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Bunching and non-bunching at kink points of the Swedish tax schedule☆

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ABSTRACT

Recent microeconometric studies of taxpayers' responsiveness to taxation have shown that intensive margin labor supply and earnings elasticities typically are modest and sometimes equal to zero. A common view is that long-run responses still might be large if micro-estimates are downward biased owing to optimization frictions. In this paper we estimate the taxable income elasticity at a very large kink point of the Swedish tax schedule using the bunching method. During the period of study the change in the log net-of-tax rate reached a maximum value of 45.6%. Interestingly, we obtain a precise elasticity estimate of zero for wage earners at this large kink. We also conclude by the means of numerical simulations that, even though the kink point we study is very large, income effects are unlikely to bias our estimates. The size of the kink allows us to derive tighter bounds on the long-run elasticity than previous studies. If wage earners on average tolerate 1% of their disposable income in optimization costs, the upper bound on the long-run compensated taxable income elasticity is 0.39.

1. Introduction

Recent microeconometric studies of taxpayers' responsiveness to taxation have shown that intensive margin labor supply and earnings elasticities typically are modest and sometimes equal to zero (Chetty, 2012; Chetty et al., 2011; Saez, 2010; Saez et al., 2012). However, a common view is that long-run responses might still be large since micro-estimates are downward biased owing to optimization frictions. In this paper we make use of population-wide register data sets covering the time periods 1998–2008 to estimate the taxable income elasticity at a particularly large kink point in the upper middle part of the Swedish income distribution (the first central government kink point). During this period, the change in the log net-of-tax rate at the kink reached a maximum value of 45.6%. This is a substantially larger change in marginal incentives in comparison to similar kinks studied elsewhere for the purpose of estimating behavioral elasticities.[1] The size of the kink allows us to derive tighter bounds on the long-run elasticity than previous studies.

The behavioral parameter of interest in this paper is the compensated taxable labor income elasticity with respect to the net-of-tax rate. As the kink is very large, one might worry that income effects may bias the estimated elasticity. The reason is that a large convex kink will affect the disposable incomes of those who in the absence of the kink would choose to locate to the right of the kink. Therefore, in this paper we do not only estimate the elasticity at the kink point, but also systematically

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[1] Comparable kinks are kinks at the upper middle part of the income distribution. The jump in marginal tax rates at the first central government kink point was 17.4–23.3 percentage points in 1998–2008. The threshold for the top tax in Denmark analyzed by Chetty et al. (2011), 1994–2001, amounted to 12.5–15 percentage points during the period of study, and the second federal tax kink in the U.S. 1988–2002 examined by Saez (2010) implied a marginal tax rate increase of 13 percentage points (both for married and singles).

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examine the impact of income effects on the estimated compensated elasticity by the means of numerical simulations.[2]

Owing to the size of the central government kink point, the standard frictionless model predicts a substantial amount of bunching even if the elasticity is very small. In Fig. 1 we have simulated taxable income distributions under the 2002 Swedish tax schedule for two very modest values of the compensated elasticity, 0.01 and 0.1.[3] Both values of the elasticity are below the elasticity estimates obtained in most empirical studies of the taxable income elasticity using tax reforms for identification.[4]

The figure demonstrates that, even when the elasticity is as low as 0.01, there is a clear spike at the first central government kink of the Swedish tax schedule. When the elasticity is 0.1 the spike is huge. In the real world, one cannot expect individuals to bunch exactly at the segment-limit, although if the distribution of deviations between actual and desired income choices of individuals is smooth and symmetric we should observe a *hump* rather than a spike at the kink point.

Given the simulated income distributions of Fig. 1 our empirical results are striking. Among wage earners we find no economically significant bunching of taxpayers at the large central government kink point. This implies an observed compensated elasticity of zero. The self-employed, on the other hand, displays sharp and statistically significant bunching at the first central government kink point. However, the implied elasticity estimates are small, around 0.02 for broader groups of self-employed individuals and around 0.07 for the 'purely self-employed' who only earn income from the firm they own. By analyzing the deduction behavior of these individuals we find evidence pointing in the direction that the self-employment response is related to reporting behavior rather than real labor supply responses. It is interesting to note that the 'purely self-employed' also displays bunching at the *second* central government kink point which is noticeably smaller and located further up in the income distribution.

The absence of bunching at the large central government kink point suggests that local behavioral responses to tax changes in these income ranges are negligible in the short run. This finding is consistent with the well documented empirical regularity that labor supply tends to be relatively inelastic along the intensive margin. Since we study the taxable labor income elasticity, which also includes deduction-related responses, this paper lends even stronger support to the earlier finding that taxpayers' short run responses to changes in marginal tax rates are small.

Our finding that the observed compensated elasticity is zero does not however lead us to believe that taxes are without distortions. While it is costly for taxpayers to respond to tax changes in the short run due to adjustment costs, hours constraints and inattention, long-run responses to tax changes might still be substantial. In particular, long-run responses to taxes do not need to take place at the individual level and as such cannot be captured by conventional micro-economic models. Other potentially important channels are collective agreements and the regulatory structure of the labor market.

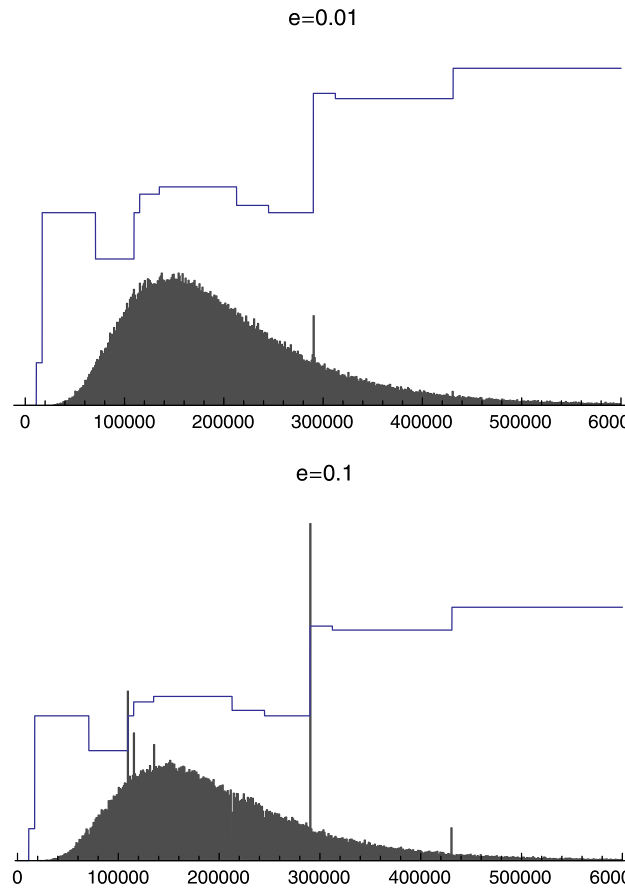

Fig. 1. Simulated income distributions assuming an elasticity of 0.01 (top panel) and 0.1 (bottom panel) shown together with the marginal tax schedule under the Swedish income tax in 2002. The large and salient federal income tax kink appears at an earnings level of 290,100 SEK and generates a sharp empirical prediction for the taxable income distribution.

Chetty (2012) recognizes the discrepancy between structural elasticities (the elasticities we would observe in a world without optimization frictions) and observed elasticities. By making assumptions about the extent to which individuals tolerate utility losses by ignoring tax changes, Chetty is able to put bounds on the structural elasticity based on observed behavior. If we adopt Chetty's procedure and baseline assumption that individuals, on average, tolerate one percentage point of their disposable income in utility losses, we find an upper bound on the long run elasticity of 0.39. Noticeably, this upper bound on the compensated elasticity lies below the upper bounds implied by the elasticity estimates obtained by both Blomquist and Selin (2010) and Gelber (2013), two other recent studies on Swedish data. As our kink is very large, and technically the upper bound shrinks at a quadratic rate in the change in the log net-of-tax share, a substantial amount of information is contained in our estimates (Table 6).

Finally, as already mentioned, we contribute methodologically to the bunching literature by analyzing the potential impact of income effects on bunching estimates. While it is possible to prove analytically that income effects do not influence the bunching estimator when the tax change is small, it is difficult to appeal to this result when analyzing a kink point as large as in the present paper. A large convex kink will induce a non-negligible change in disposable income for individuals depending on how far to the right of the income level of the kink they would choose to locate in the absence of the kink. To address the issue, we perform Monte Carlo simulations, where the data is generated by a utility function implying substantial income effects. This exercise reveals that income effects are unlikely to bias the compensated elasticity in an economically significant way.

[2] As taxable labor income is obtained by subtracting deductions from gross labor income, the estimated elasticity does not only include hours of work responses to taxation but also responses related to deduction behavior. The standard static labor supply model can be generalized to a model for taxable income. In the labor supply model the individual equates the marginal disutility of work and the marginal net-of-tax hourly wage rate in optimum. In the taxable income model the individual instead supplies taxable income until the marginal disutility of supplying taxable income is equal to the marginal net-of-tax rate (1-marginal tax rate). The taxable income elasticity captures more margins than hours of work (e.g. effort per hour, tax avoidance and tax evasion).

[3] In the simulations the income supply function is $z = z_0(1 - \tau)^e$, where z is taxable income supply, z_0 is the 'potential income', τ is the marginal tax rate and e is the taxable income elasticity. This supply function has been derived from an iso-elastic utility function (see the parametric example in Saez, 2010). The log normal 'potential income' distribution is calibrated such that the mean and variance of the realized simulated income distribution coincide with the mean and variance of the actual 2002 income distribution.

[4] See Saez et al. (2010) for a U.S. centered overview of the taxable income literature and Section 4 of Pirttilä and Selin (2011) for a survey of the Swedish literature.

The paper is organized as follows. Section 1 briefly summarizes previous literature on bunching estimation. Sections 2 and 3 present the underlying model and estimation framework. Section 4 describes the institutional setting and data, whereas Section 5 presents the main empirical analysis. Section 6 describes our Monte-Carlo exercise with income effects. Section 7 presents bounds calculations. Finally, Section 8 concludes.

1.1. Related literature

This paper primarily draws on the seminal work by Saez (2010). Saez observed that predictions of the standard taxable income supply model can be tested by making use of large register data sets. In the past, non-linear budget set models have been estimated on small survey data sets, where it has been impossible to disentangle measurement errors and optimization errors. Saez (2010) finds clear evidence of bunching at the first kink point of the U.S. earned income tax credit (EITC), the income level where the tax credit is maximized. The response is, however, concentrated among the self-employed and is interpreted as a consequence of reporting behavior, rather than real labor supply behavior.[5]

Saez (2010) also analyzes the U.S. federal income tax schedule, including the large second federal kink point. At this kink point the marginal tax rate jumps from 15% to 28% and is located at the upper middle part of the income distribution. Thus, it shares some similarities with the kink examined in the present paper. The kink point was kept constant at $54,350 (in 2008 dollars) for married taxpayers and $32,550 for single taxpayers during the period 1988–2002. Saez did not detect any bunching at this kink for any group (including the group of self-employed individuals).

