The value of travel time for long-distance railway passenger transport in the Czech Republic

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Abstract

This paper investigates the value of travel time (VTT) for long-distance railway passenger transport in the Czech Republic. The VTT is elicited using stated preference (SP) data from 232 respondents traveling on two main train routes in the Czech Republic, Brno–Prague and Brno–Ostrava, in 2017 and 2018, respectively. We estimate a median VTT of approximately 5 EUR/hour. This value is substantially lower than the values estimated for the Czech Republic from meta-studies based on data from other European countries, some of which are officially used for the assessment of transport projects in the Czech Republic.

Keywords: Value of travel time, Stated preference, Discrete choice model

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1. Introduction

The value of travel time (VTT), a monetary value assigned to time spent traveling, is an essential parameter in transport economics. Travel time is usually perceived as wasted, and people are generally willing to pay to reduce it. The VTT is therefore an important input for transport models and assessments of transport projects and policies.

The history of the valuation of time reaches back to the 1960s when the economic theory of time valuation was first formed (Mackie et al., 2001). In the founding articles by Becker (1965) and DeSerpa (1971), consumers' choice of time allocation was established in the context of utility maximization, subject to two resource constraints: a money constraint and a time constraint. A broadly used foundation for estimating the parameters of the VTT is built upon this model, which, after some extensions, enables equilibrium conditions for time allocation to be derived (Belenky, 2011). Many studies have been undertaken to elicit the VTT using various modeling techniques, including several national studies (see, for instance, Shires and De Jong, 2009; Abrantes and Wardman, 2011; Small, 2012; Kouwenhoven et al., 2014; Börjesson and Eliasson, 2014; Wardman et al., 2016; Batley et al., 2017; Dubernet and Axhausen, 2020).

This paper investigates the VTT for rail passenger transport in the Czech Republic using a sample recruited on board trains on two long-distance routes in the Czech republic (Prague-Brno and Brno-Ostrava). The values estimated in our paper are substantially lower than the values officially used by the Czech Ministry of Transportation based on the HEATCO project (Adamová et al., 2017), and those derived from meta-studies by Shires and De Jong (2009) and Wardman et al. (2016). All these are fitted values based on data from other European countries. Our result suggests that such fitted values might not correspond to the actual values measured in the country.

There are several existing studies based on Czech data, but most of them are either student theses using small samples (Moravec, 2016; Škerdová, 2018; Vejrostová, 2019) or they estimate values of travel time in different contexts (leisure car travel in Senk et al. (2012) or urban travel in Braun Kohlová (2012)). Only the study by Máca and Braun Kohlová (2019) provides values directly comparable to our findings. They use a sample recruited online from the target population of adult residents of the Prague and Brno agglomerations who had traveled on the route Prague-Brno in either direction at least once in the previous half year, to estimate the value of travel time in congested and free-flow traffic. While their recruitment strategy ensures a representative modal split, it does not guarantee that their sample is representative of the passenger population on the route. In contrast, we focus only on rail passengers, but data collection on board trains should generate a more representative sample of passengers on the selected routes.

2. Literature review

This section provides a short overview of recent literature on data and methods used for VTT estimation. It also presents the main factors affecting the resulting values.

VTT studies can be based on stated preference (SP) data, which is the data source we use in our study, or on revealed preference (RP) data or a combination of SP and RP data. Several advantages weigh in favor of SP data, which reflects choice behavior under hypothetical conditions, rather than RP data, which reflects actual choice behavior. First, the design of a hypothetical questionnaire is decided by the analyst and this means that collinearity between attribute levels can be avoided. Second, in a hypothetical questionnaire, non-existent alternatives or attribute levels can be presented to the respondents, allowing them to evaluate the monetary benefits of non-existent transport modes or routes. Last, when using a hypothetical questionnaire the analyst controls the entire choice set, including both chosen and unchosen alternatives, whereas when working with RP data it may be difficult to determine the latter. The drawbacks of the SP-based estimation results include possible biases due to the design of the choice experiment or due to the hypothetical nature of the choices (Brownstone and Small, 2005; Li et al., 2010; Peer et al., 2013; Fifer et al., 2014; Krčál et al., 2019).

