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The fiscal treatment of company cars in Belgium:

Effects on car demand, travel behaviour and external costs

February 2016

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Abstract - This paper examines the effects of the fiscal treatment of employer provided cars on the behaviour of employees. Based on a large cross-sectional study of mobility behaviours of Belgian households, we show that this favourable fiscal treatment causes households to buy more, larger and more valuable cars. The engine size of the largest car in the household increases by 5%, while its value increases by at least 62%. The odds that a household owns more than one car increases by 24 percentage points. The fiscal regime also induces people to use cars more intensively. Weekly commuting by car increases by 58.2 kilometres, while daily distances driven for other, private purposes increases by 8.2 kilometers.

We estimate the societal loss of these distortions to be 2 361 euro per car, or some 0.23 % of GDP. 27% of these societal losses is due to increased car demand, 69% due to increased congestion, and 4% due additional environmental impacts.

Jel Classification - D62, H24, R41
Keywords - Externalities, Personal Income Tax and Subsidies, Transportation: Demand, Supply and Congestion

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Executive summary

This paper seeks to understand how the current tax subsidy for the ownership and use of employer-provided cars influence behaviour by its recipients. We first seek to clarify how it affects the choice about cars, i.e. the number of cars a household owns, their engine size and their value. Second, we study the impact of the subsidy on the propensity to use a car for commuting and the number of kilometres driven for commuting and for other, private purposes. The analysis has been made on the basis of the BELDAM survey, a rich dataset on mobility behaviour in Belgium.

We find that the presence of an employer-provided car heavily influences behaviour on all margins that were studied. Households that are provided with a company car have, on average, more, bigger and more valuable, newer cars. Individual members that have a company car at their disposal have a higher propensity to use the car to go to work, which translates into a higher number of kilometres driven on the road. Apart from commuting, the presence of a company car also influences the daily number of kilometres driven by car for other, private purposes. Table 1 gives a summary.

Table 1 Central behavioural effects

	Impact
Engine size - biggest car in a household	+ 5%
Probability number of cars owned by a household is greater than one	+ 24 pp
Value of the most valuable car owned by a household	+ 62%
Probability of using a car for commuting	+ 16 pp
Weekly kilometres driven for commuting	+ 58.2 km
Daily kilometres driven for other, private purposes	+ 8.2 km

On the basis of the behavioural effects given above, we calculate the welfare loss from the tax subsidy. This includes the economic loss of excessive car consumption in terms of misallocated resources, as well as additional external congestion and environmental costs. The welfare costs to society amount to 905 million euro per year, or 0.23% of GDP. Table 2 gives a summary.

Table 2 Annual welfare losses by car and aggregate levels

	Euro per car	M euro total	Total in % GDP
Excessive value of cars	396	152	0.04
Excessive commuting kilometres by car	119	46	0.01
Excessive kilometres for other purposes	128	49	0.01
External costs: congestion	1637	628	0.16
External costs: air pollution	81	31	0.01
Total	2361	905	0.23

Synthèse

Cette étude tente d'établir de quelle manière le régime fiscal avantageux qui s'applique actuellement à la détention ou l'utilisation de voitures de société peut influencer le comportement des personnes qui en bénéficient. Dans un premier temps, nous tentons de déterminer comment ce régime influence les décisions prises par rapport au parc automobile du ménage, c'est-à-dire le nombre de voitures du ménage, leur motorisation et leur valeur. Dans un deuxième temps, nous étudions l'incidence de ce régime sur la propension à utiliser la voiture pour réaliser les déplacements domicile-lieu de travail, le nombre de kilomètres parcourus pour ces déplacements et d'autres déplacements privés. L'analyse a été menée par le biais de l'enquête BELDAM, qui constitue une base de données d'une grande richesse sur les comportements en matière de mobilité en Belgique.

Nous établissons que la présence dans un ménage d'un véhicule de société influence lourdement les différents types de comportement observés. Les ménages qui disposent d'une voiture de société ont en moyenne plus de voitures, des voitures plus grandes, plus récentes et de valeur plus élevée. Les membres du ménage qui disposent d'une voiture de société ont davantage tendance à utiliser la voiture pour aller travailler, ce qui se traduit par un nombre plus élevé de kilomètres parcourus sur les routes. La présence dans le ménage d'une voiture de société influence, outre les déplacements domicile-lieu de travail, le nombre de kilomètres parcourus à des fins privées. Le tableau 3 ci-dessous résume ces résultats.

Tableau 3 Effets moyens sur le comportement

	Effets
Cylindrée de la plus grosse voiture du ménage	+ 5 %
Probabilité que le nombre de voitures détenues par un ménage soit supérieur à un	+ 24 pp
Valeur de la voiture la plus chère détenue par un ménage	+ 62 %
Probabilité d'utiliser la voiture pour les déplacements domicile-lieu de travail	+ 16 pp
Kilomètres parcourus en voiture chaque semaine pour aller travailler	+ 58,2 km
Kilomètres parcourus en voiture chaque jour à des fins privées	+ 8,2 km

Partant des effets sur les comportements décrits ci-dessus, nous calculons la perte de bien-être occasionnée par ce régime fiscal. Cette perte englobe la perte économique liée à une détention excessive de voiture et une consommation excessive des services de transport produits par ces voitures. Cette mauvaise affectation des ressources s'accompagne de coûts environnementaux et de congestion externes additionnels. Les coûts liés à la perte de bien-être représentent 905 millions d'euros par an, soit 0,23 % du PIB. Le tableau 4 résume les effets sur le bien-être.

Tableau 4 Pertes annuelles de bien-être, par voiture et niveaux agrégés

	Euros par voiture	M euros au total	Total en % du PIB
Excès dans la valeur des voitures	396	152	0,04
Excès dans les kilomètres en voiture pour les déplacements domicile-travail	119	46	0,01
Excès dans les kilomètres en voiture pour d'autres motifs	128	49	0,01
Coûts externes : congestion	1637	628	0,16
Coûts externes : pollution de l'air	81	31	0,01
Total	2361	905	0,23

Synthese

Deze studie bestudeert hoe de huidige subsidie van bedrijfswagens voor privégebruik de mobiliteitskeuzes van de werknemer in kwestie beïnvloedt. We verduidelijken ten eerste hoe het bezit van een bedrijfswagen het aantal wagens dat een huishouden bezit beïnvloedt, naast variabelen als de waarde van een wagen en grootte van de motor. Ten tweede gaan we het effect na op het gebruik van de wagen. We onderzoeken de kans dat een wagen wordt gebruikt voor verplaatsingen voor pendelverkeer en andere motieven, net als de gemiddelde afstand van dergelijke verplaatsingen. Deze analyse gebeurt op basis van BELDAM, een rijke dataset over het mobiliteitsgedrag van de Belgen.

De belangrijkste bevindingen worden weergegeven in tabel 5. De resultaten tonen duidelijk aan dat het bezit van een bedrijfswagen het gedrag volgens alle bestudeerde marges sterk beïnvloedt. Huishoudens met een bedrijfswagens hebben gemiddeld genomen niet alleen grotere en duurdere wagens, ze hebben ook meer wagens in bezit. Het bezit van een bedrijfswagens beïnvloedt eveneens sterk de kans dat de wagen wordt gebruikt voor het pendelverkeer, wat zich vertaald in een groter aantal gereden kilometers op de weg. Los van het pendelverkeer leidt een bedrijfswagens ook tot meer kilometers gereden voor andere, private, motieven.

Tabel 5 Centrale gedragseffecten

	Impact
Grootte van de motor van de grootste wagen in het huishouden (cc)	+ 5 %
Kans dat het aantal wagens in een huishouden groter is dan één	+ 24 pp
Waarde van de meest waardevolle wagen in het bezit van een huishouden	+ 62 %
Kans om een wagen te gebruiken voor pendelverkeer	+ 16 pp
Wekelijks aantal kilometer voor pendelverkeer	+ 58,2 km
Dagelijks aantal kilometer voor ander privaat verkeer	+ 8,2 km

Op basis van de gedragseffecten die boven werden gegeven, is het mogelijk om de kost aan de maatschappij van het huidige fiscaal regime voor bedrijfswagens te berekenen. Hieronder verstaan we het economisch verlies van overmatige consumptie van wagens en kilometers wat leidt tot een misallocatie van schaarse middelen, en de externe kosten op vlak van congestie en milieuvervuiling. Deze totale maatschappelijke kost bedraagt 905 miljoen euro per jaar, ofwel 0,23 % van het bbp. Tabel 6 vat samen.

Tabel 6 Jaarlijks maatschappelijk verlies per bedrijfswagen en geaggregeerde resultaten

	Euro per wagen	Mio euro totaal	Totaal in % bbp
Excessieve waarde van wagens	396	152	0,04
Excessief aantal kilometers pendelverkeer	119	46	0,01
Excessief aantal kilometers voor andere, private motieven	128	49	0,01
Externe kosten: congestie	1637	628	0,16
Externe kosten: milieu	81	31	0,01
Totaal	2361	905	0,23

1. Introduction

This paper seeks to shed light on the welfare effects of the current tax rules for company car taxation in Belgium, using the data from the BELDAM survey, a rich survey on Belgians' mobility behaviour. It is well known that company cars in Belgium enjoy a substantial tax advantage vis-a-vis ordinary wages. Harding (2014) calculates the average tax expenditure for a typical car for all OECD countries, and finds that company cars in Belgium enjoy the largest tax advantage among European countries: 2 763 euro per car.

The result of this policy is that Belgians on average use more company cars than ever. The fleet is estimated at 383 400 company cars[1], which are intensively used during the peak period on workdays. Indeed, estimates by SD Worx even put the share of company cars during Brussels' rush hour at 50%. Moreover, most company cars are diesel cars, which are known to have higher emissions of damaging particulate matter and NOx. They thus are likely to contribute to the already high cost of congestion and local air pollution.

Maintaining this subsidy scheme makes other government policy for controlling externalities difficult. De Borger and Wuyts (2011), for example, seek to quantify the impact of company cars on the congestion problem and find that optimal congestion tolls should be set much higher than standard theory would prescribe, if the use of company cars continues to be highly subsidised by the personal income tax system. Apart from hampering efficiency, this raises equity issues as well. Indeed, if the government needs to impose a high congestion charge to compensate for the company car subsidy scheme, it may impose an unduly high costs on people having no access to a company car.

Nonetheless, the work of De Borger and Wuyts (2011) may be based on strong assumptions with respect to behaviour: in their model, owners of company cars are always assumed to use the car, while those without are assumed to follow the modal split between public and car transport that is observed by the general population in the baseline scenario. They do not allow for the possibility that owners of company cars may have a higher propensity to use a car, even without the tax subsidy. Also, they only consider the impact of company cars on commuting trips, while ignoring the potential impact on trips for other purposes.

