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Incidence and Behavioural Response to Social Security Contributions: An Analysis of Kink Points in France

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Abstract We study the incidence of social security contributions (SSCs) in France relying on the strategy developed by Alvaredo et al. (De Econ, 2017. doi:10.1007/s10645-017-9294-7). This strategy infers the incidence of SSCSs from the discontinuities in earnings distributions created by kink points in the SSC schedule. Using administrative data on earnings for the period 1976–2010, we study approximately 200 such kink points and do not find that they systematically induce a discontinuity in the distribution of gross earnings. This allows us to reject the hypothesis that SSCs are incident on workers, at least locally around kinks. Additionally, we exploit the large variations in SSC rates across kinks and years to estimate the local incidence of both employer and employee SSCs around these thresholds. We find that employer SSCs are shifted to employers while employee SSCs are shifted to employees. These findings are consistent with the economic incidence of SSCs being aligned with their statutory incidence, locally around kink points.

Keywords Social security contributions · Payroll tax · Tax incidence

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JEL Classification H22 · H55 · J32

1 Introduction

Social security contributions (SSCs) represent a major part of total taxation in France, amounting to 40% of total tax revenues, or 17% of GDP—almost twice the OECD average. These contributions are nominally split between employers and employees, with a larger share nominally paid by employers. Although the incidence of SSCs is central to many key issues in the French policy debate—in particular the ability of reductions in employer SSCs to increase employment—the literature on French data is particularly scarce (apart from the recent work by Bozio et al. 2017, which studies the earnings responses to three large SSC reforms in France).

As other papers in this special issue, we implement a novel approach to identify the incidence of SSCs from discontinuities in the earnings distributions at kink points in the SSC schedule. The technique is derived from the observation that when the marginal rate of SSCs changes discontinuously at a given threshold, the distributions of earnings including those SSCs (labour cost) and not including them (net earnings) cannot be both continuous at the threshold. In a nutshell, identifying which of the distributions is discontinuous can provide information on the incidence of SSCs: contributions are likely to be incident on workers if labour costs (i.e., including SSCs) are continuous at the threshold; they are likely to be incident on firms if earnings net of SSCs are continuous at the threshold (see Alvaredo et al. 2017, for details).[1]

We apply this new technique using administrative employer–employee data for France covering the period 1976–2010. Several features of France's socio-fiscal regulations make it an interesting case of study in comparison to other countries covered in this special issue, i.e., Germany, the Netherlands, and the United Kingdom. First, due to the high average value of SSCs, the SSC schedule exhibited very large kinks in the 1970s (up to 35 percentage points). Such large kinks are more salient than smaller kinks and they mechanically generate large discontinuities in one of the earning distributions. This increases the probability of observing discontinuities in the distribution of observed earnings (for a discussion on observed versus calculated earnings, see Bosch and Micevska-Scharf 2017, in the case of the Netherlands).

A second noteworthy aspect of the French legislation is the large number of thresholds and potential discontinuities that it creates. In particular, the French SSC schedule is different for executives and non-executives, and it includes no less than three thresholds for each of these two groups of workers. In total, there are 210 thresholds that can be studied over the period covered by the data. All of them correspond to a discontinuous decrease in the marginal SSC rate and induce a concave kink in the total amount of SSCs paid, as well as in the average SSC rate. We take advantage of this large amount of information to carry out a systematic study of the discontinuities generated by SSC

[1] Note that the analysis is complicated by the fact that there are two different types of SSCs (employer and employee SSCs) whose incidence may be different. As one earning concept is usually observed (typically earnings gross of employee SSCs and net of employer SSCs), the discontinuity in this earning concept can reflect a mix of the incidence of employer and employee SSCs if the marginal rate of both of them changes discontinuously at the considered threshold. See Alvaredo et al. (2017) and below for details.

thresholds. In particular, we exploit variations over time, across thresholds, and across group of workers (executives versus non-executives), in the size of the kinks in both the employer and employee SSC schedule, to assess the incidence of both types of contributions separately. We also investigate whether the estimated discontinuities in the gross earnings distribution vary across time periods, the size of the corresponding kink, and the location of the kink in the earnings distribution (median wage earners versus top wage earners).

The third potentially interesting institutional feature of French SSCs is that they are computed based on *hourly* wages. This implies that workers cannot avoid SSC thresholds by reducing or increasing their hours of work. The French setting therefore limits possible behavioral responses (except those due to adjustments in effort provision or tax avoidance) that would tend to create dips in the earnings distribution at thresholds where the marginal SSC rate drops discontinuously. In the absence of frictions, the dips generated by behavioral responses would create holes in the distributions, thereby preventing the estimation of purely "deterministic" discontinuities at kink points (Bosch and Micevska-Scharf 2017). With frictions, the interpretation of discontinuities at kink points would be unclear if behavioral responses are observed (see Alvaredo et al. 2017). By removing the incentive to adjust hours to avoid the kink, the French setting facilitates the estimation of discontinuities at kink points—hours of work responses are less of a concern. Nevertheless, it also implies that one cannot interpret the incidence estimates as the standard combination of labour supply and labour demand elasticities. It calls instead for a richer framework in which workers can adjust their productivity through effort or training, and firms can substitute workers with slightly different levels of productivity.

The remainder of the paper is organized as follows. Section 2 presents the institutional rules regarding SSCs in France and the data we use. Section 3 describes a simple framework where the multiple thresholds available in the French setting can be exploited to recover general estimates. Results are presented in Sect. 4 and are discussed in the concluding section.

2 Institutional Framework and Data

2.1 Social Security Contributions in France

The French welfare state is heavily influenced by the model of social insurance, funded by SSCs, in domains such as health care, pensions, unemployment insurance but also family benefits. There is a large number of different SSCs, one for each scheme and type of risk. For instance, there is a specific contribution for the main pension system of private sector employee, one funding family benefits, another one funding unemployment insurance, etc. Table 1 reports the main SSCs, their rates, and the earnings threshold at which each rate applies at the start and end of our period of study (1976 and 2010).

The different schemes are subject to different types of governance. For instance, the main social security schemes (health insurance, main old-age insurance and family benefits) are managed by social security administrations, under close supervision from

Table 1 Social security contributions for private sector wage earners (1976 vs. 2010)

Social security contribution	Threshold	Rate	
		1976 (%)	2010 (%)
Panel A: Pensions			
Main pension scheme (CNAV)—employee	SST	3.25	6.65
Main pension scheme (CNAV)—employer	SST	7.50	8.30
Main pension scheme (CNAV)—employee	Uncapped	0.0	0.10
Main pension scheme (CNAV)—employer	Uncapped	0.0	1.6
Complementary scheme (ARRCO)—employee	SST	1.76	3.0
Complementary scheme (ARRCO)—employer	SST	2.64	4.5
Non-executive complementary scheme (ARRCO)—employee	SST-3SST	1.76	8.0
Non-executive complementary scheme (ARRCO)—employer	SST-3SST	2.64	12.0
Executive complementary scheme (AGIRC)—employee	SST-4SST	2.0	7.7
Executive complementary scheme (AGIRC)—employer	SST-4SST	6.0	12.6
Executive complementary scheme (AGIRC)—employee	4SST-8SST	0.0	7.7
Executive complementary scheme (AGIRC)—employer	4SST-8SST	0.0	12.6
Additional complementary scheme (AGFF)—employee	SST	0.0	0.8
Additional complementary scheme (AGFF)—employer	SST	0.0	1.2
Additional non-exec. comp. scheme (AGFF)—employee	SST-3SST	0.0	0.9
Additional non-exec. comp. scheme (AGFF)—employer	SST-3SST	0.0	1.3
Additional exec. comp. scheme (AGFF)—employee	SST-4SST	0.0	0.9
Additional exec. comp. scheme (AGFF)—employer	SST-4SST	0.0	1.3
Exceptional and temporary exec. contribution (CET)—employee	8SST	0.0	0.13
Exceptional and temporary exec. contribution (CET)—employer	8SST	0.0	0.22
Panel B: Unemployment insurance			
Unemployment insurance—employee	SST	0.48	2.4

