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Abstract:

Germany like many other European countries subsidize commuting by granting the right to deduct commuting expenses from the income tax base. This regulation has often been changed and has regularly been under debate during the last decades. The pros (e.g. causing efficiency gains with respect to the spatial allocation of labor) and cons (e.g. causing urban sprawl) are well documented. Nonetheless, there is need for further research. For reasons of tractability the few models applied in the tax deduction related literature are based on restrictive assumptions particularly concerning the design of the income taxation scheme and the structure of households (neglecting household heterogeneity) and, most importantly, they do not integrate labor supply and location decision problems simultaneously. Here, for the first time, those and more features are taken into account in a full spatial general equilibrium simulation approach calibrated to an average German city. This model is applied to calculate the impacts of tax deductions on an urban economy thereby considering different funding schemes. Our results suggest that the tax deduction level currently chosen is below the optimal level in the case of income tax funding. If a change in the tax base occurs, e.g. toward consumption tax or energy tax funding, the optimal size of the subsidy should be even higher. Furthermore, the different policy packages cause a very differentiated pattern regarding welfare distribution, environmental (CO_2 emissions) and congestion effects. We also find surprisingly small effects on urban sprawl characterized by suburbanization of residences and jobs, increasing commuting distances and spatial city growth.

1 Introduction

Commuting expenses reduce the income tax liability in many European countries, in particular in Belgium, Denmark, Finland, France, Germany,[1] Luxembourg, the Netherlands, Norway and Switzerland (see Potter et al., 2006). In Germany this regulation has often been changed and has been under debate for decades.

Advocates of income tax deductions[2] emphasize that they reduce distortions concerning individual labor supply (Wrede, 2000; Wrede, 2001; Sinn, 2003), eliminate spatial misallocations in particular concerning working location decisions (Gasche, 2006; Wrede, 2009), or improve aggregate productivity if it is spatially differentiated (Wrede, 2009, Borck and Wrede, 2009). In contrast, objections against tax deductions arise (i) since commuting subsidies might induce negative externalities and, thus, constitute a 'bad' (Richter, 2006), (ii) for reasons of equity because high-income households benefit the most (e.g. Kloas and Kuhfeld, 2003), (iii) because it discriminates in favor of commuters who can avoid high rents in central cities but at the same time benefit from subsidized living at low-rent suburbs (Wrede, 2004; DIW, 2008), or (iv) since costs arising on account of privately caused decisions concerning commuting should not be subsidized (Gasche, 2004; Wrede, 2004; Richter, 2004; Richter, 2006).

Richter (2004) shows clearly that the issue whether commuting expenses should be tax deductible depends on whether it is privately or occupationally caused. They should be deductible only in the latter case because they are indispensable for earning income and, thus, should be exempted from the income tax base. This so called net-principle is the main reasoning in favor of tax deductions in Germany. The German Advisory Board for Economic Development (SVR, 2003) suggests that about 50% of the tax deduction is occupational caused. Wrede (2004) considers a deduction rate of slightly less than the current rate of $0.30 \, \text{\euro}/\text{km}$ as optimal. Bach (2003), Bach et al. (2007), Donges et al. (2008), Schulze (2009) argue in favor of a reduction of deductibility. In contrast, Richter (2004) takes his presumption that employer do not pay higher wages for commuters as evidence that commuting is almost entirely privately caused and, therefore, should not be tax deductible at all.

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[1] For example in Germany income tax deduction of commuting expenses caused total income tax savings (or governmental income tax losses) of commuters of about 4 billion $\text{\euro}$ in 2006 (Bach et al., 2007).
[2] In the following we only use the term 'tax deduction'.

This short review shows that the pros and cons are well known. However, the urban/transport economics literature lacks in quantitative studies analyzing economic and spatial effects regarding tax deductibility of commuting expenses. Even in technical papers employing modeling approaches (Wrede, 2001; Wrede, 2009) the optimal size of the deductions is debatable because it depends on the specific features (not) implemented in the theoretical models. Therefore, optimal deduction rates are not yet fully derived since the different lines of reasoning are yet not integrated in one unified approach. For example, the models used in the literature do not simultaneously implement spatial location and labor supply decisions along with distortionary taxation because such an approach is not analytically solvable. Moreover, the models rely on restrictive assumptions concerning the design of the income taxation scheme and the structure of households living in the urban area (they usually neglect household heterogeneity). Consequently, it is not at all clear how efficiency effects concerning residential and employment location distortions, labor supply distortions, effects on externalities such as congestion, or effects on travel mode choice and on welfare distribution behave if all those features are simultaneously considered. This is a serious gap in the debate because the consequences of not integrating these important features are not clear in advance.[3] Would this either imply a lower or a higher deduction rate than the current level? Is there a strong effect on urban sprawl and the environment, e.g., characterized by changes in travel related CO_2 emissions?

This is our point of departure. We – to the best of our knowledge for the first time – apply a spatial general equilibrium model calibrated to an average German metropolitan area to analyze the impacts of commuting subsidies characterized by tax deduction. Our focus is on the optimal tax deduction rate and the impact of varying the deduction rate on the urban economy. In addition, we go a step further in comparison to the literature where it is usually assumed that subsidies are either financed by lump-sum or income taxes. This might be useful from a systematic point of view. Nonetheless, if policymakers adjust taxes it is more appropriate to consider taxes which are less distortionary than an income tax. This is the reason why we implement revenue neutral tax reforms where we look at

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[3]Of course, there is a large body of literature on transport subsidies in general (see e.g. De Borger and Wuyts, 2009; Parry and Small, 2009; Borck and Wrede, 2009; Su and DeSalvo, 2008; Borck and Wrede, 2008; Brueckner, 2005; Borck and Wrede, 2005; van Dender, 2003; Calthrop, 2001; Martin, 2001; Zenou, 2000) applying either non-spatial or spatial approaches. Tscharaktschiew and Hirte (2011) provide a review of the corresponding literature and summarize the main findings. Nonetheless, except for Tscharaktschiew and Hirte (2011), all these papers neglect the simultaneous consideration of these features and there is no corresponding study focusing on income tax deduction of commuting expenses.

different taxes used to finance tax deductions of commuting expenses. In particular, the following funding schemes are considered: income tax, sales tax and energy tax[4] funding. This allows to consider a wide range of differentiated funding related effects. For example, funding tax deduction by sales or energy taxes also implies an increase in shopping trip costs, i.e. the costs of non productive time use while in particular energy tax funding may also induce changes in travel mode choice.

The model we apply is a numerical spatial polycentric city model in the tradition of Anas and Xu (1999), Anas and Rhee (2006; 2007) and had been extended by Tscharaktschiew and Hirte (2010a, 2010b) in different ways. In the model residential, employment and shopping location decisions as well as labor supply decisions are endogenous. Moreover, the approach takes household heterogeneity, progressive income taxation, travel mode choice and endogenous automobile congestion, gasoline consumption and CO_2 emissions into account. These features have never been simultaneously treated in a spatial economic model when studying tax deduction of commuting expenses.

Our results suggest that the current level of the tax deduction rate is about one third of the optimal level if it is financed by income taxes. Then, the optimal deduction rate were, on the one hand, about the same size as monetary round-trip commuting cost but, on the other hand, still considerably smaller than full economic (incl. time cost) round-trip commuting cost. If, however, a change in the tax base occurs the subsidy should be considerably higher. With respect to urban welfare and environmental effects the combination of an increase in tax deductibility with energy tax funding turns out to be the best policy. In this case there is a significant decline in the congestion externality and in travel related CO_2 emissions. Furthermore, the different funding scheme cause heterogeneous redistribution effects. Surprisingly, the analyses also suggest quite small impacts on urban sprawl. According to these findings, tax deduction of commuting expenses contributes only to a minor extent to suburbanization.

The paper proceeds as follows: the next section provides a short theoretical discussion of the efficiency aspect of tax deductions under different funding schemes. In Section 3 we describe the simulation model. In Section 4 we display and discuss the main results of the commuting subsidization policies. Eventually, in Section 5 we draw some conclusions.

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[4]In Germany energy taxes encompass a gasoline tax and an eco-tax component. >From a resident's perspective both components are institutionally identical. Therefore, they are considered together as energy tax. We further do not consider lump-sum tax funding (see Tscharaktschiew and Hirte, 2011).

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2 Theoretical Background

In the following we discuss a worker's decisions in a stylized urban setting. This shows that tax deductions of commuting expenses may distort a worker's non-spatial as well as spatial decisions and how the results might be affected by the differentiated funding schemes considered. This also provides a basis for discussing the efficiency effects in the full-fledged spatial model of the urban economy employed in the simulation.

