaining distribution to the left to close the gap in the density.

Applying the non-/parametric estimators to the pooled sample we find very small negative and statistically insignificant discontinuities at both earnings caps (Tab. 2, Fig. 2). We get the smallest and largest point estimates for the pension cap: $-.007$ with the parametric approach and $-.015$ with the non-parametric approach. In the pooled sample the average drop in the marginal SSC rate amounts to 8.1 pp. at the health and about 12.4 pp. at the pension insurance earnings cap for employees and employers, respectively (Tab. 2). The shifting parameters implied by the discontinuity estimates, therefore, range between $s = -0.06$ for the pension cap to $s = -.17$ for the health cap. Both are estimated parametrically.

Tab. 2: Discontinuity estimates – gross earnings

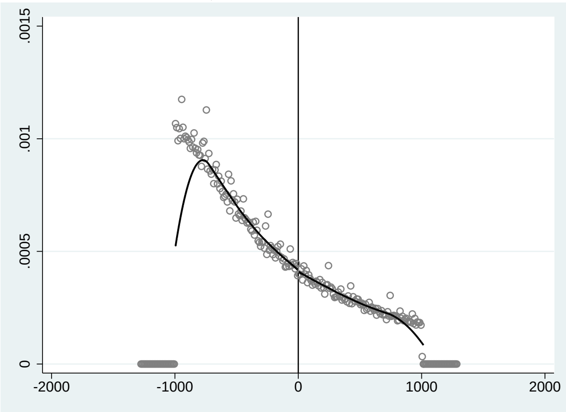
	Pension/unemployment cap					Health/care cap				
	Δt	McCrary		Polynomials		Δt	McCrary		Polynomials	
		p.e.	t	p.e.	t		p.e.	t	p.e.	t
Pooled sample	-.124	-.015	-1.42	-.007	-.54	-.081	-.009	-1.16	-.014	-1.95
Single waves										
1995	-.126	.026	1.24	.026	1.1	-.071	.007	.46	-.005	-.35
2001	-.128	-.026	-1.18	-.044	-1.83	-.076	-.043	-2.92	-.066	-3.09
2006	-.130	.012	.59	.037	1.66	-.084	-.023	-2.11	-.016	-1.22
2010	-.114	-.053	-2.92	-.072	-2.48	-.088	.001	.1	-.001	-.07

Notes: Δt – average drop in marginal SSC rate, p.e. – point estimate, t – t-value (α=0.05).
Source: GSES 1995, 2001, 2006, 2010; own calculations.

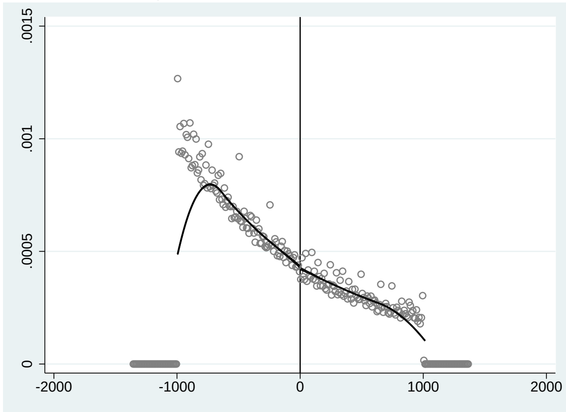
Fig. 2: Discontinuity tests, monthly gross earnings, all years pooled

McCrary test

Health/care insurance cap

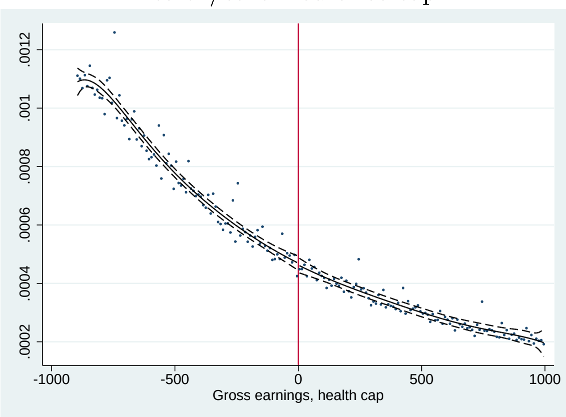


Pension/unemployment insurance cap

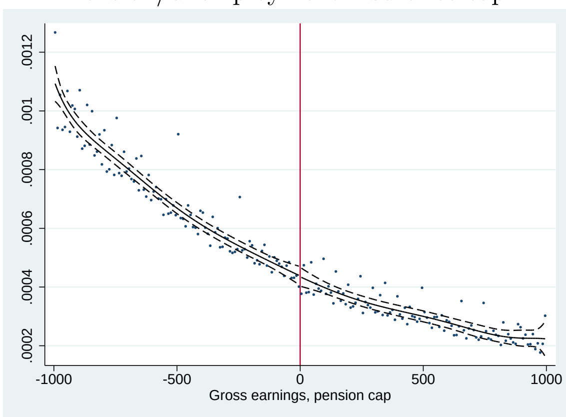


Parametric test

Health/care insurance cap



Pension/unemployment insurance cap



Source: GSES 1995, 2001, 2006, 2010; own calculations.

The fact that point estimates are not significantly different from zero implies that there is no evidence that either employers or employees shift (some of) their SSC burden. It is nevertheless instructive to look at the confidence intervals for s to see the maximum amount of shifting supported by these estimates. The left (right) limit of the confidence interval for the discontinuities at the pension cap translates to $s = -0.15$ ($s = 0.26$). It includes thus scenarios where incidence is slightly more on either employers or employees. At the limits employees (employers) are able to shift 15% (26%) of their formal SSC burden. The confidence interval for the discontinuity estimate at the health cap implies an s between 0 and .35, i.e. economic is identical to statutory incidence or slightly more on employees. Employers shift at maximum 35% of their SSC burden to employees. Accordingly, substantial burden shifting can be rejected, even for the most distinct estimates. Formal and economic incidence of SSC to pension and health insurance (almost) coincide.

This is also supported by the estimates for the separate waves which by the majority turn out to be insignificant. Notable exemptions are significantly negative discontinuities for the pension cap in 2010 as well as the health cap in 2001 and (for the non-parametric approach) in 2006 (Tab. 2). It would, however, be highly doubtful to interpret these estimates as substantive findings. Noise in the subsamples of single waves is notably higher as illustrated by more spiky histograms (Fig. C3 in the Appendix).

We conduct a number of sensitivity analyses related to choices made in the estimation. First, we vary the amount of bins: the estimation interval of 2000 €/month is split into between 10 and 1000 bins on either side of the cap. The baseline estimates are based on 100 bins implying a bin size of 10 €/month. Second, we vary the estimation interval between 1000 and 4000 €/month holding the amount of bins at the level of the baseline specification. At last, we double the interval of earnings above the caps which is excluded from the estimation. None of the alternative discontinuity estimates are qualitatively different from the baseline specification (Tab. 3). The small and insignificant estimates are very robust in terms of estimation decisions comfirming the result that statutory equals economic incidence.

Net earnings

Under measurement error the largely insignificant discontinuities for gross earnings might (in part) be resulting from a lack of identification at earnings caps and not represent actual incidence. Separate estimates based on distributions of gross and net earnings (or labor costs) provide a broader foundation for conclusions about

Tab. 3: Discontinuity estimates – gross earnings, sensitivity

	Pension/unemployment cap				**Health/care cap**			
	McCrary		**Polynomials**		**McCrary**		**Polynomials**	
	p.e.	t	p.e.	t	p.e.	t	p.e.	t
Baseline	-.015	-1.42	-.007	-.54	-.009	-1.16	-.014	-1.95
Number of bins								
10	.004	.32	.010	.64	-.004	-.45	-.019	-2.23
50	-.008	-.73	-.008	-.61	-.011	-1.48	-.015	-2.07
1000	-.013	-1.39	.004	.32	-.008	-1.36	-.013	-1.83
Estimation interval								
1000	-.010	-.59	.017	.92	-.006	-.55	.010	.96
3000	-.017	-1.77	-.009	-.94	-.011	-1.66	-.019	-3.09
4000	-.015	-1.79	-.001	-.10	-.008	-1.31	0.00	0.00
Excluded interval								
20	-.009	-.89	.002	.16	-.012	-1.62	-.018	-2.28

Notes: p.e. – point estimate, t – t-value (α=0.05).; robustness tested given the baseline parameter; baseline specification with 100 bins and estimation interval of 2000.
Source: GSES 1995, 2001, 2006, 2010; own calculations.