Table 1 continued

Social security contribution	Threshold	Rate	
		1976 (%)	2010 (%)
Unemployment insurance—employer	SST	1.92	4.0
Unemployment insurance—employee	SST-4SST	0.48	2.4
Unemployment insurance—employer	SST-4SST	1.92	4.0
Job placement for executives (APEC)—employee	SST-4SST	0.024	0.024
Job placement for executives (APEC)—employee	SST-4SST	0.036	0.036
Panel C: Health care			
Health insurance—employee	SST	2.5	0.0
Health insurance—employer	SST	10.45	0.0
Health insurance—employee	Uncapped	1.5	0.75
Health insurance—employer	Uncapped	2.5	12.8
Panel D: Family benefits			
Family benefits—employer	SST	9.0	0.0
Family benefits—employer	Uncapped	0.0	5.4

SST refers to the social security threshold and 3SST to three times this threshold. The SSCs presented in this table are the main SSCs for private sector earners. It does not include specific schemes like regional schemes or various payroll taxes

the French government, while unemployment insurance and complementary pension schemes are managed solely by employer and employee unions. SSCs can also be characterised by various degrees of tax-benefit linkage. For instance, there is almost no tax-benefit linkage for health SSCs or family SSCs, which fund universal benefits (i.e., free health care and family benefits), whereas complementary pension schemes, using a point-based system to compute pension benefits, are characterised by a very salient tax-benefit linkage.

The SSC tax schedule in France is similar to that observed in most OECD countries. The tax base is gross earnings or posted earnings, capped at different thresholds. The reference threshold, which is referred to as the social security threshold (SST) corresponds roughly to mean gross earnings, and SSCs are defined with respect to one, three, four and eight times the SST. Figure 1 shows how the marginal SSC rate (including both employer and employee contributions) drops discontinuously as the different thresholds, for executives (top panel) and non-executives (bottom panel) in 1976 and 2010.

A distinctive feature of French SSCs is that the main threshold (1*SST) is lower than in most other countries (around P70), while there are SSCs for very high level of earnings (the highest threshold being set at approximately P99.95). Importantly for our empirical strategy, the SSC schedule is computed on the basis of hourly wages, i.e., the SST is adapted to the actual hours of work and duration of the job spell. This

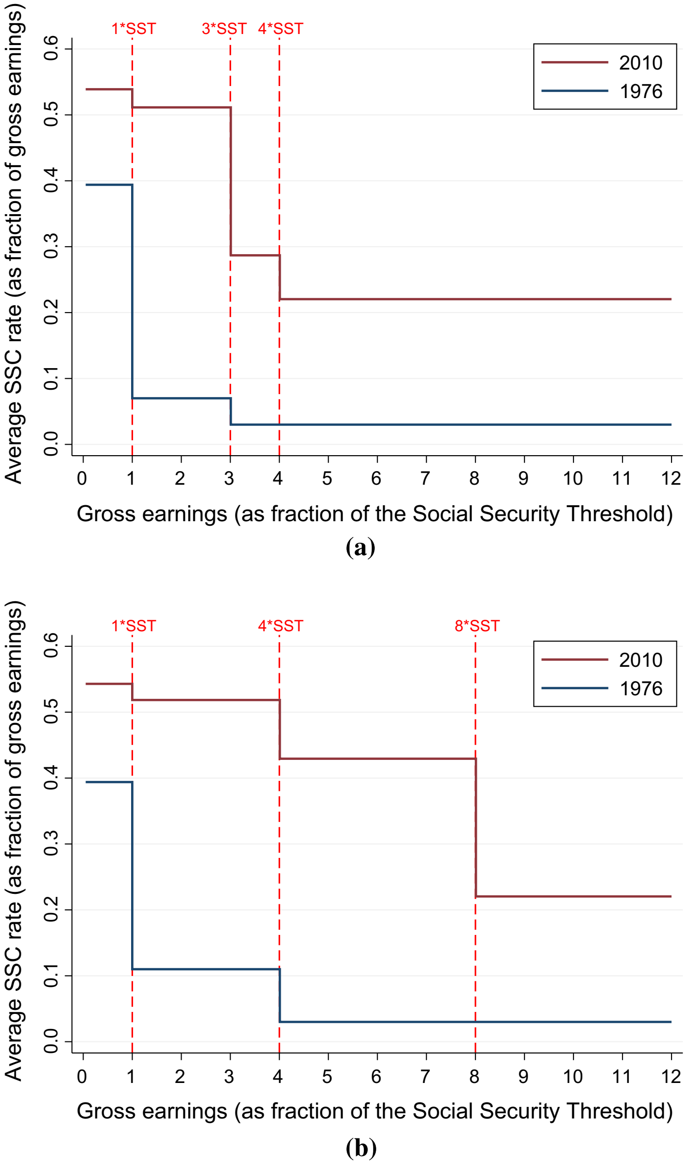


Fig. 1 Marginal SSC rates (employer + employee) by bracket of gross earnings, private sector, 1976 and 2010. **a** Non-executives, **b** executives. *Notes* Marginal tax rates are here expressed as a percentage of gross earnings, as they are legislated. These rates are applied to different fraction of earnings, which are defined with respect to the social security threshold (SST). *Sources* IPP tax and benefit tables (April 2016); TAXIPP 0.4

implies that marginal tax rates are unaffected by changes in hours of work—unlike income taxation.

To be explicit about notations, we denote throughout the paper gross earnings (or posted earnings) by y. Labour cost z is defined as earnings inclusive of employer and