2.1 A Simple Spatial Model to Illustrate Basic Effects

The city we have in mind is monocentric concerning shopping activities, i.e. there is a Central Shopping District (CSD), but not with respect to housing and employment. The place of residence (employment) is defined by its distance from the CSD, denoted by $x\,(y)$. We assume, for the time being, that $y \leq x$. Accordingly, commuting distance is denoted by $X = x - y$. Each identical worker chooses the number of shopping trips z, which is equivalent to the level of consumption, housing consumption q and leisure ℓ, the residential location x as well as the working location y to maximize utility $u = u\,(z, q, \ell)$ subject to a monetary budget and a time constraint. The budget constraint is

$$(p + cx)\,z + r\,(x)\,q = [(1 - \tau^m)\,w(y)L - CX + \tau^m \delta X]\,D. \tag{1}$$

It states that expenditures for shopping (incl. shopping trip cost) and housing equal (labor) income net of taxes and commuting costs plus tax deductions of commuting expenses. The monetary cost of each shopping trip is $p + cx$ where p denotes the mill price of the composite consumption good and c denotes monetary travel cost per round-trip shopping kilometer. The price of housing per square meter and period is $r\,(x)$. The daily net return to labor $(1 - \tau^m)\,w(y)L$ is the after tax wage where the hourly wage rate $w\,(y)$ might differ according to the location of the workplace; τ^m is the marginal wage tax rate; and L is the fix number of working hours per workday. C denotes monetary commuting cost per round-trip kilometer; δ is the tax deduction rate of commuting expenses; and D is the number of workdays (working shifts).

The time constraint is

$$(L + TX)\,D + txz + \ell = E. \tag{2}$$

The time endowment E is used for working, commuting, shopping trips and leisure. T

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and t denote travel time per round-trip kilometer required for commuting and shopping, respectively. The consolidated full economic budget constraint then is

$$(p + cx + \theta tx)\, z + r\,(x)\, q + \theta \ell = \theta E, \tag{3}$$

where

$$\theta = \frac{(1 - \tau^m)\, w(y)L - CX + \tau^m \delta X}{L + TX} \tag{4}$$

is the value of time (VOT) of the representative urban worker.

Differentiating utility subject to Eq. (3) with respect to z, q, ℓ, y and x yields the first-order conditions (FOC) for the optimal decisions with respect to the non-spatial variables z, q and ℓ

$$\frac{u_\ell}{u_z} = \frac{\theta}{p + cx + \theta tx} \qquad \frac{u_\ell}{u_q} = \frac{\theta}{r\,(x)}, \tag{5}$$

as well as the first-order conditions for the optimal spatial location decisions encompassing the working location choice (provided $D > 0$)

$$(1 - \tau^m)\, w'\,(y)\, L = -\,(C + \theta T - \tau^m \delta) \tag{6}$$

and the condition for the optimal residential location (slope of the bid-rent curve)

$$r'\,(x) = -\frac{(c + \theta t)\, z}{q} - \frac{(C + \theta T - \tau^m \delta)\, D}{q}. \tag{7}$$

These conditions show that the income tax, τ^m, distorts all decisions. Deductions can neutralize the effect of the income tax on the VOT if $\delta X = w\,(y)\, L$. While this eliminates the distortions regarding the non-spatial decisions (Eq. (5)) it, however, does not eliminate the distortions concerning the spatial location decisions (Eq. (6)) and (Eq. (7)). As a consequence, there is no optimal subsidy or tax deduction rate eliminating all distortions arising from income taxation.

2.2 The Model with German Institutions

Because further distortionary taxes exist in Germany tax interaction effects and tax revenue recycling effects are important issues (see also Parry and Bento, 2001). Therefore we have to discuss effects of tax deductions simultaneously with other taxes which might

be used to finance the commuting subsidy. In the following we extend the previous model by adding German consumption taxes and energy taxes and take different travel modes, m, into account.

In Germany energy taxes are levied with amount τ^f per unit of gasoline consumed. Gasoline consumption per round-trip kilometer of shopping and commuting, respectively, are denoted by $f(m)$ and $F(m)$ where individual demand depends on the travel mode m used for the corresponding trip purpose.

The tax on general consumption and on the energy tax liability, τ^z, as well as on other monetary travel expenditures (services), $\tau^p(m)$, are distinguished because travel expenditures might be subject to a lower sales tax rate depending on travel mode m.[5] The German income taxation scheme is progressive and exactly implemented in the simulation model. For the time being we assume that there is a general tax allowance, A, and, in addition, workers are allowed to deduct δXD from the income tax base, thus the tax liability is $\tau^m(w(y)LD - A - \delta XD)$ Then, the monetary budget constraint turns into

$$\left[(1 + \tau^z)\, p + [1 + \tau^p(m)]\, c(m)x + (1 + \tau^z)\, \tau^f f(m)\, x \right] z + r(x)\, q = \tag{8}$$
$$\left[(1 - \tau^m)\, w(y)L - [1 + \tau^p(m)]\, C(m)X - (1 + \tau^z)\, \tau^f F(m)\, X + \tau^m \delta X \right] D + \tau^m A.$$

The workers time constraint is again Eq. (2). After forming the consolidated full economic budget constraint the corresponding first-order conditions for the worker's choice problem encompass the FOCs concerning non-spatial decisions

$$\frac{u_\ell}{u_z} = \frac{\theta(m)}{p(1 + \tau^z) + \{[1 + \tau^p(m)]\, c(m) + (1 + \tau^z)\, \tau^f f(m) + \theta(m)\, t(m)\}\, x} \tag{9}$$
$$\frac{u_\ell}{u_q} = \frac{\theta(m)}{r(x)} \tag{10}$$

and the FOCs concerning the employment location and residential location decision

$$(1 - \tau^m)\, w'(y)\, L = -[1 + \tau^p(m)]\, C(m) - (1 + \tau^z)\, \tau^f F(m) - \theta(m)\, T(m) + \tau^m \delta. \tag{11}$$

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[5]In Germany the sales tax rate on public transport fares (7% in 2011) differs from that imposed on general consumption and private travel activities (19% in 2011).

$$r'(x) = -\frac{\left[(1+\tau^p)\,c(m) + (1+\tau^z)\,\tau^f f\,(m) + \theta(m)\,t(m)\right] z}{q} \qquad (12)$$
$$-\frac{\left[(1+\tau^p)\,C(m) + (1+\tau^z)\,\tau^f F\,(m) + \theta(m)\,T(m) - \tau^m \delta\right] D}{q},$$

where

$$\theta(m) = \frac{(1-\tau^m)\,w(y)L - \left[(1+\tau^p)\,C(m) + (1+\tau^z)\,\tau^f F\,(m) - \tau^m \delta\right] X}{L + T(m)X} \qquad (13)$$

is the VOT of a worker facing commuting distance X.

Eliminating the distortion in the leisure-housing decision (Eq. (10)) requires deductions to neutralize all taxes in the VOT, hence, $\tau^m \delta X = \tau^m w\,(y)\,L + \tau^p CX + (1+\tau^z)\,\tau^f FX$. This allows neither to eliminate the distortions in the leisure-consumption decision (Eq. (9)), nor to eliminate the distortions in the spatial location decisions (Eq. (12) and Eq. (13)). The FOCs also show that the way deductions are financed is important because each tax enters the FOCs in another way.

2.3 Tax Deductions, Tax Funding and the VOT

Next we focus on the VOT as a crucial variable concerning the workers's individual decisions. The VOT represents the (average) net return from labor as well as the opportunity costs of time. Therefore it provides a link between labor supply and location decisions, two of the features we integrate in our approach. Deriving the impact of a revenue neutral change in the deduction rate on the VOT also requires to consider the effect of the tax instrument used for funding deductions.

Differentiating Eq. (13) with respect to the tax deduction rate (given prices) yields

$$\frac{d\theta}{d\delta} = \underbrace{\frac{\tau^m X}{L + T\,(m)\,X}}_{\text{direct effect}} + \underbrace{\frac{\partial \theta}{\partial \tau^h}\frac{d\tau^h}{d\delta}\bigg|_{\bar{x},\bar{y}}}_{\text{funding effect}} + \underbrace{\frac{\partial \theta}{\partial y}\frac{dy}{d\delta} + \frac{\partial \theta}{\partial x}\frac{dx}{d\delta}}_{\text{relocation effects}}, \qquad (14)$$

where $h \in \{m, z, p, f\}$ denotes the tax used for funding the subsidy. The first term on the right-hand side (RHS) represents the direct effect of a change in the tax deduction rate δ. An increase in δ directly raises the VOT by $\tau^m X/\left[L + T\,(m)\,X\right]$ which is the higher

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the higher the marginal tax rate (the higher the income), and the longer the commuting distance. The second term on the RHS is the funding effect accruing on account of changes in tax rates required to finance tax deductions. The third and fourth term on the RHS comprise relocations of the places of employment and of residence as a response to the change in deductions and the corresponding change in tax rates. We cannot derive the exact effects without simultaneously differentiating the whole system of FOCs. We refrain from doing this and focus on the funding effect in the following.