Most studies elicit their values using short-term decisions, such as whether to take a shorter but more expensive connection or whether to travel by bus or train, with choice attributes pivoted around a reference trip (see e.g. Börjesson and Eliasson, 2014; Kouwenhoven et al., 2014; Schmid et al., 2021; Weis et al., 2021). Only a limited number of studies measure the value of travel time in the context of longer-term choices, for instance those related to where respondents live or work (Tillema et al., 2010; Kim et al., 2005; Peer et al., 2015; Beck et al., 2017; Schmid et al., 2022). In line with the most of the literature, our choice experiment consists of short-term decisions with attributes pivoted around a specific reference trip.

Several types of discrete choice models are used for estimating the VTT from the SP data (see e.g. Hensher, 2011; Walker and Ben-Akiva, 2011). While the multinomial logit model (MNL) is widely used and valued for its simplicity, it has several limitations. It does not allow for differences in preferences, nor does it account for correlations across alternatives stemming from multiple observations per respondent. These problems are typically addressed by mixed logit models or latent class choice models. The most advanced frameworks not only deal with heterogeneity but are also able to capture other factors related to the design of the hypothetical choice setting, such as reference dependence or non-linearities in sensitivities (Hess et al., 2017). In line with more recent methodological developments, this study estimates the VTT using mixed logit models and adjusts for reference dependence using as-now dummy variables.

The theoretical literature suggests that the VTT consists of two main components: the opportunity cost of travel, i.e. the monetary compensation for not being able to pursue more enjoyable activities than travelling, and the direct (dis)utility from spending the time during the trip (De-Serpa, 1971; Kouwenhoven and de Jong, 2018). The opportunity costs of travel differ among individuals and are positively linked with personal income, while other socioeconomic factors have little effect on it (Hössinger et al., 2020). In contrast, the direct (dis)utility of travel is related not only to supply-side factors, such as perception of different modes, noise level, crowding, reliability and congestion, or the availability of WiFi and power sockets, but also to demand-side factors such as travellers' preferences about how they wish to spend their travel time (De Oña and De Oña, 2015; Tang et al., 2018; Kouwenhoven and de Jong, 2018; Schmid et al., 2021).

3. Survey design

The respondents are asked six hypothetical questions, each consisting of a choice between two travel options, which are characterized by travel time and travel cost. For this two-attribute experiment, we use the Bradley design based on De Jong et al. (2007). This type of design does not have any dominant questions by default and presents each attribute's real-life level in each choice pair. For example, alternative A may represent the real duration and price of a journey on the route Brno-Prague (148 mins and 219 CZK[1]) while alternative B offers a shorter journey (e.g. 128

[1] 1 EUR was approximately equal to 26 CZK in 2017.

mins) at a higher price (e.g. 273 CZK). As Table 1 reports, the survey uses two levels of reduction and increase in both attributes, with the same absolute changes on both routes (Brno–Prague and Brno–Ostrava).

Table 1
Changes in travel time and cost

Attribute level	Change in travel time (min)	Change in cost (CZK)
-2	-30	-81
-1	-20	-27
0	0	0
1	20	54
2	60	270

Note. Level 0 = base level. Levels -2, -1, 1, 2 = decrease/increase below/above the base level. Base travel time is 148 for Brno–Prague (255 km) and 140 minutes for Brno–Ostrava (172 km). Base cost is 219/179/155 CZK for adult/IN 25/student fare Brno–Prague, and 245/184 CZK for adult/IN 25 Brno–Ostrava (IN 25 is a purchasable railcard issued by the Czech Railways entitling the bearer to reduced price tickets).