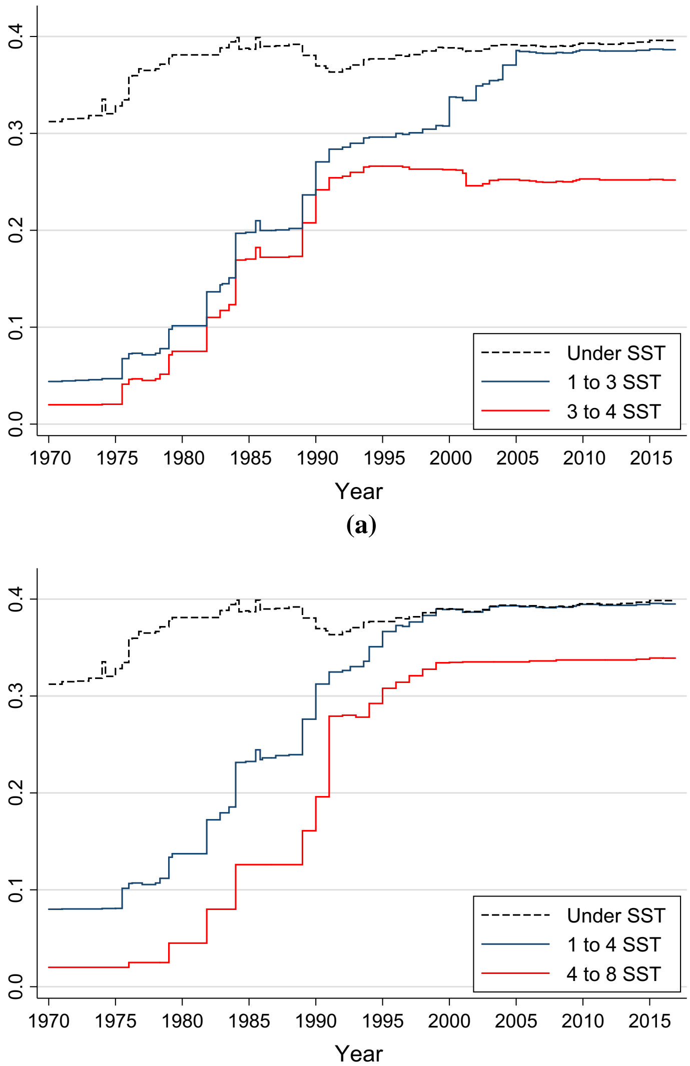
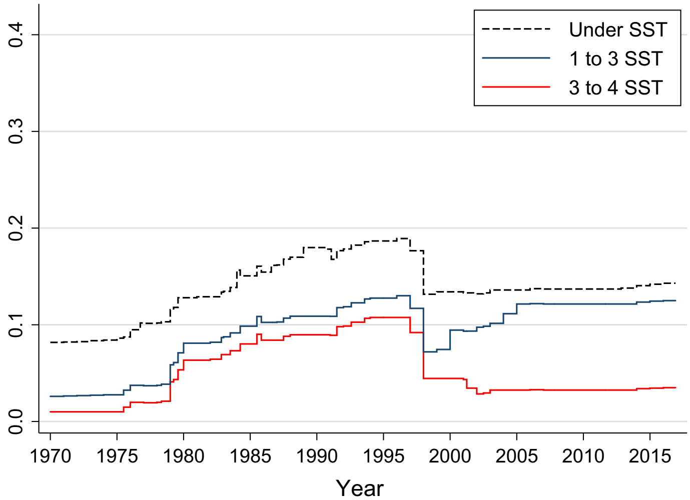


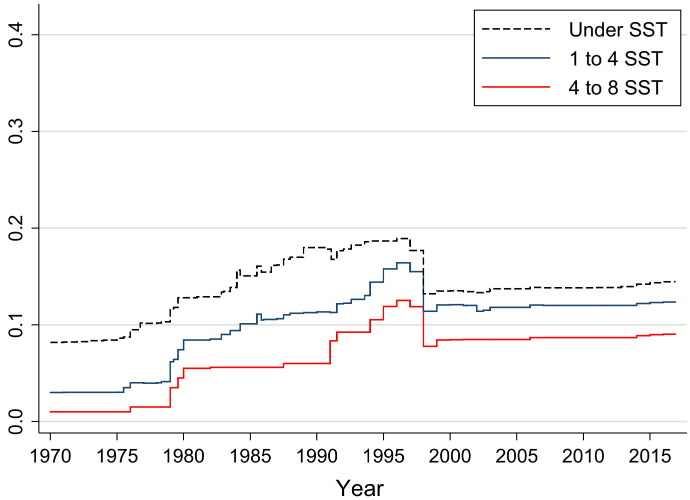
Fig. 2 Marginal employer SSC rates, private sector, 1970–2016. **a** Non-executives, **b** executives. *Notes* Marginal tax rates are here expressed as a percentage of gross earnings, as they are legislated. These rates are applied to different fraction of earnings, which are defined with respect to the social security threshold (SST). *Sources* IPP tax and benefit tables (April 2016); TAXIPP 0.4

employee SSCs, and net earnings c are defined as earnings net of employee SSCs. This is the amount that the worker actually receives before paying the income tax.

Figure 2 shows the evolution over the period 1970–2016 of marginal SSC rates for different fractions of earnings, separately for non-executive workers (top panel) and for executives (bottom panel), who are covered by a mandatory pension scheme up to 8 times the SST. While the rates of employer SSCs that apply to the fraction of earnings



(a)



(b)

Fig. 3 Marginal employee SSC rates, private sector, 1970–2016. **a** Non-executives, **b** executives. *Notes* Marginal tax rates are here expressed as a percentage of gross earnings, as they are legislated. These rates are applied to different fraction of earnings, defined with respect to the social security threshold (SST). *Sources* IPP tax and benefit tables (April 2016); TAXIPP 0.4

below the SST have increased modestly (from 36% in 1976 to 38% in 2010), the rates applied to the fraction of earnings above the SST increased dramatically during the same period (from 7 to 38% for non-executives, from 10 to 38% for executives). Figure 3 provides similar evidence for the marginal employee SSC rates. The levels are much lower, reflecting the predominance of employer SSCs in the French SSC schedule, and variations over time are also less frequent. The main reform took place in the late 1990s, with the shifting of part of employee SSCs to a general income tax (*Contribution sociale généralisée*, CSG; and *Contribution au remboursement de la dette sociale*, CRDS).

Finally, we present in Fig. 4 the size of the drop in the marginal SSC rate at each threshold over time, which is the variation we exploit in this paper. By and large, the largest discontinuities are observed in earlier years at the lowest threshold (1*SST), while they tend to increase at higher thresholds—as marginal rates converge below the highest thresholds. These changes were driven by a continuous process of uncapping of SSCs (which were previously capped at the SST).

2.2 Data

Our primary data source comes from the matched employer–employee panel *Déclaration Annuelle de Données Sociales* (DADS), which is constructed by the French National Institute for Statistics (INSEE) from the compulsory social security declarations made annually by all employers for each of their employees. The main purpose of these declarations is to provide the different social security schemes with the information required to determine workers' eligibility to benefits and to compute their levels, notably for pension schemes. The raw DADS data have been transformed by the INSEE into user files available to researchers under restricted access.[2] The panel version of the DADS consists of a 1/25 sample of private sector employees, born in October of even-numbered years, from 1976 onwards. In 2002, the sample size was doubled to represent 1/12 of all private sector workers. The data includes roughly 1.1 million workers each year between 1976 and 2001, and 2.2 million workers from 2002 onwards. Unfortunately, some years of the original data sources were lost (1981, 1983 and 1990) and are therefore missing in the panel data.

The DADS Panel provides information about the firm (identifier, sector, size) and each job spell (start and end date, earnings, occupation, part-time/full-time). Hours of work are recorded since 1993. Importantly for our study, raw data about earnings come under the form of "net taxable earnings", i.e., earnings reported for income tax. Gross earnings reported by employers are available since 1993.[3] In earlier years, they were only estimated by the INSEE on the basis of the reported net taxable earnings. Finally, the DADS Panel records a measure of reported net earnings since 1993, which corresponds to earnings as paid through the pay slip, i.e., after deduction of some specific employee contributions to restaurant vouchers or public transport cards.

To implement our estimation strategy, we need to compute gross earnings, as the SST is defined in relation to this earnings concept. We use the TAXIPP model developed at the Institut des politiques publiques (IPP) to compute gross earnings in all years

[2] We were granted access to the DADS data by the decisions of the *Comité du secret statistique* ME27 of 02/10/2013, ME56 of 25/06/2014 and ME91 of 25/06/2015.

[3] The variable reported in the data is the tax base for Contribution sociale généralisée, a concept close but not exactly the same as the gross earnings tax base of SSCs (some forms of remunerations are included in the former, but not in the latter).

