Do Commuting Subsidies Increase Commuting Distances? Evidence from a Regression Kink Design

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Abstract

I exploit a kink in the benefit scheme of a large commuter tax break to study the effect of subsidizing commuting costs on the commuting distance of employees. My results show a significant change in slope in the relationship between income and commuting distance exactly at the income level where the commuting subsidy becomes more generous. I test the robustness of this finding by using variation in the location of the benefit kink over time. My results indicate that commuting subsidies can indeed increase the length of the commute. This finding contributes to discussions about the efficacy of such subsidies, which often are justified on the grounds of making workers more mobile.

Keywords: Public policy, commuting subsidy, commuting behavior, taxation, administrative data
JEL codes: H21, H24, J22, J38, R23, R41

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1 Introduction

This paper aims to study the effect of commuting subsidies on the commuting distances of employees. Specifically, it investigates whether commuting subsidies can increase the willingness of employees to commute further. Such commuting subsidies exist in many countries, sometimes included in general work-related deductions (e.g., France or Italy), designed as a single allowance for commuters (e.g., Germany, Netherlands, Denmark, Switzerland), or come in the form of income-dependent tax credits (e.g., Japan) (see Potter et al. 2006 for an overview). In general, these subsidies are seen to incentivize wage earners to accept jobs that are more distant from their homes. A body of theoretical literature shows how such commuting subsidies should be designed in order to reach an efficient level of job search and commuting (e.g. Wrede 2001, Richter 2006, Borck and Wrede 2008, 2009). From a social welfare perspective, encouraging people to increase their job search radius in order to find better matches can be seen as positive, but longer commutes also entail negative externalities. Overall welfare implications depend on the combination of better job searches and those externalities. The goal of this study is to carefully examine whether taxpayers' commuting decisions are indeed responsive to such subsidies. This responsiveness can then be mapped against potential externalities.

While there exists a larger number of empirical studies that examine the relationship between wages and commuting (see, e.g., Van Ommeren and Gutiérrez-i-Puigarnau 2011, Mulalic et al. 2013, Guglielminetti et al. 2015), evidence of the effect of commuter tax breaks on commuting behavior is scarce. Some studies have shown how income as well as property taxes can distort commuting and residential decisions, but none of them analyze commuting tax subsidies specifically (e.g. Wildasin 1985, Brueckner and Kim 2003, Agrawal and Hoyt 2017). Boehm (2013) examines whether workers become more likely to switch job or move house when commuting subsidies are significantly reduced. Relatedly, Heuermann et al. (2017) investigate to which extent firms compensate workers for their commuting expenses in response to a large reduction in the German commuting tax subsidy. Overall, the only limited amount of empirical research on the efficacy of such commuting tax subsidies seems surprising, given the non-negligible sums in tax refunds many countries spend on these subsidies.[1]

This paper provides novel evidence of the effect of commuter tax subsidies on individuals' commuting distances to work. I investigate the effect of such subsidies by exploiting a kink in the benefit scheme of the Austrian commuter tax break. In essence, for wage earners with income *below* the first income tax threshold, the commuter tax break does not increase with commuting distance. In contrast, for wage earners with income *above* the first income tax threshold, the size of the commuter tax break gradually rises with commuting distance (as well as income). Thereby, the Austrian commuter tax break implies lower effective costs of commuting for individuals with income above the first income tax threshold, other things being equal. I show that sorting of male wage earners around the first income tax threshold is minimal, and use a Regression Kink Design

[1] For instance for Germany, the sum of foregone tax revenues from the commuter tax break amounted to roughly EUR 5 billion in 2010, equal to 0.5 percent of overall public expenditures (Umweltbundesamt 2014).

to uncover the effect of the commuter tax break on distance travelled to work.

My results show a significant change in slope in the relationship between income and commuting distance exactly where the commuting subsidy becomes more generous. I find the commuting distance to increase more steeply above the first income tax threshold, paralleling the rise of the commuting subsidy. I test the robustness of this result by using variation in the location of the first tax threshold over time. Interestingly, the slope change in the relationship between income and commuting distance shifts with the location of the first tax threshold. This works in favour of my hypothesis, suggesting that the commuter tax break has indeed an effect on the commuting distance of employees. Null results from placebo tests with fake tax thresholds corroborate this finding. Sensitivity checks confirm the positive effect of the commuter tax break on the commuting distance. Furthermore, I find that the tendency to longer commutes above the first tax threshold is also reflected in a higher take-up rate for the commuter tax break.

In sum, my results indicate that commuting subsidies increase the length of the commute. Specifically, I find that a more generous compensation of commuting costs increases commuting distances. This presents an important finding for discussing the efficacy of such subsidies, since they are often justified on the grounds of encouraging workers to increase their job search radius and to commute further for better job matches. Simple back of the envelope calculations show that the estimated effect appears reasonable as well as economically significant, broadly in line with what the literature has found when estimating related parameters. Finally, the design of the Austrian commuter tax break, where compensation depends on the length of the commute, is similar to commuting subsidies in many other countries. This makes the results also relevant from a wider policy perspective.

2 Institutional setting

The taxing unit in the Austrian personal income tax code is the individual. Hence, there is no taxation of married couples or households. Figure 1 depicts the income tax schedule during the time period of this study, 2005 to 2011: As shown by the figure, the marginal income tax rate t increases steeply from 0 to 38% (after 2009: 36.5%) at the first income tax threshold of EUR 10,000 (after 2009: EUR 11,000). Similar to many other income tax codes, taxpayers can reduce their tax liability by claiming certain deduction items. The commuter tax break is one of only two tax credits (besides a child tax credit) employees can claim directly through their employers' payslip (comparable to the W-2 form in the U.S.), which makes this tax break very salient. This makes the commuter tax break one of the first (and one of the most widespread) tax credits wage earners are claiming in order to reduce their taxable income.[2]

[2]There are other deductions which become available at the first tax threshold, e.g. expenses for private retirement or health care plans. However, every wage earner in Austria has to contribute to a comprehensive public pension and health care system, so the relevance of these deductions is low. Further, capital income in Austria is taxed at the source to a favorable rate of 25% and thus, usually absent from personal income taxes. Finally, it is important to note that employers have to start withholding (and reporting) social security contributions much lower than the first tax threshold, namely when the employees' wage earnings exceed 375 EUR per month.

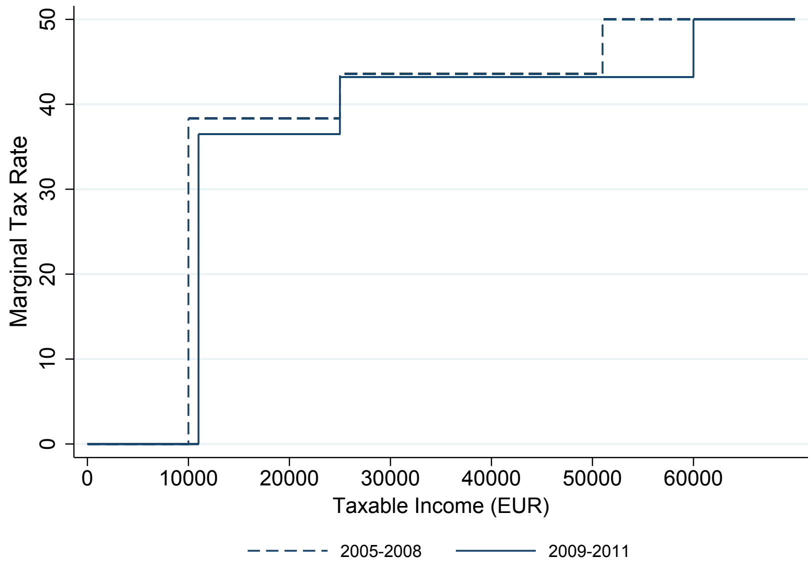


Figure 1: Austrian income tax schedule 2005-2011

Importantly, the income tax schedule with its large change in the marginal tax rate t at the first tax threshold creates a kink in the benefit scheme of the Austrian commuter tax break. Specifically, EUR 130 of the Austrian commuter tax break is a refundable tax credit, so that commuting wage earners with income *below* the first tax threshold who owe zero taxes get EUR 130. Wage earners with income *above* the first tax threshold receive EUR 130 until their taxes owed exceed EUR 130, above which their commuter tax credit increases with their taxes until they hit the maximum possible credit. This maximum credit depends on the commuting distance (as well as the means of transportation), with a longer commute giving wage earners a higher commuter tax break.