Calculating the funding effect gives

$$
\frac{\partial \theta}{\partial \tau^h} \frac{d\tau^h}{d\delta}\bigg|_{\bar{x},\bar{y}} = -\frac{1}{L + T(m)X} \times
\begin{cases}
[w(y)L - \delta X]\frac{d\tau^m}{d\delta} & \text{if } d\tau^m \\
\tau^f F(m)X\frac{d\tau^z}{d\delta} & \text{if } d\tau^z \\
C(m)X\frac{d\tau^p}{d\delta} & \text{if } d\tau^p \\
\left[C(m) + \tau^f F(m)\right]X\frac{d\tau^z}{d\delta} & \text{if } d\tau^z,\, \tau^p = \tau^z \\
(1 + \tau^z)F(m)X\frac{d\tau^f}{d\delta} & \text{if } d\tau^f
\end{cases}
\tag{15}
$$

According to Eq. (15) each tax discussed affects the VOT negatively.[6] There is, however, a remarkable difference between income and other taxes. While the funding effect is negative and proportional to commuting distance X for sales tax $(d\tau^z, d\tau^p)$ and energy tax funding $(d\tau^f)$, the impact of the commuting distance in the case of income tax funding $(d\tau^m)$ is positive. The reason for the latter is that tax deductions depend on the marginal income tax rate. As a consequence income tax funding favors longer commuting trips while the other funding schemes punish longer commuting trips. Accordingly, ceteris paribus urban sprawl[7] and congestion are expected to be more pronounced with income tax funding than under other policies. However, with income tax funding there is a further effect, $w(y)L$, independent from commuting distance. This effect lowers the VOT to a relatively large extent compared with the commuting distance dependent effects under the alternative

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[6]For the case of income tax funding this implies assuming $w(y)L - \delta X > 0$.

[7]There is no standardized procedure how to measure urban sprawl. Nechyba and Walsh (2004) point out that a common way to document the presence of urban sprawl is to look first at the evolving relationship of population levels between suburbs and central cities. Anas and Rhee (2006) use changes in the daily average travel time per worker as a measure of sprawl. Ewing et al. (2002) operationalize, or measure, sprawl using several variables that represent different aspects of development patterns (e.g. neighborhood mix of homes, jobs, and services). Brueckner (2000) defines sprawl as excessive spatial growth of cities while Su and DeSalvo (2008) refer to the decentralization of urban population. We measure sprawl as changes in average commuting distance, the spatial expansion of the urban area and the decentralization of employment and residences.

funding schemes. But since a lower VOT discourages labor supply and, in addition, favors slower travel modes such as walking, the effects on urban sprawl, congestion and emissions are in fact ambiguous.

Furthermore, the effects of sales and energy tax funding depend on the travel mode chosen. The higher gasoline usage the stronger the adverse effects on the VOT imposed by energy tax and sales tax funding. This provides an incentive for commuters to diminish these adverse effects by switching to alternative, i.e. less gasoline intensive, travel modes such as walking or public transport. As this lowers emissions and congestion it improves welfare. The magnitude of the funding effect also depends on the degree of change in the respective tax rate. This, in turn, depends on the tax base and the respective behavior of the household, e.g. travel mode choice. Because there is a tax allowance on income, the income tax rate presumably increases more than other tax rates to finance the same change in the deduction rate. This induces stronger efficiency losses in comparison to funding by other than the income tax.

Let us summarize:

- Tax deductions raise the value of time entailing higher labor supply primarily of high-skilled workers. Unfortunately, this is attended with more sprawl, more congestion and higher emissions.

- Tax funding impairs this positive effect on labour supply through lowering the VOT. This, in turn, mitigates the adverse effects of tax deductions on urban sprawl, congestion and emissions.

- Income tax funding rewards long-distance commuting while the other funding schemes sanction longer commuting trips. However, the commuting distance independent part of the funding effect under income tax funding lowers the VOT relatively. As a consequence, the net effect on, e.g., congestion is in fact ambiguous.

- Energy tax funding discriminates against commuting by automobile, sales taxes do it to some degree, too. Hence, both imply less road traffic and, thus, less congestion and emissions.

Having discussed distortions and various effects induced by tax deductions the next step would be to discuss optimal instruments. Because there is no full set of instruments a

second-best issue arises and the optimal subsidy has to be derived in an optimal tax approach. The appropriate approach would be to maximize indirect utility subject to the first-order conditions of the location decisions (reservation wage, Eq. (11), and the slope of the bid-rent, Eq. ((12)), the public budget constraint, resource constraints and conditions concerning local land and local labor markets. Because this cannot be solved analytically without setting additional restriction we direct our attention to the simulation model. Nevertheless, the discussion above suggests that it is useful to differentiate subsidies and taxes for different travel modes or different travel purposes.

3   The Spatial Simulation Model

The spatial urban general equilibrium model we use is an extension of the model described in Tscharaktschiew and Hirte (2010a). Here we add an endogenous city fringe to the model required to look at tax deduction induced impacts on urban sprawl. In the following we only provide a description of the model's main characteristics.

The model explicitly takes into account the interactions between different markets (land, labor, commodities), households and firms in nine urban districts. The innermost zone of the city provides the best accessibility and, thus, will endogenously become the city center. All zones have a diameter of 4.5 kilometers so that the whole urban area expands over 40.5 km. Supply of land increases with distance from the city center but is fixed for all but the outer suburbs where land supply is endogenous. The urban locations are linked via a transport network with given distances between the centers of the locations.

A sufficiently large number of identical and competitive firms produce in each zone a zone specific commodity by applying a Cobb-Douglas technology that combines land and labor supplied by low-skilled and high-skilled workers. These commodities are sold at place of production. The firms located in the same zone are identical but goods differ across locations implying spatial product differentiation.

Urban households are heterogeneous concerning idiosyncratic tastes for urban locations. In addition, household type heterogeneity is taken into account by differentiating households with respect to employment status (non-working households and working households each encompassing one potentially employed person) and skill level[8] (low-skilled and high-

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[8]The differentiation with respect to skill level applies to working households.

skilled households). Idiosyncratic tastes and household type heterogeneity imply mixed land use and differentiated travel patterns within the urban area (see also Anas et al., 1998; Train, 2003; Tscharaktschiew and Hirte, 2010b).

Households endogenously decide where to reside, where to work (working households), where and how much to shop, how much labor to supply and, thus, how often to commute (working households), how much land to rent, and which travel mode to use. The residential location i and the employment location j (working households) determine the specific location choice sets $\{i\}$ and $\{i,j\}$, respectively. Households face a simultaneous decision problem in terms of consumption quantities (composite commodity Z, housing approximated by lot size q and leisure ℓ) and location decisions (residential and employment locations). The random utility function of a typical (working) household is $U_{ij} = u\left[Z\left(z_{ijk}, \forall k\right), q_{ij}, \ell_{ij}\right] + \epsilon_{ij}$, where $u\left[\cdot\right]$ is a Cobb-Douglas utility function and Z represents the CES shopping subutility function over shopping locations k. The idiosyncratic taste constant ε_{ij} represents the stochastic part of the random utility function which is relevant for the location decisions.

The household maximizes utility with respect to consumption (location specific shopping), housing, leisure, and the number of workdays (only working households) subject to the budget and time constraints, (similar to Eq. (8) and Eq. (2)). It also faces a discrete mode choice problem concerning travel modes *walking*, *public transport* and *automobile* available for the trip purposes commuting and shopping. A discrete choice approach is also applied to determine residential and working locations of the households based on U.

All spatial location decisions implicitly determine commuting and shopping trip distances, frequencies and – along with travel mode specific travel speeds – travel times. Individual automobile travel causes three kinds of externalities: congestion (travel time delays), additional gasoline consumption, and additional CO_2 emissions, all caused by the fact that the marginal car driver may affect travel speed of all other drivers being on the road. Since all travel decisions are endogenous, the extent of the externalities is endogenous as well. Automobile travel times, gasoline consumption and CO_2 emissions are endogenously determined and specified by empirically determined functional relationships.

The federal government levies progressive income taxes, sales taxes and energy (gasoline) taxes, grants tax deductions to working households and income transfers to non-working households and redistributes – according to fiscal interdependencies among public authorities in Germany – shares of its revenues to the local urban government. The federal tax

revenues not redistributed to the urban private households and the city government are used for public consumption consisting of purchasing locally produced commodities. The city government receives its shares of federal tax revenues and levies a local lump-sum tax to finance local goods such as roads. Infrastructure costs consist of opportunity costs due to land used for infrastructure. Absentee landowners use their rent income and an external transport sector monetary travel costs (except for travel-related taxes) accruing from urban travel activities to purchase urban commodities.

In Germany there is a progressive federal income taxation scheme. The average tax rate increases with an increase in taxable income (see Figure 1). Commuting subsidies are granted as deductions from the income tax. Basically the treatment of tax deductibility of commuting expenses is implemented as it is applied in Germany. This means it is taken into account that the individual taxpayer could also deduct a general employee tax allowance (see also the parameter A in the theoretical model) from the income tax base (currently 920 €/year) as long as this allowance exceeds aggregate commuting and further non-commuting expenditures.[9]

Figure 1: Income taxation scheme Germany (Tariff 2009)

On account of the spatially differentiated land, labor and commodity markets prices in the urban area are spatially differentiated too. They endogenously adjust to clear all local markets. The model is implemented in GAMS (General Algebraic Modeling System) and calibrated to an average German metropolitan area of 1.75 million households. Adding endogenous land supply at the urban fringe is an important feature concerning the findings. Nonetheless it does not change the benchmark in comparison to a model with fixed land endowment. This is the reason why we do not present the calibration and the characteristics of the benchmark city in the following. The reader is referred to Tscharaktschiew and Hirte (2010a).

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[9]Consequently, this treatment allows to account for the fact commuters whose residential and employment locations are close to each other could actually not directly benefit from higher deductions up to a certain level because aggregate deductible commuting and (non-commuting) expenses do not exceed the general employee tax allowance. The reason is that in such a case the taxpayer would behave rational by deduction of the general employee tax allowance.

