Effect of Traveler's Nationality on Daily Travel Time Expenditure Using Zero-Inflated Negative Binomial Regression Models

Results from Belgian National Household Travel Survey

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In this study, data stemming from the 2010 Belgian National Household Travel Survey were used to assess the effect of a traveler's nationality on daily travel time expenditure. Negative binomial (zero-inflated) models were estimated to isolate the effect of nationality after other contributing factors such as sociodemographics, residential characteristics, transport options, and temporal characteristics were controlled for. The results indicate that even if one controls for a series of other influencing factors, nationality plays a significant role in differences in travel time expenditure. This finding is especially relevant in the development of policy packages that are targeted at social inequalities. From a methodological perspective, methodological options—two weighting schemes and two bootstrap solutions—were presented to provide sufficient support for the conclusions. To generalize the results in further studies, an oversampling of travelers of different nationalities is strongly recommended. Future research should focus more on the underlying psychological constructs of why ethnic and cultural differences persist even if one accounts for other determinants.

Over the past decades, the proportion of immigrants in many western countries has increased considerably, and this tendency is expected to continue in the foreseeable future (*1, 2*). As a result, populations become more ethnically and culturally diverse. This increased diversity in turn affects the socioeconomic and demographic composition of the population and consequently alters travel behavior patterns. Hence, a deeper understanding of the underlying travel behavior could help to find suitable policies that address environmental and ethnic justice concerns and thus meet the travel needs of all population groups (*3–6*). To enhance the success of such policies, empirical research on the relationship between ethnicity and other factors that directly and indirectly influence travel behavior is critical (*5, 7*). This relationship can be investigated by examining the ethnic variation of people's travel time expenditures and the factors contributing to such expenditures (*8*). The contribution of ethnic diversity in altering travel behavior within a population is especially prominent from a social exclusion point of view that calls for the inclusion of time use analyses (*9*).

The literature indicates the relevance of ethnic differences on various levels of the trip-making decision process. Concerning short-term decisions, ethnicity significantly influences mode choice and destination choice (*10–13*). In particular, Bora et al. concluded that areas populated by persons of a particular nationality are visited more frequently by other members of that community (*13*). Further evidence of the relationship between destination choice and ethnicity is provided by Silm and Ahas, who found that ethnicity has a significant impact on the activity spaces of out-of-home nonwork activities (*14*). With regard to long-term decisions, the literature points out the significant influence of ethnicity on car ownership, residential location, and home ownership (*5, 7, 11, 15*).

Regarding daily travel time expenditure, Volosin et al. stressed that it is a key measure of travel demand and that a thorough comprehension of contributing factors can help in increasing the performance of travel demand forecasts, for instance, by balancing mode choice preference and travel demand to achieve an acceptable level of service (*8*). Moreover, they expanded the notion of a travel time frontier developed by Banerjee et al. and concluded that the frontier values as well as the ratio of travel time expenditure to these frontier values differ considerably across sociodemographic groups (*16*). With respect to the factors explaining differences in daily travel time expenditure, a variety of sociodemographic variables, residential characteristics, transport options, modal choice habits, and journey characteristics play a significant role (*17–25*).

The role of ethnic variety in travel behavior and the importance of daily travel time expenditure in transportation planning, as described earlier, underline the need for investigating the effect of ethnic differences on daily travel time expenditure within the Belgian context. The research particularly focuses on whether the total daily travel time expenditure (i.e., the travel time spent on all trips realized during the day of reporting, irrespective of the trip motive) as well as the daily travel time expenditure for the most common trip motives vary by nationality.

DATA

To assess the effect of nationality on daily travel time expenditure, data stemming from the 2010 Belgian National Household Travel Survey (BELDAM) are analyzed (*26*). For each individual, the daily

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travel time expenditure was defined as the sum of the duration of all trips performed during the day of reporting. The daily travel time expenditure was defined as zero for the respondents who indicated that they did not make any trip during the day of reporting.

Although the individuals with zero travel time are interesting from the perspective of studying immobility, they were disregarded from further analysis because the day of reporting was not recorded for these individuals within the BELDAM survey (*27*). After all, in the questionnaire design of the BELDAM survey, information with respect to temporal information (including the date) was recorded in the trip diary, which was returned empty for individuals that did not produce any trips. However, information about the day of reporting is essential given the large importance attributed to daily travel time expenditure in the context of day-of-week and holiday effects (*19*).

With respect to factors accounting for differences in daily travel time expenditure, it should be highlighted that information about, nationality, the main factor of interest, was collected in the person questionnaire of the BELDAM survey. Given the fact that the BELDAM survey uses a random sample from the population residing in Belgium, the relative share of respondents with a nationality different from Belgian is relatively low. Therefore, the analysis focuses only on the nationalities for which at least 30 individuals were surveyed. In particular, data from travelers with the following six nationalities were considered (the number of unweighted observations is reported in parentheses): Belgian (7,399), Dutch (51), French (153), Italian (135), Moroccan (36), and Spanish (37). To account for the imbalance in the number of observations per nationality, a dedicated methodology was adopted (see the methodology section) to ensure that the relative weights of each group in the final analysis were equal and that there was optimal efficiency in the comparison of the different nationalities.

Besides nationality, a series of other factors that have been indicated as contributing factors to travel time expenditure are incorporated in the data. These additional factors could be broadly categorized into sociodemographics, residential characteristics, transport options and mode use frequencies, and temporal characteristics. With respect to the sociodemographical factors, the age, gender, obtained educational level, and professional activity of the respondents were considered for the analysis as well as the net monthly household income, the household size and whether the respondent had a partner or companion, children, or both. With regard to the residential characteristics, the urbanization degree of the residence, dwelling type, and ownership were taken into account. Concerning the transport options, the respondent's possession of a season ticket for public transport and driver's license were considered as well as bike and car possession at the household level. Furthermore, whether the respondent's mobility was restricted because of impairments was explicitly considered. In addition, the frequency (defined as at least 4 days a week) of walking, biking, car use (either as driver or passenger), and public transit was assessed. Finally, in terms of temporal characteristics, the effect of weekend days and school holidays was taken into account as well as the travel time expenditure spent on the remaining trip motives (referred to as "travel time expenditure: other"). The last was defined as the difference between the total travel time expenditure and the travel time expenditure on trips for a given motive.

DESCRIPTIVE ANALYSIS

An overview of the basic descriptive statistics of the travel time expenditures per nationality and per trip motive is given in Table 1. These expenditures only correspond to respondents who made at least one trip during the day of reporting, as was explained earlier. The share of respondents who did not made any trip during the day of reporting, defined as immobility, is also presented in Table 1. From the data in Table 1 it can be observed that large differences exist between the different nationalities, especially in the context of total travel time expenditure (i.e., the travel time spent on all trips realized during the day of reporting irrespective of the trip motive) and visits. The most striking difference is the considerably higher travel time expenditure on visit trips by French travelers, who spend even more than twice the other nationalities investigated.