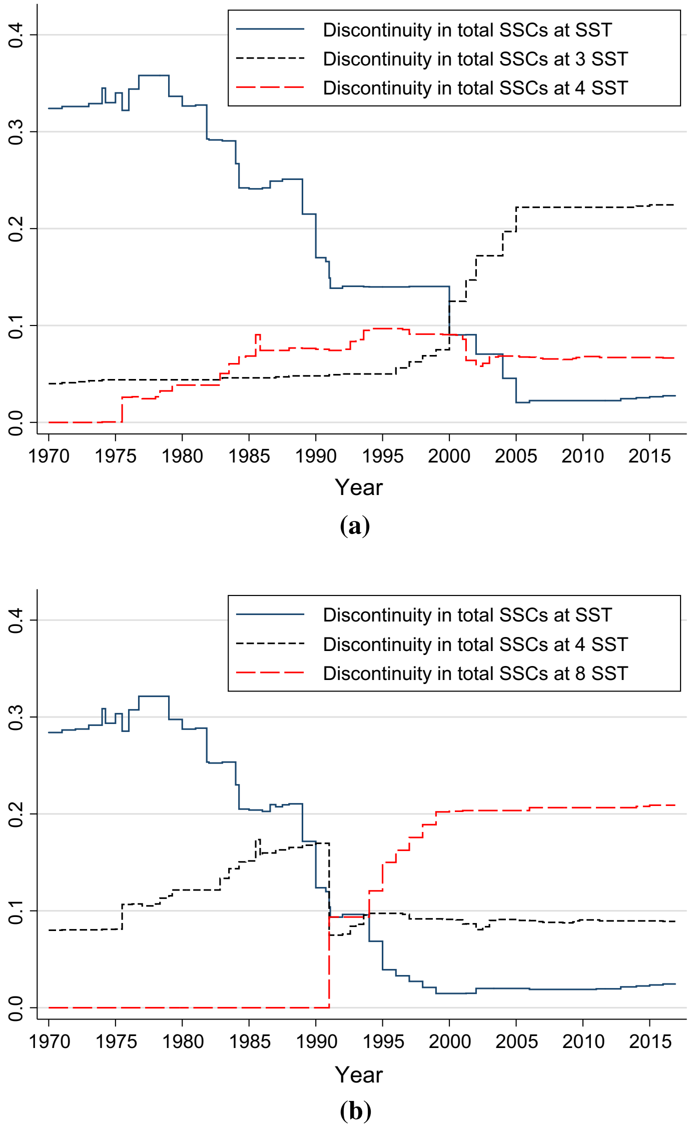


Fig. 4 Drop in total SSC rates at various thresholds, private sector, 1970–2016. **a** Non-executives, **b** executives. *Notes* Marginal tax rates are here expressed as a percentage of gross earnings, as they are legislated. These rates are applied to different fraction of earnings, which are defined with respect to the social security threshold (SST). The figure reports the marginal tax rate to the *left* of the threshold minus the marginal tax rate to the *right* of the threshold. *Sources* IPP tax and benefit tables (April 2016); TAXIPP 0.4

based on the recorded net taxable earnings. The model takes as input the SSC schedule, which is collected in the IPP Tax and Benefit Tables[4] and computes employee and employer SSCs, reductions in employer SSCs, flat-rate income tax (CSG and CRDS) as well as other payroll taxes. One limitation of our data is that it lacks hours of work before 1993, which implies that we cannot accurately estimate gross earnings for part-time workers before 1993.

In our empirical analysis, we use both observed gross earnings since 1993 and calculated gross earnings (from net taxable earnings) since 1976. We are thus able to exploit the large discontinuities from the earlier period, and we can compare the estimated discontinuities using the two measures of gross earnings (observed versus calculated) for the period after 1993.

3 Methodological Framework

The main methodology that we use in this paper has been presented in the introduction to this special issue (Alvaredo et al. 2017). Here, we discuss issues related to sample restrictions, as well as a general framework to exploit the multiple kinks that are available in the French context.

3.1 Sample Restrictions

We restrict the analysis to workers with a single job in a given year, and who work full time during the entire year. These sample restrictions are aimed at limiting measurement error, which has been shown to considerably blur the discontinuities in the earnings distributions at kink points (see Neumann 2015; Bosch and Micevska-Scharf 2017). The first restriction is to avoid several complications in the calculation of SSCs for multiple job earners. The second restriction is motivated by the fact that the location of kink points depends on hours of work and cannot therefore be computed with certainty for part-time workers before 1993—hours of work being unobserved during that period. The final restriction stems from the fact that annual updates in the value of the SST often occur in the middle of a calendar year. For workers employed during the entire year, SSCs are computed based on an annual SST, which is the sum of 12 (possibly different) monthly SSTs. For these workers, the thresholds are unambiguous. By contrast, we do not know the exact timing of earnings for workers who are only employed during part of the year, which makes it impossible to compute the applicable thresholds with reasonable accuracy.

The analysis is performed separately for executives and non-executives—as different marginal SSC rates apply to each group—for all years between 1976 and 2010. Since there are three kink points in the SSC schedule for both executives (at 1*SST, 4*SST and 8*SST) and non-executives (at 1*SST, 3*SST and 4*SST) each year, the analysis includes no less than 210 possible discontinuities in the distribution of calculated gross earnings, and 108 possible discontinuities in the distribution of observed gross earnings (1993–2010 only). The number of observations is too small to estimate

[4] See http://www.ipp.eu/en/tools/ipp-tax-and-benefit-tables/social-security-contributions/.

some of the discontinuities at 4*SST for non-executives, leaving us with a final sample of 192 (resp. 108) estimated discontinuities in the distribution of calculated (resp. observed) gross earnings. Finally, we estimate "placebo" discontinuities at 2*SST (where there is no kink) for both executive and non-executives in all years covered by our sample.

3.2 Exploiting Multiple Kinks

As both employer and employee SSCs exhibit kinks at each of the considered thresholds, finding no evidence of discontinuities in gross earnings is hard to interpret. This may indeed reflect different combinations of distinct incidences of employer and employee SSCs. Fortunately, the availability of multiple discontinuities makes it possible to separately identify "shifting parameters", which we denote by s_r and s_e, for both employer and employee SSCs, provided that the parameters are constant across kinks. We examine this possibility below, by first introducing the parameters formally, and then by estimating them using non-linear least squares on the entire sample, and on various subsamples of kinks.

In what follows, we denote by $T_r(y)$ the SSCs that are *nominally* paid by employers, and by $T_e(y)$ the SSCs *nominally* paid by employees. Both functions $T_r(\cdot)$ and $T_e(\cdot)$ are assumed to be increasing with y, and the sum of their derivatives to be between 0 and 1, i.e., the total tax rate does not exceed one. We thus have $z = y + T_r(y)$ and $c = y - T_e(y)$.[5]

We then introduce "counterfactual earnings", n, which are defined as the earnings that would be observed in the absence of SSCs, i.e., when $T_r = T_e = 0$, we have $z = y = c = n$. Our key assumption is that n has a continuous probability density function $p(\cdot)$, with c.d.f. denoted by $P(\cdot)$. The counterfactual earnings n may be understood as an underlying ability parameter that affects earnings and is smoothly distributed. Under perfect competition, n would simply be equal to each worker's marginal productivity.