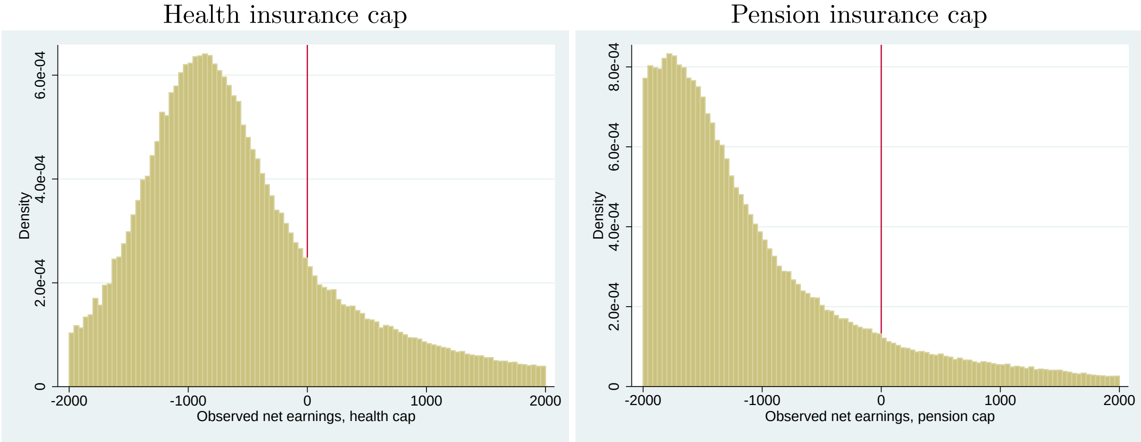
economic incidence. The difference in the size of discontinuities across distributions is proportional to the drop in the SSC rate. Should s in fact be (close to) zero resulting in no (a small) discontinuity in gross earnings, a sizeable discontinuity would emerge in net earnings. In our case its magnitude would equal (be close to) the drop in marginal rates of $-.124$ for the pension and $-.081$ for the health cap which should be identifiable empirically. When, on the other hand, the small and insignificant discontinuities in gross earnings are driven by noisy data and imprecise estimates, we would expect to get insignificant results for net earnings as well.

A major advantage of the GSES is that actually paid employees' SSC are available. Note that using this information is different from calculating net earnings (labor costs) mechanically from observed gross earnings. The main systematic difference between such 'calculated' and 'observed' net earnings we use in this paper are contributions to private health insurance (and other voluntary contributions).[4] As a result individual locations of the caps in the observed net earnings distribution vary in an unknown way and estimates should be downward biased. Histograms for observed net earnings indeed seem to lack sharp discontinuities at the caps for pension and health insurance (Fig. 3, Fig. C5 in the Appendix).

Turning to our statistical tests, we find substantial and significantly negative

[4]For 'calculated' net earnings (see the consistency check below) public health insurance has to be assumed for everyone as the actual insurance status is not observed.

Fig. 3: Distribution of observed monthly net earnings, all years pooled



Source: GSES 1995, 2001, 2006, 2010; own calculations.

point estimates for observed net earnings (Tab. 4, Fig. 4 and Fig. C7 in the Appendix). These discontinuities arise in the pooled sample and in almost all single waves. Both the non-parametric and the parametric test yield similar estimates. Discontinuities at the pension cap are larger in magnitude than those at the health cap. These patterns are consistent with the findings for gross earnings and expectations given the differences in SSC rates.

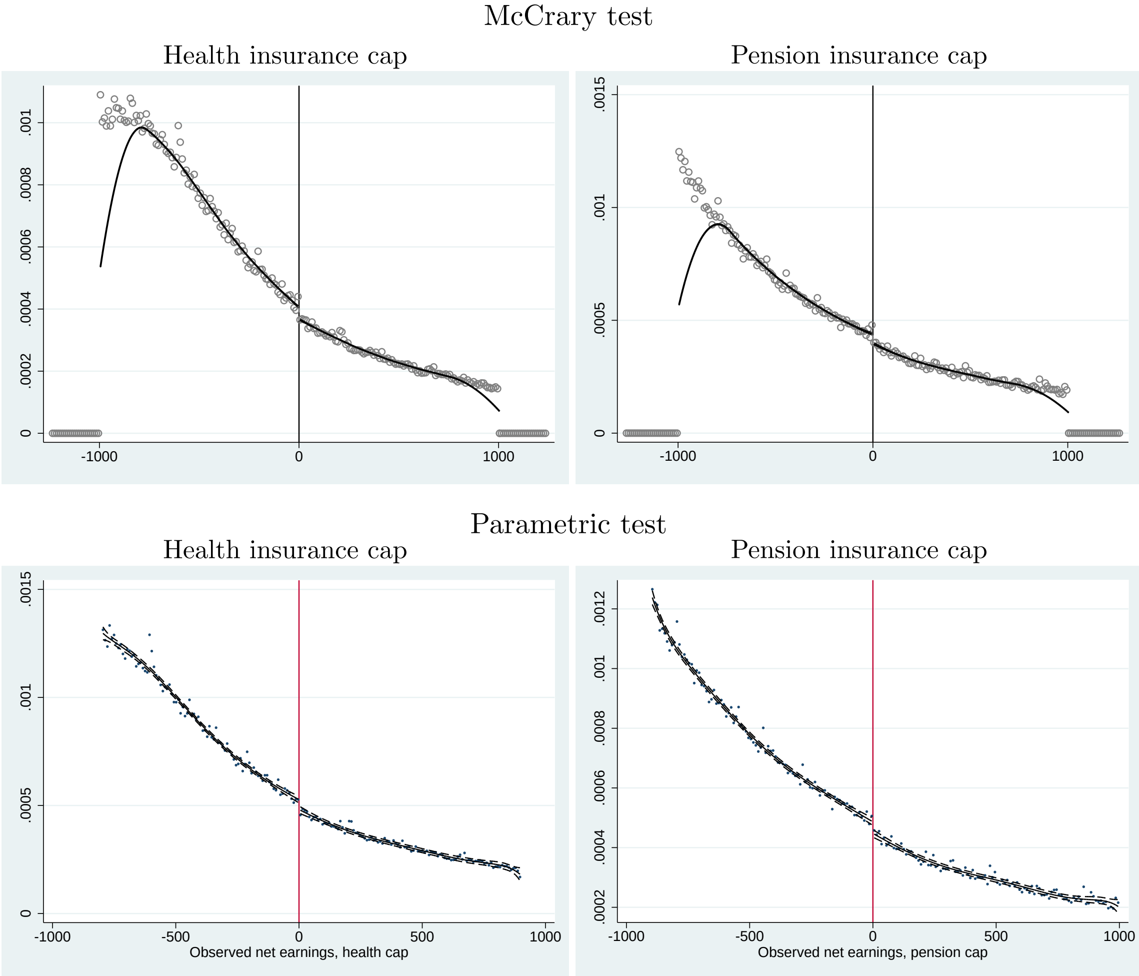
Tab. 4: Discontinuity estimates – observed net earnings

	Pension/unemployment cap					**Health/care cap**				
	Δt	**McCrary**		**Polynomials**		Δt	**McCrary**		**Polynomials**	
		p.e.	t	p.e.	t		p.e.	t	p.e.	t
Pooled sample	-.124	-.080	-6.86	-.087	-6.43	-.081	-.067	-8.38	-.096	-12.5
Single waves										
1995	-.126	-.044	-1.89	-.060	-2.58	-.071	-.029	-1.89	-.055	-3.84
2001	-.128	-.104	-4.92	-.105	-3.88	-.076	-.079	-6.01	-.075	-4.23
2006	-.130	-.024	-1.07	-.019	-.820	-.084	-.113	-8.32	-.112	-7.13
2010	-.114	-.128	-5.54	-.174	-6.82	-.088	-.087	-5.53	-.109	-6.35

Notes: Δt – average drop in marginal SSC rate, p.e. – point estimate, t – t-value (α=0.05).
Source: GSES 1995, 2001, 2006, 2010; own calculations.

Closer examination of the magnitude reveals that the majority of these discontinuities is somewhat smaller than the drop in the marginal SSC rate. One exception for the pooled sample is the parametric test for the health cap yielding a discontinuity slightly larger in size than the actual change in SSC rates (Tab. 4). At face value statutory and economic incidence do not seem to fully coincide. The pooled non-parametric estimate for the pension cap of $-.080$ implies a shifting parameter

Fig. 4: Discontinuity tests, observed monthly net earnings, all years pooled



Source: GSES 1995, 2001, 2006, 2010; own calculations.

of $s = .35$ with a confidence interval ranging from .17 to .54. For the pension cap the non-parametric point estimate in the pooled sample is $-.067$ which means that the shifting parameter amounts to $s = .17$ with a confidence interval of $-.02$ to .37.

As argued above there is a reason for expecting discontinuity estimates to be somewhat downward biased. Given that we do not observe the insurance status there is measurement error in earnings caps for individuals with private health insurance. Therefore the discrepancy between the size of the discontinuity and the drop in marginal SSC rates should not be over-emphasized. In 2003 the threshold for compulsory health insurance was raised to a level between the health and pension earnings caps. We have thus 'cleaner' estimates at the health cap in 2006 and 2010 which may serve as an informal test for this interpretation.[5] Estimates

[5]The cap for pension insurance is higher up in the distribution and therefore still affected by this measurement error.

from observed net earnings are indeed larger and close to the actual change in SSC rates (Tab. 4). Smaller estimates in other years and at the pension cap might be mainly driven by measurement error for individuals with private health insurance. Altogether the evidence from gross earnings supports the interpretation that there is not much shifting going on for either employers or employees.