4   Simulation and Results

4.1   Research Design

Our research design is as follows: we vary the deduction rate in the range of $0.0 \leq \delta^\tau \leq 1.3$ €/km. The benchmark level is 0.30 €/km. This implies that we consider an upper ceiling of the tax deductibility rate which, on the one hand, exceeds monetary commuting costs but, on the other hand, falls below full economic commuting costs (see Table 1). This range allows to find optimal subsidy rates under income tax funding.

Table 1: Average (full economic) commuting cost ('Benchmark')

Commuting cost component	Urban worker	
	low-skilled	high-skilled
Monetary commuting cost [€/round-trip km]	0.73	1.00
Commuting time cost [€/round-trip km]	0.88	1.20
Full economic commuting cost [€/round-trip km]	1.61	2.20

We implement four scenarios differing in the way tax deductions are financed:

- **Policy 1 (income tax funding)**: varying the (marginal) income tax rates,

- **Policy 2 (general sales tax funding)**: adjusting the sales tax rate holding constant the reduced sales tax rate on public transport,

- **Policy 3 (energy tax funding)**: adjusting the energy tax rate,

- **Policy 4 (multiple sales tax funding)**: adjusting, first, the reduced sales tax rate on public transport (holding the general sales tax rate fix) and, then, adjusting the general sales tax. If deductions are raised the reduced sales tax rate is incrementally increased until it reaches the level of the general sales tax rate, then both tax rates are raised together. If deductions decline the reduced sales tax rate is incrementally lowered until zero, then the general sales tax rate is additionally lowered.

Policies 2, 3 and 4 also constitute a change in the tax base away from income to consumption and energy taxation. We distinguish two scenarios concerning the adjustment

of the sales tax rate. Raising the general sales tax rate but holding the reduced tax rate constant, i.e. Policy 2, implies a raise in the subsidy to public transport. In contrast, raising the reduced sales tax rate on public transport until it reaches the level of the general sales tax rate i.e. Policy 4, implies a reduction in the subsidy to public transport.

4.2 Spatial and Economic Effects

4.2.1 Spatial Effects

Starting with spatial effects, Table 2 displays the results for three selected levels of the tax deduction rate. The results are printed as changes compared to the benchmark level.

The general pattern is in accordance with intuition. Abolishing tax deductions lowers average commuting distances and causes an incremental shrinkage of the city as well as a decline concerning suburbanization of residences and jobs. Raising the commuting subsidy induces diametrical effects which are, however, surprisingly small. A doubling of the deduction rate from currently 0.30 €/km to 0.60 €/km leads to a very small increase in the average commuting distance of only 0.6% to 1.5%. An increase to 1.20 €/km, after all an increase of 400% compared with the initial level, increases the average commuting distance of at most 5.4%. Also very small is the percentage change in the city size. The urban area increases by 0.14% to 0.52% as a response to a doubling of the deduction rate. This is very small in comparison with the results of Su and De Salvo (2008) who found much higher effects for car subsidies in the U.S. (an elasticity of about 0.1). One reason for this weak impact in our study is that funding subsidies provokes an countervailing raise of the tax rate used for funding. Another reason is that shopping trip costs do hardly change by commuting subsidies. Furthermore, we consider different types of individuals where non-working households do not receive commuting subsidies and low-skilled workers face only a small subsidy on account of their low marginal wage tax rate. Given that, abolishing commuting subsidies is not an instrument to lower sprawl substantially. The gross effects on residential and job relocation are also relatively small. Even raising the tax deduction rate to 1.20 €/km prompts at most 7000 workers or a percentage of unity to relocate from the city to the suburbs. These findings query the standard objection against commuting subsidies, namely, that they are an important cause for suburbanization. Accordingly, abolishing the tax deduction rate of commuting expenses is not a very effective device to reduce sprawl or commuting distances.

Table 2: Spatial effects of different tax deduction rates under different funding schemes

	Tax deduction rate [€/km]		
	0.0	0.6	1.2
Income Tax Funding			
Average commuting distance[1] [%]	−1.8	+1.5	+5.4
Suburban expansion [km^2]/[%]	−2.2/−0.24	+1.3/+0.14	+2.8/+0.32
Spatial allocation of residences and jobs			
Residences in the city[2] [total]/[%]	+1,595/+0.2	−1,486/−0.2	−4,131/−0.6
Jobs in the city[2] [total]/[%]	+633/+0.1	−392/−0.1	−1,408/−0.2
General Sales Tax Funding			
Average commuting distance[1] [%]	−1.8	+1.5	+4.7
Suburban expansion [km^2]/[%]	−3.3/−0.37	+4.2/+0.47	+12.4/+1.39
Spatial allocation of residences and jobs			
Residences in the city[2] [total]/[%]	+1,916/+0.3	−2,223/−0.3	−6,412/−0.9
Jobs in the city[2] [total]/[%]	+633/+0.1	−366/−0.1	−1,223/−0.2
Energy Tax Funding			
Average commuting distance[1] [%]	−1.8	+1.5	+5.4
Suburban expansion [km^2]/[%]	−3.4/−0.39	+4.6/+0.52	+13.8/+1.55
Spatial allocation of residences and jobs			
Residences in the city[2] [total]/[%]	+1,971/+0.3	−2,378/−0.3	−6,997/−1.0
Jobs in the city[2] [total]/[%]	+698/+0.1	−554/−0.1	−1,996/−0.3
Multiple Sales Tax Funding			
Average commuting distance[1] [%]	−0.9	+0.6	+3.9
Suburban expansion [km^2]/[%]	−1.8/−0.20	+1.5/+0.17	+9.6/+1.08
Spatial allocation of residences and jobs			
Residences in the city[2] [total]/[%]	+1,155/+0.2	−949/−0.1	−5,067/−0.7
Jobs in the city[2] [total]/[%]	+369/+0.1	+95/0.0	−720/−0.1

Changes in relation to the 'Benchmark'
[1] Averaged over all travel patterns and workers
[2] Gains (losses) of the city = losses (gains) of the suburbs

4.2.2 Aggregate Labor Supply and Congestion

Figure 2 displays changes in the number of aggregate commuting trips which, due to the complementarity of commuting trips and working days, is proportional to changes in labor supply. Abolishing tax deductions reduces commuting trips and labor supply by about 0.5%, while a raise of the deduction rate increases both. Doubling the deduction rate from 0.30 €/km to 0.60 €/km raises labor supply by about 0.5% in case of energy tax and general sales tax funding. Policy 2 and Policy 3, as well as Policy 4 (though to a smaller degree) shift the marginal tax burden from labor to consumption. Consumption and shopping trips are, therefore, getting relatively more expensive in comparison to

commuting trips and labor supply. For this reason commuting and labor supply increase. This effect, however, almost vanishes if the income tax is used to finance subsidies. In this case (curve with rhombuses in Figure 2), aggregate labor supply and commuting do hardly change if the subsidy rate moves upward.

Figure 2: Effects of tax deductibility of commuting expenses on commuting trips

Despite this relatively small effects on aggregate labor supply, there are strong changes in congestion and, more important, even different signs of the effects. Figure 3 displays the changes in congestion costs for different subsidy levels and different taxes used for funding. All changes are printed as percentage changes compared with the benchmark ($\delta = 0.30$ €/km). With income tax funding (curve with rhombuses, Policy 1) and general sales tax funding (curve with triangles, Policy 2) a reduction of the deduction rate mitigates while an increase aggravates congestion. The changes range from a reduction of 2% to an increase of about 5% and 8% and if the deduction rate achieves its upper ceiling, thus the increase is slightly stronger with consumption taxes. Congestion accumulates faster than aggregate commuting trips. Raising incomes when commuting subsidies are increased also raise the number of shopping trips. Moreover, an increase in tax deductions causes the VOT to increase which in turn favors mode choice toward faster travel modes such as automobile contributing the most to congestion.

Figure 3: Effects of tax deductibility of commuting expenses on congestion

Recall that Policy 4 (curve with circles) implies abolishing the reduced sales tax rate advantage for public transport if the commuting subsidy is raised and expanding the subsidy to public transport if the tax deduction rate is lowered. The first change boosts automobile usage and, thus, aggravates congestion. The second change shifts demand toward public transport and mitigates congestion. These effects explain the strong change in congestion around the benchmark level of tax deduction rate.

The most interesting result is Policy 3 (curve with squares). Because the energy tax constitutes a tax mainly on automobile usage, reducing the tax offsets the positive effect of a lower deduction rate on congestion. Therefore congestion exacerbates. In contrast, congestion strongly declines if the energy tax rate is raised. The reason is that more and

more workers switch their travel mode toward public transport. Because this does not affect the level of commuting subsidies, this policy implies a strong decline in congestion. Doubling the deduction rate reduces congestion by about 10%. This effect is non-linear. Concerning congestion a high deduction rate plus a high energy tax imposes the strongest positive effect. This policy discriminates in favor of public transport usage.

4.3 Aggregate Welfare and Environmental Effects

Figure 4 displays the aggregate welfare effects measured by the equivalent variation (left axis) as well as changes in travel related CO_2 emissions (right axis). Urban welfare is printed as the solid dotted lines and welfare of absentee landowners by the dashed lines with dots. The solid lines with triangles depict changes in CO_2 emissions.

