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Disaggregate Analysis of Gasoline Consumption Demand of Greek Households

Theodore Tsekeris

Centre of Planning and Economic Research (KEPE)
11 Amerikis, 10672 Athens, Greece
e-mail:tsek@kepe.gr

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The expenditure on private vehicle usage is an important aspect of the budget allocation process of households, which has important implications for the sustainable urban development and transport, energy and environmental policy making. This paper examines the gasoline consumption demand of Greek households using cross-sectional micro-data from a country-wide Household Budget Survey (HBS) during the period 2004/05. The two-step Heckman modeling methodology is adopted to jointly estimate the probability of selecting to use private vehicle and the amount of using it. In this way, it can help to identify and better explain factors for which some private vehicle owners/holders do (not) actually consume that mode.

The results offer valuable insight into the existence of feedback relationship between the decision-making mechanisms of selecting to use private vehicle and amount of usage, in terms of the amount of money spent for gasoline consumption. They also indicate the statistically significant impact of region-specific fixed effects, which implies that unobserved or omitted factors associated with each Region have a different impact on the decision to choose and the amount of using private vehicle. The income variable has a statistically significant positive impact on the selection and usage of a private vehicle. The estimated income elasticity suggests that a private vehicle travel is relatively inelastic (normal and necessity good). Its value reflects the increased car dependence and it is within the range of other income elasticities found in the literature.

The male gender of household head, the amount of cars owned, the participation of family members in the labour market, the family size (a single-parent or couples with at least one child older than 18 years-old) and the expenditure on communication and tourism increase the probability of private vehicle gasoline consumption. The latter finding verifies that private vehicle constitutes an important means of transport during vacation. The use of communication devices, especially a mobile phone, reinforces the use of private vehicle, as it weakens the need for short-range activity planning in advance and the range and extent of social networking.

On the contrary, the high population densities, the connection to the internet and the aging of household head reduce the probability of private vehicle gasoline consumption. The above results signify the role of personal and intra-household constraints, mostly related to size and aging structure, on the selection and use of a private vehicle.

The expenditure on most other transport categories, such as an urban public transport, taxi, coach and rail negatively and statistically significantly affect private vehicle gasoline consumption. This outcome stresses the competitive relationship between the private vehicle and other transport modes which are mainly used in urban areas (urban bus, metro, and taxi).

The study findings suggest the design of more sustainable leisure travel services, focussed on upgrading the quality of public transport modes servicing tourist resort areas. Policy measures to manage private vehicle use must be spatially targeted, accounting for the local climate, residential densities, infrastructure and accessibility conditions and the service quality of alternative modes in each Region. These measures can be supplemented with the adoption of suitable information and communication technologies to reduce the demand for private vehicle travel and increase the level of public transport services, as well as investments in clean vehicle technologies.

Keywords: *transport energy, transport management, private passenger transport, public transport, travel demand, limited dependent variable models.*

Introduction

This paper investigates the consumption demand of Greek households for private vehicle usage, in terms of the gasoline expenditure. The amount of money spent by households for trip making can provide a useful metric of their travel demand for different passenger transportation modes. Specifically, the magnitude of (monthly average) expenditures on private vehicle usage can incorporate such information as those related to the frequency and amount of car trip making as well as the monetary cost of car travel. The processing of disaggregate (at the household level) expenditure data can facilitate the identification and interpretation of major determinants of household budget allocation for private vehicle usage, which can vary among users belonging to diverse economic, social and demographic population groups and dissimilar geographical settings. The knowledge on the amount of private vehicle travel and energy consumption is vital for the measurement of the benefits and costs and assessment of new or improved transport projects (Jakimavicius & Burinskiene, 2009; Bazaras & Miceviciene, 2010; Rudzianskaite-Kvaraciejiene et al., 2010).

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The current dataset refers to the (most recently processed) 2004-05 Greek Household Budget Survey (HBS). Section 2 provides an overview of current econometric models used in the literature to estimate gasoline consumption demand using micro-data on transportation expenditures. Section 3 briefly reports underlying trends of the demand for gasoline consumption in Greece and the current study data. Section 4 presents the model specification, relevant tests and estimation results. Section 5 includes conclusions and implications of the study for the design and assessment of several transport and relevant energy and environmental policies at the local and international level.

