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Abstract

The objective of this paper is to study if taxpayers behave in a loss averse manner when filing their tax returns. This is important for tax design but also for understanding human behavior in general. The predictions of prospect theory can be contrasted to those of expected utility theory. We use data for 3.6 million Swedish taxpayers for the income year 2006. Our research method is quasi-experimental using a regression kink and discontinuity approach. We also use an alternative instrumental-variables approach. There is strong evidence of loss aversion. We estimate the coefficient of loss aversion using actual behavior and the instrument-variables approach. Our estimate is very close to the estimates reported in the experimental literature.

Keywords: loss aversion, prospect theory, tax compliance, quasi-experiment, regression kink, regression discontinuity

JEL Codes: C21, C26, D03, H24, H26

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1   Introduction

Behavioral economics is a field that has received a rapidly increasing interest during the last decades. The theoretical advances are many. The concept of loss aversion has been recognized in the literature since Kahneman and Tversky (1979). Most empirical studies of loss aversion have used laboratory experiments with student samples and have found that people seem to be loss averse.[1]

Loss aversion has very strong support from laboratory studies. There is, however, much less real-world evidence of loss aversion. Pope and Schweitzer (2011) is an important real-world exception. They study the putting behavior of professional golf players on the PGA tour. This is an important contribution as it uses actual data with 2.5 million observations, experienced players, and high stakes. They find clear evidence of loss aversion. The sample is quite special, however. It is an open question whether it is possible to generalize the results.

We also study a real-world situation. The setting is, however, more general than in previous studies. Very few become professional golfers but almost all of us pay taxes. We study all Swedish taxpayers and their behavior when filing their income tax returns. We find evidence of loss aversion. The probability of claiming a deduction is much higher if the taxpayer has taxes due according to the preliminary tax balance than if the taxpayer will get a refund. This is the first study that we know of documenting loss aversion among a large general sample of the population when doing a very common real-world duty.

Previous studies suggest that people who have paid too little in preliminary taxes actually are less likely to comply than those who have paid too much. Preliminary tax payments should, however, have no effect on tax compliance according to standard neoclassical theory. Chang and Schultz Jr (1990) find for the United States that those who owe additional taxes when they file their returns are less likely to comply than those who have refunds due. They cannot, however, establish a causal relationship. Persson (2003) is a previous descriptive study using Swedish data. She reports similar results, people with tax deficits are more prone to claim dubious deductions. Experimental studies also suggest that advance tax payments actually matter for compliance.[2]

These findings are not consistent with expected utility theory. They can, however, be explained by reference dependence and loss aversion. Reference dependence means that the individual attaches a value to the deviation of an outcome from a reference point. It is likely that a zero preliminary tax balance is such a reference point in our particular application.

Some theoretical studies in the area of prospect theory that focus on tax compliance suggest the following line of reasoning:[3] Loss aversion implies that the individual values losses compared to the reference point more than gains of the

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[1] See, e.g., Tversky and Kahneman (1992), Thaler et al. (1997), Schmidt and Traub (2002), Abdellaoui et al. (2007), and Abdellaoui et al. (2008)

[2] See, e.g., Robben et al. (1990), Schepanski and Shearer (1995), and Copeland and Cuccia (2002).

[3] See, e.g., Yaniv (1999), Bernasconi and Zanardi (2004), and Dhami and al Nowaihi (2007).

same amount. An individual with a preliminary tax deficit (more taxes due) will, therefore, perceive a higher marginal value of extra income than an individual with a preliminary tax surplus (some taxes will be refunded) of the same amount. Those with a preliminary tax deficit would consequently be less inclined to comply.

Most empirical studies testing these hypotheses are experimental. The difficulty in getting reliable real-world data on tax compliance is a reason for this. We use high quality tax return data. Our theoretically founded empirical analysis concerns a particular type of non-compliance. We study the probability that taxpayers claim deductions for "other expenses for earning employment income".

These deductions express tax non-compliance in many cases. RSV (2001) reports that almost all audited claimed deductions for "other expenses for earning employment income" were rejected.[4] We simply view this behavior as expressing *tax aversion*. It is not possible to determine if a particular rejected claimed deduction actually is an attempt to evade taxes or not.

The full dataset we use consists of 3.6 million Swedish taxpayers. The data concern the income year 2006, the tax assessment year is 2007. We design a quasi-experiment using a regression kink and discontinuity approach. This regression technique allows us to eliminate potential problems of endogeneity and selection in ways that previous empirical studies have not been able to do.

We find behavior to be consistent with loss aversion in the following sense: Taxpayers who have a preliminary deficit are more likely to claim deductions for "other expenses" than those who have a preliminary surplus. This is a major contribution of the paper. Loss aversion is the natural candidate for explaining this result. The deduction probability should, on the other hand, evolve smoothly around zero preliminary balance according to expected utility theory.

Can we rule out selection? The empirical analysis shows that none of the covariates exhibits a similar evolution around zero preliminary balance.

We also use an alternative instrumental variable (IV) approach. Actual local tax rates are set with two decimals of a percentage. Preliminary local tax rates are, on the other hand, the actual local tax rates rounded to the closest integer percentages tax rates. Preliminary balances, therefore, vary exogenously depending on in which municipality the taxpayer lives. We use the difference between the actual and the preliminary rates as an instrument when estimating probability models for claiming a deduction. Our results are confirmed using this approach.

We also estimate the coefficient of loss aversion in our empirical analysis. The estimate, $\hat{\lambda} = 2.17$ for the full sample, is very close to the estimate reported by Tversky and Kahneman (1992), $\hat{\lambda} = 2.25$.

The remainder of the paper is organized as follows: We discuss prospect theory and its application to tax compliance in Section 2. Section 3 describes our data and the institutional setting. We then present a simple theoretical model, in which the taxpayers' decisions are studied, in Section 4. The model provides predictions

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[4]A more recent follow-up in 2006 drew a random sample of claimed deductions. There were errors in 93 percent of the cases.

for the empirical analysis. Some descriptive results are presented in Section 5. Section 6 presents the empirical results using the regression kink and discontinuity approach. The empirical results using the IV-approach and our estimates of the coefficient of loss aversion are in Section 7. Section 8 concludes the paper.

2   Prospect theory and tax compliance

Kahneman and Tversky (1979) were the first to define prospect theory.[5] The elements of prospect theory we primarily use are *reference dependence* and *loss aversion*. Reference dependence implies that people perceive outcomes as gains and losses compared to some reference point rather than caring for final states of total wealth. Loss aversion makes people consider losses as more salient than gains: "... [t]he function is steeper in the negative than in the positive domain; losses loom larger than corresponding gains." (Tversky and Kahneman, 1991, p. 1039). This implies that the utility function is kinked at the reference point.

Although the concept of loss aversion was first introduced in risky settings (and has been proposed to explain parts of observed risk aversion), Tversky and Kahneman (1991) show that it can also explain behavior in the absence of risk.

The existence of loss aversion has been studied in many experimental settings, both risky and riskless, mostly using student subjects. Kahneman et al. (1990) conducted one of the first famous experiments in a riskless setting. Half of the subjects were given a mug, for which they were then asked to give a selling price. The rest were asked for their willingness to pay for a mug. The price mentioned by the former group widely exceeded the one mentioned by the latter. This "endowment effect" has been seen as a test of loss aversion and reference dependence.[6]

Many experimental studies have followed. Tversky and Kahneman (1992), Schmidt and Traub (2002), Abdellaoui et al. (2007), and Abdellaoui et al. (2008) are some studies finding evidence of loss aversion to various extent in within-subject comparisons. They let the subjects (in most cases rather few university students) make several choices and concluded that the same individual makes different choices depending on gains or losses.

The subjects in the experiment by Gächter et al. (2007) are car buyers. The authors make both within- and between-subject comparisons and study both risky and riskless choices. They find that loss aversion in riskless and risky settings are strongly positively correlated. Individuals do, however, differ.

Loss aversion has been found to explain behavior also in real-life situations. The studies are fewer than the experimental. Odean (1998) finds that investors

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[5]The original prospect theory by Kahneman and Tversky (1979) was later refined by Tversky and Kahneman (1992) into the cumulative prospect theory with the inclusion of weighting functions of probabilities. Loss averse behavior, therefore, does not stem solely from the utility function according to cumulative prospect theory. It is also determined by the weights put on the probabilities of different outcomes (Schmidt and Zank, 2005). We deal with riskless decision making in this paper, implicitly assuming original prospect theory.

[6]See, e.g., Bateman et al. (1997).

tend to keep losers and sell winners, the reference point is the purchasing price. A similar result is found by Genesove and Mayer (2001). They study sellers of residential real estate. These cases, however, deal with substantial amounts. This implies that behavior partly could be due to equity constraints, not loss aversion.

Pope and Schweitzer (2011) test for loss aversion using data on professional golfers' performance on the PGA tour. They study data on more than 2.5 million putts and find evidence of loss aversion in a high-stake context. Although golfers ought to care only about the total score, they seem to consider par as the reference point when putting. They are more accurate on average when putting for par (avoiding a loss) than when putting for a birdie (increased winning).

The existence of loss aversion has, therefore, been established. It is another question how important it is. Loss aversion means that the utility (or value) function is steeper for gains than for losses, but how much steeper? This can be captured by the coefficient of loss aversion, λ. There is no overall consensus on how this should be measured: Tversky and Kahneman (1992) originally defined it as the ratio of utilities: $\lambda = -U(-1)/U(1)$, while Köbberling and Wakker (2005) instead focus on the different slopes: $\lambda = U'_{\uparrow}(0)/U'_{\downarrow}(0)$. Abdellaoui et al. (2007) summarize and discuss various methods of measuring λ. Different definitions and different questions and samples have also given rise to quite disperse estimates of λ. The most frequently cited estimate is by Tversky and Kahneman (1992): $\hat{\lambda} = 2.25$. Abdellaoui et al. (2007) refer to studies that have found estimates of λ ranging from 1.4 to 4.8 in risky settings. For the risky setting Gächter et al. (2007) estimate average $\hat{\lambda} = 2.6$ and for the riskless $\hat{\lambda} = 2.0$.

Schmidt and Traub (2002) find women to be more loss averse than men. Gächter et al. (2007), on the other hand, find no significant gender difference once controlling for other covariates. They find that loss aversion increases in age and income but decreases in education.

There are several theoretical papers that use prospect theory when studying tax compliance. Dhami and al Nowaihi (2007) set up a rigorous model. They make a complete analysis to explain some "tax-evasion puzzles" and how these puzzles can be explained by various components in cumulative prospect theory. The most relevant result for our study is that the evaded amount is increasing in the degree of loss aversion.

Bernasconi and Zanardi (2004) also model tax evasion in the realm of cumulative prospect theory. Their simulations show that people initially in the loss domain evade. They will evade sufficiently to enter the gain domain if not caught. People starting in the gain domain do not evade so much that they risk an income lower than the reference income.

Some papers focus on how important advance tax payments are to deter tax evasion in the light of prospect theory. Yaniv (1999) sets up a simple theoretical model to show how advance payments reduce evasion. The intuition is clear: Those who have paid too much in advance get a refund. This is considered a gain. The value function is concave for gains under prospect theory implying risk aversion.

The value function is, on the other hand, convex for losses under prospect theory implying risk seeking. A taxpayer has to pay the difference and experiences a loss if the advance tax payments are lower than actual tax liabilities. Such a taxpayer might be more willing to take the risk of evading. It is, therefore, clear that advance tax payments higher than true tax liabilities deter tax evasion.

Elffers and Hessing (1997) also find that advance payments promote compliance. They, however, also point to the fact that withholding too much may make people feel wrongly treated. This has an opposing effect. They also claim that a standard deduction would increase tax compliance.

There are also empirical studies that focus on the effects of loss aversion on tax evasion. Cox and Plumley (1988) find that the share of tax returns needing correction increases with balance due. Chang and Schultz Jr (1990) also study how compliance depends on over- and under-withholding at the time of filing using actual tax return data. Those who owe more taxes when they file their returns comply less than those who have refunds due. This holds true in all income brackets.

Persson (2003) is a previous descriptive study using Swedish data, which reports results similar to the two above mentioned American studies. She finds that people with a tax deficit are more prone to claim dubious deductions. Moreover, all claimed deductions in one region were audited. Those with tax deficits were less likely to have their claimed deductions approved than those with tax surpluses.

Kirchler and Maciejovsky (2001) have data on self-reported tax evasion and use them to explain compliance behavior in an experimental setting. They find evidence of both reference dependence and loss aversion. Schepanski and Shearer (1995) focus on the effect of withholding in an experimental study where the subjects are undergraduate students. They find that hypothetical taxpayers who are under-withheld are more likely to underreport income. Robben et al. (1990) also use students in a hypothetical experiment. They find that having to pay extra tax after insufficient tax has been withheld leads to more evasion than receiving a refund after too much has been withheld.

All the above mentioned studies focus on tax evasion as a risky action. The taxpayer needs to pay a fine in addition to the tax if the taxpayer evades and is caught. The situation we study is different, however. We study deductions for expenses that the taxpayer may or may not have had. The deduction may not be justified even if the taxpayer have had the expense. The reason is that the particular expense may not be deductable. We cannot, therefore, be entirely sure if it is tax evasion, tax avoidance, or something else going on. We know, however, that those who claim the deduction are *tax averse*. They find it worthwhile to claim the deduction although it comes at a cost (administrative and/or moral). We, moreover, restrict our analysis to small claimed deductions. The probability of having these claimed deductions audited was negligible at the time of the study. And there was no additional fine for sufficiently small deductions if the deduction was audited and not accepted.[7] Neither were there any fines for large rejected deductions provided

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[7]The tax law has changed since. The threshold value that expenses have to exceed before the

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that the taxpayer could prove that he had had the expense he claimed the deduction for. The choice to claim a deduction was, therefore, completely without risk.