Table 2 provides an overview of the descriptive statistics of the remaining explanatory factors considered in the study. For the continuous variables, the correlation with travel time expenditure is given, whereas for the categorical explanatory variables the mean travel time expenditures are tabulated per category. From these data, one can observe that the different types of explanatory variables—sociodemographics, residential characteristics, transport options and usage, and temporal characteristics—all appear to account for at least a part of the daily travel time expenditure. Regarding total travel time expenditure, especially education, professional activity, and the possession of a season ticket for public transit use, all exhibit differences. For commuting trips, large differences can be detected for professional activity, possession of a season ticket, and the day

TABLE 1 Daily Travel Expenditure in Minutes by Nationality

Expenditure	Parameter	Belgian	Spanish	French	Italian	Moroccan	Dutch
Total	Mean	80.0	75.0	100.0	67.8	82.2	99.4
	SD	6.1	45.9	48.5	27.1	85.6	56.8
Commuting	Mean	24.8	30.5	34.9	24.0	26.3	29.7
	SD	3.1	40.0	20.3	21.8	40.2	36.8
Shopping	Mean	12.0	13.8	11.8	8.6	15.7	12.7
	SD	3.1	27.4	13.5	9.1	33.7	19.8
Leisure	Mean	7.9	9.1	6.8	4.8	2.1	7.0
	SD	2.5	26.8	12.9	8.5	10.2	11.2
Visits	Mean	8.9	4.9	20.1	5.7	7.2	6.9
	SD	2.1	12.3	43.7	7.8	26.2	16.4

NOTE: Immobility: Belgian = 25.7%; Spanish = 19.6%; French = 23.5%; Italian = 32.5%; Moroccan = 35.7%; Dutch = 22.7%.

TABLE 2 Descriptive Statistics for Travel Time Expenditure and Explanatory Variables

Parameter	Total	Commuting	Shopping	Leisure	Visits
Continuous Explanatory Variables (Pearson correlation)					
Age	0.027	–0.157	0.174	–0.044	0.063
Household size	–0.066	0.038	–0.110	–0.009	–0.015
Travel time expenditure other	na	–0.291	–0.076	–0.068	–0.129
Categorical Explanatory Variables (average expenditure in minutes per category)					
Sociodemographics					
Gender: female	84.5	26.3	14.2	6.2	9.9
Gender: male	83.7	30.4	10.7	6.3	8.0
Higher education: yes	100.1	33.9	15.9	6.9	8.9
Higher education: no	72.3	24.3	9.9	5.9	9.0
Professional activity: yes	95.1	39.9	10.8	4.5	5.9
Professional activity: no	71.8	15.6	14.2	8.3	12.3
Net monthly household income: €0–€1,499	79.1	19.6	12.5	7.8	9.4
Net monthly household income: €1,500–€3,999	88.3	29.4	14.2	6.4	12.0
Net monthly household income: ≥€4,000	88.2	35.3	8.9	5.8	4.8
Net monthly household income: undeclared	64.7	30.4	11.4	2.5	1.2
Companion: yes	88.9	28.6	15.0	4.9	9.2
Companion: no	77.7	28.0	9.1	8.1	8.6
Having child(ren): yes	87.2	28.9	11.1	5.8	6.5
Having child(ren): no	82.7	28.1	13.0	6.5	10.0
Residential characteristics					
Urbanization residence: urban	81.5	28.0	12.4	6.1	9.5
Urbanization residence: suburban, rural	90.0	29.3	12.5	6.7	7.7
HH dwelling ownership: yes	82.3	27.2	12.1	5.0	10.8
HH dwelling ownership: no	86.9	30.3	13.1	8.5	5.8
HH dwelling is detached house: yes	89.7	24.9	14.6	6.6	7.4
HH dwelling is detached house: no	82.6	29.3	11.9	6.2	9.3
Transport options and mode use frequencies					
Season ticket for public transport: yes	103.6	39.3	13.8	8.7	11.3
Season ticket for public transport: no	76.5	24.2	11.9	5.4	8.0
Car driver's license: yes	91.7	29.2	14.3	5.6	9.7
Car driver's license: no	63.1	26.1	7.3	8.2	6.9
Mobility restraints: yes	59.7	23.1	10.0	6.1	9.2
Mobility restraints: no	88.9	29.4	12.9	6.3	8.9
Bike possession: yes	92.1	31.5	12.2	6.9	9.3
Bike possession: no	66.2	21.3	13.0	4.9	8.3
Car possession: yes	84.1	28.3	13.2	5.6	8.8
Car possession: no	83.7	28.7	9.4	9.1	9.4
Frequent walking: yes	86.9	26.7	13.5	7.0	9.7
Frequent walking: no	74.0	34.3	8.5	3.9	6.4
Frequent cycling: yes	90.3	24.5	12.8	14.2	9.9
Frequent cycling: no	82.4	29.4	12.3	4.2	8.7
Frequent public transit use: yes	93.7	37.0	11.9	7.5	6.4
Frequent public transit use: no	76.9	22.0	12.8	5.4	10.8
Frequent car use: yes	86.3	27.0	13.3	5.0	10.0
Frequent car use: no	76.3	33.0	9.4	10.7	5.3
Temporal characteristics					
Weekend day: yes	75.1	9.1	16.5	12.1	11.0
Weekend day: no	87.1	35.0	11.0	4.3	8.2
School holiday: yes	80.5	29.9	7.9	3.3	17.1
School holiday: no	84.7	28.1	13.3	6.8	7.4

NOTE: na = not applicable; HH = household.

of reporting (weekend day or not). With respect to differences in travel time expenditure on shopping trips, differences regarding the possession of a driver's license and the occurrence of a school holiday are appealing. For leisure trips, noticeably higher travel time expenditures can be found among travelers during weekends and among those who are frequently using the bicycle as transportation mode. This finding is in line with the fact that people choose bike or car for weekend social trips because of having more freedom in their mobility schedule. Finally, concerning visit trips, the considerable difference between school holidays and regular days draws attention.

METHODOLOGY

Negative Binomial Regression

To investigate the effect of contributing factors on the variability of daily travel time expenditure, and to assess the effect of traveler's

nationality in particular, five (zero-inflated) negative binomial models were fitted. From Figure 1, it can be observed that for the motive of specific travel time expenditures (i.e., time spent traveling for commuting, shopping, leisure, and visits), a higher number of zeros is present, as one would normally expect from count data. The inflation of zeros indicates that during the day of reporting, the traveler did not realize a trip for that particular activity. However, in the analyses only respondents who indicated that they had realized at least one trip during the day or the reporting period (i.e., mobile respondents) were included. Consequently, for the total travel time expenditure considering all trips together, no zero values are observed.

