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Welfare Effects of Distortionary Company Car Taxation

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WELFARE EFFECTS OF DISTORTIONARY FRINGE BENEFITS TAXATION: THE CASE OF EMPLOYER-PROVIDED CARS

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Abstract

In Europe, for many employees, the employer-provided car is the single most important fringe benefit. Company cars are provided by employers as fringe benefits to their employees at a lower price than employees pay in the car market, mainly due to favourable taxation of company cars. We analyse the welfare effects of favourable taxation of company cars for the Netherlands. The annual welfare costs of the distortionary taxation of company cars are estimated to be substantial and at least €2,000 per company car. For the whole of Europe, the welfare costs of distortionary taxation of this fringe benefit are estimated to be at least €40 billion per year.

Keywords: Fringe benefits; taxation; company car; welfare

JEL classification: D12; D61; J33; R41; R48

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1. Introduction

One of the core activities of many economists is to focus on the optimal setting of taxes in the economy. Not surprisingly, labour market economists spend a lot of time analysing the effect of income taxation on the welfare in the economy. The majority of the latter research focuses on the distortionary effect of taxation of wages. Although the supply and demand for fringe benefits receive a lot of attention in economics textbooks (e.g., Ehrenberg and Smith, 2003), the effects of distortionary fringe benefits taxation receive little attention in the recent empirical literature.[1] This may be justified as previous studies have found that the distortionary effect of fringe benefits taxation is small (Turner, 1987). However, these studies have ignored the provisions of cars by employers, the so-called company cars, which in Europe have become by far the most important category of fringe benefits. Employer-provided cars are cars that are owned or leased by employers and provided to their employees for *private* usage. The employer pays for the car (or the car lease) including insurance, repairs and taxes. Furthermore, it is common that the employer pays for fuel consumption of private trips.

Company cars are extremely common. For example, in the Netherlands, which will be the focus of our empirical analysis, about one in seven male employees and one in 38 female employees has a company car (Statistics Netherlands, 2003). Compared to other European countries, the Netherlands seems to take an average position in this respect, whereas in the UK company cars seem to be more commonly used than anywhere else in the world.[2] Company cars are not only frequently received by employees as a fringe benefit, they are, apart from the wage, the single most important compensation for the employees' labour activity: the average annual cost of a company car is around €10,000 (the exact amount depends on its use), substantially more than other fringe benefits (including pensions). It is therefore not surprising that company cars, and their taxation, are an important discussion topic in the political arena of many countries, mostly in Europe but also in Israel.

[1] One exception is healthcare benefits in the US (e.g., Gruber, 2001; Gruber and Lettau, 2004).
[2] In Europe, 42% of all *new* personal cars sold are bought by firms (including rental companies). In the Netherlands, this percentage is 43%, just above the European average (Economist Intelligence Unit, 1996). It has been estimated for the Netherlands that about 12% of the *stock* of personal cars are company cars.

As we will explain later on, labour market theory is quite clear about the optimal taxation of fringe benefits (which takes into account that fringe benefits may be productive for the firm), and it is not so hard to see that in the Europe the tax system is likely far from optimal in this respect: company cars are provided to employees at an effective price that is in the range of 20 to 60% lower than when bought in the car market. Only under very specific circumstances can such a high tax advantage be justified. It is therefore rather surprising that we know of no attempt to estimate the welfare effects of the tax system in Europe regarding the single most important fringe benefit: the company car.[3]

In the current paper, we are interested in estimating the welfare effects of distortionary taxation of company cars. We will take into account that firms provide cars to employees as fringe benefits at lower prices than the market due to three reasons[4]: (i) the presence of lower income-taxes on company cars than wages, (ii) firms are able to buy or lease cars at lower prices than consumers or (iii) company cars can be used for business purposes. The latter implies that company cars may provide additional revenue for the firm, and are therefore productive. For instance, it is plausible that a sales person with a car is more productive than a sales person without a car, because the former may spend less time on travelling to potential clients than the latter.

Taxation of company cars has already been described as distortionary in the 1980s (see Ashworth and Dilnot, 1987), but its consequences have not been empirically addressed. Distortionary taxation may have large negative welfare implications through overconsumption of cars which may be revealed in a number of ways.[5] Our emphasis is on the welfare effect of distortionary taxation of company cars through a change in *household car ownership*, defined

[3] We are only aware of one attempt to estimate the effects of changes in UK taxes on company cars in terms of environmental implications (e.g., Inland Revenue, 2004), but our study indicates that the welfare implications are not so much driven by the use of the car but by the increased household demand for cars.

[4] These reasons do not differ from the ones that explain why other fringe benefits such as personal computers, mobile phones etc. are supplied. Reasons why profit-maximizing firms offer fringe benefits to employees can be found in the employees' compensation literature (e.g., Ehrenberg and Smith, 2003). Fringe benefits do not generate as much value to employees as net wages of equal monetary value, because employees prefer wages to non-monetary benefits. Fringe benefits are attractive only when firms supply them at lower prices than employees would pay in the goods market. It is then economical to offer fringe benefits to employees for private usage and simultaneously reduce the wages. Firms and employees are then both better off (see Zax, 1988).

[5] Note that it is theoretically possible that favourable taxation of company cars (relative to wages) generates positive welfare effects given the presence of other taxes, particularly the presence of purchase taxes on personal cars. We will examine this case as well.

here as the number of cars in a household, but we also investigate the effect of distortionary taxation through a change in the value of cars used by the household.

Company car taxation may also change the travel behaviour of employees. In the empirical analysis, we will demonstrate that travel behaviour by employees is not so much affected by the possession of a company car in the household. The negative welfare effects of favourable taxation through travel behaviour are therefore likely relatively small. This justifies our assumption that company car taxation may only change household demand for cars (viz. car ownership and household value of cars).[6]

Tax treatment of fringe benefits is quite different among European countries, but a common characteristic is that the tax on company cars is related to the purchase price of the car. Employees' net income may be defined as $w - \tau(w + \pi f)$, where w is the (gross) wage, τ is the marginal income tax rate, f is the company car's purchase price, and π is the imputed *tax rate* of the purchase price. Hence, πf is the imputed value of a company car according to tax authorities (which is added to the employee's taxable income). In the Netherlands, when the company car is privately used, 22% of the car value must be added to taxable income, so π = 0.22.

According to theory, a company car should be accounted for as employee's income and be taxed according to the firm's *net* costs of providing the company car to the employee, defined as the firm's gross costs minus the costs for business travel with this car, because costs of business usage of a company car should not be taxed (see Clotfelter, 1983; Katz and Mankiw, 1985). Only when the company car is not or hardly used for business purposes (about 25% of the company cars), then the firm's gross costs are equal to the net costs. Hence, we raise the question whether the imputed tax rate on a company car covers the firm's *net* costs of company car provision to the employee.

We will argue here that the imputed 22% tax rate on the value of a company car is *much* less than the (optimal) non-distortionary rate. We will focus on the Netherlands, but for other

[6] Hence, we avoid the complication that car demand is determined by the price of owning a car as well as by the price of using a car (De Jong, 1990). Company car taxation affects both these prices. Because we assume that travel behaviour is not affected, it is arbitrary whether company car taxation influences car demand through a reduction in the price of ownership or the price of car use. Hence, we may assume that the household's car demand depends on the total cost of owning and using the cars.

European countries similar arguments can be made. In the Netherlands, the average purchase price of a company car in 2006 is (about) €20,000, so each year €4,400 is added to the employees' taxable income when a company car is provided.[7] As explained later on in detail, the firm's annual net costs of providing a company car to the employee exceed this imputed company car's value by a large amount. The firm's average annual net costs appear to be in the range of €6,300 to €10,500, much more than the €4,400 imputed by the tax authorities. Hence, employees that receive a company car face a *much* lower price than they would pay in the car market and are therefore expected to increase their demand for cars in various ways.

In most European countries, a company car is exempted from any imputed tax when the number of private kilometres is less than a certain threshold value. In the Netherlands, the threshold value is 500 kilometres per year *excluding commuting*.[8] This exemption rule is likely extremely distortionary, as it gives an incentive for employees to use the company car only for the commute, and to use another (privately-owned) car for other private trips. One consequence of this tax exemption rule is that the households' demand for the number of cars will increase.

