ISSN 2042-2695

CENTRE *for* ECONOMIC PERFORMANCE

CEP Discussion Paper No 1207

May 2013

Concentration Versus Re-Matching? Evidence About the Locational Effects of Commuting Costs

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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Abstract
Using administrative employer-employee data from Germany, I exploit two reductions of tax breaks for commuting in 2003/4 and 2006/7 to estimate commuting costs' effect on the decision to switch job and move house. Standard theory predicts that higher commuting costs should lead to increased concentration in urban centers. However, I find that re-matching of existing jobs and houses to reduce commuting distances is much more prevalent in the data. With these estimates I calculate the effect of a complete abolition of the tax breaks on overall travel distance, fuel usage, greenhouse gas emissions, the tax base, and the de-population of the countryside.

Keywords: Work/residence location choice; commuting costs; environmental effects of tax policy; employer-employee data
JEL Classifications: R00; J61; J68; Q48; Q58

This paper was produced as part of the Centre's Labour Markets Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements
I am grateful to Jörn-Steffen Pischke, Luis Garicano, Daniel Sturm, Henry Overman, Stephen Redding, Guy Michaels, Gabriel Ahlfeldt and seminar participants at LSE for comments and suggestions. I would also like to thank the Institute for Employment Research in Nuremberg (IAB) for their very friendly and helpful support. All errors and omissions are my own.

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Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

1 Introduction

There is an ongoing debate about what are the factors that shape our cities and determine the use of the land. While theorists in urban economics and economic geography have developed many interesting models and predictions, causal empirical evidence is relatively scarce. More specifically, many theories are concerned with the effect of transport costs on the concentration of individuals and firms within and between cities, but much of the existing empirics is either descriptive or anecdotal.[1] In this paper I provide causal evidence on the effect of an increase in a particular component of transport costs - commuting costs - on individuals' location decisions.

I estimate the effect of two reductions in per kilometer tax breaks for commuting in Germany on employees' decisions to move house and to switch jobs. Further, I analyze whether these moves or switches leave employees with a shorter commute and whether they make them locate their residences or jobs in concentrated locations, i.e. cities. Theoretical models in urban economics and economic geography are unanimous in their prediction that higher transport or commuting costs will lead to increased concentration of economic activity and population. However, these models are concerned with the long run general equilibrium, while from a public policy point of view we are also interested in the effect that occurs within a couple of years.

A convincing alternative hypothesis to concentration predicts that higher commuting costs will lead to a substantial amount of "re-matching", which is the process of occupying existing residential units and jobs differently but not changing their relative supply or utilization. Assume that some individuals live in location A and work in B while others work in A and live in B. If commuting costs rise, it becomes more attractive to live *and* work in *either* A *or* B and some (pairs of) individuals may now find it optimal to re-match in order to reduce their commuting distance. A precondition for this hypothesis is that individuals are heterogeneous in their residential preferences and in their productivity in different jobs. I investigate in how

[1] For a descriptive study, see Bento, Cropper, Mobarak, and Vinha (2005). It has also been argued that low fuel prices are the main reason for the spread-out shape and the lack of viable public transport of American cities compared to European ones (Krugman 2008).

much the response to the tax break changes fits the concentration and in how much it fits the re-matching hypothesis.

I find that individuals strongly react to higher commuting costs by switching jobs and moving residence. In my preferred regressions, a 1000 euros reduction in commuter tax breaks per year, which amounts to about a 300 euro increase in taxes paid for the average tax payer, leads to a 2.7 percent increased probability to change job location on average and it leads to a 1.7 percent increased probability to change residential location. The probability to change job or residence such that the commuting distance becomes shorter even rises by 8.9 percent.

In addition, there is evidence for both of the theoretical hypotheses in the data. Individuals become equally more likely to switch jobs from rural to urban locations as from urban to rural locations. However, they become more likely to move house from rural to urban locations but they do not become more likely to move house from urban to rural locations. Thus, on the one hand, there is no further concentration of jobs in cities due to the tax break changes. On the other hand, individuals' residential moves clearly show signs of an increased population concentration in cities, much as the standard theory predicts. Yet, the concentration effect for residential moves is substantially smaller than the re-matching effect.

I also do not find an increase of residential property prices in urban areas, which suggests that it is not inelastic housing supply or occupation rates that prevent stronger population concentration, but that the tax break changes' effect on demand for urban property is weak in the first place. In addition, a more detailed look at the dynamics of the adjustment shows that the bulk of the effect happens within two years after the change in commuting costs. This suggests that the short run effects considered in this paper may not be too different from the long run effects that the standard theory is concerned with.

Finally, I calculate the effect of the commuting tax breaks on outcomes that are directly relevant for policy. Assuming that they only have an effect on journeys via commuting and abstracting from general equilibrium effects (on fuel prices and congestion, for example), the tax breaks' hypothetical complete abolition in 2003/04

would have led to about a four percent reduction in the overall number of kilometers traveled in Germany within a year. Due to this, fuel usage would have declined by 5.2 percent and emissions by 3.4 percent while the effect on the movement from rural locations to cities would have been negligible. Despite the behavioral response of switching to job-residence combinations that feature a shorter commute, the increase in the tax base would have been substantial.[2] These results are also informative about the potential effects of reductions in similar commuting subsidies that exist in several other advanced countries such as the Nordic- and the Low Countries, Austria, Switzerland, Italy, France, and Japan.

My results contribute to several discussions in policy and academia. First, they show that an increase in commuting costs leads to increased concentration of population in cities, but not of jobs. This relates to the debate about the effect of transport costs and commuting costs in economic geography and in urban economics, respectively. The results also show that the bulk of the adjustment is re-matching, which requires substantial individual heterogeneity. This relates to the thriving literature on local labor markets, an important assumption of which is heterogeneity. Moreover, I estimate the effect of the commuting tax break change on overall tax revenues, fuel usage, greenhouse gas emissions, commuting distance, and the depopulation of the countryside. This relates to the policy debate about the benefits and costs of the abolition of this subsidy to commuting. Finally, I show that German employees are on average more mobile in terms of their jobs than in terms of their residences, which can be interpreted as that they value their private lives more than their careers.

For my analysis I use a representative two percent sample of all German employees provided by the Federal Employment Agency. This quarterly updated panel features locational information on residence and employment at the municipality level. I supplement the information with geocodes for all of the ca 12,500 municipalities in order to calculate commuting distances for each individual in the sample. I exploit the fact that tax breaks of commuting were reduced substantially at the turn of

[2]I refrain from comparing the environmental gains to the welfare losses for workers who lose part of their commuting subsidies as this would require strong assumptions about the distribution function of alternative work-residence combinations.

2003/4 and again in 2006/7 to estimate the effect of an increase in commuting costs on individuals' likeliness to switch job location, move residence location, switch such that the new combination features a shorter commute, and the commuting distance itself. Moreover, I estimate in how far the switches constitute relocations toward one of the 80 cities of more than 100,000 inhabitants in the country.

The paper is related to several strands of literature. First, I contribute to the ongoing debate about the determinants of land use and urban shape. The standard monocentric urban model (for example, see Brueckner 1987, Fujita 1989) predicts that higher commuting costs lead to an increased population concentration near the urban center and to a steeper rent gradient. Classic economic geography shifts the focus from locational decisions within cities to between cities (for a survey, see Moretti 2011), while the new economic geography literature has started to explicitly model transport costs and firms' locational decisions (e.g. Helpman 1998, Redding and Sturm 2008). In general, all of these models predict that higher transport or commuting costs should lead to more concentration in terms of population and of economic activity (i.e. firms). I provide causal evidence for the existence of this concentration effect for individuals' residences, but don't find evidence for it in terms of jobs.

Second, the more important component of the adjustment to the tax break changes is what I call re-matching. This constitutes evidence for substantial individual heterogeneity in terms of productivity in different jobs and in terms of preferences for residential locations. Heterogeneity of workers is an important assumption of the thriving literature on local labor markets (for example, see the model in Moretti 2011), but it was considered an important feature of realistic theoretical models even much earlier (e.g. Michel, Perrot, and Thisse 1996).

Third, there is a policy debate about the effect of gasoline, carbon, and public transport prices on travel demand, CO2 emissions, household location, commuting choice and economic activity.[3] I show that travel distance, CO2 emissions, and loca-

[3]For example, see Ahlfeldt and Feddersen (2010), Bento, Goulder, Jacobsen, and von Haefen (2009), Knittel and Sandler (2010), Busse, Knittel, and Zettelmeyer (2009), and Li, von Haefen, and Timmins (2008). A paper that is methodologically related to mine is by Molloy and Shan

tional decisions are strongly affected by commuting tax breaks. In general, the tax break change experiment seems more suited to analyzing the locational impact of a change in transport or commuting costs than many other experiments: the decline in the value of a job-residence combination is independent of the chosen transport mode or of intensive margin responses, such as driving more fuel-efficiently. This lets me focus on the extensive margin response of moving house or switching job. Moreover, the tax break changes are arguably fully exogenous to the effect analyzed - they were decided as part of an across-the-board cut in subsidies due to a dire fiscal situation - while fuel prices or most public transport investments are endogenous to travel demand.

Fourth, there is a domestic German debate about the reasons for and against the abolition of the commuter tax breaks. The claims that such a policy change would have no effect or only long run effects on peoples' locational decision (e.g. Distelkamp, Lutz, Petschow, and Zimmermann 2008, Schulze 2009, Graeb and Vorgrimler 2005) are closest related to my analysis. I show that individuals do react to the decreases in commuting tax breaks and that they do it swiftly - to a substantial degree even before the changes are implemented. Moreover, I estimate their effect on the overall reduction in gasoline consumption, emissions, travel distance, and the tax base. Nonetheless, I make the theoretical argument that the tax breaks, when they are set at the right level, support efficient matching in the housing and in the labor market. Environmental and fiscal goals should be pursued using different policy tools, such as gasoline taxes.[4]

The fifth group of literature this paper deals with is concerned with job mobility and the migration decision (most notably, consider Topel and Ward 1992, Bartel 1979). I show that there is a causal effect of pecuniary (i.e. wage) changes for the current job-residence combination on mobility. Moreover, by observing the strength of the reaction in terms of moving and in terms of switching jobs, I provide evidence

(2010), who study the effect of gasoline prices on household location via commuting costs. They find that construction activity reacts strongly to changes in locations' relative attractiveness due to increased transport costs but, just as this paper, find no significant effect on house prices.