Table 2
Bradley design - 16 choice pairs and distribution into 3 subsets of 6 questions each

ID	Side of *Time 0*	Same sign	Time change	Time level	Cost level	Subset
1	left	yes	increase	1	1	2
2	right	yes	increase	1	2	3
3	right	yes	increase	2	1	1
4	left	yes	increase	2	2	3
5	right	yes	decrease	1	1	1
6	left	yes	decrease	1	2	1, 3
7	left	yes	decrease	2	1	2
8	right	yes	decrease	2	2	3
9	left	no	increase	1	1	2
10	right	no	increase	1	2	2
11	right	no	increase	2	1	1
12	left	no	increase	2	2	2
13	right	no	decrease	1	1	1
14	left	no	decrease	1	2	1
15	left	no	decrease	2	1	2, 3
16	right	no	decrease	2	2	3

Table 2 presents all 16 choice situations used in our design. *Side of Time 0* shows whether the base time level is displayed on the left (variant A) or on the right (variant B) of the choice situation; *same sign* specifies whether the changes in time and cost have the same sign or not; *time change* determines whether the non-base time increases or decreases; and the *time level* and *cost level* variables determine which non-base values are used (see Table 1 for the actual values used on both routes).[2] Since each respondent is given six questions, three respondents are needed to cover

[2]All participants faced the same highest bid of 810 CZK. Only a small share (about 5%) of all participants were not

the full choice set, with two questions duplicated so that the total number of questions equals 18. The last column (*subset*) details the distribution of the 16 choice situations into three subsets of six questions. Table 3 provides examples of four choice situations listed in Table 2.

Table 3
Examples of hypothetical choice situations (IDs from Table 2)

Choice 1		Choice 7		Choice 10		Choice 16	
A	B	A	B	A	B	A	B
Time 0	Time 1	Time 0	Time -2	Time 1	Time 0	Time -2	Time 0
Cost 1	Cost 0	Cost -1	Cost 0	Cost -2	Cost 0	Cost 2	Cost 0

4. Data

The survey was conducted on two of the main train routes in the Czech Republic, Brno–Prague and Brno–Ostrava, both of which are operated by the Czech Railways. The data were collected onboard trains on these routes during spring 2017 (Brno–Prague) and winter 2018 (Brno–Ostrava) from a total of 232 respondents. The final data contain 1,392 observations, as each respondent answered six hypothetical choice questions. A summary of the respondents' socio-demographic characteristics can be found in Table 4.

Female travelers are prevalent among the respondents, mainly due to a high proportion (over 70%) of females traveling on the Brno–Ostrava route. The respondents are quite evenly distributed between the age categories, have a median net monthly income of between 15,001 and 20,000 CZK[3], and nearly 70% are either employed or self-employed workers.

There are significant differences between the travelers on the two routes. On the Brno–Prague route, the respondents are more evenly distributed in terms of gender and age, compared to those on the Brno–Ostrava route, where young females made up a substantial share of travelers.[4] The difference between the routes is also evident when we look at respondents' net income. While those traveling on the Brno–Prague route had median monthly income between 20,001 and 30,000 CZK, the median reported income was lower (15,001–20,000 CZK) on the second route. That lower median income correlates with the significantly higher proportion of students traveling on the Brno–Ostrava route. The respondents significantly differ in gender and age, net income and occupation distributions between the two routes (Chi-squared test, all p-values < 0.05).

willing to accept (or were willing to pay) the bid, which means that our estimates should not be substantially biased by the value of the highest bid in our survey design. Additionally, a small share of the respondents demonstrated non-trading behavior: 5.6% of them always chose the cheaper alternative and 3.4% always chose the faster alternative.

[3] The average gross wage at the end of 2017 was CZK 31,646 (`https://www.czso.cz/csu/czso/ari/average-wages-4-quarter-of-2017`, cited on 26. 1. 2022), which resulted in the net wage of around CZK 24,000 for a single individual without children.

