KNOWLEDGE-WORKERS AND THE SUSTAINABLE CITY: THE TRAVEL CONSEQUENCES OF CAR-RELATED JOB-PERKS

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ABSTRACT

Attracting firms in knowledge and technology intensive (KTI) sectors is highly sought by national and regional policy makers as a powerful engine of economic growth. Due to fierce competition in the KTI sector, KTI firms often attract employees by offering car-related job perks in addition to wage. This study analyzes the impact of company-cars and car-allowance on the travel behavior of knowledge-workers. The importance of this issue derives from the tendency of knowledge-based economy to concentrate in highly populated metropolitan regions. The analyzed data comprise 750 observations, retrieved from a revealed-preferences survey among KTI workers in the Tel-Aviv metropolitan region in Israel. Results show that car-related job perks are associated with (i) high annual kilometrage, (ii) high propensity of using the car as main commute mode, (iii) long commute distances and travel times, (iv) high trip chaining frequency in commuting trips, and (v) high frequency of long-distance weekend leisure trips. The results suggest that the development of sustainable knowledge-based cities should consider (i) the replacement of car-related job perks by other incentives, (ii) the provision of pedestrian and cyclist friendly infrastructures, and (iii) public transport improvements.

Key words: Knowledge workers, knowledge cities, sustainable development, company car, car-related job perks.

1. INTRODUCTION

Over the last decades, governmental institutions and regional authorities across world regions have shown increasing interest in designing policies aimed towards incubating, attracting, retaining and nurturing knowledge and technology intensive (KTI) firms and business services (KIBS), as means for inducing economic growth and enhancing the national and regional competitive edge. Among designed policies are the establishment of science and technology parks (e.g., Colombo and Delmastro, 2002; Felsenstein, 1994; Kim and Jung, 2009), the establishment of business incubator programs (e.g., Ratinho and Henriques, 2010), the national funding for universities, research and development programs and commercialization of scientific knowledge (e.g., Cornett; 2009; Kaiser, 2003; Raspe and van Oort, 2006; Yigitcanlar et al., 2008), the financial support for international knowledge-based companies (Yigitcanlar et al., 2008), the infrastructure grants for knowledge specialized regions (e.g., Raspe and van Oort, 2006; Yigitcanlar et al., 2008) and the establishment of regional growth forums (Cornett, 2009).

In the resulting micro-cosmos of knowledge intensive agglomerations, KTI and KIBS compete with their spatially proximate counterparts for vital knowledge resources, among which human capital is of the outmost importance (Raspe and van Oort, 2011), in their continuous struggle for survival and growth. Motivated by the growing need to attract and retain highly-skilled knowledge-workers and by national taxation policies, the provision of car-related job perks has become an international labor market phenomenon (van Ommeren et al., 2006). In the U.S., 14% of management, business and financial workers receive commuting allowance in comparison with 6% of the workers in other sectors (U.S. Department of Labor, Bureau of Labor Statistics, 2010). In Canada, car-allowance is the second most popular job perk, as it is offered by 46% of the employers to attract highly-skilled workers (Canadian Payroll Association, 2008). In the U.K., more than half of employers (54.6%) offer a car-allowance, while more than two-fifths (44.7%) offer a company car (Chamberlain, 2010). In New-Zealand company cars are offered by 22% of the employers (New Zealand Institute of Chartered Accountants, 2005). In Israel, 61% of knowledge-workers in the KTI sectors receive a company-car with respect to 16% of workers in other sectors (Keinan, 2007). Furthermore, survey results from the U.K. and Australia indicate that 28% and 50% of the workers, respectively, desire car-related job perks (Employee Benefits, 2006; Interestrate, 2005). The sheer magnitude of this labor phenomenon is highly visible at a

national level as the share of company-cars in the new car fleet in OECD countries ranges between 10% and 50%, with the highest rates in Israel, Sweden, the Netherlands and Germany with 56%, 50%, 45% and 42%, respectively (Cohen-Blankshtain, 2008).

The impact of car-related job perks on travel behavior have hardly received any systematic attention (Cohen-Blankshtain, 2008; Van Ommeren et al., 2006), although a few recent studies provide evidence regarding the impact of company-cars on travel behavior. These studies mainly concern annual kilometrage (Graus and Worrell, 2008; Johansson-Stenman, 2002; Ramaekers et al. 2010), probability to commute by car (Dargay, 2005; Ramaekers et al. 2010), fuel efficiency (Graus and Worrell, 2008), and safety (Albert et al., 2009). In addition, evidence is provided regarding the role of commuting time on negotiating car-related job perks (van Ommeren et al., 2006).