Figure 2 shows the after-tax cash value of the commuter tax credit versus gross income relative to the first tax threshold. As described above, for commuters with income below the first tax threshold (indicated by the dashed vertical line), the after-tax cash value of the commuter tax break is flat and EUR 130. In contrast, for commuters with income above the first tax threshold, the cash value of the commuter tax break increases with income until the (distance-dependent) maximum tax credit is reached.[3] In a nutshell, for commuters with income *above* the first tax threshold, the after-tax cash value of the commuter tax break increases with income as well as commuting distance, which is never the case when earning *below* the tax threshold.

Put differently, the first tax threshold in combination with the commuter tax break creates a discontinuous change in the after-tax price of commuting. Thus, another way of describing the design of the commuter tax break more formally is to show how the marginal price of commuting changes at the first tax threshold. The price of commuting p an additional EUR 1 worth of time

[3] Please note that for illustrative purposes, all figures indicate the tax threshold at EUR 10,000, while the actual kink is at EUR 10,342 EUR due to the refundable commuter tax credit of EUR 130 (EUR 130 divided by the marginal tax rate of 0.38 gives EUR 342). In all the analyses, I center the data around this actual threshold, but for reasons of simplicity and comprehensibility I display the statutory threshold at EUR 10,000.

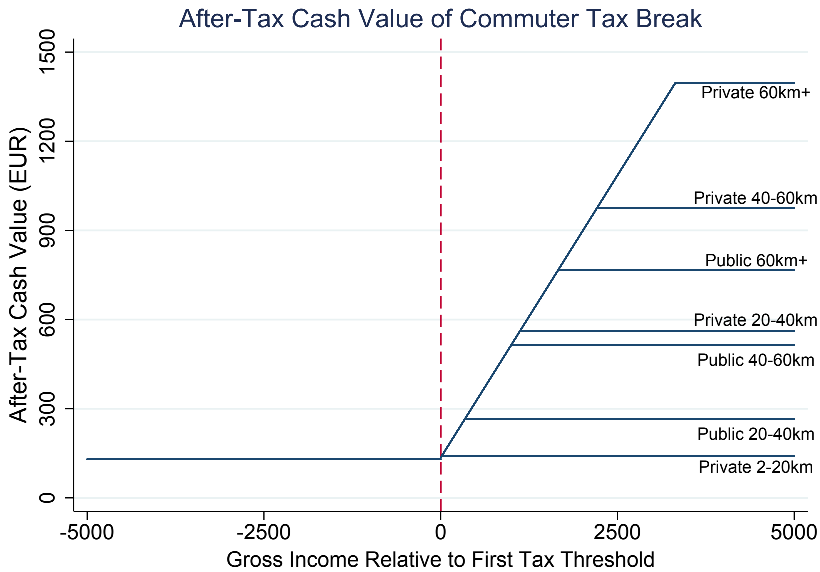


Figure 2: Benefit schedule of the commuter tax break

Notes: This figure depicts the benefit scheme of the commuter tax break, showing its (after-tax) cash-value against gross income relative to the first income tax threshold. The dashed vertical line at zero shows the location of the first income tax threshold.

is given by the formula below:

$$\begin{aligned} p &= €1 \quad if \quad y < (10,000 + \tfrac{130}{0.38}) \\ p &= €1(1 - t(y)) \quad if \quad (10,000 + \tfrac{130}{0.38}) < y < (10,000 + x) \\ p &= €1 \quad if \quad y > (10,000 + x) \end{aligned}$$

where y stands for income, $t(y)$ for the marginal tax rate at income y, and x for the deductible amount of the commuter tax break. Table 1 displays the maximum deductible amount x as stated in the tax code, which varies with commuting distance and the means of transportation:

Table 1: Max. deductible amount x of commuter tax break (in Euros)

Distance Bracket	**Public transport** available	**Public transport** not available
2–20 km	–	372
20–40 km	696	1,476
40–60 km	1,356	2,568
>60 km	2,016	3,672

The formula presented above shows that the after-tax price of commuting an additional € 1 worth of time is € 1 when earning below the first tax threshold of $(10,000 + \frac{130}{0.38})$. In contrast, for people earning above the first tax threshold, this after-tax price of commuting an additional € 1 worth of time is €1$(1 - t(y))$, until their (distance-dependent) commuter tax deduction x hits the maximum credit.

It is important to see the relationship between the after-tax cash value of the commuter tax break depicted in Figure 2 and the deductible amount x presented in Table 1: Table 1 shows the amount taxpayers can deduct from their taxable income, depending on their commuting distance and means of transportation. For instance, when commuting between 40-60 km by private car allows taxpayers to deduct a maximum of EUR 2,568 from their taxable income. This translates then into an after-tax cash value of the commuter tax break of EUR 975, calculated by EUR 2,568 times the marginal tax rate t of 38%. This is the maximum after-tax cash value taxpayers who commute between 40-60 km by private car and with income above the tax threshold can realize, shown by the horizontal line 'private 40-60km' in Figure 2.

To sum up, for commuters with income below the first tax threshold, the after-tax cash value of the commuter tax break does not increase with income or commuting distance and is always EUR 130. In contrast, for commuters earning above the first tax threshold, the cash value of the commuter tax break increases with both income and commuting distance. Thus, the design of the commuter tax break creates a discontinuous change in slope of the after-tax cash value of the commuter tax credit at the first tax threshold. This change in the price of commuting at the first tax threshold motivates the use of a Regression Kink Design for identification. Interestingly, Figure 2 shows that there are other kinks in the slope of the after-tax cash value, namely where the commuter tax credit hits its maximum and flattens out. However, it is difficult to use these kinks for identification since they occur at many different income levels. In contrast, the slope change at the first tax threshold occurs for all commuters, which makes it also very salient. This is why I will focus on this kink for identification.[4]

Finally, one may think of using the changes in the deductible amount x at the distance bracket thresholds (i.e., the 20km/40km/60km thresholds) presented in Table 1 to identify changes in commuting distances. However, running an RD or RK Design based on these distance bracket thresholds is non-informative because the running variable would be endogenous to the outcome variable. Specifically, in such an RD Design the running variable (e.g. distance to the 20km bracket threshold) and the outcome variable (commuting distance) would be mechanically linked and from the same data-generating process. Due this endogeneity, I desist from using these distance bracket thresholds to identify changes in the commuting distance. However, in the end of Section 4 I will explore whether or not commuters respond with bunching/lumping to these distance bracket thresholds.