To fully understand the economic and environmental impact of company cars, we need to understand the impact of the fiscal treatment on behaviour along different behavioural margins. Ideally, we should be able to distinguish the impact on the number of cars in the household, the size or market value of the cars and the number of vehicle kilometres driven for different purposes.

Until now, empirical research on company car use in Belgium has been scarce. The only detailed studies that we know of, have been done by Ramaekers etal. (2010) and De Witte and Macharis (2010 & 2012).

1 A microsimulation exercise performed for us by Federal Public Service Finance revealed that in 2011, 383 400 tax returns had a positive value for the taxable benefit for an employer-provided company car. This may be underestimate due to the fact that couple can also file a joint tax return. This figure, which will be used in this paper, lies well below the 722 000 based on car registrations by Harding (2014), but above the 365 000 for the 4th quarter of 2011 from the social security administration.

Using a multivariate regression analysis, the former finds a difference of 9 200 kilometres driven between those with and those without a company car. De Witte and Macharis (2012) suggest different behavioural impacts for various types of company car users. In an earlier study, De Witte and Macharis (2010) found strong effects of company car possession on the propensity to use the train by commuters to Brussels.

Other research abroad includes work done regarding Israel by Shiftan, Albert and Keinan (2012), who find that a company car increases the amount of kilometres driven by 3 000 to 10 000 km per year, depending on whether a fuel card and free parking are included in the compensation package. For the Netherlands and Germany, Kloosterboer (2012) found strong effects of company cars on modal choice, with public transport losing market share in the Netherlands. In Germany, however, no effect was found.

Gutierrez and Van Ommeren (2011) provide the most detailed analysis of behavioural reactions yet. They studied the effect of owning a company car on the value of cars in the household, the commuting distance and the number of daily kilometres driven for private, non-commuting purposes. Using diverse panel datasets for the Netherlands, they found large effects on car values, but relatively modest effects on the commuting distance and kilometres driven. In their study, the value of the most expensive car in the household is inflated by about 10 000 euro when it is a company car. As for car use, private weekend travel is increased by 3 km and total commuting distance, regardless of the mode taken is increased by 5 km per day.

Some surveys ask people directly how abolishing the company car regime would alter their mobility behaviour. For Belgium, for example, about 20% of current users state they would switch to another mode of transport (mainly rail) if they had no company car at their disposal. This effect is most pronounced for females. (Cornelis e.a., 2011b) A survey conducted in Israel by Shiftan et al. (2011) states that half of company car users would still stick to their own privately owned car as the main mode of commuting.

The purpose of this paper is to quantify the different effects of company car taxation on different decision variables, so as to be able to provide a full picture of the societal costs of the preferential tax treatment of company cars. In order to do this, we follow the method of Gutierrez and Van Ommeren (2011), which relies on survey data to quantify the tax distortion for the Netherlands.

We calculate the effect of company car possession on average engine size, the number of cars, and the car value per household, alongside car use. Within car use, we distinguish between commuting and other purposes. For car use, we implement econometric models that are able to distinguish between modal choice and the amount of kilometres driven per trip, exploring the use of double hurdle models for transport analysis alongside standard discrete choice models.

After calculating behavioural effects, we also provide an estimate of the societal loss from company car subsidies. This is done not only by calculating the standard economic welfare loss from excessive consumption through product subsidies, but also by providing an estimate of the additional external costs from induced car use. Both congestion costs and environmental costs are considered.

2. Theoretical framework

Gutierrez and Van Ommeren (2011) provide a framework for estimating the distortion from company car taxation. Using simplifying assumptions, a tractable equation is derived from the utility maximisation of an employer deciding to offer a company car or not.

A household without a company car is assumed to maximise utility U defined over two goods: car 'units' x and other goods y. Car 'units' can be understood as anything that makes a car desirable: engine size, extra facilities or the mileage that is driven with it. Note that mileage is understood as being for private car use, commuting and other purposes but not for work-related travel.

The price of the good y is normalised to 1, that of cars is p. Gross income m is taxed at rate τ. The maximalisation problem is thus:

$$max_{x,y} U(x, y)$$

$$s.t. px + y = m(1 - \tau)$$

or:

$$max_x \ U(x, m(1 - \tau) - px))$$

This yields a first order condition:

$$U_x / U_y = p$$

and a demand curve for car units:

$$x = x(p, m(1 - \tau))$$

Households with access to a company car solve a similar problem. The main difference is that the income from a company car is taxed differently from other income. More precisely, a unit of company cars x^c is valued by the tax administration at $H \leq p$. Their problem is:

$$max_{x^c,y} U(x^c, y)$$

$$s.t. px^c + y = m^c(1 - \tau) - \tau H x^c + px^c$$

or:

$$max_x \ U(x^c, m^c - \tau(m^c + Hx^c))$$

Firms wish to maximise revenue by offering a package of company cars x^c and money wages m^c, such that employees would be indifferent as to whether they have a company car or not. This implies:

$$U\big(x, m^c - \tau(m^c + Hx^c)\big) = U(x, m(1 - \tau) - px))$$

When company cars do not yield any benefit to the firm[2], the result of the firm's maximisation problem is:

$$U_{x^c}/U_y = p - \tau(p - H) = p^c$$

This equation is important, since it shows that the relevant price to the household is the market value of a company car unit less the tax subsidy, i.e. the difference between the market value and the value assumed by the tax system, evaluated at the marginal income tax rate. If H equals p, there is no distortion from the tax system, and the number of car units demanded by households that own a company car x^c is equal to that demanded by households without a company car x. When $H < p$, the tax subsidy rises proportionally to the tax rate, so that the tax subsidy rate not only depends on the realism of the imputed value H, but also on the reference marginal tax rate.

In reality, x^c and x will not be equal. This may be due to different household characteristics as well as the tax treatment of company cars. Empirical work must thus isolate the latter effect from other characteristics.

This can easily be done if demand functions of households i are assumed to be additive:

$$x_i = h(p_i) + k(m_i) + j(s_i)$$

Where p_i is the price for a car unit corrected for the income tax treatment (p^c for households with a company car, p for one without), m_i is money income and s_i are other important household characteristics.

Differences in demand for car units between households with or without a company car can be expressed as:

$$\Delta x_i = x_i - x_i^c = h(p) - h(p^c) + k(m_i) - k(m_i^c) + j(s_i) - j(s_i^c)$$

Empirical work should estimate the magnitude of the first difference on the right hand side $\Delta x = h(p) - h(p^c)$. It is the demand change induced by the preferential tax rules on company cars, controlling for changes in income.

The welfare losses to society equal the changes in consumer surplus ΔCS and environmental cost ΔEC. The change in consumer surplus ΔCS can be captured by the simple deadweight loss formula of a linear demand curve:

$$\Delta CS = 1/2 \, {}^{\Delta p}/_{p} \, \Delta x$$

In the context of a subsidy, this deadweight loss can be understood as the loss to society due to excessive consumption of the good in question. Because the subsidy distorts relative prices, consumers are induced to buy a different bundle of goods compared to the situation in which prices are not affected by government policy.

2 We will assume this is the case throughout the analysis.

The term ΔCS represents the loss to society due to this misallocation of resources. Intuitively, it is the gain to consumers when the subsidy is abolished and they receive the revenue back in freely disposable cash, which would allow them to buy a bundle of good that is closer to their preferences.

In the context of our study, we consider the excessive consumption of car units, i.e. the number and value of cars, and the number of vehicle km driven by them for commuting and other (private) purposes.

To arrive at complete welfare effects, one also needs to consider the effects on external costs ΔEC:

$$\Delta EC = \Delta x(MEEC + MECC)$$

$MEEC$ and $MECC$ are marginal external environmental and marginal external congestion costs, respectively.

3. Empirical results

3.1. Data

Identifying the effect of company cars' preferential tax rules on the demand for car units, controlling for income and household characteristics, requires microdata rich enough to encompass the socio-economic, fiscal and mobility aspects involved. This kind of data is unfortunately not abundant for Belgium. Several promising datasets, such as the Labour Force Survey, or the decennial (micro) census datasets, miss one or other critical piece of information required for the analysis. In particular, microdata that explicitly includes information about the availability and use of a company car in a household is scarce. Though the development of relevant microdata based on administrative registers is possible, the situation in that respect is not yet mature in Belgium, and we hence have resorted to an alternative solution: the BELDAM (BELgian DAily Mobility) survey.

BELDAM is a sampled cross-sectional survey, carried out in 2010, and covering the population of Belgian residents. The sample consists of some 8 500 households that represent more than 15 800 individuals aged six or more. Though response rates vary across segments of the population, this survey is sufficiently large and correctly weighted to be considered as representative of the Belgian population for our purpose, with known caveats.

The first questionnaire in the survey addresses general characteristics such as household income, the educational and professional status of each household member and many other useful control variables. It also provides detailed information on the number of vehicles owned by the household and their characteristics, including whether they are a company car. It includes aggregate use data in the form of kilometers driven per year, regardless of purpose.

The second questionnaire is individual, and includes each person in the household aged six or more, for whom a number of items regarding regular mobility behavior and a trip log for a randomly selected day during the survey period are reported. The first part of this questionnaire addresses, among other matters, commuting behavior to work or school, providing information on the transport modal chain, distances and the weekly pattern. It does not directly specify whether car trips are made with a company car or not, but this information can be inferred from a question related to the way commuting expenses are covered by the employer. The second part of the questionnaire provides detailed information for all trips occurring on the selected day, including distance, time and mode for each leg of each trip, purposes of the trips and, if applicable, which of the household's cars was used. This last piece of information allows identification of whether car trips are made with a company car.

This rather rich dataset is the basis of several econometric analyses, whose description unfolds in the following sections. The household questionnaire is exploited first, linking the presence of a company car to overall car ownership and usage by the household. Car usage by purpose is then explored in more depth using the individual questionnaire, with separate treatment of car usage for work commuting and for other purposes.

3.2. Overall results: the household questionnaire

Ideally, in this initial analysis we would explore the link between the value of the household's cars and the presence of a company car. However, the crucial variable on the value of the car at purchase that was available to Gutierrez and Van Ommeren (2011) is missing from our survey data. We shall therefore use a proxy based on the car characteristics available to us. The best candidate in this respect is the engine displacement in cubic centimeters (CC)[3]. Additional information on car units is in the age of the car. From this data, a depreciation can be inferred, to better reflect the market value of the car at the survey date. This will, among other things, capture the fact that company cars are renewed much more frequently than privately owned cars. This car value index is defined as the car's engine displacement, depreciated at a rate of 15% per year. This rate seems a reasonable average of estimations in international studies on second-hand car markets. The household questionnaire allows us therefore to estimate the effects of a company car on engine displacement and the car value index. This can be seen as a (rough) measure of 'car units' in the model presented in section 2. Likewise, the extra number of yearly vehicle kilometres driven by company cars can be estimated, as an additional use-based measure of 'car units'.

