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The disutility of driving below the speed limit on highways

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Abstract: Reducing travel speed below the highway speed limit leads to savings in fuel consumption and CO_2 emissions. However, car drivers may be reluctant to drive more slowly either because they do not want to lose time or for other reasons we refer to as 'the disutility of driving at lower speeds'. In this paper, we use a survey experiment to isolate the disutility of driving at lower speeds by comparing drivers' willingness to accept compensation for a fixed increase in travel time caused either by taking a longer route or by travelling at below-limit speeds. We show that Czech drivers require higher compensation for travelling at lower speeds than they require for the same travel time increment caused by a longer distance. This result represents the first piece of evidence showing that the disutility of driving at below-limit speeds on a highway is substantial and economically relevant.

Keywords: CO_2 emissions, highway speed, voluntary climate action, survey experiment

JEL Classification: R41, Q54, C90

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Introduction

The transport sector contributes significantly to the production of greenhouse gases. According to the European Union, transport generates almost 30% of all carbon dioxide emissions. Passenger cars produce most of that CO2, accounting for more than 60% of total transport emissions (European Parliament, 2019). Emissions of greenhouse gases and other pollutants from vehicles are affected by speed (Van Benthem, 2015). While the emission benefits of stricter speed limits on local roads (e.g. reducing from 50 to 30 km/h) are unclear, reducing speed limits on highways (e.g. from 90 to 80 km/h for heavy goods vehicles or from 130 to 110 km/h for passenger cars) would lead to substantial benefits (Panis et al. 2011, EEA 2020). Driving at lower speeds on the highway could therefore be considered as one way of taking voluntary action beneficial to the environment.

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Drivers may choose to drive at the highway speed limit in order to save time or to avoid driving at lower speeds for other reasons; we refer to these latter reasons collectively as the *disutility of driving at lower speeds*. We use a survey experiment to identify this disutility of driving at lower speeds. The experiment compares drivers' willingness to accept compensation (WTA) for the same travel time increment caused either by an increase in distance or by a reduction in speed. The disutility of driving at lower speeds is measured as the extra compensation drivers require for lost time due to travelling at a below-limit speed compared to losing the same time while travelling at the limit speed. If the disutility is sizeable, it might be an important cost to consider when imposing a speed restriction. To improve the generalizability of our results, we test two different scenarios: a long one-off trip and a short daily commute.

We find that a higher compensation is required for a time loss resulting from lower travelling speeds than for the same time loss resulting from a longer distance in both scenarios. The required compensation is 50% higher for long one-off trips and 95% higher for a short daily commute. This result suggests that the disutility of driving at below-limit speeds on a highway is substantial and economically relevant. This disutility seems to be caused by a general dislike of travelling slowly on highways; safety or time management reasons are less important. This offers a possible explanation for why a large share of passenger cars travel at high speeds despite the substantial economic and environmental benefits of slowing down.

Our contribution is closely related to the literature that estimates the value of travel time. The theory behind time valuation dates back to Becker (1965) and DeSerpa (1971) who derive the concept from consumers' choice of time allocation in the context of utility maximization subject to a money and time constraint. Most empirical studies estimate the value of time for car drivers and passengers in general (Shires and de Jong 2009, Abrantes and Wardman 2011, Kouwenhoven et al 2014, Börjesson and Eliasson 2014, Wardman et al. 2016, Batley et al 2019, Goldszmidt et al. 2020, Buchholz et al. 2020) or car passengers in autonomous vehicles in particular (Kolarova et al. 2019, Zhong et al. 2020). A closely related result found in this literature is that the value of time is higher in traffic jams than in freely flowing traffic. For example, Wardman et al. (2016) estimate the value of time of a smooth ride at €6.51 per hour and of a ride in heavy traffic at €9.25. Similarly, the disutility of driving at below-limit speeds would translate into a higher value of travel time savings at below-limit speeds compared to the limit speed. We are, to our knowledge, the first to test the existence of a disutility of driving at lower speeds on the highway.