3 Data and summary statistics

For the empirical analysis I use the Austrian Social Security Database (ASSD), a linked employee-employer dataset. Using the ASSD, I am able to link employees to their workplace, which allows to

[4]There are other (small) kinks in the schedule of the commuter tax break created by the change in marginal tax rates at higher incomes. However, these hikes are small, from 38% to 42% to 50% (see Figure 1). Thus, only the first tax threshold where tax rates jump from 0% to 38% appears to be salient for taxpayers. This is documented by large bunching of self-employed taxpayers at the first income tax threshold, and a lack of bunching of the self-employed at the two other tax thresholds.

observe both the residence and workplace location of the individual at the zip-code level. I then use a route planner (as is commonly used in navigation devices) to calculate the commuting distance between the centroids of these two zip-codes, which will be my (outcome) variable of interest. This procedure for calculating travel distances to work has been used by previous research, for instance to uncover misreporting of driving distances by Austrian taxpayers (Paetzold and Winner 2016, Frimmel et al. 2018). Importantly, this non-compliance does not invalidate my research design here, because the data I use to measure actual (i.e. 'true') commuting distance is unrelated to the distance taxpayers report for tax purposes. Specifically, the administrative purpose of the ASSD is to collect social insurance contributions of Austrian employees and their employers, which makes this data completely unrelated to any reporting regarding tax matters, such as the commuter tax break. Thus, by using the workplace location recorded by the ASSD to measure commuting distances, misreporting in my variable of interest (i.e. distance-to-work) should be negligible.

I restrict my analysis along some dimensions. First, I exclude employees with more than one employer, since it is unclear which commuting distance should be assigned to those workers. Second, I follow previous studies and focus on workers who commute less than 100km and work for companies with less than 3,000 employees (see, e.g., Guglielminetti et al. 2015, Heuermann et al. 2017).[5] Workers who live more than 100km away from their workplace are most likely weekly commuters, which have not been eligible for the commuter tax break during the time of my study (see Einkommenssteuergesetz 1988). Furthermore, the ASSD unfortunately does not provide a clear provision on whether the employer identifier is used for a company or for single establishments of a (larger) company. Sometimes only the headquarter of a company with several establishments is recorded in the ASSD.[6] This would inflate my variable of interest (i.e., commuting distances), since I assign such employees a much greater distance (i.e., to the headquarters) than where they actually work (i.e., the local establishment). Finally, I focus only on individuals and their commuting distances in the year they experience a job or residential move. Specifically, I construct a sample of all job or residential moves I observe in the data, and focus on the new commuting distance decision individuals take at the time of the move. Income tends to vary over time, while location decisions are rather long-term. Therefore, I want to focus on commuting decisions individuals take at the time of the move. In sum, the final sample consists of more than 2 million person-year observations, stemming from 1,724,948 unique individuals.

Descriptive statistics are given in Table 2. In the first column I present descriptive statistics for the whole sample. In the third column, I provide descriptives for taxpayers around the first income tax threshold, defined as having income within EUR 2,500 on each side of the tax threshold. For the whole sample, I find that taxpayers are on average 37 years old, 46 percent are female, and 20 percent work part-time. The mean gross income is EUR 21,152, and 32 percent of all taxpayers file for the commuter tax break. The average commuting distance to work for all taxpayers is around 17km. Looking at taxpayers around the first tax threshold, I find a mean age of 35 years, 73 percent women, and the share working part-time being 40 percent. The mean gross income is

[5] The latter restriction leaves my findings qualitatively unaffected. Results available upon request.

[6] Reassuringly, previous research has concluded that in the vast majority of firm identifiers in the ASSD, single establishments are recorded (see Fink, Kalkbrenner and Weber 2010).

EUR 11,293, and around 26 percent file for the commuter tax break. The average travel distance to work is ca. 15km.

Table 2: Summary statistics of wage earners, 2005-2011

	Whole Sample		**Around First Tax Threshold**	
	Mean	**S.D.**	**Mean**	**S.D.**
	(1)	**(2)**	**(3)**	**(4)**
Age	37.4	10.8	35.2	11.1
Female	0.464	0.499	0.734	0.441
White-collar worker	0.522	0.5	0.463	0.498
Working part-time	0.196	0.397	0.4	0.49
Job tenure	9.6	4.03	8.1	4.7
Academic degree	0.058	0.233	0.042	0.2
Gross income	21,152	20,290	11,293	1,488
Commuting distance	17.0	19.5	15.4	19.1
Fraction receiving commuter tax break	0.315	0.468	0.256	0.434
Observations	2,065,652		375,873	

4 Identification strategy

To identify changes in the commuting distance in response to the asymmetric incentives below and above the first income tax threshold, I use a Regression Kink Design (RKD). Hence, I exploit the change in slope of the treatment function at the tax threshold to identify changes in the willingness to commute longer. The identification assumption is that unobserved determinants of the commuting distance evolve smoothly around the first tax threshold. Following standard practice (see, e.g., Card et al. 2015a), this identifying assumption can be evaluated by analysing whether there is i) a manipulation of the assignment variable, and ii) a kink in covariates at the first tax threshold. To assess i), I inspect gross income distributions around the first tax threshold for women and men separately (see Panel A of Figure 3). The female income distribution (series in diamonds) shows a clearly visible hump around the first tax threshold, suggesting behavioral responses of women to it. In contrast, there is no evidence for manipulation of the assignment variable in the case of male wage earners, indicated by the lack of bunching in the male income distribution (series in dots).[7] To further substantiate this finding, I also conduct McCrary tests to detect signs of discontinuity in the density at the threshold (McCrary 2008). For women, I find a significant log change in height at the first tax threshold (discontinuity est.$= 0.057; S.E. = 0.013$). In contrast, for men the McCrary test fails to detect such a break in density at the first tax threshold (discontinuity est.$= 0.019; S.E. = 0.018$). This null result for male wage earners speaks

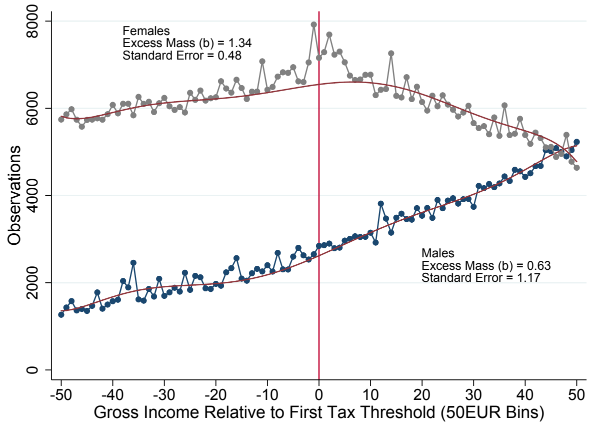
[7]Please note that I only use wage earners in my analysis, since self-employed are not entitled for the commuter tax break. Wage earners in general engage much less in bunching at kink points, a frequent result found by the literature (see, e.g., Saez 2010, Kleven 2016). Furthermore, this literature consistently finds much larger responses to tax rates for females than for males. Thus, my finding here is in line with the literature on behavioral responses to income taxation.

against the concern that there is manipulation of the assignment variable and thus, I proceed with my analysis using men only.[8] Second, I evaluate whether observable characteristics of male wage earners are smooth around the first tax threshold. In the spirit of Card et al. (2015a), I construct a 'covariate index' - the predicted commuter distance of wage earners using underlying personal characteristics as regressors. Thus, I build a vector of predetermined covariates including information on age, education, working part-time, and years of job tenure.[9] Panel B of Figure 3 plots the mean value of the covariate index against EUR 50 bins of gross income. The index moves reasonably smoothly across the first tax threshold (the vertical line), and I provide more formal tests of continuity in the Appendix (see Appendix A.2). Furthermore, I test whether individuals on both sides of the tax threshold follow similar trends in income growth over time. Therefore, I examine the persistence of incomes around the first tax threshold over time (see Appendix A.3). Overall, I find individuals to the left and right of the tax threshold having very similar trends in permanent income, suggesting that people are no different on either side of the threshold.