[4]Knittel and Sandler (2013) estimate empirically the welfare losses of taxing a variable (commuting in our case) that is imperfectly correlated with an externality and find that they are substantial.

that the average employee values her residence (and thus her private life) more than her job.[5]

The remainder of the paper proceeds as follows. I explain the data in the next section. Then I present the theoretical hypotheses about the effect of a reduction in commuting tax breaks on an individual and an aggregate level as well as the empirical strategy. Section 4 reports and interprets the main results, and section 5 estimates effects on variables that are of immediate concern for policy makers. Section 6 concludes.

2 Data

2.1 German Employment Records

The data that I use are a two percent representative sample of the quarterly updated administrative records of all German employees, the so-called "BA employment panel", collected by the Federal Employment Agency.[6] Employers have to provide quarterly notices about their employees in order for the public administration to determine entitlements to unemployment insurance and the accumulation of retirement benefits. The information provided should therefore be highly accurate and up to date.

The data range from 1999 to 2007 with about 500,000 to 600,000 individuals per year. They include information on each individual's age, gender, education, income, and municipality of work and residence. They also include job and employer characteristics, such as industry sector and size of the employer and the worker's position (e.g. in training, regular worker, or foreman). Unfortunately, there is no information on home ownership, marital status, children, and place of birth provided. I also don't know which individuals are occupying a second home near their workplace

[5]Again, pinning down the rents from existing work places and residences over alternatives that might feature a shorter commute would require putting a lot of structure on the distribution of these combinations in the population and I refrain from it in this paper.

[6]The weighting of observations as in survey data is not necessary as the sample is representative of the population of German employees and there is no panel attrition in the sense that workers only disappear when they cease to be employed in actuality.

from where they travel to work during the week.

Table 1 reports important descriptive statistics on the individuals in the data. A person stays about seven out of nine years in the dataset on average (so the panel is quite balanced), she switches job location about 0.9 times and house location about 0.7 times during that period.[7] Underlying these averages is substantial heterogeneity in all the characteristics across individuals as indicated by the reported distribution quantiles of the variables. Tables 3 and 2 show that there are about 12,500 municipalities of residence and 10,500 municipalities of workplace in the dataset. Of course, the size distribution between municipalities is very dispersed with the biggest municipalities being many times larger than the smallest ones. Moreover the tables report the number of connections per work or residence municipality, i.e. the number of different municipalities from- or to which workers commute, respectively.

I supplement the data by adding detailed geographic coordinates (geocodes) for each municipality, which I retrieved using Google Maps.[8] I use this information to estimate the commuting distance by car (termed cardistance in the following) for every individual in the dataset.[9] The cardistance is the relevant distance between residence and workplace because the actual tax breaks are calculated according to the fastest car distance, although they are granted independent of the actual means of transport used. Tables 4, 5, and 6 document the distribution of cardistance in the years 2002, 2004, and 2007. We see that the average cardistance has mostly been increasing over time, which is also documented in Grau (2009). Therefore, the identification strategy below will use year fixed effects to control for overall differences in switching behavior across years.

[7]Throughout the paper, I use the female form to refer to females and males alike unless I specifically make clear that I'm referring to a female only.

[8]The geocodes were downloaded on 5 May 2010 from `http://www.gpsvisualizer.com/geocoder/` (last accessed 2013-03-11).

[9]The cardistance estimate was calculated following Einig and Puetz (2007) who use the crow fly distance between the midpoints of two municipalities and multiply the result by 1.3. The latter is the average ratio between car- and crow fly distance. Idiosyncratic mistakes in this approximation method should not matter given the large number of municipality combinations in the dataset. However, one may imagine a bias for municipalities of large (area) size and the under- or overestimation of the commuting distance for some of their residents or workers.

2.2 Commuter Tax Breaks

Tax breaks for commuting apply in most European countries including Germany.[10] As early as 1920, the actual costs of traveling to the workplace were acknowledged in Germany as income-related expenses and thus could be deducted from the income tax bill. Initially, only the cost of public transport was accepted, but in 1955 the federal constitutional court allowed each kilometer traveled by car to be deducted with 0.50 Deutschmark. From the year 2001 onward, a flat rate irrespective of the means of transport of 0.36 euros for the first ten kilometers and 0.40 euros thereafter applied.

Over the years, the reduction (or even the full abolition) of these tax breaks became a constant matter of political debate. The critics, often from the political left or liberals, argued that the tax breaks are environmentally- and fiscally damaging. The supporters, often politically conservative or with a mandate from a rural constituency, countered that the tax breaks support rural- and family life, and that they are enhancing mobility in the labor market because they allow individuals to travel longer distances to their workplace.

Real change on commuter tax break had to come for another reason—the dire fiscal situation that the country faced throughout the early 2000s. In September 2003, two powerful state premiers from the big political parties, the conservative Roland Koch from Hesse and the social democrat Per Steinbrueck from North-Rine Westphalia, published a joint proposal to cut subsidies across the board in order to free resources for the government's budget. The commuter tax breaks were herein considered as a subsidy and in December an arbitration commission in parliament decided to reduce them to 0.30 euros per kilometer from the first of January 2004 onward. The second, and larger, reduction of the subsidies came during 2006 when the two big parties had formed a formal coalition and the government decided to

[10]The following historical review for Germany is based on `http://de.wikipedia.org/wiki/Entfernungspauschale#cite_note-21`, `http://www.pendlerrechner.de/geschichte.shtml`, and the database of parliamentary events `http://dipbt.bundestag.de/dip21.web/bt` (last accessed 2013-03-11). For international comparisons see Borck and Wrede (2009) and the references therein.

abolish the tax breaks starting in 2007 for commutes below 20km. However, on 9 December 2008, the federal constitutional court ruled that this new regulation was an unequal and inconsistent treatment of citizens before the law and that it was against the constitution. Hence, the pre-2007 situation was reinstated, but this is beyond the reach of my dataset, which ends in 2007.

In practice, there have thus been two reductions in the value of a given commute during my sample period. For individuals who live very close to their workplace this generally matters less than for individuals who commute long distances, since the tax break that an individual receives is the oneway cardistance between residence and workplace times

- 0.36 euros for the first ten kilometers and 0.40 euros thereafter from 1999 to 2003,
- 0.30 euros per kilometer during 2004 to 2006, and
- 0.30 euros per kilometer from kilometer 20 onwards for 2007.

In order to estimate the yearly tax-deductible amount for each worker, I multiply the resulting amount by 220 workdays per year (Schulze 2009) and divide by 1000 in order to report the tax breaks in thousands of euros.[11]

Figure 1 displays the tax breaks enjoyed by the median, the average, the 90, and the 95 percentile commuter in terms of cardistance over the years. We see that the tax breaks follow an upward trend in years where there is no policy change, which reflects the fact that cardistances generally have been increasing as mentioned above. However, in the years of policy changes, the tax breaks drop, and they drop more the longer is the cardistance. The strongest and most equally impacting drop happens

[11]There is a complication about the tax breaks for the years from 1999 to 2001 because these were determined as a flat rate only for car commuters while commuters on public transport had to prove the actual incurred cost. For simplicity, I ignore this issue in my calculations. It should not distort my results too much, since, according to Grau (2009), the majority of commuters are still using their cars to travel to the workplace and more than three quarters of commuters of distances above 25km are using their cars—the group that is most affected by the tax break (changes). I also ignore slightly lower commuter tax breaks before 2001, when the rate for commutes beyond 10km was 0.36 instead of 0.40 euros.

in 2007 when tax breaks are only granted above 20km cardistance. For the longer distance commuters, the overall drop is substantial: the individual at the 95 percentile experiences an overall reduction in tax breaks of almost 1,500 euros per year.

2.3 Strength of the Experiment

Before moving on to the specific empirical predictions, it is helpful to develop a better understanding of how important the tax break changes are for different individuals in the sample and thus the strength of the effects that one could reasonably expect. This discussion and the analysis in the following will be done in euros of tax break changes rather than the net income gain that they imply. The reason is that marginal tax rates depend on workers' marital status as well as other income components and deductibles, which are not reported in the data. These problems in determining the marginal tax rate - in addition to the fact that high-earners may react differently to the same (relative) change in the net euro value of a job-residence combination than low-earners - also prevents me from using the difference in the net value of tax break changes for different earnings groups as additional identifying variation in the estimation below.

For the determination of the strength of the experiment, I start with the net effect of a 1000 euros tax break change on an average individual.[12] If this person earns 25,000 euros a year and thus faces a marginal tax rate of 30 percent, the tax break change reduces her net yearly income by 300 euros or by about 2.5 percent. If she has a planning horizon of 15 years and discounts the future by five percent, this amounts to a net present value of the change of about minus 3,300 euros. Thus, the extents of some very common tax break reductions seem already non-negligible.