We also contribute to the literature that discusses the costs and benefits of different speed limits (Van Benthem 2015; Tscharaktschiew 2020, Ang et al. 2020, de Albornoz et al. 2022). If people derive utility from driving at high speeds, the benefits of a speed limit increase should be higher than the value of travel time savings.

Experimental design and procedures

We designed a survey experiment with two treatments (Q1 and Q2) administered between subjects. These treatments consist of two hypothetical scenarios. We elicit our respondents' willingness to accept (WTA) compensation for: a) in Q1, driving at a speed of 110 km/h rather than at the highway speed limit of 130 km/h; or b) in Q2, taking a longer route. In both scenarios, the proposed change results in the same time loss. The WTA elicitation is justified by expected monetary savings, since reduced speed leads to lower fuel consumption in Q1 and the detour avoids a tolled section of the road (tunnel) in Q2.

Each treatment elicits WTA for two different trips (within subject): 1) a *long trip* with a route of 190 km, most of it on the highway. Driving at 110 km/h or taking the toll-free detour would prolong the trip by 15 minutes, from 105 to 120 minutes; and 2) a *daily commute* with an original route of 14 km, of which 10 km is on the highway, where speed reduction or the toll-free detour would prolong the trip from 8 minutes to 8 mins and 45 seconds. For the daily commute, we elicit the WTA for a year of commuting. The values elicited by means of multiple price lists (MPLs) are displayed in Table 1.

Table 1: Multiple price lists and the corresponding WTA values

Long trip		Daily commute	
Willing to reduce speed/take a detour for	WTA (CZK)	Willing to reduce speed/take a detour for	WTA (CZK)
0 CZK	0	0 CZK	0
15 CZK	7.5	200 CZK	100
30 CZK	22.5	400 CZK	300
45 CZK	37.5	600 CZK	500
60 CZK	52.5	800 CZK	700
75 CZK	67.5	1000 CZK	900
90 CZK	82.5	1400 CZK	1200
105 CZK	97.5	1800 CZK	1600
120 CZK	112.5	2200 CZK	2000
150 CZK	135	2500 CZK	2350
Not even for 150 CZK	150	Not even for 2500 CZK	2500

The order of the trip types is randomized, resulting in four different versions of the questionnaire Q1A or Q1B, and Q2A or Q2B, where A labels the order with the long trip first and short commute second, and B labels the order with the short commute first and the long trip second.

All other components of the hypothetical scenarios are the same: all respondents drive a car common in the Czech Republic (Škoda Octavia 1.4 TSI) on a highway with two lanes in each direction with a smooth surface and no restrictions. There is little traffic on the highway, which allows the driver to travel most of the way at any speed without having to overtake slower cars or dodge faster ones.[4]

[4] The setup maximum speed of 130 km/h corresponds to the Czech setup and is also relevant for other European countries. 8 out of the 10 most populous countries in the EU have a speed limit on motorways of 130 km/h or more. The only exceptions are Spain and Belgium, where the limit is 120 km/h. In smaller countries, lower speeds limits are more common, but this often reflects the quality of the road network. The only two countries with a motorway speed limit of 110 km/h are

Additionally, the questionnaires contained several socio-demographic questions (gender, age, net income) and other questions about driving on the highway. These enable us to find out, for example, at what average speed the respondents usually drive on the highway and whether, and for what reasons, they would ever drive on the highway at a speed of 110 km/h. These questions were identical for both questionnaires. See the Appendix for the full questionnaire.

The questionnaire responses were collected online in the spring of 2021 from Czech respondents. The randomization was performed via a common link that automatically directed equal numbers of respondents to each of the four versions of the questionnaire. We collected a total of 172 observations, but subsequently removed 13 observations in which respondents answered “not at all clear” or “rather unclear” to the question “Was this questionnaire clear?” (Q11 in the Appendix).

As shown in Table 1, the WTA values are set at the mid-points between the accepted value of compensation and the value on the previous line.[5] The corner choices are coded as follows: if the choice is 0 CZK, the WTA value is equal to zero; if even the maximum amount is not accepted, the WTA value is equal to the maximum amount of compensation offered (150 CZK or 2,500 CZK). Since the corner choices are present in our data (see the bottom of Table 2), our analysis will use the Tobit model to account for censoring in our data.