The present study focuses on investigating the impact of car-related job perks, specifically the provision of a company-car and alternatively a car-allowance, on the travel behavior of knowledge-workers employed in KTI sectors. In particular, the current study investigates the hypotheses that car-related job perks increase daily commute and long-distance leisure travel, and hence induce an unsustainable kilometrage increase that implies additional negative externalities such as congestion, pollution and risk exposure. The importance of this issue derives from the influence of knowledge-workers' travel behavior on highly congested urban and metropolitan transportation networks, since knowledge-based economy tends to concentrate mainly in metropolitan regions (Florida, 2002). As knowledge-based economy is often linked to ecologically, socially and economically sustainable urban development (Sarimin et al., 2010; Yigitcanlar et al., 2008), the mobility and environmental externalities of car-related job perks as a popular mean for the attraction and the retention of knowledge-workers deserve serious consideration.

To pursue the research objective, the current study takes a disaggregate approach and employs econometric models to unveil the multiple facets of the impact of car-related job perks on knowledge-workers' travel behavior. The analyzed data comprise 750 observations, retrieved from a revealed-preferences survey among KTI workers who work and reside in the Tel-Aviv metropolitan area in Israel.

The remainder of the paper is organized as follows. Section 2 describes the research methodology including hypotheses, population, geographical scope and survey design. Section 3 describes the collected data sample and section 4 presents the empirical analysis. Last, policy implications are discussed and further research is proposed in section 5.

2. RESEARCH HYPOTHESES

This study explores three hypotheses regarding the linkage between the provision of car-related job perks and the travel behavior sustainability of knowledge-workers.

The first hypothesis (*H1*) concerns car use intensity. Car-related job perks are hypothesized to be positively linked to greater car use intensity, since they reduce the financial burden associated with both car purchase and usage costs for insurance, fuel and parking. The importance of this issue derives from the undesirable decrease of travel behavior sustainability with the increase of private car use.

The second hypothesis (*H2*) is related to commuting trips. Since the provision of car-related job perks results in reduced commuting costs related to fuel and parking, it is hypothesized to be associated with longer commute travel times, frequent trip chaining, and lesser use of sustainable transport modes, including telecommuting, public transit and non-motorized modes. The importance of this hypothesis derives from the high frequency of commuting trips, the short time frame during which they are conducted (i.e., morning and evening peak hour), and their concentration within the metropolitan area. Hence, the sustainability of these trips has a relatively large influence on the quality-of-life within the metropolitan area.

The third hypothesis (*H3*) is related to long-distance leisure and recreational trips. Since the provision of car-related job perks results in reduced fuel costs, it is hypothesized to be positively associated with higher frequency of long-distance leisure and recreational trips on weekends. The importance of long-distance leisure travel derives from its high impact on the total kilometrage driven, despite their small share in the number of trips, and from the increase in the number of leisure trips during the last decades (LaMondia et al., 2011, Dargay and Clark, 2010). In Israel, which is the study region, long-distance leisure trips above 60 kilometers on weekends comprise 5.9% of all weekend trips and roughly 32.0% of the total kilometrage (see Bekhor et al., 2011).

3. DATA COLLECTION

3.1 Research region and population

The empirical study took place in the Tel-Aviv Metropolitan (TAM) region, which is Israel's largest and most central metropolitan region, and the country's cultural and financial center. The TAM encompasses the Tel-Aviv district and the Central district, covers 1,518 square-kilometers and hosts 3.0 million inhabitants, roughly over 40% of the country's population. The total built area comprises 40% of the total area in the TAM. About 90% of the TAM's population reside in urban areas and about 55% of the population reside in the nine largest cities. The TAM has a classical concentric structure, with the city of Tel-Aviv as the core of the metropolitan area, surrounded by three concentric rings. The city of Tel-Aviv hosts 400 thousands inhabitants and provides 1.0 million jobs.

The TAM, a world city in evolution and a cosmopolitan metropolis, is known as the 'the startup metropolis', as in the late 1990's was hosting 86% of Israel's high-technology firms and three of its main industries: communication, information technology, and the Internet. In addition, the core area and the inner ring, which supply 49% of the jobs in the TAM region, are characterized by a high level of specialization in finance and business activities and they function as the country's financial and administrative center. Finally, the TAM region serves as the center of the 'creative class' and the bohemia including world-known musicians, actors, dancers and visual artists (Kipnis, 2004; Frenkel, 2007).