Gasoline consumption demand modeling using expenditure micro-data

Despite that the effects of several social, economic and demographic factors on household automobile travel choices have been well documented and studied using cross-sectional data from a variety of sources, there are very few studies investigating the mechanisms of household spending behavior for automobile trip making. These studies are principally based on the use of limited dependent variable models. The most familiar type of such models is the Tobit model (Tobin, 1958), which has been applied to a wide range of consumer demand studies using micro-data (Labeaga, 1993; Deaton, 1997; Yoo, 2003; Fang, 2008). Amongst them, Hagemann (1981) studied the household expenditures for vacation travel using the 1972-73 US Consumer Expenditure Survey (CES). Nolan (2003) investigated the urban household travel decisions in the Dublin area, separately with regard to gasoline, bus and taxi fares using the 1994-95 Irish HBS. Also, Thakuriah and Liao (2006) examined the household decisions on the daily short-distance (urban) overall travel expenditures using the 1999-2000 US CES.

The use of Tobit models is based on the rather restrictive assumption that the same variables affect in the same way both the decisions of travelers to use or not to use a specific transportation mode and the intensity of using it. In this way, Tobit models can only capture *corner solutions*, which imply that all households are potential users and choose to use or not to use a particular mode due to the lack of affordability (low income) or the high price of gasoline or public transportation fare, or both (low income and high price). However, zero observations can sometimes be attributed to other factors, such as habitual non-usage of a specific mode and infrequency of traveling with that mode. In order to address this potential bias in travel consumption demand estimation using micro-data, the Heckman's two-stage sample selection estimator, also know as Heckit model or adjusted Tobit model, or the Limited Information Maximum Likelihood selection estimator (Heckman, 1979) can be implemented. According to this methodology, the dichotomous choice of households to travel or not to travel with private vehicle dominates over their decision about the intensity of using it.

The consumption demand equation that describes the amount of expenditures y_i made by household i for gasoline can be described as a latent dependent variable equation, which is typically solved using Ordinary Least Squares (OLS) among the subsample $y > 0$, as follows:

$$y_i^* = x_i\beta + u, \qquad \text{where } u \sim N(0, \sigma^2) \tag{1}$$

with x being a set of explanatory variables of the decision of each household i on the amount of gasoline expenditure to be spent and β being the corresponding vector of coefficients. In contrast with the actual outcome, i.e., the true expenditure made by a household i, the potential outcome is a latent variable y_i^* that is only partially observed. The non-zero observation values are assumed to be true observations of the potential outcome, but zero values indicate observations for which the potential outcome is missing (latent). The zero observations do not represent zero values for the potential outcome. In contrast with the Tobit model, rather than y^* being observed when $y^* > 0$, the y^* value is assumed to be observed based on the value of a second latent variable, z^*, where:

$$z_i^* = w_i\alpha + v, \qquad \text{where } v \sim N(0, \sigma^2) \tag{2}$$

with w being the set of selection variables of the decision of each household i on whether to use or not to use private vehicle and α being the corresponding vector of coefficients. Equation (2) is typically estimated using a binary probit (or logit) model, which provides the probability of household i to travel or not to travel by private vehicle. In this case, y is only observed if $z^* > 0$. Furthermore, the model is assumed to be governed by the following observability criteria:

$$z_i = \begin{cases} 1 & \text{if } z_i^* > 0 \\ 0 & \text{if } z_i^* \le 0 \end{cases} \tag{3}$$

Equation (1), usually referred to as the *consumption* or *outcome* equation, and equation (2), usually referred to as the *participation* equation, together constitute the Heckit model. In contrast with the Tobit model, the participation and the consumption part of the Heckit model do not involve the same error structure. In addition, the selection variables w are not identical to the variables x of the consumption equation. Assuming that (u,v) has a bivariate normal distribution, i.e.

$$\begin{pmatrix} u_i \\ v_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_u^2 & \rho\sigma_u \\ \rho\sigma_u & \sigma_v^2 \end{pmatrix}\right] \tag{4}$$

where ρ is the correlation between u and v, the conditional equation providing the consumption part of the Heckit model can be written as follows:

$$E(y_i | z_i = x_i\beta + \rho\sigma_u\left[\frac{\phi(w_i\alpha)}{\Phi(w_i\alpha}\right] = x_i\beta + \rho\sigma_u\lambda$$

where $\lambda = \left[\frac{\phi(w_i\alpha)}{\Phi(w_i\alpha)}\right]$ is the Inverse Mill's Ratio (IMR) that denotes the non-selection hazard. If the estimate $\hat{\lambda}_i$ is significant, then $H_0 : \rho = 0$ can be rejected, which