Mathematically, the probability distribution $f(y)$ and log likelihood function L of the negative binomial model are respectively represented by Equations 1 and 2, which are parameterized in the function of the mean μ and the negative binomial dispersion parameter k (*28, 29*). In this study, the negative binomial model is applied

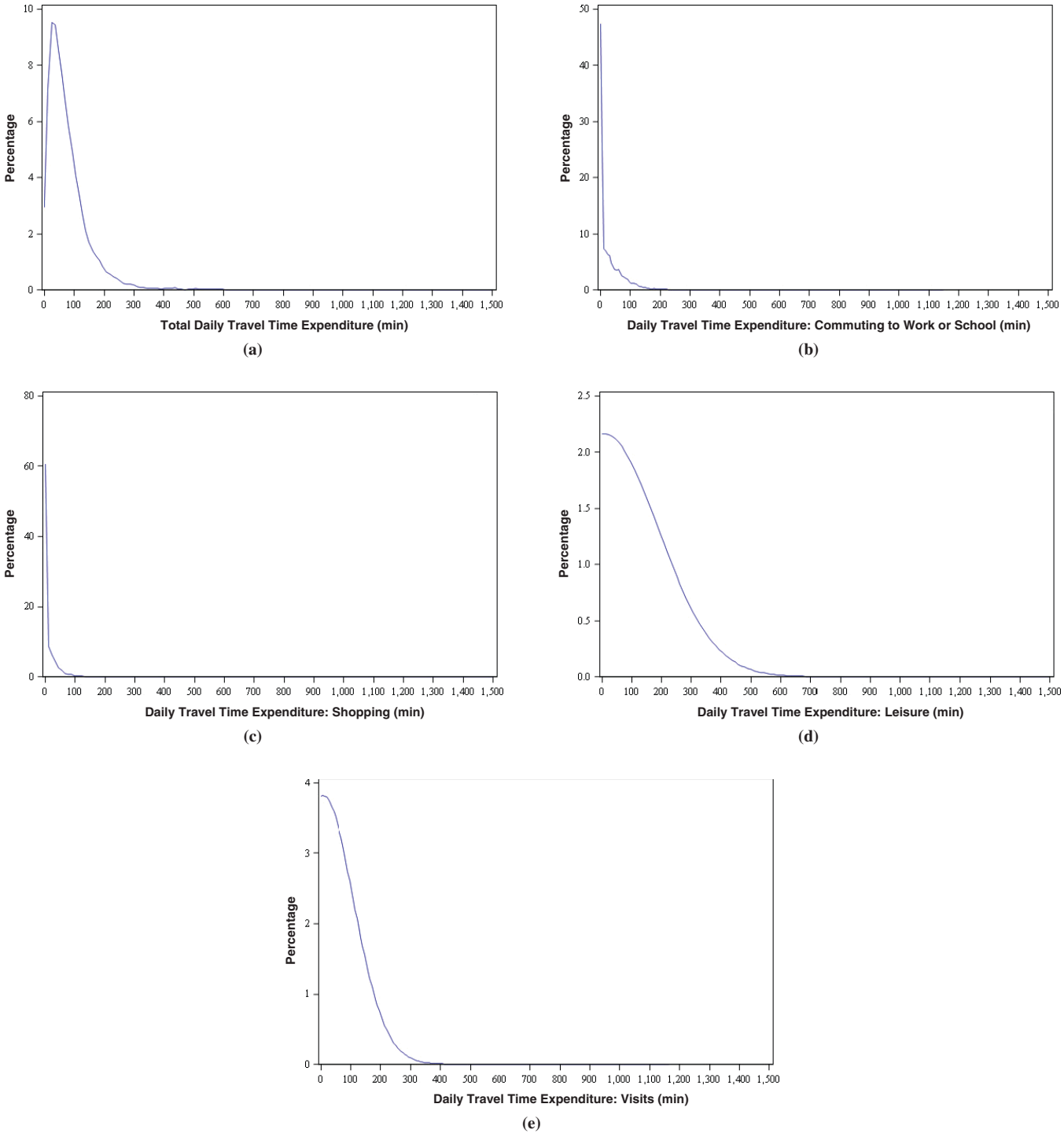

FIGURE 1 Kernel density estimates of daily travel time expenditure distributions.

to the total daily travel time expenditure and thus y represents this expenditure. Besides, the mean μ is calculated by a linear combination of the explanatory variables (Tables 1 and 2).

$$f(y)=\frac{\Gamma\left(y+\frac{1}{k}\right)}{\Gamma(y+1)\Gamma\left(\frac{1}{k}\right)}\frac{(k\mu)^y}{(1+k\mu)^{y+1/k}} \qquad \text{for } y=0,1,2,\ldots \tag{1}$$

$$L=\sum_i l_i=\sum_i\left[\begin{array}{l} y_i\ln\left(\frac{k\mu}{w_i}\right)-\left(y_i+\frac{w_i}{k}\right)\ln\left(1+\frac{k\mu}{w_i}\right) \\ \qquad +\ln\left(\frac{\Gamma\left(y_i+\frac{w_i}{k}\right)}{\Gamma\left(\frac{w_i}{k}\right)}\right) \end{array}\right] \tag{2}$$

where w_i is the observation weight.

The probability distribution and log likelihood function of the zero-inflated negative binomial are given by Equations 3 and 4, where ω represents the zero-inflation probability and λ represents the mean (*29–30*). In this study, the zero-inflated negative binomial models are estimated for the four motive-specific travel time expenditure models, and correspondingly y represents the expenditure for a particular trip motive. Analogous to the negative binomial model, ω and λ are calculated by a linear combination of the explanatory variables.

$$f(y)=\begin{cases}\omega+(1-\omega)(1+k\lambda)^{-1/k} & \text{for } y=0 \\ (1-\omega)\dfrac{\Gamma\left(y+\frac{1}{k}\right)}{\Gamma(y+1)\Gamma\left(\frac{1}{k}\right)}\dfrac{(k\lambda)^y}{(1+k\lambda)^{y+1/k}} & \text{for } y=1,2,\ldots\end{cases} \tag{3}$$

$$L=\sum_i l_i=\sum_i\begin{cases}\ln\left[\omega_i+(1-\omega_i)\left(1+\frac{k\lambda}{w_i}\right)^{-w_i/k}\right] & y_i=0 \\ \left[\begin{array}{l}\ln(1-\omega_i)+y_i\ln\left(\frac{k\lambda}{w_i}\right) \\ -\left(y_i+\frac{w_i}{k}\right)\ln\left(1+\frac{k\lambda}{w_i}\right) \\ +\ln\left(\frac{\Gamma\left(y_i+\frac{w_i}{k}\right)}{\Gamma(y_i+1)\Gamma\left(\frac{w_i}{k}\right)}\right)\end{array}\right] & y_i>0\end{cases} \tag{4}$$

In the foregoing equations for the log likelihood, the observation weight w_i is included. As noted in the data description, two sets of weights were used in the analysis. The first (conservative) set makes sure that the weighted number of observations per nationality is equal to the smallest group size (i.e., 36 observations), whereas the second (progressive) weighting scheme makes sure that the weighted number of observations per nationality is equal and that the (weighted) total number of observations equals the (unweighted) total number of observations used in the analysis (the number of data points). With this definition, the progressive weights are a linear function of the conservative weights. As a consequence, the differences between the weighting schemes are translated into a linear transformation of the variance of all the variables and consequently are fully captured by the dispersion parameter k in the (zero-inflated) negative binomial models. With the exception of the dispersion parameter, models with conservative weighting will yield the same parameter estimates and standard errors as those with progressive weighting.

The models are developed in a backward manner, keeping variables significant at the 5% level in the model. All nonsignificant variables, with exception of the main variable under study, nationality, are omitted from the final model. All explanatory variables in the models are continuous or dummy variables, and thus the overall significance of these variables can be assessed by interpreting the corresponding p-values of the Wald chi-square tests. The only exception is the effect of nationality, for which the six nationalities were represented by five dummy variables, with Belgian nationality as the reference category. Since reference coding was used, the overall level of significance is assessed by using a likelihood ratio test comparing the final model with the model excluding the five dummy variables.