The road system in the TAM region includes about 5800 lane-km, of which 11% are divided highways. In the core city of Tel-Aviv, the fraction of transportation land-use from the total built area is 20%, almost twice as much than in other two large metropolitan areas in Israel, namely Haifa and Jerusalem (Tel-Aviv Municipality, 2008a). The motorization rate in the TAM region is about 350 private cars per 1000 inhabitants. This level is higher than the national level of about 280 and in several cities the motorization level exceeds 400 private cars per 1000 inhabitants. This motorization rate is expected to exceed 500 cars per 1000 inhabitants in many cities within the TAM (Tel-Aviv Municipality, 2008a). Trips mode split in the TAM region is about 70% in favor of the private car (Matat, 2010). Traffic during the peak hours is directional, moving into the Central Business District (CBD) area during the morning peak hours and out of the CBD during the evening peak hours. During morning peak hours, the travel demand along radial roads

to the CBD is particularly high from the east (12,920 car trips), and from the south (11,600 car trips), and medium-high (8,470 car trips) from the north. In addition, there is a high demand for peripheral trips in the metropolitan fringe towards the east from the south (11,560 car trips) and from the north (9,230 car trips) (Tel-Aviv Municipality, 2008a). Highly stable heavy congestion is frequently observed on major highways, with average travel speed of 31 kilometers per hour in the inbound direction during morning peak hour and 29 kilometers per hour in the outbound direction during afternoon peak hour (Stern, 2004). Traffic counts conducted by the Tel-Aviv municipality in various check points around the city between the years 2004-2006 reveal that many roads are characterized by a low level of service, with heavy congestion in both directions on main arterial roads, and in the main entrances to the core city from every direction (Tel-Aviv Municipality, 2008a). The level-of-service during morning peak hours on the road system is presented in figure 1. Notably, major highways and arterial roads are characterized by level-of-service E (marked in red, describe operation at capacity) and F (marked in blue, describes breakdown in the vehicle flow and formation of traffic jams). The heavy congestion during morning peaks hour heavily influences the satisfaction of the residence of the TAM region, as 28% of the residents in Tel-Aviv are dissatisfied from their commuting time (Tel-Aviv Municipality, 2008b).

The target population in the current study consists of business-oriented knowledge-workers in the high-technology services (e.g., computer science, electrical engineering, biotechnology) and financial business services (e.g., banking, market analysis, and investment consultancy), according to Schwartz's (2006) classification. The sample was recruited through 1,500 relevant firms, whose main offices and facilities are located in the TAM region. The firms were drawn from the Dun and Bradstreet database and the Israel Venture Capital Research Center database that include information regarding activity sector, number of employees and year of establishment of each firm. The sample covered a wide range of high-technology and financial activity sectors, as well as firm sizes and ages.

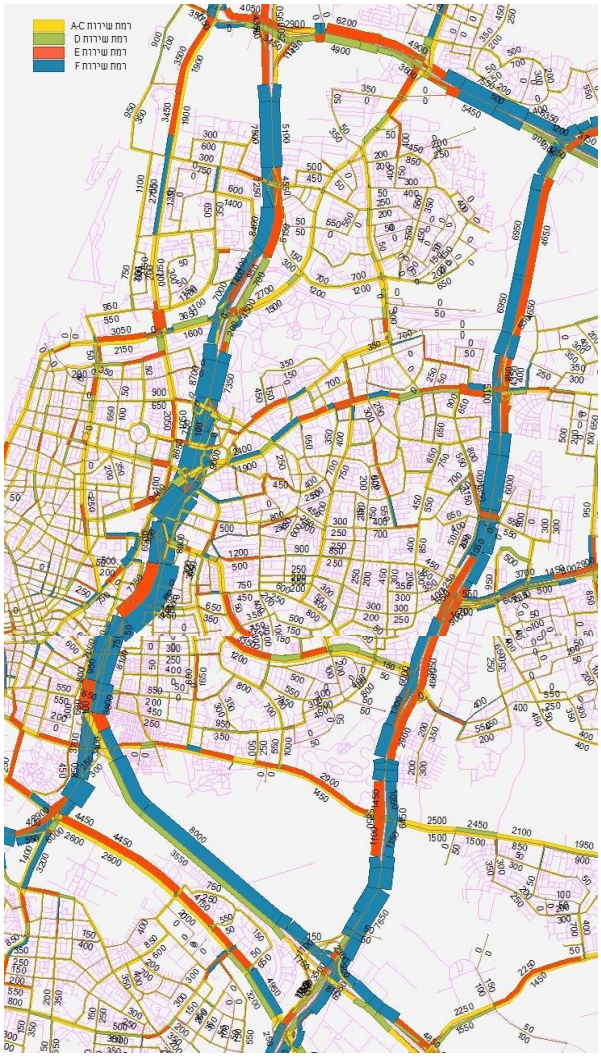

Figure 1 - Traffic volumes and level-of-service during morning peak hours in 2010 at the central part of the Tel-Aviv metropolitan area (Source: Ayalon Highway, 2011)

3.2 Survey design

The data were collected through a revealed-preferences survey from June 2009 to February 2010 by means of a custom-designed questionnaire for the purpose of the current research. The questionnaire included questions regarding socio-economic characteristics, residential and workplace location, car-ownership, company-car and car-allowance availability, annual kilometrage, travel time and mode to the workplace, trip chaining on the way to the workplace, and frequency of long-distance leisure travel during weekends.