[4] Approximately 63% of these young females stated they were students. This gender imbalance may be caused by the presence of technically focused universities in Ostrava. Those are traditionally more popular among male students, which may result in a significantly higher proportion of young females traveling to Brno for non-technically focused higher education.

Table 4
Descriptive statistics

		All	Brno–Prague	Brno–Ostrava
Respondents		232	113	119
Gender, N (%)				
	Male	84 (36.2)	50 (44.2)	34 (28.6)
Age category, N (%)				
	15 to 26 y/o	78 (33.6)	26 (23.0)	52 (43.7)
	27 to 35 y/o	47 (20.3)	32 (28.3)	15 (12.6)
	36 to 50 y/o	56 (24.1)	30 (26.5)	26 (21.8)
	Above 50 y/o	51 (22.0)	25 (22.1)	25 (21.8)
Net income category, N (%)				
	0–5,000 CZK	26 (11.2)	5 (4.4)	21 (17.6)
	5,001–10,000 CZK	23 (9.9)	4 (3.5)	19 (16.0)
	10,001–15,000 CZK	34 (14.7)	20 (17.7)	14 (11.8)
	15,001–20,000 CZK	39 (16.8)	16 (14.2)	23 (19.3)
	20,001–30,000 CZK	51 (22.0)	28 (24.8)	23 (19.3)
	30,001–40,000 CZK	29 (12.5)	19 (16.8)	10 (8.4)
	40,001–50,000 CZK	17 (7.3)	10 (8.8)	7 (5.9)
	Above 50,000 CZK	13 (5.6)	11 (9.7)	2 (1.7)
Occupation, N (%)				
	Employee	119 (51.3)	58 (51.3)	61 (51.3)
	Student	45 (19.4)	12 (10.6)	33 (27.7)
	Own-account worker	39 (16.8)	26 (23.0)	13 (10.9)
	Retired	22 (9.5)	11 (9.7)	11 (9.2)
	Other	7 (3.0)	6 (5.3)	1 (0.8)

5. Models & results

5.1. Overview

Table 5 presents the results of random parameters models to estimate the VTT. As a robustness check, we estimated three mixed logistic regressions in total, using different levels of variation in the population. Table 6 summarises the results of the model adjusted for individual-specific covariates, namely gender, age, and income categories.

The models are estimated using 3,000 Halton draws with primes of the sequence used in ascending order and 100 elements dropped. The high number of draws was selected to mitigate the impact of simulation noise resulting from the arbitrarily selected order of parameters (Palma et al., 2020). The distribution of random parameters is chosen based on the ex-ante evaluation of the most likely scenario of their behavior (see Section 5.2).

5.2. Random parameters distribution

Setting a suitable distribution of parameters is crucial for the random parameters model, as misspecification can lead to severely biased results. There are various possible distributions to choose from when working with a mixed logistic regression; the most common one is the normal distribution. By setting the distribution to normal, the researcher apriori assumes that the estimated coefficient can gain both positive and negative values. Allowing the cost coefficient to gain positive values seems to contradict the underlying rational economic behavior. It means accepting that utility increases with increasing cost, i.e., ceteris paribus, individuals enjoy paying more. In theory, using the normal distribution for the time coefficient seems to be irrational as well. However, the presence of unobserved travel-time factors might cause longer rides, everything else being equal, to be preferable to shorter ones (Hess et al., 2005).

While the use of the unrestricted time coefficient can be justified, the unrestricted cost coefficient could be caused only by a non-zero probability of some respondents not deciding in line with the rational economic behavior. Therefore, we use two triangular distributions[5], one unbounded and one restricted (zero-bounded). Nevertheless, it is essential to keep in mind that, when working with the unrestricted coefficients, a possible negative VTT may result from the apriori chosen distributions, rather than being revealed by the data.