Some aspects of prospect theory, such as risk aversion in the gain domain and risk seeking in the loss domain, do not, therefore, apply here. Loss aversion and reference dependence may, however, be as important in risk-free situations as in risky ones (Tversky and Kahneman, 1991). We identify the impact of loss aversion on tax compliance by studying how preliminary balances affect deduction behavior.

3 Data and institutional setting

Our entire dataset has data on 4.7 million Swedes, 16–67 years old, filing their tax returns in 2007 for the income year 2006. We have access to a limited number of variables: employment income, marginal tax rate, gender, age, claimed deduction for other expenses for earning employment income, and the preliminary balance in taxes due.

Assessed employment income includes salaries, social insurance system benefits (such as sickness benefits and parental benefits), and unemployment benefits. Approved costs for commuting to work are subtracted. Assessed employment income also includes public pensions and occupational pensions. Retirees cannot be expected to have salary income and, therefore, claim deductions for other expenses. This explains the upper age limit in our sample. Moreover, taxpayers who had earned business income were not included.

The sequence of events for a taxpayer is as follows:[8] Employees pay employment income taxes at source during income year. Employers transfer the tax payments to the Tax Agency. Analogous principles apply for capital income taxation (interest received and paid, dividends, etc).

The Tax Agency sends a preliminary income tax return to the taxpayer in April the following year (the assessment year). This tax return is based on the statements of income that the Tax Agency has received from employers, banks, etc. The Tax Agency also calculates a preliminary balance in taxes due. The preliminary balance can show a deficit (more taxes due) or a surplus (there will be a tax refund). The taxpayer can add missing information to the tax return, for instance claiming deductions. The filing must be done by 2 May. The refund is paid out in June or August if there is a surplus after the filing. If there is a deficit, the taxpayer has to pay the taxes due in November or December.[9]

It is a major event in Sweden when the Tax Agency starts sending out the final tax statements. Media often fuels the sense of a giant mandatory lottery taking place. An illustrative example is given by an article in the tabloid *Aftonbladet* that

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tax liability decreases was increased considerably. There is now no longer any point in claiming deductions of small amounts.

[8]See also the information from the Tax Agency reproduced in Appendix A.

[9]The interest paid on surpluses and the interest levied on deficits are independent of the filing date. Appendix A presents the details that applied during the assessment year 2007. The issues that Slemrod et al. (1997) discuss for the United States do not arise in the same way in Sweden.

gave notice to the event.[10] The preamble exclaims: "Praise mammon, here comes the tax refunds" and continues: "If you are lucky the money could be on your account before Midsummer". The chance of getting a refund is generally high since most Swedes have paid too much in preliminary taxes. One could in some sense describe the event as Christmas for grownups–but there is always a risk that it is not Santa but the tax collector that is coming down your chimney.

We would like the preliminary balance to be a correct signal from the Tax Agency to the taxpayer. The preliminary balance should also be exogenous to the taxpayer. We, therefore, exclude taxpayers for whom the preliminary balance might not be exogenous.

Taxpayers can ask taxes at source during the income year to be based on their individual economic situation instead of the default rules. The preliminary balance can be expected to be endogenous for these taxpayers. We exclude these taxpayers from the sample. In addition, we exclude taxpayers who actively have made advance tax payments directly to the Tax Agency at their own initiative in the beginning of the assessment year. There are incentives for taxpayers with preliminary deficits larger than SEK 20,000 to make advance tax payments before mid February to avoid having to pay extra interest.[11] We can expect the preliminary balance to be endogenous also for these taxpayers. Finally, only taxpayers with "normal" annual employment incomes are included in the sample. We interpret normal annual employment income to be in the interval SEK 100,000–1,000,000. These selection criteria leave us with a *full sample* of 3.6 million taxpayers.[12]

Why not use the defaults rules? And why make advance payments? One reason is that taxation at source and the Tax Agency's preliminary calculations of taxes due cannot correctly take some taxes into account. This is because the Tax Agency does not have all the necessary information from the statements of income received from employers, banks, etc. This concerns the wealth tax (repealed in 2007), capital taxation of realized capital gains (financial instruments, real estate), and taxation of business income. Our selection criteria should exclude most taxpayers who pay these taxes.

So why does not taxation at source exactly match the true tax liability for the taxpayers? In other words, why do preliminary tax balances deviate from zero? The way the proportional local government part of the employment income tax is levied is an important reason. The actual tax rates are set with two decimals of a percentage (for example, 30.83 percent or 31.12 percent). The Tax Agency decides on tax tables that employers use when withdrawing preliminary tax for their employees. These tables are created assuming integer percentages tax rates at source (for example, 31 percent). Taxpayers who live in municipalities for which tax rates at source are above the actual rates will tend to pay to much in preliminary taxes. This will increase their preliminary balances. The opposite applies for taxpayers

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[10]The article is from 22 March 2011 and was published in the smart-phone version of the tabloid under the name "Tax refund? You can now log in and check!", our translation.

[11]See Appendix A for more information on interest rates etc.

[12]Descriptive statistics for the full sample are presented in Appendix B.

who live in municipalities with actual rates higher than the rates used at source.[13]

The progressive central government part of the employment income tax and the personal exemption, that depended on employment income, are other possible reasons. Benefits from the social insurance systems are included in employment income but replacement rates are below 100 percent. Absenteeism may affect the preliminary balance and so does overtime work. A taxpayer with varying employment income over the year will tend not to pay the same amount in preliminary taxes as a taxpayer with the same annual employment income evenly distributed over the year. Having several employers might also result in that not enough taxes will be paid at source.

Deviations from a zero preliminary balance may also arise from capital income taxation. Taxpayers who pay deductable interest and who have not asked for the preliminary taxation take this into account will tend to have preliminary surpluses.

Assessed employment income was reduced by approved "other expenses for earning employment income" exceeding SEK 1,000 (USD 150 in 2006) during the income year 2006. So which types of expenses are approved? Some examples are expenses for safety equipment, safety clothes, tools, and instruments related to work not paid for by the employer, expenses for an office if the employer does not provide one (an office at home is not approved in general), expenses for books and journals related to work for some occupations if not paid for by the employer, and expenses for phone calls related to work if not paid for by the employer (not the phone and not the subscription).

There are some studies of randomly audited claimed deductions for "other expenses".[14] The finding is that 90–95 percent of the claims were not approved. Claiming such deductions is, therefore, a clear sign of tax aversion. In some cases, the taxpayer may simply not understand the rules and believe that he is entitled to the deduction. The taxpayer may take a chance in other cases. Some claimed deductions are, however, clearly not attempts not to comply. This is likely to be true especially for large claimed deductions. It is difficult to invent very large "other expenses". Large deductions are more often accurate than small (Persson, 2003).

Suppose that there is a taxpayer with a large preliminary deficit who claims a large deduction. One might then suspect that the preliminary balance is endogenous. The taxpayer has in advance planned to claim the deduction to reach a zero tax balance in the end. This is an important reason for only including relatively small deductions for "other expenses". We, therefore, exclude deductions higher than SEK 20,000.

It was almost without risk to claim small deductions in 2007. The audit probability was low for small claimed amounts. The taxpayer had only to pay the increased tax liability if the claimed deduction was audited and not approved. There were no fines for incorrectly claimed deductions of small amounts.

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[13]It is not likely that the local tax rate is set strategically in terms of rounding. It is the sum of tax rates set by two distinct jurisdictions: the municipality and the county council.

[14]See RSV (2001) and Persson (2003).
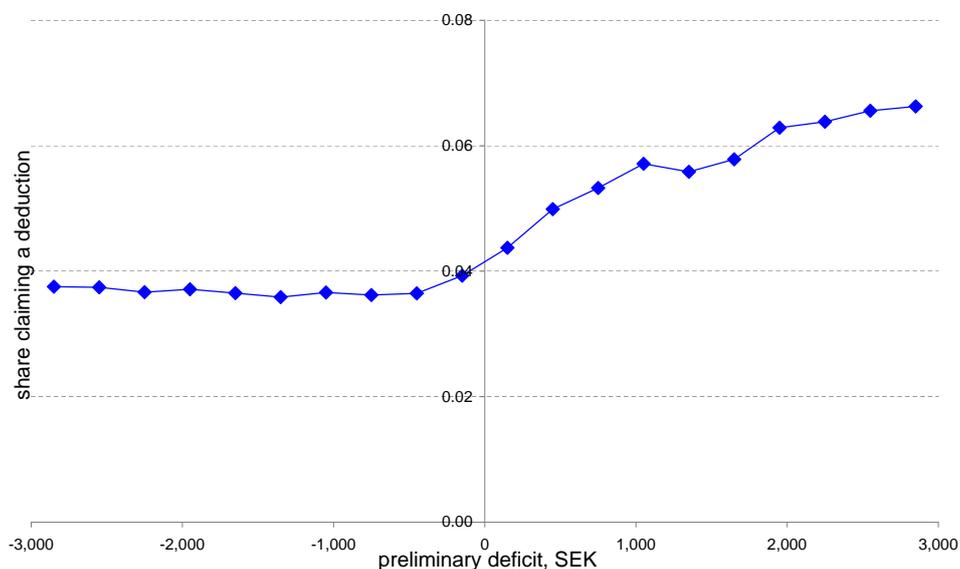
Figure 1: The share claiming a deduction as a function of the preliminary deficit.

The 3.6 million taxpayers in our full sample exogenously end up having a pre-liminary surplus or a preliminary deficit. The preliminary balances become more or less random for taxpayers very close to zero preliminary balance. We, therefore, focus on taxpayers with a preliminary balance in the interval SEK ±3,000. There are 1.2 million in this sub-sample that we label *the maximum bandwidth sample*.[15] Our approach is that the deduction behavior of these taxpayers can be viewed as a quasi-experiment.

Figure 1 shows that the probability of claiming a deduction is higher for taxpay-ers with a preliminary deficit than for those with a preliminary surplus. The share claiming a deduction is, moreover, independent of the preliminary balance for those with a surplus in the maximum bandwidth sample. Slightly less than 4 percent of those with a preliminary surplus claim a deduction for "other expenses". Each data point in the figure represents the share for taxpayers with a preliminary deficit in a SEK 300 interval. The share is, however, increasing in the preliminary deficit for those with a deficit.

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[15] Descriptive statistics for the maximum bandwidth sample are also presented in Appendix B. This sample is based on the preliminary deficit being weighted by the taxpayer's employment income for reasons that will be explained in Section 5. Weighting increases the probability of including tax-payers with high employment income in the sample. Employment income and deduction probability are positively correlated. This is the reason why the deduction probabilities reported in Table 3 in Appendix B are slightly higher than those shown in Figure 1.

4 An illustrative theoretical model

The purpose of this section is to provide predictions for our empirical exercise. We, therefore, keep the analysis as simple as possible. It is beyond our scope to provide a complete model of how tax compliance is related to advance tax payments. We, therefore, do not use the complete prospect theory as presented by Kahneman and Tversky (1979). Loss aversion and reference dependence are the two components we use.

Consider a taxpayer i who is about to file the tax return. He receives information about his preliminary balance in taxes on the tax return. Taxpayer i has taxes due if he has a preliminary deficit, $D_i^p > 0$, and will receive a refund if $D_i^p \leq 0$. He compares the preliminary deficit to his reference point.

What should be the valid reference point has been widely discussed.[16] Dhami and al Nowaihi (2007) argue that legal after-tax income should be used as the reference point. This is related to the idea that the reference point should be based on rational expectations (Köszegi and Rabin, 2006), i.e., how much the taxpayer expects to owe or to get refunded.

It is likely that most people perceive their advance payments to be what they are supposed to pay unless there are special circumstances. We, therefore, assume that the reference point is a zero preliminary tax balance.[17] Taxpayer i has to pay more taxes if the preliminary balance is a deficit, i.e., $D_i^p > 0$. He, therefore, experiences himself to be in the loss domain. He will, on the other hand, get a tax refund if he is in the gain domain, i.e., $D_i^p \leq 0$.

The value function with reference dependence and loss aversion is:

$$
V(D_i^p) = \begin{cases} -v D_i^p & \text{if } D_i^p \leq 0, \\ \\ -\lambda v D_i^p & \text{if } D_i^p > 0, \end{cases} \tag{1}
$$

where $\lambda > 1$ is the coefficient of loss aversion.

We follow Benartzi and Thaler (1995), Schmidt and Traub (2002), and Pope and Schweitzer (2011) and assume a linear value function. This implies constant marginal values. We disregard strict concavity in the gain domain and strict convexity in the loss domain by this assumption. Utility tends, however, to be almost linear on very small intervals. A linear approximation should work well since we limit our analysis to a narrow area around zero.

The taxpayer's only choice in our very simplified model is whether or not to claim a deduction of a fixed amount, δ, the same for all taxpayers. What is the probability that he claims the deduction to reduce his tax liability? The amount δ is sufficiently small to ensure that the taxpayer perceives to be at no risk of being audited if he claims the deduction.[18]

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[16]See, e.g., the discussion in Kirchler and Maciejovsky (2001).

[17]We present sensitivity analyses allowing the reference points to be endogenous in Section 6.2.

[18]We abstract from detection risks in our model contrary to previous studies of tax compliance. Our main results, however, remain valid even if we include a risky choice of evasion.

Claiming the deduction δ comes at a certain cost, c_i. This cost varies across taxpayers, $c_i \backsim U[0, \bar{c}]$. It may reflect the administrative cost of claiming the deduction or the moral cost of doing so if the deduction is not rightful. The deduction is worth $t\delta$, where t is the constant marginal tax rate.