The survey design is web-based, since its benefits in comparison with traditional survey forms (e.g., home interviews and phone surveys) are minimal disturbance to the daily activities of the knowledge-workers due to schedule and location flexibility, and modest operational costs. A web-based environment is particularly advantageous for survey administration among knowledge-workers who use the Internet media on a regular basis. Nevertheless, a challenge in conducting web-based surveys concerns sample reliability, as the web-based environment provides a high degree of anonymity. In order to control the sample composition, the recruitment of respondents was conducted through human resources offices in KTI companies, and the workers provided their contact details as pre-conditions for receiving the promised incentive. As post validation procedure, a follow-up contact by e-mail on July 2010 verified the identity of the respondents.

4. EMPIRICAL RESULTS

4.1 Sample characteristics

The survey yielded 900 respondents, of which 750 (83.3%) carried the survey through to conclusion. The sample includes evenly spread employees across 410 firms and consists of both workers in managerial and non-managerial positions, as well as both salaried and self-employed workers. 77.9% of the respondents either reside or work in the TAM region. Table 1 summarizes the socio-economic characteristics of the respondents. The average age is 38 years, 71.9% of the respondents are male, 81.4% are married and 77.7% have children. The wage level of the sample population is higher than the average wage of knowledge-workers, as 53.8% of the respondents earn above 20,000 New Israeli Shekels (NIS), in comparison with the average wages of 15,800 NIS and 14,200 NIS in the high-technology and finance sector (CBS, 2008).

In terms of car-related job perks, 57.9% of the respondents receive a company-car, an additional 11.1% are given car-allowance, and the remaining 31% do not receive any car-related job perks. However, the share of workers provided with a company-car is similar to the findings reported by Keinan (2007).

The majority of company-car drivers enjoy the reimbursement of its usage and operating costs. Car license and insurance are fully paid by the employer for 58.8% of the respondents and partially paid for another 13.1%. Fuel expenses are fully reimbursed for 85.0% of the

respondents and partially reimbursed for another 12.2%. Parking expenses are fully repaid for 9.4% of the respondents, while are paid exclusively for work related trips for 64.3%.

Table 1 - Sample characteristics

VARIABLE	CATEGORIES (%)			
Gender	Male	Female		
	71.9	28.1		
Marital Status	Single	Married	Co-habit	Divorced
	10.8	81.4	5.9	1.9
Number of children	None	1 child	2 children	More than 2 children
	22.3	17.6	26.4	33.7
Age	Mean	Standard deviation		
	37.5	8.3		
Monthly wage (NIS)	$\leq$ 12,500	12,500-20,000	20,000-30,000	$\geq$ 30,000
	18.6	27.6	31.4	22.4
Level of education	High-school	B.Sc.	M.Sc.	Ph.D.
	8.8	51.1	56.4	3.6

4.2 Annual kilometrage

The first hypothesis (*H1*) is explored by investigating the linkage between car-related job perks and annual kilometrage as an indicator for car use intensity. The linkage is analyzed by means of ordered-response probit model estimation, since in the survey data about annual kilometrage was collected by eliciting four annual kilometrage categories: under 10,000 kilometers, 10,000-20,000 kilometers, 20,001-30,000 kilometers, and over 30,000 kilometers. The annual kilometrage is assumed to be related to a vector z_n of knowledge-worker characteristics and an error term ε_n as follows:

$$A_n^* = \beta' z_n + \varepsilon_n \quad (1)$$

The vector of individual characteristics z_n includes the availability of a company-car and car-allowance, individual socio-economic characteristics (i.e., age, marital status, presence of children in the household, and wage), car ownership, residential location (i.e., location in the metropolitan fringe versus the center) and workplace location (i.e., location in the metropolitan fringe versus the center). β encompasses the parameters to be estimated.