means that there is selection bias. Otherwise, the second term of equation (5) that includes the IMR is removed, and the Heckit model is reduced to the Two-Part Model (2PM) (Duan et al., 2003). Kayser (2000) employed the Heckit model to analyze the gasoline consumption behavior in the U.S.A., using the U.S. Panel Study of Income Dynamics (PSID). For similar purposes, Asensio et al. (2003a) used the 1990-91 Spanish HBS, and West and Williams (2007) employed the 1996-98 US CES. The present study implements the Heckit methodology for the disaggregate analysis of Greek household expenditure on private vehicle transport.

Demand for gasoline consumption in Greece and study data

Transport sector traditionally requires significant amounts of (fossil) fuels for different kinds of activities. As shown in Table 1, following the consumption of energy in households and trade facilities, the sectors of industry and road transport are the most energy-intensive sectors of the economy, in both Greece and the EU-15 and EU-27 countries. The energy consumption in rail and inland water transport is particularly low, compared to the consumption levels of road transport. In percentage terms, road vehicles cover the 82 %, airplanes the 14 %, railways the 2,5 % and inland water transport means the 1,4 % of the total energy consumptions in the transport sector (ERF, 2008). Figure 1 shows the inter-temporal evolution of the consumption of the two most important types of fuels (Diesel and gasoline) used in the road transport sector in Greece in the period 1963-2007. The graph demonstrates the rapid growth of fuel consumption, with a rate of 3,9 % per annum, in Diesel, and 6,9 %, in gasoline. The higher growth rate of gasoline, compared to Diesel, can be attributed to relevant technological advances as well as the increased purchase and use of private passenger cars in the given period. The current analysis refers to the gasoline expenditure data, as they are originated from the 2004/5 Greek HBS, which comes from household member interviews. The completed questionnaire of the survey interviews includes rich information about travel (and non-travel) expenditures made by 6555 households (~2/1000 of the total population), using a multilayer stratified sampling methodology to ensure the representation power of the sample at the level of administrative Regions (NUTS II). Provided that gasoline consumption is regarded to concern only those households possessing at least one private vehicle, households which possess no vehicle have been removed from the current analysis; this has yielded a total of 4323 observations. Despite that the current study relies on cross-sectional data it uses information about the spatial structure of prices in the model specification. Specifically, the income variable is expressed here by the total monthly household expenditures, which typically provide a proxy of the household permanent income, weighted by the Region's Relative Consumer Price Index (RCPI) for gasoline. The RCPI is given by the ratio of the CPI for gasoline at a specific Region to the CPI for all transportation modes at the particular Region.

Table 1

Fuel energy consumption (millions of tons of petrol equivalent) in different sectors in Greece, EU-15 and EU-27, 2005

	Industry	Households, Trade	Road transport	Rail transport	Inland water transport
Greece	**4,1**	**8,5**	**6,1**	**0,1**	**0,6**
EU 15 Total	274,8	405,3	262,9	8,1	5,2
EU 27 Total	326,3	480,4	296,9	9,5	5,3

Source: European Road Foundation

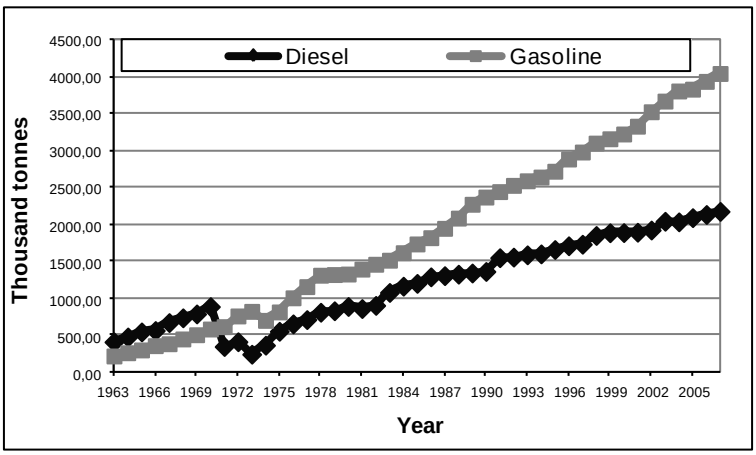

Figure 1. Temporal evolution of the fuel energy consumption (million tons of Diesel and gasoline) for transport in Greece during 1963-2007