The taxpayer compares the value of his preliminary tax balance, $V(-D_i^p)$, to the value if he claims the deduction, $V(-D_i^p + t\delta) - c_i$. He claims the deduction if the latter exceeds the former. There are three different domains where the taxpayer may end up depending on the sign and size of D_i^p. The three conditions for claiming the deduction δ are:

$$
\begin{array}{llll}
\text{A:} & c_i & < & \lambda v t\delta & \text{if } D_i^p > t\delta, \\[2mm]
\text{B:} & c_i & < & v\left[t\delta - D_i^p(1-\lambda)\right] & \text{if } D_i^p \in (0, t\delta], \\[2mm]
\text{C:} & c_i & < & v t\delta & \text{if } D_i^p \leq 0.
\end{array} \tag{2}
$$

The value of the deduction in the three cases above are illustrated in Figure 2.
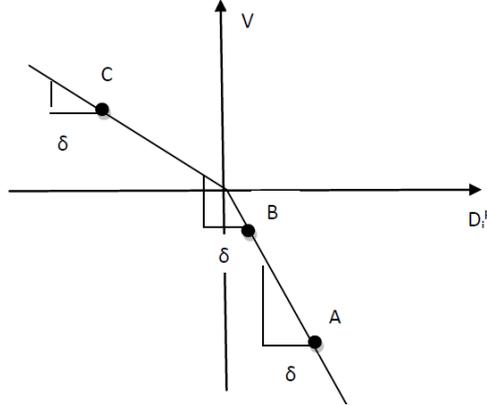
Figure 2: The value of claiming a deduction in three cases depending on the preliminary deficit.

The assumption of a uniformly distributed cost makes it straightforward to use the conditions (2) to predict the share of taxpayers deducting at various preliminary deficits. The threshold cost for claiming the deduction in the loss domain is lower than in the gain domain as $\lambda > 1$. A larger share of the taxpayers should, therefore, claim δ in the loss domain than in the gain domain. The share of taxpayers who deduct should, moreover, be independent of the preliminary balance when the balance is positive. This is because the value function is linear. The same applies for those with a large preliminary deficit (where $D_i^p > t\delta$) who still will have a deficit even after the deduction. It is only in the middle group, $D_i^p \in [-t\delta, 0)$, where the

share of taxpayers deducting is expected to increase in the preliminary deficit:

$$\Delta \;\; = \;\; v\left[t\delta - D_i^p(1-\lambda)\right],$$

$$\frac{\partial \Delta}{\partial D_i^p} \;\; = \;\; v(\lambda - 1) > 0.$$

(3)

We then predict the pattern for the share of taxpayers claiming the deduction to be as shown in Figure 3.
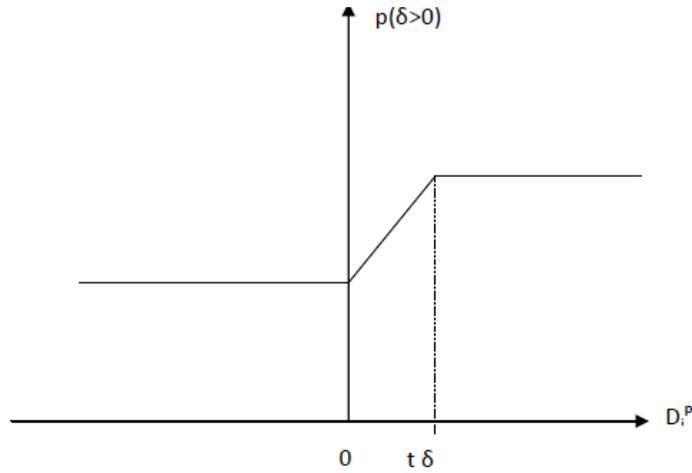
Figure 3: Share of taxpayers claiming the deduction depending on the preliminary deficit.

The pattern in Figure 3 can be summarized as follows:

Prediction 1. *The share of taxpayers with a preliminary deficit who will claim the deduction δ is higher than the share of taxpayers with a preliminary surplus who will.*

Prediction 2. *The probability of claiming the deduction δ, as a function of the preliminary deficit, has the shape as in Figure 3 with kinks at 0 and at $D = t\delta$.*

The above connection can then be used to estimate the coefficient of loss aversion, λ. Tversky and Kahneman (1992) originally defined $\lambda = -U(-1)/U(1)$ and estimated $\hat{\lambda} = 2.25$ using experimental data. Each individual was observed in both the gain domain and the loss domain. Köbberling and Wakker (2005) instead propose the following definition, which is independent of unit of payment: $\lambda = U_\uparrow'(0)/U_\downarrow'(0)$, which was also informally suggested by Benartzi and Thaler (1995). The two definitions are equivalent in our setting with a linear value function. Later studies have used similar techniques to estimate λ. Some have used the mean and others the median to estimate the aggregate value (see, e.g., Abdellaoui et al., 2007, and references therein).

Our approach is different. We observe many people in the gain domain and the loss domain. It is, therefore, possible to estimate an aggregate coefficient of loss aversion. We plot the shares claiming the deduction for each level of preliminary deficits as sketched in Figure 3. The share claiming the deduction in the gain domain is:

$$\int_{c=0}^{vt\delta} f(c)dc = X. \tag{4}$$

We observe the actual share, X, in our data. If we assume the cost to be uniformly distributed, (4) is easily solved to yield:

$$\frac{vt\delta}{\bar{c}} = X. \tag{5}$$

The share claiming the deduction in the part of the loss domain where $D_i > t\delta$ is:

$$\int_{c=0}^{\lambda vt\delta} f(c)dc = Y \quad \Rightarrow \quad \frac{\lambda vt\delta}{\bar{c}} = Y. \tag{6}$$

Equations (5) and (6) then gives $\lambda = Y/X$. The coefficient of loss aversion is simply the ratio between the two shares claiming the deduction.

Prediction 3. *If $c_i \backsim U[0, \bar{c}]$, where c_i is the cost of claiming the deduction, the coefficient of loss aversion, λ, is:*

$$\lambda = \frac{Y}{X},$$

where Y is the share deducting in the part of the loss domain where $D_i > t\delta$ and X is the share deducting in the gain domain.

We will use this prediction to estimate the coefficient of loss aversion, λ, in Subsection 7.2.

5   Descriptive results

Let us now return to Figure 1. It shows that a higher share of those with a preliminary deficit claim a deduction for "other expenses" than those with a preliminary surplus. The share claiming a deduction is independent of the preliminary balance for those with a surplus as predicted by theory. Slightly less than 4 percent of those with a preliminary surplus claim a deduction for "other expenses". The share is, however, increasing in the preliminary deficit for those with a deficit.

Is this caused by the preliminary balance or is it selection? Plotting the distribution of individuals over preliminary deficits is a simple graphical test of selection. If the distribution changes around zero we might have problems with selection. Figure 4 shows that the distribution does not seem to kink or jump at zero.

We could, however, still have problems with selection that do not show up in the frequency distribution plot. The individuals slightly below zero could be
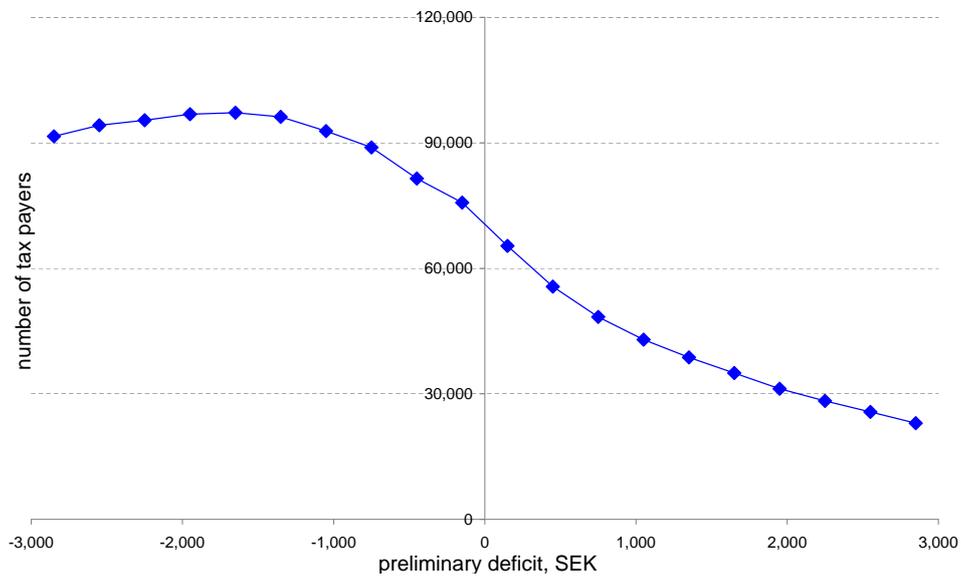
Figure 4: Frequency distribution of preliminary deficits.

very different from the individuals slightly above even if the distribution is smooth around the reference point. We, therefore, need to look closely at how the covariates evolve around the reference point. Suppose that there is selection based on any of the covariates or selection based on any unobservable factor that is correlated with the covariates. This would show up as a kink or discontinuity around zero. The pattern in Figure 1 could then be due to selection. If, on the other hand, all covariates evolve smoothly around zero it suggests that there is a causal effect of the preliminary balance.

We will here present descriptive tests if the predetermined covariates show kinks or discontinuities at zero preliminary balance. The formal econometric tests are presented in Section 6. Employment income is a crucial variable. We consider this first.

The (blue) diamonds in Figure 5 show the relationship between preliminary deficit and employment income. The kink slightly below zero preliminary deficit is very natural. The higher employment income, the more difficult it is to calibrate the tax payments at source correctly–the deviations will be scaled up in proportion to the income. Higher employment income will, therefore, move us further away from zero preliminary balance. This is exactly the pattern we see in the unweighted version of the relationship.

The unweighted relationship in Figure 5 suggests that we do not have a correct specification. There is, however, a possible solution to the problem. We might ask: Is the impact of having SEK 1,000 in preliminary deficit the same for a high-income taxpayer and a low-income taxpayer? It can be argued that the marginal utility of claiming a deduction is higher for a low-income taxpayer. There are,

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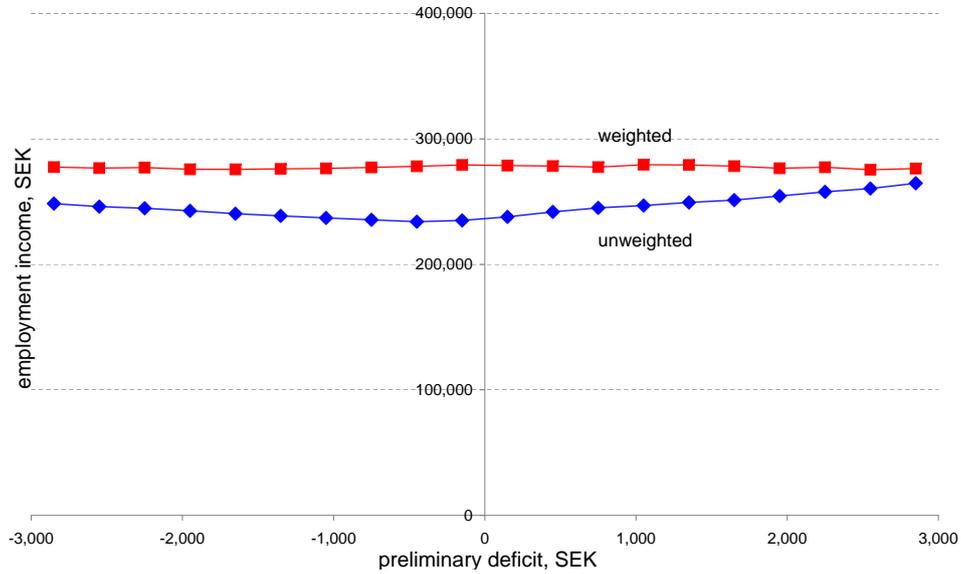
Figure 5: Employment income as a function of the preliminary deficit.

therefore, good reasons to instead measure the preliminary deficit weighted by employment income.

Define the weighted preliminary deficit of taxpayer i as:

$$d_i^p \equiv (\bar{E}/E_i) * D_i^p, \tag{7}$$

where d_i^p is the weighted preliminary deficit of taxpayer i, D_i^p is the unweighted preliminary deficit of taxpayer i, E_i is employment income of taxpayer i, and $\bar{E}$ is average employment income. The weight for the individual taxpayer, $\bar{E}/E_i$, is the inverse of the taxpayer's employment income relative to average employment income. This will move those with employment income above the average closer to the reference point. Those with below-average employment income will be moved away from the reference point. The kink at zero preliminary deficit disappears when we measure the preliminary deficit weighted by employment income, see the (red) squares in Figure 5.

The other conditioning variables do not seem to have kinks or discontinuities at zero preliminary deficit. Figure 6 and Figure 7 show this. It does not matter for this result whether we use unweighted or weighted preliminary deficits.