Table 7 below provides some descriptive statistics for the subsample of households owning at least one car. From the consideration of sample standard deviations, we can conclude that for the subsample of households owning a company car, car characteristics and usage are more homogeneous than for the subsample of households without a company car. In the dataset, when the biggest car is a company car, its engine displaces on average 12% more CC, and its value index is 70% higher. The total number of yearly vkm driven in a household is 109% higher if at least one company car is present. 74% of households that own a company car have 2 cars or more, as opposed to only 33% of other households. A regression analysis should determine whether this also holds when controlling for important household characteristics such as income, household composition, etc.

Table 7 Household dataset: descriptive statistics (weighted)

	Engine size biggest car (CC)		Share of HH +1 cars	Annual mileage (vkm)		Highest car value index	
	Mean	SD		Mean	SD	Mean	SD
Whole sample	1781.8	455.4	38.0%	19109.4	25638.8	834.5	514.1
Company car	1970.7	360.8	74.5%	35907.9	23913.2	1314.7	450.8
No company car	1758.7	460.5	33.8%	17147.3	25114.6	773.5	489.0
N	5636		6427	6427		5420	

As for car characteristics and the number of cars, we estimate in turn 1) the effect of company car ownership on the engine size of the largest car in the household or alternatively on the highest value index car, 2) the effect of the presence of a company car on the probability that the household has at least two cars or more and 3) the effect of the presence of a company car on the total number of CCs owned by a household. The results are reported in Table 8 and Table 9 below. The second analysis is performed through a logistic regression.

[3] In section 4 we illustrate the tight link between car value and engine displacement, showing that on a log-scale, there is a strong linear relationship, with log-value of cars behaving like 1.3 times log-displacement of engines.

The results indicate that, among households that own a car, the engine size of the largest car in the household is 5% larger for those owning a company car. The value index of the car with highest value is 61% larger for households where the highest value car is a company car. This very significant difference is statistically robust, and still below the effect estimated by Gutierrez and Van Ommeren (between 0.8 and 1.2 in logarithm, thus between 122% and 230%). However, the car valuation method used by these authors gives a large premium to cars under three years of age, a category that contains 75% of company cars[4]. The parameters of the logistic regression imply that for households with a company car, the probability of having two or more cars is 24 percentage points (pp) higher than for households without company car. The third regression shows that the total number of ccs owned by a household with a company car is 15% higher. Finally, the sum of value indexes of all cars in the household is estimated to be 68% higher for households with at least one company car. All relevant coefficients are highly significant, implying a marked effect of subsidies on car choice.

Also noteworthy is the effect of household income, composition and location. As expected, income has a strong positive effect on engine size, car value and the number of cars in the household. It is a highly significant predictor of both margins, more so than the education and employment status of the head of the household (regressions that include these variables are not shown).

In the fourth column of table 8, we report the effect of company car ownership on total vehicle kilometres driven by a household. The estimated coefficient implies that abolishing the company car regime would diminish vkm driven by households with a company car by 34% or about 12 077 vkm per year.

Again, income, household composition and location of residence are highly significant. Age has a negative impact on kilometers driven; the presence of children in the household seems to have a positive effect.

[4] Gutierrez & Van Ommeren (2011) attribute to cars less than three years old their new listed price, and for older cars, a second-hand market value. As company cars are always bought new, the retained value for such cars is the new value, whereas it is well established that depreciation is high in the first year for cars. This therefore probably distorts estimates of the difference in car value between company and privately owned cars, overstating that difference.

Table 8 Results from the household questionnaire: engine size, number of cars and annual vkm driven (weighted)

	H1 Log cc biggest car (OLS)	H2 Probability number cars > 1 (Logistic)	H3 Log total cc's owned by a household (OLS)	H4 Log total annual vkm (OLS)
At least 1 company car in HH		0.24***(7.89)	0.14***(8.10)	0.41***(11.94)
Biggest car = company car	0.05***(4.65)			
Log age head of household	-0.06***(-5.42)	-0.16***(-7.12)	-0.15***(-7.73)	-0.83***(-21.31)
Income = 500-999 euro/month	-0.00 (-0.01)	-0.23***(-14.82)	-0.23***(-2.91)	-0.05 (-0.33)
Income = 1000-1499 euro/month	0.02 (0.53)	-0.26***(-8.19)	-0.19**(-2.50)	-0.03 (-0.22)
Income = 1500-1999 euro/month	0.07 (1.57)	-0.23***(-4.73)	-0.11 (-1.47)	0.06 (0.42)
Income = 2000-2499 euro/month	0.08* (1.90)	-0.19***(-4.97)	-0.08 (-1.07)	0.17 (1.17)
Income = 2500-2999 euro/month	0.10** (2.28)	-0.15***(-3.19)	0.00 (0.05)	0.20 (1.37)
Income = 3000-3999 euro/month	0.09** (2.09)	-0.11* (-1.86)	0.03 (0.48)	0.32**(2.19)
Income = 4000-4999 euro/month	0.15***(3.23)	-0.01 (-0.17)	0.17**(2.24)	0.44***(2.99)
Income = 5000-9999 euro/month	0.22***(4.69)	0.09 (0.89)	0.30***(3.73)	0.66***(4.27)
Income = 10000+ euro/month	0.43***(6.73)	0.21 (1.04)	0.52***(4.72)	0.81***(3.86)
Gender head HH = female	-0.07***(-10.01)	0.02 (1.33)	-0.07***(-5.75)	-0.13***(-4.82)
Urbanisation level = 2	0.03***(4.21)	0.17***(8.30)	0.11***(7.94)	0.13*** (4.49)
Urbanisation level = 3	0.04***(4.58)	0.20***(8.99)	0.14***(9.96)	0.12*** (4.22)
Urbanisation level = 4	0.04***(3.92)	0.20***(8.09)	0.12***(7.77)	0.17*** (5.50)
Region = Flanders	0.03**(2.09)	0.07**(2.18)	0.05**(2.15)	0.16***(3.82)
Region = Wallonia	-0.01 (-0.72)	0.11***(4.05)	0.04*(1.73)	0.35***(8.15)
Renter	-0.04***(-4.94)	-0.11***(-7.45)	-0.10***(-7.16)	-0.07** (-2.40)
Other residence	-0.06*** (-2.86)	0.05 (1.01)	-0.07 (-1.82)	-0.10 (-1.36)
Two adults	0.04*** (5.31)	0.30***(20.96)	0.19***(13.71)	0.18***(6.35)
Children in HH	0.02*** (3.08)	0.11***(7.46)	0.09*** (7.37)	0.17***(7.01)
Constant	7.56*** (118.91)		8.04***(73.91)	12.26***(57.33)
N	5275	6342	5548	5275
R^2	0.17	0.33	0.34	0.32

t statistic in parentheses. *** denotes significance at level 0.01, ** at level 0.05, * at level 0.10. For the logistic regression, we report marginal effects at means and the pseudo-R^2 The subsample includes only households that own at least one car. Model H4 only considers households with a non-null total annual vkm.

Table 9 Additional results for the household questionnaire: value indexes

	H1b Log value index biggest car (OLS)	H3b Log total value index owned by a household (OLS)
At least 1 company car in HH		0.52***(13.67)
Max index car = company car	0.48***(12.70)	
Log age head of household	-0.41***(-10.10)	-0.48***(-10.93)
Income = 500-999 euro/month	-0.11 (0.69)	-0.07 (-0.40)
Income = 1000-1499 euro/month	0.43***(2.74)	-0.26 (1.54)
Income = 1500-1999 euro/month	0.58***(3.75)	0.44***(2.65)
Income = 2000-2499 euro/month	0.71***(4.54)	0.55***(3.28)
Income = 2500-2999 euro/month	0.80***(5.09)	0.68***(4.06)
Income = 3000-3999 euro/month	0.84***(5.39)	0.76***(4.56)
Income = 4000-4999 euro/month	0.92***(5.85)	0.91***(5.40)
Income = 5000-9999 euro/month	1.13***(6.91)	1.10***(6.31)
Income = 10000+ euro/month	1.19***(5.28)	1.32***(5.45)
Gender head HH = female	-0.01 (-0.43)	-0.01 (-0.29)
Urbanisation level = 2	0.06** (2.16)	0.10***(3.31)
Urbanisation level = 3	0.00 (0.09)	0.06** (1.98)
Urbanisation level = 4	0.09***(2.63)	0.13***(3.61)
Region = Flanders	0.07 (1.46)	0.09* (1.83)
Region = Wallonia	0.20***(4.37)	0.25***(5.17)
Renter	-0.16***(-5.13)	-0.21***(-6.44)
Other residence	-0.23***(-2.89)	-0.28***(-3.23)
Two adults	0.12***(3.96)	0.23***(7.15)
Children in HH	-0.03 (-1.40)	0.01 (0.23)
Constant	7.16***(31.66)	7.54***(31.23)
N	5278	5278
R^2	0.19	0.25

t statistic in parentheses. *** denotes significance at level 0.01, ** at level 0.05, * at level 0.10. For the logistic regression we report marginal effects at means and the pseudo-R^2 The subsample includes only households that own at least one car.

One criticism of the regressions based on the household dataset could be that it only provides data for a total amount of vkm driven by car. There is no distinction between purposes of travel, so one could argue that the extra vehicle kilometres driven by people with a company car are due to work–related travel, such as visiting clients, driving between different plants, etc. If these extra kilometers are necessary for the proper functioning of the job, then it would be an error to label them as 'distortive'. The individual dataset provides a breakdown of travel by purpose so that this criticism can be avoided. The following sections take advantage of this to study independently the car usage for commuting and for other purposes than work and commuting.

3.3. Commuting by car: the individual questionnaire

3.3.1. The empirical framework

The individual dataset allows us to reconstruct daily commuting patterns of employees on a detailed basis. It provides information on the length of the itinerary towards work that is usually followed, broken down by mode. Also, the number of days that is usually spent working per week is given. This allows us to deduce the number of kilometers spent commuting by car in a typical workweek. The questionnaire also provides a few other controls that might influence the results, namely the sector (public vs private vs non-profit), work schedule (flexible, shifts, etc.), the number of hours worked (full-time vs part-time), some accessibility parameters (ease of parking near home and near the workplace, proximity of public transport to home location), and, of course, characteristics derived from the household questionnaire (household monthly income, individual education level and a crude measure of the type of job, region of residence and urbanisation category of the district of residence).