Given measurement error and round number bunching, it might be that earnings caps randomly coincide with a spike or gap in the density that is not related to incidence. We therefore conduct a sensitivity analysis and look at 'placebo thresholds' below the health and above the pension insurance cap for the pooled sample (Tab. 5). The area between both earnings caps is not used for this robustness check to avoid potential interferences among them. We get significant placebo estimates slightly above the pension cap, in particular with the parametric approach. It is, however, clearly smaller in magnitude than the discontinuity at the threshold. Moreover, as indicated above there is a discrepancy between the counterfactual and observed density also above the cap, as both densities slowly converge (Fig. B1 in the Appendix). It is not surprising that the parametric estimator picks up this difference above the cap. Consistent with theoretical expectations we do not find any discontinuities further up or down the respective densities. An exception is at $\bar{y}^h - 150$ where the point estimate is merely one third of the original estimate.

Tab. 5: Discontinuity estimates – observed net earnings, sensitivity w.r.t. breakpoint

	Pension/unemployment cap					**Health/care cap**			
	McCrary		**Polynomials**			**McCrary**		**Polynomials**	
Breakpoint	p.e.	t	p.e.	t	Breakpoint	p.e.	t	p.e.	t
$\bar{y}$	-.08	-6.86	-.087	-6.43	$\bar{y}$	-.067	-8.38	-.096	-12.5
$\bar{y}+50$	-.033	-2.75	-.063	-5.57	$\bar{y}-50$	-.013	-1.92	-.037	-4.92
$\bar{y}+100$	.020	1.53	-.006	-.70	$\bar{y}-100$	.012	1.70	.008	1.06
$\bar{y}+150$	.006	.47	0.00	0.00	$\bar{y}-150$	.010	1.41	.032	4.23

Notes: Δt – average drop in marginal SSC rate, p.e. – point estimate, t – t-value (α=0.05).
Source: GSES 1995, 2001, 2006, 2010; own calculations.

A final plausibility check concerns 'calculated' net earnings. There is a deterministic link between gross earnings y and net earnings c (sub-section 2.1). By equation (7) almost smooth gross earnings distributions as in our case deterministically create discontinuities in net earnings about the size of the drop in the marginal SSC rate. Estimating discontinuities for calculated net earnings serves as consistency test. Discontinuities are clearly visible in the histograms for 'calculated' net earnings (Fig. C6 in the Appendix). This is confirmed by statistically significant negative estimates for the pooled sample and for single waves (Tab. D1 in the Appendix). The point estimates are slightly above expectations given the changes in SSC rates under no shifting. This is, however, perfectly consistent with the small negative point estimates in gross earnings (Tab. 2). We find the largest estimates for the pension cap in 2010 and the health cap in 2001 and 2006 where discontinuities in gross earnings were also bigger.

4 Discussion and conclusion

In this paper we analyze economic incidence of social security contributions (SSC) with cross-sectional estimators. The main advantage of this approach is that it does not rely on reform-induced, exogenous changes in SSC institutions over time. Panel data which often suffer from insufficient sample sizes or imprecise or missing information (e.g. hours of work) are therefore not needed. Moreover, identification does not depend on the validity of a control group and is not solely based on short-term responses.

We refine the original framework of Alvaredo and Saez (2007) and discuss the identifying assumptions more explicitly. An empirical implementation of the framework is sketched out and it is shown that non-parametric as well as parametric estimators capture the effects of economic incidence on different earnings densities at earnings caps of SSC.

The main contribution of this paper is the application of the framework to employer-employee data. The German Structure of Earnings Survey (GSES) used here satisfies the necessary requirements in terms of data quality: We pool four waves of data and generate a sample size sufficiently large to reduce random noise in earnings distributions. Being part of the official labor cost statistics the amount of earnings subject to SSC is measured with little error. More importantly, it contains a direct measure of employees' SSC which allows us to analyze discontinuities at earnings caps for gross as well as net earnings distributions. We, therefore, do not rely on a single cross-sectional distribution.

The overall picture of the empirical evidence is conclusive. We see no or very small significant discontinuities in the gross earnings distribution which means that legal and economic incidence coincide. This interpretation is confirmed by the identification of statistically significant negative discontinuities in the distribution of observed net earnings. The result is robust for the parametric and non-parametric estimator. Differences in magnitude of the point estimates are qualitatively consistent for varying SSC rates between the pension/unemployment and the health/long-term care insurance cap. Estimates from net earnings are slightly downward-biased because of measurement error for privately insured individuals. We thus do not over-emphasize the fact that discontinuities are somewhat below the drop in the marginal SSC rates at the cap leaving room for partial incidence on employees.

Our reading of the overall evidence is that economic and legal incidence are more or less identical for SSC in Germany. Employers and employees thus share the burden of SSC for health and pension insurance. Even in the extreme cases supported by our estimates neither employees nor employers shift a substantial share of their SSC burden to the respective other side of the market. Relying on precise data with gross earnings as well as actually paid employees' SSC we argue that measurement issues do not drive this result. Among the substantive explanatory factors salience or adjustment frictions are less convincing in our setting with long-standing earnings caps and our empirical framework which is based on equilibrium incidence. Our local estimates at earnings caps would not be informative about underlying incidence when the drop in average SSC rates above the cap was not or not yet internalized into bargained earnings during wage negotiations. In this scenario incidence would be systematically different below and above the cap which would bias the discontinuity estimates (as shown in Appendix A.3).

The result of non-standard economic incidence is in line with recent studies for different countries which are mostly based on quasi-experimental identification (Saez et al., 2012; Skedinger, 2014; Bennmarker et al., 2009; Korkeamäki and Uusitalo, 2009; Huttunen et al., 2013). It also corroborates previous evidence for Germany which exploits a reform of the earnings cap of the health insurance in East Germany (Neumann, 2015). There are, however, studies which provide evidence for complete shifting of SSC to employees (Gruber, 1994, 1997). A potential explanation could be the different institutional settings, in particular divergent wage setting mechanisms (Alesina and Perotti, 1997; Daveri and Tabellini, 2000).

References

Alesina, Alberto and Roberto Perotti, "The Welfare State and Competitiveness," *The American Economic Review*, December 1997, *87* (5), 921–939.

Alvaredo, Facundo and Emmanuel Saez, "The Effects of Payroll Taxes on Earnings: Evidence from Spanish Administrative Data," Working Paper 2007.

Antonczyk, Dirk, Bernd Fitzenberger, and Katrin Sommerfeld, "Rising wage inequality, the decline of collective bargaining, and the gender wage gap," *Labour Economics*, 2010, *17* (5), 835–847.

Bennmarker, Helge, Erik Mellander, and Björn Öckert, "Do regional payroll tax reductions boost employment?," *Labour Economics*, October 2009, *16* (5), 480 – 489.

Daveri, Francesco and Guido Tabellini, "Unemployment, growth and taxation in industrial countries," *Economic Policy*, April 2000, *15* (30), 47–104.

Fitzenberger, Bernd, Karsten Kohn, and Alexander C. Lembcke, "Union Density and Varieties of Coverage: The Anatomy of Union Wage Effects in Germany," *Industrial and Labor Relations Review*, January 2013, *66* (1), 169–197.

Fullerton, Don and Gilbert E. Metcalf, "Tax incidence," in A. J. Auerbach and M. Feldstein, eds., *A. J. Auerbach and M. Feldstein, eds.*, Vol. 4 of *Handbook of Public Economics*, Elsevier, 2002, chapter 26, pp. 1787–1872.

Grabka, Markus, "Alternative Finanzierungsmodelle einer sozialen Krankenversicherung in Deutschland – Methodische Grundlagen und exemplarische Durchführung einer Mikrosimulationsstudie.," Dissertation, Technical University Berlin, 2004.

Gruber, Jonathan, "The Incidence of Mandated Maternity Benefits," *American Economic Review*, 1994, *84* (3), 622–41.

_ , "The Incidence of Payroll Taxation: Evidence from Chile," *Journal of Labor Economics*, July 1997, *15* (3), 72–101.

Huttunen, Kristiina, Jukka Pirttilä, and Roope Uusitalo, "The employment effects of low-wage subsidies," *Journal of Public Economics*, 2013, *97*, 49 – 60.

Kleven, Henrik J. and Mazhar Waseem, "Using Notches to Uncover Optimization Frictions and Structural Elasticities: Theory and Evidence from Pakistan," *The Quarterly Journal of Economics*, 2013, *128* (2), 669–723.

Kleven, Henrik Jacobsen, Martin B. Knudsen, Claus Thustrup Kreiner, Søren Pedersen, and Emmanuel Saez, "Unwilling or Unable to Cheat? Evidence From a Tax Audit Experiment in Denmark," *Econometrica*, 2011, *79* (3), 651–692.