Source: Ministry of Economy, Competitiveness and Shipping, Greek Government

The CPI for all transportation modes has been calculated as the weighted sum of the CPIs of urban and inter-urban bus and rail services, sea ferries, airline services, taxi tariffs and gasoline. The corresponding weights were provided by the National Statistical Service of Greece (NSSG) and they refer to the relative contribution of the monetary travel cost of each transportation mode to the total CPI for all transportation modes in year 2004. The information about the regional price variations of the taxi tariffs and public transportation fares was obtained from the Greek Ministry of Infrastructure, Transport and Networks, while the information on the regional variation of gasoline prices was obtained from the Greek Ministry of Economy, Competitiveness and Shipping. In addition to the income variable, a range of other economic, social and demographic variables has been used in the present study to represent the characteristics of each household. Also, a HBS population density index was used to demonstrate contiguous sets of local areas with varying levels of residential density and total population size (see EUROSTAT, 2005). Finally, regional dummy variables have been used to represent local-specific effects.

Model specification and results

The specification of the model was based on the relevant theory of travel demand, log-likelihood performance criteria, the convergence behavior of the likelihood-maximizing estimator and the need for assuring the identification of the Heckit model. Table 2 shows the set of variables used in the model estimation and summary statistics. These variables are extensively used in various forms to explain and interpret behavioural changes and forecast trends in passenger travel demand (Ben-Akiva & Lerman, 1985; Washington et al., 2010). The current model interpretation is twofold. First, it explains whether there is a significant interrelationship between the decisions of private vehicle selection and usage (amount of expenditure). Second, it identifies whether and how significantly each of the explanatory variables affects the decision to use private vehicle and the amount of using it. This is carried out by testing the null hypothesis of the equality of each coefficient to zero according to the conventional levels of statistical confidence, based on the asymptotic *t*-test statistics.

In contrast with the participation equation, the consumption equation includes variables related to other categories of transport as well as non-transport (i.e. tourism and communication) expenditures. A number of composite variables concerning the aging structure and economic status of household members have been employed to demonstrate possible interaction effects on the decision to choose and the amount of using private vehicle. In accordance with the standard econometric formulation of similar studies for the analysis of household travel (and non-travel) expenditures (Bergantino, 1997; Asensio et al. 2003a; Asensio et al. 2003b), the consumption equation follows a semi-log linear form by employing the logarithms of the dependent (monthly travel expenditures by private vehicle) and income variables.

The first hypothesis tested here refers to the interrelationship of the decision-making mechanisms of private vehicle selection and usage, in terms of the existence of statistically significant correlation between the error terms of the two (participation and consumption) equations. The result of the maximum likelihood ratio test rejects the null hypothesis of zero correlation ($\rho = 0$) between the error terms of the participation and consumption equations, based on the 5% significance level of the χ^2 statistical distribution (χ^2 (1)=53.854> $\chi^2(1)_{.05} = 3.841$, with $Prob > \chi^2 = 0.000$). Namely, this outcome fails to reject the hypothesis that the decision to choose private vehicle is influenced by the amount of using it. This feedback mechanism reflects the formation of consumption habits, with respect to the private vehicle usage, leading to car dependence. The fact that the utility related to the amount of using private vehicle does significantly affect the decision to choose it can be mainly attributed to intrinsic features of automobile, like the ability of door-to-door personalized transport, comfort, privacy and the concept of freedom, compared to the public transport modes.

Table 3 demonstrates the value, sign and statistical significance of the estimated coefficients of the variables of the participation and consumption equations and the resulting elasticities of the variables of both equations for the expected value of gasoline consumption. The effects, in terms of the direction and significance, of the explanatory variables are generally found to be the same between the participation and consumption equations, except of the regional fixed effects. Namely, unobserved or omitted factors associated with each Region have a different impact on the decision to choose and the amount of using private vehicle.

The income variable has a statistically significant positive impact on the selection and usage of a private vehicle. The magnitude of income elasticity (~0.4) denotes that the demand for private vehicle use is income inelastic; hence, travel by private vehicle can be regarded as a normal and necessity (rather than luxury) good. This low elasticity value reflects the increased car dependence and the frequent use of a private vehicle for mandatory activities (e.g., travel to work, school etc.). The value is within the range of other income elasticities found in the literature (Koshal et al., 1996; Ingram and Liu, 1999; Goodwin et al., 2004; Graham & Glaister, 2004; Basso & Oum, 2007; Tsekeris, 2008).