According to the ordered-response probit model, the annual kilometrage A_n^* of knowledge-worker n is a latent continuous variable measured by M observed threshold categories ($m=1,\ldots,M$). Given annual kilometrage categories defined by a set θ of constants $(\theta_1, \theta_2, \ldots, \theta_M)$, for which holds $\theta_1 < \theta_2 < \ldots < \theta_M$, the unobserved continuous annual kilometrage A_n^* of knowledge worker n belongs to an observed category m when its value lies between its upper bound θ_{m-1} and its lower bound θ_m:

$$\theta_{m-1} < A_n^* \leq \theta_m \tag{2}$$

Assuming that the error term ε_n is identically and independently distributed (i.i.d.) normal across knowledge-workers, the probability of knowledge-worker n to drive annual kilometrage A_n^* is as follows (Maddala, 1983, pp. 46–49):

$$P\left(\theta_{m-1} < A_n^* \leq \theta_m\right) = \Phi\left(\theta_{m-1} - \beta' z_n\right) - \Phi\left(\theta_m - \beta' z_n\right) \tag{3}$$

The unconditional log-likelihood LL over N knowledge-workers who drive annual kilometrage A_n^* is as follows:

$$LL = \sum_{n=1}^{N}\sum_{m=1}^{M} \log\left[\Phi\left(\theta_{m-1} - \beta' z_n\right) - \Phi\left(\theta_m - \beta' z_n\right)\right]^{d_{mn}} \tag{4}$$

where d_{mn} equals one if the annual kilometrage of knowledge-worker n belongs to kilometrage category m, and zero otherwise.

Table 2 presents the model estimation results. The model is estimated for 600 observations due to missing values in the collected data. The model estimation results show that the annual kilometrage is significantly and positively related to the provision of car-related job perk, namely the provision of company-car and car-allowance. Notably, individual socio-economic characteristics, car ownership and workplace location are not significantly related to vehicle mileage in the sample, and the only relevant variables are car-related job-perks and residential location in the metropolitan fringe. The model goodness-of-fit indicates good explanatory power and suggests that car-related job perks are indeed important determinants of the total annual kilometrage. The results confirm hypothesis (*H1*) that car-related job perks are positively linked to greater car use intensity, possibly since they reduce the financial burden associated with car purchase and the usage costs of car licensure, fuel and parking.

Table 2 - Annual kilometrage model estimation results

Variable	Categories	Coefficient	t-statistic
Car-related job perks	None[a]	-	-
	Company-car	1.317	10.82***
	Car-allowance	0.354	2.12**
Age (years)		0.013	1.87*
Gender	Female[a]	-	-
	Male	0.112	1.02
Marital status	Unmarried[a]	-	-
	Married	0.025	0.166
Children	None[a]	-	-
	Children	-0.174	-1.20
Monthly wage in NIS	Under 12,500[a]	-	-
	12,500-20,000	-0.020	-0.13
	20,000-30,000	-0.020	-0.12
	Over 30,000	-0.043	-0.23
Car ownership (number of cars per household)		0.053	0.56
Residence at the metropolitan fringe		0.595	5.90***
Workplace at the metropolitan fringe		0.171	1.82*
Annual kilometrage Cut-off values	Under 10,000 [a]	-	-
	10,000-20,000	0.844	2.96**
	20,000-30,000	2.105	7.21***
	Over 30,000	3.120	10.32***
Number of observations			598
Restricted log-likelihood			-803.692
Log-likelihood at estimates			-694.875
McKelvey and Zavoina Pseudo R-square			0.339

Note: [a] reference category, *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

4.3 Travel behavior related to work trips

The following sections are aimed at exploring the second hypothesis (*H2*) regarding the relationship between the provision of car-related job perks and commuting trips. The investigated aspects are travel time, travel mode, and trip chaining.

4.3.1 Commuting time

The survey elicited the perceived commute travel time to work during morning peak hours (06:00-09:00) and the analysis focused on commute travel time by car, since it is the main travel mode to work for 79.4% of the respondents. The commute travel time to work is naturally related to the residential and workplace location, but may also be linked to car-related job perks, individual socio-economic characteristics and car ownership. The linkage between the commute travel time and car-related job perks is investigated by means of a multivariate regression model as follows:

$$t_n = \beta' z_n + \varepsilon_n \quad (5)$$

where t_n is the travel time to work of knowledge-worker n, z_n is the aforementioned vector of individual characteristics, ε_n is an error term, and β encompasses the parameters to be estimated.

Table 3 presents the model estimation results. The model is estimated for 638 observations due to incomplete data. Despite the relatively low goodness-of-fit, the model estimation results clearly indicate that commute travel time to work is positively and significantly linked to the provision of company-car, but not to the provision of car-allowance. Other variables that relate to travel time to work are gender, income, residential and workplace location. Male tend to have longer commute times with respect to women, and knowledge-workers with higher income tend to have shorter commute time, possibly due to their higher value-of-time. Knowledge-workers who reside at the metropolitan fringe have longer commute time, while workers who work at the metropolitan fringe have shorter commute time, most likely since 74.8% of the respondents who work at the metropolitan fringe also reside nearby, while only 54.0% of the respondents employed in the center also reside there. The results support the hypothesis that the provision of a company-car is associated with longer commute travel times.