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Figure 6: Gender as a function of the preliminary deficit.
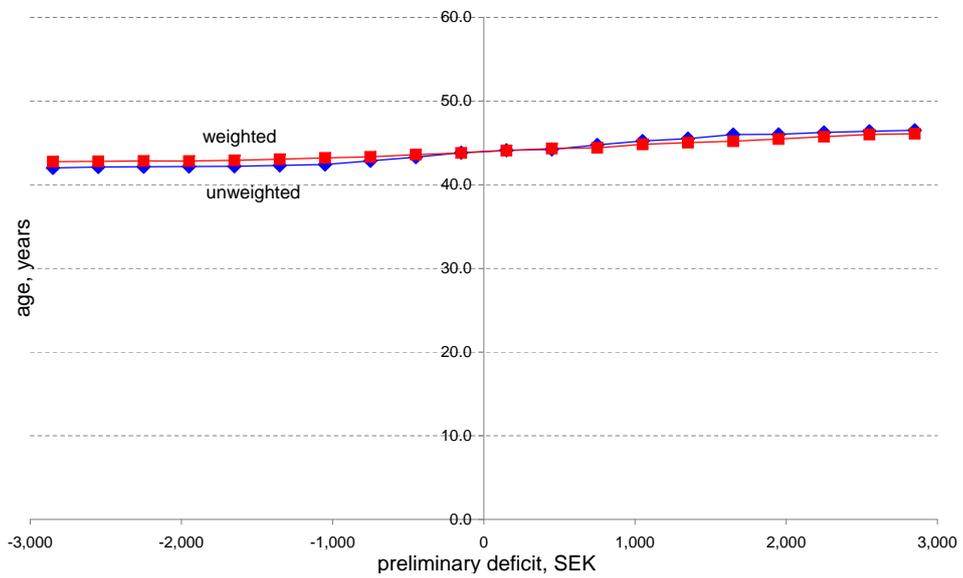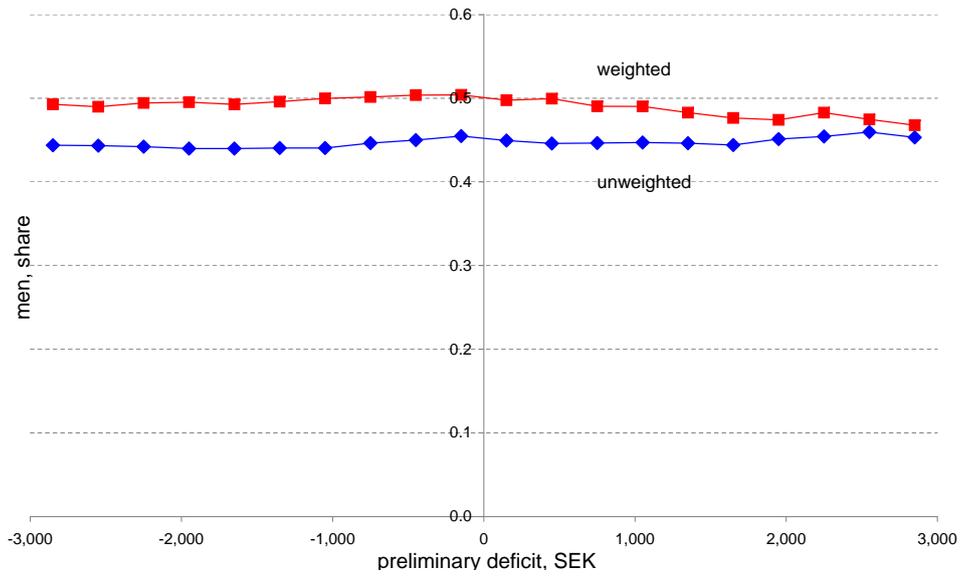
Figure 7: Age as a function of the preliminary deficit.

6 Estimations

6.1 Baseline models

A main objective in this section is to formally test whether the observed impact of the preliminary deficit on the probability of claiming deductions is causal and not due to selection. We follow some of the empirical strategies suggested in the manuals for regression discontinuity design (Lee and Lemieux, 2010) and regression kink design (Card et al., 2009). The empirical tests essentially consist of answering two questions:

- Does the impact of the preliminary balance on the probability of claiming a deduction have a statistically significant kink or discontinuity around zero preliminary balance?

- Can we rule out corresponding statistically significant kinks or discontinuities for the predetermined covariates?

We, therefore, estimate spline models of the following type (additional covariates are suppressed):

$$\Delta_i = \alpha_0 + \alpha_1 I_i + \gamma_1 d_i^p + \beta_1 I_i d_i^p + \epsilon_i, \tag{8}$$

where Δ_i is an indicator of claiming a deduction, I_i is an indicator for a positive preliminary deficit, d_i^p is the (weighted) preliminary deficit, and ϵ_i is an error term. The coefficient α_0 measures the intercept, α_1 measures a potential discontinuity at the reference point (zero preliminary deficit), and β_1 measures a possible kink at the reference point.

We iterate the estimation over many bandwidths. Bandwidths go from preliminary deficit of SEK $\pm3,000$ at the most and SEK ±500 at the least. We use symmetric bandwidths around the reference point (zero preliminary deficit).[19] A bandwidth of SEK 3,000 means that we only include individuals with weighted preliminary balances in the range from SEK -3,000 to SEK 3,000. A large bandwidth gives a larger sample size and, therefore, more precise estimates. A smaller bandwidth, on the other hand, gives sharper identification but less precise estimates. There are 1.2 million taxpayers in the maximum bandwidth sample (SEK $\pm3,000$) as previously mentioned. The minimum bandwidth sample consists of 200,000 taxpayers with weighted preliminary balances in the interval SEK ±500.

We have argued that a linear model is appropriate very close to zero. It is, however, reasonable to test for more flexible specifications, in particular for larger bandwidths. We, therefore, also estimate models that include higher order polynomials. We set the maximum polynomial order to 3 and the minimum to 0. The estimated coefficients of interest are β_1 for a possible kink and α_1 for a possible discontinuity.

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[19]We use a logarithmic scale when we iterate over bandwidths. This gives relatively more measurement points at lower bandwidths than at higher bandwidths as seen in, for example, Figure 8.

The second- and third-order specifications are:

$$\Delta_i = \alpha_0 + \alpha_1 I_i + \gamma_1 d_i^p + \gamma_2 (d_i^p)^2 + \beta_1 I_i d_i^p + \beta_2 I_i (d_i^p)^2 + \epsilon_i, \qquad (9)$$

$$\begin{aligned} \Delta_i &= \alpha_0 + \alpha_1 I_i + \gamma_1 d_i^p + \gamma_2 (d_i^p)^2 + \gamma_3 (d_i^p)^3 + \\ &+ \beta_1 I_i d_i^p + \beta_2 I_i (d_i^p)^2 + \beta_3 I_i (d_i^p)^3 + \epsilon_i. \end{aligned} \qquad (10)$$

The zero-order specification focus exclusively on a possible discontinuity at zero preliminary balance:

$$\Delta_i = \alpha_0 + \alpha_1 I_i + \epsilon_i. \qquad (11)$$

We estimate the four models (8)–(11) for each bandwidth. The optimal model for each bandwidth is then determined based on minimizing a Schwarz Bayesian criterion (SBC). This information criterion weighs better goodness of fit against lost degrees of freedom. SBC is a modification of the Akaike information criterion that punishes lost degrees of freedom harder. We then plot the kink- and discontinuity-estimates from the optimal model over a range of symmetric bandwidths.

Our primary interest is in the β_1 estimate. We base this on the theoretical predictions from Section 4. The β_1 parameter measures the change in the derivative at the reference point or, in other words, the kink. We are also interested in if there is a discontinuity at the reference point. This is measured by α_1.

Figure 8 reports our estimates of a possible kink at zero preliminary balance. Optimal models are second-order for bandwidths above SEK 2,500, see the (blue) thick bracketed line. First-order models for bandwidths down to SEK 800 are optimal. Zero-order models are optimal for smaller bandwidths with some exceptions.

The estimated kink is significant for bandwidths larger than SEK 800 and for bandwidths around SEK 600. The (red) thick solid line reports the estimated coefficients while the (red) thin solid lines provide the limits of 95 percent confidence intervals. The figure also shows that the estimated coefficients decrease when the polynomial order decreases. The estimated coefficients remain stable in a wide range of bandwidths from SEK 2,500 to SEK 800.

It is also possible that there is a discontinuity in the relationship between the preliminary deficit and the probability of claiming a deduction at zero preliminary balance. Figure 9 reports our estimates of this. The estimated coefficients of a discontinuity at zero are statistically significant for all bandwidths except a few bandwidths around SEK 600. It is also clear from the figure that the estimated coefficients increase when the polynomial order decreases. The estimated coefficients decrease when the bandwidth decreases for given order of the model.

We now turn to the corresponding estimates for the three covariates. Figures corresponding to Figure 8 and Figure 9 are presented in Appendix C. We start with the gender indicator. There is a significant negative kink for large bandwidths when the optimal polynomial order is one. The optimal order decreases to zero for bandwidths smaller than SEK 1,300. We estimate a significant negative discontinuity instead of a kink for even smaller bandwidths. The discontinuity-estimates increase

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Figure 8: Kink - estimates of β_1.
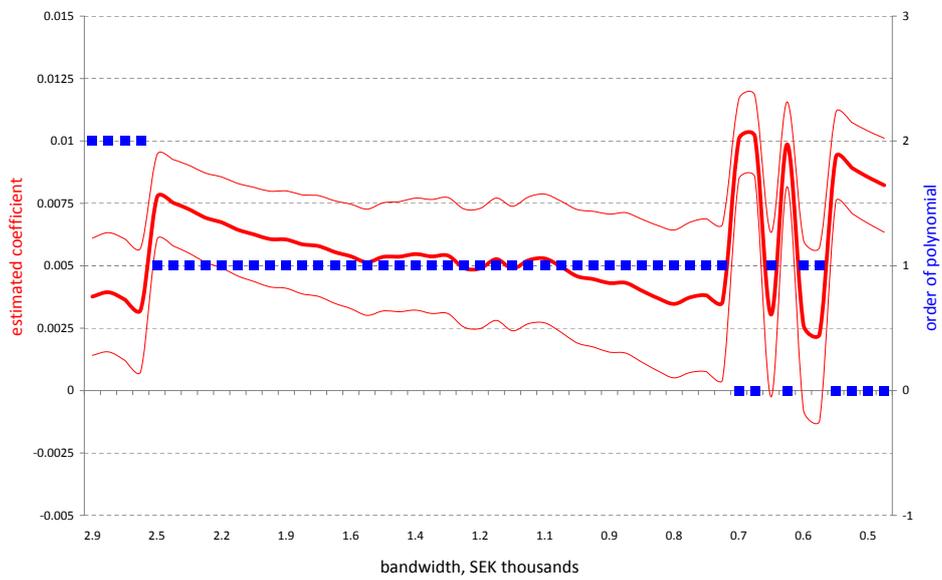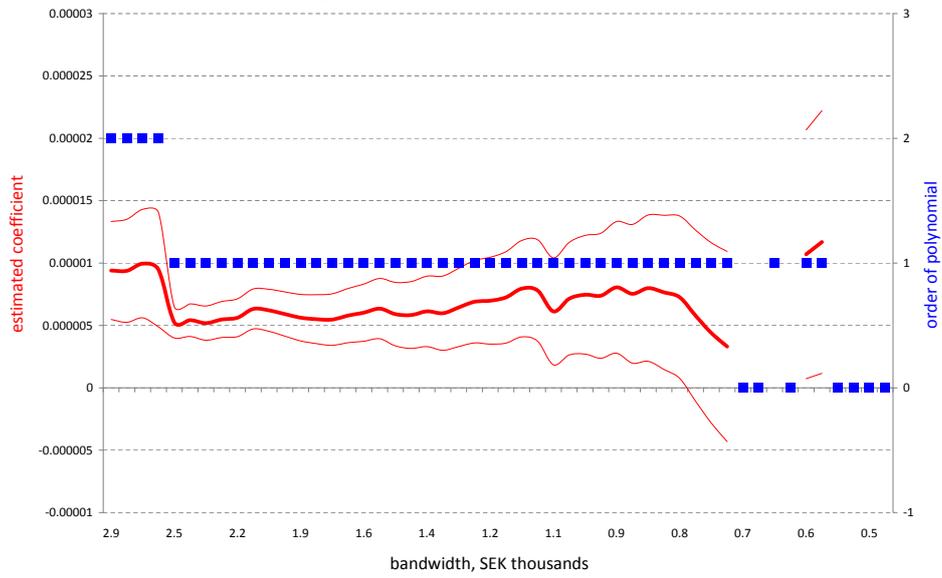
Figure 9: Discontinuity - estimates of α_1.

when the bandwidth becomes smaller and remain significant for bandwidths down to SEK 750.

The corresponding results for age show decreasing kink-estimates for bandwidths lower than SEK 2,500. The estimates becomes insignificant below a bandwidth of about SEK 1,400. The optimal polynomial order is one except for very large and very small bandwidths. The discontinuity-estimate is insignificant and stable for bandwidths below SEK 1,900 as long as the optimal polynomial order is one. These estimates increase and become significant for very small bandwidths when there is no kink included in the specification.

The results for employment income show that the kink-estimate is negative and significant for bandwidths between SEK 2,700 and SEK 1,400. The optimal polynomial order is zero for smaller bandwidths. The discontinuity-estimate is only significant for a narrow range of bandwidths between SEK 1,400 and SEK 1,000.

Let us compare the results for the deduction probability with the corresponding results for the covariates. The estimated kinks and discontinuities for the covariates jump around much more. The results for deduction probability show a stable and significant kink for a wider range of bandwidths than for the covariates. The discontinuity-estimates for the deduction variable decrease when the bandwidth becomes smaller. It, however, also remains significant in a much wider range than the estimates for the covariates.

6.2 Sensitivity analysis – placebo kinks and discontinuities

There is a risk that even the smallest and economically insignificant estimates become statistically significant when the sample size is very large. It is, therefore, relevant to ask whether kinks and discontinuities at the zero reference point are more pronounced than kinks and discontinuities at other reference points. We, therefore, present estimates of kinks and discontinuities based on a range of different placebo reference points. We let the reference points vary between SEK -3,000 and SEK 3,000. The bandwidth is fixed at SEK 1,000 in all regressions.

The analysis serves two related purposes. The first has to do with causality. The evidence of causal effects becomes stronger if we find that the kinks and discontinuities in deduction probability are more pronounced for the theoretically predicted reference points. The second has to do with selection. It speaks against selection driving the increase in deduction probability around zero if the kinks and discontinuities for the covariates are not more pronounced around zero than elsewhere.