In further calculations I consider the extent of the tax break changes in relation to estimated overall costs of commuting, including the time use, and compared to the variation in annual fuel costs of commuting. I find that the commuter tax break changes make up about one ninth of overall commuting costs, while the yearly varia-

[12]Note that 1000 euros is not excessively high, since all individuals who live more than 20km away from their workplace in 2006 face a tax breaks reduction of about 1,400 euros.

tion in gasoline costs is generally a fraction of the net value of the tax break reduction, in particular for the 2006/07 change.[13]

Another more important consideration is what fraction of my sample actually benefits from the tax breaks. In general, any individual who files a tax return can claim the tax breaks. This should be a very high portion among the individuals covered by the social security system and thus in the data.[14]

However, there may be individuals who benefit from the tax breaks but are systematically not identified in my data as such and vice versa. The former group could be commuters who live in the same (large) municipality as they work but still travel a substantial distance to work. In this case, my estimator of the average effect of a tax break change would be upward biased because I attribute a given overall effect to a too small treated group. The latter group may be individuals who work part time, who have a second home near their workplace from which they commute, who do not earn enough to pay taxes at all, or who do not exceed a general annual allowance of income related expenses of currently 920 euros.[15] The existence of these groups downward-biases my estimate of the average treatment effect of the tax break change.

3 Theoretical Hypotheses and Empirical Strategy

In this section, I first derive individual-level predictions and then aggregate implications. The third part presents the empirical strategy.

[13]For conciseness, I do not report the details of these calculations but they are available upon request.

[14]According to the Federal Statistics Office, out of 35.7million employees, 30.3million considered themselves commuters in 2004.

[15]`http://de.wikipedia.org/wiki/Werbungskostenpauschbetrag` (last accessed 2013-03-11). Kloas and Kuhfeld (2003) from the German Institute for Economic Research (DIW) provide a more complete list of such cases and estimate that they constitute about 0.5 percent of total employment. Also, there is a maximum annual claimable amount of commuter tax breaks (4,500 euros in December 2010).

3.1 Micro-Level Predictions

Consider an individual i who currently works at job (location) w and lives at residence (location) r but who is aware of all the other latent jobs and residences that are available to her. Assume her utility to be additively separable in money, more exactly, tax break euros. I can then write

$$u_i(r, w) = v_i(r, w) + TB(\overline{rw}), \tag{1}$$

where $v_i(r, w)$ is the non-tax break component of utility including the disutility of commuting and the gross tax break $TB(\overline{wr})$ is an increasing function of the commuting distance and the tax break rate per kilometer. Clearly, when the tax break rate per kilometer falls or when tax breaks are abolished for the first 20 kilometers, latent combinations of work and residence that feature shorter commutes than w and r will become relatively more attractive.

Note that the components of equation (1) should be interpreted as flows for a correct utility maximization via choosing the highest $u_i(r, w)$: the tax breaks $TB(\overline{rw})$ occur every year that the person lives and works in the work-residence combination $r, w)$ and accordingly $v_i(r, w)$ is the flow utility per year in this combination.

Figure 2 illustrates how the relative attractiveness of combinations changes with the commuting distance for the specific policy changes of 2003/4 and 2006/7. In the case of 2003/4, the relative change in tax breaks is higher the larger is the difference between the two commuting distances. A proportional relationship also holds for the combinations within 20 kilometers for the 2006/7 change, but thereafter the relative attractiveness doesn't change any further. This is because, for example, a commute of 30 kilometers has lost the same money value as a commute of 50 kilometers.

The valuations of the currently chosen and the latent job-residence combinations fluctuate all the time for every individual,[16] but from figure 2 I would expect them to fluctuate more when changes in commuting tax breaks occur. The reason is that these changes add to the "normal" variation in relative valuations by making short

[16]This is the reason for the turnover in jobs and residences that we observe in the data.

cardistance combinations relatively more attractive compared to long cardistance combinations. I would thus expect that individuals are more likely to switch jobs and/or residence in years where commuting tax breaks fall. Moreover, they are more likely to switch in a way such that the new cardistance is shorter.

It is also interesting to understand whether individuals are more likely to react to tax break changes by changing job or by changing residence. On the one hand, it provides evidence on the causal effect of pecuniary changes for the current job or residence location on the likeliness to switch job or to move house. This is of interest in relation to the job mobility and migration literature (see, for example, Bartel 1979, Topel and Ward 1992) and location-based policies, which have a rationale if individuals are geographically immobile to a substantial degree (see the discussion in Moretti 2011). On the other hand, it reveals what the average person values more: her residence location, and thus a significant part of her private life, or her job? More precisely, the coefficient on the tax break change in the regressions on the likeliness to switch jobs or move residence will provide me with the fraction of individuals for whom the difference in the value of the current job or residence over the best alternative job or residence is less than a constant ($prob(u(w,r) - u(w',r) < c)$ and $prob(u(w,r) - u(w,r')) < c)$.[17] Note that the differences $u(w,r) - u(w',r)$ and $u(w,r) - u(w,r')$ are actually rents. Thus, I can examine whether the average individual has a higher valuation of her current house or her job over the best alternative, or, equivalently, whether she is more job- or residentially mobile.

I construct outcome variables to analyze the predictions on the individual level: four indicators which assume the value of one if, from the previous to the current year, the individual concerned changes her location of workplace (*Work Switch*),[18] her location of residence (*Residence Switch*), either of those (*Any Switch*), or she switches such that she ends up with a shorter commute (*Closer Switch*). Moreover, I construct

[17] In fact, as I argue below, it provides me with a lower bound on that fraction.

[18] If I were interested in job mobility without the geographical component, it would be preferable to examine the effect of the tax break changes on whether individuals change the establishments they work instead of looking at whether they change their municipality of workplace. I don't report these alternative regressions here because I am indeed focusing on the locational impacts. Nonetheless, the direction of the effect on establishment switches is the same as the ones for the work (location) switch, though the magnitude is somewhat lower.

the change in cardistance from the previous to the current year (*Cardistance Ch*). If individuals behave like hypothesized in equation (1) and figure 2, and if moving costs are not prohibitively high compared to the money value of the tax break change, I would expect that the tax break changes make it more likely that the indicator variables assume the value of one. Moreover, the average change in cardistance should turn out more negative.

Table 7 provides the means per worker for the indicator outcome variables in the year 2002, while tables 4, 5, and 6 describe the distribution of the change in cardistance in general and conditioning on a change occurring for the years 2002, 2004, and 2007. We see that, per year, almost 14.9% of individuals change their job location and 12.1% change residence location. Overall, they switch 18.4% of times while they switch closer only 5.6% of times.[19][20] Tables 4, 5, and 6 support this last point, showing that most of the switches are resulting in longer cardistances.

3.2 Macro-Level Predictions

The previous section has shown that, ceteris paribus, the reduction in commuter tax breaks should make every employee weakly prefer a shorter work-residence combination. According to standard theory in urban economics and in economic geography, this shift in aggregate demand for a short commute should lead to increased concentration of population and economic activity.

First, the Alonso-Mills model in the urban economics literature (e.g., see Brueckner 1987, Fujita 1989) focuses on the spatial equilibrium for one city with a central busi-

[19]These numbers seem quite high and I can only speculate why this is the case. One potential reason may be mis-recording postcodes for work or residence municipalities in some years which is corrected in other years and thus increases the measured job and residence turnover. Whatever the reason, if the upward-bias in measurement of the switches variables is unrelated to the explanatory variables in the regressions below, this should not be a problem.

[20]There also seem to be more changes in job- and work locations in 2005 than in other years. I have searched for explanations for this myself and I enquired about it at the Institute for Employment Research. I found that in 2005 the distinction between East- and West Berlin was abolished and thus municipality assignments have changes. Also, there might have been some updating of employee information from part of employers because there were administrative changes in the pension insurance system. At this stage, there is no reason for me to believe that these changes should be systematically and substantially correlated with the tax break changes of individuals.

ness district in which all firms are exogenously concentrated and around which consumers locate. If commuting costs rise, demand for more central locations of residence increases, which drives up their relative price and the rent gradient (the ratio between rents in the urban center and the periphery) becomes steeper. Further, if housing supply is not completely inelastic, either because of variable lot sizes or the possibility of construction of new houses, the population density close to the center will increase (concentration).

Second, classic economic geography a la Rosen-Roback (see Roback 1982, Moretti 2011) shifts the focus from locational decisions within cities to between cities. Again, there exists a spatial equilibrium in which the marginal consumer-worker is indifferent between locations. Transport costs, which are the equivalent to commuting costs in urban economics, are only introduced explicitly in the new economic geography literature. For example, Helpman (1998) proposes a general equilibrium model in which different cities are characterized by an exogenously given amenity (i.e. housing stock), and firms and individuals optimally locate under agglomeration economies and transport costs. If transport costs increase, the new equilibrium is characterized by a stronger concentration of individuals and firms in the locations which have more housing stock. Redding and Sturm (2008) generalize this model by endogenizing the housing stock, but the concentration implication remains.

Yet, there exists a convincing alternative hypothesis to the concentration prediction on how the adjustment to a rise in commuting costs may look like. Assume individuals are heterogeneous in terms of their residential preferences and in their productivity in different jobs. It may then be the case that some of them live in municipality A and work in B, while others work in A and live in B. If commuting costs rise, it becomes more attractive to live *and* work in *either* A *or* B and some (pairs of) individuals who were sufficiently close to indifference initially may now find it optimal to re-match in order to reduce their commuting distance. I term this the "re-matching" hypothesis.