Table 2 summarizes the remaining 159 observations, divided between the four versions of the questionnaire administered between subjects. The variables AgeY and IncomeH are dummy variables indicating participants younger than 27 years and those with net monthly income above 30,000 CZK, respectively. The table shows that we have a young sample of respondents with a slight overrepresentation of women. The relatively young age and student status of some of our respondents correspond with the low share of people with net income above 30,000 CZK, which corresponds to the average income in the Czech Republic in the second quarter of 2021[6]. The share of young participants is lower in Q2B and the share of participants with the above-average income is lower in Q2A, but none of the differences in gender, age or net income is statistically significant.

Results

Table 2 shows that our participants require higher compensation for time loss due to speed reduction from 130 to 110 km/h (Q1) than for the same time loss caused by taking a longer, toll-free route (Q2). This is true for both long trips and short repeated commutes. When comparing questionnaires 1 and 2 for a given order using the Mann-Whitney U test, all four pairs provide statistically significant differences (long trip Q1A and Q2A: $p = 0.004$; long trip Q1B and Q2B: $p = 0.005$; short commute Q1A and Q2A: $p = 0.0008$;

Sweden and Estonia.

[5] The use of the mid-points can be justified as follows. Suppose a respondent is willing to accept a speed reduction for 75 but not for 60 CZK. Assuming each value between 60 and 75 is equally likely, the expected WTA equals to the mid-point of 67.5 CZK.

[6] The net income is calculated from the gross income statistic by applying the basic tax rate (https://www.czso.cz/csu/czso/ari/average-wages-2-quarter-of-2021 [cited on 2022-02-17]).

short commute Q1B and Q2B: $p = 0.04$). The effects are not only statistically significant but also economically substantial. The disutility of driving at lower speeds is relatively larger compared to the WTA for a longer route (Q2). Lower speed increases the WTA by more than 50% for a long trip, as the mean WTA is 92.7 CZK in Q1 and 60.7 CZK in Q2, and by 95% for a short commute, as the mean WTA equals 1208 CZK in Q1 and 619 CZK in Q2.

Table 2: Summary statistics

Variable *mean (s.d.)*	Q1A	Q1B	Q2A	Q2B
Socio-economic variables:				
Female	0.543 (0.504)	0.525(0.506)	0.541 (0.505)	0.528 (0.506)
Age below 27 years (AgeY)	0.587 (0.498)	0.525 (0.506)	0.568 (0.502)	0.417 (0.5)
Net monthly income > 30,000 CZK (IncomeH)	0.283 (0.455)	0.25 (0.439)	0.135 (0.347)	0.222 (0.422)
Willingness to accept (WTA):				
WTA long trip (CZK)	90 (52.0)	95.8 (52.6)	58.2 (41.8)	63.3 (46.9)
WTA short commute (CZK)	1209 (959)	1206 (947)	482 (630)	758 (809)
Left/right censored WTA:				
● Long trip	4/12	8/8	3/2	4/3
● Short commute	8/8	5/14	9/1	4/5
Number of observations	46	40	37	36

The values measured for the long-trip scenario correspond to a 15-minute delay. The per-hour value of lost time while driving at 130 km/h then equals 243 CZK/hour, which is remarkably similar to the value of travel time of 222 CZK/hour estimated by Máca and Braun-Kohlová (2019) for drivers on the route between Brno and Prague. The disutility of driving at lower speeds than 130 km/h equals 128 CZK per hour of lost time. Interpretation of our results for the short-term scenario is more problematic, given that we did not explicitly state the number of commutes per year. Counting with 440 commutes (two trips per working day, 250 working days per year, 30 days of holiday), the total time lost due to the lower driving speed is 5.5 hours (440 times 45 seconds). This corresponds to a substantially lower value of time of 112 CZK per hour of time lost while driving at 130 km/hour and to a per-hour disutility of driving at lower speeds of 107 CZK.