It should be noted that in the US, cars provided by employers are taxed broadly in line with economic theory. In the US, it is common that employers pay an amount of money to employees that can be used to lease a car (the employee is the lessee). The employee is then taxed on this amount of money as wage. When the company car is used for business purposes, the employee will receive from the employer a reimbursement for the marginal costs. This reimbursement is not taxed, in line with recommendations of optimal taxes by economic theory (Katz and Mankiw, 1985).[9]

To determine the welfare effects of distortionary taxation on (consumer) goods, it is usually sufficient to know (i) the change in the price of the good due to taxation and (ii) the demand price elasticity to determine the change in consumption due to change in the price of the

[7] Given a marginal income tax of maximally 52%, the additional tax is then €2,300 a year. Most company car owners are taxed at a marginal income tax rate of 42 or 52%.
[8] To be more precise, before 2001 and after 2004 private usage was defined by the Dutch tax authorities not to include the commute; only in 2002 and 2003 commuting was considered private. According to the tax authorities, a large proportion of drivers declare to the tax authorities that they do not use the company car privately, although in reality they do, so the effective tax on company cars may even be less than explained in the main text.
[9] It is therefore unsurprising that in the US company cars have not received any attention by economists or the general public.

good. Given the assumption that the supply is fully elastic and the absence of other distortionary taxes, the 'rule of a half' can be used (Varian, 1992). Hence, in principle, it is sufficient to know only (i) the average reduction in the price paid by the employee for the company car, and (ii) the effect of company car possession on the demand for cars. However, this ignores the complication that fringe benefits are often productive. Hence, the standard welfare analysis is not appropriate. As explained above, company cars may also be used during working hours as means of production. We will consider explicitly a set of assumptions that abstract us from this complication and allow us to apply a standard welfare analysis to the effect of distortionary taxation on car ownership. Unfortunately, these assumptions are not applicable to the effect of distortionary taxation on the value of the cars in the household, so here we restrict ourselves to the case that the company car is not used for business purposes.

Note further that the effect of company car taxation on the demand for cars *cannot* be derived from standard demand elasticities (e.g., provided by the empirical transport literature), because the effect of favourable taxation of company cars on household car demand may be quite different from general car price reductions. General price reductions affect the prices of all cars in the household, whereas favourable taxation of company cars affects only company cars in the household. This implies that the results of studies that focus on general car price elasticities are only indicative. Nevertheless, this literature suggests that the tax-induced effect on *the number of cars* in each household where a company car is present is in the order of about 10 to 50%,[10] whereas the effect on *the value of the cars in the household* is even more substantial because of high demand elasticities for the value of the car (Berry et al., 1995; Verboven, 1996).

[10] Meta-analyses using different studies conclude that the (long-run) *fuel price* elasticity of ownership is around –0.25 (Goodwin et al., 2004; Brons et al., 2006). This suggests that the presence of a company car may increase the number of cars *through free fuel only* by, on average, 25% (–100 × –0.25), if all company car owners receive free fuel for private travel. The (long-run) *car price* elasticity of ownership is estimated to be between –0.1 and –0.5 (Johansson and Schipper, 1997; Dargay and Vythoulkas, 1999; Goodwin et al., 2004; Ubbels, 2006), whereas the more elastic estimate is more common and plausible (Trandel, 1991). Company cars are provided to employees at an effective price that is in a range of 20 to 60% lower than when bought in the car market, so the result of the latter studies suggest an increase between 10 and 30% in the number of cars due to company car offers

The welfare analysis in the current paper is developed using empirical results of the effect of company car provision on household car demand.[11] The remainder of the paper is structured as follows: section 2 provides information on the data used, introduces the different statistical models and presents the empirical results. Section 3, 4 and 5 discuss the welfare analyses using different measures, section 6 discusses the effect of company car on travel behaviour, and section 7 concludes.

2. Car Ownership Analysis

2.1. *The data*

Our empirical analyses are based on information from two Dutch surveys: the annual DNB (Dutch Central Bank) household survey for the years 1995–2006 and the NTS survey (National Travel Survey) for 1996. Both surveys allow us to distinguish between private and company cars. The NTS survey contains information on travel behaviour of all members of a household during one day.[12] The DNB survey has the advantage of being a panel.

2.2. *Selection of sample and descriptive statistics*

We will argue later on that it is useful to focus on samples of households that posses *at least* one car and then investigate whether the company car increases the probability that households own at least two cars. For one-adult households, the probability that households own at least two cars is close to zero, so the effect of company car cannot be easily identified. Hence, we will exclude observations of *one*-adult households. To facilitate interpretation we will base our analyses on samples of *two*-adult (one male, one female) households, and we further require that one of these adults works full-time.

For the samples of two-adult households with *at least* one car, 14 respectively 17% of the households own a company car. In both datasets, households with a company car have on

[11] We are aware of two studies that examine explicitly the company car possession effect on household car ownership (Whelan et al., 2001; Han, 2001). These studies also find that the presence of a company car increases household car ownership. However, they ignore a range of statistical issues. In particular, they do not take into account endogeneity issues, selection effects, and control only for a few explanatory variables. Furthermore, they do not attempt to derive the welfare effects of distortionary taxation. The present work deals with these issues.

[12] This survey includes the employees' number of business kilometres that is used to instrument company car in the empirical analysis.

average 1.70 cars, whereas households without a company car have 1.35 cars, that is, 30 to 40% less cars. This suggests that the effect of company car possession on household car ownership may potentially be large.[13]

2.3. *Standard estimation*

In our empirical application, employees within a household are labelled as either *1* or *2*, and characteristics of these employees receive a subscript i (i = 1, 2). The number of cars in the household is denoted as N (N = 0, 1, 2, 3…). We will assume that the number of cars is determined by the following specification:

$$N = \alpha_0 + \alpha_{11} C_1 + \alpha_{12} C_2 + \alpha_{21} X_1 + \alpha_{22} X_2 + \alpha_3 H + \varepsilon_1, \quad (1)$$

where C_i is a dummy indicator of the presence of a company car, X_i refers to employee i characteristics (e.g., age) and H refers to household characteristics (e.g., children).

Standard estimation approaches based on the above specification will generate inconsistent estimates of α_{11} and α_{12}, because possession of a company car implies that $N > 0$, so the relationship between company car and car ownership is deterministic and ε is not properly defined. To address this issue we make two assumptions. The first assumption is that it is not essential to distinguish between possession of one or two company cars within one household, so $C = C_1 + C_2 = 0$ when $C_1 = 0$ and $C_2 = 0$, $C = 1$ if $C_1 = 1$ and/or $C_2 = 1$. This assumption can be justified numerically.[14] The second assumption is that company cars are only provided to, and accepted by, households that already possess at least one car. One justification for the latter assumption is that company cars are predominantly provided to households with higher incomes who almost always have at least one car. Another justification is that for households who prefer to have at least one car, company car ownership is likely to be exogenous with respect to

[13] In both datasets, 8 respectively 10% of households possessing *one* car have a company car. Households possessing *at least* two cars (almost) always have a private car and 25% of these households have a company car. The latter indicates that to understand multiple car ownership in the Netherlands and other European countries, information on company car provision is vital, although usually ignored.

[14] In our datasets, 3% of households with at least one company car have two company cars and only 0.5% of households with at least one car have two company cars.

household demand for cars, because for these households company car offers by firms will (almost) never be rejected.[15]

Given these two – and we believe reasonable – assumptions, equation (1) can be estimated on a dataset of (two-adult) households *with at least one car*, because C is exogenous and ε is properly defined.[16] Given this selection, the model is probabilistic in nature, $C_1 + C_2$ can be assumed to be exogenous, and standard statistical methods can be applied.