Bootstrapping

In addition to the weighting procedure, which ensures that each investigated nationality has the same weight in the final analysis, a second approach, bootstrapping, is adopted to verify and validate the results obtained from both weighting approaches. The basic idea behind bootstrapping is that inferences about a population from a sample (in this study the BELDAM sample) can be modeled by resampling the data and by making inferences on these bootstrap samples. The most important advantages of bootstrapping are (*a*) fewer assumptions (e.g., with respect to the data distributions or sample sizes), (*b*) greater accuracy in comparison with many classical methods, and (*c*) promotion of understanding (conceptual analogies to theoretical concepts discussed in classical methods) (*31*). Similar to the weighting procedure, both a conservative and a progressive approach of the bootstrapping process are considered. The bootstrapping procedure is as follows:

Step 1. Determine the sample size per stratum. To ensure maximum efficiency of intergroup (interstratum), the same number of observations needs to be drawn from each group.

– Conservative approach. The sample size per group is defined as the smallest group size in the original sample, 36 respondents per nationality.

– Progressive approach. The sample size per group is defined as the total number of observations in the original sample divided by the number of groups, 1,302 per nationality.

Step 2. Resampling. From each group (i.e., nationality), the required number of observations is drawn using simple random sampling with replacement. This sampling selection procedure is repeated 1,000 times so that 1,000 different bootstrap samples are obtained.

Step 3. Inference per bootstrap sample. For each of the bootstrap samples, the different (zero-inflated) negative binomials are fitted using the variables that were selected following the weighting procedure. Thus, for each explanatory variable in the models a vector of the maximum 1,000 parameters is obtained. The size of the final vector might be inferior to 1,000 in case of estimation problems (e.g., lack of convergence, or semidefinite Hessian covariance matrix).

Step 4. Final inference. For each parameter, the final parameter estimate is defined as the median $\mu_{1/2}$ of the 1,000 parameters, and the standard error s is defined in an analogue way compared with standard normal confidence intervals, using the average distance to the 95% percentile bounds, and calculated with Equation 5 in which $p_{2.5}$ and $p_{97.5}$ represent respectively the lower and upper bounds of the 95% bootstrapping percentile interval. For each parameter, the

null hypothesis that the parameter is equal to zero can be defined by the chi-square value equal to the squared value of the median $\mu_{1/2}$ divided by the standard error *s*. This value follows a chi-square distribution with one degree of freedom.

$$s = \frac{\frac{(\mu_{1/2} - p_{2.5})}{1.96} + \frac{(p_{97.5} - \mu_{1/2})}{1.96}}{2} = \frac{p_{97.5} - p_{2.5}}{3.92} \quad (5)$$

RESULTS AND DISCUSSION

Overall Results

To get a comprehensive overview of the different results, the directions of the effects are shown in Table 3, from which it can be seen that for some variables the effect is ambiguous (represented by question marks). This result is partially due to the fact that in a zero-inflated model a variable might have an increasing effect on the mean parameter and simultaneously an increasing effect on the probability of having a zero, thus decreasing the overall value of the estimate.

A second, although less important, reason for the ambiguity is the fact that the four models (i.e., conservative and progressive weighting and conservative and progressive bootstrapping) do not always yield the same direction of effects. In this context, the nonsignificance of parameters did not contribute to the ambiguity. For example, the effect of higher education on total travel time expenditure has an increasing effect in three of the four models but was not significant in the conservative bootstrapping model. In the latter case, this parameter is considered to have a positive (increasing) effect on travel time expenditure.

The total daily travel time expenditure is modeled by using a "classical" negative binomial model, whereas the motive-specific

TABLE 3 Significance and Direction of Effect

Parameter	Total	Commuting	Shopping	Leisure	Visits
Sociodemographics					
Nationality					
Spanish	− (2)	+ (3)	− (3)	− (3)	− (3)
French	+ (3)	+ (3)	+ (3)	− (3)	+ (3)
Italian	− (3)	+ (3)	− (3)	0	− (3)
Moroccan	+ (2)	0	+ (3)	− (3)	0
Dutch	+ (2)	0	+ (2)	− (3)	+ (2)
Age	+ (3)	?	+ (7)	?	+ (3)
Gender: female	0	− (5)	+ (6)	?	+ (3)
Higher education	+ (3)	+ (3)	+ (3)	+ (6)	?
Professional activity	+ (3)	+ (4)	− (3)	− (3)	− (3)
Net monthly HH income: €1,500–€3,999	− (1)	+ (3)	− (3)	+ (2)	0
Net monthly HH income: ≥€4,000	− (3)	− (2)	− (3)	+ (2)	− (2)
Net monthly HH income: undeclared	− (3)	0	− (3)	− (1)	− (3)
HH size	− (3)	+ (3)	?	− (2)	?
Companion	+ (2)	?	0	+ (3)	− (2)
Having child(ren)	0	− (3)	?	− (2)	− (3)
Residential Characteristics					
Urbanization residence: urban	− (3)	?	− (3)	0	?
HH dwelling ownership	− (3)	− (3)	− (3)	− (3)	+ (3)
HH dwelling is detached house	+ (3)	+ (2)	+ (3)	+ (3)	0
Transport Options and Mode Use Frequencies					
Season ticket for public transport	+ (3)	+ (6)	?	+ (6)	+ (3)
Car driver's license	+ (3)	+ (2)	+ (5)	− (3)	+ (6)
Mobility restraints	− (3)	0	− (3)	0	0
Bike possession	+ (4)	+ (3)	+ (3)	?	+ (6)
Car possession	0	?	?	+ (3)	− (3)
Frequent walking	+ (3)	− (3)	+ (6)	0	0
Frequent cycling	0	0	+ (2)	+ (7)	0
Frequent public transit use	+ (3)	+ (6)	+ (3)	0	0
Frequent car use	+ (2)	0	0	?	+ (3)
Temporal Characteristics					
Weekend day	− (2)	− (4)	+ (3)	+ (6)	+ (6)
School holiday	0	− (4)	+ (2)	0	+ (6)
Travel time expenditure: other	na	− (7)	− (4)	− (3)	− (8)

NOTE: 0 = no effect; − = negative effect; + = positive effect; ? = ambiguous effect. Values in parentheses indicate number of parameters (in the four models) confirming the effect.

models were modeled by using a zero-inflated negative binomial model. The need to account for the excess in zeros is confirmed by the likelihood ratio tests that compare the likelihood of the zero-inflated models with the alternative without the zero-inflated part. For each of the motive-specific models, the likelihood ratio test is highly significant (p-value less than .001); this finding acknowledges the need for a zero-inflated model, which was also observed from the inspection of the kernel density estimates of the data distributions shown in Figure 1.

With respect to the direction of the effects, it can be observed from Table 3 that for the majority of the variables, the direction of the effect depends highly on the motive. This finding provides evidence of a travel time frontier, which indicates that travelers are not willing to surpass a certain threshold in terms of time traveling for a day [see work by Volosin et al. (*8*)]. Further evidence is provided by the negative effect of travel time spent on trip motives other than the one under study.

Total Daily Travel Time Expenditure

Parameter estimates of the negative binomial model for the total daily travel time expenditure are shown in Table 4. It can be observed that in general the estimates of the four adopted techniques lie in the same direction but that the reported standard errors and p-values using conservative bootstrapping are considerably different. The latter is an indication that when the bootstrap samples are too small in size, the power to detect significant differences is too weak.