5.3. Modelling the VTT

Let us define the utility function for a person n and alternative i in choice situation t

$$U_{nit} = V_{nit} + \epsilon_{nit} = \beta_n' x_{nit} + \epsilon_{nit}, \tag{5.1}$$

where V_{nit} is the deterministic part of the utility function, x_{nit} represent alternative- and individual-specific covariates, β_n is a vector of coefficients, and ϵ_{nit} is iid extreme value over time, people, and alternatives (Train, 2009). The VTT derived from the random parameter model is computed for a person n as a ratio of the marginal utilities of time and money (cost) as

$$VTT_n = \frac{\beta_{Time,n}}{\beta_{Cost,n}} \tag{5.2}$$

or with additional covariates as

$$VTT_n = \frac{\beta_{Time,n} + \sum_j \beta_{Time:x_j}}{\beta_{Cost,n} + \sum_j \beta_{Cost:x_j}}, \tag{5.3}$$

where x_j is the vector of explanatory variables interacted with either the time or the cost coefficient.

Incorporating random taste heterogeneity enables us to analyze posterior distributions of continuously distributed random parameters that use the evidence given by each respondent's choices. We estimate means and half ranges for coefficients following the triangular distribution. Coefficients following the zero-bounded triangular distribution are defined only by their mean, and their definition domain varies from 0 to twice the mean.

Since using these random parameters models necessarily involves using information on the distribution of the estimated coefficients, it is good practice to use several distributions for robustness checks. This in turn requires us to compare the goodness of fit of the resulting models, i.e. of the distributions used.

[5] We prefer the triangular distribution to the normal distribution as it appears to fit the data better. First, we found the estimated values to be interchangeable between the specifications of model with restricted cost coefficient and these models provide nearly identical goodness of fit. The log likelihood (LL) of model N-ZBT, as an alternative to Model T-ZBT (LL = -618.042) in Table 5, is equal to -617.72. Second, model N-N, as an alternatives to Model T-T, could not converge, hence implying its misspecification.

5.4. Base models

We estimated three mixed logistic regression models varying in the restrictions set on the estimated coefficients, in the following form

$$V_{nit} = \beta_{Time,n} Time_{nit} + \beta_{Cost,n} Cost_{nit} + \beta_{Time\ \text{`as-now'}} Time\ \text{`as-now'}_{nit} + \beta_{Cost\ \text{`as-now'}} Cost\ \text{`as-now'}_{nit} + \beta_{Time:R2} Time_{nit}{:}R2_n. \tag{5.4}$$

Each model includes alternative-specific covariates of time and cost. The models also incorporate 'as-now' travel time and cost dummy variables, capturing bonus values for the real values of one or other of travel time and cost. Furthermore, a dummy variable (R2) interacted with the time coefficient, and referring to the Brno–Ostrava route, is included in the models as the respondents on the two routes were found to have significantly different socio-demographic characteristics (see Section 4).

All model-pairs were compared using the likelihood ratio (LR) test. It appears that the model putting no restrictions on the sign of the estimated coefficients, by following the triangular distribution, fits the data best. The other two models, which provide a similar fit, restrict the cost coefficient by zero-bounded triangular distribution to obtain only negative values, while treating the time coefficient either as restricted by following the zero-bounded triangular distribution or as unrestricted by following the triangular distribution. None of the estimated models with the cost coefficient treated as restricted identified a negative VTT, hence the results are in line with the traditional perception of travel time as wasted time. However, the model with both coefficients treated as unrestricted identified a negative VTT for one person.

Although the LR test revealed the model with the least restrictions on the coefficients' signs as providing the best fit to the data, all the estimated models give similar results. As the model with both coefficients treated as unrestricted identified a negative VTT that seems to be driven by misspecification of the model rather than being revealed by the data, our preferred specification is the model in which the time coefficient follows a triangular distribution and the cost coefficient follows a zero-bounded triangular distribution, as this in line with the underlying rational economic behavior (see Section 5.2). The results of the models are summarized in Table 5.