By virtue of its transparency and its reliance on within-year variation (the between-year marginal tax variation at a given earnings level is often low whereas differences in marginal tax rates across two segments are sometimes high in progressive tax systems), the bunching method has recently gained popularity in the empirical public finance literature. A prominent example is the paper by Chetty et al. (2011). Chetty et al. set up a model with endogenous hours constraints and search costs. They test the predictions of the model on Danish individual level tax register data 1994–2001 using the bunching method. In Section 4 we briefly comment on how our results relate to the results obtained by Chetty et al. on Danish data.

While the above mentioned studies estimate elasticities at convex kink points, Kleven and Waseem (2013) exploit discontinuous jumps in *average* tax rates ('notches') to estimate the taxable income elasticity on data from Pakistan. There is sharp bunching at the notches, especially among the self-employed. However, the implied compensated elasticities are small (close to zero for wage earners and at most around 0.1 for the self-employed). The method developed by Kleven and Waseem has also been used by Kleven et al. (2013) who analyze the effects of income taxation on the international migration of top earners using the Danish preferential foreigner tax scheme.

The bunching method has also been applied in combination with other experimental and quasi-experimental methods. In the context of randomized field experiments, Kleven et al. (2011) analyze a tax enforcement field experiment in Denmark. They compare the excess mass at a large kink before and after a treatment (randomized audits and randomly assigned threat-of-audit letters). In a similar vein, Chetty and Saez (2013) compare bunching at the first EITC kink in the U.S. before and after informing randomly selected taxpayers about the tax system.

Equipped with a huge register based data set Chetty et al. (2013) show that differences in 'sharp bunching' among the self-employed, at the exact income level where the U.S. EITC is maximized, can be used as a proxy for local knowledge about the EITC schedule. They use this proxy to construct treatment and control groups in a difference-in-difference set up. Chetty et al. exploit the change in EITC incentives triggered by the birth of a child, and the assumption that mothers in areas with no sharp bunching on average behave as if the credit induces no change in their marginal tax rate, in order to recover earnings elasticities.

[5] Using a modified estimation approach, Weber (2011) detects significant bunching for both wage earners and self-employed at the second EITC kink, where the phase out region starts. This is partly explained by the fact that Weber defines the EITC kinks as a function of Adjusted Gross Income (AGI) rather than earned income.

2. Derivation of bunching formula

We now illustrate, in the simplest possible way, the theory underlying the bunching estimation technique initiated by Saez (2010). Consider a situation where each individual maximizes the quasi-linear utility function $U(c, z) = c - v(z)$ subject to the budget constraint $c = z - T(z) + m$, where c is the consumption, z is the taxable income, $v(z)$ represents the disutility associated with supplying taxable income, $T(z)$ is the income tax function and m is the non-labor income. Assume a pre-reform situation where individuals' taxable incomes are distributed according to a smooth density function $h_0(z)$ and all individuals face a proportional tax schedule with a single marginal tax rate, $T(z) = \tau_1 z$. A kink is introduced at an earnings level k, so that for income $z \geq k$ the tax rate $\tau_2 > \tau_1$ applies. This reform will transform the income distribution as individuals adjust their taxable income to the new tax system. Denote the density function for the post-reform earnings distribution by $h(z)$. This hypothetical reform will have the following consequences:

1. The earnings distribution to the left of k is unaffected, i.e. $h(z) = h_0(z)$ for $z < k$.
2. Individuals who before the reform reported taxable incomes with $z > k$ will reduce their earnings in response to the tax increase.
3. We will observe a spike in the income distribution. The specific mass of taxpayers $B = \int_k^{k+\Delta z} h_0(z)dz$ will move to k where $[k, k + \Delta z]$ is the interval of taxpayers who choose to locate at the kink after the reform.

In the tradition of Feldstein (1995) we define the compensated taxable labor income elasticity, *locally at k*, as

$$\tilde{e}(k) = \frac{percentage\,change\,in\,z}{percentage\,change\,in\,(1-\tau)} = \frac{\Delta z}{k} \Big/ \frac{\Delta(1-\tau)}{(1-\tau_1)}. \quad (1)$$

Unless one is willing to impose further assumptions on the structure of preferences and abilities, $\tilde{e}(k)$ can in general not be given a structural interpretation. However, it is possible to relate $\tilde{e}(k)$ to the number of individuals who bunch at the kink. Note that

$$B(\Delta z) = \int_k^{k+\Delta z} h_0(z)dz = \Delta z h_0(\xi) \quad (2)$$

for some $\xi \in [k, k + \Delta z]$.[6] Hence inserting Eq. (2) into Eq. (1) and rearranging gives

$$\tilde{e}(k) = \frac{B(\Delta z)}{k \times h_0(\xi) \times \frac{\Delta(1-\tau)}{(1-\tau_1)}}. \quad (3)$$

For small tax changes ($\Delta\tau = d\tau$ and $\Delta z = dz$) we have $\xi \to k$ and the number of individuals who bunch is $B(dz) = h_0(k)dz$. Thus, we have that

$$\lim_{\Delta\tau, \Delta z \to 0} \tilde{e}(k) = e(k) = \frac{dz}{d(1-\tau)} \frac{(1-\tau)}{z} = \frac{B(dz)}{k \times h_0(k) \times log\left(\frac{1-\tau_1}{1-\tau_2}\right)} \quad (4)$$

[6] This follows from the mean value theorem of integration calculus.

where e is the 'structural' compensated elasticity of taxable income. In Eq. (4), k and $log\left(\frac{1-\tau_1}{1-\tau_2}\right)$ are directly observable, while B and $h_0(k)$ need to be estimated. Following Chetty et al. (2011) we refer to $b=\frac{B}{h_0(k)}$ as *the excess mass* of taxpayers at k. Hence, given that b can be estimated, the above method non-parametrically identifies e when the kink point is small. Note that the number of individuals who bunch at the kink is proportional to the compensated elasticity locally at k.[7] In Section 1 we show that this result holds also in the presence of income effects on labor supply.

3. Estimation procedure

The general idea of bunching estimation is to construct a measure of the excess mass of taxpayers at the kink by comparing the mass of individuals at the kink point with the mass of individuals at this same earnings level in the absence of a kink. The key methodological challenge is to remove the influence of the kink from the observed income distribution to obtain the 'counterfactual distribution'. Saez (2010) uses the actual (observed) income distribution to the left and to the right of the kink to infer the counterfactual distribution locally around the kink (where it is not observed). Chetty et al. (2011) propose a somewhat different procedure where they estimate the counterfactual distribution by fitting a polynomial to the observed income distribution, omitting an income band around the kink. In practice these two approaches often yield similar results. The identifying assumption is that there should be no peak in the counterfactual distribution exactly at the kink point.

Our estimation procedure, which draws on Chetty et al. (2011), proceeds as follows. First, a 'wide bunching window' around the kink point is specified and taxable income is expressed in terms of the absolute distance to the kink point. This window specifies the sample to be used in our estimation of bunching and the counterfactual distribution. The data is collapsed into bins of width 1000 SEK and each bin j is represented by an income level Z_j defined as the mean absolute income distance between the observations falling within income bin j and the kink point. In other words, Z_j is the distance between bin j and the kink point (measured in steps of 1000 SEK). Visual inspection of the histogram $\{Z_j\}$ guides the selection of a bandwidth R and the associated 'small bunching window' $[-R,R]$. Ideally, this window should be chosen so as to capture exactly those individuals bunching. The number of individuals in income bin j is given by the regression:

$$C_j=\psi\left(Z_j,R\right)+\eta_j \tag{5}$$

where ψ is a 7th degree polynomial in Z_j including dummy variables for observations close to the kink (as measured by R) and n_j accounts for the error in the polynomial fit.[8] In our estimation we use the same procedure as in Chetty et al. (2011) to estimate Eq. (5) and refer the interested reader to this paper for a more thorough description of this estimation procedure.[9]

Denote by $\hat{C}_j$ the predicted values from regression in Eq. (5). Bunching is estimated as the number of taxpayers at the kink (denoted by $\hat{B}$) relative to the average height of the counterfactual distribution in the band $[-R,R]$

$$\hat{b}=\frac{\hat{B}}{\sum_{j=-R}^{R}\frac{\hat{C}_j}{R+1}}.$$

Note that this measure is not unit-free and depends on the choice of binwidth d. When presenting our results we also report elasticities which are invariant to the unit of measurement and the binwidth d. When evaluating the elasticity, k of Eq. (4) should be expressed in units of d. Standard errors are calculated using the bootstrap on binned data. We sample from the empirical distribution function associated with the observed income distribution and compute $\hat{b}$ repeatedly.

4. Institutional setting and data

4.1. Personal income taxation in Sweden

The Swedish personal income tax system is characterized by separate taxation of spouses and separate (dual) taxation of labor income and capital income. Thus, neither capital income nor spousal income is included in the individual's taxable labor income. Thus, in contrast to countries where these tax bases interact, uncertainty with respect to capital and/or spousal income does not translate into uncertainty with respect to the segment limits as a function of the individual's labor income net of own deductions.

The basic structure of the taxation of labor incomes, which to a large extent is the result of the comprehensive tax reform of 1991, is simple. The labor income tax system consists of two parts. First, a proportional local tax rate applies to taxable labor income, which includes earned income, taxable transfers and deductions. The proportional local tax rate varies somewhat between municipalities, but the average rate has been fairly constant during the period of study (ranging between 31 and 32%). Second, individuals with taxable labor income exceeding a certain threshold are also subject to central government taxation.

During 1991–1998 the central government tax schedule contained two brackets generating one convex kink; the tax rate in the first bracket has always been zero while the tax rate in the second bracket was 20% between 1991 and 1995 and 25% between 1995 and 1998. In 1998 the jump in the marginal tax rate was 23.3 percentage points due to the existence of a tax deductible mandatory general pension contribution. Nonetheless, the change in the log net-of-tax-share reached 45.6% that year, generating the largest change in marginal incentives during the period of study.[10]

In 1999 a third bracket was introduced with a marginal tax rate of 25% and the tax rate on the second bracket was changed back to 20% (generating a second convex kink). Henceforth, we will refer to the first convex kink, where the central government tax kicks in, as *the first central government kink point* and the smaller upper kink, where the marginal tax jumps by 5 percentage points, as *the second central government kink point*.