Models 1 and 3 in Table 3 report the same results in Tobit regressions with additional variables controlling for small imbalances in gender, age and income between the treatment groups. The Q1 variable, which measures the *disutility of driving at lower speeds* (the difference between WTA in Q1 and WTA in Q2, shown by the constant), is highly significant in both models. Once we estimate the same models with order B (we do not report these regressions in this paper for the sake of brevity), that significance remains in model 1 ($p < 0.0001$), but not in model 3 ($p = 0.08$).

Our findings are robust to alternative specifications and several additional data restrictions. We find very similar results if instead of AgeY and IncomeH we control for all four age intervals and eight net-income intervals in our regressions (see Q3 and Q4 in the Appendix). The results also hold if we exclude 26 participants who usually travel on highways at speeds equal to or lower than 110 km/h, or even if we exclude 59 participants who drive at speeds equal to or lower than 120 km/h. The results are also qualitatively similar if we exclude 20 participants who state that they never drive on highways, or if we exclude the 5 participants who state they always travel at the last minute and do not have enough time to slow down (see Q6, Q7 and Q8 in the Appendix).

Table 3: Tobit regressions explaining the WTA

	Long commute		Shorter commute	
Variable	Model 1	Model 2	Model 3	Model 4
Q1	37.776***	–20.418	873.149***	144.855
	(14.648)	(22.418)	(253.689)	(405.105)
Order A	6.105	5.027	427.557	395.586
	(15.319)	(13.464)	(266.019)	(244.202)
Q1 * Order A	3.687	7.342	–422.939	–378.855
	(21.069)	(18.677)	(360.717)	(244.202)
Female	–23.566**	–1.849	–611.94***	–310.327***
	(11.26)	(10.763)	(192.028)	(189.653)
AgeY	–18.257	–17.971	57.007	63.754
	(11.688)	(10.353)	(198.409)	(182.420)
IncomeH	14.221	8.347	306.584	227.109
	(13.969)	(12.496)	(235.436)	(217.891)
Annoyed		13.347**		211.348**
		(5.722)		(103.82)
Q1 * Annoyed		17.296**		198.937
		(7.237)		(128.191)
Const	57.314***	16.400***	549.240	–72.732
	(13.906)	(19.213)	(238.421)	(348.786)
Observations	159	159	159	159
Left censored	16	16	27	27
Right censored	31	31	21	21

*Note: Standard errors in parentheses. Significance: *p<0.1, **p<0.05, ***p<0.01*

Interestingly, the statistical significance in models 2 and 4 disappears altogether once we control for Q9 (the *Annoyed* variable), which measures how annoyed participants would be by reducing their speed to 110 km/h (a Likert scale ranging from 1 = not at all to 5 = very). In Q10, we also inquired about the respondents' reasons for this disutility. The most common answers (multiple answers were accepted) are either "nothing" (36% of all participants) or described disutilities arising from the lower speed, such as that they don't like driving that slowly (38%), or that they would have to evade faster vehicles if they want to drive in the left lane at that speed (26%). Reasons related to safety are less common (8%) as are those related to travelling without any time buffer (8%). Taken together, these findings provide compelling evidence for the existence of disutility associated with driving at reduced speeds on the highway.

Conclusion

This paper studies whether people experience disutility related to driving on a highway at a speed substantially below the legal speed limit. Using a survey experiment, we find that journey time loss must be compensated more when it is caused by a lower driving speed than when it is caused by taking a longer route. This effect is large and statistically significant: the required compensation is more than 50 % higher for a one-off long trip and 95 % higher for a regular short commute.

These results could explain why people rarely reduce their speed to below the highway limit in the Czech Republic even though this would be a relatively cheap way of engaging in climate-beneficial behaviour. Of course, it is also possible that Czech drivers take the speed limit as an instruction, perhaps out of habit, or are not aware of the potential ecological benefits or monetary gains of lowering their speed.