We have estimated car ownership models allowing for different effects for characteristics for males and females (e.g., male and female education) as well as assuming that the effects are identical. As the effect of company car is almost the same, we provide here only the latter results. So, we assume that $\alpha_1 = \alpha_{11} = \alpha_{12}$ and $\alpha_2 = \alpha_{21} = \alpha_{22}$. Hence, we obtain:

$$N = \alpha_0 + \alpha_1 C + \alpha_2 (X_1 + X_2) + \alpha_3 H + \varepsilon_1, \qquad (2)$$

where C measures the presence of at least one company car in the household, and $X_1 + X_2$ are *household* characteristics (e.g., household age).[17]

In the Netherlands, the number of households with three or more cars is limited (merely 5% of the households with at least one car own three or more cars). We therefore distinguish only between households that choose to have exactly one car or at least two cars, so we have a discrete choice model of the choice between one or at least two cars. This model can be estimated using a discrete choice (e.g., probit, logit) or a linear probability model. We have applied both models and the estimates are (almost) identical. We provide the full empirical

[15] Hence, even households with an unobserved love for cars (who are more likely to have two cars) and households with an unobserved distaste for cars (who are more likely to have one car) are equally likely to benefit of jobs that provide a company car (and are therefore equally likely to search for and accept the offer of a company car).

[16] Usually, results for selective samples cannot be generalized to the population. There are two reasons why we believe it is unproblematic to generalize the result for the selective sample in the current application to the population. First, in the sample of the *whole* population (of two-adult households with a full-time working member), merely 6% of households do not own a car. Thus, the non-selected sample is rather small. Second, households without a car seldomly belong to the group of households of which employees receive a company car, because household characteristics differ strongly between households without a car and households with a company car. In particular, in the datasets we analyse, households with a company car have a much higher income. This has also been reported in Statistics Netherlands (2000). Thus, if we select households with *at least* one car it is plausible that we can generalize the results of the effect of the presence of a company car to the population (of two-adult households).

[17] So, if X_i is a dummy then $X_1 + X_2$ can take three values: *0, 1* or *2*. Note therefore that household variables of individual characteristics (e.g., age) are measured as the sum of the individual characteristics. For example, household age is the sum of the male's and female's age.

results of a probit model for the (cross-section) NTS and of a linear probability model with household fixed-effects for the DNB panel data.[18] We use the following control variables for both datasets: household highest achieved level of education, number of children, address density (number of addresses per square kilometre) in the municipality of residence, household employment status and net household income. For the DNB, we also use the following additional controls: year, region, ownership of the current residence, type of employment, number of working hours per week, job duration (in years), and employment duration in the labour market (in years) by the head of the household.[19] For the NTS, the additional controls are household age, province of residence and workplace.

The estimated marginal effects can be found in Table 1, column [1] and Table 2, column [1].[20] The marginal effect of company car on household car ownership is estimated to be 0.29 (s.e. 0.01) and 0.34 (s.e. 0.02) for the DNB and NTS respectively. Both datasets generate about the same estimate of company car on car ownership. Hence, the presence of a company car substantially increases the number of cars in the household. Note that the estimates for the DNB and NTS may differ because the NTS estimate is based on one year (1996) during which the tax rate was slightly high (24%) than later on (22%). The effects of other explanatory variables are in line with those reported in the literature (e.g., Dargay and Vythoulkas, 1999). The main difference is that we find a weak effect of income. This difference is not surprising because we select households with at least one car, whereas in the transport literature the whole population is selected.[21]

By selecting households with at least one car, we have argued above that it is plausible that company car provision by firms (and acceptance by employees) is likely to be exogenous in the sense that the provision of company cars is independent of the household demand for cars N. However, one may argue that these estimates are biased (upwards or downwards), because

[18] A logit model with fixed-effects gives the exact same effect of company car on household car ownership as the linear probability model with fixed-effects. This is not surprising, as linear probability models consistently estimate average effects under normality of regressors (Stoker, 1986). Moreover, for a wide range of distributions of regressors, biases are very small (see Fernández-Val, 2005).
[19] We lack information about some labour market variable of the spouse. For these variables, we use the head's individual characteristics instead of household ones.
[20] The coefficients of all variables can be obtained from the authors upon request.
[21] In the transport literature, the effect of income on car ownership is usually found to be quite large. For example, Dargay and Vythoulkas (1999) estimate a long-run elasticity of 0.7. Our estimates suggest an elasticity of only 0.08.

of a limited number of explanatory control variables. So, there may be unobserved heterogeneity bias.[22]

2.4. *Dealing with unobserved heterogeneity bias*

The application of panel data techniques is one solution to the unobserved heterogeneity problem in the DNB dataset. We therefore proceed by estimating a random-effects model, which allows unobserved household effects to be correlated over time, and a household fixed-effects model, which only uses within-household variation.

For the random-effects model, we find a marginal effect of company car of 0.37 (s.e. 0.02); for the fixed-effects model, it is 0.46 (s.e. 0.02), see columns [2] and [3] of Table 1.[23] Both estimates are statistically significant. The fixed-effects estimate of company car on car ownership is somewhat larger than the random-effects estimate.[24]

For the NTS data, we do not have panel data so we address the endogeneity issue using an instrument variables approach (IV).[25] We use *household* business' travel distance (viz. the sum of the business travel of both employees belonging to the same household) and the *individual* characteristics of the employee in one-earner households (viz. the age and education

[22] The estimates are likely to be overestimates (underestimates) if unobserved characteristics of the household that determine the demand for cars are positively (negatively) correlated with unobserved characteristics of company car provision. Arguably, these characteristics are more likely to be negatively correlated for a number of reasons. First, in the Netherlands, about 30% of employees that do not receive a company car, receive a reimbursement for the car commuting costs, which on average amounts to about 5% of the net wage (Rouwendal and van Ommeren, 2007). Hence, employees that do not receive a company car are induced by firms to have more private cars in a way unobserved in the data. Second, company cars are more likely to be provided to male employees with high earnings. The spouses of these male high earning employees tend to work part-time and to choose workplace locations with shorter commutes (about 50% shorter). Hence, households with company cars are more likely to belong to households where the female has less demand for a car. It is therefore more likely that any bias due to unobserved heterogeneity is downwards.

[23] The estimate for company car is greater addressing the endogeneity of company car in line with our suggestion that there is a downward bias in the estimates.

[24] Note that fixed-effects estimates tend to capture *short-run* effects (Kuh, 1959). Hence, one interpretation of the results is that short-run effects are slightly higher than long-run effects. This interpretation is plausible as it is noted that the costs of having too many cars may be small, whereas the costs of having too few cars may be large. As a result, some households may not immediately reduce the number of cars in the household when they receive a company car (e.g., for reasons of personal attachment of their car or of time lags in selling their second-hand car), whereas they will more quickly buy another private car when in a new job they will not receive a company car, because the costs of having too few cars may be large.

[25] We have applied the Rivers-Vuong approach to test for exogeneity of company car (Wooldridge, 2001, p. 476). The Rivers-Vuong test, which tests for correlation of company car with the disturbance term in regression (2), is *just* rejected. This suggests that endogeneity is an issue, but likely not a very important one.

of the employee) as instruments for company car possession. Therefore, the first assumption we make is that firms' demand for business travel is exogenously determined with respect to household car ownership. The fundamental idea is that the employees' business travel is determined by firm's demand for travel (e.g., visiting clients) which does not depend on household car ownership. It is then plausible that conditional on the firms' demand for travel, the firm will decide to provide a company car.[26] The firm's demand for travel is measured by means of the number of kilometres travelled by the employee on the day of the survey. For one-earner households, the *individual* characteristics of the *employee* can be used as instruments under the assumption that these characteristics affect company car provision, but not directly household car ownership (controlling for household characteristics).[27] The marginal effect of the IV approach can be found in column [2] of Table 2.

The IV approach based on the NTS in 1996 generates higher marginal effects of company car (0.68; s.e. 0.10) than the, presumably more reliable, fixed-effects approach based on the 1995–2006 DNB survey, but strictly statistically speaking the difference in these estimates is absent.[28] Summarizing, for both datasets and using different techniques to take into account unobserved heterogeneity, we find that the estimate for company car is between 0.29 and 0.68, whereas the most reliable estimate based on a fixed-effects approach is 0.46. The latter estimate will be used in the welfare analysis later on.