It should be noted that the identification strategy does not aim to isolate the workplace decision from the residential location decision. To be more precise, the focus of this study is to examine whether commuter subsidies increase the length of the commute people undertake, but not to explicitly explore the source of this increase. However, I find that a change in workplace is much more prevalent in Austria than a change in residency, in line with previous research (see, e.g., Guglielminetti et al. 2015). Specifically, I find that only 20% in my sample change residency, compared to around 80% who change their workplace.

[8]In this context it is important to note that around 70% of all recipients of the commuter tax break are male. Excluding subgroups for which the identifying assumption doesn't hold is not uncommon in RK-Design. For instance Card et al. (2015b) exclude all individuals working in manufacturing due to a visible break in the distribution.

[9]Please note that I do not include firmsize, industry and occupation in the covariate-index since these variables are likely to be endogenous to commuting distance. For instance, there is a positive correlation between distance and firmsize as well as occupation in Austria (see Halla and Zweimüller 2013, Guglielminetti et al. 2015).



Panel A

Panel B

Figure 3: Assessment of RKD assumptions

Notes: Panel A and B test the validity of the identifying assumptions of the RK-Design. Data is presented in EUR 50 gross income bins relative to the first tax threshold, plotting bins in the range [-50,50]. Panel A uses bunching techniques to detect manipulation of the assignment variable (gross income). The solid lines in Panel A represent seventh-degree polynomials fitted to the empirical distributions excluding a bunching window of 20 bins on each side of the first tax threshold (see Chetty et al. 2011). Panel B plots the predicted commuting distance using personal characteristics as regressors (males only). See text for details.

Finally, I want to explore whether commuters respond with bunching to the distance bracket thresholds of 20km/40km/60km shown in Table 1. Although these distance bracket thresholds cannot be used for identification due to the endogeneity between the running and outcome variable (see description at the end of Section 2), bunching would be an indication of behavioral responses to these distance thresholds. I start with looking at the distribution of commuting distances using a Kernel density plot to visually spot clustering around the bracket thresholds. Figure A.1 in the Appendix displays the commuting distance distribution of the sample of all job or residential movers in the year of the move.[10] The dashed lines indicate the three distance bracket thresholds (20km/40km/60km). I find no clear spikes in the distance distribution around these three distance bracket thresholds. Only *below* the 40km distance bracket threshold, I observe a small hump in the distribution. Figure A.2 in the Appendix zooms in on each bracket threshold and provides McCrary tests to detect signs of discontinuity. The estimate of the log change in height and its bootstrapped standard error is displayed directly on each graph and indicate no clear lack of continuity at the thresholds. Again, only *below* the 40km distance bracket threshold, I observe a small break in the distribution. A model of sorting in response to the distance bracket thresholds would rather predict lumping *above* the bracket thresholds. However, previous research has shown that taxpayers respond strongly to these bracket thresholds with cheating (see Paetzold and Winner 2016), thus clear sorting of wage earners *above* the thresholds may not be necessary. More generally, the reason why I do not find signs of substantial clustering around the distance bracket thresholds could be that there is no need to bunch at these thresholds since it is so easy

[10]Please note that I use the entire sample of job or residential moves, and not just those with incomes around the first tax threshold. Thus, the sample is identical to the one shown in column 1 of Table 2 in the main text.

to cheat on them (at the margin, more than 80% of commuters cheat, see Paetzold and Winner 2016). Thus, potential real behavioral responses (i.e. moving residence or job location) to the distance bracket thresholds may be swamped by the reporting (i.e. cheating) response. Due to this and the above-mentioned issue of endogeneity between the running and outcome variable, I desist from using the distance bracket thresholds to identify changes in commuting distances. Instead, I employ third-party reported wage earnings and the kink in the commuter tax break at the first tax threshold to identify its effect on commuting distances.[11]

5 Empirical results

Figure 4 plots the actually observed commuting distance of wage earners against EUR 50 bins of gross income around the first tax threshold. Please note that I plot the entire population of wage earners who experience a job or residential move in a given year, irrespective of whether a person receives the commuter tax break or not, since take-up might be endogenous.[12] Two things are worth noting in Figure 4. First, it displays a clear change of slope occurring exactly at the point where the commuter tax break becomes more generous. The solid lines represent best-fit linear regressions estimated on the microdata separately for observations above and below the tax threshold. The hypothesis that the two slopes are equal is rejected with a p-value smaller than 0.01. Thus, the commuting distance increases more steeply above the tax threshold, mirroring the rise in the cash value of the commuter tax break above the threshold. Second, the figure also shows some 'flattening out' of the rise in the commuting distance at higher income bins above the threshold. This is consistent with the flattening out of the slope of the benefit function, when the commuter tax credit hits its respective maximum (see Figure 2).

[11] Thus, the running variable I use is third-party reported wage earnings. Wage earnings data is administratively recorded and collected by the government to calculate pension obligations. This type of of data is usually considered to be (almost) free of manipulation, and containing only little measurement error (see, e.g., Saez et al. 2012).

[12] Thus, my results are robust to potential selection bias of certain individuals into treatment, something which could arise if I would only focus on individuals who actually take up the commuter tax break.

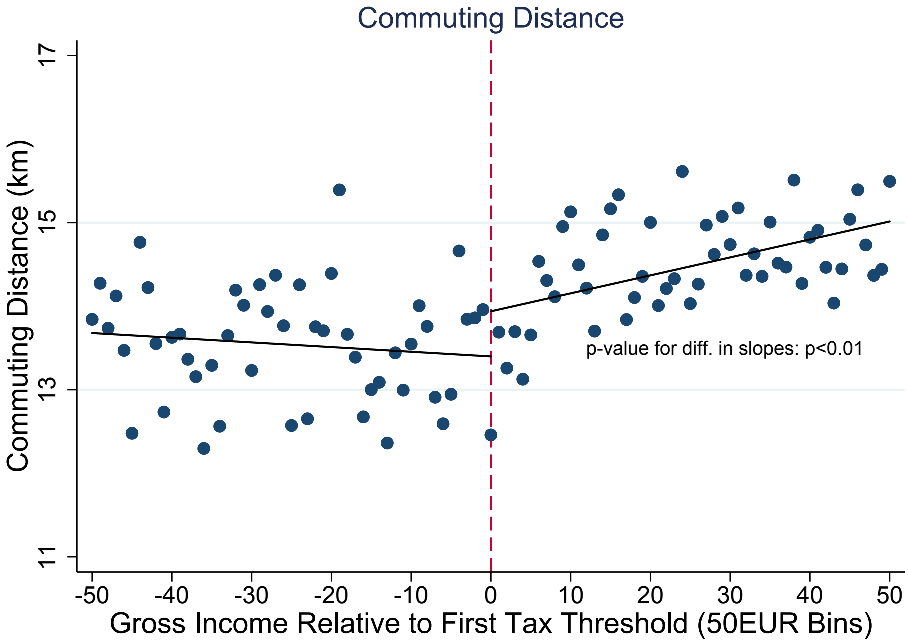


Figure 4: Commuting distance around first tax threshold

Notes: The figure plots the observed commuting distance against gross income. Data is presented in EUR 50 gross income bins relative to the first tax threshold, plotting bins in the range [-50,50]. The solid lines represent best-fit linear regressions estimated on the microdata separately for observations above and below the first tax threshold.