We finally consider two "shifting parameters", s_r and s_e, that are identical across earnings and tax levels. The parameters s_r and s_e are defined as the fractions of employer and employee SSCs that are *effectively* borne by *employers*, based on the comparison of observed and counterfactual earnings. Namely, we have:

$$\begin{cases} z &= n + s_r T_r(y) + s_e T_e(y) \\ y &= n - (1 - s_r) T_r(y) + s_e T_e(y) \\ c &= n - (1 - s_r) T_r(y) - (1 - s_e) T_e(y) \end{cases}$$

The above equations allow us to relate discontinuities in the distribution of earnings at kink points in the tax schedule, i.e., points where the derivatives of $T_r(\cdot)$ and $T_e(\cdot)$ are discontinuous. Denoting F (resp. f) the c.d.f. (resp. the p.d.f.) of y, we have:

[5] Income tax also induces mechanical discontinuities in earnings distribution at thresholds in its schedule. However, the thresholds in the income tax schedule are different from those in the SSC schedule. There is therefore no risk of contamination of our local estimates by the income tax, and we do not model it for simplicity.

$$\begin{cases} F(y) = P\left(y + (1 - s_r)T_r(y) - s_e T_e(y)\right) \\ f(y) = \left(1 + (1 - s_r)T_r'(y) - s_e T_e'(y)\right) p(n) \end{cases}$$

The p.d.f. of y on each side of a given kink point $\overline{y}$ can then be written:

$$\begin{cases} f(\overline{y})_- = \left(1 + (1 - s_r)t_r^- - s_e t_e^-\right) p(n)_- \\ f(\overline{y})_+ = \left(1 + (1 - s_r)t_r^+ - s_e t_e^+\right) p(n)_+ \end{cases}$$

with t_r^-, t_r^+, t_e^- and t_e^+, the employer and employee marginal tax rates to the left and right of the kink point. Since $p(\cdot)$ is a continuous function, we have:

$$disc_{\overline{y}} = \frac{f(\overline{y})_+ - f(\overline{y})_-}{f(\overline{y})_-} = \frac{(1 - s_r)(t_r^+ - t_r^-) - s_e(t_e^+ - t_e^-)}{1 + (1 - s_r)t_r^+ - s_e t_e^+} \tag{1}$$

Even if s_r and s_e cannot be directly interpreted as the standard microeconomic incidence of SSCs resulting from supply and demand responses, it is informative of the way employer and employee SSCs are shared, at least locally around kink points. Equation (1) clarifies the relationship between the shifting of SSCs and the sign of the discontinuities at kink points. For example, if both employer and employee SSCs are expected to be incident on employees (standard case), we have $s_r = s_e = 0$ and $\frac{f(\overline{y})_+ - f(\overline{y})_-}{f(\overline{y})_-} = \frac{(t_r^+ - t_r^-)}{1 + t_r^+}$. In that case, a concave kink ($t_r^+ - t_r^- < 0$) leads to a *drop* in the density of observations at the kink.

Equation (1) also shows that s_e and s_r cannot be separately identified based on a single kink. Under the assumption that the parameters s_e and s_r are constant across years or countries, they can however be separately identified using different kinks for different years or countries. Equation (1) can, for instance, be fitted using non-linear least squares if more than one estimated discontinuity is available. A specific contribution of this paper is to do undertake such an exercise.

4 Results

In this section, we present the results based on the analysis of possible discontinuities in the distribution of gross earnings at each kink point in the SSC schedule for the period 1976–2010. We then provide evidence exploiting the multiple kinks that are available in the French context.

4.1 Graphical Evidence

We start with a visual inspection of discontinuities in the earnings distribution at the SST, where the kink is the largest and therefore provides the most statistical power, as compared to kinks higher up in the earnings distribution. The graph in the upper-left corner of Fig. 5 shows the distribution of calculated gross earnings around the SST for all workers (i.e., executives and non-executives) in 1978, which is the year with the largest kink. The total SSC rate drops from 51.5 to 15.7% for non-executives,

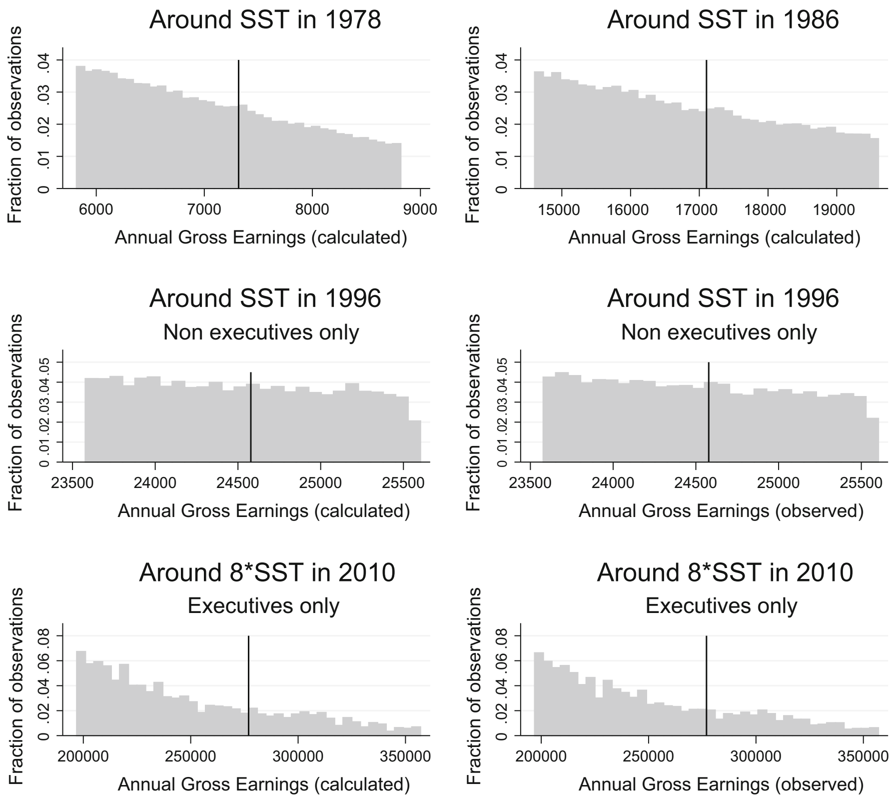


Fig. 5 Density of annual gross earnings around kinks: examples. *Notes* The graphs for 1978 and 1986 are based on the sample of workers working full-time during the entire year whose earnings are within the represented window. The number of observations is 127,762 in 1976, and 123,965 in 1986. The graphs for non-executives in 1996 are based on 17,878 observations. The graphs for executives in 2010 are based on 1740 observations

and from 51.5 to 19.4% for executives. This represents a 35 percentage point drop for non-executives, and a 32 percentage point drop for executives. The graph in the upper-right corner presents similar evidence for 1986, when the total SSC rate drops by 24.5 percentage points for non-executives, and by 21.8 percentage points for executives at the SST. None of the two plotted distributions exhibits a visible discontinuity at the SST, nor is there any graphical evidence of a behavioral response due to the kink, such as a dip in the distribution to the right of the kink point. Note, however, that the French legislation makes such responses unlikely in the case of full-time workers (our sample), since the SST itself is proportional to the number of hours worked. Only adjustments in effort provision or tax avoidance might affect the distribution of gross earnings around the SST in France.

The middle and lower graphs in Fig. 5 show similar distributions for non-executives at the SST in 1996, and for executives at 8*SST in 2010. The marginal SSC rate at those points drops respectively by 14 and 21 percentage points.[6] Since actual gross earnings are observed after 1993, we present evidence based on both calculated gross earnings (left-hand side) and observed gross earnings (right-hand side). The distributions, plotted at different points of the earnings distribution, are remarkably continuous, irrespective of whether we consider observed or calculated gross earnings.

4.2 General Patterns of Estimated Discontinuities

To confirm the visual impression that there are no sizeable discontinuities at kink points, we carry out a systematic estimation of their magnitude. Because discontinuity measures can be quite sensitive to the estimation methods and adopted empirical specifications, we apply the two empirical methods (denoted 1 and 2) that are used in the papers included in this issue. For each of these strategies, we further consider two alternative empirical implementations (denoted A and B). We therefore provide four estimates for each kink point (1.A, 1.B, 2.A and 2.B).