Table 3 - Commute travel time model

Variable	Categories	Coefficient	t-statistic
Car-related job perks	None[a]	-	-
	Company-car	8.740	5.16***
	Car-allowance	3.556	1.49
Age (years)		-0.001	-0.00
Gender	Female[a]	-	-
	Male	3.201	1.96**
Marital status	Unmarried[a]	-	-
	Married	-0.762	-0.34
Children	None[a]	-	-
	Children	1.166	0.54
Monthly wage	<12,500[a]	-	-
	12,500-20,000	-6.247	-2.80**
	20,000-30,000	-5.274	-2.22**
	≥30,000	-7.355	-2.69**
Car ownership (number of cars per household)		-2.076	-1.573
Residence at the metropolitan fringe		16.898	11.29***
Workplace at the metropolitan fringe		-7.879	-5.57***
Intercept		28.25	7.14***
Number of observations			638
R-squared			0.221

Note: [a] reference category, *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

4.3.2 Commuting mode

The current study analyzes the propensity to travel to work by car versus other modes, since 79.4% of the respondents travel to work by car, while only 7.5% are public transport riders and 3.1% use non-motorized modes. Telecommuting is not considered in the current analysis since only 1.1% of work regularly at home and the availability of car-related job perks is not related to telecommuting habits of respondents, as only 29.7% of the respondents telecommute

occasionally regardless of car-related job perks. Due to the strong tendency of knowledge-workers to travel to work by car, a binary probit model is estimated to explore the linkage between car-related job-perks and the probability to travel by car versus other travel modes. According to the binary probit model, the probability to choose a car as main travel mode to work is as follows:

$$P_{ncar} = 1 - \Phi\left(\theta - \beta' z_n\right) \quad (6)$$

where P_{ncar} is the probability of knowledge-worker n to travel by car in work-related trips, z_n is the aforementioned vector of individual characteristics and the availability of car-related job perks, and β and θ are parameters to be estimated. The corresponding unconditional log-likelihood LL over N knowledge-workers is as follows:

$$LL = \sum_{n=1}^{N} \log\left[1 - \Phi\left(\theta - \beta' z_n\right)\right]^{d_n} \quad (7)$$

where d_{mn} equals one if knowledge-worker n travels by car to work, and zero otherwise.

Table 4 depicts the model estimation results for the choice to travel by car in work-related trips. The model is estimated for 638 observations due to incomplete data. The model goodness-of-fit indicates good explanatory power. The results indicate that the provision of a company-car and car-allowance is significant and positively related to an increase of the probability to travel by car to work. Other variables that positively relate to the probability to travel by car as main mode to work are car ownership, gender, marital status and workplace location at the metropolitan fringe.

Table 4 - Transport mode to work model

Variable	Categories	Coefficient	t-statistic
Car-related job perks	None[a]	-	-
	Company-car	0.955	5.92***
	Car-allowance	0.602	2.74**
Age (years)		0.014	1.22
Gender	Female[a]	-	-
	Male	-0.580	-3.39***
Marital status	Unmarried[a]	-	-

	Married	-0.898	-3.86***
Children	None[a]	-	-
	Children	0.281	1.42
Monthly wage	<12,500[a]	-	-
	12,500-20,000	0.113	0.55
	20,000-30,000	0.256	1.14
	≥30,000	0.248	0.93
Car ownership (number of cars per household)		0.960	7.15***
Car travel time to work		-0.006	-1.86*
Residence at the outskirts of the metropolitan area		0.034	0.65
Workplace at the outskirts of the metropolitan area		0.205	3.29**
Constant for car as main mode to work		-1.152	-2.85**
Number of observations			638
Restricted log-likelihood			-224.04
Log-likelihood at estimates			-326.601
McKelvey and Zavoina Pseudo R-square			0.487

Note: [a] reference category, *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

4.3.3 Trip chaining on the way to the workplace

82.2% of the respondents form a trip chain including an intermediate stop for bringing children to schools or kindergarten on their way to or from the work place. The linkage between propensity to trip chain for bringing the children to school and car-related job perks is analyzed by means of binary probit model estimation. The probability of bringing children to school on the way to work is as follows:

$$P_{nchild} = 1 - \Phi\left(\theta - \beta' z_n\right) \quad (8)$$

The vector of individual characteristics z_n includes the availability of a company car and car allowance, individual socio-economic characteristics, travel time and main travel mode to work, residential and workplace location. β and θ encompass the parameters to be estimated.

The corresponding unconditional log-likelihood *LL* over *N* knowledge-workers is as follows:

$$LL = \sum_{n=1}^{N} \log\left[1 - \Phi\left(\theta - \beta' z_n\right)\right]^{d_n} \quad (9)$$

where d_{mn} equals one if knowledge-worker n brings the children to school or kindergarten on the way to work, and zero otherwise.