In 1999, 20% (4%) of all taxpayers, or 37% (8%) of all full time employees earned taxable labor incomes above the first (second) central government kink point. Accordingly, the first central government is located centrally in the upper middle part of the income distribution while the second central government kink point is located at a point where the income distribution is considerably thinner. Fig. 2 shows

[7] As shown by Saez (2010) this also holds true when elasticities differ between individuals at a given income level. Then the average elasticity at k is identified.

[8] Here we follow Chetty et al. (2011) and use the same polynomial order in every estimation, rather than choosing the polynomial order, case-by-case, so as to maximize a goodness-of-fit measure.

[9] We are grateful to John Friedman and Tore Olsen for making their programs available to us.

[10] In 1998 the average local tax rate was 31.65% and the general pension contribution was 6.95%. Since the general pension was deductible, the marginal tax rate for an individual locating to the left of the central government kink point was $(1-0.0695)\times 0.3165+0.0695=0.364$. To the right, the marginal tax rate was $(1-0.0695)\times(0.3165+0.25)+0.0695=0.597$.

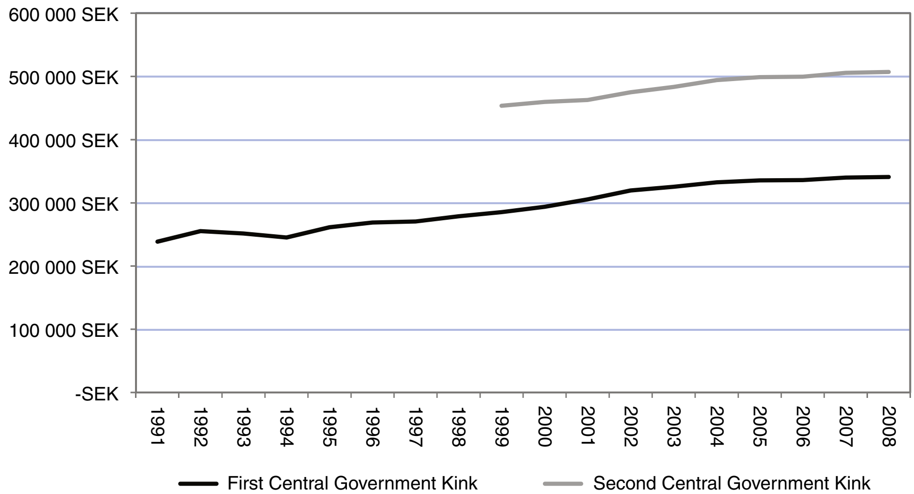

Fig. 2. The first central government kink point and the second central government kink point 1991–2008, segment limits are inflated by the consumer price index. (2008 prices). 1 USD = 7 SEK.

the evolution of the central government tax schedule in 1991–2008. Since 1995 there has been a steady, but non-dramatic, increase in the location of the first central government kink point. The jumps in marginal tax rates at the kink during the period of study are reported in Table 1.[11],[12]

Table 1
The marginal tax change at the central government kink points 1998–2008.

	First central government kink point			Second central government kink point		
	τ_1	τ_2	$\Delta log\left(\frac{1-\tau_1}{1-\tau_2}\right)$	τ_1	τ_2	$\Delta log\left(\frac{1-\tau_1}{1-\tau_2}\right)$
1998	0.364	0.597	0.456			
1999	0.366	0.54	0.321	0.506	0.556	0.107
2000	0.34	0.53	0.340	0.504	0.554	0.106
2001	0.33	0.523	0.340	0.505	0.555	0.106
2002	0.317	0.514	0.340	0.505	0.555	0.106
2003	0.324	0.52	0.342	0.512	0.562	0.108
2004	0.327	0.524	0.346	0.515	0.565	0.109
2005	0.322	0.52	0.345	0.516	0.566	0.109
2006	0.316	0.516	0.346	0.516	0.566	0.109
2007	0.3155	0.5155	0.346	0.5155	0.5655	0.109
2008	0.3144	0.5144	0.345	0.5144	0.5644	0.109

How salient are these kink points to individual taxpayers? The central government kink points are very salient in the sense that most taxpayers in these income ranges know about their existence. Still, it requires some degree of sophistication to trace out the exact locations of the bracket cut-offs as a function of taxable income. The reason is that the Swedish Tax Agency often reports segment limits using an income concept which does not correspond to the individual's taxable labor income.[13] Technically, to obtain the relevant bracket cut-off in terms of taxable income one needs to add back the so-called basic deduction and, before the tax year of 2006, the general pension contribution. Both the basic deduction and the deduction for the general pension contribution were mechanically provided by the tax authorities. The general pension contribution amounted to 6.95% of taxable labor income in 1999–2000, but was gradually reduced in 2001–2005 and, finally, completely abolished in 2006.

A large share of total taxes on labor income in Sweden is levied on the employer side in the form of social security contributions (payroll taxes).[14] The payroll tax rate, expressed as a percentage of the wage bill, was proportional and fairly constant, around 32–33%, during the period of study. The effective value added tax (VAT) rate, expressed as a percentage of consumption, is currently around 21% (Pirttilä and Selin, 2011).[15]

4.2. The components of taxable income

Table 2 shows a stylized characterization of the composition of the individual's taxable labor income. Note that capital income as well as deductions for interest expenses are absent. This is a consequence of the Swedish dual income tax system that taxes labor income separately from capital income. Notably, transfers, like unemployment insurance

[11] The tax and benefit system also creates important (both convex and non-convex) kink points at lower parts of the income distribution. Some of those are generated by the basic deduction, which is phased in at lower income levels and phased out at higher income levels with consequences for the marginal tax rate facing individuals in these income ranges. Moreover, a system of housing allowances has for a long time been in place in Sweden. Housing allowances create large convex kinks (at the point where the phase-out of these allowances starts) and large non-convex kinks (at the point where the entire allowance is taxed away). Other kink points are created by the study grant system and the social assistance system. The multitude of kinks at the bottom part of the income distribution – together with the substantial heterogeneity in budget sets across subpopulations – renders bunching estimation problematic in these income ranges. In this paper we focus on the first and second central government kink points which are located in well-behaved parts of the income distribution.

[12] As a general rule, the kink points of the central government schedule are 'protected' against general real wage growth through indexation (Swedish Tax Agency (2010), p. 72 and the table at p. 92). Each year, the kink points are adjusted upwards by the inflation rate plus an additional 2 percentage points. However, in practice legislators have made small year-to-year deviations from this rule during the period of study. The kink points, expressed in nominal values of SEK, of the central government tax schedule of year t are legislated by parliament by the end of year $t - 1$. The kink points are assessed in terms of price base amounts (PBA). The PBA for year t is set based on the price level of June of year $t - 1$. Thus, information on the segment limits is publicly available to taxpayers before the start of the tax year.

[13] Our taxable labor income concept corresponds to the administrative concept 'taxerad förvärvsinkomst' and not the administrative Swedish concept 'beskattningsbar förvärvsinkomst'.

[14] In 2008, SEK 393 billion was paid by the employers to the tax authorities as social security contributions (Table 8, The Swedish Tax Agency, 2010). In the same year, SEK 413 billion was collected in personal income taxation (net of tax reductions). Total tax revenues amounted to SEK 1495 billion.

[15] Since payroll taxes and VAT are proportional they do not affect the percentage change in the net-of-tax rate at the kink. However, it can still be an issue that the social security contributions paid by the employer generate social benefits only up to a certain ceiling. In particular, individuals earn future social security benefits up to a taxable labor income level of 7.5 income base amounts (7.5 price base amounts up to 2000). During the period of study, 1998–2008, the mean distance between the pension kink and the first central government kink point was SEK 17,250. The distance was the lowest in 2002 (SEK 990) and the largest in 1998 (SEK 40,470).

Table 2
Components of taxable income.

Sources of income	Deductions
Employment income	*Deductions from employment income*
Wages and salaries*	Commuting expenses
Fringe benefits	Expenses for official journeys
Sickness insurance benefits	Work-related living costs
Unemployment insurance benefits	Other expenses
Parental leave benefits	
Public pension benefits	
Occupational pension benefits	
Other sources of earned income	
Business income	*Deductions from business income*
Profits from active and passive sole proprietorships and partnerships	
	General deductions
	Private pension contributions
	Alimony paid
	Business deficits

* Includes wages and salaries from the own firm for owners of closely held corporations.

benefits, enter taxable income. As compared to a situation where these transfers were excluded from taxable labor income, the tax base becomes less volatile.

The most important deductions from taxable income are those for commuting expenses and private pension contributions. Almost one half of the taxpayers in the vicinity of the first central government kink point claimed deductions for deferrals to tax-favored savings accounts in our sample. 25% of taxpayers around the first central government kink made deductions for commuting expenses.

Is it easy for taxpayers to fine tune their deductions in such a way that they bunch at the kink point? While income tax returns for the tax year t typically are due in early May year $t + 1$, the individual is only eligible for deductions for expenses that occurred in year t. If an individual wishes to make pension contributions up until she reaches the kink (where the marginal tax price for pension contribution increases) she needs to make these contributions before the end of year t. However, as recently shown by Engström et al. (2011), some deductions (e.g. the deductions for 'other expenses') leave room for manipulation at the time when the individual files her income tax return.

4.3. Data and sample selection

This study exploits two (partly overlapping) data sets. To study bunching behavior among wage earners we use administrative tax records covering the whole universe of Swedish taxpayers through the years 1998–2005.[16] The data set entails variables corresponding to the boxes of the personal income tax return form. In addition, we have information on some demographic characteristics. Unless otherwise stated, in the empirical analysis of Section 5 we remove 'self-employed' individuals from the sample of 'wage earners'. For these purposes we define self-employment in the following way. We pool data for 1999–2005 and define those who either report positive active business income or are considered as being connected to a closely held corporation *any of those years* as self-employed.[17] As in Chetty et al. (2011), we restrict the sample to individuals who are aged between 15 and 70.

We conduct a special analysis of the self-employed for the years 2000–2008 on a data set that is particularly suited for such an exercise. The FRIDA ('Företagsregister och individdatabas') contains individual level tax register data for the main groups of self-employed; sole proprietors, partnership owners and owners of closely held corporations. The two former organizational forms are taxed at the personal level, whereas closely held corporations are separable taxable entities. The FRIDA data contains the total Swedish population of self-employed individuals complemented with firm level data.