Method 1 relies on the nonparametric sorting test proposed by McCrary (2008), which estimates the density to the left and right of the SSTs using local linear regression. Method 2 consists in fitting a flexible polynomial function to the density values at the center of each histogram bin. The discontinuity is measured by the coefficient on an indicator variable which takes the value one for bins above the threshold, and zero for bins below the threshold. We place greater weight on results from method 2 as it seems slightly more appropriate to capture a step in the density at a threshold which is likely to continue further above it (Alvaredo et al. 2017).

In practice, separate estimations are performed at each SST and/or for each occupation group, to account for differences in the density of earnings across kinks and occupation groups. Specification choices are kept constant across years. The details of the two different empirical implementations of each method at each kink point are provided in the “Appendix”. In total, our comprehensive analysis of kinks points in the SSC schedule in France relies on 1,006 estimates of possible discontinuities in the distribution of calculated gross earnings (including 144 placebo estimates at 2*SST), and 560 estimates of possible discontinuities in the distribution of observed gross earnings.[7]

For each of the four proposed methods, Table 2 reports summary statistics for the estimated normalized discontinuities ($\frac{f(\overline{y})_{+}-f(\overline{y})_{-}}{f(\overline{y})_{-}}$) in the distributions of both calculated and observed gross earnings at kinks point in the SSC schedule. Discontinuities estimated at each threshold are systematically normalized by the density of gross earnings immediately to the left of the point at which they are estimated, so that they can be interpreted as a fraction of this density. For some of the proposed methods, we had

[6] We consider here the largest kink for non-executives at the SST during the post-1993 period. Note that the kink at the SST has almost entirely disappeared for executives in 1996, which is one of the reasons why, for this group, we investigate higher up in the distribution where large kinks have appeared.

[7] Those sample statistics include estimates at the placebo kink at 2*SST. Also, the very small number of non-executives with earnings around 4*SST does not allow to convincingly estimate the discontinuity in non-executives’ earnings at this threshold using all four methods for some years.

Table 2 Summary statistics on discontinuities in the distribution of calculated and observed gross earnings at kink points in the SSC schedule

Estimation method	Method 1.A[a] (1)	Method 1.B (2)	Method 2.A (3)	Method 2.B (4)
Panel A: 1976–2010 (calculated gross earnings)				
Number of estimated discontinuities	191	175	192	192
Mean discontinuity	0.039	0.038	−0.054	−0.049
Standard deviation of discontinuities	0.323	0.252	0.391	0.228
Fraction significantly different from zero[b]	0.162	0.171	0.094	0.089
Including positive only	0.126	0.120	0.063	0.078
Including negative only	0.037	0.051	0.031	0.011
Panel B: 1976–1992 (calculated gross earnings)				
Mean discontinuity	0.111	0.092	−0.006	−0.030
Standard deviation of discontinuities	0.274	0.229	0.349	0.227
Fraction significantly different from zero	0.179	0.169	0.131	0.096
Including positive only	0.143	0.133	0.083	0.084
Including negative only	0.036	0.036	0.048	0.012
Panel C: 1993–2010 (calculated gross earnings)				
Mean discontinuity	−0.018	−0.010	−0.092	−0.064
Standard deviation of discontinuities	0.348	0.263	0.418	0.228
Fraction significantly different from zero	0.150	0.174	0.065	0.083
Including positive only	0.112	0.109	0.046	0.073
Including negative only	0.037	0.065	0.019	0.010
Panel D: 1993–2010 (observed earnings)				
Mean discontinuity	0.058	−0.020	−0.116	−0.088
Standard deviation of discontinuities	0.443	0.217	0.404	0.253
Fraction significantly different from zero	0.102	0.098	0.074	0.053
Including positive only	0.083	0.076	0.019	0.011
Including negative only	0.019	0.022	0.056	0.042

The table reports statistics on the estimated discontinuities computed from our panel datasets of calculated gross earnings (period 1976–2010) and observed gross earnings (period 1993–2010). The discontinuity at a given kink is normalized by the density of the corresponding distribution to the left of that kink point. The placebo kink at 2*SST has been excluded from the analysis

[a] The methods correspond to different empirical strategies used to estimate the discontinuities in the earning distributions. Estimates 1.A and 1.B are based on the McCrary (2008) procedure (using different bandwidths and windows), whereas 2.A and 2.B are based on polynomial methods (again, using different bandwidths and windows). See details in the “Appendix”

[b] Fraction significantly different from zero is given at the 5% statistical level, i.e., when the *t* statistics associated to the estimated kinks are above or below 1.96

to exclude certain kinks from the analysis as the number of observations was too small to apply the method.

When the McCrary procedure is used (estimates 1.A and 1.B), the discontinuities estimated for the distributions of calculated gross earnings over the period 1976–2010 are on average positive (i.e., $disc_{\overline{y}} > 0$) and amount to approximately 4% of the density at the kink point. Note that this is not the sign that we would expect if both employee and employer SSCs were fully incident on workers, as is often assumed in the literature. However, the standard deviation of the estimated discontinuities is very large, showing that there is wide dispersion. By contrast, estimates obtained using polynomial methods (estimates 2.A and 2.B) are on average negative, but are highly scattered. Whichever approach is used, the estimated discontinuities are not significantly different from zero on average (at any reasonable statistical level). Reassuringly, they are also not significantly different from each other across methods.

For each empirical approach, we then compute the share of the estimated discontinuities that are significant at the 5% level. Under the assumption of no discontinuities at all examined kinks, we would expect this share to converge towards 5% as the number of kinks considered goes to infinity. We find a slightly higher share of significant discontinuities—between 9 and 17% depending on the method. The statistically significant discontinuities are two to five times more often positive than negative.

The patterns outlined above are also observed when we consider subperiods of the data (1976–1992 and 1993–2010). The results obtained using calculated and observed gross earnings over the period 1993–2010 are also in line, showing that the computation of gross earnings from net earnings does not significantly bias the analysis by mechanically introducing kinks in the distribution of gross earnings. The only difference is that the number of significant discontinuities is closer to 5% when we use observed earnings, which is the expected share if the the distribution of gross earnings is in fact smooth at the thresholds.

Table 3 then provides summary statistics on subsamples of the discontinuities in the distribution of *calculated* gross earnings. There are no striking differences across subsamples. The few noteworthy points are that (i) differences between executives and non-executives are small; (ii) there are more significantly positive kinks at 1*SST than at kinks higher up in the distribution (at 3, 4 and 8*SST); (iii) the estimated discontinuities are smaller for the placebo kink at 2*SST; and (iv) the fraction of estimated discontinuities that are significantly different from zero at the 5% level is closer to 5%.

Overall, the results in Tables 2 and 3 show no clear evidence of discontinuities in the earnings distribution at kink points in the SSC schedule. The only piece of evidence consistent with the existence of discontinuities is that the share of significant discontinuities at the 5% level is slightly higher than 5%, and that these significant discontinuities are more often positive than negative.[8] If anything, this finding goes against the hypothesis of SSCs being incident on workers, as negative discontinuities would be expected in that case.

To further investigate whether the few significant estimates represent anything else than a statistical artifact, we relate the estimated discontinuities to the corresponding kinks in the SSC schedule. If the earnings distributions were truly discontinuous, larger kinks should on average be associated with larger discontinuities. Figure 6 plots

[8] To ensure consistency across estimations, we used a common polynomial order for each group of estimates. We did not therefore apply the optimal estimation procedure separately for each discontinuity, which may explain the fact that the share of significant discontinuities at the 5% level is slightly higher than the nominal rate of 5%.