Figure 4: Aggregate welfare effects of tax deductibility of commuting expenses

4.3.1 Income Tax Funding (Policy 1)

Income tax funding of commuting subsidies is the case usually discussed in the literature (see above). Concerning this policy the upper left panel of Figure 4 reveals that the optimal deduction rate is 0.90 €/km which is three times as large as the current rate.[10] However, the welfare gains achievable are at best about 70 million € or about 40 € per household and year on average. Abolishing tax deductions lowers welfare by about 60 million €. There are opposite effects present. On the one hand, the net reduction of income taxes for commuters which happens if deductions are increased lowers the taxation of productive time use (see Kleven, 2004). This raises welfare. On the other hand, the increase in tax deductions implicitly lowers the taxation on the externality and, thus, lowers welfare (see Sandmo, 1975). A comparison with the absentee landowners shows that gains and losses are also capitalized in rents, as the similar run of the curves indicates. The effects on travel related CO_2 emissions are small. Even a shift of the deduction rate to 1.30 €/km raises CO_2 emissions only by about 3% in comparison to the benchmark, whereas abolishing tax deductions lowers CO_2 emissions only by about 2%.

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[10]If the urban fringe were exogenous the optimal deduction rate is considerably smaller, amounting to 0.50 €/km (see Tscharaktschiew and Hirte, 2011).

4.3.2 General Sales Tax Funding (Policy 2)

Funding tax deductions by general sales taxes induces the same sign but stronger effects than income tax funding (see the upper right panel of Figure 4). Abolishing tax deductions lowers welfare twice as strong as with income tax funding. An increase in tax deductions implies a much stronger and almost linear increase in welfare. At a deduction rate of 1.00 €/km welfare improves by about 430 million €. Because this policy induces a relative reduction of distortionary labor taxation it constitutes a shift toward stronger taxation of time used non-productively. This also slightly dampens the negative effect of the deductions on congestion by raising the full economic travel cost of shopping. Interestingly, tax deduction induced effects on the labor market increases incomes in the city which causes aggregate consumption and, thus, shopping (trip) activities actually to increase. Because of the similar pattern in regard to changes in congestion the effects on CO_2 emissions are almost the same as in the case of income tax funding.

4.3.3 Energy Tax Funding (Policy 3)

The results regarding energy tax funding are displayed in the lower left panel of Figure 4. Abolishing tax deductibility diminishes welfare, which is almost the same compared with sales tax funding. The gains from raising deductions are higher compared to those accruing under consumption tax funding. Taxing gasoline taxes non productive use of time (e.g. travel) and, in addition, imposes a stronger taxation on the congestion externality. The most outstanding result is that this policy is the only one considered which achieves a strong reduction concerning CO_2 emissions, while the other policies entail a raise in emissions. The reduction mainly stems from, first, a reduction in congestion and associated with this lower automobile emissions emissions per vehicle kilometer and, second, a switch in travel mode choice away from emission intensive automobile road traffic.

4.3.4 Multiple Sales Tax Funding (Policy 4)

The trends are the same than with consumption taxes. However, the strong impact on congestion caused by the changes in the sales tax on public transport implies that welfare effects around the benchmark level differ from the welfare effects with general sales tax funding. In particular, a local welfare maximum is reached at a deduction rate of 0.22

€/km and a global minimum at the deduction rate of 0.41 €/km. Also with respect to this funding procedure effects are capitalized in rents but the effect is less distinctive.

4.4   Aggregate Distribution Effects

Figure 5 displays distribution effects based on aggregated equivalent variations of the different household groups.[11] In each scenario the non-working households (dashed curves) benefit from a decrease and suffer from an increase in the deduction rate. First, they also contribute to financing the subsidy and second, they also suffer from congestion, even though to a smaller extent than working city residents.

Figure 5: Aggregate distribution effects of tax deductibility of commuting expenses

The dotted lines in Figure 5 represent the equivalent variation of low-skilled households. In general low-skilled workers benefit from commuting subsidies which are – according to the current institutional arrangement of the tax deduction policy in Germany– also granted for public transport usage. Their gains are the lower the stronger their contribution to financing the subsidy and the higher their labor supply is taxed which is the case with income tax funding (Policy 1). Because their tax burden is the lowest under energy tax funding they prefer Policy 3. However, with multiple sales tax funding (Policy 4) their benefits and losses around the benchmark deviate from general trends. Here, a reduction of the subsidy to public transport required to finance higher tax deductions adversely affects the low-skilled workers.

Welfare changes of the high-skilled workers are printed as solid curves in Figure 5. They are very differently affected depending on the funding scheme. Income tax funding (Policy 1) makes them worse off because this directly taxes their labor supply and counteracts the positive effect of the deductibility (see also Eq. (15)). Their tax burden is the lowest with sales tax funding (Policy 2). With energy tax funding (Policy 3), however, two opposite effects are at work. While they benefit from a reduction in congestion they suffer from the

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[11] Aggregate distribution effects take the relative shares of the calibrated number of the different household types into account. Because the number of urban households differs among the different household types (Non-working households: 586,250; low-skilled working households: 931,000; high-skilled working households: 232,750) aggregate distribution effects may differ from those accuing on an individual household level basis (see below).

stronger taxation of automobile travel. Because of the fact that the congestion externality decreases with an increase gasoline taxation the first effect is relatively strong close to the benchmark level, the latter effects is predominant for higher deduction rates implying a decline in welfare.

To summarize: from the perspective of the non-working households the best policy is a deduction rate of about 0.18 €/km together with a stronger subsidy on public transport (multiple sales tax funding). The low-skilled workers as a whole are better off with energy tax funding and higher deductions and the group of high-skilled workers as a whole gains the most under general sales tax funding and higher deductions.

4.5   Acceptance of Policies

An individual worker is probably more concerned with changes in his relative wealth as well as in his individual payoffs in comparison to other income groups. This will be important concerning his acceptance of policies. Therefore we also consider the equivalent variations of different groups in per capita terms to gain an insight into the level of acceptance of different policies (see Figure 6). Of course, the inhabitants of the metropolitan area cannot decide on federal policy. Nonetheless, metropolitan areas might lobby in favor of one of those policies. Three large cities are even able to vote on such a policy in the Federal Council of Germany (Bundesrat) because they coincide with a German state (Berlin, Hamburg, Bremen). Furthermore, cities' inhabitants vote on representatives for the German parliament (Bundestag).

While aggregate distribution effects imply that higher deductions cause a redistribution in favor of the low-skilled workers, looking at distribution effects in per capita terms (see Figure 6) reveals that the high-skilled workers benefit considerably more than the low-skilled with higher deductions by general sales tax or multiple sales tax funding.

Figure 6: Average distribution effects (per household) of tax deductibility of commuting expenses

There is no policy most favored by more than one group of urban households in terms of individual welfare. The non-working households (dashed curves) prefer reducing deductions along with multiple sales tax funding, low-skilled workers (dotted curves) prefer higher deductions financed by energy taxes (as absentee landowners do, see Figure 4),

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whereas high-skilled workers (solid curves) most favor higher tax deductions financed by general sales taxes. Though, lower skilled workers constitute a small majority (931,000) in comparison to the other households (819,000), they might not be able to push their representatives to vote for this policy. To achieve this it is useful that more than one group agrees on a specific policy. Given that, higher deductions financed by energy taxes or general sales taxes are the two policies unambiguously advantaging both groups of workers in comparison to the benchmark – though the distribution effects are totally different. Unfortunately, because high-skilled workers lose with income tax funding and even with a low level of multiple sales taxation and low-skilled workers might lose with multiple sales tax funding both groups have to worry if they push a raise in deductions when the funding scheme applied by policymakers is uncertain. If their representatives have to compromise to achieve higher deductions this might be even worse for them than the benchmark. Moreover, if only a small increase in tax deductibility is politically feasible, the low-skilled workers might even be better off if deductions are reduced under multiple sales tax funding, though the possible gains per household are less than 100 €/year.

These could be the reasons why the current policy arrangement seems to be acceptable by the working households. Even the non-workers might accept the current situation because reducing deductions provide them a welfare gain of at most 50 €/year which is only fraction of their yearly income.

5   Summary and Conclusions

In this paper we have examined the tax deductibility of commuting expenses by applying a spatial urban general equilibrium simulation model to an average German metropolitan area. Although there is large body of literature analyzing commuting subsidies or transport subsidies in general, only a restricted number of papers theoretically analyzes commuting subsidies in the form of tax deductions. This paper contributes to the literature by providing for the first time an insight into the magnitude of the effects of tax deduction policies by implementing several institutional details of the German tax system in regard to tax deduction (in particular non-linear progressive income taxation). In addition, the approach takes into account the following features that have never been simultaneously treated in a spatial setting when studying tax deduction of commuting expenses: endogenous labor supply decisions and location decisions where the urban area is

not restricted to be monocentric, household heterogeneity by considering multiple household types differentiated by skills and employment status, commuting and non-commuting (shopping) trips, different funding schemes, travel mode choice, travel related externalities such as congestion, and feedback effects between urban land, labor and commodity markets.