In Table 3, I present regression results for the regression-kink coefficient (change in slope) with and without demographic control variables and for different bandwidths. I estimate the effect of the commuter tax break on the commuting distance using the following linear model:

$$Y_{it} = \alpha + \beta R_{it} + \theta D_{it} + \delta[D_{it} * R_{it}] + \gamma X_{it} + \eta_t + \epsilon_{it} \tag{1}$$

where i denotes the individual and t the year. R_{it} is (binned) gross income, and D_{it} is an indicator taking 1 when having gross income above the first tax threshold. The parameter δ measures the treatment effect, i.e. the change in the slope at the tax threshold. X_{it} are a set of control variables, η_t are year fixed effects and ϵ_{it} is the error term. First, I find that when including control variables in my regression, the estimated size of the kink remains very stable and is always statistically significant. This suggests that individuals to the left and to the right of the first tax threshold are indeed very comparable regarding their characteristics. Second, I find that the size of the kink at zero somewhat decreases with increasing bandwidth. As shown on the right-hand side of Figure 2 and as discussed above, there are other kinks in the slope of the after-tax cash value where the commuter tax credit hits its maximum. Specifically, a positive slope in the after-tax cash value of the commuter tax credit over the entire bandwidth of 2500 does only exist for individuals with very long commutes. Thus, the decreasing size of the estimated kink when using larger bandwidths is consistent with the fact that less individuals are affected by the positive slope in the commuter tax credit when moving further up from the tax threshold. However, even when using a large bandwidth of 2500, the kink remains to be highly statistically significant. Specifically, I estimate a significant change in slope of 0.018 (including controls) for a bandwidth of 2500.

Table 3: Treatment effect estimates on commuting distance (km) using different bandwidths around the threshold

	(1) **No controls**	**(2)** **Controls**	**(3)** **Observations**
Bandwidth			
2500	0.020^{***}	0.018^{**}	99,543
	(0.008)	(0.008)	
2000	0.020^{**}	0.019^{*}	77,579
	(0.010)	(0.010)	
1500	0.044^{***}	0.043^{***}	56,784
	(0.016)	(0.016)	

Notes: Sample period 2005-2011. Robust standard errors two-way clustered by residential zip-code and individual level in parentheses. *, ** and *** indicate significance at 10-, 5- and 1-percent levels, respectively. All regressions include year fixed effects. The regressions with controls include age, education, working part-time, years of job tenure.

To substantiate the claim that it is the change in the benefit scheme of the commuter tax break which induces people to accept longer commutes, I use variation in the location of the first income tax threshold over time. In 2009, the location of the first tax threshold and hence, the location of the change in slope of the commuter tax break was shifted by EUR 1,000, from EUR 10,000 to EUR 11,000.[13] Thus, I can study whether the change in the location of the first tax threshold corresponds with a change in the location of the kink in commuting distances. Panel A of Figure 5 plots the relationship between the commuting distance and gross income for individuals in my sample from 2005-2008, and Panel B for those from 2009-2011. There is a clear kink in this relationship for the 2005-2008 group at the location of the 2005-2008 income tax threshold (bin 0). Interestingly, this kink disappears for the 2009-2011 group, when a new kink appears right at the location of the shifted 2009-2011 income tax bracket (bin 20). The fact that the location of the change in slope shifts with the location of the first tax threshold is supportive of an effect of the commuter tax break on commuting distances.

[13] Note that no other changes to the benefit scheme of the commuter tax break were applied in 2009.

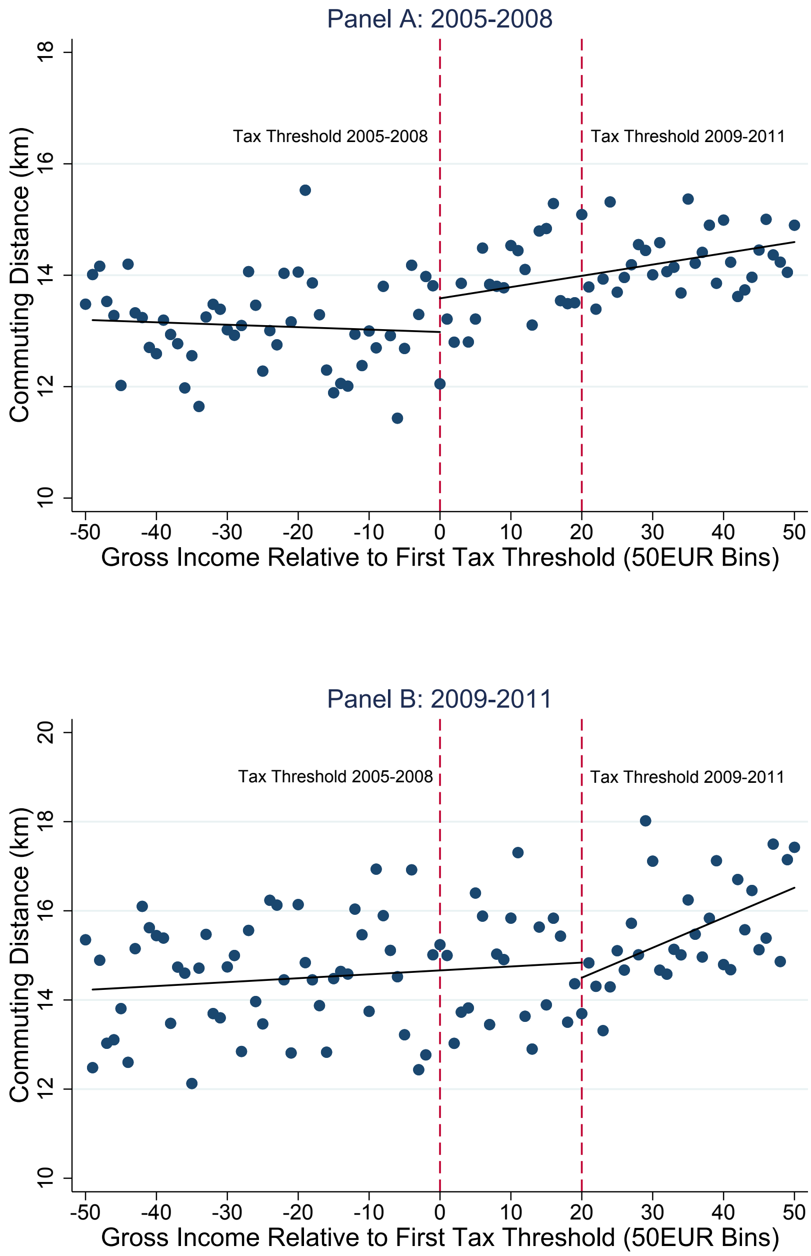


Figure 5: Variation in the first tax threshold and commuting distance

Notes: The graph shows average commuting distances in each bin of gross income in 2005-2008 (Panel A) and 2009-2011 (Panel B). In 2009, the location of the tax threshold and hence, the location of the kink in the benefit scheme of the commuter tax break was shifted by EUR 1,000 (= 20 bins). This is indicated by the two vertical lines, showing the position of the first tax threshold for the two periods. Data is presented in EUR 50 gross income bins relative to the 2005-2008 tax threshold (i.e., bin 0 = EUR 10,000). See text for details.

To check whether the kink at the new location of the shifted 2009-2011 income tax bracket is i) significant and ii) not just by chance, I conduct placebo tests using a number of fake tax thresholds. Specifically, I create three placebo thresholds with an interval of EUR 1,000 below the actual tax threshold of EUR 11,000 in the years 2009-2011 (i.e., at 8K, 9K, and 10K). I then apply the same econometric specification as shown in equation (1) to test for significant kinks at these placebo thresholds as well as at the actual threshold. To begin with, Column (1) of Table 4 provides estimates when using the actual threshold at EUR 11,000 (2009-2011). I find a positive and statistically significant kink at the actual threshold, mirroring the result displayed in Panel B of Figure 5. In contrast, when using the placebo thresholds, I do not find any significant kinks at any other location. Specifically, columns (2) to (4) present the estimates for a potential kink at the different placebo tax thresholds. None of these placebo thresholds show a significant kink.