Table 10 provides some descriptive statistics. On average, weekly commuting vkm by car for a company car owner are more than double those of an employee without a company car. This is due to the former working more days per week and having longer total distances, but also because they have a higher propensity to use a car. 92% of those with access to a company car use the road regularly to commute, while this applies to only 69% of those without one.

Table 10 Individual dataset: descriptive statistics (weighted, car owning employees only)

	Car part of the modal chain			Car as main mode		
	Probability of using a car	Weekly vkm by car (one way)	Weekly vkm by car, car users only (one way)	Probability of using a car	Weekly vkm by car (one way)	Weekly vkm by car, car users only (one way)
Whole sample	71.4%	69.3	99.8	70.5%	76.7	108.2
Company car	92.0%	134.5	141.3	92.7%	141.4	152.2
No company car	68.7%	60.9	91.2	67.6%	68.0	100.1
N	4820	4341	4341	4169	4169	4169

Notes: For “car as part of the modal chain”, real distances driven by car are reported. For “car as main mode”, the whole commuting distance is considered driven by car for those commuters that have the car as main mode of transport.

Due to missing values, the effective sample sizes differ depending on the variable under study. This explains how the probability of using the car as the main mode of transport is higher than that of using a car at all for company car owners.

Our aim is to assess the effect of the possession of a company car on the total commuting distance travelled by car for employees. The dependent variable will hence be the total distance travelled by car on a typical week, or rather the logarithm thereof, for statistical reasons. Though the BELDAM survey would allow us to identify exact distances driven by car for multimodal trips as well, we will stick to a “main mode of transport” approach. In other words, a main mode is identified for each employee, based on a hierarchical rule over modes of transports used and the distance covered by each mode. The whole commuting trip is then assumed to be covered using this main mode. This allows us to keep a sensible distinction between car users and non-car users without referring to distances driven, which will prove important in what follows. This being said, consideration of table 10 shows that only a small fraction of car users do not have a car as their main mode of transport, so the distortion attributable to this simplifying choice is arguably small.

The total distance travelled by car depends on two main factors: the modal choice of the commuter, and the distance between the place of residence and the place of work. The presence of a company car may have an influence on both factors.

Regarding the modal choice, the presence of an all-expenses-paid car of a quality probably higher than that which the household would have chosen if they had paid for it themselves (as demonstrated in the previous section) is an incentive to choose commuting by car. It may also happen that, having provided the employee with a company car, the employer does not cover expenses linked with other modal choices, such as train tickets or an urban transport travel pass. In that case, the choice of car would also be the favoured alternative on a cost basis. Hence we expect that the presence of a company car would increase the probability of commuting by car. But other factors, such as the commute distance, other constraints (children, unusual working hours at odds with public transport time schedules, residence in a poorly connected area, personal preferences that may correlate with age, gender or other observable characteristics, etc.) also impact the modal choice of commuters. This means that a broad regression model has to be specified to estimate this impact.

Regarding the distance between place of residence and place of work, the link with the presence of a company car is less obvious at first, but also more complex to specify correctly. On the one hand, on condition of being provided with an all-expense-paid company car, individuals could accept jobs further away from their home than they would have done without being offered a car. In this respect, the presence of a company car could, on average, have a positive causal effect on the job-home distance and the total kilometers driven. On the other hand, workers with long commutes (e.g. living in remote areas or interested in job positions only available at potentially distant specific locations such as airports, harbours or capital cities) may specifically select jobs for which company cars are provided, to ease the commuting burden. In that case, the causal relation is inverted, and longer commuting distances imply, by selection, a higher chance of registering a company car in the household.

We do not seek a comprehensive model for an agent's decision on mode and commuting distance that would structurally address these uncertainties. Such a model would, among other characteristics, require specific company car attribution modeling, which is the subject of further research that extends far beyond the informational content of our data source. We rather focus on providing an estimate of the impact on kilometers driven of the hypothetic abrogation of the specific fiscal treatment of company cars[5]. To this aim, we do not necessarily need a fully-fledged structural model behind agents' decision processes, but can work with some reduced-form econometric model as long as endogeneity issues appear manageable. This model will provide an insight into the causal relation between the presence of a company car and number of kilometers driven, conditional on a series of control variables, as evidenced by our data source. To specify such a model, a qualitative consideration of the decision mechanism at work is nonetheless required, allowing us to propose a relevant functional form and a coherent selection of covariates. In what follows, we first deduce an appropriate econometric model specification from qualitative considerations regarding the demand mechanism for kilometers driven by car for commuting, and then discuss on this basis the endogeneity issues that may arise. The estimation results conclude this section.

[5] Using the formal vocabulary of treatment impact analysis, we seek an estimate of the (average) treatment effect on the treated, or (A)TT.

3.3.2. Model specifications

Distances driven by car for commuting purposes are not a direct decision by employees, but rather a consequence or a part of their labour market decisions. Agents maximise their net utility derived from work by balancing the income and cost consequences of accepting a specific job. Commuting cost is one among many aspects considered. This cost obviously depends on the job location and the place of residence of the worker, which determine the commuting distance. But it also depends on the job's accessibility in a broader sense: availability of public transport close to home and work, ease of parking close to home and work, compatibility of the job's time schedule with the public transport offering, provision of transportation means by the employer and other similar characteristics which have an impact on the generalised cost of commuting; that is, the cost in both time and monetary dimensions. The choice of a commuting mode is an integral part of the optimisation program of the worker when faced with a job opportunity in that it influences the generalised cost of commuting. All in all, one has to consider that, in making decisions about the job market, workers simultaneously choose a professional occupation, a commuting distance and the main mode of transport. This decision depends on job characteristics, household characteristics and transport-related variables.

As a consequence, for our empirical work, observed demand for distances driven by car in the commuting context can be considered ex post as a simultaneous decision regarding using a car, and how far to drive it, depending on the aforementioned characteristics. Although the underlying decision process diverges from the optimal choice problem for usual consumption goods, this strongly relates to the "participation decision/amount of consumption decision" framework of double hurdle models, which have been widely used in the consumer demand literature (see e.g. Deaton 1986). Application of such models to transport demand is still limited; but notably, Tsekeris & Dimitriou (2008) use such a framework to study demand for public transportation in Greece, and Eakins (2016) uses such models to study the demand for car fuels in Ireland. This type of model provides a flexible specification to accommodate the presence of numerous zero observations in the response variable, arising in our case when the modal choice for commuting is not the car.

The general idea behind these models revolves around two concepts: truncation and the separation of different aspects of the decision making in the modeling process. Truncation relates to the fact that consumption is positive, and hence bounded by zero below. Linear consumption equations must hence be truncated at zero. This leads to the archetypical Tobit (Tobin, 1953) model. The separation of different aspects in the decision making typically distinguishes between the decision to consume a given good at all and the choice of the amount to consume. That would be, in our case, the decision to commute by car, and the distance to commute. In the models based on this rationale, the observation of zero consumption may then have several sources: either the household is not willing to consume the good at all, for non-economic reasons (participation decision), or the household is willing to consume the good, but economic considerations produce a corner solution and the household demand is null (consumption decision). Both decisions can be related to different but overlapping sets of explanatory factors. This framework involving two adequately modelled causes for observing null consumption provides much safer theoretical ground for building econometric models fitting the data than a simple linear demand equation.

The first source of zero observation implies a binomial outcome variable (participation or not), which is typically related to Probit or Logit models when considered on its own. The second source of zero observations relates to truncation, and by itself points toward Tobit models. When considered simultaneously, these two sources of zero observation lead to the concept of double hurdle models. These models consider the two aspects simultaneously, and provide a unified and coherent econometric framework to estimate their features. Tsekeris & Dimitriou (2008) give a good account of the historic development of multiple hurdle models in this situation, while one may refer to Humphreys (2013) for a survey of associated econometric approaches. We will make use of this kind of model here, while keeping the simpler Probit model as a useful alternative (modeling the participation decision only) should the modeling of distance between job and residence locations prove inadequate.

In the case of work commuting modeling, one might more precisely argue in favour of a "first hurdle dominance" model within the broader family of double hurdle models. Such models assume that all households participating will have a strictly positive consumption. In our case, "participating" refers to choosing the car as the main mode of transport for commuting purposes, and as our sample consists only of employed individuals working at a fixed location outside the home, the commuting distance is always positive, hence "car kilometer" consumption is always positive when the car is the modal choice. In this case, the participation (modal choice) decision is modeled by a Probit model, and the consumption intensity is a log-linear model that ensures positive consumption. The two models may be related through correlation in the random effects: this allows for the possibility that unobserved factors impact simultaneously the modal decision and the distance to commute by car.

Formally we then have, for each observation i in the sample:

$$w_i = V_i'\gamma + \eta_i$$

$$d_i = \begin{cases} 1 \; if \; w_i \geq 0 \\ 0 \; if \; w_i < 0 \end{cases}$$

$$\ln(y_i) = \begin{cases} X_i'\beta + \varepsilon_i \quad if \; d_i = 1 \\ unobserved \; if \; d_i = 0 \end{cases}$$

$$(\varepsilon_i, \eta_i) \sim \mathcal{N}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & \sigma \end{pmatrix}\right)$$

Here, w is an unobserved latent variable that represents the probability of participating in the car commute market given observable characteristics V and unobservable characteristics summarised by the random factor η. We observe only d, the indicator of the modal choice of car. Variable y is the distance commuted by the car of interest, which is observed only when modal choice is the car, that is, $d = 1$. The explanatory variables for the modal choice of car V may be different from the explanatory variables for the distance commuted by car X, whereas the random effects ε and η have possibly non-null correlation ρ. The logarithm in the equation for y ensures that y is always positive, being the exponential of some real quantity. Such a model thus predicts a strictly positive number of driven kilometers by car for commuters that choose the car as a mode of transport, which obviously makes sense.

The alternative Probit model is obtained by considering only the first stage of this model, with d as the response variable, and dropping the second equation in y.

3.3.3. Estimation strategy

We now devote some time to our estimation strategy, given the potential presence of endogeneity. Two sources of problems can be distinguished. First, "car-lovers" may have the tendency to select jobs granting company cars, independently of transport related considerations. In this case, company car owners may on average show a higher propensity to use the car as a main commuting mode than other employees, even after the specific fiscal treatment of company car is abrogated, hence a typical case of selection bias. Second, as mentioned above, the direction of the causal relation between the presence of a company car and the commuting distance is unclear, pointing to a case of simultaneity bias.