A key feature of the re-matching hypothesis is that existing residential units and jobs are occupied in a different way but their relative supply or utilization is un-

changed. It also requires sufficient heterogeneity in individuals' locational preferences - maybe because they strongly value the place where they grew up - and in job match quality. This further implies that there exist rents for the current job-residence match and not every worker-consumer is exactly indifferent between locations or the distance that she lives from the urban center as in the homogeneous version of the spatial equilibrium.[21]

I expect the existence and the relative strength of the concentration and the re-matching effect to depend on several key factors. First, if housing supply or occupation rates of the existing housing stock (lot sizes in the terminology of urban economics) are elastic, many individuals will be able to move to urban centers where jobs are disproportionately located.[22] This leads to a strong effect on population concentration and we may also see more concentration of jobs in urban centers.[23] Second, if housing supply or lot sizes are inelastic, the higher demand for more central locations will be absorbed into prices, and property prices in urban areas will rise while concentration will hardly be affected. In terms of the re-matching hypothesis, I expect to see a lot of it if jobs are located in diverse municipalities and if individuals are sufficiently heterogeneous such that there is a lot of scope for re-matching while not being too heterogeneous such that rents are not unsurpassably high. Finally, the concentration hypothesis is an implication from long run general equilibrium models, while the time frame of adjustment that can be considered in this paper is only two years. Re-matching may be much easier during a short period because, by definition, it does not need the housing stock or lot sizes to adjust.

I construct variables that take the value of one if an individual changes job or residence location from a non-urban municipality to one of the 80 cities with more than 100,000 inhabitants, i.e. *Work Switch Urban* and *Residence Switch Urban*, and

[21] In his survey paper, Moretti (2011) argues that heterogeneity and rents are an economically important feature of reality and he incorporates them into his generalized spatial equilibrium model.

[22] Occupation rates may also adjust if there are search frictions in the housing market and thus there exists a natural rate of vacancies which is affected by the change in demand.

[23] Employers might however be located in the center already so that no further adjustment on this margin is possible. Moreover, an employer's commuting distance minimization problem is much more complicated than the one of an employee, because the employer has to take into account the commuting distances of all of her employees.

the value of minus one if they do the opposite switch, i.e. *Work Switch Rural* and *Residence Switch Rural*.[24] If the hypothesized concentration effect is at work in my dataset, I would expect positive coefficients on the tax break change regressor for the *Work Switch Urban* and *Residence Switch Urban* outcome variables and less positive, or negative, coefficients on *Work Switch Rural* and *Residence Switch Rural*. Table 7 reports that only a small fraction of overall job switches or house moves are switches from a rural to an urban municipality or vice versa.

3.3 Empirical Strategy

In order to examine the causal impact of changes in tax breaks on individuals' locational decisions, and thereby assess the empirical value of the two hypotheses, I run the following general regression:

$$\text{location change} = \beta * \text{tax break change} + \gamma * \text{controls} + \epsilon \tag{2}$$

A unit of observation in this regression is an individual in a given year. Location change on the left hand side of the equation refers to the different outcome variables defined above, while tax break change refers to the change in tax breaks for an individual's work-residence combination.

One important feature that I have to control for in the regression is the cardistance of last year's work-residence combination. This is because individuals who have a high value of commuting distance are generally more likely to change location and the commuting distance is mechanically related to the change in tax breaks, since the latter is calculated using the former. In my main regressions I prefer to be conservative and to include municipality combination fixed effects to account for this.[25] I also include year fixed effects to account for general differences in the likeliness to change location between different years. My identification thus relies on a systematically different

[24]The list of cities with more than 100,000 inhabitants is from Wikipedia `http://en.wikipedia.org/wiki/List_of_cities_in_Germany_with_more_than_100,000_inhabitants` (last accessed 2013-03-11).

[25]This is only possible because my dataset is truly large so that I have enough realized municipality combinations for statistical inference.

likeliness to change location for individuals in far-distance municipality combinations relative to individuals in short-distance municipality combinations around the tax break change years.

In some of the regressions I even include an interaction of individual fixed effects together with the municipality fixed effects so that the identification relies solely on individuals who do move or switch from the respective municipality. This is because those individuals who don't change location during the sample period are absorbed by the individual-municipality-combination fixed effect. Hence, I can separately examine the tax break changes' effect on the direction and timing of existing moves.

In order for regression (2) to identify the average treatment effect of the tax break change on an individidual's location change,[26] the following assumption needs to hold: There is no other factor than the tax break change that affects the relative likeliness of location changes for far-distance municipalities compared to short-distance municipalities over different years. One such factor may be gasoline prices, which I control for explicitly in the regressions. Other control variables that are less central for claiming causality of the regression coefficient, but are nonetheless included in the regression, are dummies for age quartiles, income quartiles, plant size quartiles and the individual's position in the job.

One concern for the causal interpretation of the estimates themselves may be that it is not clear how far in advance individuals expect the tax break changes to happen. The regression results in the next section show that some of them anticipate tax break reductions by moving in the preceding year - even before the contemplated changes were finally decided. However, the optimal response in terms of minimizing the negative impact is to a first degree independent of the information release about the policy change: ideally, one would want to move at the 31st of December before the new rules come into effect. Therefore, the timing of information release should not constitute a major problem for the causal interpretation of the estimated effects.

[26]In fact, this is potentially a short run general equilibrium effect because many individuals are hit by the tax break decrease which may systematically affect fuel prices and wages even in the short run. For simplicity and because the overall size of changes are not large enough to impose it, I abstract from general equilibrium effects in this paper.

Before getting to the presentation of the empirical results, it is important to explain the construction and the timing of the outcome and the explanatory variables: In terms of the outcome variables, I consider every individual's work-residence combination in the fourth quarter of each year and compare it to the combination in the fourth quarter of last year to calculate the switches and the change in cardistance. In terms of the regressors, unless a switch took place, I do not know which specific work-residence combination an individual considered an attractive alternative to the prevailing work-residence combination last year. Therefore, I cannot calculate the relative money worth change between the two combinations as a regressor. Instead, I rely on calculating the change in the tax break worth of last year's combination that occurred at the last turn of the year ("TB Ch") and that occurs at the next turn of the year ("TB Ch (Next Yr)") just after the fourth quarter that the observation refers to. The coefficient on the "TB Ch" regessor captures the effect of the tax break change last year on location change between last year and this year while the coefficient on "TB Ch (Next Yr)" captures the effect of the tax break change this year, i.e. on an anticipatory move. Figure 3 illustrates using a timeline when the respective regressors may assume values different than zero (they are negative then, as tax breaks only decline during the sample period).

4 Regression Results

In this section I first present the results from the individual-level regressions and then discuss their implications in light of the concentration and the re-matching hypothesis.

4.1 Individual-Level Results

I start by estimating regression equation (2) for the likeliness to switch jobs, switch residence, switch either, and to switch closer using a linear probability model. The results of my preferred specification with municipality combination fixed effects are displayed in table 8. The change in gasoline cost for the cardistance this year and next year as well as dummies for years, age quartiles, income quartiles, plant size

quartiles, and the individual's position in the job are included as control variables throughout. Standard errors are clustered on the municipality combination level.

We see from the table that the tax break change for last year's cardistance between this year and last year has a statistically significant and positive effect on the likeliness to switch or move this year as well as last year. Individuals are also more likely to switch closer. This is all in accordance with the individual-level predictions from section 3.1: individuals are supposed to be more likely to move and switch jobs when tax breaks change and they are more likely to do so in order for the resulting cardistance to be shorter. They also engage in anticipatory moves and switches in the sense that some of them switch already in the run up to a tax break change at the turn of the year.

Moreover, the effect on switching closer in column four is stronger than the overall effect on switching in column three. This is as one would expect because increases in commuting costs should encourage switches that lead to a shorter cardistance while at the same time discouraging switches that lead to a longer cardistance. Thus, when tax breaks for commuting fall, the number of shortening switches should increase more than the overall number of switches.[27]

Next, I examine the magnitude of the effect. A tax break change of 1000 euros - the net equivalent of this for an average individual is about 300 euros - increases the likeliness of switching jobs, moving house, switching either, and switching closer by about 0.4, 0.2, 0.5, and 0.5 percentage points, respectively. Given that the averages of these variables are 14.9, 12.1, 18.4, and 5.6 percent, a 1000 euros tax break change increases the likeliness to switch jobs, move house, switch either, and switch closer by 2.7, 1.7, 2.7, and 8.9 percent, respectively. Thus, the effect of the tax break change is significant statistically and in magnitude, and it is strongest for the likeliness to switch closer as we should expect.

Tables 9 and 10 rerun the main regressions replacing the municipality combination

[27]It also suggest that the following general equilibrium effect, though plausible, is not of great empirical importance: some long-cardistance combinations become more attractive (possibly because of lower rents or house prices) for people who are not affected very much by the tax break change (possibly because of a low marginal tax rate).

fixed effects by individuals within municipality combination fixed effects and last year's cardistance as the main controls, respectively. The results are quite similar but somewhat stronger. As mentioned above, in the case of individual municipality combination fixed effects, the variation exploited only comes from individuals who do move or switch from the respective municipality. Thus, the tax breaks not only induce new switches or prevent distance-increasing moves that otherwise would have happened, but they also influence the direction or the timing of existing switches. We also see that the coefficient on either work or residence switches is now strictly smaller than the coefficient on the closer switches. This implies that the tax break changes prevent or postpone some longer-distance switches on top of encouraging additional shorter-distance switches.

The effect of changes in fuel prices on switching decisions turns out very inconclusive in the tables. This may not be very surprising. First, individuals continuously change their expectations about future fuel prices and price changes affect them immediately, contrary to tax break changes. Thus, when new information is revealed, they may find it optimal to move right away. Such an adjustment process can hardly be fully captured by the yearly average gasoline price changes included in my regressions. Second, individuals have different margins of adjustment to a gasoline price change - such as driving less, changing transport mode, or engaging in car sharing - that are not available in the case of a tax break change and that may be preferred to moving or switching job. In fact, the recent literature in transport economics and in environmental economics finds strong effects of gasoline price changes on driving behavior, new car purchases, and vehicle scrappage decisions (see Li, von Haefen, and Timmins 2008, Bento, Goulder, Jacobsen, and von Haefen 2009, Knittel and Sandler 2010).