2.5. *Sensitivity analysis*

Several analyses have been conducted to evaluate the sensitivity of the reported effect of

[26] One alternative for firms to deal with its demand for travel is that the employee uses a private car for which the firm has to pay the marginal or average costs of car travel (see Section 3) or that the employee uses other modes than the car (bicycle or public transport) for business purposes.

[27] The instrument – household business' travel – is positive, statistically significant and has a large effect on company car possession, see Appendix B. The other instruments add prediction power, but are individually statistically insignificant, and the effect of other explanatory variables are conform intuition. In the specification, household business' travel is chosen as log(1 + males' business travel) + log(1 + females' business travel). Other specifications of business travel give almost the same results.

[28] Note that in the standard analysis the estimate based on the NTS in 1996 is also slightly higher that on the DNB dataset, that includes more recent years. Again, one explanation for this result may be that having a second car has become slightly more favourable over time. Another explanation may be that the fixed-effects approach predominantly measures the short-run effect, which may be higher. Further, it may be the case that the instruments used here are not admissible. For example, it may be the case that households inclined to own more cars may enjoy driving and seek out employment at firms that require a high level of business trips.

company car possession on household car ownership. The sensitivity analyses of the ownership model to sample selectivity, inclusion of additional controls (e.g., commuting distance) and different effects for one-earner and two-earner households are shortly discussed here.

In our analysis of the effect of company car on household car ownership, we have selected two-adult households. As a sensitivity analysis, we have re-estimated the ownership models allowing for arbitrary number of adults for the DNB data. The results are (almost) identical.[29] Hence, our results can be generalized to the population.

One may argue that demand for cars is influenced by commuting distance and, thus, the above-reported effect of company car may partially capture the effect of commuting distance on car ownership (as company car is positively correlated with commuting distance). We have therefore re-estimated the fixed-effects model for the DNB dataset, controlling for commuting distance. We find that the effect of company car remains the same.[30]

We have next investigated for the NTS whether it is useful to distinguish between *one* and *two-earner* households because it seems plausible that the effect of company car depends on the labour market state of the spouse. We find a similar effect of company car on car ownership using different samples (two-adult households, only one-earner households, only two-earner households), although the effect is somewhat larger for two-earner households. This is as expected, because the demand for cars by non-employed spouses is likely to be weaker than by employed spouses.[31] Summarizing, the above results of the effect of company car on household car ownership are robust with respect to a number of data selection and specification issues.

[29] This result is not too surprising, because the percentage of two-adult households in the data is 80% of the population, and one-adult households are less likely to receive a company car.

[30] Note that commuting distance is likely endogenous with respect to car ownership, so our preferred estimates are without commuting distance. We have also estimated a similar model with controls for private kilometres travelled but this turns out to be less relevant as households with a company car travel hardly more privately by car (except for commuting purposes).

[31] In addition, we have investigated the importance of interaction variables with the variable company car (e.g., urbanization degree of the residence location interacted with company car). The interactions turn out to be of no importance.

3. Welfare Effects: the Number of Cars in the Household

3.1. *Theoretical considerations*

We have argued in the introduction that company cars are implicitly subsidized due to favourable taxation, which implies negative welfare effects. The calculation of the welfare effects of distortionary taxation, and therefore also the distortionary company car taxation, depends on assumptions one is willing to make with respect to the labour market (Zax, 1988), and on the market for fringe benefits, which in the case of company cars is the car market.[32] In the current paper, we assume that labour and car markets are competitive.[33] The calculation of these welfare effects depends also on the presence of *other* distortionary taxes: taxes on income and taxes on personal cars. In addition, the calculation of welfare effects of favourable taxation of company cars is non-standard, because, as we have emphasized in the introduction, cars (company cars as well as privately-owned cars) may be used during working hours for business purposes (e.g., visiting clients) and the use of these cars may therefore affect the firms' productivity.

Taxes on personal cars. Taxes on personal cars entail taxes on: ownership, purchase (Vehicle Excise Duty), and use of these cars (through fuel taxes and parking charges). Note that the aggregate revenues from these taxes are considerably in Europe, so, in principle, they cannot be ignored. We *initially* assume that these car taxes are at the optimal level. One justification for this assumption is that these taxes are a way of addressing environmental and congestion externalities and use of public goods. Although these taxes are unlikely optimal as first-best instruments, they may be optimal as second-best instruments, for governments that are not able to use first-best instruments such us road pricing. Later on, this assumption will be relaxed.

Taxes on income. In a recent paper by Parry and Bento (2001), it has been argued that employees choose labour supply (number of working hours) at a non-optimally low level,

[32] In the transport literature, it is common to derive welfare effects of exogenous change in transport supply specifying a full utility function (see Small and Rosen, 1981; Small and Verhoef, 2007). It is not clear whether such an approach is feasible for fringe benefits such as company cars, as employers offer fringe benefits taking into account the effect of the fringe benefit on the utility of employees (see Clotfelter, 1983; Klatz and Mankiw, 1985; Zax, 1988).

[33] The assumption that the car market is competitive is not a restrictive assumption. The consequences of the assumption of a competitive labour market, although commonly made in the context of fringe benefits, are not well understood. Results by Zax (1988) though, indicate that allowing for monopolistic power generates welfare effects of the same magnitude.

because of the income tax τ. One of the consequences is then that favourable taxation of company cars through a lower π may have positive consequences for welfare, but only when this reduction in τ increases labour supply. We will argue however that the effect of favourable taxation of company cars on labour supply is negligible. This is based on two arguments. First, the number of hours worked for full-time positions depends mainly on the employees' *hourly* compensation, and less on fringe benefits, such as company cars, that are usually given independent of the number of hours worked (Ehrenberg and Smith, 2003). Second, and probably more importantly, labour supply effects in the economy are mainly through variation in *female* labour participation and not so much in change of number of hours worked given labour market participation. As indicated in Section 2, females are much less likely to receive a company car than males, so that it is safe to assume that the labour supply effect of favourable company car taxation is close to zero.

Company cars are productive fringe benefits. As emphasized in the introduction, a standard welfare analysis cannot be used, because company cars are fringe benefits that may affect the firm's productivity. In a competitive market without distortionary taxes, as assumed above, the optimal expenditure on company cars by firms is such that the sum of the marginal firm's revenue and the marginal employee's utility are equal to the company car's marginal costs (see e.g., Katz and Mankiw, 1985). Suppose that the firm will choose the number of business kilometres such that the company car's marginal revenue of these kilometres is equal to the marginal costs of these kilometres. The household will choose the number of private kilometres such that the (company) car's marginal utility is equal to the marginal costs. In this case, the firm's *net* costs of providing a company car are equal to the gross costs minus the costs for business travel. Hence, the change in the price of a company car due to distortionary taxation is equal to the difference between the firm's *net* costs and the value of the company car as imputed by tax authorities (Katz and Mankiw, 1985). This result cannot be easily applied here due to the presence of *fixed* costs of a car. It is a priori unclear who pays for the fixed costs.

We solve this ambiguity by making two distinct sets of underlying assumptions. Given the first set (Set A), firms pay only for the company cars' *marginal* costs of business travel. Given the second set (Set B), firms pay for the company cars' *average* costs of business travel.

Given the choice of one of the two sets, the welfare calculation is straightforward using the 'rule of a half' (Varian, 1992).

A. Firms pay only for the cars' marginal costs of business travel. In order to calculate the welfare effects of favourable taxes of company cars, we assume that either: (i) the company car is not used for business purposes *or* (ii) employees that (sometimes) use a car for business purposes commute anyway to work by car (this may be a company or a privately-owned car). The latter assumption implies that the firm has a car available which can be used for business purposes (independent of whether a company car is provided).

The assumption that either (i) or (ii) occurs can be justified numerically from other data sources (Dutch Car Panel Survey PAP).[34] About 25% of the company cars are not used for business purposes (during a period of one month of observation). At least 85% of employees that (sometimes) use a car for business purposes would commute anyway by car.[35] So, for less than 14% of the observations, the assumption that either (i) or (ii) occurs may be inaccurate ($0.14 = 1 - 0.25 - 0.75 \times 0.85$).