Regarding nationality, in comparison with Belgians, the French have a significantly higher daily travel time expenditure, whereas

TABLE 4 Maximum Likelihood Parameter Estimates for Negative Binomial Regression Model: Total Daily Travel Time Expenditure

	Weighting			Conservative Bootstrapping			Progressive Bootstrapping		
Parameter	Est.	SE	Sig.	Est.	SE	Sig.	Est.	SE	Sig.
Intercept	3.668	0.046	<0.001	3.683	0.389	<0.001	3.717	0.064	<0.001
Sociodemographics									
Nationality									
Spanish	–0.057	0.027	0.036	0.016	0.212	0.941	–0.044	0.036	0.219
French	0.185	0.020	<0.001	0.202	0.240	0.401	0.187	0.041	<0.001
Italian	–0.133	0.021	<0.001	–0.044	0.206	0.830	–0.107	0.038	0.005
Moroccan	0.073	0.029	0.012	0.082	0.240	0.732	0.020	0.039	0.600
Dutch	0.055	0.023	0.018	0.036	0.190	0.848	–0.009	0.036	0.807
Age	0.001	0.001	0.027	0.001	0.004	0.792	0.001	0.001	0.044
Higher education	0.126	0.016	<0.001	0.150	0.140	0.282	0.130	0.023	<0.001
Professional activity	0.079	0.017	<0.001	0.131	0.139	0.347	0.126	0.022	<0.001
Net monthly HH income: €1,500–€3,999	–0.030	0.020	0.130	–0.044	0.156	0.779	–0.058	0.027	0.030
Net monthly HH income: ≥€4,000	–0.099	0.026	<0.001	–0.096	0.218	0.660	–0.115	0.034	0.001
Net monthly HH income: undeclared	–0.247	0.031	<0.001	–0.306	0.245	0.211	–0.320	0.039	<0.001
HH size	–0.038	0.007	<0.001	–0.041	0.059	0.487	–0.041	0.010	<0.001
Companion	0.044	0.018	0.014	0.027	0.144	0.853	0.020	0.024	0.402
Residential Characteristics									
Urbanization residence: urban	–0.039	0.018	0.032	–0.139	0.152	0.360	–0.121	0.025	<0.001
HH dwelling ownership	–0.055	0.018	0.002	–0.137	0.142	0.336	–0.121	0.022	<0.001
HH dwelling is detached house	0.087	0.019	<0.001	0.167	0.171	0.329	0.134	0.029	<0.001
Transport Options and Mode Use									
Season ticket for public transport	0.231	0.019	<0.001	0.315	0.165	0.056	0.317	0.027	<0.001
Car driver's license	0.253	0.024	<0.001	0.238	0.210	0.257	0.264	0.032	<0.001
Mobility restraints	–0.111	0.022	<0.001	–0.212	0.211	0.314	–0.188	0.035	<0.001
Bike possession	0.277	0.017	<0.001	0.298	0.148	0.044	0.311	0.022	<0.001
Frequent walking	0.117	0.017	<0.001	0.165	0.141	0.241	0.166	0.025	<0.001
Frequent public transit use	0.210	0.018	<0.001	0.216	0.153	0.158	0.219	0.026	<0.001
Frequent car use	0.182	0.019	<0.001	0.089	0.151	0.558	0.112	0.024	<0.001
Temporal Characteristics: Weekend Day	–0.068	0.016	<0.001	–0.028	0.142	0.841	–0.020	0.023	0.380
Model Specific Parameters									
Dispersion[a]	0.005	0.000	<0.001						
Dispersion[b]	0.186	0.003	<0.001						
Dispersion[c]				0.440	0.049	<0.001	0.502	0.009	<0.001

NOTE: Est. = estimate; SE = standard error; sig. = significance.
[a]Conservative weighting.
[b]Progressive weighting.
[c]Bootstrapping.

Italians spend significantly less time traveling on a daily basis. The higher travel time expenditure by the French can be explained by their longer travel times on commuting, shopping, and visit trips. The lower expenditure by Italians can be accounted for by their lower shopping and visit distances and by a relatively higher proportion of professionally inactive persons. Concerning other sociodemographic effects, travelers with a higher degree of education spend 13.4% (= exp(0.126) – 1) more time on traveling in comparison with their counterparts.

With respect to residential characteristics, people residing in urban areas have a lower daily travel time expenditure. This finding can be accounted for by the typically larger and denser number of activity opportunities in urban areas. Moreover, those who own their household dwelling spend less time on travelling. This finding suggests that in comparison with tenants, owners have a better residential location to satisfy their needs for activity participation. In addition, whether the dwelling type is a detached house has an increasing effect on daily travel time expenditure.

Concerning transport options and mode use, all estimates lie exactly in the direction that would be expected: a higher number of transport options have an increasing effect on daily travel time expenditure. Moreover, the more frequently one uses different transport modes, the higher the daily travel time expenditure. Those who have physical mobility constraints spend less time traveling; this finding could be a sign of a lower level of out-of-home activity participation.

Finally, with regard to the temporal characteristics, less time is spent on travelling during weekend days. Notwithstanding, some concern needs to be taken in generalizing these effects, since this particular effect was only acknowledged by the two weighted models.

Motive-Specific Travel Time Expenditures

Commuting Trips

With regard to motive-specific travel time expenditures, Table 5 shows parameter estimates of the model predicting travel time expenditure on commuting (work or school) trips. The motive-specific models have two sets of parameters. The first set relates to the parameters estimating the effect on the mean parameter (negative binomial part), whereas the second set relates to the zero-inflation part.

Focusing on the sociodemographics, one could observe from the estimates of nationality that Spanish, French, and Italian travelers spend significantly more time on commuting trips in comparison with Belgians. This finding can be explained by the fact that they are prepared to commute longer distances to find a job that matches their education. With regard to age, age has an increasing effect on mean travel time expenditure, whereas it increases the probability of a zero travel time expenditure. It can be observed that gender decreases the overall travel time expenditure and moreover increases the probability of a zero travel time expenditure. This negative effect provides evidence for two phenomena: (*a*) a lower professional participation rate among women and (*b*) a better job–housing balance of women, since the female proportion of caretakers of children is still higher than that of males because of traditional role patterns.

An obvious but very significant effect is the decreased likelihood of a zero travel time expenditure on commuting trips when the traveler is professionally active. In the same context, the temporal characteristics (i.e., weekend day and school holiday) significantly affect the probability of a zero travel time expenditure.

In addition, the increasing effect of frequent public transit use draws the attention. This effect can be partially explained by the fact that travelers who use the train for their work commute typically travel longer distances and have correspondingly longer travel times.

Shopping Trips

Table 6 shows parameter estimates of the model predicting daily travel time expenditure on shopping trips. The strongest effects with respect to nationality are the considerably higher travel time expenditure of Moroccans and lower expenditure of Italians in comparison with Belgians. The higher daily travel time for shopping for the Spanish and Moroccans can be explained by the distance between their residence and the shopping locations that correspond to their own food preferences. This result could be an index of social exclusion or low integration of these national groups into Belgian society (*9*).

Regarding other sociodemographics, the gender difference is especially noticeable. Women have a higher mean travel time expenditure and a lower probability of a zero travel time expenditure in comparison with men. This finding provides evidence that the general idea that shopping is mainly a female activity holds true.