5. Empirical analysis

Bunching estimation is a genuinely visual technique. Accordingly, we report in a figure each estimate of the excess mass and the implied elasticity, along with a graph of the corresponding income distribution locally around the kink point under study. For each year, we express the taxable income variable in the price level of 2008 (unless otherwise stated), and we redefine the taxable income variable such that it takes on the value of zero at the bracket cut-off. After that, we pool data from several years. The histogram is displayed as a series of dots. The solid line represents the polynomial fitted to the taxable income distribution while excluding bins in the 'small bunching window'. In our study we use an interval of [−SEK 5000, SEK 5000] around the kink point as our baseline.

5.1. Wage earners

Fig. 3a shows the taxable income distribution, locally around the first central government kink point, for the total population that includes both wage earners and self-employed. The figure is based on the sample for the years 1999–2005, a period where the central government tax schedule was very stable and the reduction in the log net-of-tax rate at the bracket cut-off was in the range 32.1%–34.6% (see Table 1). In the figure we report the excess mass (b) which, as explained above, should be interpreted as the number of individuals who bunch divided by the average number of taxpayers in the range [−SEK 5000, SEK 5000]. The figure shows that there is a statistically significant excess density in an interval close to the first central government kink point, however it is not significant in any economic sense — the implied elasticity is 0.004. Fig. 3b displays the same information when self-employed has been removed from the estimation sample. This figure demonstrates that the small bunching found for the total sample is driven entirely by the self-employed. It is striking that there is no significant excess mass in the aggregate when wage earners are the sole scope of focus. Taken literally, in a frictionless model, this estimate of the excess mass implies a precise estimate of the compensated taxable income elasticity of zero. In Section 7 we elaborate on how this zero estimate can be interpreted.[18]

We have also investigated bunching at the second central government tax kink, where the log net-of-tax rate decreases by around 11% in the years 1999–2005. Not surprisingly, there is no evidence of bunching for high income wage earners at this substantially smaller second kink point.

It is a convention in the labor supply literature to examine different demographic groups separately. Therefore, we partitioned the sample of wage earners into single women, married women, single men and married men. There is no significant bunching of taxpayers at the large and salient kink point for any of these demographic groups. Additionally, we examined subgroups based on sector and industry classifications, but we did not detect bunching for wage earners in any of these subgroups either.

Real labor supply responses can be difficult to fine tune in a world with optimization frictions. Deductions, on the other hand, are under the taxpayers' direct control. To find out whether those who make large deductions bunch, we separately examine wage earners with deductions over SEK 50,000, a group which constitutes around one percent of the population. As can be seen from Fig. 4, there is no significant

[16] This is the same data set that was used by Selin (2012).

[17] The relevant variables are *nakte* ("inkomst av aktiv enskild näringsverksamhet"), *nakthb* ("inkomst av aktiv näringsverksamhet för delägare i handelsbolag") and *bfoab* ("kod för samgranskning med fåmansföretag"). The *bfoab* variable is not present in the 1998 data. For 1998 we therefore let the self employment dummy takes on the value of 1 if the individual reports positive business income in 1998 or if the individual is self-employed any of the years 1999–2005.

[18] It is noteworthy that the income distribution takes on a trapezoid shape in the estimation window when all wage earners in different years are pooled.

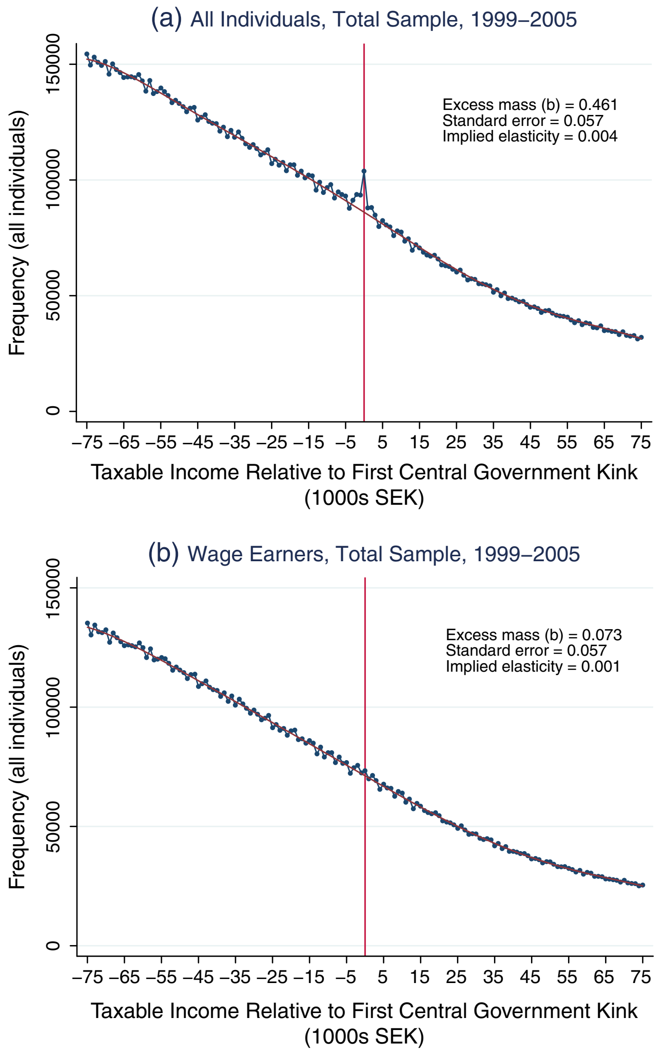

Fig. 3. All individuals vs. all wage earners.

bunching at the first central government kink among those who make large deductions.

In 1998 there was a 23.2 percentage point jump in the marginal tax rate at the first central government kink point, implying a 45.6% reduction in the log net-of-tax rate at the kink. As we emphasize in Section 7, the size of the kink is of great theoretical importance. Therefore, we analyze the 1998 data separately. Fig. 5 reveals that the density of taxpayers did not display any major spike or hump around the bracket cut-off in 1998 but there is an extremely small increase in the density at the kink. Due to the high degree of precision in the polynomial fit, the excess density is statistically significant. However, the implied elasticity estimate is 0.001 and not in any sense *economically* significant from zero. Thus, we consider the zero result for wage earners to be very robust.[19]

5.2. Self-employed

The estimation sample for the self-employed contains the total Swedish population of owners of closely held corporations, sole proprietors and partnership owners. In the same spirit as above, we pool the years 2000–2008. Fig. 6 reports histograms and elasticity estimates for the total group of self-employed individuals and for these three groups. In contrast to the wage earner sample, there is clear evidence of bunching at the first central government kink where the marginal tax rate jumps by 20 percentage points. But the implied compensated elasticity estimate is small. In the pooled sample the estimated elasticity at the first central government kink is 0.024.

Table 3
Heterogeneity among the self-employed.

	b	b_{se}
All	2.714	0.093
Age 15–24	3.229	0.424
Age 25–34	2.549	0.112
Age 35–44	2.724	0.105
Age 45–54	2.939	0.116
Age 55–64	2.702	0.107
Age 65–70	1.961	0.161
Women	2.295	0.085
Men	2.882	0.103
Unmarried	2.549	0.098
Married	2.834	0.100
Standard deviation below median	1.913	0.194
Standard deviation over median	2.793	0.181
No university degree	2.929	0.104
University degree	2.329	0.090

'Standard deviation below/over median' refers to the standard deviation in taxable income for the individual self-employed individual in the years he/she participates in the self-employment sample.

It is interesting to examine how the excess mass estimates differ across different subgroups of self employed, see Table 3. We find no large differences with respect to age, even though the estimated excess mass is somewhat lower for self-employed aged 65–70. Men bunch more than women, married more than unmarried, and low-educated bunch more than highly educated. Finally, we have partitioned the sample according to the standard deviation in taxable income. It turns out that those with more volatile incomes bunch more. This is consistent with the findings reported in Section 3 below, namely that intertemporal income shifting (smoothing tax payments across years) can explain a large part of the bunching response.

There is also some interesting heterogeneity across the subsamples with respect to organizational form, as shown in Fig. 6. The corporate owners in panel (b) display a somewhat smaller elasticity than the other categories under the standard choice of bunching interval around the kink [−SEK 5000, SEK 5000]. On the other hand, the histogram plot clearly suggests that there is broader hump of corporate owners around the threshold for central government taxation. As mean incomes are higher for corporate owners than for the rest of the population, it actually turns out that the central government kink coincides with the mode of the taxable income distribution for owners of closely held corporations in 2000–2008. It lies beyond the scope of the present analysis to assess to what extent this phenomenon reflects 'broad bunching' around the first central government kink point.

The taxable income distribution for the sole proprietors locally around the first central government kink, which is visualized in panel (c), is considerably more triangular shaped than its counterpart for corporate owners. There is a clear spike in the observed density in a narrow range around the bracket cut-off. The implied elasticity is 0.027, i.e. still very small. The partnership owners (panel d) exhibit a similar response as sole proprietors. A large spike is discernible at the first central government kink point, but the implied elasticity is only 0.025. For all groups of self-employed the elasticity estimate is statistically distinct from zero.

One might wonder how sensitive the estimation results are to the choice of the width of the 'small bunching window'. The baseline, i.e. [−SEK 5000, SEK 5000], was chosen based on visual inspection of the

[19] In addition, we have analyzed the time periods 1991–1994 (when the jump in marginal tax rates at the central government kink was 20 percentage points) and 1995–1998 (when the jump was similar in size to the jump in 1998) using the smaller register-based data-set "LINDA" which contains around 3% of the Swedish population. The zero result for wage-earners is very robust.

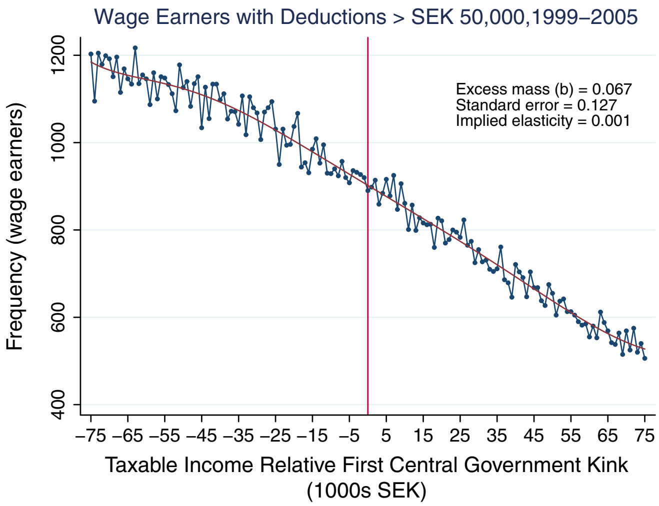

Fig. 4. Wage earners with deductions >50,000 SEK.