Table 3 Summary statistics on subsamples of the discontinuities in the distribution of calculated gross earnings

Estimation method	Method 1.A[a] (1)	Method 1.B (2)	Method 2.A (3)	Method 2.B (4)
Panel A: Social security threshold (SST)				
Mean discontinuity	0.031	0.043	0.038	0.030
Standard deviation of discontinuities	0.095	0.084	0.102	0.125
Fraction significantly different from zero[b]	0.250	0.281	0.172	0.172
Including positive only	0.234	0.250	0.156	0.156
Including negative only	0.016	0.031	0.016	0.016
Panel B: Three, four and eight times the SST				
Mean discontinuity	0.043	0.036	−0.100	−0.088
Standard deviation of discontinuities	0.391	0.310	0.467	0.256
Fraction significantly different from zero	0.118	0.108	0.055	0.043
Including positive only	0.071	0.045	0.016	0.035
Including negative only	0.047	0.063	0.039	0.009
Panel C: Two times the SST (placebo)				
Mean discontinuity	−0.002	0.002	0.013	0.008
Standard deviation of discontinuities	0.074	0.072	0.088	0.080
Fraction significantly different from zero	0.047	0.094	0.047	0.047
Including positive only	0.031	0.063	0.047	0.047
Including negative only	0.016	0.031	0.000	0.000
Panel D: One, four and eight times the SST, executives				
Mean discontinuity	0.031	0.040	−0.116	−0.096
Standard deviation of discontinuities	0.232	0.235	0.315	0.270
Fraction significantly different from zero	0.146	0.146	0.094	0.063
Including positive only	0.094	0.083	0.031	0.042
Including negative only	0.052	0.063	0.063	0.021
Panel E: One, three and four times the SST, non-executives				
Mean discontinuity	0.047	0.037	0.008	−0.001
Standard deviation of discontinuities	0.396	0.273	0.447	0.165
Fraction significantly different from zero	0.179	0.203	0.094	0.120
Including positive only	0.158	0.165	0.094	0.120
Including negative only	0.021	0.038	0.000	0.000

The table reports statistics on the estimated discontinuities computed from our panel dataset of calculated gross earnings (period 1976–2010), using different subsamples around kink points. The discontinuity at a given kink is normalized by the density of the corresponding distribution to the left of that kink. Except when otherwise mentioned, the reported statistics do not include the placebo kink at 2*SST

[a] The methods correspond to different empirical strategies used to estimate the discontinuities in the earning distributions. Estimates 1.A and 1.B are based on the McCrary (2008) procedure (using different bandwidths and windows), whereas 2.A and 2.B are based on polynomial methods (again, using different bandwidths and windows). See details in the “Appendix”

[b] Fraction significantly different from zero is given at the 5% statistical level (when the *t* statistics associated to the estimated kinks at above or below 1.96)

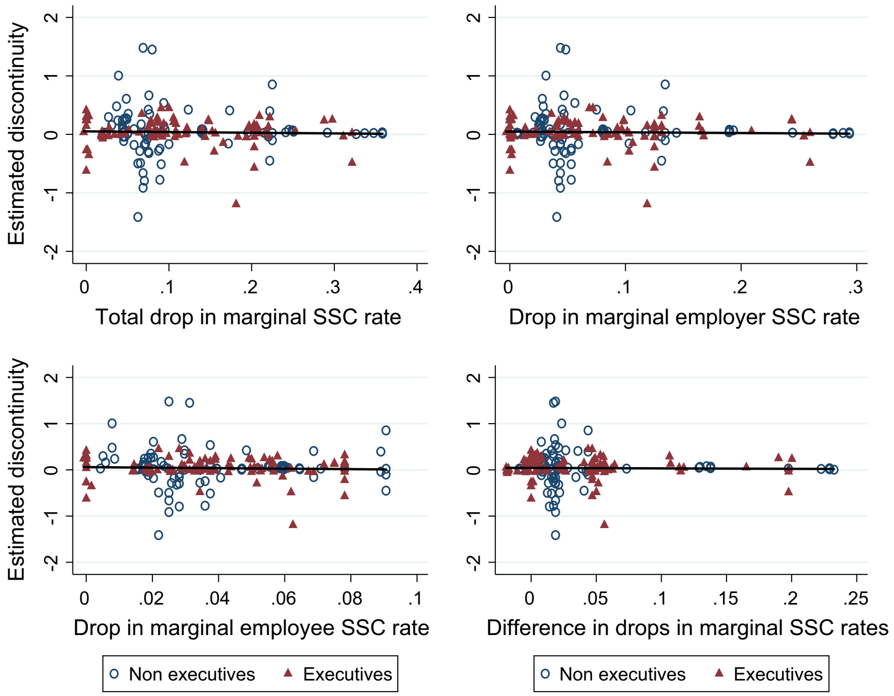


Fig. 6 Discontinuities in calculated gross earnings as a function of the kink size. *Notes* The *straight lines* show linear fits. The difference in drops in marginal SSC rates is the drop in employer SSC marginal rate minus the drop in employer SSC marginal rate at the kink

the discontinuities in the calculated gross earnings distribution (using estimates from the first method) against various measures reflecting the characteristics of the kink at which the discontinuity has been estimated.

The graph in the upper-right panel shows that for both executives and non-executives, the estimated discontinuities at kinks are uncorrelated with the total drop in the marginal SSC rate at the kink. Under the assumption that the incidence of employer and employee SSCs is identical, both types of SSCs should have opposite effects on the distribution of gross earnings at the kink (because gross earnings lie in between the two types of contributions). We therefore look separately at the relationships between the discontinuities and the associated drops in (i) employer marginal SSCs (upper-right panel); and (ii) employee marginal SSCs (lower-left panel). We finally check whether the difference between the drops in employer and employee marginal SSCs is related to the estimated discontinuities (lower-right panel). Discontinuities in calculated gross earnings seem unrelated to marginal SSC rates, irrespective of the measure we consider for the latter. The study of observed earnings after 1993, and a more formal statistical analysis, confirm this observation.

We finally look for a possible time trend in the incidence of SSCs, as limited evidence of a small trend towards a slight increase in the SSC burden falling on employees is found for Germany by Müller and Neumann (2017). Results are mixed. A regression of discontinuities estimated using the McCrary approach (estimates 1.A

Table 4 Non-linear least square estimates of the share of employer and employee SSCs that are shifted to employers

Method	Method 1.A (1)	Method 1.B (2)	Method 2.A (3)	Method 2.B (4)
s_r: share of employer SSCs	0.989*	1.207**	1.311*	1.322***
That are shifted to employers	(2.09)	(3.27)	(2.11)	(3.61)
s_e: share of employee SSCs	0.606	0.0132	−1.585	−1.833*
That are shifted to employers	(0.57)	(0.02)	(1.07)	(2.09)
Number of observations	191	175	192	192

The table presents estimates of s_r and s_e obtained from estimating Eq. (1) using non-linear least squares. Distinct estimates are provided depending on the method used to compute the discontinuities. t statistics are given in parentheses. The methods correspond to different empirical strategies used to estimate the discontinuities in the earning distributions. Estimates 1.A and 1.B are based on the McCrary (2008) procedure (using different bandwidths and windows), whereas 2.A and 2.B are based on polynomial methods (again, using different bandwidths and windows). See details in the "Appendix"
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

and 1.B) on a linear function of years reveals a negative time trend consistent with more of the burden of SSCs falling on employees. This trend corresponds to a downward shift of approximately 10% of the earnings density to the left of the threshold after approximately 30 years. However, it is not robust to using the polynomial approach (estimates 2.A and 2.B), which yields a trend virtually equal to 0. It is not robust either to restricting the sample to the period 1993–2010, nor to using estimates based on observed earnings during that period. Our conclusion is therefore similar to that of Müller and Neumann (2017) for Germany: there is some evidence, but very limited, of a time trend towards a slight increase in the SSC burden falling on employees.