Table 2

Variables used in the model estimation and summary statistics

Variable		Symbol	Mean	Std. Dev.
Private vehicle gasoline expenses (Euros/month)		*gas*	97.322	78.820
Income variable for private vehicle users (Euros/month)		*income*	2765.759	1522.021
Gender (male=1)	*(d)*	*sex*	0.848	0.359
Age of the head of household (hoh)		*age*	49.493	13.985
Hoh age < 30 y.o.	*(d)*	*age20*	0.064	0.245
Hoh age between 30 - 40 y.o.	*(d)*	*age30*	0.207	0.405
Hoh age between 40 - 50 y.o.	*(d)*	*age40*	0.247	0.431
Hoh age between 50 - 60 y.o.	*(d)*	*age50*	0.233	0.423
Hoh age between > 60 y.o.	*(d)*	*age60*	0.250	0.433
One car owned	*(d)*	*ncar1*	0.792	0.406
Two cars owned	*(d)*	*ncar2*	0.182	0.386
Three or more cars owned	*(d)*	*ncar3*	0.026	0.160
Density > 500 inhab. / sq.km and population > 50000 inhab.	*(d)*	*hden*	0.446	0.497
Density between 100 – 500 inhab. / sq.km and population > 50000 inhab. or adjacent to a densely populated area	*(d)*	*mden*	0.029	0.169
Density < 500 inhab. / sq.km and population < 50000 inhab.	*(d)*	*lden*	0.525	0.499
Hoh working full-time	*(d)*	*ftime*	0.693	0.461
Both hoh, spouse and at least one other member working	*(d)*	*hhe1*	0.052	0.221
Both hoh and spouse work, no other member working	*(d)*	*hhe2*	0.253	0.435
Either hoh or spouse, and least one other member work	*(d)*	*hhe3*	0.086	0.280
Either hoh or spouse work, no other member working	*(d)*	*hhe4*	0.322	0.467
At least two members working excl. the hoh and spouse	*(d)*	*hhe5*	0.022	0.145
One member working excl. the hoh and spouse	*(d)*	*hhe6*	0.083	0.276
None working in the household	*(d)*	*hhe7*	0.183	0.387
None, primary or lower secondary education	*(d)*	*ledu*	0.428	0.495
Upper secondary, post-secondary non-tertiary education	*(d)*	*medu*	0.349	0.477
Higher education (all refer to the hoh)	*(d)*	*hedu*	0.223	0.416
One person, aged 65 years or more	*(d)*	*hht1*	0.014	0.116
One person, aged 30 to 64 years	*(d)*	*hht2*	0.051	0.220
One person, under 30 years	*(d)*	*hht3*	0.010	0.100
One person with children (< 18 y.o.)	*(d)*	*hht4*	0.015	0.121
Couple without children, older person aged 65 or more	*(d)*	*hht5*	0.089	0.285
Couple without children, older person under 65 years	*(d)*	*hht6*	0.109	0.311
Couple with one child (< 18 y.o.)	*(d)*	*hht7*	0.102	0.303
Couple with two children (< 18 y.o.)	*(d)*	*hht8*	0.147	0.354
Couple with more than two children (< 18 y.o.)	*(d)*	*hht9*	0.034	0.181
Single parent or couple with at least one child > 18 y.o.	*(d)*	*hht10*	0.316	0.465
Any other type of household	*(d)*	*hht11*	0.113	0.316
Ownership of second residence	*(d)*	*seres*	0.258	0.437
Communication expenses (Euros/month)		*comm*	102.975	75.221
Internet connection	*(d)*	*web*	0.259	0.438
Tourism (hotel & restaurants) expenses (Euros/month)		*hotel*	243.930	249.748
Garage availability	*(d)*	*garage*	0.125	0.331
Urban public transport expenses (Euros/month)		*urban*	7.871	17.088
Taxi expenses (Euros/month)		*taxi*	6.814	20.163
Coach & rail expenses (Euros/month)		*land*	2.485	11.431
Sea expenses (Euros/month)		*sea*	4.210	15.202
Air expenses (Euros/month)		*air*	1.893	16.804

(d): indicates dummy variable (0 or 1)

Table 3

Estimated coefficients of the variables of the participation and consumption equations and resulting elasticities