Leisure Trips

Regarding the parameter estimates of the leisure trip model (Table 7), the Dutch and Moroccans especially are spending less time on leisure trips in comparison with Belgians. A possible explanation for the Moroccans is that they are more committed to their original cultural traditions and therefore prefer to spend leisure time with other Moroccans, who are often geographically clustered. Furthermore, one can see that the effect of owning a dwelling in comparison with being a tenant and the effect of higher education play an important role in the context of leisure trips. Concerning temporal characteristics, leisure trips are especially a weekend-day activity, since the probability of zero travel time expenditure is considerably lower during weekends.

Visit Trips

A final set of parameters corresponds to the prediction of travel time expenditure on visit trips. From Table 8, it can be seen that the Spanish and Italians spend considerably less time on visit trips in comparison with Belgians, whereas the French spend significantly more time. This finding can be partially explained by the fact that the Belgians and French have a higher probability of having family or close friends living in Belgium or in the same city, whereas Spanish and Italian groups have a lower probability. Moreover, for the French, it is still reasonable to visit relatives and friends in France given the geographical proximity, whereas this type of visit is less likely for the Italians and Spanish. Besides, the effect of school holidays should be noted; these holidays have an increasing effect on overall travel time expenditure and a decreasing effect on the likelihood of a zero expenditure.

TABLE 5 Maximum Likelihood Parameter Estimates for Zero-Inflated Negative Binomial Regression Model: Daily Travel Time Expenditure on Commuting Trips

	Weighting			Conservative Bootstrapping			Progressive Bootstrapping		
Parameter	Est.	SE	Sig.	Est.	SE	Sig.	Est.	SE	Sig.
Negative Binomial Part									
Intercept	3.371	0.060	<0.001	3.575	0.581	<0.001	3.631	0.078	<0.001
Nationality									
Spanish	0.127	0.040	0.002	0.258	0.319	0.419	0.196	0.047	<0.001
French	0.112	0.026	<0.001	0.193	0.300	0.520	0.159	0.046	0.001
Italian	0.105	0.030	0.001	0.181	0.323	0.575	0.140	0.052	0.007
Moroccan	–0.019	0.044	0.667	–0.039	0.323	0.903	–0.072	0.048	0.136
Dutch	0.061	0.036	0.095	0.075	0.338	0.824	0.033	0.049	0.506
Age	0.008	0.001	<0.001	0.013	0.009	0.139	0.012	0.001	<0.001
Gender: female	–0.148	0.020	<0.001	–0.111	0.167	0.505	–0.122	0.024	<0.001
Higher education	0.122	0.024	<0.001	0.099	0.215	0.645	0.086	0.029	0.003
Net monthly HH income: €1,500–€3,999	0.095	0.033	0.004	0.202	0.278	0.466	0.178	0.037	<0.001
Net monthly HH income: ≥€4,000	–0.075	0.038	0.050	0.016	0.321	0.961	–0.037	0.045	0.415
Net monthly HH income: undeclared	0.050	0.043	0.248	0.085	0.373	0.820	0.066	0.047	0.160
Companion	0.073	0.024	0.002	0.038	0.212	0.856	0.049	0.028	0.082
Urbanization residence: urban	–0.203	0.024	<0.001	–0.400	0.231	0.084	–0.363	0.032	<0.001
HH dwelling ownership	–0.145	0.025	<0.001	–0.198	0.203	0.331	–0.181	0.031	<0.001
HH dwelling is detached house	0.093	0.026	<0.001	0.021	0.253	0.935	0.041	0.038	0.283
Season ticket for public transport	0.137	0.028	<0.001	0.126	0.272	0.644	0.091	0.033	0.006
Car driver's license	0.170	0.033	<0.001	0.026	0.327	0.936	0.044	0.043	0.306
Bike possession	0.111	0.025	<0.001	0.137	0.215	0.524	0.145	0.030	<0.001
Car possession	0.152	0.032	<0.001	–0.103	0.273	0.707	–0.084	0.036	0.019
Frequent walking	–0.139	0.023	<0.001	–0.204	0.194	0.293	–0.191	0.027	<0.001
Frequent public transit use	0.524	0.028	<0.001	0.459	0.265	0.084	0.479	0.036	<0.001
Travel time expenditure other	–0.001	0.000	<0.001	–0.002	0.002	0.412	–0.001	0.000	<0.001
Dispersion[a]	0.004	0.000	<0.001						
Dispersion[b]	0.135	0.004	<0.001						
Dispersion[c]				0.310	0.053	<0.001	0.408	0.009	<0.001
Zero-Inflation Part									
Intercept	–1.507	0.221	<0.001	–2.358	1.540	0.126	–2.148	0.194	<0.001
Age	0.052	0.003	<0.001	0.065	0.022	0.003	0.059	0.003	<0.001
Gender: female	0.372	0.068	<0.001	0.102	0.547	0.852	0.078	0.073	0.289
Professional activity	–2.767	0.092	<0.001	–3.358	0.777	<0.001	–3.023	0.097	<0.001
HH size	–0.163	0.037	<0.001	–0.138	0.245	0.572	–0.117	0.032	<0.001
Companion	0.417	0.091	<0.001	0.596	0.681	0.381	0.496	0.095	<0.001
Having child(ren)	0.413	0.106	<0.001	0.553	0.842	0.511	0.479	0.113	<0.001
Urbanization residence: urban	–0.162	0.071	0.023	–0.125	0.647	0.847	–0.086	0.082	0.290
Season ticket for public transport	–0.268	0.105	0.011	–0.923	0.744	0.215	–0.814	0.092	<0.001
Car possession	–0.403	0.136	0.003	–0.333	0.743	0.654	–0.337	0.101	0.001
Frequent public transit use	–0.234	0.102	0.021	–0.315	0.736	0.668	–0.306	0.092	0.001
Weekend day	2.907	0.088	<0.001	3.406	0.826	<0.001	3.105	0.106	<0.001
School holiday	1.415	0.090	<0.001	1.746	0.835	0.037	1.605	0.110	<0.001
Travel time expenditure other	0.014	0.001	<0.001	0.026	0.009	0.003	0.023	0.001	<0.001

[a]Conservative weighting.
[b]Progressive weighting.
[c]Bootstrapping.

TABLE 6 Maximum Likelihood Parameter Estimates for Zero-Inflated Negative Binomial Regression Model: Daily Travel Time Expenditure on Shopping Trips