Table 5 also summarises the VTT resulting from the estimated models. We report mean values derived directly from the regression coefficients and standard errors calculated using the delta method. As the distributions of the VTT are skewed, we also report the median values and the first (Q1) and third (Q3) quartiles. The results are highly robust between the specifications, with the VTT being lower for the Brno–Ostrava route, as expected.

The estimated median VTT is equal to roughly 140 CZK/hour (5.4 EUR) for the Brno–Prague route and 120 CZK/hour (4.6 EUR) for the Brno–Ostrava route. These values are slightly lower than the median gross hourly wage in 2018, which amounted to 6.2 EUR[6], and similar to the corresponding net wage of roughly 5 EUR. These values are around 44 % of 2017 labor costs[7], which is remarkably close to the ratio of 0.43 reported by Wardman et al. (2016, table 6 (2001 and after, No Purp)).

[6] `https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Wages_and_labour_costs`, cited on 2. 2. 2021

[7] `https://ec.europa.eu/eurostat/databrowser/view/lc_lci_lev/default/table?lang=en`, cited on 22. 2. 2021

Table 5
Base models

	Dependent variable: Choice		
	Model 1 (ZBT^a-ZBT^b)	Model 2 (T^a-ZBT^b)	Model 3 (T^a-T^b)
Time	−0.096*** (0.010)	−0.096*** (0.010)	−0.100*** (0.010)
Cost	−0.038*** (0.004)	−0.038*** (0.004)	−0.041*** (0.004)
Time 'as-now'	0.489*** (0.092)	0.490*** (0.095)	0.502*** (0.099)
Cost 'as-now'	0.225* (0.093)	0.226* (0.094)	0.284** (0.100)
Time:R2	0.020*** (0.006)	0.019** (0.006)	0.021*** (0.006)
HR Time		0.097*** (0.015)	0.096*** (0.015)
HR Cost			0.051*** (0.006)
Observations	1,392	1,392	1,392
Log Likelihood	−617.982	−618.042	−612.812
	Value of travel time (CZK/hour)		
Brno–Prague			
– Mean (SE)	152 (7.9)	151 (7.9)	147 (7.9)
– Median (Q1; Q3)	143 (114; 216)	143 (114; 216)	135 (108; 216)
Brno–Ostrava			
– Mean (SE)	121 (6.1)	121 (6.6)	116 (7.0)
– Median (Q1; Q3)	116 (87; 178)	116 (87; 179)	110 (83; 178)

Note. Time and cost coefficients are treated either as following a zero-bounded triangular (ZBT) or triangular (T) distribution. The remaining coefficients are kept fixed (non-random).

R2 - Brno–Ostrava route; HR - Half range of the distribution; SE - Delta method standard error

[a]Distribution of time coefficient; [b]Distribution of cost coefficient

*p<0.05; **p<0.01; ***p<0.001

5.5. Models with individual-specific covariates

Since all the presented base models give similar results, Table 6 summarizes the results of a random parameters model with all the alternative, as well as individual-specific, covariates following a zero-bounded triangular distribution. The model is estimated in the following form

$$\begin{aligned} V_{nit} = {} & \beta_{Time,n} Time_{nit} + \beta_{Cost,n} Cost_{nit} + \beta_{Time\ \text{`as-now'}} Time\ \text{`as-now'}_{nit} + \\ & \beta_{Cost\ \text{`as-now'}} Cost\ \text{`as-now'}_{nit} + \beta_{Time:R2} Time_{nit}{:}R2_n + \\ & \beta_{Cost:Male} Cost_{nit}{:}Male_n + \beta_{Cost:Age} Cost_{nit}{:}Age_n + \beta_{Cost:Age^2} Cost_{nit}{:}Age_n^2 + \\ & \beta_{Time:LnIncome} Time_{nit}{:}LnIncome_n + \beta_{Time:R2:LnIncome} Time_{nit}{:}R2_n{:}LnIncome_n. \end{aligned} \tag{5.5}$$