Variable	Participation	Consumption	Elasticity
income	0.176***	0.386***	0.398***
sex	0.572***	0.112***	0.054**
age30	-0.140	-0.022	-0.008
age40	0.014	-0.090*	-0.029**
age50	-0.473	-0.057	-0.018
age60	-0.750*	-0.145**	-0.032**
ncar2	1.266***	0.413***	0.088***
ncar3	5.233***	0.773***	0.031***
hden	-0.333***	-0.046*	-0.008*
mden	0.058	0.036	0.001
ftime	0.352	-0.045	-0.017
hhe1	5.570***	0.358***	0.014***
hhe2	1.453***	0.352***	0.045***
hhe3	1.442***	0.402***	0.024***
hhe4	1.144***	0.335***	0.054***
hhe5	6.393***	0.391***	0.006***
hhe6	2.083***	0.065***	0.020***
medu	0.053	0.006	0.003
hedu	-0.046	-0.008	-0.001
hht1	0.005	-0.284***	-0.0002
hht2	-0.104	0.068	0.004
hht3	-0.433	0.210*	0.001
hht4	0.115	0.024	0.001
hht5	-0.068	-0.044	0.003
hht6	0.083	0.111**	0.008*
hht7	0.432	0.075	0.002
hht8	0.535	0.150***	0.018***
hht9	4.952***	0.090	0.002
hht10	0.032	0.091**	0.020*
seres	0.729***	0.028	0.0005
comm		0.0004**	0.088***
web	-0.185	-0.020	-0.018***
hotel		0.0003***	0.087***
garage	0.250	0.035	0.003
urban		-0.003***	-0.023***
taxi		-0.002***	-0.017***
land		-0.002**	-0.004*
sea		0.0004	0.002
air		0.0006	0.001
att	-0.223	0.169***	0.068***
emt	-0.815**	0.114	0.007**
cma	-0.404	0.141**	0.026***
wma	-1.012**	0.114	0.002
epi	-0.718*	0.202**	0.004**
the	-0.116	0.105	0.003
ion	-0.198	0.051***	0.0004
wgr	-0.631*	0.214***	0.010***
cgr	-0.803**	0.173***	0.005*
pel	-0.476	0.063	0.003
cre	-0.208	0.197***	0.009***
Mills λ	0.632***	Wald $\chi^2(89)$ = 2050.47, *p=0.000*	

Notes: (*) indicates 0.05<*p*-value<0.1, (**) 0.01<*p*-value<0.05, (***) *p*-value<0.01, using the asymptotic *t*-test statistics. Regional dummy variables: *att*: Attica, *emt*: Eastern Macedonia and Thrace, *cma*: Central Macedonia, *wma:* Western Macedonia, *epi*: Epirus, *the*: Thessaly, *ion*: Ionian islands, *wgr*: Western Greece, *cgr*: Central Greece, *pel*: Peloponnesus, *cre*: Crete, reference dummy: (South and North) Aegean Regions.

Several variables are found to significantly increase the probability of gasoline consumption. These include the amount of cars owned, which provides more opportunities and freedom for personal travel for each adult member of the household, and the gender (male) of household head, signifying the role of intra-household activity allocation for private vehicle use. Moreover, the participation of family members in the labour market has a significant positive impact on vehicle usage, since it is associated with affordability as well as commuting and work-based trips. The larger the size of families is, especially those of single-parent or couples with at least one child older than 18 years-old, the higher the need for private vehicle use becomes. In addition, the spending on communication and

tourism activities significantly positively influences private vehicle travel. The latter finding verifies that private vehicle constitutes an important means of transport during vacation. Also, the use of communication devices, especially mobile phone, reinforces the use of private vehicle because it encourages social networking and weakens the need for short-range activity planning in advance (Hjorthol, 2008).

On the contrary, there are some factors which have a statistically significantly negative impact on the use of private vehicle. These include high population densities, which generally reduce the need and frequency of using and the distance travelled by private vehicle. The negative effect of the connection to the internet can be attributed to the potential substitutability between travel and such activities as tele-commuting, tele-education, tele-shopping etc. The aging of household head reduces the probability of gasoline consumption. This outcome signifies the role of personal (physical) and intra-household constraints related to the aging structure of household on the selection and use of private vehicle. Finally, the expenditure on urban public transport, taxi, coach and rail negatively and statistically significantly affect gasoline consumption. This finding stresses the competitive relationship between the private vehicle and other transport modes which are mainly used in urban areas (i.e., urban bus, metro, and taxi), typically for daily travel and execution of activities like employment, education and shopping.