Korkeamäki, Ossi and Roope Uusitalo, "Employment and wage effects of a payroll-tax cut—evidence from a regional experiment," *International Tax and Public Finance*, December 2009, *16* (6), 753–772.

Liebman, Jeffrey and Emmanuel Saez, "Earnings Responses to Increases in Payroll Taxes," Technical Report, Harvard University, University of California, Berkeley, and NBER, 2006.

McCrary, Justin, "Manipulation of the running variable in the regression discontinuity design: A density test," *Journal of Econometrics*, 2008, *142* (2), 698 – 714.

Melguizo, Angel and Jose Gonzalez-Paramo, "Who bears labour taxes and social contributions? A meta-analysis approach," *SERIEs*, 2013, *4* (3), 247–271.

Neumann, Michael, "Earnings Responses to Social Security Contributions: Evidence from two German Administrative Data Sets," Technical Report, DIW Discussion Paper No. 1489, German Institute for Economic Research (DIW Berlin) 2015.

OECD, "OECD revenue statistics," 2016.
https://stats.oecd.org/Index.aspx?DataSetCode=REV; accessed 2015.

Saez, Emmanuel, "Do Taxpayers Bunch at Kink Points?," *American Economic Journal: Economic Policy*, 2010, *2* (3), 180–212.

— , **Manos Matsaganis, and Panos Tsakloglou**, "Earnings Determination and Taxes: Evidence From a Cohort-Based Payroll Tax Reform in Greece," *The Quarterly Journal of Economics*, 2012, *127* (1), 493–533.

Skedinger, Per, "Effects of Payroll Tax Cuts for Young Workers," *Nordic Economic Policy Review*, 2014, *5* (1), 125–169.

A Model extensions

A.1 Varying SSC rates

We assume identical statutory SSC rates for employers (r) and employees (e) in our model. Relaxing this assumption yields

$$y = \frac{n}{1 + t_r max(0, s) + t_e min(s, 0)}. \tag{10}$$

As in our baseline model, $s > 0$ implies that employers are able to shift part of their burden to their employees. In that case, the distortion of n depends on the SSC rate of the employer, t_r. If $s < 0$, employees are able to shift part of their burden to their employers and the distortion of n depends on the SSC rate of the employee, t_e.

Considering the left and right limit of the density of realized gross earnings when y approaches $\bar{y}$:

$$\begin{aligned} \mathrm{f}(\bar{y})_- &= \mathrm{p}\{\bar{y}[1 + t_r max(0, s) + t_e min(s, 0)]\} \left[1 + t_r max(0, s) + t_e min(s, 0)\right] \\ &= \mathrm{p}\{\bar{y} + \bar{y} t_r max(0, s) + \bar{y} t_e min(s, 0)\} \left[1 + t_r max(0, s) + t_e min(s, 0)\right] \\ &= \mathrm{p}(\bar{n}) \left[1 + t_r max(0, s) + t_e min(s, 0)\right] \end{aligned} \tag{11}$$

$$\begin{aligned} \mathrm{f}(\bar{y})_+ &= \mathrm{p}\{\bar{y} + \bar{y} t_r max(0, s) + \bar{y} t_e min(s, 0)\} \\ &= \mathrm{p}(\bar{n}) \end{aligned} \tag{12}$$

The interpretation of the size of the discontinuity depends on its sign. If the distribution exhibits a drop (jump), full shifting is implied by a change of t_r% (t_e%).

A.2 Varying SSC rates with asymmetric incidence

When, in addition, employers' and employees' contributions are allowed to be shared independently, gross earnings in terms of ability become

$$y = \frac{n}{1 + t_r s_r - t_e s_e} \tag{13}$$

As before, the potential discontinuity in the earnings distribution at the threshold can be characterized as follows:

$$f(\bar{y})_- = p(\bar{n}) \left[1 + t_r s_r - t_e s_e\right] \tag{14}$$

$$f(\bar{y})_+ = p(\bar{n}) \tag{15}$$

The discontinuity, thus, identifies an average of the SSC rates of employers and employees weighted by the corresponding shifting parameters. Separate identification of s_r and s_e would require differential changes of employer and employee SSC rates over time.

A.3 Heterogeneous shifting

The analysis in the main text is based on the assumption of s to be homogeneous. Allowing for heterogeneity in s raises the question whether a potential discontinuity in a given distribution at an earnings cap is informative about average economic incidence in the population. We thus use the simulation from the estimation section 2.3 (for details on the simulation see Appendix B) to check how representative this local estimate is. Homogeneity from the main simulation is relaxed and s is allowed to vary according to alternative distributional assumptions.

The first and second moments are held constant throughout this exercise: the shifting parameter s has a mean of 0.5 and a standard deviation of .239 for each distribution. This means that employers are on average able to shift half of their SSC burden to employees. For an assumed drop in the SSC rate of 7.6% at the cap, this yields a 'true' drop in the gross earnings density of .038 for the average individual. We start with a *uniform* distribution where s varies between 0 and 1. Alternatively we estimate discontinuities for underlying *normal* and *log-normal* distributions of s. Finally we allow for a correlation between the the shifting parameter and earnings. We use a *bivariate normal* distribution (with first and second moments for y and s as above) and a correlation coefficient of .5. This means that employers' ability to shift their SSC burden to employees is increasing in earnings.

For homogenous s we find a discontinuity of -0.037 with the non-parametric and -0.038 with the parametric approach (Tab. A1). Both estimates match the 'true' discontinuity of $-.038$. Allowing for heterogeneity in s we see that both, the parametric and the non-parametric test employed in this paper yield discontinuity estimates of between -0.036 and -0.037. The estimates also closely resemble the true mean incidence in these scenarios regardless of the distribution of s with confidence intervals increasing slightly. As long as the distribution of shifting parameters is not related to earnings, the locally identified estimate is representative for mean incidence in the sample.

Tab. A1: Discontinuity estimates – simulation of heterogeneous shifting parameter

	McCrary		**Polynomials**	
	p.e.	CI	p.e.	CI
Homogeneous s	-.037	[-.057, -.019]	-.038	[-.054, -.024]
Heterogeneous s				
Uniform	-.036	[-.063, -.010]	-.037	[-.052, -.021]
Normal	-.036	[-.058, -.014]	-.037	[-.052, -.022]
Log-normal	-.037	[-.060, -.013]	-.037	[-.052, -.023]
Heterogeneous s, correlation with y				
Bivariate normal	-.046	[-.065, -.027]	-.044	[-.058, -.030]

Notes: p.e. – point estimate, CI – 95% confidence intervall.
A mean of the shifting parameter of $s = 0.5$ and a drop in the marginal SSC rate of 7.6% yield a 'true' drop in density of .038 for the average in individual in the population.
Source: Own simulation.

The picture changes in a situation where the employers' ability of shifting their SSC burden is correlated with earnings. For a positive correlation coefficient of .5 we find a discontinuity estimate of $-.046$ (Tab. A1). The upward bias in the estimate of mean incidence can be explained by selection: The cap is located in the upper part of the earnings distribution. Given the assumed positive combination with shifting this results in an above-average s for individuals around the cap. The local estimator is no longer able to capture mean incidence in the sample under these circumstances.

A.4 Behavioral responses

Alternative margins of adjustment, e.g. quantity adjustments on the labor market, are not modelled in our framework (sub-section 2.1). A change of the marginal SSC rate at an earnings cap, however, also entails labor supply and demand incentives. This is particularly relevant as underlying labor supply and demand elasticities might drive both behavioral responses as well as economic incidence. Alvaredo and Saez (2007) provide a model extension with variable labor supply. Assume individuals with skill (or preference for work) n to maximize quasi-linear utility $u^n(c, z)$ which is a function of net earnings c and labor costs z (with $c = z - T(z) = \frac{1-t}{1+t}z$ where T(z) is total tax liability). It holds that $\partial u/\partial c > 0$ and $\partial u/\partial z < 0$ (costs of labor supply). Quasi-linear preferences rule out income effects. This is not restrictive in our framework, though. As the discontinuity at the cap is driven by employees located close to the cap, the change in average tax rate is limited and so is the incentive for income effects.

Under neoclassical labor supply a positive labor supply elasticity makes it suboptimal to locate close to the earnings cap (Saez, 2010). That is, if the labor supply elasticity is homogeneous and strictly positive, the distribution of earnings will feature a gap around the cap. Although a potential discontinuity generated by economic incidence would theoretically be present at the borders of the gap, it would be impossible to identify it empirically as the probability mass directly around the cap is zero.

If the labor supply elasticity is heterogeneous and zero for at least some individuals, the earnings distribution would feature a dip instead of a gap (Saez, 2010; Neumann, 2015). Depending on the size of the elasticities, it is theoretically still possible to identify a discontinuity in the density of gross earnings. The discontinuity is in principle not affected by the labor supply behavior. As discussed above a potential discontinuity is informative about economic incidence for individuals who locate close to the earnings cap. Those people have by definition small labor supply elasticities, otherwise they would not sit there. When labor supply behavior and economic incidence are correlated, the incidence estimate is highly selective.