Given this additional assumption, the firm pays only for the marginal costs of the business kilometres, whereas the employee pays *fully* for the fixed costs and the marginal costs of the private kilometres. This can be seen by supposing the presence of another employee in the economy who owns a private car and works for another firm that does not provide a company car. In a competitive labour market, employees with or without company car are equally well off. The employee without the company car pays for the fixed costs of the private car. This implies that the employee who receives the company car must *fully* pay for the fixed costs (through a lower wage), otherwise this employee would be better off.[36]

B. Firms pay for the cars' average costs of business travel. The result that the employee pays fully for the fixed costs of the car relies on the underlying assumption that the employee commutes to work by car (when cars are used during working hours), as explained above. One

[34] In the data used here, we have no information about the number of business kilometres over a longer period (e.g., one month), so we cannot disaggregate our calculation for workers that do, or do not, use the company car for business purposes.

[35] The percentage of 85 has been calculated based on the proportion of *private* car drivers that use the car for commuting *and* use this car for business purposes during a period of one month (Statistics Netherlands, 1999). For potential company car drivers, this percentage must be higher.

[36] Hence, given the assumption that the employee would come anyway to work by car, the firm can 'force' the employee to pay for the fixed costs.

may argue however that it is possible that employees may commute to work by other transport means than the car and only use the company car during working hours for business purposes. Given this assumption, the firm may have the option to let the company car outside working hours to non-employees at the *average* costs of car use (total car costs divided by the car's total number of kilometres) as in car rental markets, prices are determined by average costs. Hence, the firm will have the opportunity to let the car at the average costs of car use and not at the marginal costs of car use. The main implication is then that the firm will pay for the company car's marginal costs of the business kilometres plus a *share* of the fixed costs. The share is defined by the number of business kilometres divided by the total number of kilometres.

Accordingly, the welfare costs of distortionary company car taxation depend on whether it is assumed that (A) the firm pays for the marginal costs or (B) the average costs of car use when the car is used for business purposes. In the Netherlands, fixed costs are about 53% of the total company cars' costs (see Appendix A). So, the fixed costs are an important component of the total costs. We will provide calculations of the welfare costs given both assumptions.[37]

3.2. *Empirical results*

Recall that we have argued in the introduction that the effect of company car on household car ownership is predominantly tax-induced and that the empirical marginal effect of the company car on household car ownership is in the range of 0.29 to 0.68. Our interest lies in quantifying the involved welfare costs. As mentioned above, we use the fixed-effects estimate of 0.46, which is in the middle of the range of estimates, and which is likely the most accurate estimate.

Given the assumptions made in Section 3.1, we are able to examine now the welfare effects of the company car taxation using available welfare analysis techniques (Varian, 1992).[38]

[37] Note that in the absence of distortionary taxation, supply of company cars will have positive consequences for welfare because the employee may share the company car with the employer. We take this into account in the empirical analysis by using the firm's *net* costs of providing a company car.

[38] Small and Rosen (1981) show that demand curves generated by a set of individuals making discrete choices are appropriate measures of the marginal benefit curves. From this it follows that changes in aggregate consumer surplus (the areas to the left of the demand curve and below the current firms' net costs) are appropriate measures of welfare. Note that the 'rule of a half' implies the fundamental assumptions of a linear demand curve and a horizontal marginal cost curve (supply completely elastic). The latter assumption seems reasonable as cars are imported from the international market.

We assume a linear demand function for cars.[39] The welfare costs can then be calculated as half times the change in number of cars in households times the tax advantage, known as the 'rule of a half', so ½ × ($Q_1 - Q_0$) × ($\pi f - p_0$), where the tax advantage is calculated as the difference between the firm's annual *net* costs of providing a company car (p_0) and the value of the company car as imputed by tax authorities (πf). In the Netherlands, there are 795,000 company cars (RDC, 2002). So, given an estimated effect of 0.46, the tax-induced increase in the number of cars ($Q_1 - Q_0$) is 365,700 (0.46 × 795,000). The imputed company car value (πf) is on average equal to €4,400. The value of p_0 depends on underlying assumptions with respect to whether firms pay for marginal or for average costs of business travel.

A. Firms pay only for the cars' marginal costs of business travel. The firm's annual *gross* costs of providing a company car are on average €13,400, and the firm's annual *net* costs €10,500. The latter exceed the imputed company car's value by €6,100 (see Appendix A). Hence, the employee obtains a tax advantage of 61%. So, the annual welfare costs in the Netherlands of favourable taxation of company cars through increased household car ownership only are just above €1,100 million (0.5 × 0.46 × 795,000 × €6,100). The annual welfare costs per company car are just above €1,400 (0.5 × 0.46 × €6,100). These results imply that the optimally chosen imputed tax rate is equal to 53%, which is far above the rate currently used in the Netherlands or any other European country.

Our calculations imply that every percentage-point-reduction of imputed tax rate of the company car's value (e.g., from 22 to 21%) generates welfare costs of about €46 per company car through increased household car ownership. Our results allow to calculate the effects of policy changes. For example, in the Netherlands, the imputed company car's value has recently decreased. For instance, for a large share of the company car commuters, the imputed value has decreased from 24 to 22%.[40] Hence, the welfare costs due to this change in policy are just below €100 per company car.

[39] The assumption of linearity may be a good approximation of car demand for small changes in π, for big changes in π the results may be biased.
[40] The imputed tax rate of a company car was 24% before 2001 and 22% since 2004 (between 2001 and 2004, other changes in the tax rules were introduced making a comparison impossible).

B. Firms pay for the cars' average costs of business travel. The firm's annual *gross* costs of providing a company car are on average €9,000. The firm's annual *net* costs are on average €6,300. The latter exceed the imputed company car's value by €1,900 (see Appendix A). The employee obtains subsequently a tax advantage of 'only' 19%. So, the annual welfare costs are almost €350 million (0.5 × 0.46 × 795,000 × €1,900), and the average annual welfare costs per company car are almost €450 (that is, 0.5 × 0.46 × €1,900). Hence, the welfare costs are still substantial given the assumption that firms pay for the cars' average costs of business travel. It can further be shown that the optimal tax rate is 31% given this assumption.

In conclusion, the welfare effects of distortionary company car taxation *through increase in car ownership only* are substantial. We will focus now on other measures of car demand.

4. Welfare Effects: the Value of the Cars in the Household

We have also examined the effect of favourable company car taxation on household *value* of cars for the 1995–2006 DNB survey. The value of cars is the sum of the estimated value of all cars in the second-hand market, as reported by the respondent. For cars that were owned for less than three years, the purchase price was reported by respondents. We have used this price as the estimate of the current value. We use a similar methodology as applied in Section 2, so we use a sample of (two-adult) households (with one of these adults working full-time) that own at least one car. We have used a dummy indicating the presence of a company car as well as the company car's value as regressors to explain the household value of cars. Using a household fixed-effects model with the same explanatory variables as used in Table 1, we find that the effect of the presence of a company car on household value of cars is about €12,446, see column [2] of Table 3, and that the marginal effect of the *value* of a company car on household value of cars is 0.76 (s.e. 0.03), see column [1] of Table 3. The average value of cars of a household without a company car is about €9,900.[41] So, the increase in value due to the company car is 126% (€12,446 / €9,900). The latter effect is much higher than the previously demonstrated

[41] This number has been calculated based on the mean value of explanatory variables of household with a company car. So, the value of cars of a household with a company car is equal to €22,400 (that is, €12,500 + €9,900).

effect of company car on household car ownership (46%, see Section 2). This implies that the large majority of the households swap their private car for a much more expensive company car.

Only for company cars not used for business purposes, about one in four company cars (Statistics Netherlands, 1999), we are able to determine the welfare effects of distortionary taxation using the 'rule of a half'.[42] Our analyses indicate that for these cars the welfare costs exceed €6,000 per company car (0.5 × €12,446). This estimate is *considerably* higher than the above reported, indicating that our estimate of the welfare costs based on the increase of number of cars is extremely conservative.