The next section presents the results of exploiting the multiple kinks available in France to recover incidence estimates.

4.3 Recovering Incidence Estimates of SSCs from Multiple Kinks

Table 4 reports the estimates of the shifting parameters s_e and s_r, based on non-linear least squares applied to Eq. (1). Distinct estimates are provided for each of the four strategies that are used to estimate these discontinuities.[9] We consistently find that employer SSCs are shifted to employers (i.e., $\hat{s}_r$ is not significantly different from one). The shifting of employee SSCs is less clear, as our estimates are quite sensitive to the method used to compute the discontinuities in SSCs, and in some cases fall outside the range of the expected incidence (e.g., estimates 2.A and 2.B). Those estimates are nevertheless closer to zero than to one, i.e., more consistent with a shifting of employee SSCs to workers rather than to employers.

Overall, the results are consistent with the hypothesis that the economic incidence is close to the nominal incidence locally around the kinks—employer SSCs are shifted to employers while employee SSCs are shifted to employees. Estimating the shifting

[9] Note that the standard errors reported in this table do not account for the fact that the dependent variable is itself estimated.

parameters on subsamples of the data (discontinuities for executives or non-executives only, discontinuities at 1*SST only) produces fairly noisy estimates, but confirms the general pattern obtained using the full sample. The imprecision in estimates comes in part from the fact that drops in employer and employee SSCs are strongly correlated across kinks and types of workers, as well as over time. The correlation between $(t_r^+ - t_r^-)$ and $(t_e^+ - t_e^-)$ is indeed around 0.95, implying that Eq. (1) is difficult to estimate in practice due to the strong alignment of employer and employee SSCs. As France is probably the only country where separate estimates for employer and employee SSCs can be obtained, it is certainly worth providing such estimates, but the aforementioned caveat should be kept in mind.

5 Concluding Comments

We have found that concave kinks in employer and employee SSCs do not induce negative discontinuities in the distribution of gross earnings in France. This allows us to reject the hypothesis that SSCs are entirely incident on workers locally around the kinks. If it were the case, we would expect to observe negative discontinuities in the distribution of gross earnings. We also provide suggestive evidence that the economic incidence of SSCs is aligned with their nominal incidence. This finding—similar to the results obtained by other papers in this issue—is consistent with both labour demand and labour supply being very inelastic at kink points. However, Alvaredo et al. (2017) tend to favour alternative explanations such as bargaining norms or pay fairness norms. Rather than repeating their arguments, we offer a couple of additional comments that seem to be of particular relevance in the French case.

First, the lack of adjustment at kink points may also be in part explained by adjustment frictions, especially because the location of the kinks changes every year. This implies that for discontinuities to show up in the distribution of gross earnings, demand and supply adjustments to the kinks—mostly through effort in France—would need to occur in the short run, and to move at roughly the same pace as the social security threshold. Wages would also need to adjust sufficiently quickly to fully equate demand and supply in the short run. This seems to be a strong requirement, as earnings are typically negotiated once a year, usually at a different period than that at which the SSC thresholds are updated. Wage stickiness in the short run combined with the fact that concave kinks in the French SSC schedule vary every year, are not very salient, and typically generate limited behavioural responses, provide additional arguments to suggest that our results are not that surprising.

Finally, discontinuities at kink points in the earnings distribution identify incidence in a very local sense. The findings from this study may therefore not be extrapolated to more general and steady-state environments in which both quantities and prices have time to adjust, and in which expected adjustments are larger.

Appendix: Estimation of Discontinuities in the Distribution of Earnings at Kink Points

To estimate discontinuities in the distribution of earnings at a kink point k, we set two parameters:

(i) the window w is the total range of earnings that are considered on each side of the kink point k (we only consider symmetric windows around the kink);
(ii) the number of bins n_b is the number of sub-intervals into which the window will be divided before performing the analysis.

The bin size b is given by $b = w/n_b$.

Implementation A

Both the McCrary (2008) density test (Method 1) and the polynomial approach (Method 2) can be implemented after setting the values of the three parameters w, n_b and b. Our first empirical implementation relies on fixing the window w_1 first, and then use the formula proposed by McCrary (2008) to determine an optimal bin size and the number of bins given the window. We use $b_1 = 2 * \sigma_N * N^{-1/2}$, where N is the number of observations in the earnings interval $[k - w_1, k + w_1]$ and σ_N is the standard deviation of wage observations in this earnings interval.

We set $w_1 = \min(0.4 * SST, 0.9 * (\text{SST} - \text{MINWAGE}))$ for the kink at SST, where MINWAGE is the French minimum wage; $w_1 = 0.9 * \text{SST}$ for the kinks at $2 * \text{SST}$ (placebo), $3 * \text{SST}$ and $4 * \text{SST}$; and $w_1 = 3.9 * \text{SST}$ for the kink at $8 * \text{SST}$. These choices apply to both executives and non-executives (when relevant to them). They are aimed at including as many observations as possible, while keeping other kinks and the minimum wage outside of the considered windows.

Implementation B

In contrast to implementation A, the second implementation of Methods 1 (McCrary) and 2 (polynomial fit) relies on setting the number of observations n in the first bin to the left of the kink point. We set $n = 200$ for the kink at SST, $n = 80$ for the placebo kink at $2 * \text{SST}$, $n = 40$ for the kinks at $3 * \text{SST}$ and $4 * \text{SST}$, and $n = 15$ for the kink at $8 * \text{SST}$. These choices reflect a trade-off between the number of observations per bin and the number of possible bins. This is why the number of observations per bin need to be much smaller for kinks in regions of the earnings distribution with few observation. Otherwise, the bins would be too wide and there would be too few bins in a window that excludes other kinks.

The parameter b_2 (bin size) is then determined based on the value of n. The window is subsequently set to include a maximum of 200 bins, while still excluding other kinks and the French minimum wage: $w_2 = \min(200 * b_2, 0.9 * (\text{SST} - \text{MINWAGE}))$ for the kink at SST; $w_2 = \min(200 * b_2, 0.9 * \text{SST})$ for kinks at $2 * \text{SST}$, $3 * \text{SST}$ and $4 * \text{SST}$; and $w_2 = \min(200 * b_2, 3.9 * \text{SST})$ for the kink at $8 * \text{SST}$. This second approach has the advantage of not arbitrarily imposing a given window.

Polynomial Degree in the Polynomial Approach (Method 2)

For both implementations of the polynomial approach (estimates 2.A and 2.B), we set the polynomial degree d as follows: $d = 10$ for the kink at SST; $d = 5$ for the kink at $2 * SST$; $d = 4$ for the kinks at $3 *$ SST and $4 *$ SST; and $d = 3$ for the kink at $8 *$ SST. The polynomial degree is lower for kinks strictly above the SST because the number of observations around those thresholds is comparatively small.

References

Alvaredo, F., Breda, T., Roantree, B., & Saez, E. (2017). Contribution ceilings and the incidence of payroll taxes. *De Economist*. doi:10.1007/s10645-017-9294-7.

Bosch, N., & Micevska-Scharf, M. (2017). Who bears the burden of social security contributions in the Netherlands? Evidence from Dutch administrative data. *De Economist*. doi:10.1007/s10645-017-9296-5.

Bozio, A., Breda, T., & Grenet, J. (2017). *Incidence of social security contribution: Evidence from France*. Working paper.

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

Müller, K.-U., & Neumann, M. (2017). Who bears the burden of social security contributions in Germany? Evidence from 35 years of administrative data. *De Economist*. doi:10.1007/s10645-017-9298-3.

Neumann, M. (2015). Earnings responses to social security contributions: Evidence from two German administrative data sets. DIW discussion paper no. 1489.