Figure 10 shows the estimated kinks in deduction probability for different placebo reference points. The kink-estimates peak slightly below zero at a reference point of about SEK -200. There is a concave increase in the deduction probability for those with a preliminary deficit, see Figure 1. This generates moderate negative kinks as long as the optimal polynomial order is one. The optimal polynomial order is zero for reference points above SEK 1,700 further to the right.

The corresponding discontinuity estimates displayed in Figure 11 mirror the kink estimates. There is a local peak in the discontinuity estimates for reference

points close to zero. The moderate increases in deduction probability (see Figure 1) generate large and significant discontinuity estimates further to the right when the optimal specification does not include a kink.

We conclude that the estimated kinks for different reference points follow a pattern that is highly consistent with loss aversion based on a reference point close to zero. Loss aversion does not, in its simplest form, generate a discontinuity in the deduction probability around zero. The empirical evidence for a discontinuity is also weaker. The largest and most significant discontinuity estimates are at reference points between SEK 1,700 and SEK 3,000.

We now turn to the corresponding analysis of the covariates. Appendix D has the figures. We find that neither kink nor discontinuity estimates are more pronounced around the zero reference point than elsewhere for any of the covariates. We are, therefore, confident to conclude that selection is a very unlikely source of the increase in deduction probability around zero. It would require very strong selection on some unobservable factor to produce the pattern we see in Figure 1. It is hard to come up with a candidate for such an unobservable factor. It is even harder provided that it also needs to be virtually uncorrelated with gender, age, and employment income.

6.3   Interpretation and discussion

Figure 12 reports the combined effects of estimated kinks and discontinuities for the different bandwidths. Suppose that we compare the probability of claiming a deduction for a taxpayer with a SEK 2,000 in preliminary deficit with and without the estimated effects of kinks and discontinuities. The figure shows that the differences in the probabilities of claiming a deduction is 2.5 percentage points for bandwidths larger SEK 2,500. The optimal models are here of the second order. The probabilities differences are about 2 percentage points for smaller bandwidths down to SEK 800 when the optimal models are of the first order. The optimal models are of zero order for the smallest bandwidths. The probability differences here are about 1 percentage point.

The descriptive statistics show that 6.2 percent of those with a preliminary deficit in the maximum bandwidth sample claim the deduction for "other expenses". This give perspective to the estimated difference in the figure. The estimated effect is substantial.

Let us briefly summarize the econometric results so far. We find clear evidence of a kink in the deduction probability at zero preliminary balance for a wide range of bandwidths. Employment income and age do not kink or jump at zero preliminary balance for smaller bandwidths. The fraction of men shows a very small but statistically significant jump at zero. This fraction, however, shows even larger jumps at other reference points.

Figure 10: Placebo kinks - estimates of β_1.

reference point, SEK thousands

reference point, SEK thousands
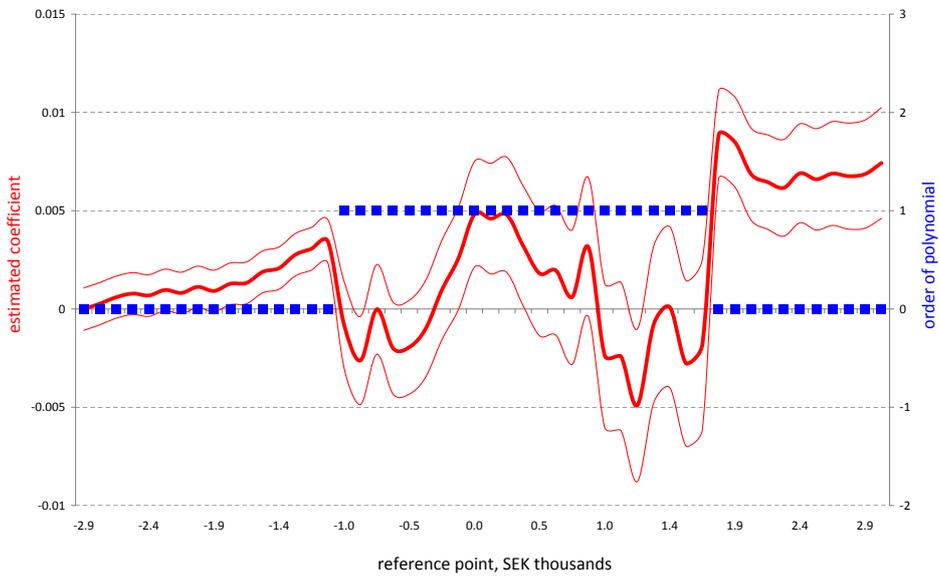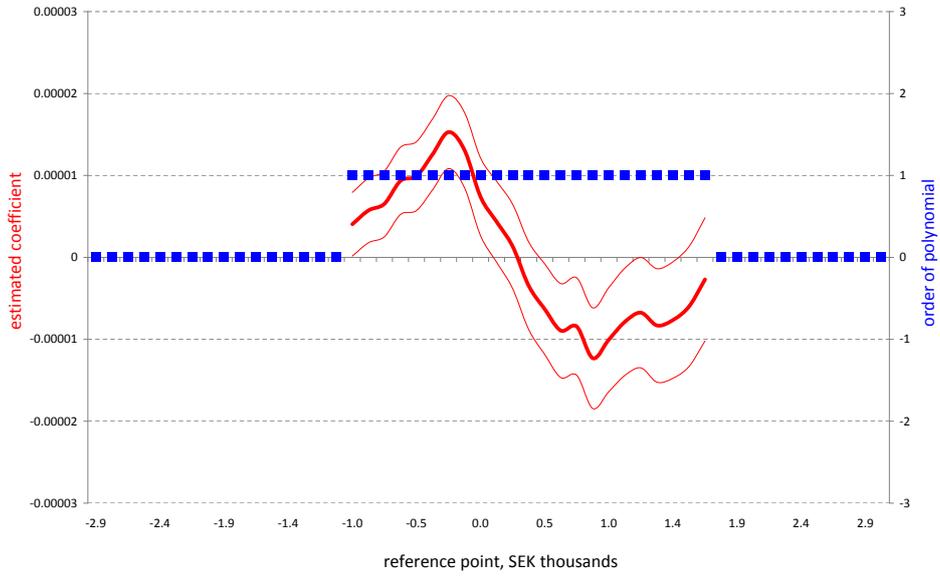
Figure 11: Placebo discontinuities - estimates of α_1.
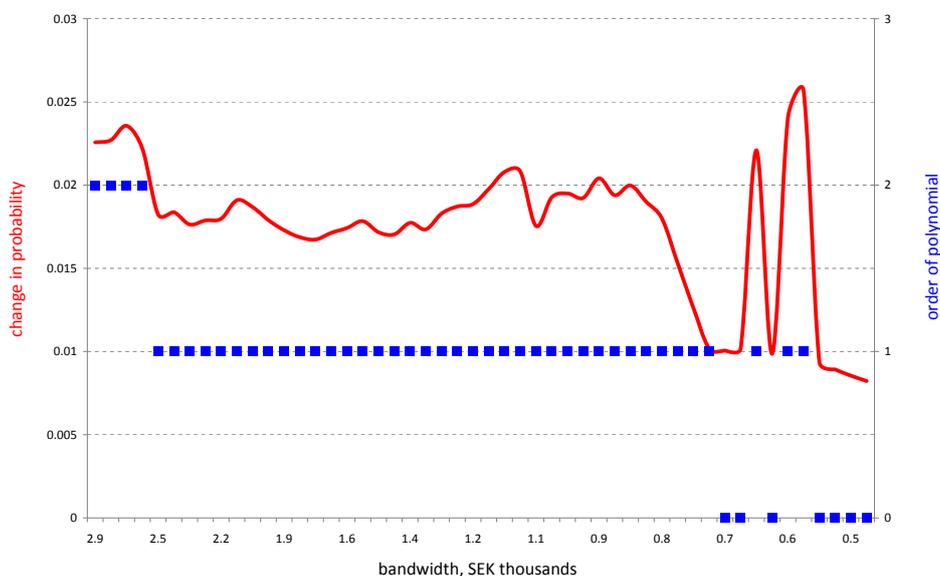
Figure 12: The differences in probabilities of claiming a deduction at a SEK 2,000 preliminary deficit with and without estimated kinks and discontinuities.

7 Extensions

7.1 An alternative IV-approach

There is a difference between the actual local employment income tax rate and the local employment income tax rate used for preliminary taxation at source as discussed in Section 3. The basic idea in this section is to use this difference as an instrument for a preliminary deficit indicator when estimating probability models for claiming a deduction. Figure 13 shows that a higher share of those having the preliminary tax rate rounded downwards have preliminary deficits than those having the preliminary tax rate rounded upwards.

The local tax rate is the result of decisions in two separate jurisdictions, the municipality and the county council (covering several municipalities). It would, therefore, be extremely difficult for the municipality to set the local tax rate strategically trying to use the rounding principles for taxation at source. This would require to correctly predict the behavior and response of the county council. It would be even more difficult for the county council to act strategically in this respect. This would involve predicting the behavior of several municipalities. It would, consequently, also be very difficult for a taxpayer to predict where to move to take advantage of a lower preliminary tax rate.

We use two different instruments for the preliminary deficit indicator in the IV-analysis: i) the difference between the preliminary and actual local tax rates and ii) the interaction between the first instrument and employment income. The second
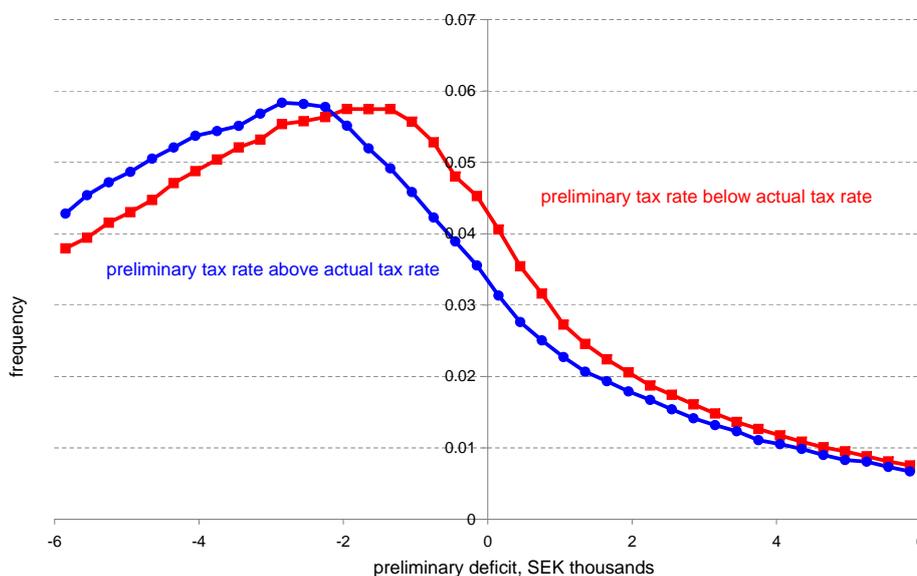
Figure 13: Relative frequency distributions for taxpayers with preliminary tax rates rounded upwards and downwards.

instrument can be interpreted as the impact of the rounding on the preliminary balance. The IV-analysis uses the full sample of 3.6 million taxpayers. The OLS and baseline IV-estimate use the standard set of controls, see the notes to Table 1 for details. The models with interacted treatments also include all relevant interacted controls and instruments.

The upper part of Table 1 reports the estimation results for the probability of claiming a deduction. The OLS estimate shows that having a preliminary deficit increases the probability of claiming a deduction by 2.0 percentage points. This estimate cannot, however, be causally interpreted since preliminary deficit may be correlated with the probability of claiming a deduction.

The causal estimate given by the IV-estimation suggests an even stronger effect. We estimate an impact of 5.0 percentage points. The overidentification test does not reject the validity of the instruments.

The remaining columns in Table 1 report IV-estimations that test for possible differences between different sub-groups in our sample. We conclude that there are no significant gender differences from the estimation reported in column 3. Column 4 in the table presents the results from a corresponding estimation where we test if the response of those older than 40 years differ from the estimated response of younger taxpayers. The result suggest that there are no such differences. We do find, on the other hand, that there is a significant difference in response between those with employment income higher than SEK 250,000 (the median income is SEK 250,200) and those below this threshold. The response of those with relatively high income is significantly stronger.

Table 1: The probability of claiming a deduction and the coefficient of loss aversion, IV-approach, full sample.

	1 OLS	2 IV	3 IV, gender	4 IV, age	5 IV, income
preliminary deficit, indicator:	0.020 (0.000)	0.050 (0.006)	0.048 (0.007)	0.055 (0.010)	0.044 (0.007)
preliminary deficit, indicator, interacted with:					
man, indicator			0.009 (0.013)		
old (age>=40), indicator				-0.005 (0.013)	
high income ($>$ SEK 250,000), indicator					0.031 (0.013)
overidentification test, p-value		0.798	0.356	0.708	0.442
$\hat{\lambda}$	1.43 (0.007)	2.17 (0.184)			
$\hat{\lambda}$, men / old / high income			1.97 (0.212)	2.00 (0.208)	2.21 (0.226)
$\hat{\lambda}$, women / young / low income			2.91 (0.404)	2.66 (0.382)	3.54 (0.626)
p-value, t-test			0.038	0.130	0.046

Notes. Number of observations: 3,610,972.
Heteroscedasticity-corrected standard errors within parentheses.
Baseline instruments: the difference between actual local tax rate and preliminary local tax rate and the tax rate difference times employment income.
Baseline covariates: age, age^2, employment income, (employment income)^2, gender.