From table 8 we see that the number of individuals who switch jobs in response to a tax break change is higher than the number who move residence. As mentioned above, the likeliness that the average person's flow valuation of her job over the next best alternative is below 300 euros (tax breaks of 1000 euros) is about 0.4 percent

while the corresponding likeliness for her residence is about 0.2 percent.[28] Thus, there are much less individuals who derive a relatively low utility rent from their current house than there are individuals who derive a relatively low utility rent from their current job. I interpret this as evidence that the average person values her residence (location) more than her job (location).

In principle, one could use this information to try to determine the distribution of- or the average rents from existing work places and residences in the population. However, this would require strong functional form assumptions and strong assumptions about which alternative work-residence combinations individuals are aware of or, equivalently, the combinations' arrival rates in a search model. I thus refrain from such an exercise in this paper.

I conclude from this discussion that the tax break changes for some individuals are substantial enough to change their preferred job-residence combination and to raise the utility differential between the old and the new combination above potential fixed costs of moving house or switching job. Moreover, the direction of the effect turns out as expected. Finally, the average individual seems much more likely to be willing to switch jobs rather than to move house in response to a fixed change in the value of her current combination, which can be interpreted as a higher valuation of her private life than her job.

4.2 Concentration Versus Re-matching

In order to understand how much of the overall adjustment to the tax break changes stems from concentration versus re-matching, I need to examine to what extent the effect leads to rural-to-urban and urban-to-rural moves.

Table 11 reports the results of the regressions that address this question.[29] We see that individuals are significantly more likely to switch their jobs and their residences

[28] These numbers are strictly lower bounds because in fact only the relative attractiveness of combinations with a shorter cardistance increases in response to the tax break reduction. Moreover, the relative attractiveness of combinations that feature a non-zero cardistance does not rise by the full 300 euros because tax breaks for these combinations themselves fall.

[29] The results are again similar but somewhat stronger when using individual-municipality combination fixed effects or cardistance as controls instead of municipality combination fixed effects.

from a rural to an urban location. They are equally likely to switch jobs from an urban to a rural location whereas the tax break reduction leads to a much weaker increase in urban-to-rural relocations of residence. Furthermore, the magnitude of each of the effects is a fraction of the overall adjustment reported in table 8.

The last observation indicates that the re-matching effect in terms of job as well as residence relocation is much stronger than potential concentration effects. Indeed, the concentration effect for jobs seems to be non-existent because there are as many induced urban-to-rural moves as there are rural-to-urban moves. As the overall distribution of jobs between rural and urban locations remains unchanged, these switches should therefore be considered as rematches. In terms of residential relocations, there seems to be a concentration effect, since more individuals are induced to move into cities than are induced to switch in the opposite direction.

What does this imply about the empirical validity of the urban and the economic geography models in the short run? First of all, jobs do not get more concentrated, potentially because they are already to a great degree located in urban centers or because minimizing the overall commuting distance of their employees is simply too complicated and costly for employers.[30] Therefore, the assumption of the vast majority of models that firms are exogenously located in the central business district seems to be harmless.

A stronger concentration effect on residential switches may be restrained either because the demand for relocating toward urban areas is not strongly affected by the tax break changes or because the supply of housing stock and the occupation rates are not very flexible in cities. According to the standard theory, the latter reason would imply a substantial increase in the relative price of existing urban housing stock. I examine this.

Figure 4 plots the relative property price index for big and medium-sized cities compared to the overall property price index for old and new flats and houses.[31]

[30]It seems that the latter explanation might be the more relevant one since we do observe individuals switch their jobs from urban to rural locations.

[31]The data were downloaded from the Bank for International Settlements website `http://www.bis.org/statistics/pp.htm` on 17 November 2010. Property prices seem to be a better measure of the effect on the housing market than rental rates because of two reasons. First, rent increases

There seems to be a general upward trend in the relative price of flats in cities and a u-shape for houses in cities, but it is hard to see any effect on prices around the time of the tax break changes, 2003/04 and 2006/07. A set of formal regression analyses with different specifications in order to account for the time trend also fail to discover a relationship.[32] I abstain from reporting these regressions in the paper for conciseness.[33]

Although there may be other reasons why urban versus rural property prices do not visibly react to the tax break changes,[34] the overall message from the results above seems to be that the relative demand for urban locations is not very strongly affected. This implies that re-matching is much more important as a channel of adjustment to increased commuting costs than concentration. It further implies that the assumptions underlying the re-matching hypothesis seem to be economically meaningful: individuals are substantially heterogeneous in terms of their locational preferences as well as how productive they are in different jobs. Moreover, there exist rents for the currently occupied job-residence combinations.

So far this analysis has not focused on the dynamics of the adjustment because it only considers the overall switches in the years before and after the tax break changes take effect. Yet, it is interesting to understand better how fast people react and in how much their movements precede or follow the changes. Further, the dynamics of the adjustment might inform us on the long run effect of changes in commuting costs or transport costs more generally. Unfortunately, in this data, I cannot analyze

within a short time frame (like one or two years) are restricted by law for privately used properties in order to protect tenants. Second, property prices should factor in the whole net present value of the effect, including the short as well as the long run.

[32]The non-findings of an effect of the tax break changes in property prices are also robust to using property price indices for big cities instead of big and medium-sized cities and for rural areas instead of an overall price index.

[33]Given that I find hardly any effect of the tax break changes on relative property prices, the tiny effect on moving residence from an urban to a rural location should stem from re-matching: either because the employer is located in the rural area that the person is moving to, or the rural area is better connected to the urban area where the employer is located than the previous urban area.

[34]Foremost, there might be institutional reasons which prevent prices to reflect supply and demand in the German property market in the short run. For example, rental rate adjustment is very constrained due to laws that protect (private) tenants from high raises. If property prices reflect the net present value of rental income, this should dampen the adjustment to a tax break change. In general, it is a widely held point of view that the German property market is not very free.

longer time periods than two years, because there is a new policy change coming up in 2006/07 for the 2003/04 change and the available data end in 2007. Moreover, even if it were possible to observe a longer time series of the data, it is unclear if this by itself were much more informative. The reason is because the effects of the tax break changes might be contaminated by other substantial long run shifts that affect land use and urban shape.

Therefore, I separate the available time periods into smaller units instead of of looking at longer horizons. Table 12 reports the regression results for the effect on the switches for quarters around the tax break changes.[35]

We see that individuals react already in the first quarter of the year of the change by moving house or switching jobs indicated by the coefficient on "TB Ch Q1 (Next Yr)". The effect then grows until the 5th or 6th quarter ("TB Ch Q1 (Last Yr)" and "TB Ch Q2 (Last Yr)") after the tax break change before it drops back to zero.[36] This seems to indicate that most of the adjustment happens in the short term already. Alternatively, it may simply take very long for housing supply to change, but the change might be continuous and small in the subsequent periods, so that we have a strong and visible effect of mostly re-matching and some concentration in the short term and a continuous and small per quarter effect on concentration via new housing supply in the medium and the long term. The lack of an effect on property prices casts doubt on this second explanation, however.[37]

5 Implications for Public Policy

Up to this point, the discussion has ignored the effect of the tax break reduction on the average distance commuted. The reason for this neglect was that estimation of equation (2) with (the change in) cardistance on the left-hand side is in fact biased in

[35]The results are again similar but somewhat stronger when using individual-municipality combination fixed effects or cardistance as controls instead of municipality combination fixed effects.

[36]Note that the coefficients for the tax break change last year, i.e. quarters five to eight, are based solely on the 2003/04 change and might therefore not reflect the average adjustment to both events.

[37]Yet, Moretti (2011), in his survey paper, quotes studies that find that the adjustment to local demand shocks take around 10 years.

panels with a short time dimension and fixed effects (Nickell 1981), and the focus of the analysis was on the causal identification of the treatment effect of the tax break change.[38]

However, in this section I want to focus on the implications that the tax break change has for policy-relevant variables such as fuel consumption, CO2 emmissions, and tax payments and revenues. Therefore, I need its effect on the commuting distance in the first place. Table 13 reports this information. The first column reports the preferred regression with municipality fixed effects as controls. On average, a one thousand euro decrease in tax breaks leads to an overall decrease on the commuting distance of about 0.79 kilometers (summing the coefficients on "TB Ch" and "TB Ch (Next Yr)"). This is about a decrease of one thirtieth of the average cardistance in the sample according to tables 4-6.

Compared to column (1) in table 13, the second column distinguishes between the tax break changes in 2003/4 and those in 2006/7 and the third and fourth column examine the change in cardistance conditioning on the event that a switch takes place. We see that the 2006/7 tax break changes seem to have had more than double the impact on the commuting distance than the 2003/4 tax break changes. Moreover, conditioning on the event that a switch takes place, the impact on the distance is (unsurprisingly) very high: a 1,000 euro tax break change makes the switch lead to a more than four kilometer lower commuting distance.

I want to consider the effect on the commuting distance and fuel usage in three scenarios of tax break changes: the actual reductions of 2003/4 and 2006/7 as well as a hypothetical complete abolition of tax breaks in 2003/04. Table 14 lists the preferred coefficient of 0.79 kilometers lower cardistance for a 1,000 tax break change together with further information that is used and the respective sources. Using the average tax break changes of 0.5 thousand euros in 2003/4 and 0.6 thousand euros in 2006/7 as well as the average overall tax break in 2003 of 2.3 thousand euros, I arrive at an overall effect of the three scenarios of a decline in the average annual

[38]Nickell's result is that in short panels with lagged dependent variables and individual fixed effects the lagged dependent variables are correlated with the component of the observation's error term that is constant over time.

commute of 0.40, 0.47, and 1.82 kilometers, respectively. This is displayed in the first row of table 15.[39] Using the average number of workdays per year, the fact that the above distance is just oneway, and the total number of employees, the effect of the three scenarios of tax break changes on the overall cardistance commuted becomes 6,714, 8,124, and 30,886 million kilometers, respectively. These are 0.98, 1.18, and 4.53 percent of the 690 billion kilometers traveled in the country overall per annum.