To address the first issue, related to modal choice, we enrich the set of covariates in the model and perform the estimation on propensity score matched samples. We include all variables that may reflect a potential higher propensity to use a car in the modal equation that is in the V vector. In particular, we include variables reflecting a rather objective but not necessarily work-related need to use a car (such as the presence of children or the rural nature of the home district), as well as markers of an idiosyncratic preference for the car with the presence of more than one car in the household and the value index for the household cars except the most valuable. We then treat the issue as one of selection on observables, and trim the sample based on a propensity score matching procedure. This ensures company car owners are matched against employees in the survey sample with comparable characteristics in terms of both objective and idiosyncratic preference for cars.

The second issue, regarding the endogeneity of the distance from home to work, is more complex to address given our data source. Indeed, it would ideally call for a joint modeling of the commuting distance and company car attribution. We do not, however, have enough labour market information in our data source to propose a credible model for company car attribution. Basic data such as wages, the size of firms, detailed type of functions, work experience of employees or sector of activity of the firms are not available and would be required for such a model.

Rather than making wild guesses, we consider two cases in parallel which correspond to the extreme cases where one or the other effect dominate. This allows us to propose lower and upper bounds for the impact of the presence of a company car on the total number of kilometers driven by car for commuting purposes.

In the first case, when the commuting distance is considered endogenous and the presence of a company car exogenous, we cannot use the commuting distance in the matching process, as it is influenced by the treatment variable. But there is no simultaneity bias issue, and the double hurdle model, in its first hurdle dominance flavor, is adequate. We estimate this model on the sample matched on propensity scores excluding the commuting distance variable.

In the second case, where the commuting distance is considered exogenous and the presence of a company car endogenous, we can (and should) use the commuting distance in the propensity score model to perform the matching. But in this case, the double hurdle model makes no sense, as its second equation would suffer from an obvious reverse causality issue. Under the hypothesis that the presence of a company car does not cause a change in commuting distance, there is, however, no need to estimate this second equation to assess the impact of the abrogation of the fiscal treatment of company cars on car commuting distances. The Probit model of modal choice is sufficient to estimate this impact, and it is adjusted on the sample matched on propensity score including the commuting distance.

In table 11 we reflect the results of the propensity scoring model including commuting distance, as it provides an empirical insight into possible mechanisms at work in the attribution of company cars. Obviously, this cannot replace a thorough investigation of this aspect, including a proper economic modeling of the associated labour market agent's decisions. However, it provides some useful background for further research in this domain.

Table 11 Estimation results for the propensity scoring model

	Estimate	t-stat	Significance
Intercept	-9.68	-4.80	***
Value index of extra cars in the household	6.02	4.06	***
More than one car in the household	0.38	2.39	**
Log of commuting distance	0.20	3.33	***
Log of age	6.44	2.66	***
Log of age squared	-2.33	-2.64	***
Gender = female	-0.97	-6.99	***
Works in private sector	2.26	13.07	***
Professional level = low	-2.53	-8.65	***
Professional level = medium	-1.13	-7.62	***
Education level	0.45	5.37	***
Work = part-time 51-99%	0.75	1.69	*
Work = full-time	1.61	3.95	***
Region of residence = Flanders	-0.11	-0.62	
Region of residence = Wallonia	-0.67	-3.84	***
Variable work schedules	0.27	2.22	**

*** denotes significance at level 0.01, ** at level 0.05, * at level 0.10

Only significant variables are reported. Influential factors stemming from work characteristics are the sector of activity (a job in the private sector gives a much higher chance of being granted a company car than a job in the public sector), the professional level (which has a positive effect on the propensity to have a company car), the working hours (full-time jobs have higher chances of granting company cars than part-time jobs), and a variable work schedule, which has some positive impact on the propensity score. Personal characteristics of importance are the gender of the worker, with a much lower propensity to have company cars for women, and age with a maximum positive effect on the propensity to have a company car around 40 years for our quadratic specification. The region of residence has a significant influence, with Walloon workers showing a lower propensity to have a company car than Flemish and Brussels workers. The variable "more than one car in the household" has a positive impact on the propensity to have a company car. The variable "value index of the cars in the household except the highest valued" has a less significant but still positive impact. Thus our markers of idiosyncratic preference for the car indeed show a positive impact on the propensity score. Last but not least, the commuting distance also shows a significantly positive influence on the propensity score. Castaigne et al. (2010) make similar observations regarding the attribution of company cars, based on an ad-hoc survey.

Table 12 provides the estimation result for the two most useful models related to our two alternatives regarding the causality relation between commuting distance and the presence of a company car: the Probit model fitted to the sample matched on propensity scores including the commuting distance, and the first hurdle dominance model fitted to the sample matched on propensity scores excluding the commuting distance.

Table 12 Estimation results for commuting behavior

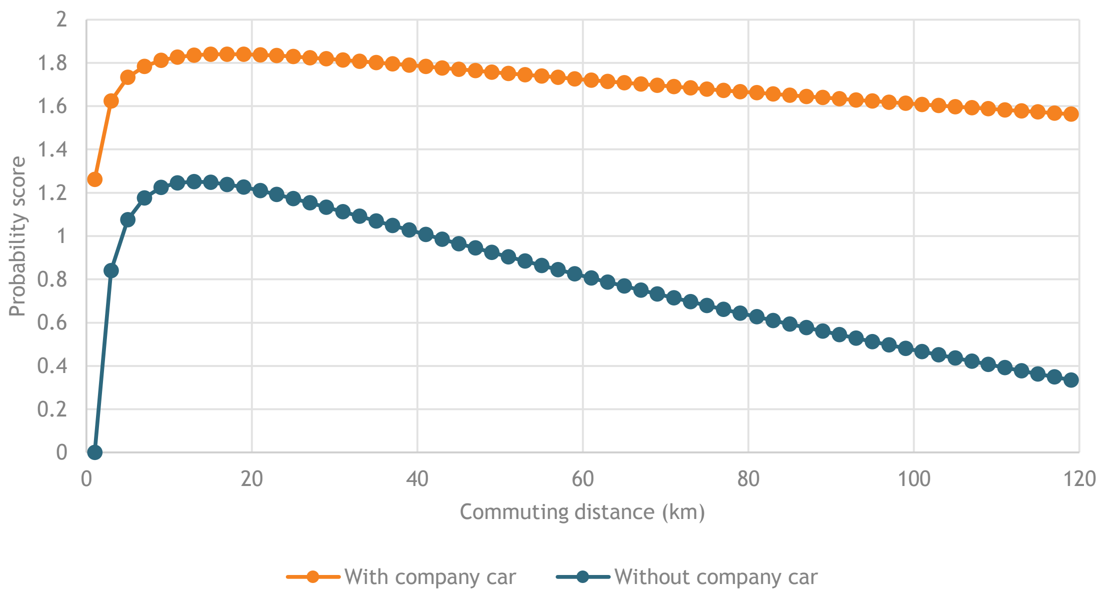
	Probit model			First hurdle dominance model		
	Estimate	t-stat	Significance	Estimate	t-stat	Significance
Modal choice - participation equation						
Intercept	1.22	0.58		1.08	0.56	
Value index of extra cars in the HH	2.49	1.67	*	2.51	1.71	*
More than one car in the HH	0.62	3.95	***	0.69	4.46	***
Has a company car	1.26	2.15	**	1.17	2.24	**
Log age	-0.73	-0.27		-0.02	-0.00	
Log age squared	0.30	0.32		0.18	0.21	
Log hh income	-0.34	-2.37	**	-0.34	-2.39	**
Work = part-time 51-99%	0.18	0.39		-0.54	-1.10	
Work = full-time	0.33	0.81		-0.29	-0.64	
Works in private sector	0.14	0.82		0.23	1.27	
Urbanisation level = 2	0.07	0.38		-0.05	-0.27	
Urbanisation level = 3	0.43	2.08	**	0.29	1.36	
Urbanisation level = 4	0.25	1.46		0.19	1.14	
Region of residence = Flanders	0.22	1.21		0.19	1.07	
Region of residence = Wallonia	0.43	2.28	**	0.37	2.01	**
At least one child in the HH	-0.08	-0.62		0.06	0.42	
At least to adults in the HH	-0.18	-0.98		-0.22	-1.21	
Number of wage earners in the HH	-0.10	-0.78		-0.14	-1.16	
Ease of parking close to workplace	0.73	5.52	***	0.72	5.35	***
Home far from public transportation	0.40	2.53	**	0.31	2.15	**
Variable work schedule	0.08	0.70		0.04	0.36	
No cc = log comm. Distance	0.97	3.37	***	0.90	3.75	***
No cc = (log comm. Distance) ^2	-0.19	-3.98	***	-0.17	-4.12	***
Cc = log comm. Distance	0.41	1.27		0.44	1.40	
Cc = (log comm. Distance)^2	-0.07	-1.20		-0.07	-1.26	
Distance equation						
Intercept				4.05	7.51	***
Log number of cars				0.12	0.98	
Professional level = low				-0.15	-0.84	
Professional level = medium				0.02	0.29	
Education level				0.10	2.13	**
Has a company car				0.13	1.83	*
Gender = female				-0.26	-3.05	***
Work = part-time 51-99%				-0.47	-1.66	*
Work = full-time				-0.04	-0.18	
Works in private sector				0.18	1.42	
Urbanisation level = 2				-0.05	-0.42	
Urbanisation level = 3				0.15	1.26	
Urbanisation level = 4				0.15	1.51	
Region of residence = Flanders				0.46	3.81	***
Region of residence = Wallonia				0.70	5.88	***
Has an alternative residence place				-0.27	-1.47	
At least one child in the HH				0.04	0.45	
At least to adults in the HH				0.17	1.40	
Number of wage earners in the HH				-0.06	-0.81	
Ease of parking close to workplace				-0.08	-0.70	
Home far from public transportation				0.17	2.10	**
Variable work schedule				0.03	0.47	
Standard deviation	1.04			0.92	39.7	***

*** denotes significance at level 0.01, ** at level 0.05, * at level 0.10

These estimation results identify several characteristics as significant in the determination of kilometers driven by car for commuting purposes. Based on the coefficient's sign and magnitude, and focusing on the statistically significant covariate only, the following summary can be sketched for the Probit model.

- The distance between the place of residence and the place of work has a significant impact on the *probability* of using the car as the main commuting mode. The probability of using a car grows quickly with the distance to cover, and then reaches a maximum around 20 kilometers. For distances above 20 kilometers, the probability of commuting by car slowly decreases with distance.
- The presence of a company car increases the probability of commuting by car, but also acts as a strong dampening factor on the effect of distance mentioned above. With a company car, the probability of using the car is always higher and much less impacted by the commuting distance. The evolution of the linear probability score with the distance is depicted in graph 1.
- Another strong influence on modal choice stems from the ease of access and use of the different alternatives. The probability of using a car is positively impacted by the ease of parking at the work location, and by the distance to the nearest public transport means from home.