Table 4: Treatment effect estimates using the actual and three placebo tax thresholds (2009-2011 period)

	(1) actual threshold EUR 11K	**(2) placebo threshold EUR 8K**	**(3) placebo threshold EUR 9K**	**(4) placebo threshold EUR 10K**
controls incl.	0.050^{**}	-0.168	-0.005	0.021
	(0.024)	(0.112)	(0.024)	(0.016)
Obs	22,974	22,974	22,974	22,974

Notes: The analysis is based on the sample of movers for the period after the tax threshold was shifted to EUR 11,000 (2009-2011). Column (1) provides the estimate when using the actual tax threshold of EUR 11,000. Column (2) to (4) present estimates for different placebo tax thresholds. Robust standard errors two-way clustered by residential zip-code and individual level in parentheses. *, ** and *** indicate significance at 10-, 5- and 1-percent levels, respectively. The regressions include age, education, working part-time, years of job tenure and year fixed effects as controls.

Finally, I want to examine whether the tendency to accept longer commutes above the first tax threshold is also reflected in a higher take-up rate for the commuter tax break. Since eligibility for the commuter tax break depends on the length of the commute (e.g., people with access to public transport are only eligible for the tax break when commuting more than 20km), one may expect a kink in the take-up rate if people indeed commute longer above the first tax threshold. Figure 6 plots take-up rates of the commuter tax break against EUR 50 bins of gross income, using a binary outcome variable with entry one for take-up. The figure shows a clear change of slope occurring exactly at the first tax threshold. The solid lines represent best-fit linear regressions estimated on the microdata separately for observations above and below the tax threshold. The hypothesis that the two slopes are equal is rejected with a p-value smaller than 0.01. In sum, I observe the probability of take-up to change its slope above the first tax threshold, paralleling the rise in the commuting distance displayed in Figure 4. This finding works in favor of the hypothesis that the commuter tax break has indeed an effect on the commuting distance of taxpayers.

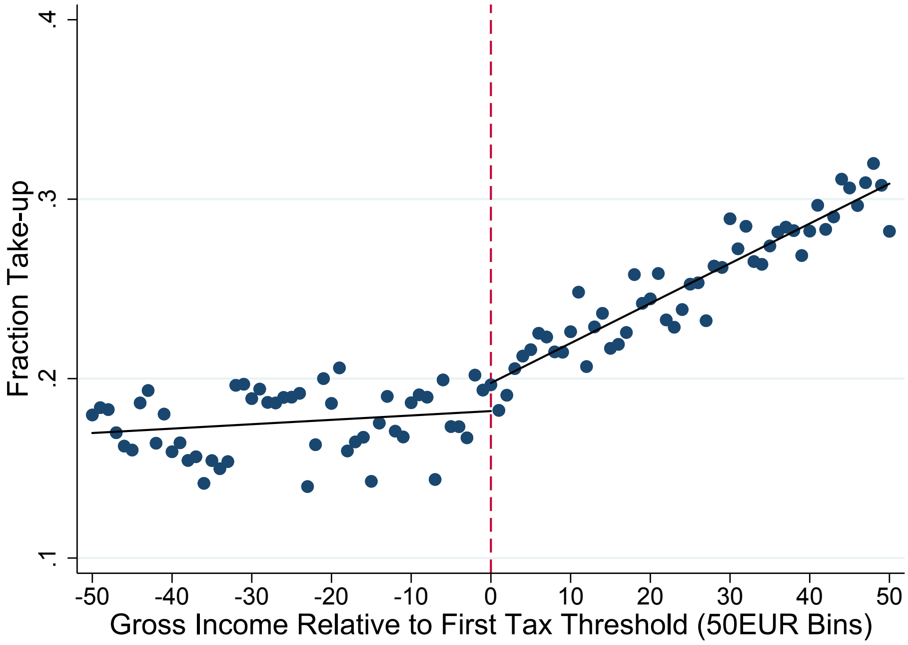


Figure 6: Take-up rate of commuter tax break

Notes: The figure plots the take-up rate of the commuter tax break against gross income relative to the first tax threshold. Data is presented in EUR 50 gross income bins relative to the first tax threshold, plotting bins in the range [-50,50]. The solid lines represent best-fit linear regressions estimated on the microdata separately for observations above and below the first tax threshold.

6 Sensitivity

I conduct additional analyses to examine the robustness of my results. More precisely, I conduct sensitivity checks adding quadratic and cubic functions (i.e. second- and third-order polynomials) to my regression equation (1). Section A.5 and Table A.2 in the Appendix discuss and present the corresponding results. As it can be seen from the table, when adding second-order polynomials (Model A), the estimated kink (i.e. the interaction term) remains statistically significant. The same is true when adding third-order polynomials (Model B). In sum, I find the result of a change in commuting distance at the benefit kink to be robust to the inclusion of higher-order polynomials.

7 Discussion of the results

In order to give a sense of the magnitude of the estimated effects, I want to relate the change in commuting distance to the change in after-tax cash value of the commuter tax break taxpayers received. The change in the commuting distance at the first tax threshold is shown in Figure 4, and estimated in Table 3: I find the change in slope at the threshold to be 0.018 including controls, which is my preferred estimate (see row 1 column 2 of Table 3).

Figure A.4 in the Appendix plots the mean after-tax cash value taxpayers received from the commuter tax break within each bin of gross income.[14] I observe a very clear change of slope at the first income tax threshold, reflecting the kink in the benefit scheme of the commuter tax break illustrated in Figure 2. The change in slope of the after-tax cash value at the threshold equals 1.15. This means that for every EUR 50 bin of income above the first tax threshold, individuals on average receive an additional EUR 1.15 in after-tax cash value, compared to individuals below the threshold.

Now one can relate the change in slope in commuting distance to the change in after-tax cash value to obtain an estimate of the magnitude of the responsiveness: When the after-tax cash value of the commuter tax break increases by 1 EUR, individuals increase their commuting distance by additional 15.6 meters (calculated by 0.018/1.15). Put differently, an after-tax cash value of EUR 64 induces an increase of the commute by 1 km (one-way). To put this result into perspective, I suggest the following back of the envelop calculation: Assuming a commuting speed of 30 km/hour,[15] an additional 1 km commute increases the daily commute by around 4 minutes. Given that many people around the first tax threshold work part-time (see Table 2), I assume that individuals run this commute about 150 times per year. This translates into 600 additional minutes spend behind the wheel per year. Using the extra after-tax cash value of EUR 64 associated with this extra 1 km commute, one receives an hourly wage rate of EUR 6.4. Unfortunately, the tax data does not report hourly wage rates this could be compared with. However, using the average annual gross income of ca. EUR 11,000 of people around the first tax threshold (see Table 2), and assuming 150 days of work with 8h per day, the gross hourly wage rate is around EUR 9.[16] Transport economists using stated preference data typically find that the commuters' value of time is about 50% of the gross wage rate (Small and Verhoef 2007). Similarly, Brownstone and Small (2005) find that the average value of commuting time varies among different industrialized cities in the US from 20% to 90% of gross wage rate. Small et al. (2005) find somewhat higher estimates with the value of time being about 93% of the average wage.[17] Thus, the magnitude of the effect of the commuter tax break is broadly in line with what the literature has found when estimating related parameters. However, it is important to note that this back of the envelope calculation is based on a contemporaneous (i.e., present-day) perspective. Specifically, taxpayers in my sample have a fair degree of both income and locational mobility over time. For instance, Appendix A.3 shows that only 20-30% of taxpayers around the first tax threshold remain in the same income bin after 2 years. Changing income may also affect the size of the commuter tax break an individual receives. In addition, I find more than a quarter of the individuals in my sample to change job or

[14] Again, I do not select on claiming the commuter tax break but use the entire population, see also Footnote 8 of the paper.