In order to compute the estimated fuel savings for the whole economy in terms of liters and money value, I assume that every commuter goes to work by (gasoline engine) car by herself. The estimates in the following should thus be interpreted as an upper bound, since going by car is known to be the most fuel-intensive and CO2 emitting transport mode.[40] Using the data on the average fuel consumption and the fuel price in the respective years from table 14, the amount of fuel saved becomes 537, 626, and 2,471 million liters, and 577, 793, and 2,654 million euros, respectively (see table 15). Overall, the country-wide fuel usage in the transport sector is 48 billion liters per year, hence a full abolition of commuter tax breaks in 2003/04 would have reduced fuel usage in the transport sector by up to 5.2%.

These savings in fuel consumption also have an effect on the emission of greenhouse gases, notably CO2. Burning one liter of gasoline generates about 2.32 kilogram of carbon dioxide, hence the tax break changes reduce emissions by an estimated 1.25, 1.45, and 5.73 tonnes. Using data on European Union emission rights trading between firms, the market would price this at "only" 12.96, 9.36, and 59.62 Mio euros of environmental savings.[41] In terms of overall emissions in passenger traffic, the tax breaks lead to an emission reduction of 0.74, 0.94, and 3.39 percent, respectively.

While the impact of the tax break change on kilometers traveled, fuel burnt, and greenhouse gases emitted seems unambiguously positive, its expansionary effect on

[39] Note that there is no incentive for an "intensive margin" of adjustment (apart from an income effect), since the tax breaks are independent of transport modes, car sharing, or the actual distance traveled per journey.

[40] Yet, note that this assumption is in fact not very extreme since about two thirds of all commuters use the car (Grau 2009).

[41] There is widespread criticism claiming that the practice of allocating a large number of emission rights to firms for free leads to a too low price for the emission rights. Therefore, the above numbers might severely underestimate the true social benefits from the carbon emissions reduction.

the tax base may be good news for the exchequer but not for the taxpayer. Using the respective formulae to calculate the tax breaks before and after the changes in 2003/04 and 2006/07, the first row in table 16 provides the average per person reduction for the old cardistance, i.e. without taking into account individuals' reaction to the change. As individuals switch their workplace and residence closer together, the claimable tax breaks decrease even further or, to put it from the exchequer's perspective, the tax base rises even further. Row two of the table displays this effect.[42] Overall, the tax base per year increases by 21, 26, and 98 billion euros, respectively, helped by individuals' behavioral responses of moving residence and job location in order to reduce commuting distances. This is a substantial amount and assuming that the average marginal income tax rate is around 30 percent, it provides the government with additional tax revenues of 6.3, 7.8, and 27 billion euros, respectively.[43]

Conservative commentators and politicians have argued for a long time that the commuter tax breaks serve the purpose of supporting and preserving life on the countryside. Indeed, the results in table 11 show that the tax break changes make individuals more likely to move from rural areas to urban areas more than they make them engage in the opposite move. Yet, the concentration effect is only 0.1 percent per 1000 euros tax break change. Thus, even tax breaks' hypothetical full abolition in 2003/04 would have increased the likeliness to move from the countryside to a city of more than 100,000 inhabitants by just 0.23 percentage points temporarily. This effect can hardly be termed as "landflight".

Despite all the positive effects on the environment and travel expenses that the reduction in tax breaks seemed to have, I cannot make a normative statement whether it was "beneficial". In fact there is a sound economic justification for the commuter tax breaks:

Suppose that one can split up the overall utility $u(r, w)$ from a each job-residence

[42] In order not to have to deal with the exact distribution of cardistances for the 2006/07 change, I assume that all the individuals are in fact able to claim positive tax breaks for every kilometer, i.e. I ignore the 20km with zero tax breaks. Therefore, the estimated effect again should be considered an upper bound of the true effect.

[43] In addition to the changing commuting distances, wages might respond to in general equilibrium which would affect tax revenues. The direction and the extent of such an effect is hard to assess without putting a lot of specific structure on the problem, however, and from which I refrain.

match into all other benefits $b(r, w)$ and commuting costs $c(r, w)$. It is then efficient for every individual to choose

$$u(r^*, w^*) = b(r^*, w^*) - c(r^*, w^*) = max\{u(r_j, w_k)\}$$

for all j, k. If proportional income taxation is used, in order not to distort the choice of efficient job-residence matches, the tax rate should be applied to the commuting costs as well, i.e. $(1 - t)[b(r, w) - c(r, w)]$. Individuals should thus be allowed to deduct the exact commuting costs from their gross taxable income. More generally, in order to preserve efficient matches, proportional income taxation should only be applied to the "rent" from these matches.

If it is very costly and subject to fraud to have each individual prove their exact commuting costs to the tax authorities, a tax break that reflects the average costs per kilometer traveled may be a second best solution to this problem, i.e. $TB(\overline{rw}) = avg[c(r, w)]$.[44] This is the rationale for the introduction of the commuting tax breaks in the first place. The full abolition of commuting tax breaks in 2003/04 might therefore seem attractive from an environmental, travel expenses, and tax revenues point of view, but it might have distorted efficient matching in the housing and the labor market.[45][46]

[44] Although Knittel and Sandler (2013)'s results suggest that using such a proxy is fraught with error.

[45] Note that if the individual's costs $c(r, w)$ do not reflect society's cost from commuting - which is likely the case - there is a rationale for bringing $c(r, w)$ to its efficient level trough taxation.

[46] There exists a crude test whether the original tax breaks were higher than the actual commuting costs per kilometer: if $TB(\overline{rw}) > avg[c(r, w)]$, the chosen distances would have been inefficiently long. Hence, a reduction in tax breaks would increase $b(r^*, w^*) - c(r^*, w^*)$. If we think of $b(r^*, w^*)$ as mainly the wage and note that $-c(r^*, w^*)$ always increases because of the decreasing commuting distance, an increasing wage as a response to an increase in tax breaks would constitute evidence that the tax breaks were too high initially. In unreported regressions I find that there is no clear effect on wages. Thus there is no strong evidence for too high commuter tax breaks in the first place.

6 Conclusion

This paper has shown that individuals switch job or move residence in order to reduce their commuting distance when the costs of commuting rise. It has also provided strong evidence that higher commuting costs strengthen forces of population concentration, which is a core result from standard theory in urban economics and in economic geography. However, concentration is just a small part of the overall adjustment in terms of individuals' residence location and there is no evidence for job concentration. This is interesting because another margin of adjustment that has not received much attention in the urban and geography literature seems to account for the majority of the reaction - namely that individuals change the occupation of existing jobs and houses to reduce commuting distances. I term this margin of adjustment "re-matching".

The analysis has ignored some potentially important factors that were beyond the scope of the paper. Most importantly, no broadly encompassing general equilibrium notion of the effects was developed apart from a preliminary analysis of the effect on relative housing supply and property prices. For example, one could have argued that the tax break changes and the resulting lower cardistances might also have an effect on fuel prices and even wage rates, which in turn affects individuals' location decisions. Moreover, in the theoretical part I focused entirely on the substitution effect of increases in relative prices whereas the policy change may also have heterogeneous income effects for every individual in the data.[47]

Naturally, the question arises whether results from the specific experiment exploited in this paper can be generalized to other contexts. Germany is a decentralized and densely populated country.[48] The fact that many employees can choose between jobs in different employment centers may favor the re-matching effect over the concentration effect - compared to centralized countries like France or the United Kingdom. It may also favor the re-matching effect compared to a large country like the United

[47]For example, the Fujita (1989) book assumes positive income effects on commuting distance, i.e. that wealthier households prefer to locate farther away from the urban center.

[48]When comparing it with other developed countries it also seems to have an efficient public and private transport infrastructure but an underdeveloped housing market.

States, where switching employment between different urban areas while residing at the same place seems less feasible. For cultural and institutional reasons, Germans are generally less mobile than Americans in the labor market as well as in the housing market. Therefore, and because of the greater distances involved, one might expect the overall adjustment to a given change in commuting costs on distances between home and work to be even larger in the United States than in Germany.

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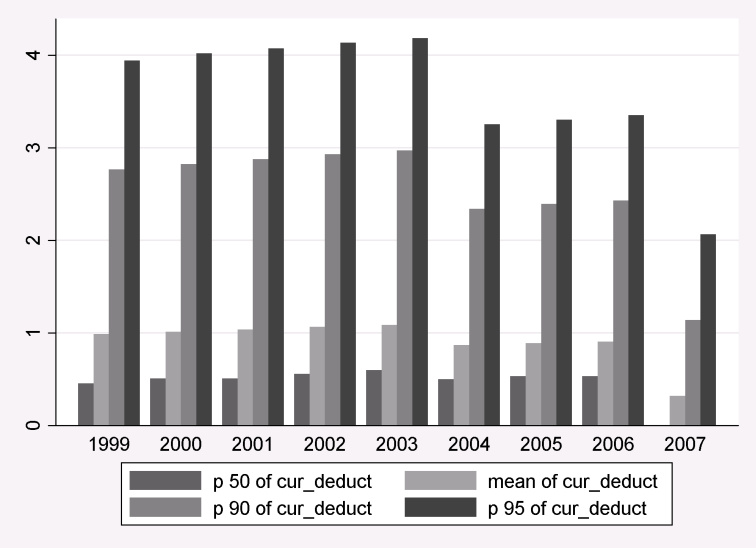
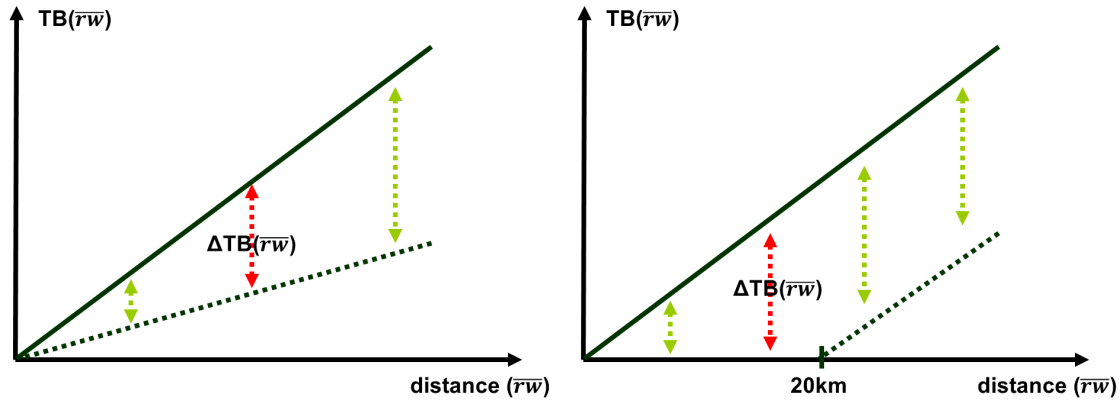
Figure 1: The Commuter Tax Break Distribution Over the Years



Note.—The figure depicts the median, mean, 90th, and 95th percentile of the tax break distribution in thousand euros over the sample years.