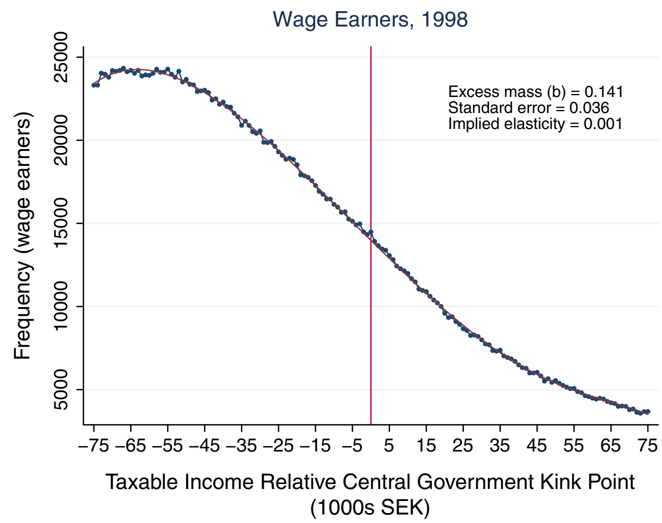

Fig. 5. Wage earners in 1998.

histogram plots for the self-employed.[20] Table 8 in Appendix A shows that deviating from this baseline choice has only minor consequences for the obtained results. When the 'small bunching window' increases, a larger number of bins are excluded from the polynomial fit, resulting in larger standard errors. This effect is especially pronounced for owners of closely held corporations. We have also experimented with asymmetrical windows around the threshold with no major changes to the results (see Appendix A). Finally, the results are also, by and large, robust to changes in the wide bunching window (the baseline width is [−SEK 75,000, SEK 75,000]), and to changes in the polynomial order (see Table 9 in Appendix A).

Our large sample sizes allow us to examine subgroups that can be expected to be particularly responsive to marginal tax rates. One such candidate is the subcategory of 'purely self-employed', i.e. those who do not simultaneously act as wage earners. We define 'pure' corporate owners as those whose earned income exclusively come from the firm they own. 'Pure' sole proprietors and partnership owners, who both are taxed at the personal level, are defined as exclusively reporting business income from the relevant organizational form and no wage income. Based on Fig. 7, panel (a), we infer that the excess mass at the first central government kink point almost increases by a factor three as compared to the case when examining the total aggregate of self-employed, 2000–2008.

Interestingly, in the sample containing the 'pure' self-employed there is also discernible bunching in the immediate vicinity of the *second* central government kink point, where the log net-of-tax share is reduced by around 11%. During the time period 2000–2008 the average value of the second central government bracket cut-off was SEK 487,000 (expressed in the price level of 2008) as compared to SEK 325,000 for the first central government kink. Because of the small number of observations in these higher income ranges, the excess mass estimate becomes statistically more uncertain. However, the estimate is indeed statistically significant from zero at a level of 1% (two-tailed confidence interval). Needless to say, the implied elasticity is still low, 0.016.[21]

5.3. The anatomy of the self-employment response

Does the response among the self-employed reflect a real labor supply response or tax avoidance behavior? And to what extent do individuals engage in inter-temporal and intra-temporal income shifting? We examine these questions by studying the filing behavior of the self-employed classified as 'pure sole proprietors', defined as sole proprietors with no wage income. We concentrate on this group as the link between the personal tax base and the firm's account is strongest for these individuals. In contrast to our main empirical exercise, where we have examined taxable income net of deductions, we have added back four categories of deductions, one by one, to the taxable income of the sole proprietors, and then re-estimated the excess mass in each of these cases for the tax year 2008.

The first deduction is 'positive interest allocation'. Non-corporate firms are entitled to reclassify as capital income a portion of taxable income equal to the amount of capital invested in the firm, times a presumed rate of return. This amount is then taxed at a (typically lower) flat rate of 30%.[22] Thus, the use of this deduction implies *intra-temporal* income shifting between the labor income tax base and the capital income tax base. The second category of deductions is 'periodic funds', which is a device for *inter-temporal* income shifting. Sole proprietors may shift up to 30% of their business surplus into periodic (temporary) funds which must be extracted (as taxable labor income) within six years. The third category, 'expansion funds', is also related to inter-temporal income shifting. Business surplus can be invested into expansion funds which is then taxed according to the relatively low corporate tax rate. If the funds are extracted they are taxed as labor income with a rebate for the corporate taxes already paid.[23] The fourth and final category is the deduction for pension contributions. Pension contributions are deducted against business income and can be withdrawn from the age of 55. Withdrawals are taxed as labor income.[24]

In the group of pure sole proprietors the excess mass is high in the baseline scenario, 12.89. The consequences of adding back the various deductions are illustrated in Table 4. The first thing to notice is that the adding back of deductions has an enormous impact on the excess mass estimate.[25] Accounting for periodic funds, which are used to smooth

[20] This interval was also used for wage earners. In practice, the choice of small bunching window for wage earners is of very little importance as there are no visual indications of bunching among wage earners.

[21] Using Danish data Chetty et al. (2011) also estimate a larger taxable income elasticity for the self-employed at the larger kink in the top of the income distribution than at the smaller kink in the middle of the income distribution.

[22] This rule was introduced to achieve neutrality between corporate and non-corporate firms.

[23] See Edmark and Gordon (2013) for a description of these rules.

[24] These rules are described in detail by Selin (2012).

[25] One should of course keep in mind that adding back deductions would reduce bunching even if these deductions were made randomly. Notice, however, that the deductions analyzed here are considerably more prevalent among bunchers than non-bunchers.

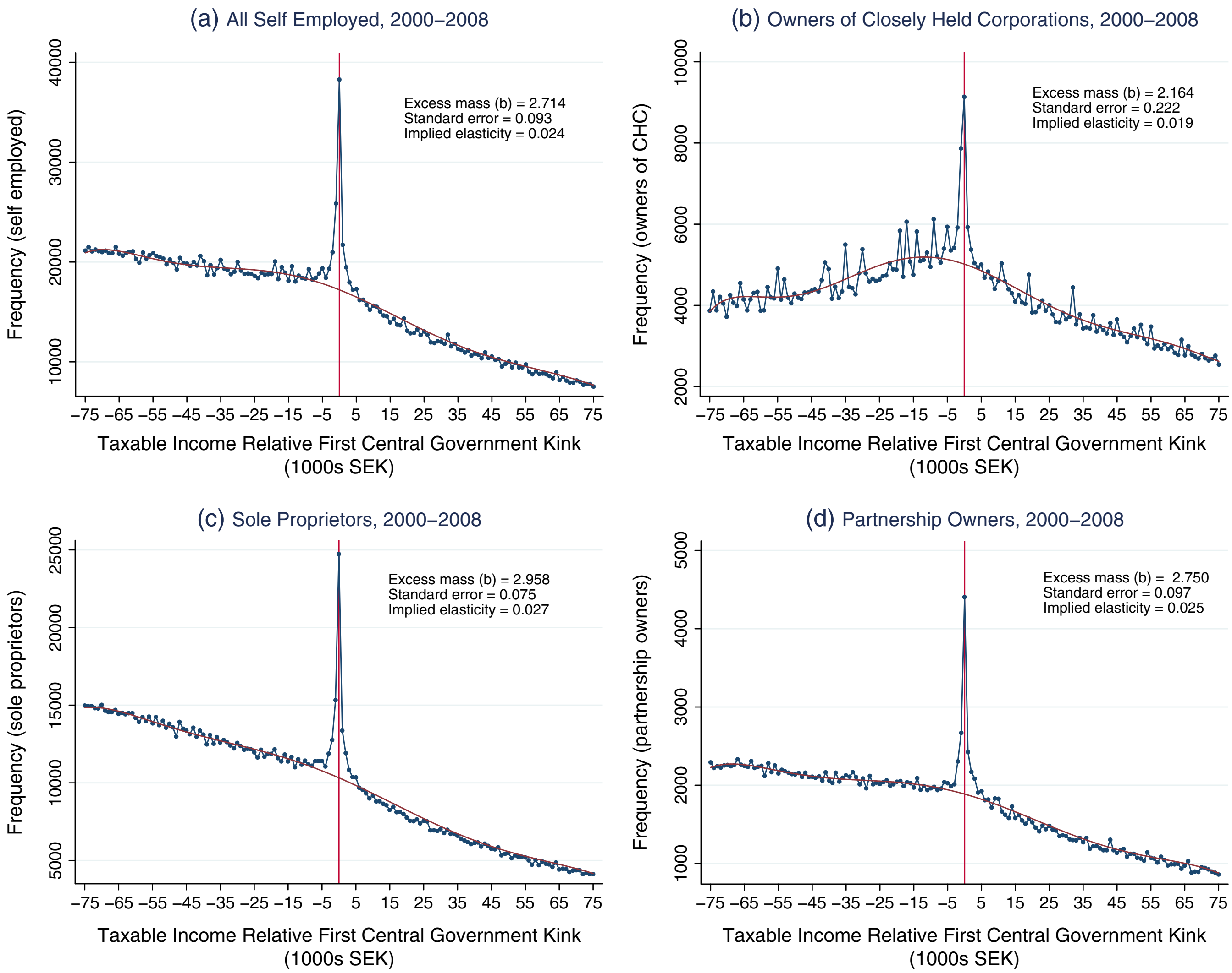

Fig. 6. Self-employed.

tax payments over time, implies a shrinkage of the excess mass from 13 to 3. When all four categories of deductions are added back the excess mass is no longer significant. This analysis suggests that the self-employment response is not a real labor supply response. It appears that legal channels to reduce the tax liability via both intra-temporal and inter-temporal income shifting can explain the bunching response. In an inter-temporal model, the magnitude of these responses would be explained both by the particular income shifting technology and the individuals' time preference for consumption.[26]

5.4. Comparison with other studies

It is worth noting that the results we obtain here are qualitatively different from those obtained by Chetty et al. (2011) on Denmark, a neighboring country that share many institutional features with Sweden. Both countries have highly unionized labor markets, high tax-to-GDP-ratios and have experienced a decline in centralized wage bargaining since the 1980's. Chetty et al. find clear bunching among Danish wage earners at the cut-off for the so-called 'top tax', but found an implied elasticity for wage earners of merely 0.01. This means that our results and the results of Chetty et al. are quantitatively rather similar. Needless to say, with only two observations we lack means to assess the causal determinants of bunching at a cross country level. However, some aspects of Danish and Swedish tax law deserve to be discussed.

According to Danish tax law, the movement in the top tax bracket from year t to year $t+1$ is pre-determined by the wage growth from year $t-2$ to $t-1$. This makes the movement in the kink more predictable from the perspective of the unions and employers' organizations. In Sweden, on the other hand, discretionary year-to-year changes in the bracket-offs have been made during the period of study. Seen from a broader perspective, the most striking difference between Sweden and Denmark with respect to the taxation of labor incomes is that no payroll taxes are levied on the employer in Denmark (see p.260 in

Table 4
Adding back deductions for pure sole proprietors in 2008.