Table 5 shows the estimation results for trip chaining on the way to work. The model is estimated for 625 observations due to incomplete data. The results indicate that in general the propensity of such trip chaining behavior naturally increases with the presence of children in the household and decreases with the parents' age. Commuting by car as a main mode to work naturally increases the propensity for such a trip chaining behavior. Commuting distance is negatively related to trip chaining behavior, possible due to the increase in delay, but is only significant at the 10% significance level. The provision of a company-car is significant and positively related to an increase of the probability to form such trip chains. The provision of car allowance is also positively related with trip chaining behavior to a lesser extent and is only significant at the 10% level.

Table 5 – Trip chaining frequency model

Variable	Categories	Coefficient	t-statistic
Car-related job perks	None[a]	-	-
	Company-car	0.464	3.02**
	Car-allowance	0.345	1.65*
Age (years)		-0.033	-3.96***
Gender	Female[a]	-	-
	Male	0.015	0.98
Marital status	Unmarried[a]	-	-
	Married	-0.136	-0.57
Children	None[a]	-	-
	Children	0.236	9.56***
Monthly wage	<12,500[a]	-	-
	12,500-20,000	0.003	0.02
	20,000-30,000	-0.033	-0.15
	≥30,000	-0.071	-0.30

Car travel time to work		-0.006	-1.86*
Main travel mode to work	Other[a]	-	-
	Car	0.550	3.35***
Residential location at the metropolitan fringe		0.092	0.65
Workplace location at the metropolitan fringe		-0.113	-0.90
Constant for trip chaining		-1.177	-3.09**
Number of observations			625
Restricted log-likelihood			-433.21
Log-likelihood at estimates			-316.05
McKelvey and Zavoina Pseudo R-square			0.499

Note: [a] reference category, *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

4.4 Travel behavior related to long-distance leisure trips

The third hypothesis (*H3*) is explored by investigating the linkage between car-related job perks and the frequency of long distance leisure and recreational trips (above 60 kilometers per direction), conducted on weekends (Friday and Saturday) in the six months period prior to the survey. Car is often the main transport mode for such trips, since the public transport system is not working from Friday afternoon until Saturday evening. The linkage is analyzed by means of ordered-response probit model estimation, since in the survey data about the trip frequency was collected by eliciting six frequency categories: (i) did not conduct long-distance trips, (ii) 1-2 trips, (iii) 2-4 trips, (iv) 4-6 trips, (v) 6-8 trips and (vi) more than 8 trips. The long distance trip frequency is assumed to be related to a vector of knowledge-worker characteristics z_n and an error term ε_n as follows:

$$LD_n^* = \beta' z_n + \varepsilon_n \quad (10)$$

The vector of individual characteristics z_n includes the availability of a company car and car allowance, individual socio-economic characteristics, residential and workplace location. β encompasses the parameters to be estimated.

According to the ordered-response probit model, the frequency LD_n^* of long distance trips conducted by knowledge-worker n during the six months prior to the survey is a latent continuous variable measured by M observed threshold categories ($m=1,\ldots,M$). Given a set θ of

constants $(\theta_1, \theta_2, \ldots, \theta_M)$, for which holds $\theta_1 < \theta_2 < \ldots < \theta_M$, the unobserved frequency LD_n^* of long distance trips of knowledge worker *n* belongs to a category *m* when its value lies between its upper bound θ_{m-1} and its lower bound θ_m.

$$\theta_{m-1} < LD_n^* \leq \theta_m \tag{11}$$

Assuming that the error term is i.i.d. normal across knowledge-workers, the probability of knowledge-worker *n* to conduct LD_n^* long distance trips is as follows (Maddala, 1983, pp. 46–49):

$$P\left(\theta_{m-1} < LD_n^* \leq \theta_m\right) = \Phi\left(\theta_{m-1} - \beta' z_n\right) - \Phi\left(\theta_m - \beta' z_n\right) \tag{12}$$

The unconditional log-likelihood *LL* over *N* knowledge-workers who conduct LD_n^* long distancetrips is as follows:

$$LL = \sum_{n=1}^{N}\sum_{m=1}^{M} \log\left[\Phi\left(\theta_{m-1} - \beta' z_n\right) - \Phi\left(\theta_m - \beta' z_n\right)\right]^{d_{mn}} \tag{13}$$

where d_{mn} equals one if the frequency of long distance trips conducted by knowledge-worker *n* belongs to frequency category *m*, and zero otherwise.