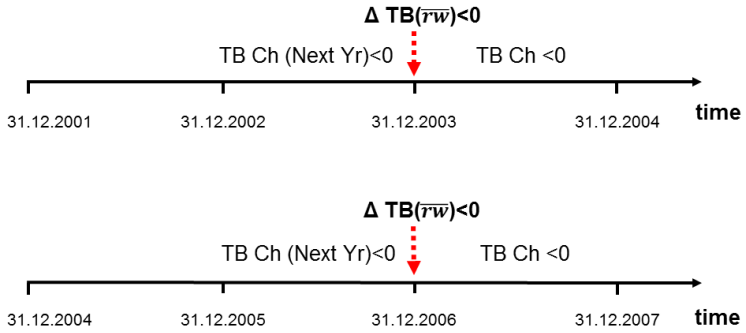
Figure 2: Tax Break Reductions and the Resulting Changes in the Relative Attractiveness of Commuting Distances

(a) Policy change in 2003/4 (b) Policy change in 2006/7



Note.—The figures illustrate the decline in the tax breaks by cardistance $\overline{rw}$ for the 2003/4 (left) and the 2006/7 (right) change.

Figure 3: The Timing of the Explanatory Variables



Note.—The figure depicts when the explanatory variables TB Ch and TB Ch (Next Yr) may assume values different from zero. TB Ch is negative for individuals observed in the fourth quarter of 2004 and 2007 who had work-residence combinations in the fourth quarter of 2003 and 2006, respectively, that featured a non-zero commuting distance. TB Ch (Next Yr) is negative for individuals observed in the fourth quarter of 2003 and 2006 who had work-residence combinations in the fourth quarter of 2002 and 2005, respectively, that featured a non-zero commuting distance.

Figure 4: Relative Property Prices over Time

Note.—The figures depicts the time series of relative price indices for new and old flats (left) and houses (right) in big and medium cities versus the overall index.

Table 1: Summary Statistics per Individual

	count	mean	p10	p25	p50	p75	p90
Years in Sample	942746	7.0	2.0	4.0	8.0	10.0	10.0
Work Switch	942746	0.9	0.0	0.0	0.0	1.0	3.0
Residence Switch	942746	0.7	0.0	0.0	0.0	1.0	2.0
Age (Years)	930122	38.5	20.0	27.0	38.0	48.9	57.5
Female	942746	0.4	0.0	0.0	0.0	1.0	1.0
Monthly Wage (euro)	914878	1703.8	297.0	660.5	1488.4	2475.1	3505.7
Cardistance (km)	911373	28.2	0.0	0.0	9.0	23.7	64.0
Urban Workplace	930122	0.5	0.0	0.0	0.3	1.0	1.0
Urban Residence	925221	0.4	0.0	0.0	0.0	1.0	1.0
Observations	942746						

Note.—The table reports means and quantiles for the number of years individuals are in the sample and the number of work- and residence switches they made during that time (the first three variables). For the remainder of the variables it reports means and quantiles in the fourth quarter of each person-year in the sample (1999-2007).

Table 2: Summary of Municipalities by Residence Numbers

	count	mean	p10	p25	p50	p75	p90
Number of Residents	12585	53.6	2.0	4.0	11.0	33.0	92.0
Number of Connections	12585	48.1	2.0	4.0	11.0	33.0	92.0
Observations	12585						

Note.—The table summarizes the distribution of the number of residents in the dataset (i.e. about two percent of the actual number of residents) for municipalities that report at least one resident in the year 2002. It also provides the distribution of the number of different employment municipalities in the data that these persons commute to.

Table 3: Summary of Municipalities by Employment Numbers

	count	mean	p10	p25	p50	p75	p90
Number of Employees	10451	64.5	1.0	2.0	8.0	29.0	92.0
Number of Connections	10451	58.0	1.0	2.0	8.0	28.0	92.0
Observations	10451						

Note.—The table summarizes the distribution of the number of employees in the dataset (i.e. about two percent of the actual number of employees) for municipalities that report at least one employee in the year 2002. It also provides the distribution of the number of different residence municipalities in the data that these persons commute from.

Table 4: Summary of Cardistance and Tax Breaks in 2002

	count	mean	p25	p50	p75	p90	p95
Cardistance (Last Year)	545486	25.8	0.0	6.4	19.6	45.4	105.0
Tax Break (Last Year)	545486	2.2	0.0	0.5	1.6	3.9	9.1
Tax Break (Change)	545486	0.0	0.0	0.0	0.0	0.0	0.0
Cardistance (Change)	516699	-0.2	0.0	0.0	0.0	0.0	7.0
Cardistance (Change) if Switch	61698	-1.5	-16.8	1.5	18.6	73.1	197.2
Observations	545486						

Note.—(Last Year) refers to the fourth quarter of the previous year, i.e. approximately the beginning of the year considered. (Change) refers to the change during the considered year, i.e. between the fourth quarter of the previous year and the fourth quarter in the current year. Cardistances are in kilometers and tax breaks in thousand euros.

Table 5: Summary of Cardistance and Tax Breaks in 2004

	count	mean	p25	p50	p75	p90	p95
Cardistance (Last Year)	544465	26.2	0.0	7.0	20.6	46.5	105.0
Tax Break (Last Year)	544465	2.3	0.0	0.6	1.7	4.0	9.1
Tax Break (Change)	544465	0.5	0.0	0.1	0.4	0.9	2.2
Cardistance (Change)	516456	0.3	0.0	0.0	0.0	0.0	5.7
Cardistance (Change) if Switch	56299	2.9	-15.9	2.8	20.3	80.2	217.5
Observations	544465						

Note.—(Last Year) refers to the fourth quarter of the previous year, i.e. approximately the beginning of the year considered. (Change) refers to the change during the considered year, i.e. between the fourth quarter of the previous year and the fourth quarter in the current year. Cardistances are in kilometers and tax breaks in thousand euros.

Table 6: Summary of Cardistance and Tax Breaks in 2007

	count	mean	p25	p50	p75	p90	p95
Cardistance (Last Year)	552369	27.9	0.0	7.6	21.8	49.9	116.6
Tax Break (Last Year)	552369	1.8	0.0	0.5	1.4	3.3	7.7
Tax Break (Change)	552369	0.6	0.0	0.5	1.3	1.3	1.3
Cardistance (Change)	533305	0.4	0.0	0.0	0.0	0.0	7.4
Cardistance (Change) if Switch	63302	3.0	-18.1	1.6	20.8	86.0	235.3
Observations	552369						

Note.—(Last Year) refers to the fourth quarter of the previous year, i.e. approximately the beginning of the year considered. (Change) refers to the change during the considered year, i.e. between the fourth quarter of the previous year and the fourth quarter in the current year. Cardistances are in kilometers and tax breaks in thousand euros.

Table 7: Summary of Switches in 2002.

	count	mean
Work Switch	622461	0.149
Residence Switch	622461	0.121
Any Switch	622461	0.184
Closer Switch	516699	0.056
Work Switch Urban	544112	0.014
Work Switch Rural	544112	0.014
Residence Switch Urban	540988	0.008
Residence Switch Rural	540988	0.008
Observations	622461	

Table 8: Main Regressions using Municipality Combination Fixed Effects as Controls

	(1) Work	(2) Res	(3) Work or Res	(4) Closer
TB Ch (Next Yr)	0.004***	0.002**	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.002)
TB Ch	0.003***	0.002**	0.004***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Petrol Cost Ch (Next Yr)	0.019*	-0.028***	0.000	0.002
	(0.011)	(0.005)	(0.013)	(0.015)
Petrol Cost Ch	0.027**	-0.001	0.032**	0.033**
	(0.011)	(0.006)	(0.013)	(0.014)
Main Control	Munic FE	Munic FE	Munic FE	Munic FE
Year Dummies	Yes	Yes	Yes	Yes
Observations	4504185	4504185	4504185	4498019

Note.—The table reports regression results of the *Work Switch*, the *Residence Switch*, the *Any Switch*, and the *Closer Switch* indicators in columns 1-4, respectively, on tax break changes that apply to last year's work-residence combination at the last turn of the year ("TB Ch") and the coming turn of the year ("TB Ch (Next Yr)"). Controls are average petrol cost changes between these years and not reported dummies for age quartiles, income quartiles, plant size quartiles, and the individual's position in the job. Moreover, year fixed effects and municipality combination fixed effects are included. Standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 9: Main Regr. using Individual-Municipality Combination FE as Controls