Concerning income tax funding (usually considered in the related literature) our results suggest that the optimal tax deduction rate in terms of welfare of the inhabitants of the metropolitan area is about three times as large (0.90 €/km) as the current deduction rate in Germany. The endogeneity of the urban fringe is the main reason why this optimal deduction rate is even higher than we found in another paper (0.50 €/km, see Tscharaktschiew and Hirte, 2011). This rate would then be close to monetary commuting costs needed for a commuting round-trip but would still be far below full economic commuting costs needed for such a trip (see Table 1). However, if negative effects of urban sprawl or higher CO_2 emissions are taken into account the optimal deduction rate is likely to be considerably lower. Moreover, the maximum aggregate welfare gain is very low and amounts to about 50 million €/year (on average about 30 €/year per household). The results also indicate that the tax deduction rate hardly contributes to urban sprawl according to the definition of sprawl used here. There is the expected positive relationship (raising the tax deduction rate raises average commuting distance and the spatial expansion of the urban area) but the magnitude of the effect is very small – e.g. the elasticity is about 0.01 (0.003) with respect to commuting distance (the size of the urban area).[12] Hence, concerning suburbanization the deductibility of commuting expenses is suggested to be only from a minor importance, at least in the case of German cities. Positive effects of tax deductions on labor supply and negative effects on congestion are also very small due to countervailing effects on the VOT accruing under income tax funding.

However, one might ask why shall income taxes be used for funding? Usually the reasoning is that income tax deductions shall be financed by income taxes in order to avoid mixing a tax reform (change in the tax base) with a commuting subsidy policy via tax deductions. However, in a spatial world with externalities and other time consuming activities funding subsidies by other taxes could be justified from an optimal tax point of view (see Kleven, 2004; and Sandmo, 1975).

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[12]Evaluated at a tax deduction level of 0.6 €/km.

Therefore, we have also looked at alternative funding procedures. Then the positive labor supply effects of the subsidy can be combined with a less harmful tax on general consumption or energy. This is equivalent to a change in the tax base in favor of taxing non-productive time use, e.g. shopping trips, or in favor of taxing externalities, e.g. congestion, caused particularly by road traffic. These are the reasons why using the energy tax for funding (Policy 3) provides the highest urban welfare gain. Moreover, this policy is the only one considered reducing travel related CO_2 emissions. Under this policy the high-skilled workers and low-skilled workers gain. In addition, non-working households are hardly affected by this policy. The switch to consumption or energy taxation implies that the optimal deduction rate is beyond our ceiling of 1.30 €/km. In these cases, granting higher deductions indirectly constitutes a tax switch away from labor taxation, usually argued to provide a distinctive potential to raise economic efficiency.

But what does this result mean? First, if one wants to examine tax deductions of commuting expenses it is necessary to distinguish different household types, different travel modes, different travel purposes as well as endogenous labor supply and location decisions. This allows to differentiate the properties of different taxes and subsidies which overlap concerning labor supply but are distinct concerning travel mode choice or travel purposes. Second, given the findings of the analyses here further research shall focus on these interrelations of tax deductions and different taxes available for funding. Does our findings really imply that tax deductibility of commuting expenses should be raised to such a high level? Concerning our research design the answer is yes. If, however, the whole tax system is debatable it might be much more promising to directly switch the tax base from income toward energy or consumption along with eliminating commuting subsidies. Then, longer commuting distances would not be rewarded and, thus, urban sprawl as well as emissions should be even lower than under the policy arrangement considered here. This, however, is a task for future research.

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Figure 1: Income taxation scheme Germany (Tariff 2009)
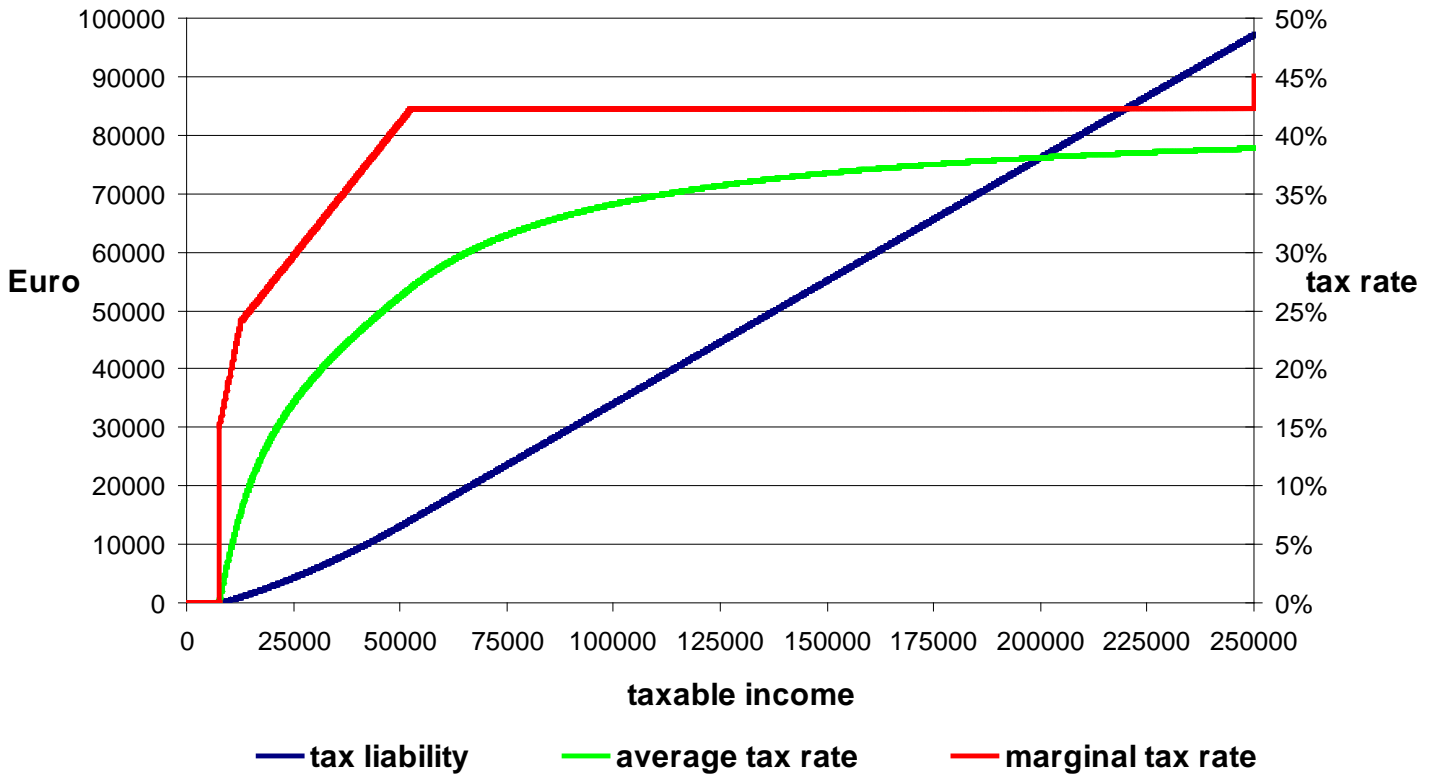

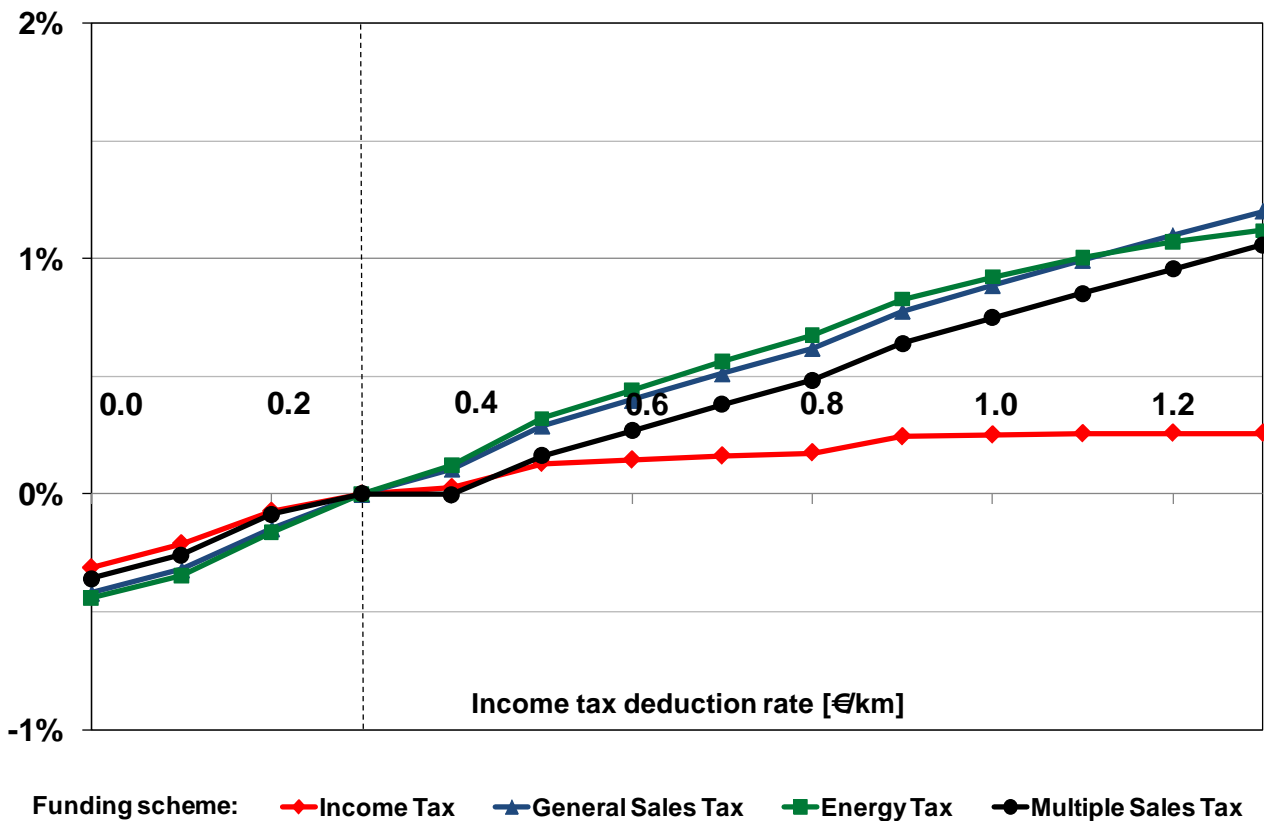Figure 2: Effects of tax deductibility of commuting expenses on commuting trips