In the case of a dip it is a practical empirical question whether an estimator picks up the curvature of such a dip and is still able to identify a discontinuity within this area. We conducted a number of Monte-Carlo simulations varying the size of the dip due to behavioral responses in order to study the sensitivity of the estimators in that regard (for details on the simulation see Appendix B). The non-parametric estimator performs in general better than the parametric estimator. It is able to pick up the curvature generated by behavioral responses and in most cases still identifies a discontinuity at the earnings cap (Tab. A2). By contrast, estimates based on the parametric approach are completely out of place. The parametric estimator is not able to identify discontinuities in the presence of sizeable dips in earnings densities.

We start with a scenario where roughly two thirds of all employees have a positive labor supply elasticity e which is simulated to be uniformly distributed in the interval $(0, .7)$. Remaining employees are assigned an elasticity of zero. Economic incidence is assumed to be homogeneous, fully with employees ($s = 1$), and independent from e. The distribution thus features a dip around the earnings cap and, in addition,

Tab. A2: Discontinuity estimates – simulation of behavioral responses

Simulation parameters	**Actual discontinuity**	**McCrary** p.e.	CI	**Polynomials** p.e.	CI
$P(e=0)=1; s=1$	-.075	-.072	[-.094;-.049]	-.076	[-.092;-.06]
$P(e \sim U(0,.7))=.67$; $P(e=0)=.33; s=1$	-.075	-.051	[-.100;0]	.141	[.117;.165]
$P(e \sim U(0,.7))=.67$; $P(e=0)=.33; s=1-e$	-.054	-.048	[-.100;.003]	.089	[.065;.113]
$P(e \sim U(0,.7))=.9$; $P(e=0)=.1; s=1-e$	-.050	.033	[-.116; .196]	.251	[.219;.284]

Notes: p.e. – point estimate, CI – 95% confidence interval.
Source: Own simulations.

exhibits a discontinuity at $\bar{y}$. The non-parametric estimate of $-.051$ is smaller than the true value of $-.075$ but remains significant, although the behavioral distortion in general reduces precision. (Tab. A2).

According to the neo-classical model incidence is determined by the labor supply elasticity ($s = 1-e$): Highly elastic employees bear less of the SSC burden than individuals with lower elasticities. We model this relationship between e and s in the last two simulations. First, the elasticity is assumed to be uniformly distributed between zero and .7 for two thirds of employees while all others are inelastic as above. The incidence parameter is thus $s = .77$ on average resulting in a true discontinuity of $-.054$. The McCrary test almost exactly delivers that value (Tab. A2). The better performance in comparison to the first simulation is a combination of a selective local estimate with the downward bias under behavioral adjustments.

Second, we increase the share of people with labor supply elasticities in the interval $(0,.7)$ to .9 which means that the the overall fraction with $e = 0$ is reduced to .1. The dip around the earnings cap is increased and the related average discontinuity decreases to -0.050. The non-parametric point estimate of .33 no longer represents the correct direction of incidence (Tab. A2). It seems that the combination of a large dip, a small amount of probability mass at $\bar{y}$, and a relatively small actual discontinuity also disables identification based on the non-parametric approach. Taken altogether behavioral responses introduce bias to incidence estimates. When incidence is correlated with elasticities, the local estimator is selective. Under large behavioral responses identification of a discontinuity is lost even with a non-parametric estimator.

Empirical studies have not been able to identify a gap or a dip around earnings caps (Liebman and Saez, 2006; Neumann, 2015). We do not find evidence for behavioral responses either (section 3.3). People with high earnings may indeed have small labor supply elasticities. Alternatively adjustment costs could be too high to locate optimally given the relatively moderate increase in utility (Neumann, 2015).

B Monte-Carlo evidence

This section provides some Monte-Carlo evidence on the performance of the parametric and non-parametric estimator of a discontinuity in an earnings distribution. Gross earnings distributions $f(y)$ are simulated on the basis of equation (3) under the assumption of full shifting of employers' SSC to employees ($s = 1$). SSC rates for employees and employers are identical. We assume the underlying ability n to be normally distributed with $p(n) \sim N(2,913; 4,481)$ and take 1000 random draws of 2,000,000 observations from this distribution. We assume a drop in the marginal SSC rate of roughly 7.6% at 3,562 €. The choice of distributional and tax parameters draws on our empirical application to the health insurance cap in 2006. The resulting density features a clear negative discontinuity (Fig. B1). The McCrary test and the parametric test identify a discontinuity of -7.2% and 7.6%, respectively, which matches the underlying parameters s and t (Fig. B2). The confidence interval of the McCrary estimate translates to an interval of $(-1.24, -0.64)$ for the shifting parameter s. The corresponding interval for s based on the parametric test is slightly narrower: $(-1.21, -0.79)$.

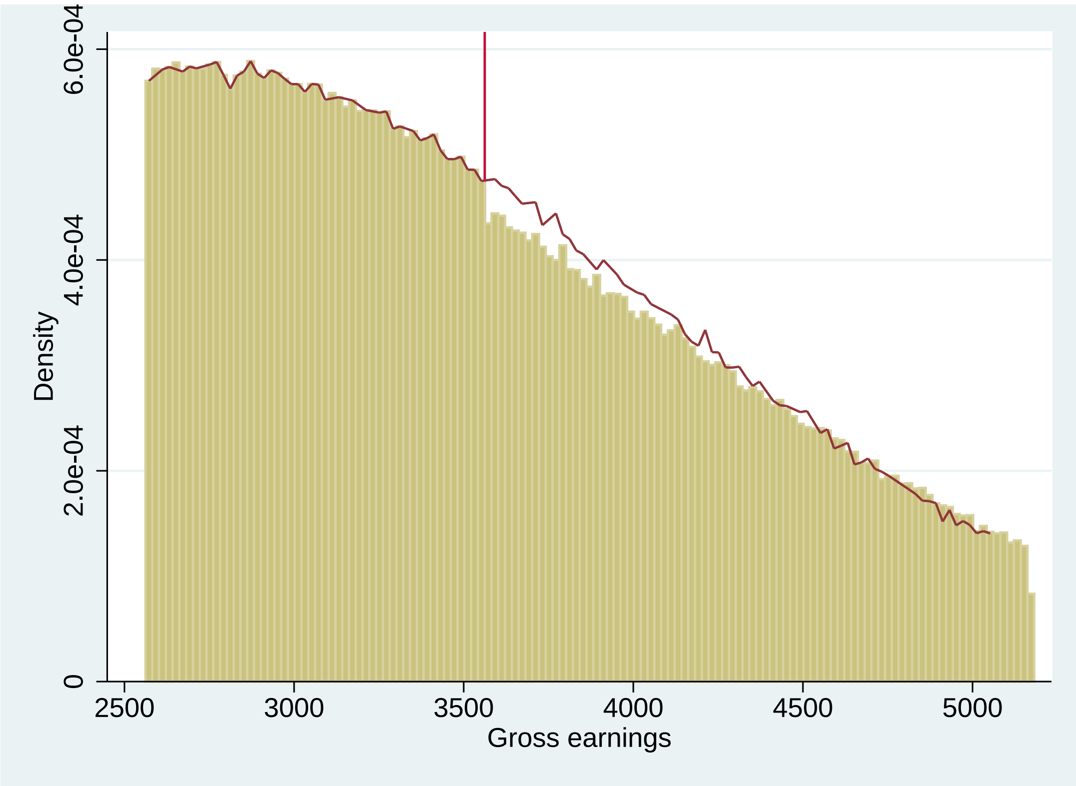
The red curve added to Figure B1 plots a counterfactual density assuming no earnings cap. The deviation from the histogram is not uniform over the whole area above the cap. To see the reason, consider both densities at the earnings level $\tilde{y} > \bar{y}$ (equations (16) and (17)).

$$f(\tilde{y})_{\text{Cap}} = p(\tilde{y} + \bar{y}ts) \tag{16}$$

$$f(\tilde{y})_{\text{No cap}} = p(\tilde{y}(1 + ts))(1 + ts) = p(\tilde{y} + \tilde{y}ts)(1 + ts) \tag{17}$$