	Excess mass estimate	Standard error
Adding back…		
…Positive interest allocation	4.575	0.3337
…Periodic funds	3.055	0.3526
…Expansion funds	9.498	0.4868
…Pension contributions	4.268	0.3406
…All four categories	0.2253	0.2769
Baseline case	12.89	0.5976

[26] Schjerning and le Maire (2012) provide a more systematic discussion about bunching and intertemporal income shifting of the self-employed for Denmark.

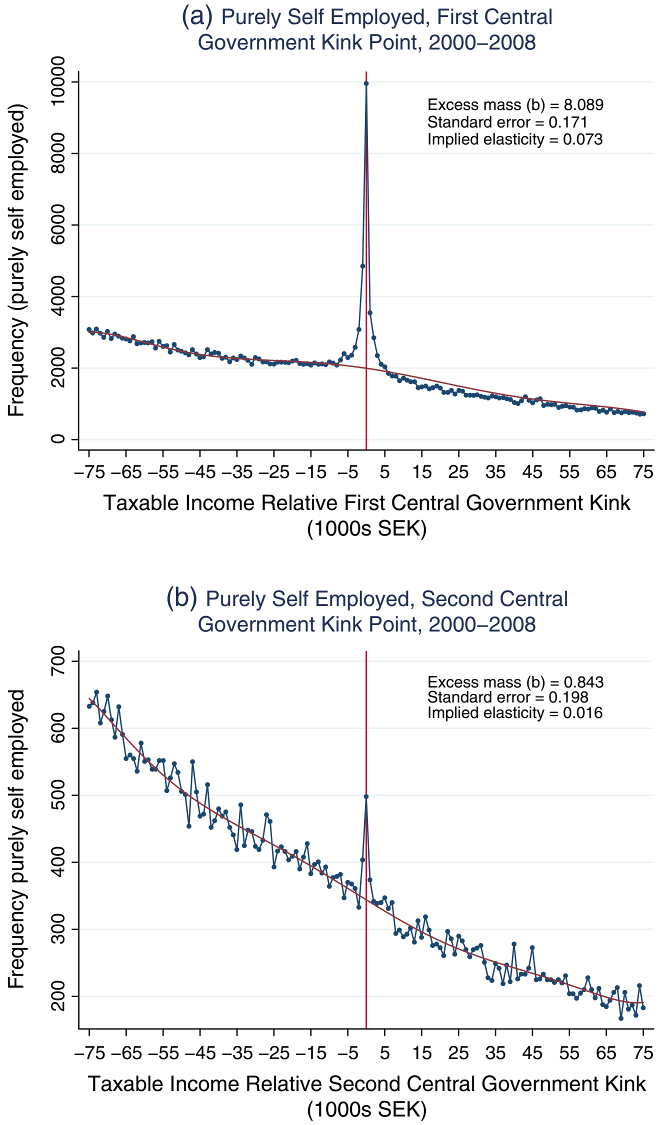

Fig. 7. Purely self-employed.

OECD, 2011). It is not clear, though, why this would lead to more bunching in the Danish case.

Bunching for self employed individuals is also more prevalent in the Danish case. Chetty et al. (2011) reports an elasticity of 0.24 for self employed, which is an order of magnitude larger than our corresponding estimate. Relatively large elasticity estimates on Denmark for the self employed have also been obtained by Kleven et al. (2011) and Schjerning and le Maire (2012). As remarked by Slemrod and Kopczuk (2002), the taxable income elasticity is not only a function of utility parameters, but also a function of the tax system itself (e.g. the possibilities for tax avoidance). Hence, it is likely that cross country differences in bunching behavior among the self employed can be traced to specific features of the tax code (e.g. the rules governing retention funds).

6. Are income effects important?

The behavioral parameter of interest in this paper is the compensated taxable labor income elasticity with respect to the net-of-tax rate. As the kink is very large, one might worry that income effects may bias the estimated elasticity. In this section we first show analytically that, when the tax change is small, the bunching estimator recovers the compensated taxable income elasticity even when there are income effects in the decision to supply taxable income. Then we perform numerical simulations to analyze the performance of the bunching estimator in recovering compensated elasticities in the presence of income effects of various degrees when the tax change at the kink is large.

6.1. Income effects when the tax change is small

Consider without loss of generality a two segment piece-wise linear tax schedule. On each linearized segment of the budget constraint the optimal choice of z is a function $z = z(1-\tau_i, y_i)$ of the marginal net-of-tax rate τ_i and the virtual income y_i facing the individual, $(i = 1,2)$. Before the reform $\tau_1 = \tau_2 = \tau$ and $y_1 = y_2 = m$. After the reform $\tau_2 > \tau_1$ and $y_2 > y_1$. Suppose that the tax change is small so that $\tau_2 - \tau_1 = d\tau$. Consider an agent locating to the right of k before the reform. The total derivative of the optimal supply function $z(1-\tau, y)$ is

$$dz = \frac{\partial z}{\partial(1-\tau)} d(1-\tau) + \frac{\partial z}{\partial y} dy. \tag{6}$$

Using the Slutsky relationship $\frac{\partial z}{\partial(1-\tau)} = \frac{\partial z^c}{\partial(1-\tau)} + \frac{\partial z}{\partial y} z$ (where z^c is the compensated supply function) we can rewrite Eq. (6) as

$$dz = \frac{\partial z^c}{\partial(1-\tau)} d(1-\tau) + \frac{\partial z}{\partial y}(dy + zd(1-\tau)). \tag{7}$$

The textbook definition of virtual income for a segment $i > 1$ of the tax schedule is $y_i = y_{i-1} + [(1-\tau_{i-1}) - (1-\tau_i)]k_i$, where k_i is the lower end point of the ith segment (c.f. Blundell and MaCurdy, 1999). On the first segment, $y_1 = m$. Accordingly, virtual income on the second segment is $y_2 = (\tau_2 - \tau_1)k + m = d\tau\, k + m$. Hence $\frac{dy_2}{d\tau} = k$ which we rewrite as $dy_2 = -d(1-\tau)k$. Thus the relevant change in virtual income for an individual who before the reform reported $z > k$ is $dy = -d(1-\tau)k$. Insertion into Eq. (7) yields

$$dz = \frac{\partial z^c}{\partial(1-\tau)} d(1-\tau) + \frac{\partial z}{\partial y} d(1-\tau)[z-k]. \tag{8}$$

The first term in the above equation is simply the compensated taxable income response whereas the second term arises because of the income effect. Intuitively, this term is larger, the larger is the share of income exceeding k (as reflected by $[z-k]$). However, for a small tax change, the interval of taxpayers who bunch at the kink point is $[k, k + dz]$ i.e. the marginal individual who bunches at the kink point is located close to k before the reform. Hence, the second term in Eq. (8) contains the product of two infinitesimal terms and is therefore of second order. If one instead introduces a *large* convex kink at k the above line of reasoning is no longer valid. A large kink will induce a non-negligible reduction in disposable income for individuals on the second segment depending on how far to the right of the income level of the kink they would choose to locate in the absence of the kink. For individuals located to the right of the kink, a certain share of inframarginal units of supplied taxable income will be subject to a larger marginal tax rate.

6.2. Bunching estimation with income effects

Here we systematically analyze how bunching estimates are affected by the influence of income effects in the decision to supply taxable income when the tax change is of a similar magnitude as the first Swedish central government kink point. We do so by the means of numerical simulations. The basic idea is the following. First, we calibrate a heterogeneity parameter (see z_0 below) in such a way that the simulated taxable income distribution resembles the actual Swedish taxable income distribution under a linear tax, τ_1. Second, we introduce a large kink at an income level k. After the reform, agents face the considerably larger marginal tax rate τ_2 on the second segment of the tax schedule. We then apply the same econometric technique as in the empirical exercise on the simulated post-reform data. In contrast to the empirical exercise, we know the true compensated elasticities and income effect terms that generate the data. As a consequence, we can assess the performance of the bunching estimator in the presence of income effects.

We base our numerical simulations on the utility function

$$u(c,z) = \frac{c^{1+\eta}}{1+\eta} - \frac{z_0}{1+\gamma}\left(\frac{z}{z_0}\right)^{1+\gamma} \tag{9}$$

where $n \leq 0, \gamma > 0$, and z_0 is an individual-specific parameter. The optimal choices of taxable income by individuals is given by the maximization of Eq. (9) subject to the budget constraint $c = z - T(z,\theta) + m$ where θ is a vector of tax parameters and m is non-labor income. The linearized budget constraint can be written $c = (1 - \tau)z + y$, where y, as in Section 1, denotes virtual income. In general, there is no closed form expression for the income supply function (i.e. the optimal choice of z) for this utility function when agents optimize along a linear segment of the budget constraint. However, if one implicitly differentiates the first order condition, one can show that the uncompensated taxable income elasticity along such a linear segment is $e_u = \frac{1+\eta S}{\gamma - \eta S}$, where $S = \frac{(1-\tau)z}{(1-\tau)z+y}$ is the share of net-of-tax labor income to total after-tax income. In a similar manner, one can show that the income effect term, defined as $\psi = \frac{dz}{dy}(1-\tau)$, is given by $\psi = \frac{\eta S}{\gamma - \eta S}$. From the Slutsky equation in elasticity form one can then infer that the compensated elasticity is

$$e = \frac{1}{\gamma - \eta S} \tag{10}$$

by subtracting the income effect from the uncompensated elasticity.[27] In the simulations we set non-labor income equal to zero, i.e. $m = 0$. If evaluated on the linear pre-reform tax system virtual income is then zero and $S = 1$ implying that the compensated elasticity in Eq. (10) is constant and equal to $e = \frac{1}{\gamma - \eta}$. We can then vary the income effect term by considering various combinations of η and γ satisfying $\gamma - \eta = k$ yielding the same compensated elasticity $e = \frac{1}{k}$ and income effect term $\psi = \frac{\eta}{\gamma - \eta}$.