	(1) Work	(2) Res	(3) Work or Res	(4) Closer
TB Ch (Next Yr)	0.003***	0.002**	0.004***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
TB Ch	0.007***	0.003**	0.009***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)
Petrol Cost Ch (Next Yr)	-0.047***	-0.028***	-0.062***	-0.046***
	(0.006)	(0.005)	(0.006)	(0.014)
Petrol Cost Ch	-0.013*	-0.009	-0.011	0.004
	(0.007)	(0.007)	(0.007)	(0.013)
Main Control	Mu*Ind FE	Mu*Ind FE	Mu*Ind FE	Mu*Ind FE
Year Dummies	Yes	Yes	Yes	Yes
Observations	4504185	4504185	4504185	4498019

Note.—The table reports regression results of the *Work Switch*, the *Residence Switch*, the *Any Switch*, and the *Closer Switch* indicators in columns 1-4, respectively, on tax break changes that apply to last year's work-residence combination at the last turn of the year ("TB Ch") and the coming turn of the year ("TB Ch (Next Yr)"). Controls are average petrol cost changes between these years and not reported dummies for age quartiles, income quartiles, plant size quartiles, and the individual's position in the job. Moreover, year fixed effects and individual-municipality combination fixed effects are included. Standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 10: Main Regressions using the Cardistance as Control

	(1) Work	(2) Res	(3) Work or Res	(4) Closer
TB Ch (Next Yr)	0.005***	0.001**	0.006***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
TB Ch	0.003***	0.002***	0.005***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Petrol Cost Ch (Next Yr)	0.016***	-0.051***	-0.021***	-0.031***
	(0.004)	(0.003)	(0.004)	(0.003)
Petrol Cost Ch	0.014***	-0.012***	0.010**	0.006**
	(0.004)	(0.004)	(0.004)	(0.002)
Main Control	Cardist	Cardist	Cardist	Cardist
Year Dummies	Yes	Yes	Yes	Yes
Observations	4504185	4504185	4504185	4498019

Note.—The table reports regression results of the *Work Switch*, the *Residence Switch*, the *Any Switch*, and the *Closer Switch* indicators in columns 1-4, respectively, on tax break changes that apply to last year's work-residence combination at the last turn of the year ("TB Ch") and the coming turn of the year ("TB Ch (Next Yr)"). Controls are average petrol cost changes between these years and not reported dummies for age quartiles, income quartiles, plant size quartiles, and the individual's position in the job. Moreover, year fixed effects and the cardistance are included. Standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 11: Urban-Rural Switch Regressions using Municipality-Combination Fixed Effects as Controls

	(1)	(2)	(3)	(4)
	Work Urb	Work Rur	Res Urb	Res Rur
TB Ch (Next Yr)	0.001***	0.001***	0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch	0.001***	0.001**	0.001***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Petrol Cost Ch (Next Yr)	0.002	0.007**	-0.005***	-0.005***
	(0.002)	(0.003)	(0.001)	(0.001)
Petrol Cost Ch	0.005***	0.009***	0.001	-0.001
	(0.002)	(0.003)	(0.001)	(0.001)
Main Control	Munic FE	Munic FE	Munic FE	Munic FE
Year Dummies	Yes	Yes	Yes	Yes
Observations	4504175	4504175	4502743	4502743

Note.—The table reports regression results of the *Work Switch Urban*, the *Work Switch Rural*, the *Residence Switch Urban*, and the *Residence Switch Rural* indicators in columns 1-4, respectively, on tax break changes that apply to last year's work-residence combination at the last turn of the year ("TB Ch") and the coming turn of the year ("TB Ch (Next Yr)"). Controls are average petrol cost changes between these years and not reported dummies for age quartiles, income quartiles, plant size quartiles, and the individual's position in the job. Moreover, year fixed effects and municipality combination fixed effects are included. Standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 12: Quarterly Regressions using Municipality-Combination Fixed Effects as Controls

	(1) Work	(2) Res	(3) Work or Res	(4) Closer
TB Ch Q1 (Next Yr)	0.001***	0.001***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q2 (Next Yr)	-0.001***	0.001***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q3 (Next Yr)	0.002***	0.000*	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q4 (Next Yr)	0.001***	0.001***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q1	0.001***	0.001***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q2	-0.001***	0.001***	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q3	0.003***	0.001***	0.004***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q4	0.000**	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
TB Ch Q1 (Last Yr)	0.000	0.002*	0.003***	0.004***
	(0.001)	(0.001)	(0.001)	(0.000)
TB Ch Q2 (Last Yr)	0.003**	0.007***	0.010***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
TB Ch Q3 (Last Yr)	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.000)
TB Ch Q4 (Last Yr)	-0.002**	-0.001	-0.002	-0.001*
	(0.001)	(0.001)	(0.001)	(0.000)
Petrol Cost Ch (Next Yr)	0.002	-0.009***	-0.006	-0.003
	(0.003)	(0.002)	(0.005)	(0.005)
Petrol Cost Ch	0.005*	-0.004***	0.001	0.003
	(0.003)	(0.001)	(0.004)	(0.004)
Main Control	Munic FE	Munic FE	Munic FE	Munic FE
Year Dummies	Yes	Yes	Yes	Yes
Observations	18327603	18327603	18327603	18319705

Note.—The table reports regression results of the *Work Switch*, the *Residence Switch*, the *Any Switch*, and the *Closer Switch* indicators at a quarterly frequency in columns 1-4, respectively, on tax break changes that apply to last quarter's work-residence combination at the last turn of the year ("TB Ch"), the previous to last turn of the year, and the coming turn of the year ("TB Ch (Next Yr)"). Controls are average petrol cost changes between the years and not reported dummies for age quartiles, income quartiles, plant size quartiles, and the individual's position in the job. Moreover, year fixed effects and municipality combination fixed effects are included. Standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 13: Regr. on Cardistance using Municipality-Combination FE as Controls

	(1)	(2)	(3)	(4)
TB Ch (Next Yr)	-0.294	-0.236	-4.647***	-4.159***
	(0.206)	(0.224)	(1.052)	(0.970)
TB Ch	-0.494**	-0.373*	-4.472***	-4.323***
	(0.203)	(0.222)	(0.897)	(0.884)
Petrol Cost Ch (Next Yr)	8.861***	8.905***	-20.340**	-19.512**
	(1.560)	(1.554)	(9.304)	(9.055)
Petrol Cost Ch	-0.287	-0.111	-18.950**	-18.088**
	(1.431)	(1.417)	(8.307)	(7.944)
TB Ch 0607 (Next Yr)		-0.558**		-7.140***
		(0.242)		(2.590)
TB Ch 0607		-1.074***		-3.228
		(0.245)		(2.974)
Main Control	Munic FE	Munic FE	Munic FE	Munic FE
Sample	Full	Full	Only Switches	Only Switches
Year Dummies	Yes	Yes	Yes	Yes
Observations	4498019	4498019	535783	535783

Note.—The table reports regression results of the cardistance on tax break changes that apply to last year's work-residence combination at the last turn of the year ("TB Ch") and the coming turn of the year ("TB Ch (Next Yr)"). Compared to the first column, the second column distinguishes between the tax break changes in 2003/4 and those in 2006/7 while the third and fourth column examine the change in cardistance conditioning on the event that a switch takes place. Controls are as in the previous tables and standard errors in parentheses: * p<0.1, ** p<0.05, *** p<0.01.

Table 14: Information and Sources for the Policy Effect Calculations

Variable	2003/04	2006/07	Source
Employees (in mio)	38.63	39.00	destatis.de
Workdays per year	220	220	Schulze (2009)
Avg fuel usage (liters per km)	0.080	0.077	autopresse.de
Fuel price (euro per liter, yearly average)	1.07	1.27	mwv.de
CO2 emissions (in kg per liter of petrol)	2.32	2.32	de.wikipedia.org
CO2 price (in euro per tonne)	10.40	6.45	eex.com
Overall CO2 emissions (in mio tonnes p.a.)	889	867	umweltbundesamt.de
Fraction of CO2 emission in traffic	0.19	0.18	umweltbundesamt.de
Overall fuel usage in traffic (bio liters p.a.)	48	47	umweltbundesamt.de
Overall person road travel (bio km p.a.)	682	687	umweltbundesamt.de
Avg cardist	26.20	27.90	iab data
Tax break rate before	0.40	0.30	iab data
Tax break rate after (<20km)	0.30	0.00	iab data
Tax break rate after (>20km)	0.30	0.30	iab data
Avg tax break (tsd euro p.a.)	2.30	1.80	iab data
Avg tax break change (tsd euro p.a.)	-0.50	-0.60	iab data
Estimated effect of tax break change on cardist (in km)	0.79	0.79	iab data

Table 15: Estimated Effect on Cardistance, Fuel Usage, and CO2 Emissions

	2003/04	2006/07	full abolition
p.p. cardistance reduction (in km)	0.40	0.47	1.82
Reduction overall distance (mio km)	6,714	8,124	30,886
Reduction overall distance (in % of person road travel)	0.98	1.18	4.53
Fuel savings (in mio liters)	537	626	2,471
Fuel cost savings (in mio euro)	577	793	2,654
Fuel savings (in % of fuel usage)	1.12	1.33	5.15
CO2 emissions reduction (in mio tonnes)	1.25	1.45	5.73
CO2 emissions reduction (in mio euro)	12.96	9.36	59.62
CO2 emissions reduction (in % of traffic emissions)	0.74	0.94	3.39

Table 16: Estimated Effect on the Tax Base

	2003/04	2006/07	full abolition
Avg tax break reduction for original cardist (tsd euro p.a.)	0.50	0.60	2.30
Tax break reduction due to cardist change (tsd euro p.a.)	0.052	0.062	0.240
Overall increase in tax base (bio euro p.a.)	21	26	98

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