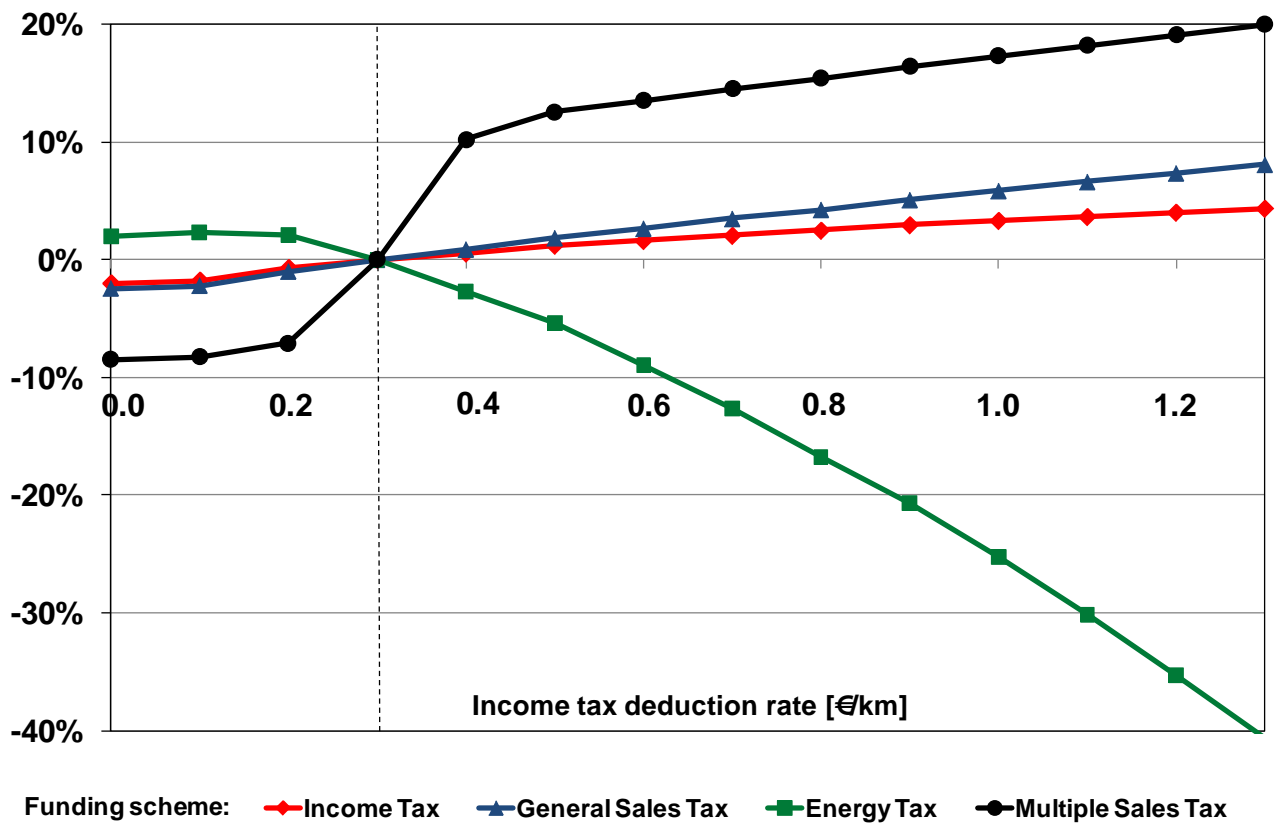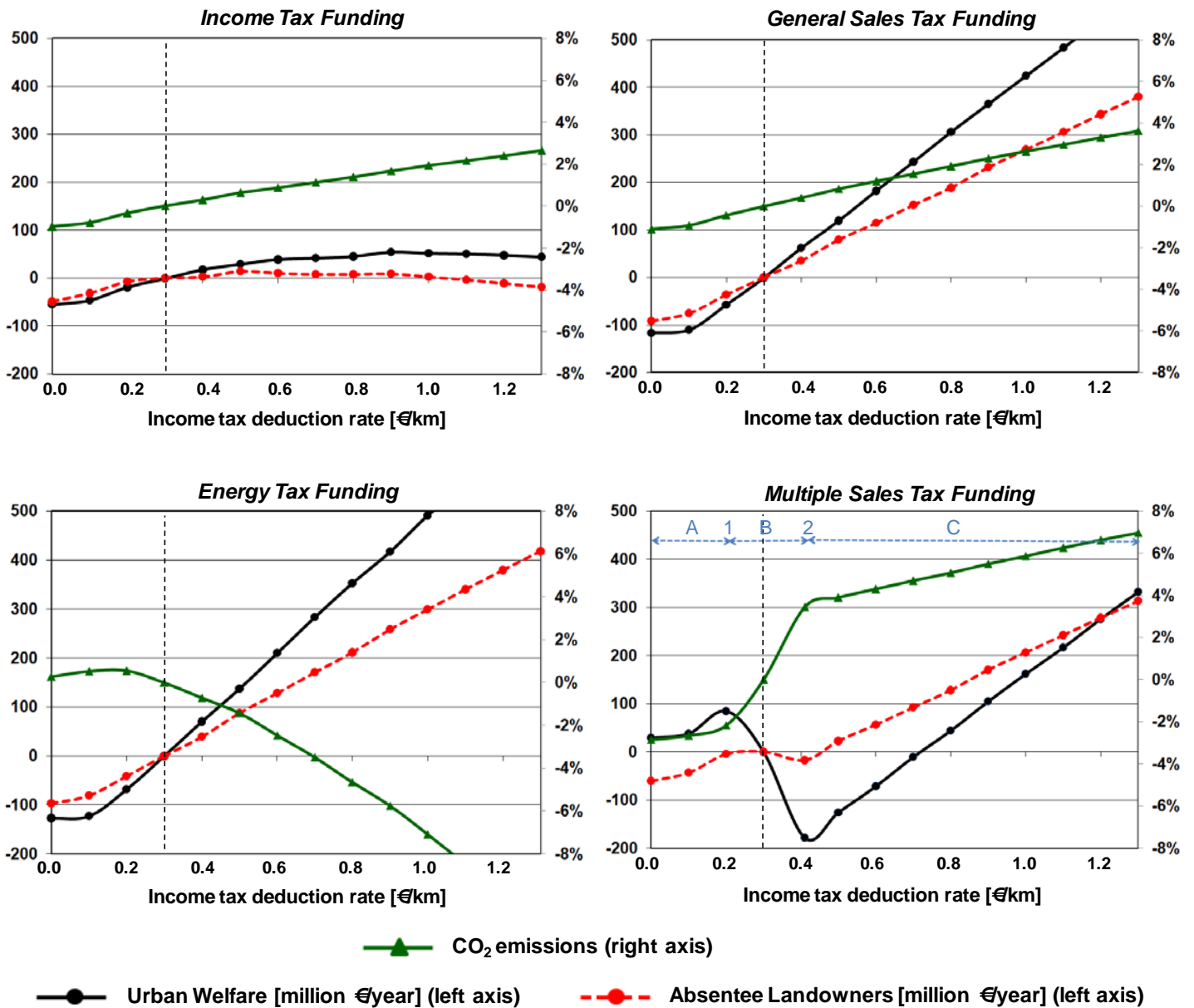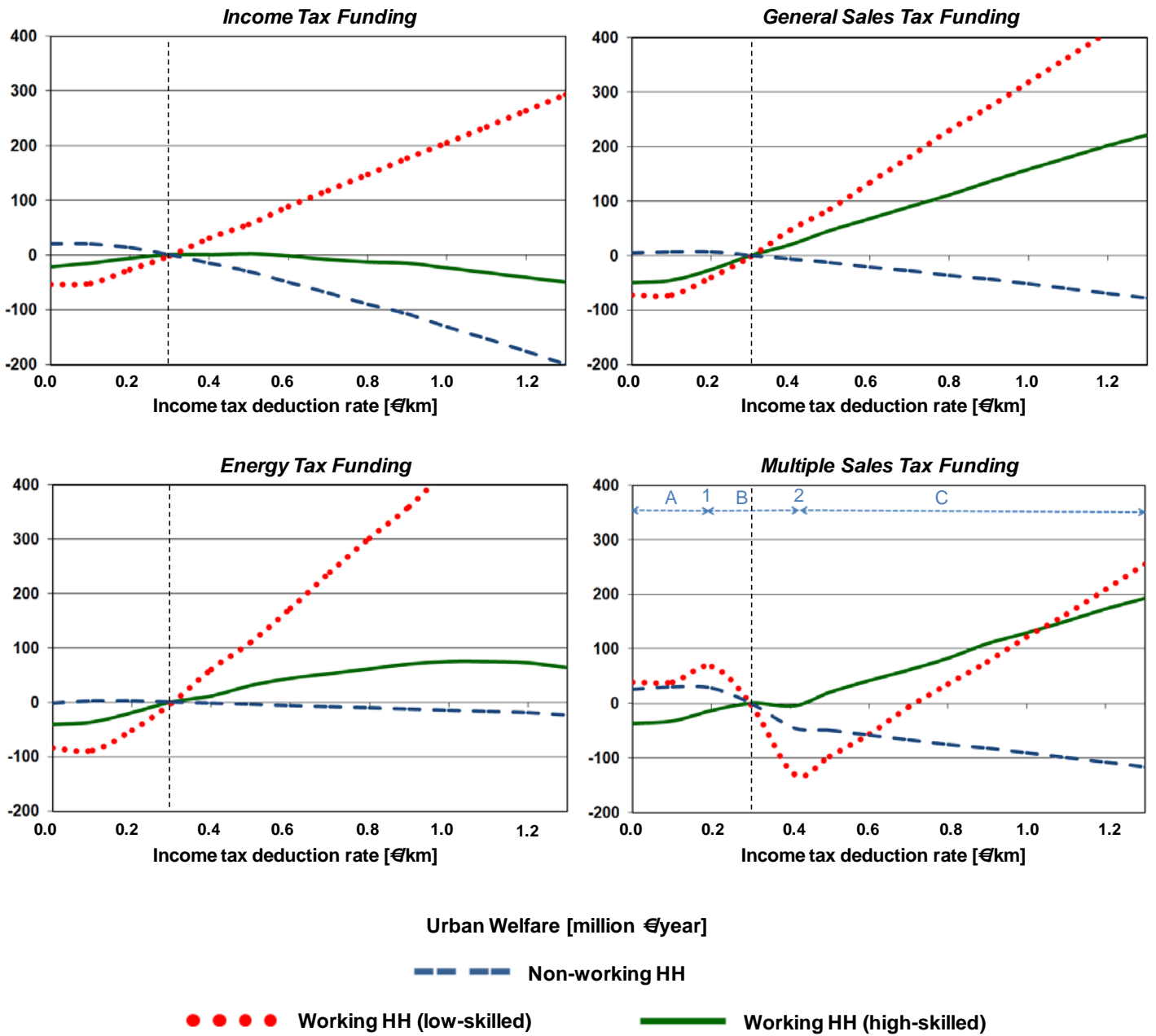Figure 3: Effects of tax deductibility of commuting expenses on congestion