7.2 Estimating the coefficient of loss aversion

The coefficient of loss aversion (λ) can be expressed in a simple way according to Prediction 3. It is the share of deducting taxpayers in the loss domain (with sufficiently large preliminary deficits) divided by the share of deducting taxpayers in the gain domain. We use the IV-estimation reported in Table 1, column 2, to calculate these shares. Our estimates of λ based on the IV-estimations ignore that the share that claims a deduction does not immediately move to a higher stable level when entering the loss domain. This will give a downward bias to our λ-estimates. The reason is that the average deduction probability in the whole deficit region is slightly lower than the average deduction probability on the level further to the right. This is clear from Figure 3. The results from Table 1 are, therefore, conservative estimates of the coefficient of loss aversion.

We estimate the probability of claiming a deduction for a taxpayer with a preliminary surplus and average values of the covariates to 4.23 percent in our full sample of 3.6 million taxpayers. The standard error of this estimate is 0.001. The corresponding probability of claiming a deduction for an average taxpayer with a preliminary deficit is 9.19 percent, with a standard error 0.005. Our estimate of loss aversion is given these assumptions:

$$\hat{\lambda} = \frac{\hat{Y}}{\hat{X}} = \frac{9.19}{4.23} \approx 2.17. \tag{12}$$

We calculate the standard error of this ratio using the delta method. The resulting estimate of the standard error is 0.184.

The lower part of Table 1 presents our estimates of the coefficient of loss aversion, $\hat{\lambda}$. We estimate λ to be higher for women than for men, 2.91 compared to 1.97. This difference is statistically significant at the 5 percent level according to a t-test. This test takes potential covariances between the estimated parameters into account. It is possible to do this as we have estimated the response of men and women in the same model.

The estimated λ for young is higher than that of old. This difference is, however, not statistically significant at the 5 percent level according to the t-test. There is, on the other hand, a statistically significant difference in the estimated λ's between those with relatively high income and those with relatively low income. The estimated λ of taxpayers with low income is much higher. This is surprising as the estimated effect of preliminary deficit was significantly higher for the high-income group. But the λ-estimate is a ratio so we need to consider differences in both the numerator and the denominator. The high λ-estimate for the low-income group is because the deduction probability for those with a preliminary surplus is only about 1.7 percent.

Our estimates are all in the range which has been reported in the literature. Tversky and Kahneman (1992) report $\hat{\lambda} = 2.25$. Our overall estimate, $\hat{\lambda} = 2.17$, is very close to this. Abdellaoui et al. (2007) cite various studies where the estimates vary between 1.4 and 4.8.

Our finding that women are more loss averse than men is similar to that of Gächter et al. (2007). Their effect vanishes though when controlling for many covariates. We have access to very few covariates. This might explain why our results differ.

Our result that low income taxpayers are more loss averse than those with high income is contrary to Gächter et al. (2007)'s findings. They, however, also control for education which is negatively correlated with loss aversion. Some of our income results might depend on education differences as education is strongly correlated with income.

8   Concluding remarks

We study if taxpayers behave in a loss averse manner when filing their tax returns. This is important for tax design. It is also important for understanding human behavior in general. We test the predictions of prospect theory in our empirical analysis. The dataset consists of 3.6 million Swedish taxpayers for the income year 2006. The research method is quasi-experimental using a regression kink and discontinuity approach.

We find behavior to be consistent with loss aversion. Taxpayers who have a preliminary tax deficit are more likely to claim deductions for "other expenses for earning employment income" than those who have a preliminary surplus. We find a significant change at zero preliminary deficit. The empirical analysis also makes clear that none of the covariates shows a similar evolution around zero preliminary deficit. We can, therefore, rule out selection. Loss aversion is the obvious candidate for explaining the result.

We also use an alternative IV-approach to strengthen the causal interpretation. Actual local tax rates on employment income are set with two decimals of a percentage (for example, 30.83 percent). Preliminary taxation at source, on the other hand, is based on actual tax rates being rounded to the closest integer percentages tax rates (for example, 31 percent). Taxpayers will tend to pay to much in preliminary taxes if they live in municipalities where tax rates at source are above the actual rates. The preliminary balances will, therefore, tend to be in surplus. The opposite applies to taxpayers who live in municipalities with actual rates above the rates used at source. We use the difference between the actual and the preliminary rates as an instrument for a preliminary deficit indicator. This indicator is used to estimate probability models for claiming a deduction. Our previous results are confirmed using this approach.

We also estimate the coefficient of loss aversion. Our estimate, $\hat{\lambda} = 2.17$ for the full sample, is very close to the estimate reported by Tversky and Kahneman (1992), $\hat{\lambda} = 2.25$. We have a different approach to estimating this coefficient compared to previous studies. This literature usually uses experimental data from samples of students while we use real-world data for all taxpayers in a country. We still arrive at results very close to those previously reported.

We believe that our findings are important for several reasons. They are important for tax design. The results suggest that tax compliance is likely to increase if preliminary balances are positive instead of negative.

The main contribution, however, is that this is the first study to identify loss aversion among millions of people doing a very common real-world duty. This is also the first study to our knowledge that can rule out selection. There are many studies reporting empirical evidence of loss aversion. Previous studies have, however, used experimental settings, very special samples, or weak identification. The hypothesis that people are loss averse is strongly supported by our study.

References

Abdellaoui, M., Bleichrodt, H., and L'Haridon, O. (2008). A tractable method to measure utility and loss aversion under prospect theory. *Journal of Risk and Uncertainty*, 36(3):245–266.

Abdellaoui, M., Bleichrodt, H., and Paraschiv, C. (2007). Loss aversion under prospect theory: A parameter-free measurement. *Management Science*, 53(10):1659–1674.

Bateman, I., Munro, A., Rhodes, B., Starmer, C., and Sugden, R. (1997). A test of the theory of reference-dependent preferences. *Quarterly Journal of Economics*, 112(2): 479–505.

Benartzi, S. and Thaler, R. (1995). Myopic loss aversion and the equity premium puzzle. *Quarterly Journal of Economics*, 110(1): 73–92.

Bernasconi, M. and Zanardi, A. (2004). Tax evasion, tax rates, and reference dependence. *FinanzArchiv*, 60(3):422–445.

Card, D., Lee, D. S., and Pei, Z. (2009). Quasi-experimental identification and estimation in the regression kink design. Working Paper 553, Industrial Relations Section, Princeton University.

Chang, O. H. and Schultz Jr, J. J. (1990). The income tax withholding phenomenon: Evidence from TCMP data. *Journal of the American Taxation Association*, 12(1):88.

Copeland, P. V. and Cuccia, A. D. (2002). Multiple determinants of framing referents in tax reporting and compliance. *Organizational Behavior and Human Decision Processes*, 88(1):499–526.

Cox, D. and Plumley, A. (1988). Analyses of voluntary compliance rates for different income source classes. Unpublished manuscript, Research Division, IRS, Washington, DC.

Dhami, S. and al Nowaihi, A. (2007). Why do people pay taxes? Prospect theory versus expected utility theory. *Journal of Economic Behavior & Organization*, 64(1):171–192.

Elffers, H. and Hessing, D. J. (1997). Influencing the prospects of tax evasion. *Journal of Economic Psychology*, 18(2-3):289–304.

Genesove, D. and Mayer, C. (2001). Loss aversion and seller behavior: Evidence from the housing market. *Quarterly Journal of Economics*, 116(4):1233–1260.

Gächter, S., Johnson, E., and Herrmann, A. (2007). Individual-level loss aversion in riskless and risky choices. IZA DP No 2961, IZA.

Kahneman, D., Knetsch, J. L., and Thaler, R. H. (1990). Experimental tests of the endowment effect and the coase theorem. *Journal of Political Economy*, 98(6): 1325–1348.

Kahneman, D. and Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2):263–292.

Kirchler, E. and Maciejovsky, B. (2001). Tax compliance within the context of gain and loss situations, expected and current asset position, and profession. *Journal of Economic Psychology*, 22(2):173–194.

Köbberling, V. and Wakker, P. P. (2005). An index of loss aversion. *Journal of Economic Theory*, 122(1):119–131.

Köszegi, B. and Rabin, M. (2006). A model of reference-dependent preferences. *Quarterly Journal of Economics*, 121(4):1133–1165.

Lee, D. S. and Lemieux, T. (2010). Regression discontinuity designs in Economics. *Journal of Economic Literature*, 48(2):281–355.

Odean, T. (1998). Are investors reluctant to realize their losses? *Journal of Finance*, 53(5):1775–1798.

Persson, A. (2003). Beslut under risk och osäkerhet. Kan prospect theory tillföra något i riskvärderingen? Skatteekonomiska meddelanden Nr 33, RSV, Stockholm.

Pope, D. G. and Schweitzer, M. E. (2011). Is Tiger Woods loss averse? Persistent bias in the face of experience, competition, and high stakes. *American Economic Review*, 101(1):129–157.

Robben, H. S. J., Webley, P., Elffers, H., and Hessing, D. J. (1990). Decision frames, opportunity and tax evasion: An experimental approach. *Journal of Economic Behavior & Organization*, 14(3):353–361.

RSV (2001). Om gratislotter och preventiv effekt. en utvärdering baserad på de skattskyldigas avdrag för övriga kostnader under inkomst av tjänst och skattemyndigheternas kontroll av detta avdrag. Rapport 2001:1, RSV, Stockholm.

Schepanski, A. and Shearer, T. (1995). A prospect theory account of the income tax withholding phenomenon. *Organizational Behavior and Human Decision Processes*, 63(2):174–186.

Schmidt, U. and Traub, S. (2002). An experimental test of loss aversion. *Journal of Risk and Uncertainty*, 25(3):233–249.

Schmidt, U. and Zank, H. (2005). What is loss aversion? *Journal of Risk and Uncertainty*, 30(2):157–167.

SKV (2009). Income self assessment and taxes in Sweden. Brochure SKV 132B, Swedish Tax Agency, Stockholm.

Slemrod, J., Christian, C., London, R., and Parker, J. A. (1997). April 15 syndrome. *Economic Inquiry*, 35(4):695–709.

Thaler, R. H., Tversky, A., Kahneman, D., and Schwartz, A. (1997). The effect of myopia and loss aversion on risk taking: An experimental test. *Quarterly Journal of Economics*, 112(2):647–661.

Tversky, A. and Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *Quarterly Journal of Economics*, 106(4):1039–1061.

Tversky, A. and Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, 5(4):297–323.

Yaniv, G. (1999). Tax compliance and advance tax payments: A prospect theory analysis. *National Tax Journal*, 52(4):753–764.

Appendix A More on the institutional framework

The Tax Agency provides a lot of information to taxpayers. The information is very detailed as is clear from this excerpt from SKV (2009).

Filing an income tax return
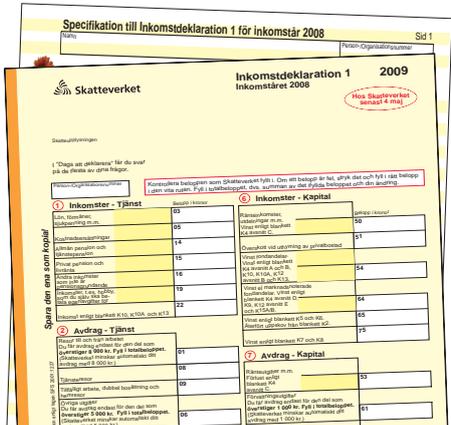
Everyone receiving an income is required to file a tax return (self assessment) the year after the income year. The income year is the year in which the income (e.g. wages or pensions) is paid out and your employer – or whoever pays out your pension – makes a tax deduction for it.

At the beginning of April, the Tax Agency will send you:

• A tax return form
Everyone required to declare income will receive a tax return form, 'Inkomstdeklaration'. Many particulars on the form have already been filled in by the Tax Agency (Skatteverket).

• An income specification
This is a list itemising the income statements (kontroll-uppgifter) sent to both you and the Tax Agency.

• A preliminary tax estimate
You will also get a preliminary estimate of your tax. It will be based on the information the Tax Agency has filled in on your tax return.

• Payment slips
In addition, you will be sent tax payment slips that you can use if you need to pay more tax.

Last day! 2 May by 24.00

If 2 May is a Saturday or Sunday, tax returns must be submitted by Monday at the latest.

Declare your income on the Internet or by phone

Most taxpayers can file their tax returns on the Internet. Visit **www.skatteverket.se** to find out who can use this service and how to proceed it.

To file your tax return on the Internet you go into **www.skatteverket.se (E-tjänster→Inkomstdeklaration).**

If you don't need to make any changes, you can approve your income tax return by telephone (020-567 100) or via sms (711 44).

| Income year	Assessment year (the year after the income year)	
January–December	**January**	**May**
All the income you have received during this year must be declared in the following year's income tax return.	**In January**, you will be sent income statements for your earnings the previous year. Your employer sends the income statement both to you and to the Tax Agency. You will be sent your tax return form in April.	**By 2 May** at the latest the Tax Agency must have received your income tax return.

4

How to fill out the form:

Check that all income statements are included in the specification sent to you and that the amounts are correct. Most of the information in the specification is also filled in on your tax return form.

Are the amounts filled in on the tax return form correct and is all the information included?

NO → Correct what is not correct! Add any missing information! You can do this on the Internet with electronic legitimation or on the form.

YES

File your tax return via the Internet with security code, by phone, by sms – or sign the form and send it in!

DONE!

Sign (electronically or on the form) and send it in!

DONE!

Tax refund

If you are salaried or a pensioner you can receive your tax refund by June. But to do this you must

- file your tax return via the Internet, phone or sms and
- have specified a bank account for refund of tax.

Everyone has a tax account

The tax account provided by the Tax Agency shows your preliminary tax figure based on income statements as well as your own tax payments, your final tax figure and other details.