[15] This value has been used by related literature as a reference point, see e.g. Mulalic et al. (2013).

[16] A similar but somewhat higher hourly wage rate for Austrian part-time employees has been reported by Böheim et al. (2011).

[17] Please note that I desist from subtracting potential monetary expenses from the after-tax cash value of the commuter tax break. This is not uncommon in the literature cited above, and seems reasonable as I do not know whether the taxpayers in my sample actually commute by car, public transport, car pool, bike, etc. While the size of the commuter tax break depends on whether public transport is available or not (see Table 1), commuters are still free to choose their specific mode of transport. Thus, I follow related literature and quantify the after-tax cash value in terms of value of time and the gross wage rate.

residence again over the next 5 years, which potentially alters their commuting distance. Assuming that individuals in my sample may treat the decision of how far to commute to work as a rather short-term decision, I decided to render the back of envelope calculation contemporaneously.

8 Conclusion

Many OECD countries provide tax subsidies for commuting. These subsidies are usually justified by assuming that financial incentives to commute will make workers more willing to take up jobs that are further away from their homes. While this seems theoretically well understood, it has been difficult so far to provide direct empirical evidence of it. In this paper, a kink in the benefit scheme of the Austrian commuter tax break is exploited to study its effect on commuting distances. Applying a Regression Kink Design I observe commuting distances to increase more steeply above the tax threshold where the commuting subsidy becomes more generous. Using variation in the location of the benefit threshold over time I find that the willingness for longer commutes shifts in accordance of the threshold. In sum, my results indicate that commuting subsidies increase the length of the commute. This presents an important finding when discussing the efficacy of such subsidies, which are often justified on the grounds of encouraging workers to increase their job search radius and to make them more mobile. In light of the non-negligible amounts many governments spend on such commuting subsidies, this finding also carries important policy implications. Finally, an overall assessment of the social welfare implications does not only have to take into account the positive effect stemming from workers who increase their job search radius, but also the negative externalities associated with longer commutes. The goal of this study is to carefully examine whether taxpayers' commuting decisions are indeed responsive to commuting subsidies. Mapping this responsiveness against potential externalities represents an important avenue for future research, helping policymakers to make better decisions about the efficient level of such subsidies.

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A Appendix

A.1 Bunching of taxpayers around distance bracket thresholds

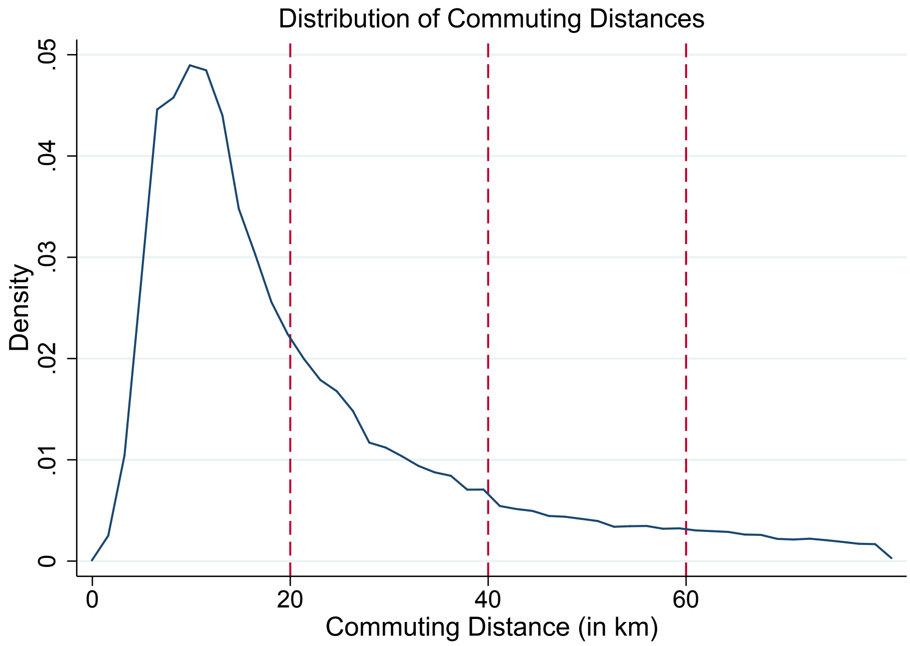
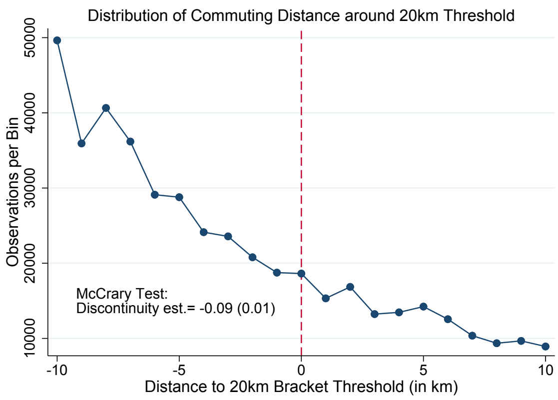


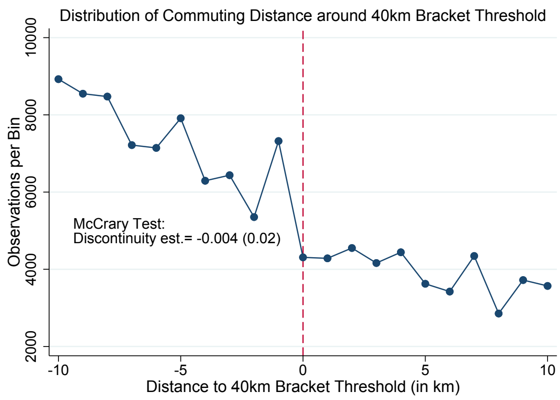
Figure A.1: Distribution of commuting distances

Notes: This figure plots the kernel density of commuting distances with a bandwidth of 1.25 km. The dashed lines represent the distance bracket thresholds presented in Table 1 (20km/40km/60km).

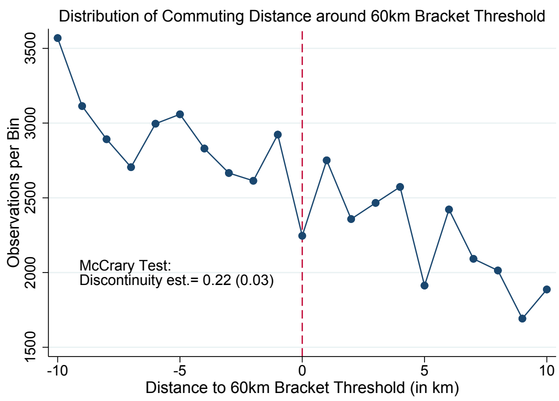
Figure A.2: Distribution of commuting distance around bracket thresholds



Panel A



Panel B



Panel C

Notes: This figure plots the distribution commuting distances around each distance bracket threshold (20km/40km/60km). In each panel, I put taxpayers in 1km wide bins of their distance to the next bracket threshold and plot the number of individuals within these bins. The dashed lines represent the bracket thresholds. Each graph also displays a McCrary test of the discontinuity of the probability density function at the respective bracket threshold.