	Weighting			Conservative Bootstrapping			Progressive Bootstrapping		
Parameter	Est.	SE	Sig.	Est.	SE	Sig.	Est.	SE	Sig.
Negative Binomial Part									
Intercept	2.513	0.096	<0.001	1.688	0.956	0.077	2.046	0.138	<0.001
Nationality									
Spanish	–0.124	0.056	0.028	–0.078	0.519	0.881	–0.325	0.097	0.001
French	0.243	0.042	<0.001	0.406	0.533	0.447	0.221	0.093	0.017
Italian	–0.298	0.047	<0.001	–0.199	0.558	0.722	–0.385	0.093	<0.001
Moroccan	0.569	0.060	<0.001	0.882	0.548	0.108	0.615	0.091	<0.001
Dutch	0.132	0.053	0.013	0.325	0.473	0.492	0.054	0.091	0.548
Age	0.008	0.001	<0.001	0.016	0.009	0.071	0.016	0.002	<0.001
Gender: female	0.129	0.029	<0.001	0.181	0.247	0.463	0.187	0.045	<0.001
Net monthly HH income: €1,500–€3,999	–0.207	0.043	<0.001	–0.372	0.436	0.393	–0.355	0.058	<0.001
Net monthly HH income: ≥€4,000	–0.451	0.056	<0.001	–0.654	0.551	0.235	–0.668	0.081	<0.001
Net monthly HH income: undeclared	–0.240	0.067	<0.001	–0.250	0.593	0.673	–0.268	0.067	<0.001
HH size	0.091	0.018	<0.001	0.063	0.184	0.731	0.081	0.040	0.045
Having child(ren)	–0.416	0.045	<0.001	–0.500	0.534	0.349	–0.534	0.099	<0.001
Urbanization residence: urban	–0.120	0.038	0.001	–0.123	0.400	0.759	–0.183	0.063	0.003
HH dwelling ownership	–0.093	0.036	0.010	–0.237	0.284	0.405	–0.221	0.042	<0.001
HH dwelling is detached house	0.141	0.040	<0.001	0.377	0.448	0.399	0.286	0.067	<0.001
Season ticket for public transport	0.168	0.042	<0.001	0.184	0.342	0.590	0.153	0.065	0.020
Car driver's license	0.122	0.049	0.012	0.281	0.566	0.620	0.217	0.076	0.004
Mobility restraints	–0.224	0.049	<0.001	–0.393	0.571	0.491	–0.449	0.091	<0.001
Car possession	0.512	0.051	<0.001	0.855	0.475	0.072	0.841	0.067	<0.001
Frequent walking	0.153	0.037	<0.001	0.215	0.388	0.579	0.183	0.050	<0.001
Frequent cycling	0.106	0.039	0.006	–0.162	0.346	0.639	–0.096	0.076	0.205
Frequent public transit use	0.343	0.039	<0.001	0.444	0.323	0.169	0.476	0.059	<0.001
Dispersion[a]	0.006	0.000	<0.001						
Dispersion[b]	0.199	0.008	<0.001						
Dispersion[c]				0.257	0.085	0.003	0.446	0.025	<0.001
Zero-Inflation Part									
Intercept	0.891	0.180	<0.001	1.640	1.243	0.187	1.516	0.166	<0.001
Age	–0.019	0.002	<0.001	–0.029	0.013	0.034	–0.026	0.002	<0.001
Gender: female	–0.295	0.055	<0.001	–0.240	0.400	0.548	–0.229	0.059	<0.001
Higher education	–0.496	0.060	<0.001	–0.520	0.486	0.284	–0.473	0.065	<0.001
Professional activity	0.527	0.069	<0.001	0.449	0.487	0.357	0.433	0.066	<0.001
HH size	0.146	0.033	<0.001	0.401	0.216	0.063	0.379	0.032	<0.001
Having child(ren)	–0.499	0.086	<0.001	–0.934	0.599	0.119	–0.860	0.086	<0.001
Season ticket for public transport	0.184	0.073	0.011	–0.379	0.464	0.414	–0.329	0.062	<0.001
Car driver's license	–0.312	0.092	0.001	–0.007	0.532	0.989	–0.009	0.080	0.912
Bike possession	–0.155	0.067	0.021	–0.733	0.469	0.118	–0.684	0.068	<0.001
Car possession	0.512	0.103	<0.001	0.011	0.549	0.984	0.029	0.071	0.685
Frequent walking	–0.182	0.060	0.003	–0.413	0.544	0.448	–0.398	0.075	<0.001
Weekend day	–0.370	0.063	<0.001	–0.773	0.458	0.092	–0.750	0.064	<0.001
School holiday	–0.265	0.074	<0.001	–0.012	0.513	0.981	–0.041	0.076	0.595
Travel time expenditure other	0.010	0.001	<0.001	0.012	0.005	0.021	0.011	0.001	<0.001

[a]Conservative weighting.
[b]Progressive weighting.
[c]Bootstrapping.

TABLE 7 Maximum Likelihood Parameter Estimates for Zero-Inflated Negative Binomial Regression Model: Daily Travel Time Expenditure on Leisure Trips

	Weighting			Conservative Bootstrapping			Progressive Bootstrapping		
Parameter	Est.	SE	Sig.	Est.	SE	Sig.	Est.	SE	Sig.
Negative Binomial Part									
Intercept	3.768	0.136	<0.001	3.406	2.934	0.246	3.791	0.192	<0.001
Nationality									
Spanish	–0.304	0.101	0.003	–0.176	1.938	0.928	–0.549	0.140	<0.001
French	–0.298	0.067	<0.001	–0.172	1.340	0.898	–0.442	0.104	<0.001
Italian	0.091	0.075	0.224	0.432	2.323	0.852	0.152	0.124	0.219
Moroccan	–0.569	0.152	<0.001	–0.627	7.807	0.936	–0.887	0.148	<0.001
Dutch	–0.761	0.073	<0.001	–0.462	1.027	0.652	–0.896	0.109	<0.001
Age	0.006	0.002	<0.001	0.010	0.031	0.754	0.008	0.002	0.001
Gender: female	0.208	0.045	<0.001	0.284	0.945	0.764	0.243	0.061	<0.001
Higher education	0.141	0.057	0.014	0.321	1.049	0.760	0.248	0.080	0.002
HH size	–0.045	0.021	0.035	–0.010	0.335	0.977	–0.017	0.024	0.466
Companion	0.193	0.063	0.002	0.122	1.003	0.903	0.197	0.073	0.007
HH dwelling ownership	–0.466	0.064	<0.001	–0.716	0.968	0.459	–0.703	0.066	<0.001
HH dwelling is detached house	0.220	0.058	<0.001	0.192	1.184	0.872	0.212	0.098	0.030
Season ticket for public transport	0.191	0.055	0.001	0.142	0.901	0.875	0.161	0.073	0.027
Car driver's license	–0.232	0.072	0.001	–0.530	1.242	0.669	–0.496	0.092	<0.001
Car possession	0.403	0.086	<0.001	0.707	1.633	0.665	0.676	0.097	<0.001
Frequent cycling	0.464	0.053	<0.001	0.546	0.965	0.572	0.620	0.086	<0.001
Frequent car use	–0.350	0.069	<0.001	–0.552	1.340	0.680	–0.516	0.077	<0.001
Weekend day	0.126	0.052	0.014	0.166	0.893	0.852	0.156	0.080	0.052
Dispersion[a]	0.006	0.000	<0.001						
Dispersion[b]	0.211	0.011	<0.001						
Dispersion[c]				0.093	0.075	0.217	0.318	0.026	<0.001
Zero-Inflation Part									
Intercept	1.813	0.179	<0.001	1.554	1.024	0.129	1.478	0.149	<0.001
Age	0.008	0.002	<0.001	0.021	0.017	0.207	0.019	0.002	<0.001
Gender: female	0.168	0.067	0.012	0.800	0.574	0.163	0.745	0.075	<0.001
Higher education	–0.506	0.077	<0.001	–0.839	0.637	0.188	–0.742	0.087	<0.001
Net monthly HH income: €1,500–€3,999	–0.323	0.106	0.002	–0.063	0.647	0.923	–0.067	0.090	0.458
Net monthly HH income: ≥€4,000	–0.587	0.123	<0.001	0.012	0.857	0.988	–0.017	0.112	0.880
Net monthly HH income: undeclared	0.086	0.176	0.627	0.624	6.258	0.921	0.556	0.150	<0.001
Professional activity	0.398	0.080	<0.001	0.833	0.661	0.208	0.763	0.086	<0.001
Having child(ren)	0.299	0.088	0.001	–0.219	0.714	0.759	–0.142	0.089	0.112
Season ticket for public transport	–0.324	0.081	<0.001	–1.037	0.680	0.127	–0.898	0.082	<0.001
Bike possession	–0.181	0.091	0.046	0.344	0.695	0.620	0.314	0.095	0.001
Frequent cycling	–0.244	0.080	0.002	–1.422	0.656	0.030	–1.273	0.082	<0.001
Frequent car use	–0.350	0.108	0.001	–0.396	0.730	0.588	–0.299	0.083	<0.001
Weekend day	–0.583	0.071	<0.001	–1.314	0.573	0.022	–1.167	0.071	<0.001
Travel time expenditure other	0.008	0.001	<0.001	0.006	0.005	0.310	0.004	0.001	<0.001

[a]Conservative weighting.
[b]Progressive weighting.
[c]Bootstrapping.