Skatteverket
Skattekontoret Wistad
Box 122
123 45 Wistad

Skatteupplysningen 0771-567 567

Besked
Slutlig skatt enligt 2009 års taxering
Wistad
580303-2805

Andersson, Margareta

Badhusplanen 2
123 48 Wistad

Skatteverket
Skattekontoret Wistad
Box 122
123 45 Wistad

Skatteupplysningen 0771-567 567

Kontoutdrag
Datum
2009-08-03
580303-2805

Andersson, Margareta

Badhusplanen 2
123 48 Wistad

June	August – September	December
In June a final tax statement (slutskatte-besked) and a statement of account (konto-utdrag) are sent out to most employees and pensioners who have filed a tax return, via the Internet, by phone or by sms and who are due to get a refund. This applies only to those who have specified a bank account.	**By September at the latest**, final tax statements and statements of account are sent out to most people who have sent in an income tax return and who have not received a final tax statement in June. Those who have paid too much tax will now get their money back.	**By mid-December at the latest**, final statements and statements of account are sent out to those who did not get them before. Those who have paid too much will now get their money back.

5

The tax account: interest rates

The taxpayer's tax account is interest bearing. During the assessment year 2007, a surplus on the tax account earned a tax exempt interest of 1.35 percent from 13 February 2007. This interest rate was increased to 1.8 percent from 1 July 2007. The increase was decided 25 June 2007. Interest was earned until the surpluses was refunded.

The taxpayer has to pay interest on deficits on the tax account. The interest paid on tax account deficits is not deductable. The interest rates were as follows during the assessment year 2007:

from	deficit	interest rate, percent
13 February	<=20000	0
	20001-30000	3
	>30001	3.75
4 May	<=30000	3
	>30000	3.75
1 July (rate increase)	<=30000	4
	>30000	5
due date	<=10000	4
	>10000	19

Preliminary employment income taxes at source

There were nine tables for preliminary employment income taxes at source for integer percentages local government income tax rates from 29 percent to 37 percent in 2006. Tax payers facing local government income tax rates with decimals of a percentage $\leq$ .50 pay preliminary income taxes according to the closest downward integer percentage table, while taxpayers facing local government income tax rates with decimals of a percentage $>$ .50 pay preliminary income taxes according to the closest upward integer percentage table.

Appendix B   Descriptive statistics

Table 2: Descriptive statistics, full sample.

	preliminary deficit	preliminary surplus	all
number of observations	810,690	2,800,282	3,610,972
deducting, fraction	0.062	0.044	0.048
deduction, SEK, conditional	4,716	3,559	3,894
	(4,324)	(3,342)	(3,692)
preliminary balance, SEK, unweighted	-10,757	6,553	2,667
	(51,232)	(6,762)	(26,017)
employment income, SEK	279,770	269,296	271 648
	(135,523)	(115,198)	(120,140)
men, fraction	0.48	0.49	0.49
age, years	46.8	42.0	43.1
	(12.5)	(12.1)	(12.3)

Note. mean (standard deviation)

Table 3: Descriptive statistics, maximum bandwidth sample.

	preliminary deficit	preliminary surplus	all
number of observations	370,929	822,686	1,193,615
deducting, fraction	0.061	0.042	0.048
deduction, SEK, conditional	4,212	3,714	3,910
	(3,813)	(3,403)	(3,578)
preliminary balance, SEK, unweighted	-1,289	1,611	710
	(1,140)	(1,153)	(1,767)
preliminary balance, SEK, weighted	-1,263	1,582	698
	(856)	(847)	(1,567)
employment income, SEK	277,908	276,876	277 197
	(130,544)	(119,073)	(122,753)
men, fraction	0.49	0.50	0.49
age, years	44.9	43.1	43.7
	(12.5)	(12.3)	(12.4)

Notes. mean (standard deviation)
Sample selection criterion: weighted preliminary balance in the interval $\pm$ SEK 3,000.
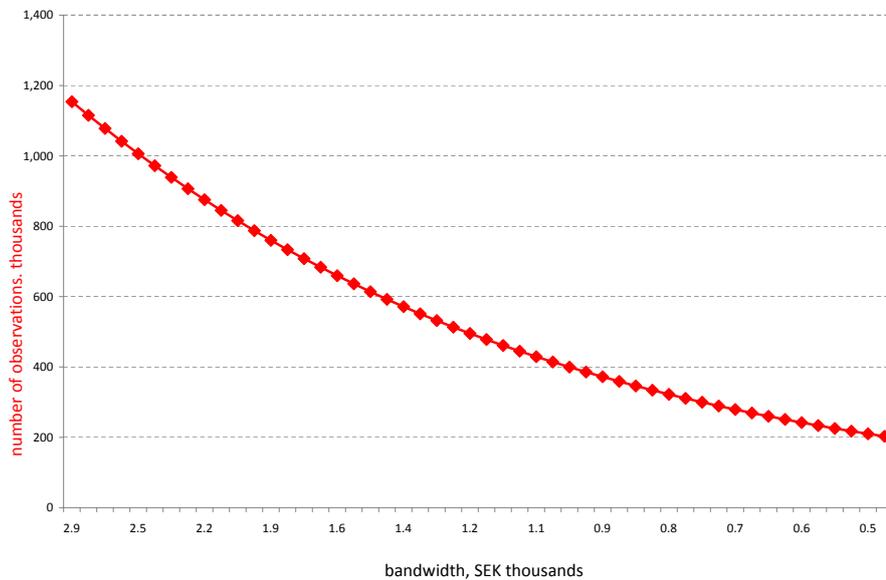
Figure 14: Number of observations at different bandwidths.

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Appendix C   Estimates for covariates

Figure 15: Kink - estimates for employment income.
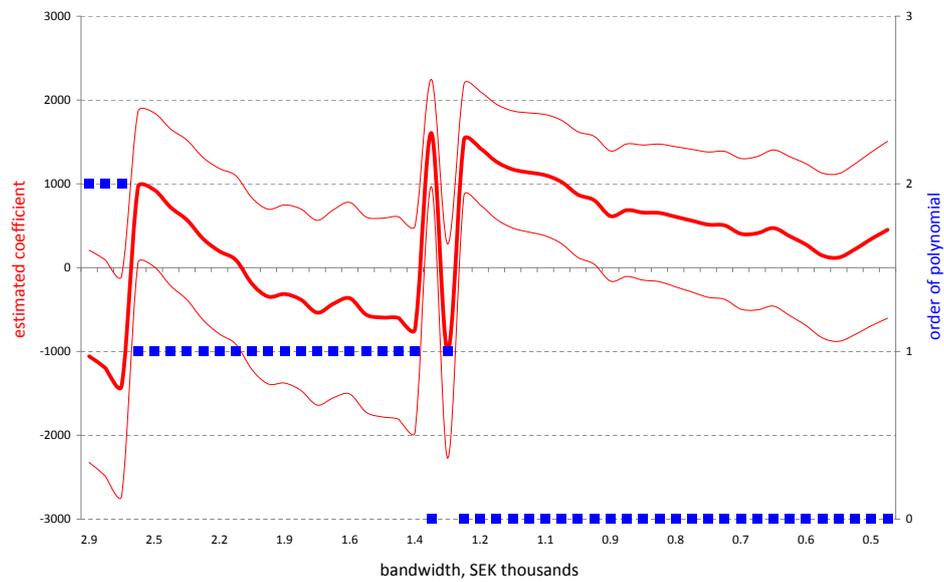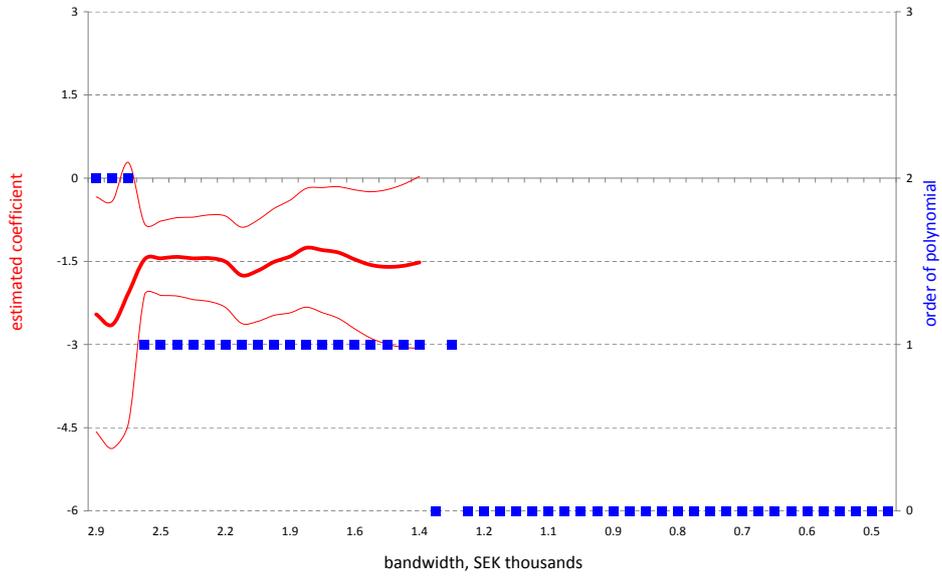
Figure 16: Jump - estimates for employment income.

Figure 17: Kink - estimates for gender.

bandwidth, SEK thousands


bandwidth, SEK thousands
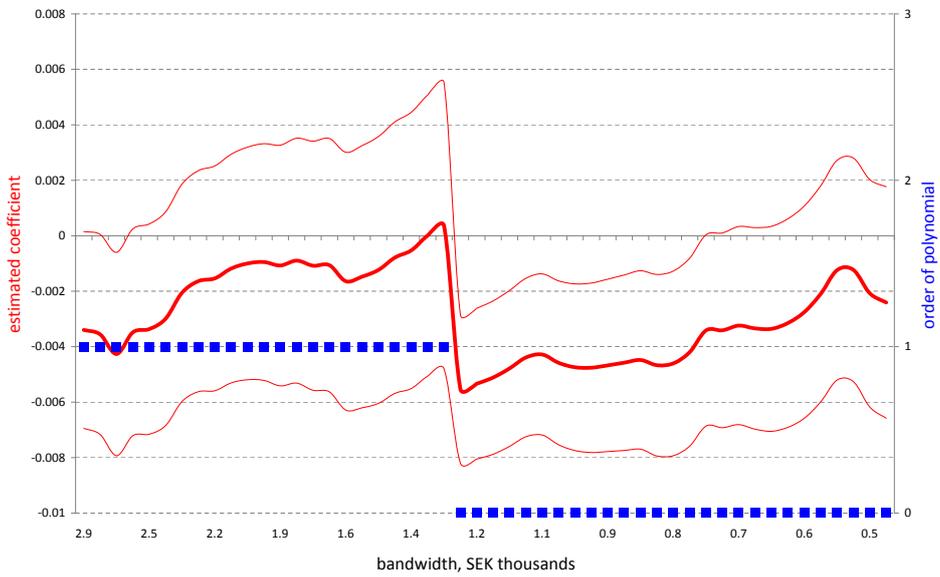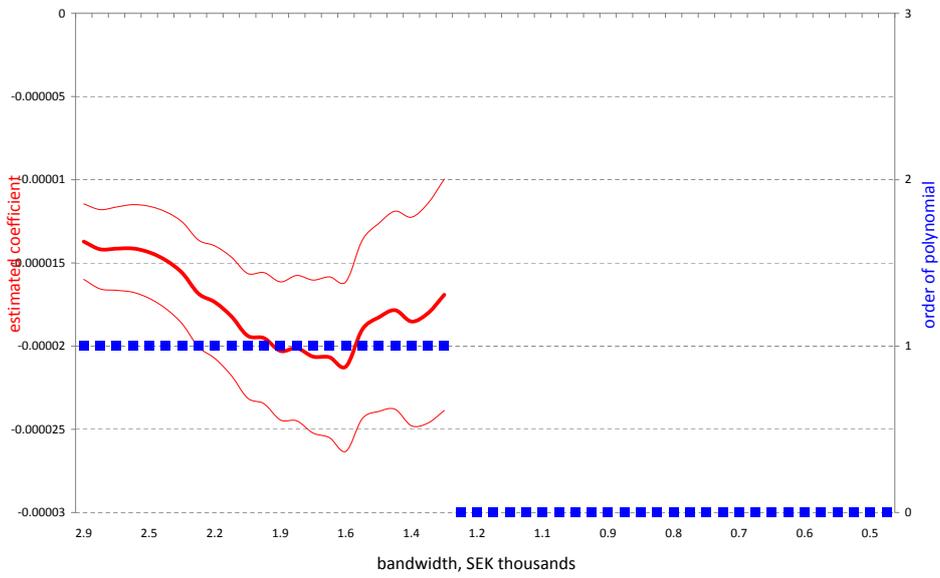
Figure 18: Jump - estimates for gender.