Table 6 describes the model of estimation results. The model is estimated for 641 observations due to incomplete data. Although the model goodness of fit is relatively low, the results clearly show that the tendency to engage in higher frequency of long distance trips is positively and significantly related to the availability of a company-car, to higher income and to working at the metropolitan fringe. Hence, the results support hypothesis H3 that the availability of a company-car increases the tendency to engage in higher frequency of long distance leisure and recreational trips.

Table 6 – Long distance leisure trip model

Variable	Categories	Coefficient	t-statistic
Car-related job perks	None[a]	-	-
	Company-car	0.214	2.06**
	Car-allowance	0.103	0.70
Age (years)		0.003	0.55
Gender	Female[a]	-	-
	Male	0.119	1.18

Marital status	Unmarried[a]	-	-
	Married	-0.064	-0.45
Children	None[a]	-	-
	Children	0.111	0.83
Monthly wage	<12,500[a]	-	-
	12,500-20,000	0.119	0.88
	20,000-30,000	0.263	1.82*
	≥30,000	0.472	2.82**
Residence at the metropolitan fringe		0.154	1.67*
Workplace at the metropolitan fringe		0.273	3.09**
Cut-off values	None [a]		
	1 trip	-1.015	-4.10***
	2-4 trips	-0.310	-1.28
	4-6 trips	0.730	3.02**
	6-8 trips	1.286	5.28***
	Over 8 trips	1.631	6.65***
Number of observations			641
Restricted log-likelihood			-1012.98
Log-likelihood at estimates			-1042.14
McKelvey and Zavoina Pseudo R-square			0.096

Note: [a] reference category, *** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level

5. CONCLUSIONS AND FURTHER RESEARCH

The present study focuses on the linkage between car-related job perks, namely the provision of a company-car and a car-allowance, and the travel behavior of knowledge-workers. The importance of this issue stems from the increasing interest in regional policies aimed towards attracting and retaining KTI and KIBS firms, from the tendency of knowledge-workers and firms to locate in congested metropolitan areas, and from the growing popularity of car-related job perks in knowledge-economy labor markets, due to the fierce competition between proximate KTI firms on valuable human capital resources. As knowledge-based economy is often linked to

sustainable urban development, this study focuses on exploring the impact of car-related job perks on sustainable travel patterns from the broad perspective of both commuting and leisure trips.

The results from this study, conducted in the TAM region, suggest that the provision of car-related job perks is related to non-sustainable travel behavior from the economic and ecological perspectives. Firstly, the results confirm the hypothesis that the provision of car-related job perks, and in particular the provision of a company-car, is positively related to higher car use intensity, namely higher annual kilometrage deriving from both commuting and long-distance leisure trips. Adding to the literature indicating that high annual kilometrage stems from business and commuting trips (Graus and Worrell, 2008), this study not surprisingly shows that the majority of company-car drivers travel also long-distance trips on weekends while enjoying the reimbursement of usage and operating costs. Secondly, evidence from this study substantiates the hypothesis that the provision of car-related job perks is associated with longer commute travel times, higher trip chaining frequency on the way to work and lesser use of sustainable transport modes in work-related trips. In particular, the provision of car-related job perks, both company-car and car-allowance, is associated to greater car use instead of sustainable transport modes, although it is not linked to telecommuting frequency. Thirdly, the findings of this study support the hypothesis that the provision of a company-car is positively associated with higher frequency of long-distance leisure and recreational trips on weekends. Overall, the results of the current study results indicate that the provision of car-related job perks induce unsustainable travel patterns for both commute and leisure trips, and place an additional burden on congested networks in metropolitan areas.

Important policy implications originate from these findings. Firstly, regional policies aimed at attracting and retaining knowledge-based firms and workers should not be regarded as a miracle cure for creating economically, socially and environmentally sustainable knowledge-cities. Rather, in order to promote sustainable knowledge-based future, the decoupling of the labor market from car-related job perks, which are often encouraged by national taxation policies or cavities, deserves serious consideration. Considering the growing share of knowledge-based economy in the global economy, policy measures should be implemented towards decreasing the attractiveness of car-related job perks, and encouraging employers to provide "green" job-perks

aimed at encouraging sustainable travel patterns. Last, particular emphasis should be placed on developing safe and friendly local infrastructure that should be designed for non-motorized transport modes and on improving the competitive edge of public transport versus private cars.

Several further research directions exist. First, self-reported travel times and annual kilometrage are subjective and potentially inconsistent across individuals. Accordingly, in-vehicle data recorders that include a Global Positioning System (GPS) would provide objective data about travel times and kilometrage. Second, the linkage between car-related job perks and travel behavior should be compared with other countries in order to identify cross-cultural differences. Last, information about car-related job perks could be collected in national travel habit surveys and embedded into activity-based transport models to better understand how policies regarding car-related job perks influence mobility and sustainability at the national level.

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