In addition to the alternative-specific parameters of travel time, cost, and 'as-now' dummy variables, the model also incorporates individual-specific characteristics. As a non-linear trend is assumed for age and net income categories, we include the quadratic form of age categories and model net income in the form of a natural logarithm. As the respondents on the two routes were found to have significantly different socio-demographic characteristics (see Section 4), we include an interaction *Time:R2:LnIncome* capturing the difference in passengers' net income between the two routes. We do not include additional interactions for gender or age for the Brno–Ostrava route as we do not find that gender significantly affects the value of travel time, while the lower age of respondents on the route Brno–Ostrava correlates with their lower income. Any residual difference between the two routes should be captured by the generic interaction term *Time:R2* referring to the Brno–Ostrava route.

Table 6
Model with individual-specific covariates

	Dependent variable: Choice
Time	-0.069^{***} (0.015)
Cost	-0.046^{***} (0.005)
Time 'as-now'	0.514^{***} (0.100)
Cost 'as-now'	0.283^{**} (0.098)
Time:R2	0.005 (0.016)
Cost:Male	0.001 (0.002)
Cost:Age	0.010^{**} (0.004)
Cost:Age^2	-0.002^{*} (0.001)
Time:LnIncome	-0.019^{*} (0.009)
Time:R2:LnIncome	0.005 (0.011)
HR Time	0.094^{***} (0.016)
Observations	1,392
Log Likelihood	−607.622

Note. Time and cost coefficients are treated as following a triangular (T) and zero-bounded triangular (ZBT) distribution, respectively. The remaining coefficients are kept fixed (non-random).

R2 - Brno–Ostrava route; HR - Half range of the distribution

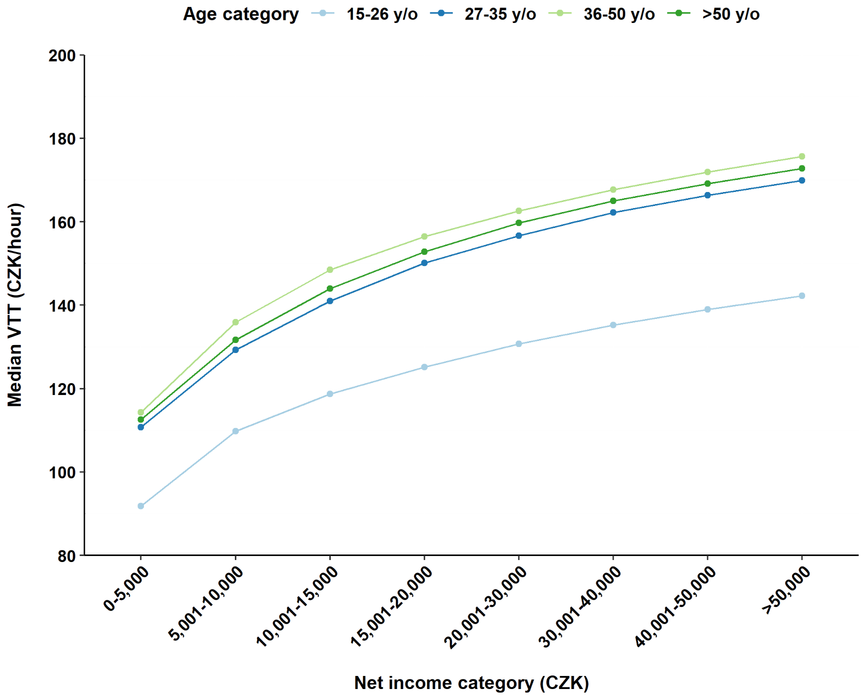
*p<0.05; **p<0.01; ***p<0.001

With the individual-specific covariates incorporated into the model, the effect of the Brno–Ostrava (R2) route disappears. While there is no evident gender effect, the VTT does seem to be significantly affected by age and net income in the expected directions. However, it is important to note that in terms of age, the only significant difference appears to be between the values for teenagers and young adults – who are for the most part (58%) students – and the values for the other age categories. The resulting values by age and net income categories are captured in Figure 1. The lowest VTT of 3.5 EUR/hour (92 CZK) is measured for the group whose monthly income is between 0 and 5,000 CZK in the 15-26 year-old age category. On the other hand, the VTT for 36-50 y/o passengers in the highest income category is almost twice as large, at 6.8 EUR/hour (176 CZK).