Conclusions and policy implications of the study

This paper provided an econometric analysis of the gasoline consumption demand of Greek households, based on micro-data of the 2004-05 Greek HBS. The current methodological approach refers to the Heckit model, as it was found that there is a statistically significant feedback mechanism between the decision to choose and the amount of using private vehicle. The model results can help to identify and better explain factors for which some private vehicle owners/holders do (not) actually consume that mode. In turn, these factors can have useful implications for making managerial and strategic decisions concerning the mitigation of road congestion, environmental protection, energy conservation and other sustainable transport policies at the local, national, European and global level (see Kugelevičius et al., 2007; Al-Mofleh et al., 2010; Streimikiene and Sarvutyte, 2010). Specifically, the increase of income level and car ownership will further encourage private vehicle travel and gasoline consumption. The positive influence of tourism expenditure on gasoline consumption calls for the design of more sustainable leisure travel services, focussed on upgrading the quality of public transport modes servicing tourist resort areas. On the other side, the current demographic trends related to the rapid aging of population as well as the growth of unemployment are expected to adversely affect the use of private vehicle. Policy measures to reduce private vehicle travel must be spatially targeted, accounting for the particular characteristics, such as geographical location, local infrastructure, accessibility conditions and service quality of alternative modes, of each Region. These measures can be supplemented with the adoption of suitable information and communication technologies (Zavadskas et al., 2010), in order to manage the demand for private vehicle travel and increase the level of public transport services, as well as investments in clean vehicle technologies.

Planning regulations which focus on increasing residential densities, especially in suburban or semi-rural areas, are anticipated to reduce the need for private vehicle travel and, hence, gasoline consumption. The statistically significant competitive relationship among the expenditures on private vehicle and on urban and surface inter-urban public transport has also important policy implications. In particular, increasing the demand for urban bus, metro, coach and rail services and/or restraining the demand for private vehicle travel will shift household budget shares from private vehicle towards those modes. This shift will support the viability of public transport firms and promote the sustainable mobility development in the large cities and peripheral areas of the country. Relevant national and EU policies and plans to foster the ridership of urban (inter-urban) public transport modes refer to fleet renewal and subsidization, as long as subsidies reflect in lower prices and/or higher frequencies and they are not absorbed by inefficiencies. Regarding the management of private vehicle travel and congestion effects (see Kersys, 2011), relevant policies and plans involve the adoption of advanced traffic management systems, introduction of road use or congestion charges, fuel and environmental taxes, increase of parking fees, and other administrative and regulatory measures, such as coordinated transport and land-use control.

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Theodore Tsekeris

Išsami benzino suvartojimo poreikio Graikijos šeimose (namų ūkiuose) analizė

Santrauka

Pramonė ir kelių transportas yra intensyviausi ekonomikos sektoriai tiek Graikijoje, tiek Europos sąjungos šalyse, turintys įtaką energijos suvartojimui. Nustatyta, kad Graikijoje 1963-2007 metais dyzelino ir benzino suvartojimas kelių transporto sektoriuje ypač padidėjo (3,9 % dyzelino ir 6,9 % benzino per metus). Didesnis suvartojamo benzino kiekis, lyginant su dyzelinu, aiškinamas technologijų tobulinimu, privačių automobilių padaugėjimu tiriamuoju laikotarpiu. Svarbus aspektas planuojant ne tik šeimos biudžetą, bet ir nagrinėjant transporto, aplinkos, politikos klausimus yra privatiems automobiliams skirtų lėšų kiekio panaudojimas.

Privačios susisiekimo priemonės panaudojimo išlaidos tampa labai svarbia šeimos biudžeto dalimi, kuri turi reikšmę sprendžiant transporto, aplinkos, politikos problemas. Šeimos išlaidų duomenų analizė padeda nustatyti šeimos transportui skirto biudžeto pagrindinius veiksnius. Šios išlaidos gali skirtis priklausomai nuo ekonominės, socialinės, demografinės bei geografinės šeimos padėties. Mėnesio išlaidas paprastai sudaro važiavimo dažnumas, kelionių atstumas ir išlaidos, susijusios su automobilio eksploatacija. Tačiau taip pat svarbiu rodikliu, analizuojant degalų suvartojimo poreikį išlieka ir pinigų suma, kurią šeimos išleidžia keliaudamos.