Graph 1 Influence of distance and company car on the probability of commuting by car



- The impact of geography is notable on the probability of using a car. Typically, residential commuter suburbs record more car users, as does Wallonia, with, however, a lower significance level.
- Finally, the household's characteristics have a mixed effect on modal decisions. The presence of at least one child has no significant effect, maybe against intuition, whereas the presence of more than one wage earner has a negative impact on the use of car. This last point might be related to the fact that only drivers are registered as using a car in our setup, while the model works at the individual level. In households with more than one active adult, car-sharing inside the household will spread the common use of the car over several individuals, thereby mechanically dividing the estimated probability of using the car *as a driver* in such households. This may also explain the negative coefficient recorded for the stated household's net income, which seems counterintuitive at first.

When considering the first hurdle dominance model, impacts on the first equation – related to modal choice – are similar to those recorded for the Probit model above. The only difference is the matching procedure, which does not include the commuting distance as a matching factor here. This has a limited impact in terms of results for this first equation. The relevant factors for the distance equation in the first hurdle dominance model are:

– A limited positive impact of the presence of a company car. The coefficient for this factor is not the most significant in the model.

– A strong impact of gender, with women showing on average shorter commuting distances, as well as of the region of residence, with both Wallonia and Flanders logically showing longer commutes than Brussels, and Wallonia still in significant excess of Flanders in this aspect.

– Other less significant factors with an influence on the total commuting distance are the education level, with higher-educated workers travelling on average longer commuting distances, as is the case for private sector workers compared to public sector workers.

3.3.4. Impact analysis

The interpretation of the sign, magnitude and significance of the model parameters provides us with useful insight regarding the factors' importance in explaining the variation in car usage for commuting. But to assess the effect of abrogating the specific fiscal treatment of company cars, we need to compute the global marginal effect of the related factor in the model. This is somewhat more cumbersome for such models than for regular linear models, especially due to the presence of significant interactions[6] between the presence of a company car and distance variables. We report "average treatment effect on the treated", that is the average difference computed for company cars owner were they to trade their company car for a normal car, or in other words, were the specific fiscal treatment to be abrogated. Results are for the two models highlighted above and include bootstrapped confidence intervals at 90%, as well as a decomposition[7] of the marginal effect between the part stemming from changes in the probability of using a car, and that stemming from changes in the commuting distance. Writing y for the kilometers driven by car and x for the set of explanatory factors, and *x:cc* the current set of factors for company car owners vs. *x:ncc* the counterfactual set of factor with all company cars replaced with normal cars, we have:

$$Total\ marginal\ effect = \mathbb{E}(y|x : company\ car) - \mathbb{E}(y|x : no\ company\ car)$$

$$\begin{aligned}
&= \mathbb{P}(y>0|x{:}\,cc)\cdot\mathbb{E}(y|y>0,x{:}\,cc) - \mathbb{P}(y>0|x{:}\,ncc)\cdot\mathbb{E}(y|y>0,x{:}\,ncc)\\
&= [\mathbb{P}(y>0|x{:}\,cc)-\mathbb{P}(y>0|x{:}\,ncc)]\cdot\mathbb{E}(y|y>0,x{:}\,cc) + \mathbb{P}(y>0|x{:}\,ncc)\cdot[\mathbb{E}(y|y>0,x{:}\,cc)-\mathbb{E}(y|y>0,x{:}\,ncc)]\\
&= [probability\ difference]\cdot current\ distance + counterfactual\ probability\cdot[distance\ difference]\\
&= Probability\ effect + Distance\ effect
\end{aligned}$$

Results are in kilometers per week for one way commutes, or percentage points for probabilities.

6 Not only do we have two equations involving the company car variable, but this variable also appears in interaction with other variables. Ad hoc computations are thus required.

7 The principle here is mimicking classical shift-share analysis.

Table 13 Marginal effects of a company car on probability of using a car and on distance travelled for commuting (one way)

Effect	First hurdle dominance	Probit
Total marginal effect	40.4 (25.9 - 57.8)	29.1 (20.1 - 37.4)
Probability effect	25.3 (19.1 - 31.8)	29.1 (20.1 - 37.4)
Distance effect	15.2 (1.2 - 30.6)	0
Probability difference (pp)	15.9 (12.2- 19.2)	15.9 (11.8 - 19.9)
Distance difference	19.4 (1.5 - 40.0)	0

To provide a unique estimate of the impact of company cars on commuting kilometers driven by car, we choose to stick to the Probit model. Two reasons, different in nature, guide this choice. First, on an economic basis, as mentioned above, this model corresponds best to the hypothesis where the commuting distance is exogenous, hence considered fixed independently of the provision or not of a car by the employer. This hypothesis implies that, were the specific fiscal treatment of company cars to be abrogated, employees would not change job or relocate their residence to reduce their commuting distance. This seems a reasonable hypothesis, at least in the short run, for the Belgian labour and housing markets. Mobility in the Belgian labour market is not high, and it is even less so in the Belgian housing market. Then, on a statistical basis, the confidence intervals computed for the "distance effect" based on the alternative hypothesis and the first hurdle dominance model are very large, and do not rule out a null effect. It therefore seems more appropriate not to make use of the larger average total effect obtained under this alternative hypothesis, but to favour the more robust and more cautious effect computed using the Probit model under the fixed distance hypothesis. We can hence propose an estimated effect of abrogating the specific fiscal treatment of company cars on kilometers driven for commuting purposes: this would decrease by some 29 km per week the (one way) amount driven by current owners of company cars on average. This difference would be due solely to a decrease of some 16 percentage points in the share of car users among current company car owners. Standing at 92.1% in our sample, this share would thus decrease to 75.1%. This is fully in line with other research for Belgium. This would remain above the 68.9% share of individuals using the car for commuting purposes while not having a company car in our sample, 3/4 of the current difference being thus attributed to the presence of a company car, as opposed to other explanatory factors. The current average usage for company car holders commuting by car is 152.19 km, and would thus decrease to 123.0 km, as compared to a current average of 100.11 km for car users without a company car. Here, more than half of the current difference appears to stem from the presence of a company car. Note that this reduction in average usage is due only to a decrease of the probability to use the car concentrated on company car holders with the longest commutes should the fiscal regime be abrogated: the individual commuting distances remain fixed. Indeed, the impact of the fiscal regime applicable to company cars on the total commuting distance is supposed to be negligible in these figures, as we cannot presently estimate it unambiguously.

We conclude this part with the restatement of its main result: **the abrogation of the specific fiscal regime for company cars would, according to our estimates, decrease the number of kilometers driven for commuting purposes by some 58.2 km per week, or around 2 794 km per year for current company car users.**

3.4. Travel for other purposes: the trip dataset

3.4.1. Empirical setup and estimation strategy

Having considered the case of travel for commuting purpose in the preceding section, we concentrate now on the distances traveled by car for other purposes, seeking to assess the effect of the presence of a company car in the household on the latter quantity. The data consist of a sample of individual trip-logs for a given survey day, linked to individual and household characteristics. We restrict the sample to employed persons owning a car. Though trips by car for other purposes without owning a car are possible – for example by way of renting a car – less than 2% of the individuals in households without a car do so in our sample. As a result, including households without a car in the study would lead to artificially enhancing the model fit statistics by including the appropriate explanatory variable "car ownership" without any benefits in terms of modeling the effects of company cars.

The trip log provides transport modes, trip duration and distance for each mode, the purpose of the trip and the type of day (weekday, weekend or holiday). We will exploit the dataset at the individual level, which allows the greater amount of detail in the potential explanatory variables. Obviously, an exploitation at the household level would have somewhat smoothed out the data by aggregating trips of the household members, and hence removed some of the high noise present in such granular data. This appears, however, to come at too great a cost after studying both alternatives. Table 14 gives some descriptive statistics for our sample.

Table 14 Individual dataset for other purposes: descriptive statistics (weighted)

	Daily vkm by car		Daily vkm by car for car users		Probability of using a car
	Mean	SD	Mean	SD	
Whole sample	17.8	38.6	33.3	47.8	53.4%
Company car	29.5	43.5	42.1	56.6	70.0%
No company car	15.5	32.9	30.7	41.0	50.6%
N	4079				4079

We will resort to similar econometric tools to those referred to in the preceding section, with two noteworthy differences. First of all, as trips for other purposes do not relate to work by definition, the endogeneity issues encountered for commuting do not appear crucial in this context. Activities that generate the trips we study here are mostly unrelated to the agent's decision on the job market (most trips are related to one of "shopping", "visiting family or friends", "culture and leisure" or "picking up someone"). Indeed, results obtained with or without propensity score matching are similar, and the uncertain link between the presence of a company car and the commuting distance noted before has no equivalent in the present analysis. Secondly, in this case, we may expect the full double hurdle model to better fit the data as compared to the first hurdle dominance model used for commuting. Indeed, as opposed to the commuting situation, the amount of travel consumed for other purposes is more granular, with decisions possibly being made for several trips each day, whereas the commuting decision is a long-term decision. Moreover, the observation is over a single day. Hence the potential for zero observations stemming from true corner solutions for participating households or individuals is greater for this dataset.

Following the same reasoning, we use a double hurdle model to estimate jointly the probability of using the car as mode of transportation for purposes other than work or commuting, and the amount of kilometers effectively driven by car. In our case, a first hurdle equation will model the probability of choosing the car as a transport mode, and the second hurdle equation defining traveled distance by car will allow for a corner solution, that is, distance traveled by car may be zero even if the car is the favoured mode of transportation, for economic (cost) or non-economic reasons (e.g. lack of parking possibility at destination, unavailability of a car on the day of the trip, etc.). Using the same notations as above, we can formally write the model as follows for each observation *i* in the dataset:

$$w_i = V_i'\gamma + \eta_i$$

$$d_i = \begin{cases} 1 \; if \; w_i \geq 0 \\ 0 \; if \; w_i < 0 \end{cases}$$

$$z_i = X_i'\beta + \varepsilon_i$$

$$y_i = \begin{cases} z_i & if \; d_i = 1 \; \textbf{and} \; z_i > 0 \\ 0 & if \; d_i = 0 \; \textbf{or} \; z_i \leq 0 \end{cases}$$

$$(\varepsilon_i, \eta_i) \sim \mathcal{N}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & \sigma \end{pmatrix}\right)$$

This model thus provides ample flexibility to accommodate the high number of zeros in our trip dataset (44% of the sample show no driven car kilometers for other purposes on the day of survey). For the sake of comparison, we also provide results for a simpler Tobit model on this dataset. The Tobit model has no participation decision equation, and thus explains zero observation only as corner solutions (e.g. all households are willing to travel by car, but may not do so for economic reasons).