To determine the average welfare effects of distortionary taxation per company car, we make now the additional assumption that for company cars that are used for business purposes, the company car's value, and therefore the value of the total number of cars in the household, is optimally chosen by the firm. More likely, the company car's value exceeds the optimal non-distortionary value, so our estimates of the welfare effects of distortionary company car taxation for the average company car are an underestimate. The annual welfare costs are then approximately €2,000 per company car using the most conservative estimates (0.25 × €6,000 + 0.75 × €450).

5. Welfare Effects: Sensitivity Analysis

In our calculation of the welfare effects of distortionary taxation of company cars, we have assumed a world in which overconsumption of cars is the sole distortion in the economy. Thus, we have assumed a non-distortionary tax on personal cars, although this tax may be non-optimally set. Plausibly, taxes on car use may be justified given congestion and other externalities associated with travel (Vickrey, 1963; De Palma et al., 2006), but this is less likely for purchase taxes. Purchase taxes can possibly *partially* be justified due to finance of roads. In the Netherlands, the purchase tax is equal to 45.2% of the purchase price, which essentially

[42] Unfortunately, given the data at hand, it is impossible for us to estimate the welfare effects of distortionary taxation for all company cars through an increase in household value of cars, because we do not have any information to what extent company cars increase the firm's productivity (e.g., the employee is able to make more sales with a more expensive up-to-date car). The latter information is needed to correctly estimate the welfare effects. Note that for the effect on car ownership, we circumvent this need by making additional assumptions. These assumptions are not reasonable in the case of the value of the cars.

implies an average yearly amortized tax of €1,300. Note that this tax is much smaller than the tax advantage obtained from the provision of a company car. Nevertheless, we have re-calculated the exact welfare effects of distortionary taxation presuming that the purchase tax on personal cars is *fully* distortionary, and it appears that the welfare effects are only slightly less than given the assumption that taxes on personal cars are non-distortionary.[43]

6. Travel Behaviour

Note that the distortionary effect of company car taxation through increases in private travel is partially captured by the increase in car ownership as the demand for cars is derived from the demand for travel (De Jong, 1990). In separate analyses not shown here, we have analysed the effect of company car on travel behaviour, distinguishing between commuting, private travel on workdays (excluding commuting) and private-travel on non-working days. The analyses, based on the 1996 NTS, imply that there is no statistically distinguishable effect on private travel during workdays, whereas the effect on private travel during non-working days is positive but small. This may make sense as elasticities of car use with respect to variable costs are usually thought to be small, in particular for high income groups (Jørgensen and Dargay, 2007). Further, using the DNB panel data set, there appears a large positive effect of company car on commuting time and particularly on distance using random-effects, but this effect disappears using fixed-effects.

Let us suppose that the random-effects estimate is accurate, although in reality it is more likely a large overestimate. In this case, the negative *annual* welfare effects through increased commuting are only €240.[44] Welfare costs through increased private travel are even smaller.[45]

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[43] Given that firms pay only for the cars' marginal costs of business travel, then only €300 (0.5 × 0.46 × €1,300) should be subtracted from the welfare costs through increased car ownership as mentioned in Section 3. So, the annual welfare costs per company car are just above €1,100 instead of €1,400. The welfare effects of distortionary company car taxation through the household value of cars are then at least €1,400 per company car (0.25 × (€6,100 – €1,300) + 0.75 × €300). Given that firms pay for the cars' average costs of business travel, the employee pays only a share of the fixed costs, so 47% of the above-mentioned €1,300 should be subtracted from the firm's annual net costs of providing a company car. Subsequently, the annual welfare costs per company car are just above €300 instead of €450. The annual welfare costs of distortionary company car taxation through increased car value are €4,700 per company car (instead of €6,000).

[44] In the DNB dataset, the mean one-way commute is about 20km. An analysis based on this dataset, shows that a company car driver has, on average, a one-way commuting distance that is 40% longer, that amounts to 8km per day. As the number of working days per year is, on average, 200 days, the annual

Hence, the negative welfare effects of company car taxation due to additional travel are substantially smaller than the welfare effects associated with change in car demand.

7. Conclusions

Economic theory is quite clear on how fringe benefits should optimally be taxed. In Europe, company cars are for many employees the most important (tax-induced) fringe benefit, but the welfare effects of the current tax system in Europe are unknown. This paper offers a study of the welfare effects of company car taxation. Our results imply that the current tax system is strongly distortionary. Our analyses for the Netherlands indicate that the annual welfare costs of distortionary taxation are *at least* €2,000 per company car. When the company car is not used for business purposes (about one in four company cars), the annual welfare costs of distortionary taxation are about €6,000 per company car.

Company cars are predominantly taxed in Europe based on the company car's value (purchase price). In the Netherlands, the current imputed tax rate of 22% of the company car's value does *not* cover the firm's net costs of company car provision to the employee, which creates a distortion in the optimal car decision-making of households. Given the assumption that tax authorities seek to tax the car's value, they should set a tax at a much higher rate than the current one. Nevertheless, economic theory indicates that optimal taxation must be derived from the firm's *net* costs of providing a company car and therefore based on the lease price of the car

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increment in two-way commuting distance is 3,200km (that is, 8km × 2 × 200). The sum of the fuel and depreciation costs per kilometre of a representative company car is estimated to be about €0.15. Assuming absence of travel externalities, the annual welfare costs through commuting can then be calculated as half times the change in the commuting distance times the tax-induced reduction in cost per kilometre €240 (= 0.5 × 3,200km × 0.15€/km).

[45] The welfare costs through private travel (excluding commuting) can be calculated as half times the change in the number of kilometres travelled privately times the tax-induced reduction in cost per kilometre. An analysis based on the NTS in 1996, shows that a company car driver has, on average, a private travel distance during non-working days that is 25% longer, that amounts to 5km per day, and to 500km per year given, on average, 100 annual non-working days. In absence of travel externalities, the annual welfare costs are merely €38 (that is, 0.5 × 0.15€/km × 500km). In the survey, all travels must have occurred within the Netherlands. Further, if we suppose that the yearly amount of additional private outside the Netherlands is 2,000km, the welfare costs through private travel outside the Netherlands are €150 (that is, 0.5 × 0.15€/km × 2,000km). The welfare effects due to additional travel turn out to be relatively unimportant.

provided to the employee and the use of the car for private and business purposes, which is the current taxation practice in the US (IRS, 2006).[46]

We have provided the welfare costs of distortionary taxation of company cars through an increase in the number of cars. Furthermore, for cars that are not used for business purposes, the welfare costs through increased household value of cars have been provided. However, the *total* welfare costs of distortionary company car taxation are likely to be higher, since we ignore other welfare effects as the tax affects decision-making of households with respect to travel, although they are likely to be much smaller in magnitude at the margin. In addition, in the current paper, we have ignored the welfare effects through increased business travel. Furthermore, car value is positively correlated with size of the car, so it is likely that a tax-induced increase in the size of the car creates a range of other negative environmental, parking and congestion externalities.[47]

In other European countries (mainly the EU–15 countries) except Denmark, the level of purchase car taxes tend to be less or equal to the Netherlands (see European Commission, 2002). So, arguments made for the Netherlands can potentially be generalized to these European countries. For Denmark though, it is possible that favourable company car taxation generates welfare *benefits* as purchase taxes on personal cars can be argued to be too high, so company car taxation corrects for this distortion. We estimate that the number of company cars in the EU–15 is about 20 million.[48]Average European taxation on the value of company cars is around the Dutch level.[49] Assuming that the costs induced by company car taxation are roughly the same per company car across European countries, the welfare costs are estimated to be at least €40 billion per year.

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[46] However, this tax policy requires differentiation between business and private kilometres for tax purposes, which might entail other costs in terms of monitoring by tax authorities.

[47] In the Netherlands in 2005, 27% of all car drivers who travel at least five days a week during rush hours have a company car (AVV, 2006). This is predominantly for business and commuting trips. Outside rush hours, the proportion of company car drivers of all car drivers is only 2%. This implies that, if company car taxation induces an increased car use for business and commuting, the external costs of additional travel may be not negligible, since virtually all the additional trips will be during rush hours.