6. Discussion

In this study we set out to estimate the value of travel time (VTT) on two of the main train routes in the Czech Republic. The resulting median VTT is approximately 5 EUR/hour. When controlling for age and income groups, we find that the VTT ranges from less than 4 EUR/hour for teenage/younger adult low-income passengers to almost 7 EUR/hour for high-income passengers aged 27 years and above. Other studies provide similar estimates of long-distance VTT (Moravec, 2016; Škerdová, 2018; Vejrostová, 2019) or report even lower values Máca and Braun Kohlová (2019).

Figure 1
Median VTT by age and net income categories



The values of travel time officially used by the Czech Ministry of Transportation (Adamová et al., 2017) originate from the HEATCO project and are estimated from other studies based in other European countries (e.g., Shires and De Jong, 2009). In 2017, the reported values were 9.7 EUR/hour (251 CZK) and 11.5 EUR/hour (300 CZK) for long-distance non-work trips and long-commute non-work trips, respectively, and 23.1 EUR/hour (600 CZK) for work trips. Similarly, Wardman et al. (2016) use data from other countries to derive the value of time in interurban employer's business railway passenger transport in the Czech Republic as 19.2 EUR/hour (500 CZK/hour), in 2010 prices, or around 20.4 EUR/hour (530 CZK) in 2017 prices (adjusting for the change in CPI in the Czech Republic). Wardman et al. (2016) also estimate a premium for business trips, which is said to be dependent upon local income levels but not by a great amount. The premium is estimated to be around 2.3 in Norway, 2.15 in Slovakia, and 2.0 in Serbia. Using the premium of 2.15 for Slovakia, the resulting non-business value is essentially identical (9.5 EUR/hour (247 CZK)) to the value used for long-distance non-work trips in the Czech Republic, which originates from the HEATCO project (e.g. Shires and De Jong, 2009).

These values are not only substantially higher than those estimated from our data, they also exceed the median wage in the Czech Republic and the ratios between VTT and labor costs reported by Wardman et al. (2016). The question is whether our low values could be attributed to specific features of our data collection. First, our estimates are based only on SP data. However, the RP/SP ratio of 1.4 found by (Wardman et al., 2016, table 7) does not seem sufficient to account for the discrepancy. Second, we do not collect data on trip purpose. However, we collected data on routes between the three largest cities in the Czech Republic, so business trips and passengers with above-average incomes are likely to be over-represented in our sample of long-distance train passengers in the Czech Republic. Third, the VTT values might be biased if our sample is not representative. The passengers in our sample were randomly selected among real passengers travelling on the trains, so our sample of passengers should be representative of the population travelling on these trains. Unfortunately, we are not able to test this because full data on all passengers travelling on the two routes are not available. Another concern is that the VTT calculations could be contaminated by non-trading. As already mentioned, only 5.6% of respondents are cost non-traders and only 3.4% of respondents are time non-traders, so it is unlikely that our VTT values are significantly biased for this reason. Moreover, given the 2017 hourly labor costs of 11.4 EUR in the Czech Republic, our value of 5 EUR closely matches the VTT/labor costs ratio of 0.43 estimated by Wardman et al. (2016) from studies with no journey purpose (see Table 6, No Purpose).

Our results, therefore, raise doubts about general usability of VTT estimates derived from meta-studies in countries where no national study has yet been conducted and about the use of these values in appraisals of transport projects. They also reveal a pressing need for more nationally representative studies to measure key transport parameters.

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