The results of the double hurdle model are shown in the first two columns of table 15, with the third column containing the Tobit model results. The first column provides estimation for a double hurdle model with independent equations, whereas the second column summarises the same information for a model with dependence, hence providing an estimated correlation between unobserved factors. The correlation proves significant and entails some minor changes in parameter estimates. This points toward the presence of unobserved factor affecting both the probability of using a car, and the desired distance traveled with a car for other purposes. The effect of these unobserved factors are overall in opposite directions for the two equations, as witnessed by the negative value of the correlation coefficient. Model comparison tests[8] give an advantage to the model with correlation, but not a statistically significant one, with a p-value around 20%. Moreover, the estimation of such models in the presence of a correlation parameter is notoriously unstable, as the statistical information present in the model is usually insufficient to estimate properly the dependence parameter between equations (see Smith 2003). We shall therefore not favour the dependent model over the independent one, but see how results potentially diverge before making a final choice on the matter. Results for the first hurdle dominance model are not displayed: they yielded a significantly worse fit to the data and are not deemed relevant. This can be seen as a confirmation that both market participation and corner solutions are essential in explaining the observed zero outcomes in our dataset. A statistical test shows that the double hurdle

[8] We perform Vuong tests based on the Kulback-Leibler information criterion.

model fits the data significantly better than the Tobit model, although the goodness of fit measure seems equivalent. Again, such R-squared type measures are not really usable for model comparison in limited dependent variable setups.

These estimation results identify several characteristics as significant in the determination of kilometers driven by car for other purposes by individuals in households owning at least one car. Based on the coefficients sign and magnitude in the independent model, and focusing on statistically significant covariate only, the following summary can be sketched:

- The presence of a company car has a marked effect on the probability of using a car for other purposes. The related parameters are positive on weekdays and holidays, but appear not to be significant on weekends. However, separate models for weekdays and weekends (not shown here) yield significant parameters for the presence of a company car, but of lower magnitude on weekend days. This result departs from the findings of Gutierrez & Van Ommeren (2011), where only weekend days yield significant company car effects. But the modeling framework and data sources are widely different, hampering a really meaningful comparison.
- Another important set of factors in the model relate to usual commuting habits. Indeed, usually commuting to work by car implies a significantly higher probability of choosing the car as a mode for other purposes. That said, the fact of having commuted by car the very day of the trip survey leads to significantly shorter trips by car for other purposes. Without this being explicitly modelled, one may explain this fact by the occurrence of combined trips, where the commute to or from work is taken advantage of to pursue other goals, thereby shortening the trip distance needed for e.g. shopping or leisure motives that would otherwise need a specific trip.
- Demographic variables have significant parameters, with a significant gender effect: women appear less prone to use car for other purposes, and on average travel shorter distance when doing so. Higher age does not seem to impact the probability of choosing the car as a mode, but does lead to shorter distances as well. Having children in the household significantly raises the probability of choosing the car as a mode, which should be expected as it often proves to be a more convenient mode should children be involved. The presence of two adults or more in the household has a significant negative effect, but here again, as in the commuting model, it is at least partly a mechanical effect of modeling at the individual level: when travelling together, two adults in the same household contribute only one half to the average probability of using a car.
- Geographical variables have an effect, though less pronounced than in the commuting model. Individuals in rural areas quite logically choose to use a car more often, whereas individuals in a "commuter area" travel longer distances by car. This latter effect may be linked to the purely residential nature of these areas, involving traveling longer distances to find specific services than in both urban or rural (village) areas. As for commuting, Walloon individuals have higher probability to choose car trips, and there is a significant ranking for distance, with Brussels region residents displaying the shortest distances by car for other purposes, and Walloon residents the longest.
- It is worth noting that the level of education is positively linked to both the probability of using a car and the distance travelled therewith for other purpose. This could be labelled a "lifestyle" effect, associated with a higher use of car for leisure and cultural activities, potentially far from home or even abroad.

Table 15 Model estimates: driven kilometres for other purposes

	Independent model			Dependent model			Tobit model		
	Estimate	t-stat		Estimate	t-stat		Estimate	t-stat	
Participation equation									
Intercept	-0.26	-0.52		-0.29	-0.59				
Day type = weekend	0.09	1.28		0.11	1.79	*			
Day type = weekday during holidays	0.18	3.14	***	0.17	3.36	***			
Used the car to commute that day	-0.30	-5.69	***	-0.31	-5.99	***			
Uses the car to commute usually	0.76	13.68	***	0.77	13.95	***			
Has a company car	0.43	5.00	***	0.44	5.30	***			
Log income	-0.09	-1.62		-0.08	-1.45				
Log age	0.04	0.50		0.04	0.51				
Gender = female	-0.12	-2.72	***	-0.13	-2.88	***			
Urbanisation = 2	-0.03	-0.51		-0.03	-0.39				
Urbanisation = 3	0.02	0.29		0.03	0.38				
Urbanisation = 4	0.10	1.68	*	0.12	1.94	*			
Region = Flanders	0.10	1.33		0.08	0.99				
Region = Wallonia	0.26	3.61	***	0.25	3.51	***			
Child in the household	0.18	3.77	***	0.13	3.03	***			
Two adults in the household	-0.28	-4.57	***	-0.23	-4.23	***			
Education level	0.14	4.67	***	0.13	4.49	***			
House ownership status = tenant	-0.13	-2.15	**	-0.14	-2.35	**			
House ownership status = other	-0.08	-0.43		-0.04	-0.20				
Weekend & has company car	-0.56	-3.05	***	-0.43	-2.66	***			
Weekday during holidays & has company car	0.00	0.00		-0.07	-0.53				
Demand equation									
Intercept	3.74	6.16	***	4.57	6.72	***	0.49	0.41	
Used the car to commute that day	-0.45	-9.05	***	-0.24	-3.90	***	-0.83	-7.40	***
Uses the car to commute usually	0.1	1.55		-0.38	-3.84	***	1.73	14.04	***
Has a company car	0.25	3.53	***	0.05	0.57		1.13	6.14	***
Log income	0.05	0.85		0.12	1.97	**	-0.17	-1.30	
Log age	-0.42	-4.23	***	-0.47	-4.20	***	-0.18	-0.97	
Gender: female	-0.19	-3.74	***	-0.14	-2.47	**	-0.39	-4.01	***
Child in the household							0.39	3.66	***
Two adults in the household							-0.62	-4.68	***
Urbanisation = 2	-0.04	-0.52		-0.02	-0.21		-0.08	-0.50	
Urbanisation = 3	0.19	2.34	**	0.18	1.90	*	0.18	1.16	
Urbanisation = 4	0.06	0.98		0.01	0.09		0.27	2.07	**
Region = Flanders	0.25	2.80	***	0.18	1.82	*	0.40	2.35	**
Region = Wallonia	0.43	5.11	***	0.28	2.92	***	0.84	5.31	***
Education level	0.07	1.98	**	-0.01	-0.24		0.28	4.28	***
House ownership status =	0.15	2.28	**	0.23	2.98	***	-0.19	-1.47	
House ownership status = other	-0.15	-0.71		-0.10	-0.43		-0.23	-0.59	
Day type = weekend							0.24	1.62	
Day type = weekday during holidays							0.46	3.63	***
Weekend & has company car							-1.27	-3.20	***
Weekday during holidays & has company car							-0.32	-1.08	
Correlation between equations				-0.75	-11.80	***			
N obs used	3791			3791			3791		
R^2	0.14			0.14			0.13		

3.4.2. Impact analysis

The interpretation of the sign, magnitude and significance of the model parameters provides us with useful insight regarding the factors' importance in explaining the variation in car usage for other purposes. Here again, to assess the effect of removing the specific fiscal treatment of company cars, we need to compute the global marginal effect of the related factor in the model. We report the counterfactual distance reduction (the average difference computed for company cars owner were they to give up their company car) for the three models considered in table 16, as well as the bootstrapped confidence interval for a 90% confidence level.

Table 16 Marginal counterfactual effect of the presence of a company car on kilometres driven for other purposes

Model	Independent	Dependent	Tobit
Total effect	6.7 *(4.2 - 8.7)*	13.3 *(6.5 - 23.8)*	7.9 *(5.2 - 10.1)*
Probability effect	3.3 *(2.1 - 4.4)*	9.7 *(3.8 - 17.3)*	2.3 *(1.4 - 3.0)*
Distance effect	3.4 *(1.7 - 5.3)*	3.7 *(-4.3 - 8.9)*	5.6 *(3.7 - 7.2)*
Probability difference (pp)	12.5 *(8.5 - 16.2)*	12.4 *(8.4 - 15.9)*	10.9 *(7.8 - 14.0)*
Distance difference	5.9 *(3.0 - 9.2)*	6.4 *(-8.6 - 15.5)*	8.2 *(5.4 - 10.4)*

The rather unstable estimates produced by the double hurdle model with dependence are striking, reading this table[9]. Confidence intervals are very large, and the distance effect cannot be qualified as significant given the variability of estimates, even if on average it appears higher than for the independent model. Therefore, we shall focus on the independent model on the sequel. As in the previous section, but with much less emphasis, the Tobit model tends to underestimate the probability effect, despite having relatively larger parameter estimates, which lead to an important estimated distance effect. Again, the Tobit model is statistically dominated by the independent model, hence the effects computed based on the latter are to be favoured.

On the basis of the independent model, we can hence propose an estimated effect of abrogating the specific fiscal treatment of company cars on kilometers driven for other purposes: this would decrease the amount driven by current owners of company cars on average by some 6.7 km per day. This difference would be due to, on the one hand, to a decrease of some 12.5 percentage points in the share of car users among current company car owners. Standing at 70.0% in our sample, this share would thus decrease to 57.5%. This would remain above the 50.6% share of individuals using the car for other purposes while not having a company car in our sample, some 65% of the current difference being thus attributed to the presence of a company car, as opposed to other explanatory factors. On the other hand, the total driven distance for other purposes by individuals choosing to travel by car would decrease as well for company car users, leading to a decrease of some 5.9 km in the average daily car usage for current company car owners using their car for other purposes. The current usage is 56.6 km, and would thus decrease to 50.7 km, as compared to a current average of 41.0 km for car users without a company car. Here, a little more than one third of the current difference in distance appears to stem from the presence of a company car.

[9] One typically witnesses a very high variability of the correlation parameter on the bootstrap subsamples, which leads to a high volatility of distance effects.