[48] It appears not so straightforward to obtain estimates of the number of company cars in Europe (as only the number of *lease* cars is well recorded). We have estimated the number of cars in the EU–15 on the assumption that the average ratio of company cars to employer for the EU is equal to the ratio for the Netherlands, which is 12% (see European Commission, 2004). Given this assumption, there are roughly 20 million company cars in Europe (172 million employees × 0.12). This estimate corresponds to the number of personal cars that are sold in Europe (Economist Intelligence Unit, 1996).

[49] Note that some countries have a higher taxation on the company cars' value (e.g., the UK has a 35% tax, but applies a discount depending on the business kilometres), while others have lower rates (e.g., Spain and Finland have a 15% tax).

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Table 1. *Marginal Effects on the Probability of Owning at least Two Cars (1995–2006 DNB)*

Variables	[1] Linear probability model	[2] Fixed-effects model	[3] Random-effects model
Household company car	0.29 (0.01)**	0.46 (0.02)**	0.37 (0.02)**
Children 1	0.04 (0.01)**	0.01 (0.02)	0.03 (0.02)*
Children 2	–0.04 (0.01)**	–0.11 (0.02)**	–0.04 (0.02)**
Children >3	–0.00 (0.02)	–0.18 (0.03)**	0.06 (0.02)**
Net household income in log	0.13 (0.01)**	0.00 (0.01)	0.07 (0.01)**
Household education – low secondary	0.01 (0.01)		–0.03 (0.01)**
Household education – advanced secondary	0.00 (0.01)		–0.03 (0.01)**
Household education – polytechnic	0.02 (0.01)**		–0.01 (0.01)
Household education – university	0.00 (0.01)		–0.02 (0.02)
Household education unknown	–0.02 (0.01)*		–0.02 (0.01)**
Head employed by government	–0.07 (0.01)**	–0.01 (0.02)	–0.02 (0.01)
Head permanently employed	–0.10 (0.02)**	–0.00 (0.02)	–0.02 (0.02)
(Head working hours)/100	1.05 (0.35)**	0.33 (0.32)	0.57 (0.29)*
(Head working hours)^2/10,000	–0.01 (0.64)**	–0.67 (0.61)	–0.89 (0.55)
Head working hours unknown	0.03 (0.05)	–0.02 (0.05)	–0.02 (0.04)
(Head job duration)/100	–0.84 (0.16)**	–0.08 (0.18)	–0.18 (0.16)
(Head job duration)^2/10,000	0.02 (0.43)**	0.23 (0.44)	0.37 (0.39)
Head job duration unknown	0.02 (0.04)	0.03 (0.04)	0.04 (0.04)
(Head employment duration)/100	0.90 (0.18)**	0.37 (0.19)*	0.51 (0.17)**
(Head employment duration)^2/10,000	–0.02 (0.36)**	–0.74 (0.42)*	–0.01 (0.37)**
Head employment duration unknown	0.00 (0.04)	–0.01 (0.04)	0.00 (0.03)
Owner of residence	0.04 (0.01)**	0.04 (0.03)	0.07 (0.02)**
Residence density – very low	0.04 (0.02)**	–0.01 (0.08)	0.04 (0.03)
Residence density – low	0.08 (0.02)**	0.02 (0.08)	0.08 (0.03)**
Residence density – moderate	0.13 (0.02)**	–0.04 (0.08)	0.11 (0.03)**
Residence density – high	0.19 (0.02)**	–0.04 (0.09)	0.13 (0.04)**
Two-earner household	0.10 (0.01)**	0.03 (0.02)*	0.07 (0.02)**
Female works full-time	0.05 (0.03)	–0.03 (0.08)	–0.01 (0.04)
Year controls (12)	Included	Included	Included
Residence region controls (5)	Included	Included	Included
Adjusted R-squared	0.16	0.78	0.78
No. observations	9,332	9,332	9,332

Notes: Number of working hours per week according to the contract; current job duration (in years); employment duration in the labour market (in years). The reference category for education is primary and for residence density is 'very high'. Household variables are defined as the sum of the individual explanatory variables. **, * – indicate that estimates are significantly different from zero at 0.05 and 0.10 level respectively. Standard errors are in parentheses.

Table 2. *Marginal Effects on the Probability of Owning at least Two Cars (1996 NTS)*

Variables	[1] Probit	[2] IV probit
Household company car	0.34 (0.02)**	0.68 (0.10)**
Children 1	–0.01 (0.05)	–0.01 (0.02)
Children 2	–0.03 (0.02)*	–0.03 (0.02)*
Children >3	–0.06 (0.02)**	–0.06 (0.02)**
Household age 30–40	0.01 (0.01)	0.00 (0.01)
Household age 40–50	0.01 (0.01)	0.01 (0.01)
Household age 50–60	0.01 (0.01)	0.01 (0.01)
Household income 15–18	0.02 (0.01)*	0.03 (0.02)*
Household income 18–25	0.02 (0.01)	0.01 (0.01)
Household income >25	0.14 (0.02)**	0.07 (0.02)**
Household income unknown	0.01 (0.02)	0.01 (0.02)
Household education – low secondary	0.01 (0.02)	0.01 (0.02)
Household education – advanced secondary	0.09 (0.02)**	0.06 (0.02)**
Household education – higher	0.11 (0.02)**	0.10 (0.02)**
Residence density – low	–0.02 (0.02)	–0.03 (0.02)*
Residence density – moderate	–0.08 (0.02)**	–0.08 (0.02)**
Residence density – high	–0.10 (0.02)**	–0.10 (0.02)**
Residence density – very high	–0.13 (0.02)**	–0.14 (0.02)**
Two-earner household	0.08 (0.02)**	0.07 (0.02)**
Female works full-time	–0.01 (0.02)	0.02 (0.02)
Residence controls (12)	Included	Included
Workplace controls (12)	Included	Included
Log-likelihood	–3,521.70	–4,197.72
No. observations	6,791	6,791

Notes: Net income in annual 1,000 euros. In specification [2], household business travel and for one-earner households the employee characteristics (age and education) are used as instruments. The reference category for age is 25–30, for income is <15, for education is primary and for residence density is 'very low'. **, * – indicate that estimates are significantly different from zero at 0.05 and 0.10 level respectively. Standard errors are in parentheses. For the first-step estimation of the IV probit, see Appendix B.

Table 3. *Marginal Effects on Household Value of Cars (1995–2006 DNB)*

Variables	[1] Fixed-effects model	[2] Fixed-effects model
Household company car		12,446 (706.7)**
Value of household company car	0.76 (0.03)**	
Children 1	1,780 (548.7)**	1,792 (575.1)**
Children 2	–78.08 (716.8)	–1,092 (749.8)
Children >3	–473.5 (1,029)	–91.69 (1,081)
Net household income in log	693.9 (242.5)**	932.7 (253.8)**
Head employed by government	450.7 (485.4)	232.4 (508.6)
Head permanently employed	46.24 (617.4)	457.1 (646.6)
Head working hours	29.62 (89.32)	60.67 (93.57)
(Head working hours)^2	–1.63 (1.72)	–2.47 (1.80)
Head working hours unknown	–6,688 (1,304)**	–7,453 (1,366)**
(Head job duration)/100	93.75 (48.82)*	175.7 (51.02)**
(Head job duration)^2/10,000	–1.55 (1.13)	–2.88 (1.18)**
Head job duration unknown	6,922 (1,135)**	8,236 (1,188)**
(Head employment duration)/100	47.99 (54.72)	33.12 (57.33)
(Head employment duration)^2/10,000	–0.48 (1.18)	0.40 (1.23)
Head employment duration unknown	2,072 (1,135)*	3,892 (1,187)**
Owner of residence	436.3 (863.6)	918.4 (904.6)
Residence density – very low	–500.4 (2,093)	–375.7 (2,194)
Residence density – low	–303.5 (2,091)	–457.0 (2,191)
Residence density – moderate	–3,366 (2,066)	–2,702 (2,165)
Residence density – high	–3,296 (2,210)	–3,108 (2,317)
Two-earner household	445.2 (2,863)	–650.9 (486.6)
Female works full-time	–23.11 (2,416)	728.5 (2,999)
Year controls (12)	Included	Included
Residence region controls (5)	Included	Included
Adjusted R-squared	0.77	0.74
No. observations	6,548	6,548

Notes: Value of cars in euros; number of working hours per week according to the contract; current job duration (in years); employment duration in the labour market (in years). The reference category for residence density is 'very high'. Household variables are defined as the sum of the individual explanatory variables. **, * – indicate that estimates are significantly different from zero at 0.05 and 0.10 level respectively. Standard errors are in parentheses.