Šiame straipsnyje, remiantis 2004-2005 metų šalies šeimos biudžeto duomenimis, analizuojamas graikų šeimos poreikis benzinui. Yra labai mažai tyrimų, kuriuose būtų nustatyti veiksniai, lemiantys privataus ar visuomeninio transporto pasirinkimą, todėl šiame straipsnyje, siekiant išsamiai išanalizuoti ir palyginti duomenis regionio mastu, buvo paskaičiuotos išlaidos, susijusios su kelionėmis mieste ir tarpmiestiniais maršrutais, geležinkeliu, jūros keltais, lėktuvais, taip pat paskaičiuoti taksi tarifai ir benzino kaina.

Atliekant tyrimą, be kitų modelių buvo naudotasi *Tobit* modeliu. Tačiau tokios rūšies modeliai yra pagrįsti gana ribotomis prielaidomis, kad tie patys kintamieji daro įtaką tiek keliautojų sprendimams pasinaudoti tam tikra transporto rūšimi, tiek to transporto panaudojimo intensyvumui. *Tobit* modeliai apėmė tik tam tikrus sprendimus, kurie reiškė, kad visos šeimos yra potencialūs vartotojai ir sprendimas – naudotis ar nesinaudoti tam tikra transporto rūšimi, priklauso nuo tokių veiksnių kaip aukštos benzino kainos, viešojo transporto mokesčiai.

Tačiau tiriant buvo nustatyti ir kiti veiksniai, turintys įtaką tiriamiesiems: pvz., įprotis naudotis viena ar kita transporto rūšimi. Čia gali būti pritaikytas Heckmano dviejų pakopų pavyzdžių pasirinkimo įvertinimas. Remiantis šiuo metodu, šeimų pasirinkimas keliauti ar nekeliauti privačiu automobiliu dominuoja, lyginant su sprendimu pasinaudoti intensyvumu. Taikant šį metodą lengviau nustatyti ir paaiškinti tuos veiksmus, kurie lemia gyventojų pasirinkimą. Modelyje buvo panaudoti amžiaus ir ekonominio statuso aspektai, parodantys šių veiksnių svarbą.

Taikant šį modelį galima įžvelgti ryšį tarp sprendimų priėmimo mechanizmų ir paties sprendimų panaudojimo kiekio, kuris labai priklauso nuo pinigų kiekio, kuris išleidžiamas benzinui. Be to, labai aiškiai matyti ir priklausymas tam tikram regionui, kuris turi nemažą reikšmę analizuojant privačių automobilių naudojimo duomenis. Taigi geografinė padėtis, vietovės klimatas, infrastruktūra, susisiekimo galimybės, paslaugų kokybė ir panašūs veiksniai daro įtaką transporto panaudojimo galimybėms. Pasirinkimą naudotis viešuoju transportu ar privačiu taip pat lemia ir gaunamos didesnės pajamos, automobilio turėjimas. Privataus automobilio naudojimas turi įtaką ir suvartojamo benzino kiekiui. Kita vertus, ekonominė krizė ir nedarbo augimas gali lemti tai, kad bus pasirinktas viešasis transportas. Toks pasirinkimas bus naudingas siekiant mažinti taršą, taupyti energiją.

Komunikacijos priemonių naudojimas (ypač mobiliųjų telefonų) sustiprina būtinybę naudotis privačiu transportu, nes tai susilpnina poreikį iš anksto planuoti trumpų nuotolių veiklą, bei socialinių tinklų spektrą ir mastą. Privataus sektoriaus benzino suvartojimą lemia ir naudojimasis kitomis transporto rūšimis (pvz., viešasis transportas, taksi, geležinkeliai). Taigi galima įžvelgti konkurenciją tarp privačių automobilių ir kitų transporto rūšių, kurios ypač naudojamos miesto teritorijoje.

Planavimo organizacijos, susijusios su naujų gyvenamųjų namų kvartalų statyba, ypač užmiesčio teritorijose, turėtų būti projektuojamos taip, kad mažėtų poreikis naudotis privačiu transportu. Taip pat reikia numatyti daugiau kitokių priemonių, kurios padėtų mažinti benzino suvartojimą. Didinant viešojo transporto galimybes, būtina atsižvelgti į privataus ir viešojo transporto santykio analizę

Raktažodžiai: *transporto energija, transporto valdymas, privatus transportas, visuomeninis transportas, kelionių poreikis, ribota priklausomybė, kintamas dydis.*

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