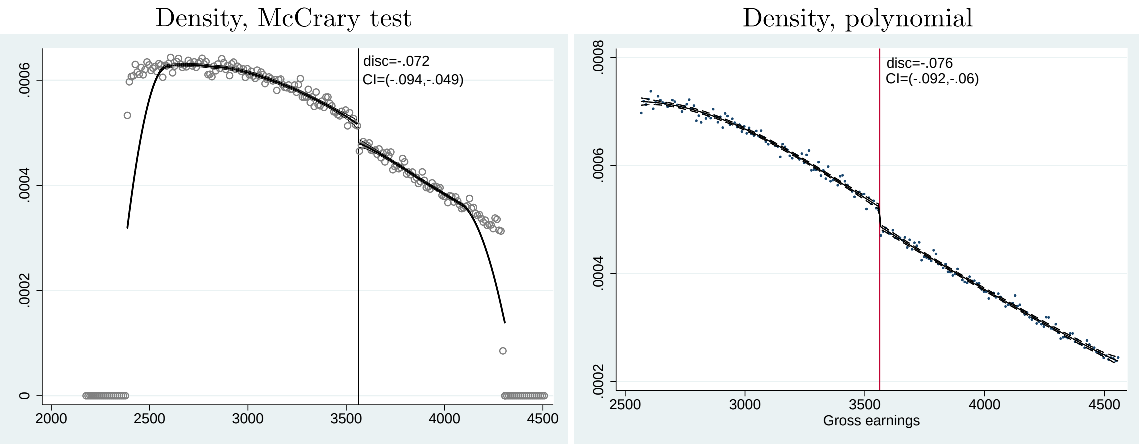
For a monotonously negative (positive) slope of the ability density above $n = \bar{y}$ it holds that $p(\tilde{y} + \bar{y}ts) > (<)\ p(\tilde{y} + \tilde{y}ts)$. The inequality becomes larger with the distance to $\bar{y}$. At the same time, for $s \neq 0$, the factor $(1 + ts)$ constantly increases the density in the case of no earnings cap. Assuming a negative slope, this implies that the deviation between both densities is at its maximum directly at the cap and diminishes slowly until it even might reverse (Fig. B1). For a positive slope, the deviation increases with the distance to $\bar{y}$.

Fig. B1: Distributions of simulated gross earnings with negative discontinuity at $\bar{y}$



Source: Own simulation.

Fig. B2: Discontinuity tests, simulation

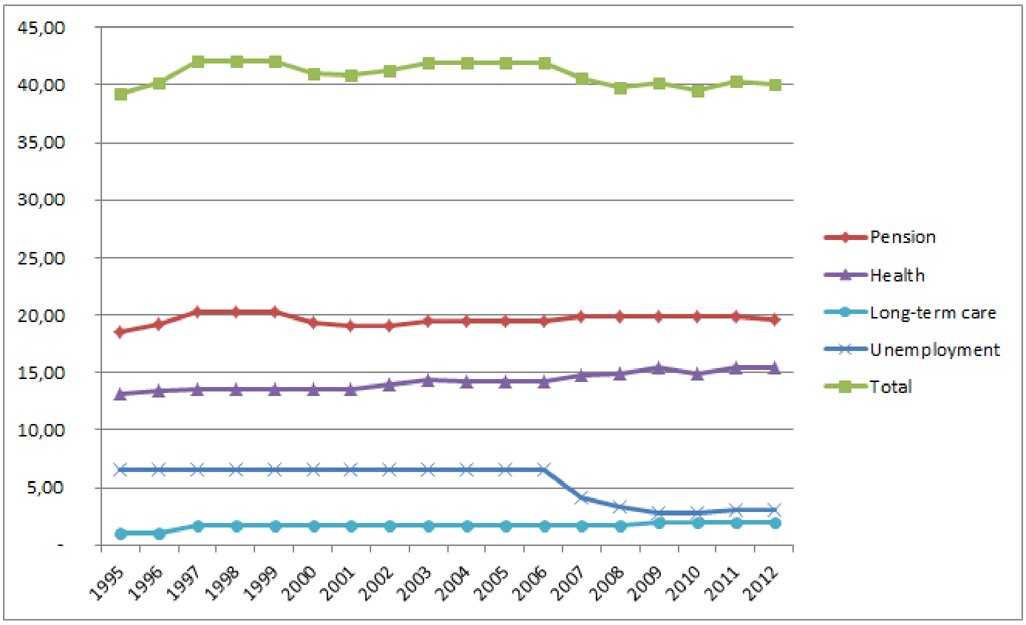


Notes: disc – p.e. of discontinuity, CI – confidence interval (α=0.05).

Source: Own simulation.

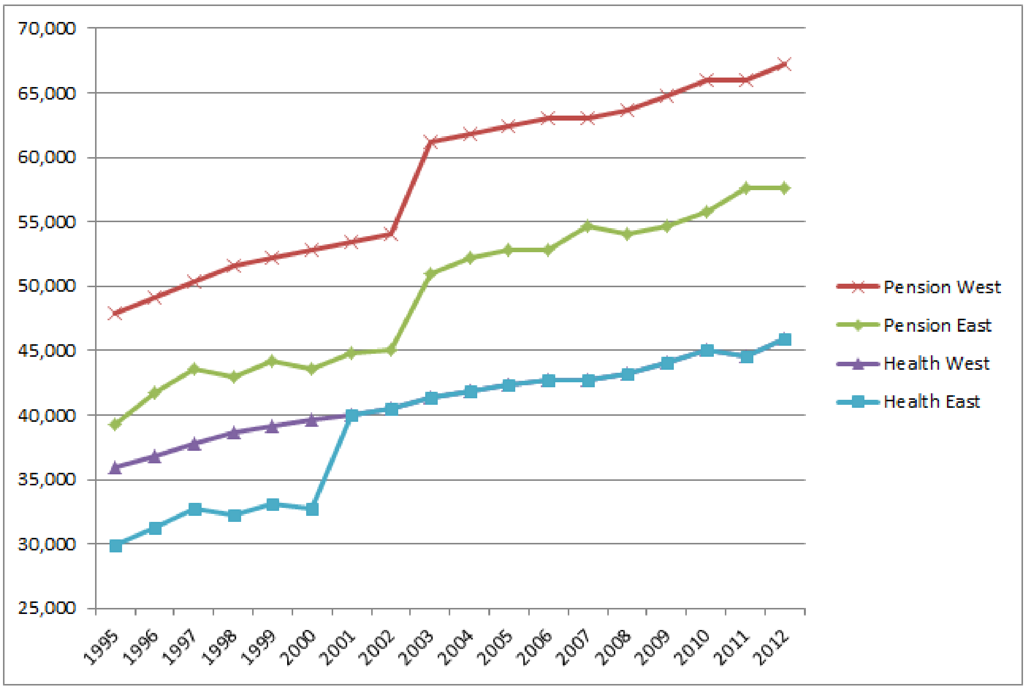
C Additional figures

Fig. C1: Development of SSC rates over time



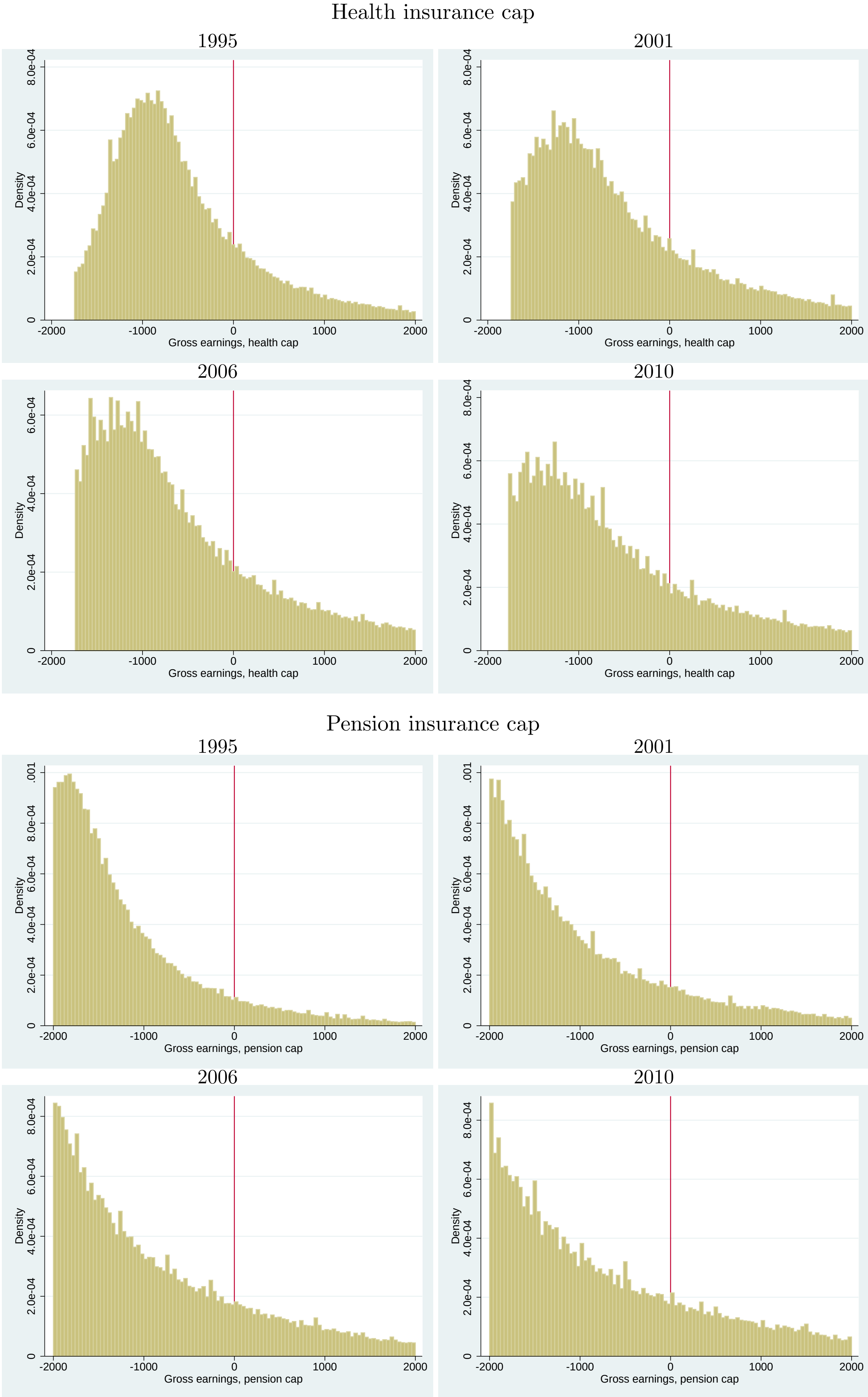
Notes: The additional fee for childless employees, introduced in 2005, is omitted; The change of SSCs which came into effect in July 2005, are considered as of 2006. Until 2006, SSC rates for health insurance varied between health insurance companies and the given numbers are averages. In 2001 for example, it varied between 11.0% and 14.9% Grabka (2004).
Source: German Statistical Office.