Appendix A: Calculation of the Firm's Annual Net Costs of Providing a Company Car to the Employee

At firm level, the decision concerning the provision of a company car to the employee is determined by the costs involved. As argued in the main text, it is essential to categorize these costs as either fixed costs, which are independent of the distance driven by the company car, or as variable costs, which are determined by the usage. The fixed costs include the purchase cost or lease of the company car, vehicle licensing fees, vehicle tax, insurance, and free road assistance. The variable costs include fuel costs, depreciation costs per kilometre (wear and tear), maintenance, and repairs.

We provide calculations under the assumption that the car is leased. We have obtained from a Dutch lease company the annual lease price of a representative car for two different amounts of kilometres per year. From the difference in the lease price we derive the lease price based on 0km. Given an average purchase price of €20,000 (Statistics Netherlands, 2002), the annual lease price of the car is €4,100 based on 0km per year. This lease price does *not* include the variable and some of the fixed costs (insurance, free road assistance) that are usually paid for by the firm.

Using the 1990–99 Dutch Car Panel Survey PAP (Statistics Netherlands, 1999), which is a survey of car use where the unit of observation is the car, it appears that, on average, company-car owners drive about 19,000 business kilometres and 17,000 private kilometres per year. The sum of the fuel and depreciation costs per kilometre of a representative company car is estimated to be about €0.15, thus the variable *private* costs are estimated to be €2,550 (that is, €0.15 × 17,000). The insurance premium is dependent on many factors such as car price, age of the car, province of residence and age of the driver. We calculate our annual premium, €1,700, for a one-year-old car in the province of North-Holland for a forty-year-old driver. Free road assistance is rather negligible, at €69.50. Firms may get substantial discounts on the lease price, particularly if they lease many cars. If firms get reductions because of market power, then these reductions should be ignored in our welfare calculation. When these reductions entail a decrease in retail distribution costs or other costs, then the decrease in costs should be included. We assume that firms get, on average, a 10% discount on the car's lease price for a decrease in costs, and correct the fixed costs accordingly. Consequently, the annual fixed costs of a company car are about €8,000, the variable costs for private travel equal €2,550 and the variable costs for business travel equal €2,850. So, the firm's average annual *gross* costs are €13,400 (that is, €8,000 + €2,550 + €2,850).

We distinguish between the two main assumptions discussed in the main text: (A) firms pay only for the cars' *marginal* costs of business travel *or* (B) firms pay for the cars' *average* costs of business travel. Under the former assumption, the firm's average annual total *net* costs of providing a company car to the employee are €10,500 (that is, €13,400 – €2,850). Under the

latter assumption, the firm's net costs of providing the company car should include the *employees*' fixed-costs'-share of the total costs. This share is defined as the number of private kilometres divided by the total number of kilometres (private kilometres + business kilometres), which is 0.47. Consequently, the firm's net fixed costs are €3,750 (0.47 × €8,000). Accordingly, the firm's average annual total *net* costs of providing a company car to the employee are €6,300 (that is, €3,750 + €2,550).

Appendix B: First Step Results of the IV Procedure

Table B1. *Probit Estimation Results for Presence of Company Car (1996 NTS)*

Variables	*Coefficients*
Instruments	
Log (1+ male business travel) + log (1+ female business travel)	0.95 (0.10)**
Employee age 30–40 (for one-earner households)	–0.06 (0.13)
Employee age 40–50 (for one-earner households)	0.06 (0.13)
Employee age 50–60 (for one-earner households)	0.14 (0.15)
Employee education – low secondary (for one-earner households)	0.20 (0.22)
Employee education – advanced secondary (for one-earner households)	0.29 (0.22)
Employee education – higher (for one-earner households)	0.22 (0.22)
Control factors	
Children 1	–0.02 (0.06)
Children 2	0.06 (0.06)
Children >3	0.07 (0.07)
Household age 30–40	0.01 (0.04)
Household age 40–50	–0.05 (0.04)
Household age 50–60	–0.06 (0.05)
Household income 15–18	–0.04 (0.05)
Household income 18–25	0.08 (0.05)*
Household income >25	0.53 (0.05)**
Household income unknown	0.09 (0.06)*
Household education – low secondary	0.24 (0.08)**
Household education – advanced secondary	0.33 (0.08)**
Household education – higher	0.20 (0.10)**
Residence density – low	0.07 (0.06)
Residence density – moderate	0.04 (0.06)
Residence density – high	–0.01 (0.06)
Residence density – very high	0.17 (0.08)**
Female works full-time	0.04 (0.06)
Two earner household	–0.05 (0.24)
Residence provinces (12)	Included
Workplace provinces (12)	Included
Log-likelihood	–2,780.76
No. observations	6,791

Notes: Business travel distance in kilometres; net income in annual 1,000 euros. The reference category for age is 25–30, for income is <15, for education is primary and for residence density is 'very low'. **, * – indicate that estimates are significantly different from zero at 0.05 and 0.10 level respectively. Standard errors are in parentheses.

latter assumption, the firm's net costs of providing the company car should include the *employees*' fixed-costs'-share of the total costs. This share is defined as the number of private kilometres divided by the total number of kilometres (private kilometres + business kilometres), which is 0.47. Consequently, the firm's net fixed costs are €3,750 (0.47 × €8,000). Accordingly, the firm's average annual total *net* costs of providing a company car to the employee are €6,300 (that is, €3,750 + €2,550).

Appendix B: First Step Results of the IV Procedure

Table B1. *Probit estimation results for presence of company car (1996 NTS)*

Variables	*Coefficients*
Instruments	
Log (1+ male business travel) + log (1+ female business travel)	0.95 (0.10)**
Employee age 30-40 (for one-earner households)	-0.06 (0.13)
Employee age 40-50 (for one-earner households)	0.06 (0.13)
Employee age 50-60 (for one-earner households)	0.14 (0.15)
Employee education – low secondary (for one-earner households)	0.20 (0.22)
Employee education – advanced secondary (for one-earner households)	0.29 (0.22)
Employee education – higher (for one-earner households)	0.22 (0.22)
Control factors	
Children 1	-0.02 (0.06)
Children 2	0.06 (0.06)
Children >3	0.07 (0.07)
Household age 30-40	0.01 (0.04)
Household age 40-50	-0.05 (0.04)
Household age 50-60	-0.06 (0.05)
Household income 15-18	-0.04 (0.05)
Household income 18-25	0.08 (0.05)*
Household income >25	0.53 (0.05)**
Household income unknown	0.09 (0.06)*
Household education – low secondary	0.24 (0.08)**
Household education – advanced secondary	0.33 (0.08)**
Household education – higher	0.20 (0.10)**
Residence density – low	0.07 (0.06)
Residence density – moderate	0.04 (0.06)
Residence density – high	-0.01 (0.06)
Residence density – very high	0.17 (0.08)**
Female works full-time	0.04 (0.06)
Two earner household	-0.05 (0.24)
Residence provinces (12)	Included
Workplace provinces (12)	Included
Log-likelihood	-2780.76
No. observations	6,791

Notes: Business travel distance in kilometres; net income in annual 1,000 euros. The reference category for age is 25-30, for income is <15, for education is primary and for residence density is 'very low'. **, * – indicate that estimates are significantly different from zero at 0.05 and 0.10 level respectively. Standard errors are in parentheses.