CONCLUSIONS

The results of the different models indicate that nationality plays an important role in explaining differences in daily travel time expenditure. Even after other contributing factors, such as sociodemographics, residential characteristics, transport options, and temporal characteristics, are controlled for, nationality still has a significant effect. This finding is especially relevant in the development of policy packages that are targeted at social inequalities.

From a methodological perspective, different methodological options (two weighting schemes and two bootstrap solutions) were presented to provide sufficient support for the conclusions. The progressive bootstrapping approach detects differences and significant effects more easily in comparison with the conservative bootstrapping

TABLE 8 Maximum Likelihood Parameter Estimates for Zero-Inflated Negative Binomial Regression Model: Daily Travel Time Expenditure on Visit Trips

	Weighting			Conservative Bootstrapping			Progressive Bootstrapping		
Parameter	Est.	SE	Sig.	Est.	SE	Sig.	Est.	SE	Sig.
Negative Binomial Part									
Intercept	1.682	0.132	<0.001	0.899	2.885	0.755	1.248	0.233	<0.001
Nationality									
Spanish	–0.870	0.103	<0.001	–0.625	1.532	0.683	–1.241	0.121	<0.001
French	0.553	0.062	<0.001	0.527	1.388	0.704	0.276	0.111	0.013
Italian	–0.651	0.074	<0.001	–0.470	1.474	0.750	–0.881	0.120	<0.001
Moroccan	–0.042	0.106	0.688	0.112	1.952	0.954	–0.237	0.135	0.079
Dutch	0.240	0.082	0.003	0.313	1.516	0.837	0.110	0.124	0.375
Age	0.015	0.001	<0.001	0.015	0.030	0.606	0.017	0.002	<0.001
Gender: female	0.201	0.045	<0.001	0.364	0.780	0.640	0.294	0.072	<0.001
Higher education	0.243	0.047	<0.001	0.189	0.810	0.816	0.290	0.062	<0.001
Net monthly HH income: €1,500–€3,999	–0.052	0.063	0.414	0.112	1.145	0.922	0.084	0.093	0.365
Net monthly HH income: ≥€4,000	–0.178	0.087	0.041	–0.060	1.771	0.973	–0.112	0.123	0.363
Net monthly HH income: undeclared	–0.524	0.132	<0.001	–4.975	8.348	0.551	–0.915	0.401	0.023
HH size	0.150	0.028	<0.001	0.193	0.529	0.715	0.137	0.037	<0.001
Having child(ren)	–0.501	0.069	<0.001	–0.409	1.343	0.761	–0.422	0.113	<0.001
Urbanization residence: urban	0.820	0.057	<0.001	1.222	1.052	0.245	1.210	0.086	<0.001
HH dwelling ownership	0.237	0.057	<0.001	0.202	1.382	0.884	0.335	0.084	<0.001
Season ticket for public transport	0.319	0.058	<0.001	0.053	1.088	0.961	0.245	0.095	0.010
Car driver's license	0.212	0.067	0.002	0.257	1.227	0.834	0.259	0.088	0.003
Bike possession	0.244	0.052	<0.001	0.161	0.926	0.862	0.215	0.064	0.001
Weekend day	0.245	0.053	<0.001	0.493	1.123	0.661	0.461	0.084	<0.001
School holiday	0.450	0.061	<0.001	0.394	1.297	0.761	0.389	0.102	<0.001
Travel time expenditure other	–0.001	0.000	0.001	–0.001	0.009	0.931	–0.001	0.001	0.470
Dispersion[a]	0.008	0.000	<0.001						
Dispersion[b]	0.284	0.016	<0.001						
Dispersion[c]				0.159	0.109	0.145	0.512	0.032	<0.001
Zero-Inflation Part									
Intercept	1.056	0.147	<0.001	0.759	1.176	0.519	0.790	0.163	<0.001
Higher education	–0.173	0.069	0.013	0.257	0.556	0.645	0.204	0.081	0.012
Professional activity	0.297	0.070	<0.001	0.386	0.537	0.473	0.302	0.071	<0.001
HH size	0.090	0.028	0.001	0.082	0.236	0.727	0.089	0.033	0.006
Companion	0.234	0.070	0.001	0.033	0.576	0.954	0.051	0.072	0.478
Urbanization residence: urban	0.220	0.065	0.001	0.849	0.547	0.120	0.728	0.077	<0.001
Car driver's license	–0.320	0.098	0.001	–0.477	0.771	0.536	–0.409	0.094	<0.001
Bike possession	–0.169	0.077	0.028	–0.269	0.589	0.648	–0.242	0.085	0.004
Car possession	0.287	0.131	0.028	0.896	0.909	0.325	0.821	0.133	<0.001
Frequent car use	–0.430	0.112	<0.001	–1.177	0.950	0.215	–1.016	0.135	<0.001
Weekend day	–0.927	0.070	<0.001	–0.829	0.591	0.161	–0.798	0.080	<0.001
School holiday	–0.678	0.083	<0.001	–0.562	0.724	0.438	–0.471	0.091	<0.001
Travel time expenditure other	0.011	0.001	<0.001	0.014	0.007	0.034	0.013	0.001	<0.001

[a]Conservative weighting.
[b]Progressive weighting.
[c]Bootstrapping.

approach, which only identifies the key variable. Yet bootstrapping identifies a smaller number of significant effects than the weighting approaches. Thus, the progressive bootstrapping approach balances the ability to depict significant differences and the simplicity of the model.

To ensure the required level of generalizability of the results in further studies, an oversampling of travelers with a different nationality is strongly recommended. Moreover, the methods that are presented enable showing the real differences in travel time expenditure among different nationalities. An example is the expenditure on commuting trips. From Table 1, it appears that Italians spend less time on commuting than Belgians, whereas after different explanatory factors are corrected for, one can observe from Tables 3 and 5 that they are spending significantly more time on commuting.

In this study, nationality was used as an indicator for assessing ethnic diversity. Although nationality is commonly used in ethnic research, other more refined indicators should be collected to more precisely refine the results. Moreover, future research should focus more on the underlying psychological constructs of why ethnic and cultural differences persist, even if one accounts for other determinants. In this context, the use of cultural dimension scales seems to be an interesting research direction. Besides, information about the size of ethnic communities as well as information about activity locations can provide additional insights in the context of visit and shopping trips.

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