We first fix a baseline flat income tax system given by a constant marginal tax rate $\tau = 0.3$. Then we consider various possibilities regarding the parameters η and γ, and for each set of values, we *calibrate* the vector of parameters z_0 such that the distribution of z resembles the (actual) empirical taxable income distribution locally around an income level k where we wish to investigate bunching.[28] Thus, the various distributions of z under the different values of η and γ are made observationally equivalent under the flat income tax. To investigate bunching, we introduce a kink into the tax system at an income level of $k =$ SEK 250,000 and recalculate each distribution of z. At the kink, the marginal tax rate jumps by 25 percentage points.[29]

The aim of our simulation exercise is to examine by how much the estimated compensated elasticity differs from the theoretical compensated elasticity e in the presence of a non-zero income effect term. However, when the kink is large, there is no longer, in general, a unique compensated elasticity to recover. The reason is that the compensated elasticity can be evaluated at different utility levels, and a large kink will change the utility level for those who pre-reform were locating to the right of the kink.[30] As earlier, e is the compensated elasticity of an individual at the income level k, i.e. the elasticity that would prevail if the budget constraint was smooth at k and the indifference curve was tangent to the budget line at that point. We have chosen to compare our bunching estimate with the average compensated elasticity *for those who bunch* at the kink, $\bar{e}$. We use an analytical expression, $\bar{e} = \frac{1}{\tau_2 - \tau_1}\int_{\tau_1}^{\tau_2} 1/\left(\gamma - \eta\frac{(1-\tau)}{(1+\tau_1)}\right)d\tau$, to calculate the average elasticity.[31]

Table 5
Robustness of bunching estimator in the presence of income effects in the decision to supply taxable income.

	ϕ	η	γ	$\hat{e}$	$\bar{e}$
$e = 0.10$	0	0	10	0.100	0.100
	−0.1	−1	9	0.102	0.102
	−0.2	−2	8	0.104	0.104
	−0.3	−3	7	0.106	0.106
	−0.4	−4	6	0.107	0.108
	−0.5	−5	5	0.109	0.110
$e = 0.20$	0	0	5	0.199	0.200
	−0.1	−0.5	4.50	0.203	0.204
	−0.2	−1.00	4.00	0.206	0.208
	−0.3	−1.50	3.50	0.210	0.212
	−0.4	−2.00	3.00	0.214	0.216
	−0.5	−2.50	2.50	0.218	0.220
$e = 0.30$	0	0	3.33	0.298	0.300
	−0.1	−0.33	3.00	0.303	0.305
	−0.2	−0.66	2.66	0.308	0.311
	−0.3	−1.00	2.33	0.314	0.318
	−0.4	−1.33	2.00	0.320	0.324
	−0.5	−1.66	1.66	0.327	0.331

The results from the simulation exercise are shown in Table 5 and illustrated graphically for one particular case in Fig. 8. The first thing to note is that when we set the income effect to zero, $\eta = 0$, we obtain estimated compensated elasticities very close to the three theoretical compensated elasticities that we consider. This shows that the estimation procedure works very well in the absence of income effects. The results of our exercise shows that even if the income effect term is as large as −0.5 (implying that the uncompensated response to net-of-tax increase is negative for the range of compensated elasticities that we consider) the compensated elasticity, is for all practical purposes, accurately recovered. We therefore conclude that income effects are unlikely to impose any serious threat when estimating a compensated response with the bunching method, even when the kink point used for identification is large.

7. Bounds on the taxable income elasticity

As mentioned in the introduction, the empirical prediction of the standard model regarding the shape of the income distribution around the large Swedish first central government kink point is extremely clear. In the absence of optimization frictions we should see a large spike in the taxable income distribution at the kink, even when the compensated taxable income elasticity is very small. The failure of the standard model in accurately predicting the behavior of agents around kink points does not necessarily imply that long run responses to taxation are absent. In fact, positive compensated elasticities can be consistent with zero bunching if one assumes that individuals make *optimization errors*. From the perspective of the econometrician, this introduces concerns about identification. Both the distribution of elasticities (preference parameters) and the distribution of optimization errors in the population are unobserved. In order to make progress, it is necessary to impose

[27] See Keane (2011), Section 3.1. The utility function in Keane (2011) is slightly different as he considers the labor supply choice in terms of hours worked, whereas we model taxable income. However, the expressions for the elasticities are the same. Interestingly, the quantity does not depend on z_0.

[28] We have chosen to work with a triangular distribution since the upper middle part of the empirical taxable income distribution in Sweden is roughly trapezoid-shaped.

[29] In the simulations we repeatedly calculate the taxable income choices of N=200,000 taxpayers in an interval around the kink.

[30] In an earlier version of this paper, Bastani and Selin (2011), we considered a different utility function, which always has a constant compensated elasticity, but offering few possibilities to vary the income effect term. We arrived at the same qualitative conclusions in this earlier exercise.

[31] The individuals who bunch at the kink point exhibit marginal rates of substitution between consumption and taxable income supply in the range of $[1 - \tau_2, 1 - \tau_1]$. When defining the elasticity, an individual with $MRS = 1 - \tau$ is considered to optimize along a linear segment with slope $1 - \tau$. Assuming that the density around the kink is uniform, we can define the average elasticity at the kink as $\bar{e} = \frac{1}{\tau_2 - \tau_1}\int_{\tau_1}^{\tau_2} \frac{1}{\gamma - \eta S}d\tau = \frac{1}{\tau_2 - \tau_1}\int_{\tau_1}^{\tau_2} 1/\left(\gamma - \eta\frac{(1-\tau)z(\tau)}{(1-\tau)z(\tau)+(\tau-\tau_1)k}\right)d\tau = \frac{1}{\tau_2 - \tau_1}\int_{\tau_1}^{\tau_2} 1/\left(\gamma - \eta\frac{(1-\tau)}{(1+\tau_1)}\right)d\tau$ since, by definition, $z(\tau) = k$ is the optimal choice of a τ-buncher on a linear segment with slope $1 - \tau$.

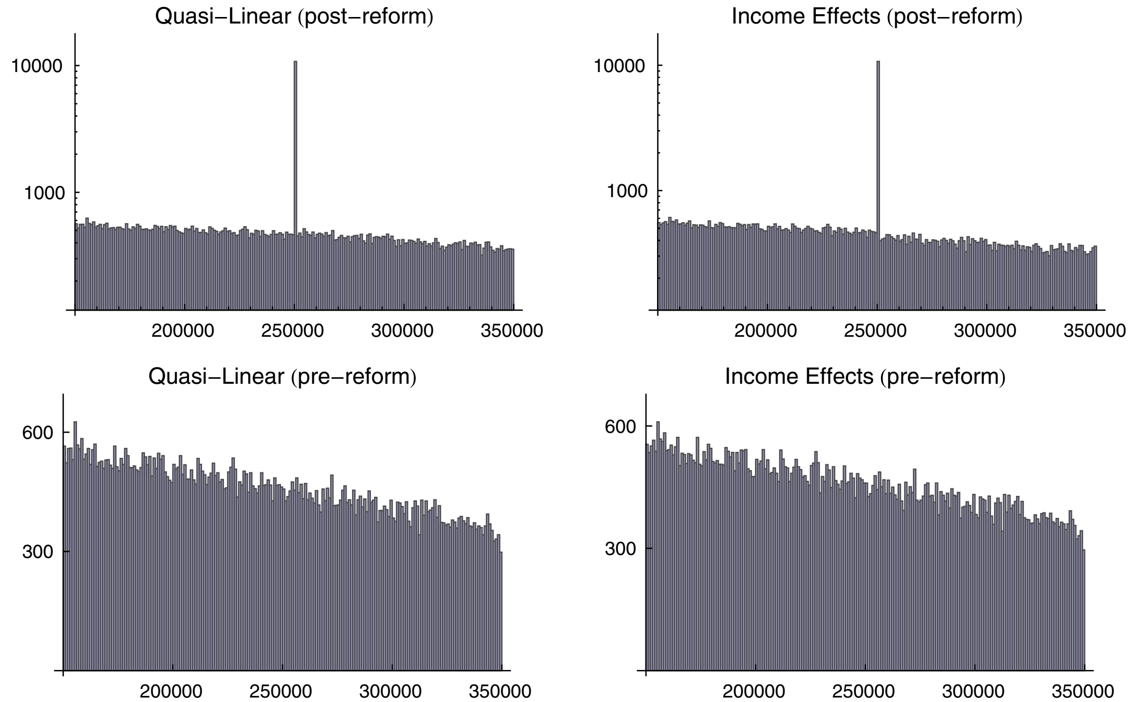

Fig. 8. Simulated income distributions under flat income tax (bottom panel) and reformed tax system (top panel, logarithmic scale), for the case $\gamma = 3.5, \eta = -1.5 (e = 0.2, \phi = 0.3)$, using 200 k taxpayers.

assumptions on the distribution of optimization errors, otherwise nothing can be said about the elasticity. In the non-linear budget set literature (e.g. Burtless and Hausman, 1978; Blomquist and Newey, 2002) point identification of the elasticity has been achieved by assuming that observed behavior is equal to desired behavior plus an additive error term which is orthogonal to the net-of-tax wage.

To our knowledge, the most comprehensive and systematic analysis of optimization errors in the labor supply context is to be found in the recent work by Chetty (2012). Influenced by the partial identification literature in econometrics, Chetty replaces the orthogonality condition with a bounded support condition. Chetty sets up a dynamic model of consumer demand, where individuals are allowed to deviate from the frictionless optimum in an arbitrary fashion provided that the expected life time utility cost of doing so is less than a certain threshold. In accordance with the non-linear budget set literature, no particular structure is imposed on the mechanisms generating the error. In this way, the optimization error can be reconciled with a large number of frictions, including adjustment costs and inattention. Chetty's framework implies that it is possible for an individual to ignore a small tax reform, but react to a larger one which implies that elasticities estimated using large tax reforms are closer to structural elasticities than 'observed elasticities' obtained by using small tax reforms. In particular, Chetty (2012) derives bounds on the size of the *compensated* labor supply elasticity as a function of the size of the tax change, captured by the log of the net-of-tax ratio $\Delta\log(1-\tau)$, and δ defined as the percent of net-of-tax earnings individuals on average tolerate in utility losses as a result of not locating at the kink.[32]

Of particular interest for our purposes is the case when the observed elasticity is zero. Then the upper bound of the compensated elasticity takes on the following simple form

$$e_U = \frac{8\delta}{[\Delta log(1-\tau)]^2}. \tag{11}$$

Note that the upper bound increases linearly in δ, but shrinks at a quadratic rate in $\Delta log(1-\tau) = |log(1-\tau_2) - log(1-\tau_1)|$. Thus, there is considerably more information contained in large tax changes as compared to small ones. In our present application we have estimated an observed compensated elasticity of zero for wage earners. The two first rows of Table 6 report the upper bounds implied by our bunching estimation exercise for 1998 and 1999–2005, respectively, for three different values of δ. While adopting Chetty's baseline assumption of $\delta = 1$, the upper bound on the compensated elasticity is 0.7 for the 1999–2005 period, but only 0.39 for 1998. The latter is a surprisingly informative bound. In Table 3 we also follow Chetty and calculate confidence intervals along the lines of Imbens and Manski (2004).[33]

How do these bounds relate to the bounds implied by other studies? Recently, Blomquist and Selin (2010) estimated the compensated taxable income elasticity while exploiting Swedish panel data and unprecedentedly large marginal tax cuts for high income earners between 1981 and 1991. For top income earners, marginal tax rates were reduced by 34 percentage points. Blomquist and Selin obtained a compensated taxable income elasticity estimate of 0.24 for married men. The large variation generates tight bounds; the lower bound being 0.12 and the upper bound being 0.5 for $\delta = 1$ when the statistical uncertainty is disregarded. Still, it is noteworthy that the upper bound of 0.39 obtained in our bunching analysis for the year 1998 is lower than the corresponding upper bound calculated based on Blomquist and Selin.[34] This point can be pushed even further if one also takes the

[32] The bounds, expressed in Proposition 1 in Chetty (2012), are derived using a quadratic approximation to the utility function. Chetty also uses the assumption that the utility functions are iso-elastic and quasi-linear, but shows that Proposition 1 is still valid for more general utility functions if one imposes the local iso-elastic assumption on the structural Hicksian elasticity.