We conclude this part with the restatement of its main result: **the abrogation of the specific fiscal regime for company cars would, according to our estimates, decrease the number of kilometers driven for other purposes by some 6.7 km per day or around 2 445km per year for current company car users**. **This translates to 11.8 km per day and 4 304 km per year for one household, based on the average number of adults per household in our sample**. **Given an average distance-weighted occupation of 1.4 per vehicle, this translates into 8.2 vehicle km per day, or 2 993 km per year.**

Aggregating the results from the models for commuting and for other purposes, we can conclude that **the abrogation of the specific fiscal regime for company cars would, according to our estimates, decrease the number of kilometers driven for purposes other than work by some 5 787 km per year for households with a company car. This is indeed less than the 12 077 km grossly estimated reduction based on the total driven distance provided by our first model, this latter quantity including kilometers driven for work-related purposes and the impact of selection effects. The discussions related to the different models above also provide support for the conservativeness of our estimate. Results obtained by other authors for Belgium are more pronounced, with Castaigne et al. (2010) reporting a partial effect around 9 200km per year for the presence of a company car in a multiple linear regression model of car usage based on an ad-hoc survey, but without specific treatment of selection bias.**

4. Estimating welfare effects

In the previous section, we have estimated the demand effects of the current company car regime. In this section, we translate these demand effects into welfare losses to society as a whole. As argued in section 2, total welfare changes ΔW can be understood as the sum of changes in consumer surplus ΔCS and changes in external costs ΔEC.

$$\Delta W = \Delta CS + \Delta EC = \frac{1}{2} \cdot {}^{\Delta p}/_{p}\, \Delta x + \Delta x(MEEC + MECC)$$

In this formula, ${}^{\Delta p}/_{p}$ is the relative price change due to the tax subsidy, Δx is the induced demand effect (in terms of kilometres driven, and car value). $MEEC$ and $MECC$ are marginal external environmental costs and marginal external congestion costs of extra kilometres driven, respectively.

Following formula x, the relative price change is:

$${}^{\Delta p}/_{p} = {}^{(p-(p-H)\tau - p)}/_{p} = -(1 - {}^{H}/_{p})\tau$$

We therefore simply need an estimate of the marginal tax rate τ facing company car users, and the imputed value for tax purposes of the benefit as a percentage of the price. We follow Harding (2014) in assuming that the relevant marginal tax rate is 61%, which is the all-inclusive rate comprising of personal income taxes and employee social security contributions, for a high – income earner. For kilometres driven, the value of ${}^{H}/_{p}$ is 0, since the fuel card is exempt of taxation. For the car itself, it is 55% (Harding, 2014).

The tax subsidy in relative terms is therefore 61% for kilometres driven, and 27.45% for the car.

The central demand effects Δx are:

– For the value of the most expensive car in the household: an increase of 62%

– For weekly commuting kilometres: 58.2 vkm per week

– For leisure travel: 8.2 km per day

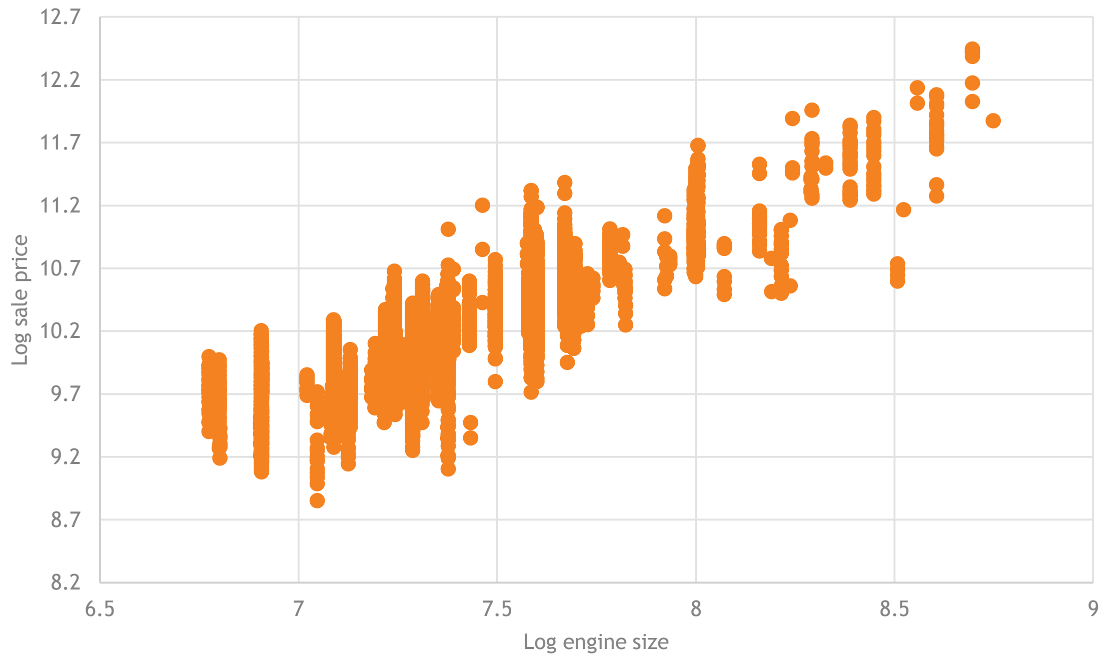
To arrive at yearly values, we assume people work 48 weeks per year. The average number of company cars is about 383 400, based on the simulation based on tax return data by the finance ministry for 2011.

Finally, we need additional data relating to prices of a car and of kilometres driven, as well as marginal external costs.

In order to calculate the components of ΔCS, the demand effects must be monetarized. For vehicle km driven, we dispose of data of tax inclusive variable costs per vkm driven. For the year 2012, it is about 0.14 euro per kilometre according to the PLANET database.

For the annual car expenditure, we assume a value of 5 800 per annum. (Harding, 2014) This includes the depreciation rate, interest and insurance, registration and annual circulation taxes as a percentage of the car purchase value. Since we don't directly measure the impact of the company car regime on the value of a car, but only on the number of CC's owned by a household, we need a relationship between engine size and car prices. On the basis of www.vroom.be, an online portal for car manufacturers, we are able to estimate such a link. As graph 2 shows, there is indeed a close relationship, with car price increasing by 1.3% with each 1% increase in engine size.

Graph 2 Relation between engine size and car value



Engine size is clearly not the only factor influencing car prices. Within each engine size class consumers have access to a range of options and car types that also determine the price of the vehicle. It can be safely assumed that company car users opt not only for bigger cars, but also choose more expensive models regardless of engine size. Our calculation of the welfare costs due to more expensive cars based on the link with engine size alone is therefore likely to be underestimated.

In order to value the external costs of vehicle kilometres driven, we use marginal external cost data from PLANET database. For environmental costs, we assume about 1.4 cents per vkm. This is as an average over the whole car park, which may be an underestimate since company cars are more likely to be diesel cars. On the other hand, they are also relatively newer vehicles which are on average cleaner. Moreover, for this calculation we assume marginal environmental costs do not change as a result of the policy, even though the increase in engine size reported in table 8 suggest this may be the case.

For time costs, we distinguish between motives. For commuting, the value is 44 cents, while for other motives, it is 14 cents per vkm. This is due to the fact that most commuting takes place during the peak period, as opposed to leisure trips.

Table 17 shows the result of the welfare calculation by car and for the economy as a whole, putting all the pieces together. Note that external congestion costs are a multiple of the ordinary distortions of demand for vehicles and kilometres. The social costs amount to 0.23% of GDP, or 2 361 euro per car, per annum. According to our estimates, 27% of societal losses are due to negative changes in consumer surplus, 69% due to additional congestion and 4% due to more air pollution.

Table 17 Annual welfare effects by car and aggregate levels

	Euro per car	M euro total	Total in % GDP
ΔCS: Distortion value / size of cars	396	152	0.04
ΔCS: Distortion commuting kilometres	119	46	0.01
ΔCS: Distortion kilometres other purposes	128	49	0.01
ΔEC: Congestion	1637	628	0.16
ΔEC: Air pollution	81	31	0.01
Total	2361	905	0.23

We would like to stress that in one important way these figures may be an underestimate, as is argued in Gutierrez and Van Ommeren (2007). Throughout the analysis, we assumed car costs are not influenced by the tax regime, which is tantamount to assuming that car markets are perfectly competitive, with a horizontal supply curve. Since Belgium is a small country importing most of its fleet, this may not be a bad assumption[10].

If the car market would be oligopolistic, as may be the case for different types of cars, our results are an underestimate. This is due to the fact that the fiscal subsidy would allow foreign car producers to increase their prices, which would mean they would capture part of the tax expenditure. The welfare of the whole of the Belgian economy would then go down by the same amount. If foreign car manufacturers are able to fully increase their prices, the distortion associated with the value of cars would be equal to the tax expenditure itself, which according to Harding (2014) is about 2 590 euro per car. Analysing the price reaction of car manufacturers is beyond the scope of this paper, however.

[10] In 2014, Belgium imported almost a million personal cars. About 516 000 where manufactured in Belgium, of which 490 000 were exported. (NBB and Febiac)

5. Discussion

This paper has attempted to estimate the impact of having a company car on car size, value and the number of vkm kilometres driven for private trips. The effects that have been found are quite large, though not extreme as compared to other similar studies in Belgium and the Netherlands. The value of the first car in the household increases by 62%, while the number of weekly kilometres by car for commuting rises by 58.2 km. Daily car vkm for other (private) purposes rises by 8.2 km per day, per household.

This excessive use of the car translates into large annual welfare losses. Per car, these are estimated at 2 361 euro per annum, most of which are due to external congestion costs and excessive consumption of car units and kilometres driven. 81 euro per car is lost due to additional emissions of greenhouse gases and air pollutants. Total losses to society amount to 0.23% of GDP.

It should be noted that the estimates in this paper only give effects of a wholesale abolishing of the current company car regime. In reality, policy changes are more likely to be piecemeal, and may be accompanied by compensatory measures, such as lowering labour income taxes or increasing subsidies on commuting by other modes. The results in this paper could be used to calibrate a simulation model that analyses the effects of more realistic policy packages.

It should also be noted that the welfare effects on this model are of a partial equilibrium nature. When interactions with other markets are significant, conclusions may change. For example, if less car use leads to more intensive use of public transport, one should take into account the second order effects from such a shift on public finances and the environment as well. This may be done by embedding this model in a general equilibrium model.

Some of the results in this paper point to further research. For example, we noted that the effect of the company car on car use for other purposes than commuting was largest during the weekdays. This may suggest that people build trip chains: commuting is combined with other trip purposes such as shopping or driving children to school. If this is the case, policies that influence commuting may have spillovers onto other markets as well.

The link between the presence of a company car and the observed distance between place of residence and place of work is another topic for further research. In this paper, while we acknowledge the existence of such a link, the home-work distance has been considered exogenous, which at best is a hypothesis valid only in the short term. More generally, developing a more sophisticated labour market model would allow this and other issues, such as the mechanism for company car attribution, to be addressed more robustly. Relying on such a model will make endogeneity and selection issues more transparent and provide workarounds, and therefore prepare the ground for more precise estimates.

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