Fig. C2: Development of earnings caps over time



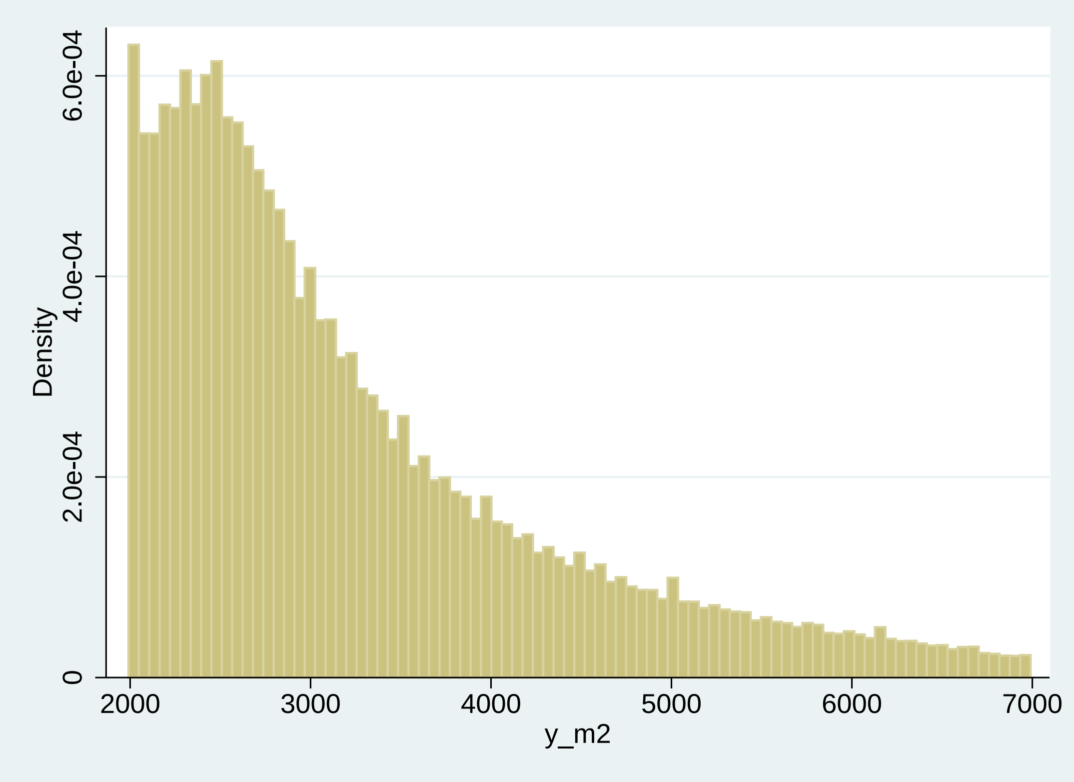
Source: German Statistical Office.

Fig. C3: Distribution of gross earnings, single years



Source: GSES 1995, 2001, 2006, 2010; own calculations.

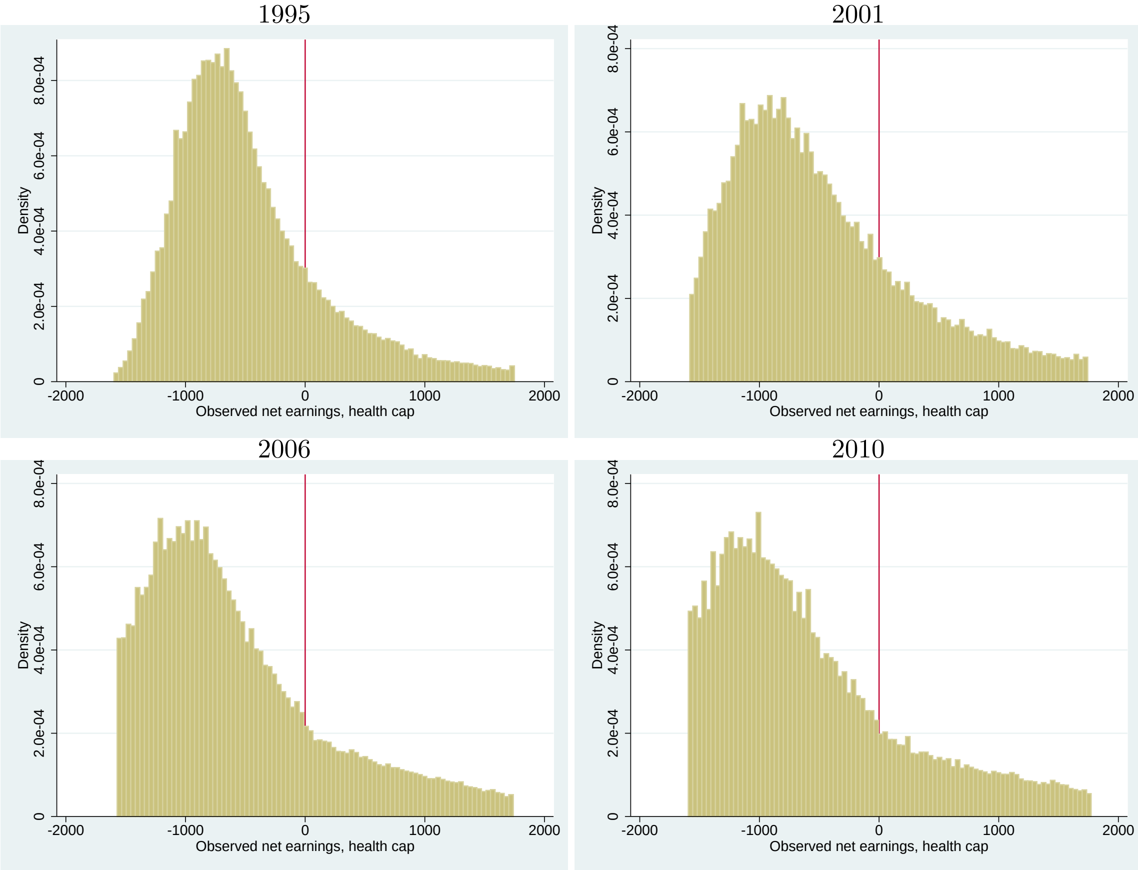
Fig. C4: Distribution of non-normalized gross earnings, West Germany, 2006