Figure 19: Kink - estimates for age.

bandwidth, SEK thousands

bandwidth, SEK thousands
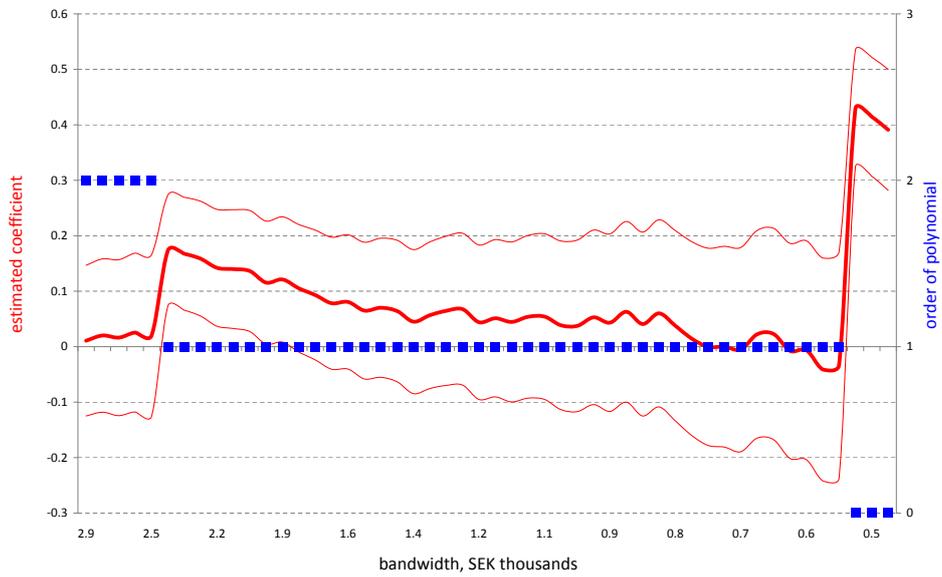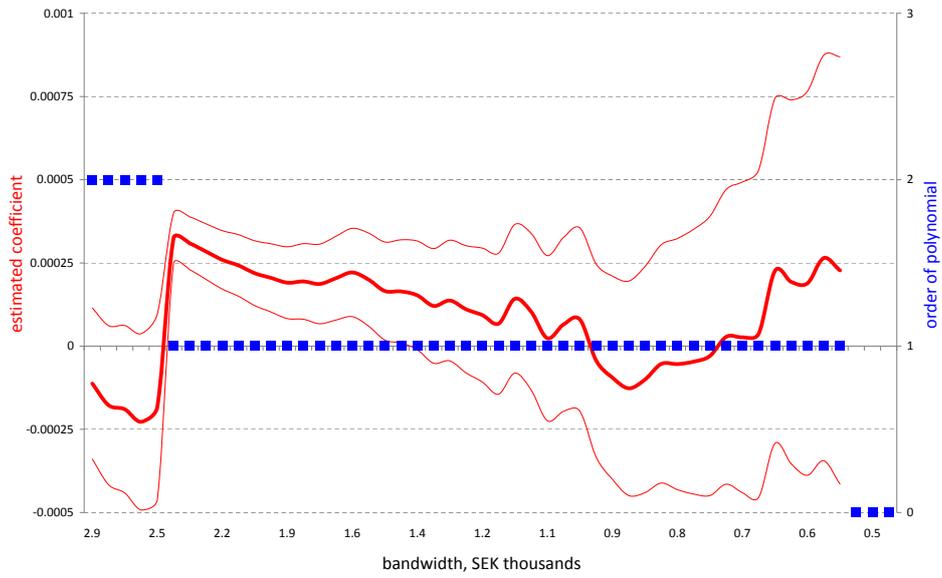
Figure 20: Jump - estimates for age.

Appendix D   Placebo estimates for covariates

Figure 21: Kink - placebo estimates for employment income.
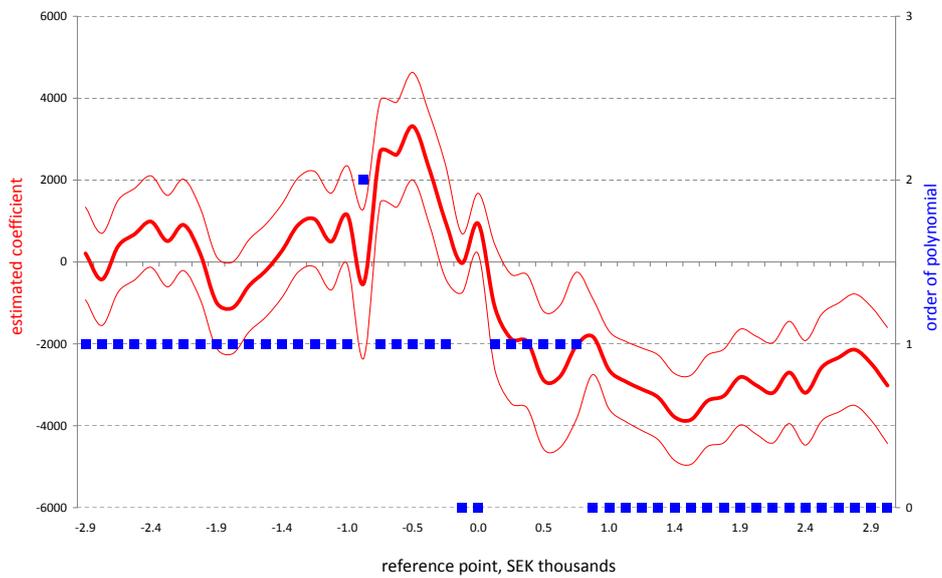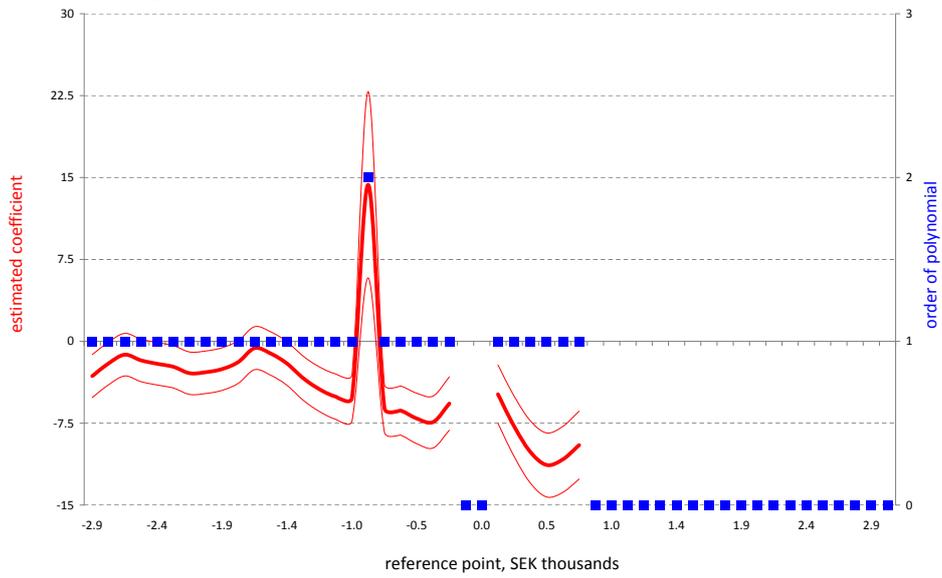
Figure 22: Jump - placebo estimates for employment income.

Figure 23: Kink - placebo estimates for gender.

reference point, SEK thousands

reference point, SEK thousands
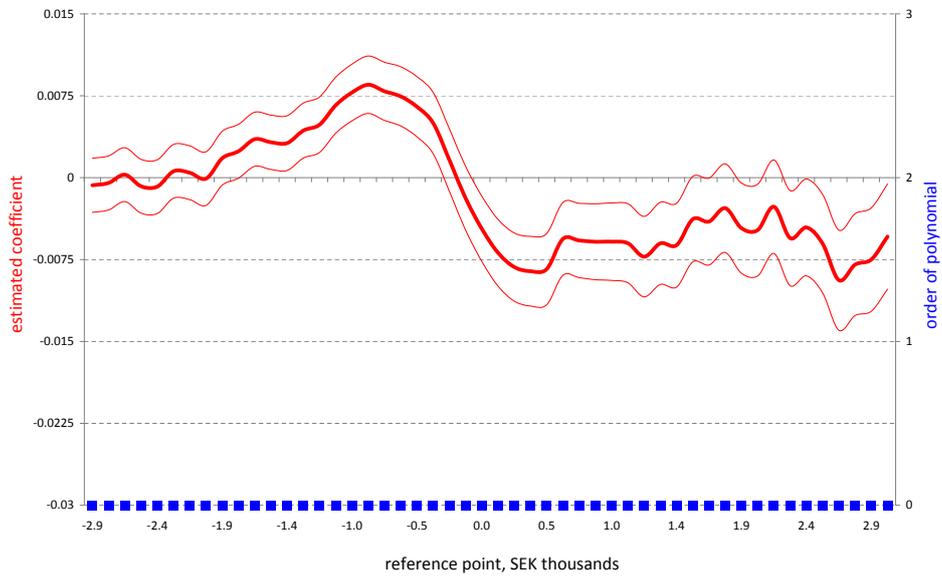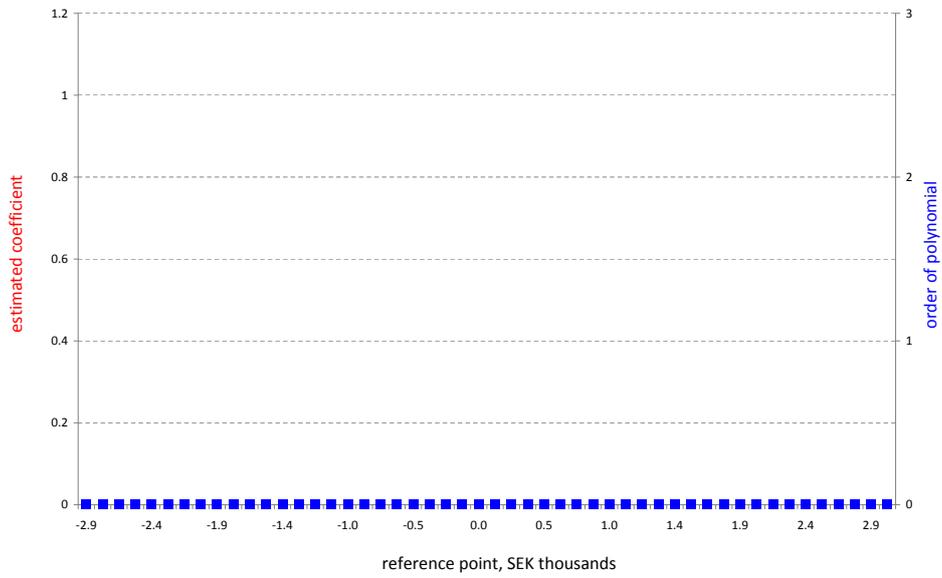
Figure 24: Jump - placebo estimates for gender.

Figure 25: Kink - placebo estimates for age.

reference point, SEK thousands

reference point, SEK thousands
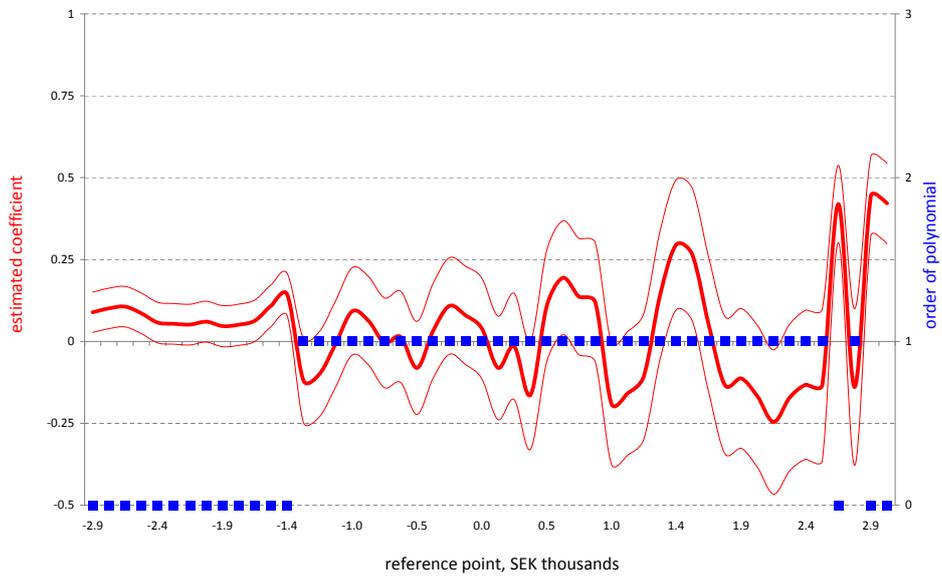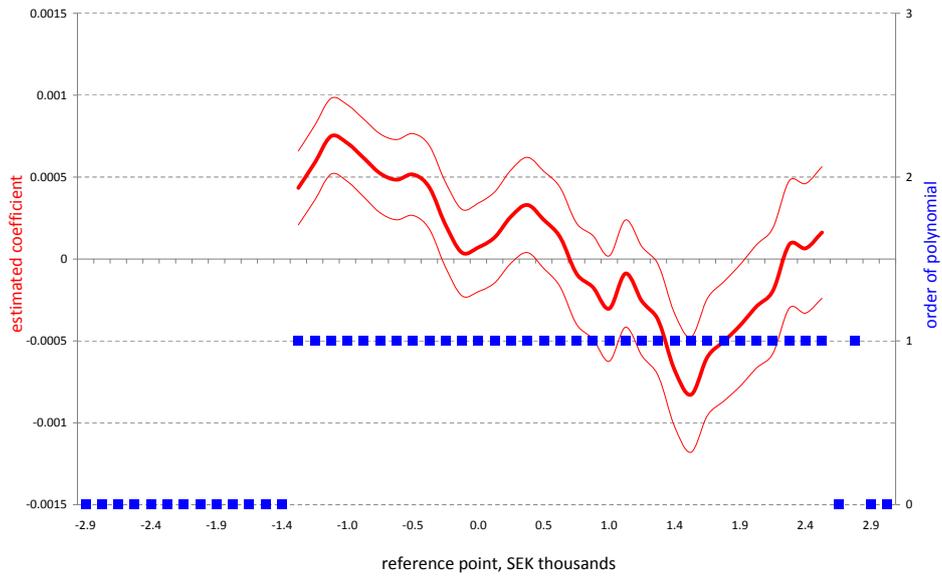
Figure 26: Jump - placebo estimates for age.

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