A.2 Estimated kink in covariate index

In this section I present estimated kinks for the covariate index using the same regression approach shown in equation (1). As described in Section 4, I construct a covariate index of the predicted commuting distance using information on age, education, working part-time and years of job tenure (see Card et al. 2015a). To make the results as comparable as possible to the estimations based on the actual commuting distance, I use the exact same model setup and bandwidths as in Table 3.[1]

Table A.1 displays the estimated kinks in the covariate index. Even though I sometimes do find statistically significant kinks in the covariate index (especially when using larger bandwidths), they are always very small in magnitude. To be more precise, the kink magnitudes in the

[1]Please note that I desist from presenting regressions including control variables, as I did in column 2 of Table 3. Including controls would lead to overfitting, since the same variables which are used to construct the covariate index would be also used as explanatory variables on the RHS of the regression.

predicted commuting distance are small in comparison to those in the actual commuting distance, accounting for at most 20% in the estimated kinks presented in Table 3.

Table A.1: Estimated Kink in Covariate Index

Bandwidth	**estimated kink**	**Observations**
2500	0.004^{***}	99,543
	(0.001)	
2000	0.004^{***}	77,579
	(0.001)	
1500	-0.001	56,784
	(0.001)	

Notes: Sample period 2005-2011. Robust standard errors two-way clustered by residential zip-code and individual level in parentheses. *, ** and *** indicate significance at 10-, 5- and 1-percent levels, respectively. The covariate index is created using information on age, education, working part-time and years of job tenure.

A.3 Income persistence around first tax threshold

Figure A.3 displays the probability to stay in the same income bin over time. Specifically, I put individuals into EUR 1,000 wide bins of gross income and plot the fraction of individuals who remain in the same income bin after two years. I also add a quadratic polynomial of the bin averages to approximate the counterfactual probability to stay in a given bin. I find the probability to stay in the same bin to decline smoothly with income, with individuals to the left and right of the tax threshold having very similar probabilities. This suggests that people on either side of the threshold have very similar trends in permanent income, and corroborates the finding that other than in commuting distances, people are no different on either side of the threshold.

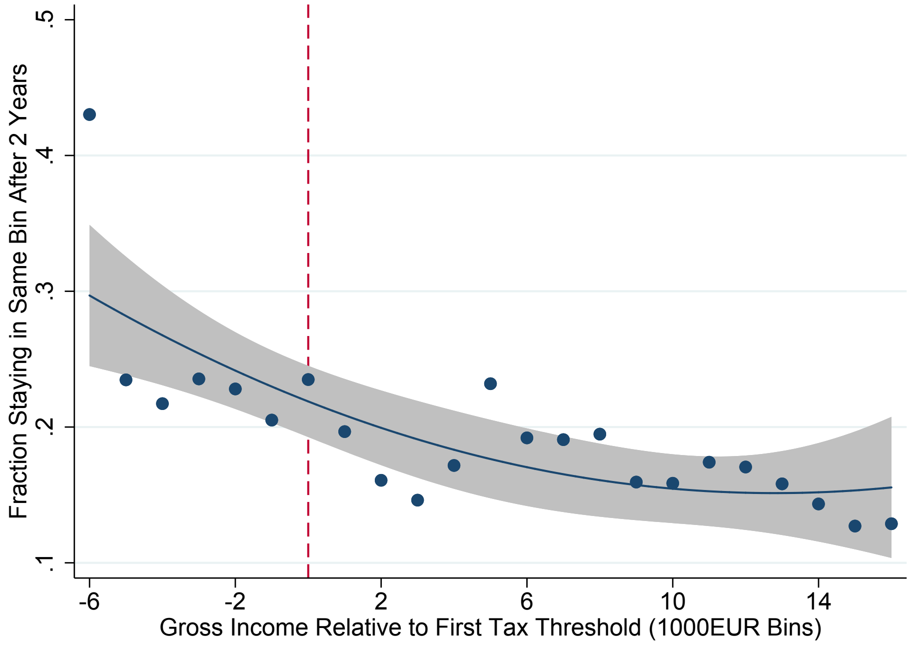


Figure A.3: Income persistence around first tax threshold

Notes: This figure shows persistence in gross income. It plots the fraction of individuals who remain in the same gross income bin after two years. The solid blue curve is a quadratic fit of the bin averages. The solid vertical line displays the first tax threshold.

A.4 After-tax cash value of commuter tax break around first tax threshold

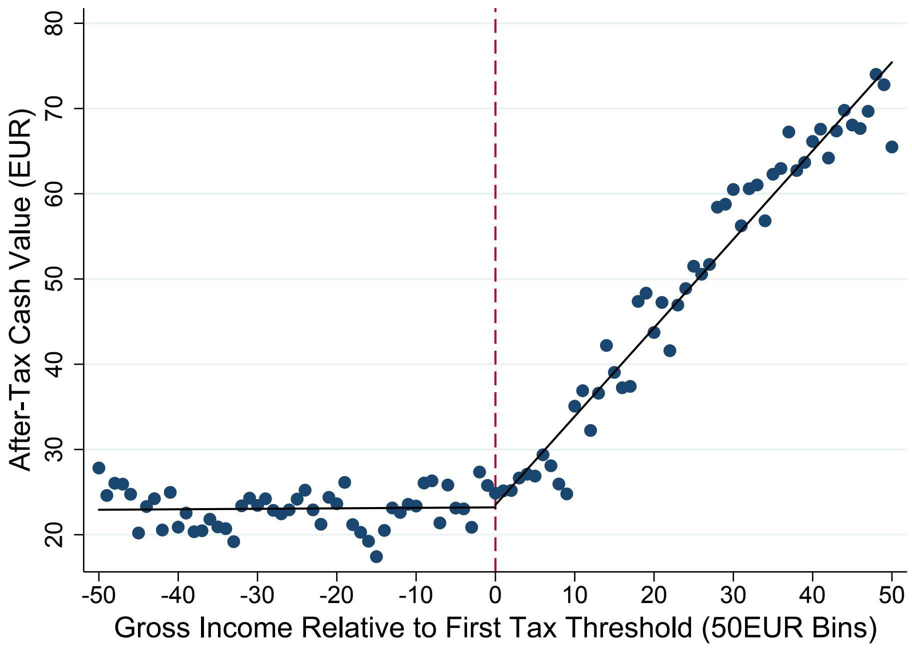


Figure A.4: After-tax cash value of commuter tax break around first tax threshold

Notes: The figure plots the mean after-tax cash value of the commuter tax break taxpayers received against gross income. Data is presented in EUR 50 gross income bins relative to the first tax threshold, plotting bins in the range [-50,50]. The solid lines represent best-fit linear regressions estimated on the microdata separately for observations above and below the first tax threshold.

A.5 Sensitivity checks using higher polynomials

I conducted sensitivity checks adding quadratic and cubic functions (i.e. second- and third-order polynomials) to regression equation (1). Table A.2 displays the corresponding results. As it can be seen from the table, when adding second-order polynomials (Model A) the estimated kink (i.e. the interaction term) remains statistically significant. The same is true when adding third-order polynomials (Model B). The bandwidth used is always 2500. Including control variables or varying the bandwidth does not qualitatively change these results. In sum, I find the result of a change in commuting distance at the benefit kink to be robust to the inclusion of higher-order polynomials.

Table A.2: Estimation results with higher polynomials

Dependent variable: Commuting distance

	Model A	**Model B**
Income bin	−0.010	−0.039
	(0.022)	(0.053)
Dummy for income above tax threshold	0.166	−0.092
	(0.331)	(0.433)
Income bin × dummy for above threshold	0.048^{*}	0.191^{***}
	(0.030)	(0.072)
Observations	99,543	99,543

Notes: Sample period 2005-2011. Model A includes second-order polynomials, while Model B adds third-order polynomials. Regressions include age, education, working part-time, years of job tenure and year fixed effects. Robust standard errors two-way clustered by residential zip-code and individual level in parentheses. *, ** and *** indicate significance at 10-, 5- and 1-percent levels, respectively. Bandwidths is always 2500.