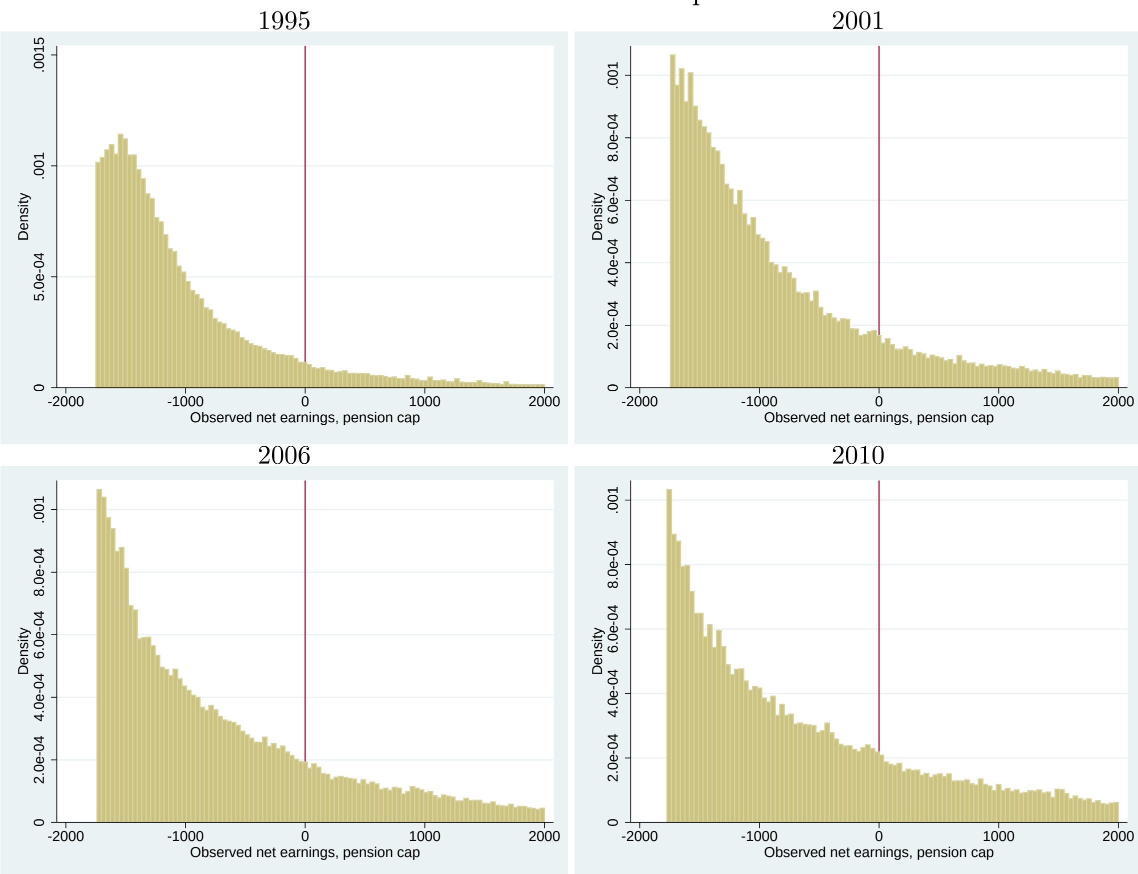
Source: GSES 2006.

Fig. C5: Distribution of observed net earnings, single years

Health insurance cap

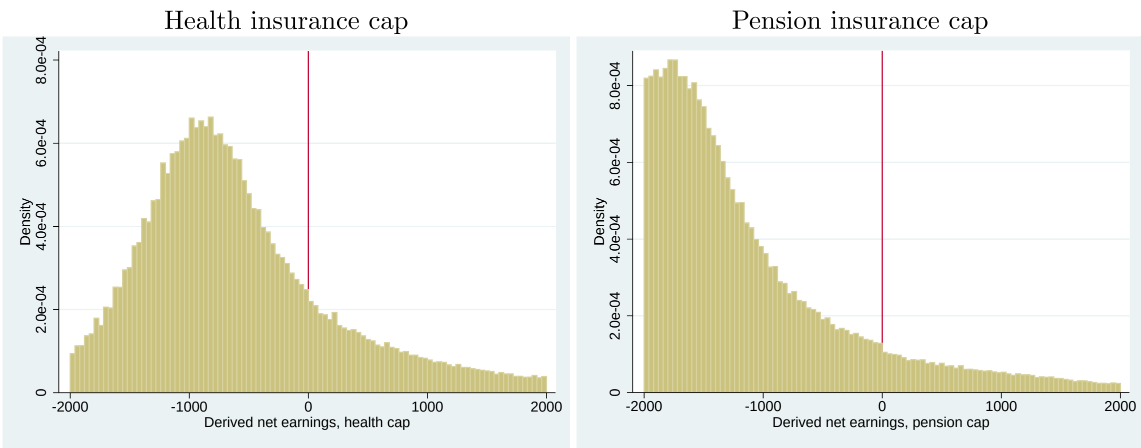


Pension insurance cap



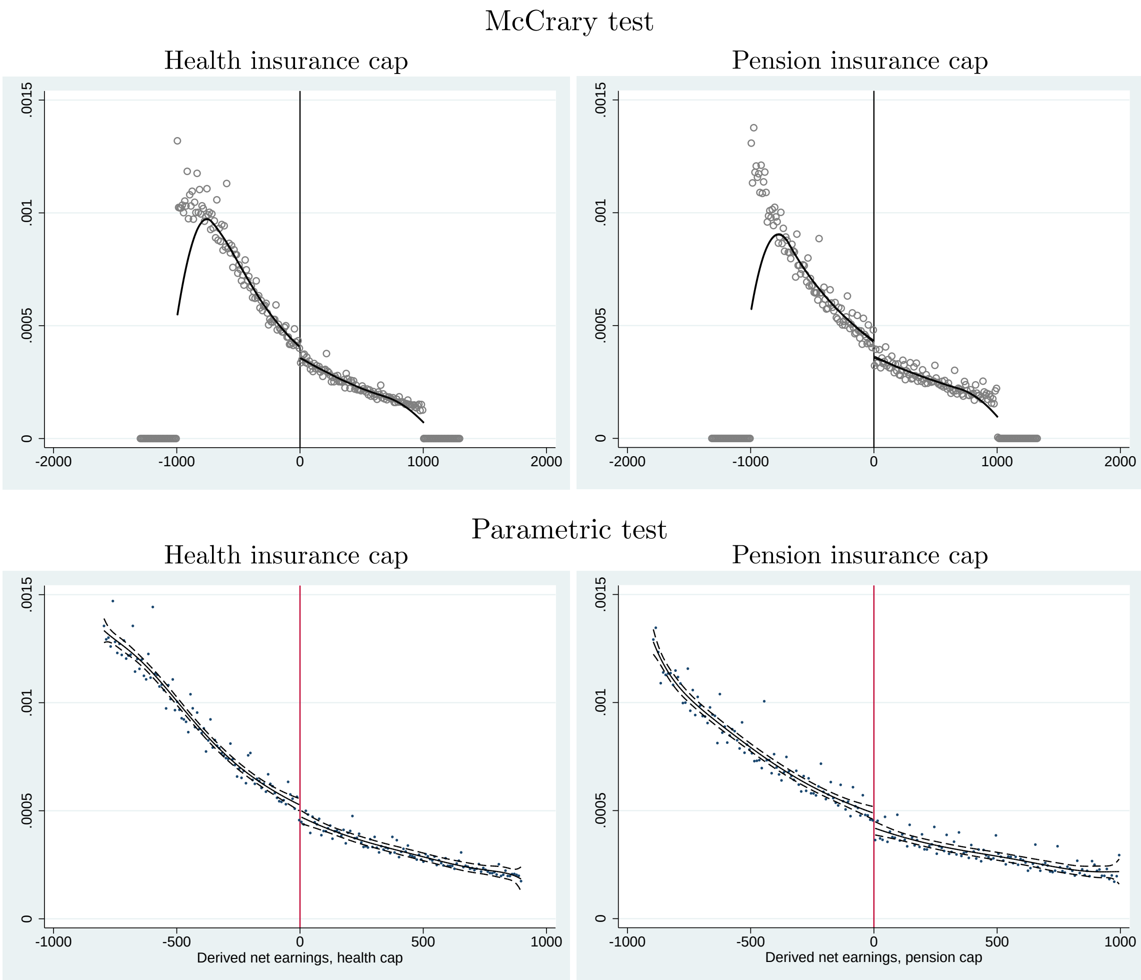
Source: GSES 1995, 2001, 2006, 2010; own calculations.

Fig. C6: Distribution of calculated monthly net earnings, all years pooled



Source: GSES 1995, 2001, 2006, 2010; own calculations.

Fig. C7: Discontinuity tests, calculated monthly net earnings, all years pooled



Source: GSES 1995, 2001, 2006, 2010; own calculations.

D Additional tables

Tab. D1: Discontinuity estimates – calculated net earnings

	Pension/unemployment cap					Health/care cap				
	Δt	McCrary		Polynomials		Δt	McCrary		Polynomials	
		p.e.	t	p.e.	t		p.e.	t	p.e.	t
Pooled sample	-.124	-.139	-12.38	-.163	-10.86	-.081	-.096	-13.28	-.113	-13.91
Single waves										
1995	-.126	-.103	-4.54	-.117	-4.39	-.071	-.096	-6.25	-.086	-5.96
2001	-.128	-.150	-7.11	-.195	-6.47	-.076	-.125	-8.62	-.165	-8.32
2006	-.130	-.119	-5.92	-.110	-4.13	-.084	-.114	-11.04	-.124	-8.87
2010	-.114	-.162	-9.27	-.246	-8.22	-.088	-.078	-5.79	-.072	-4.77

Notes: Δt – average drop in marginal SSC rate, p.e. – point estimate, t – t-value (α=0.05).
Source: GSES 1995, 2001, 2006, 2010; own calculations.