Figure 4: Aggregate welfare effects of tax deductibility of commuting expenses

Multiple Sales Tax Funding:

A: General sales tax funding with full sales tax exemption of public transport fares

1: General sales tax rate = 0.19 and full sales tax exemption of public transport fares

B: Funded by a higher/lower sales tax on public transport fares with sales tax rate on general consumption = 0.19

2: Full sales tax on public transport fares and general consumption (uniform sales tax rate = 0.19)

C: Sales tax funding (uniform higher sales tax rate (> 0.19) on public transport fares and general consumption)

Figure 5: Aggregate distribution effects of tax deductibility of commuting expenses

Income Tax Funding

General Sales Tax Funding

Energy Tax Funding

Multiple Sales Tax Funding

Urban Welfare [million €/year]

━ ━ ━ Non-working HH

●●●● Working HH (low-skilled)   **━━━ Working HH (high-skilled)**

Multiple Sales Tax Funding:

A: General sales tax funding with full sales tax exemption of public transport fares

1: General sales tax rate = 0.19 and full sales tax exemption of public transport fares

B: Funded by a higher/lower sales tax on public transport fares with sales tax rate on general consumption = 0.19

2: Full sales tax on public transport fares and general consumption (uniform sales tax rate = 0.19)

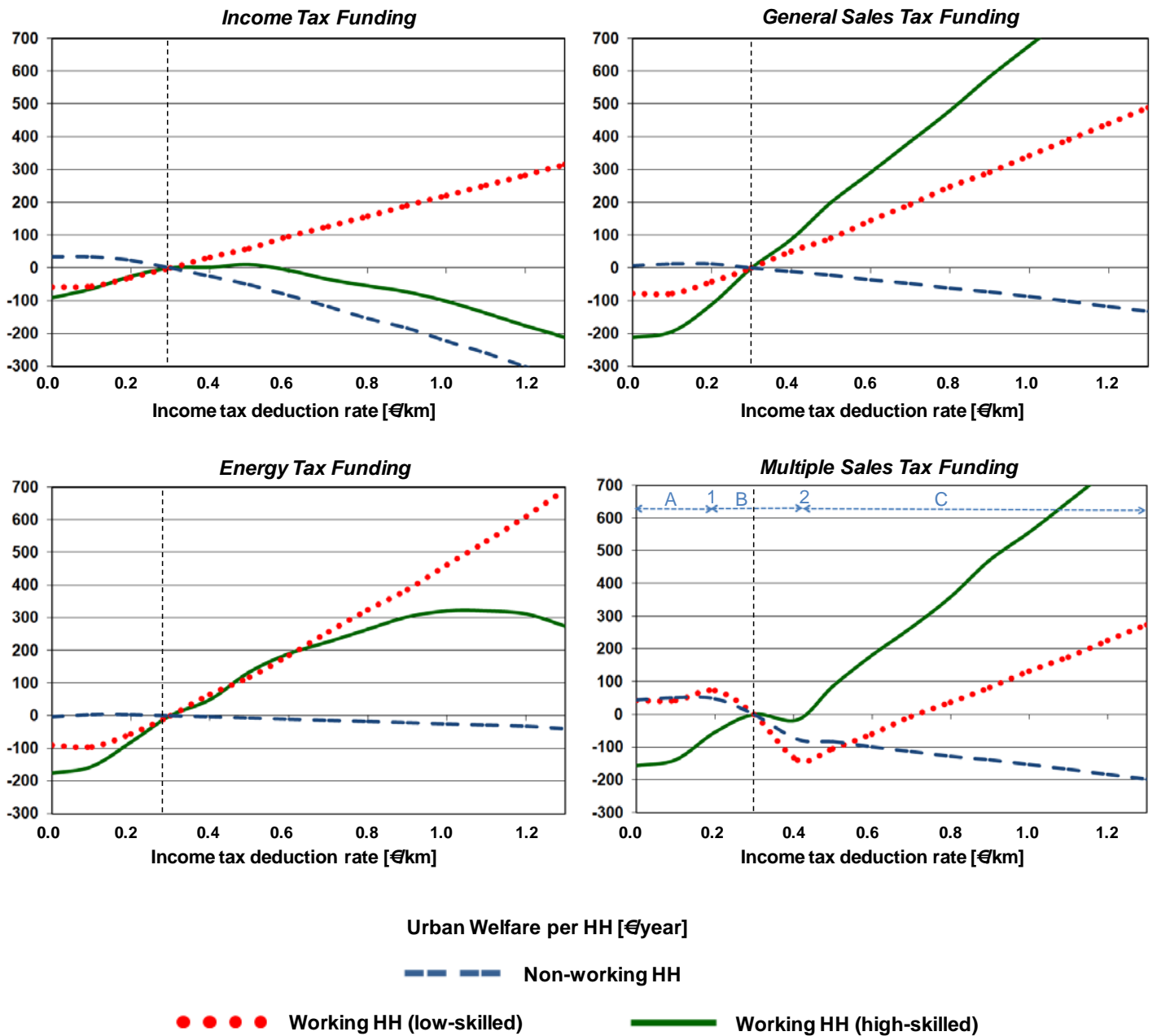C: Sales tax funding (uniform higher sales tax rate (> 0.19) on public transport fares and general consumption)

Figure 6: Average distribution effects (per household) of tax deductibility of commuting expenses

Income Tax Funding

General Sales Tax Funding

Energy Tax Funding

Multiple Sales Tax Funding

Urban Welfare per HH [€/year]

▬ ▬ ▬ **Non-working HH**

●●●● **Working HH (low-skilled)**   ▬▬▬ **Working HH (high-skilled)**

Multiple Sales Tax Funding:

A: General sales tax funding with full sales tax exemption of public transport fares

1: General sales tax rate = 0.19 and full sales tax exemption of public transport fares

B: Funded by a higher/lower sales tax on public transport fares with sales tax rate on general consumption = 0.19

2: Full sales tax on public transport fares and general consumption (uniform sales tax rate = 0.19)

C: Sales tax funding (uniform higher sales tax rate (> 0.19) on public transport fares and general consumption)

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