[33] Note that statistical imprecision is irrelevant when calculating bounds for our bunching estimates due to the small standard errors of the point estimates.

[34] The lower bound is always zero if the observed elasticity is zero.

Table 6
Upper bounds on structural compensated elasticity and comparison with Blomquist and Selin (2010).

Study	Population (wage earners)	$\|\Delta NTR\|$	$\hat{e}$	$e^{UB}(\delta = 0.5)$	$e^{UB}(\delta = 1)$	$e^{UB}(\delta = 2)$
Kink analysis 1998	All	0.46	0.00 {0.00}	0.19	0.39	0.77
Kink analysis 1999–2005	All	0.34	0.00 {0.00}	0.35	0.70	1.39
Blomquist and Selin (2010)	Married men	0.78	0.24	0.41	0.50	0.66
			{0.08}	[0.55]	[0.65]	[0.82]
Blomquist and Selin (2010)	Married women	0.50	1.40	1.97	2.26	2.74
			{0.85}	[3.57]	[3.94]	[4.52]

Standard errors for the point estimates are in curly brackets. The upper end of a 95% confidence interval centered around e^{UB} is reported in square brackets. For the kink analysis, sampling error is absent and the error in the polynomial fit is close to zero, hence the confidence interval collapses to e^{UB}. The absolute change in the log net-of-tax rate for Blomquist and Selin (2010) is calculated as twice the standard deviation of the change in the log net-of-tax rate in the estimation sample in accordance with recommendations in Chetty (2012, appendix B). δ = percentage of disposable consumption individuals on average tolerate in utility losses and $|\Delta NTR| = \left|\Delta log\left(\frac{1-\tau_1}{1-\tau_2}\right)\right|$ is the absolute log change in the net-of-tax-rate.

statistical uncertainty into account. Owing to the high degree of statistical precision in our estimates the upper end of the 95% confidence interval virtually coincides with the upper end of the identified set of elasticities consistent with $\delta = 1$.[35]

Chetty (2012), Table 1 reports bounds for $\delta = 1$ for the paper by Gelber (2013), a related study that exploits the Swedish 1991 reform to estimate compensated elasticities in a family model (including cross responses between spouses). A point estimate of 0.25 for males translates into a narrow interval of 0.12 to 0.54, i.e. a very similar band as that implied by the paper by Blomquist and Selin (2010).[36]

When comparing our bunching analysis with Gelber (2013), Blomquist and Selin (2010) and Hansson (2007) the following cautious remark should be made. While the previous studies typically have estimated behavioral parameters for the whole population, our bunching analysis recovers a local elasticity estimate at a specific region of the upper middle part of the income distribution. Thus, in so far the male response is driven by income reporting responses of top income earners the two types of studies will reflect distinct behavioral parameters.

For married females, Blomquist and Selin found a compensated elasticity of 1.40 for married women. As shown in Table 3, this large intensive margin estimate translates into very high upper bounds, e.g. 2.26 in the baseline case.[37] If the large female elasticities reflect choices along the half time/full time margin, those earlier estimates are not so relevant as a comparison for the local elasticity estimate obtained in our study. The reason is that the first central government kink point is located at an earnings level where, in principle, all individuals work full time.

8. Concluding remarks

Economic theory predicts that, if preferences are convex and smoothly distributed in the population, we should observe an excess mass (bunching) of taxpayers at convex kinks of the budget constraint. In this paper we have estimated bunching of taxpayers at a particularly large kink point in the upper middle part of the Swedish income distribution. During the period of study, the percentage change in the net-of-tax rate at the kink reached a maximum value of 45.6%. By the means of numerical simulations, we have illustrated that there is a huge discrepancy between the amount of bunching implied by the standard model and the shape of the actual income distribution locally around the first central government kink point. We found no economically significant bunching of wage earners at the large first central government kink point, implying a local estimate of the compensated taxable income elasticity of zero in these income ranges. The self-employed does bunch on the other hand, but the implied elasticities are small.

The main contribution of this study has been to examine a very large kink point in the upper middle part of the income distribution where a large number of taxpayers are located. This allowed us to derive upper bounds on the compensated elasticity along the lines of Chetty (2012) which are surprisingly tight. If wage earners on average tolerate 1% of their disposable income in optimization costs, the upper bound is 0.39 for the year 1998.

We have also contributed methodologically by investigating the role of income effects in bunching estimation. While the bunching estimator recovers the compensated taxable income elasticity for infinitesimal tax changes, Monte Carlo simulations are necessary to show that this also holds true for large tax changes. This is especially relevant to our study since we are exploiting a large kink. Our results indicate that the bunching estimator is largely unaffected by the presence of income effects, even when the income effect term is large relative to the compensated elasticity. This result cannot, of course, be immediately generalized to broader classes of utility functions. However, it clearly suggests that income effects create a second-order problem in the context of bunching estimation.

Historically, many studies of labor supply and taxable income responses have been undertaken on Swedish data. Most of these studies obtain behavioral elasticities that predict a certain amount of bunching at kink points. A final, perhaps trivial, contribution of our paper is that we are, to our knowledge, the first researchers to carefully examine the Swedish income distribution locally around kink points.

Appendix A. Summary statistics and sensitivity analysis

Table 7
Summary statistics. Self-employment sample, 2000–2008.

	All individuals	$z \in [-75, -5]$	$z \in [-5, 5]$	$z \in [5, 75]$
Age	48.294	48.102	48.384	48.488
Male	0.645	0.683	0.727	0.741
Married	0.568	0.565	0.594	0.592
University degree	0.337	0.314	0.371	0.439
Taxable income	280,063	284,142	326,049	361,190
Wage income and transfers	209,478	226,230	233,674	293,974
Business income (sole)	33,481	31,779	60,848	34,020
Business income (partner)	5803	5481	10,130	6339
CHC owner	0.227	0.233	0.278	0.318
Sole proprietor	0.658	0.660	0.612	0.569
Partnership owner	0.115	0.107	0.110	0.113
Pure CHC owner	0.012	0.007	0.006	0.009
Pure sole proprietor	0.188	0.098	0.133	0.078
Pure partnership owner	0.032	0.018	0.026	0.016
Number of observations	7,172,294	1,381,905	218,135	783,349

[35] For $\delta = 2$ (the rightmost column) the upper bound implied by the 1998 bunching analysis is 0.77, whereas the upper bound implied by the work by Blomquist and Selin is lower (at least when neglecting the statistical uncertainty). The reason is that the upper bound increases linearly in δ when the observed elasticity is 0, but grows at a decreasing rate in δ when the observed elasticity is positive.

[36] Hansson (2007), who exploits the same data source and tax variation as Gelber (2012), obtains a taxable income elasticity of 0.29 for males (Table 2, second column). This estimate cannot, however, be interpreted as the compensated taxable income elasticity.

[37] Even though the point estimate for females was significant at 10% the standard errors were considerably larger for females. On a larger data source, Gelber (2012) obtained a point estimate of 0.49 and Hansson estimated an elasticity of 0.76, both with smaller standard errors.

Table 8
Sensitivity analysis with respect to small and large bunching window.

Wide window (SEK)	Small window (SEK)	Partnership owners	Sole proprietors	Corporate owners	Wage earners, 1999–2005
[−75,000, 75,000]	[−1000, 1000]	1.915	2.042	1.488	0.025
		(0.063)	(0.060)[a]	(0.106)	(0.028)
[−75,000, 75,000]	[−3000, 3000]	2.512	2.686	1.835	0.120
		(0.076)	(0.063)	(0.167)	(0.045)
[−75,000, 75,000]	[−10,000, 10,000]	3.125	3.284	2.451	0.221
		(0.147)	(0.113)	(0.365)	(0.090)
[−75,000, 75,000]	[−15,000, 15,000]	3.070	3.286	2.979	0.208
		(0.214)	(0.166)	(0.559)	(0.128)
[−75,000, 75,000]	[−5000, 1000]	2.179	2.412	1.929	0.047
		(0.092)	(0.080)	(0.165)	(0.043)
[−75,000, 75,000]	[−1000, 5.000]	2.358	2.448	1.622	0.044
		(0.089)	(0.085)	(0.173)	(0.046)
[−75,000, 75,000]	[−10,000, 5000]	2.743	3.139	2.473	0.122
		(0.124)	(0.091)	(0.282)	(0.072)
[−75,000, 75,000]	[−5000, 10,000]	3.051	3.014	2.077	0.148
		(0.120)	(0.099)	(0.298)	(0.076)
[−50,000, 50,000]	[−5000, 5000]	2.594	2.725	1.821	0.047
		(0.110)	(0.085)	(0.261)	(0.063)
[−100,000, 100,000]	[−5000, 5000]	3.019	3.130	2.466	0.121
		(0.104)	(0.078)	(0.208)	(0.065)

[a] Bunching (excess mass) is reported with standard errors in parenthesis.

Table 9
Sensitivity analysis with respect to polynomial order.

Degree of polynomial	Wage earners, 1999–2005	Self employed, 2000-08
1	−0.296	4.143
	(0.160)[a]	(0.206)
2	0.195	3.366
	(0.111)	(0.142)
3	0.123	3.299
	(0.052)	(0.118)
4	0.125	2.956
	(0.055)	(0.103)
5	0.123	2.944
	(0.055)	(0.099)
6	0.074	2.720
	(0.057)	(0.095)
7	0.074	2.720
	(0.057)	(0.095)
8	0.044	2.565
	(0.060)	(0.095)
9	0.044	2.563
	(0.060)	(0.094)
10	0.048	2.459
	(0.065)	(0.099)

[a] Bunching (excess mass) is reported with standard errors in parenthesis.

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