The disutility is also economically important. To put these values in context, we take advantage of the structure of costs and benefits estimated by Van Benthem (2015) using the US speed limit changes from 1987. The benefits of $156 million equal the value of travel time savings approximated by the after-tax average wage. Using the more conservative 50% increase, we can calculate that the utility of driving at higher speed would amount to $78 million. This is larger than the cost of gasoline and the external cost of greenhouse gas emissions, as measured by Van Benthem, combined.

We need to be careful when interpreting our results in the context of universally enforced speed restrictions. The value of the disutility measured in this study might overstate the negative effect of such a speed restriction for at least two reasons: First, our experiment studies a unilateral speed reduction. A commonly stated reason for respondents' reluctance to slow down is that they would have to avoid faster cars in the left lane. This would not apply if the speed restriction were applied universally. Second, our questionnaire is hypothetical, and therefore open to strategic answers (Carson and Groves 2007). Respondents who oppose such restrictions and believe that the results of our study could inform policy discussions might overstate the negative value of driving at lower speeds. On the other hand, it is possible that our estimates would be higher if we had a representative sample with respect to income. Any potential decisions about speed limits should be therefore informed by a representative survey involving scenarios whose details are closely related to the proposed policy.

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Appendix

Questionnaire 1 (Q1)

Long trip

Imagine driving a Škoda Octavia 1.4 TSI (year of manufacture 2015) to a destination 190 km away. The whole route (with the exception of a few kilometers at the beginning and end) is along a two-lane highway with a smooth surface and without closures. There is little traffic on the highway (no traffic jams), so you can drive most of the way at any speed without having to overtake slower cars or dodge faster ones.

If you drive on the highway at the maximum legal speed of 130 km/hour, the journey will take you 1 hour and 45 minutes. If you drive at 110 km/hour, you will consume less petrol but the journey will take 15 minutes longer, i.e. 2 hours in total.

How much would you have to save on petrol to be willing to drive at 110 km/hour on the highway all the way?

The decision sheet below shows possible amounts you could save if you drive at 110 km/hour. Please select the lowest amount for which you would be willing to drive on the highway at a speed of 110 km/hour.

Short commute

Imagine commuting 14 km from where you live to work every day, by car. You drive a Škoda Octavia 1.4 TSI yourself (year of manufacture 2015). 10 km of the route leads along a two-lane highway with a smooth surface and without closures. There is little traffic (no traffic jams) on the highway when you drive to and from work. So you can drive most of the way at any speed without having to overtake slower cars or dodge faster ones.

If you drive at the maximum legal speed of 130 km/hour on the highway, the journey will take you approximately 8 minutes. If you drive at 110 km/hour, you will consume less petrol but each of your journeys will take three quarters of a minute longer.

How many crowns would you have to save per year to be willing to drive to work at a speed of 110 km/hour?

The decision sheet below shows amounts you could save if you drive at 110 km/hour. Please select the lowest amount for which you would be willing to drive on the highway at a speed of 110 km/hour.

Questionnaire 2 (Q2)

Long trip

Imagine driving a Škoda Octavia 1.4 TSI (year of manufacture 2015) to a destination 190 km away. The whole route (with the exception of a few kilometers at the beginning and end) leads along a two-lane highway with a smooth surface and without closures. There is little traffic on the highway (no traffic jams), so you can drive most of the way at any speed without having to overtake slower cars or dodge faster ones.

If you drive on the highway at the maximum legal speed of 130 km/hour, the journey will take you 1 hour and 45 minutes. There is a tunnel with a road toll on the planned route. If you take a detour around this tunnel, you will not have to pay the toll, but your journey will take 15 minutes longer, i.e. 2 hours in total.

How many crowns would it have to cost to go through the tunnel (how many crowns would you have to save) to be willing to take the detour around the highway tunnel?

The decision sheet below shows possible amounts you could save if you bypass the highway tunnel. Please choose the lowest amount for which you would be willing to take a detour to avoid the tunnel.

Short commute

Imagine commuting 14 km from where you live to work every day, by car. You drive a Škoda Octavia 1.4 TSI yourself (year of manufacture 2015). 10 km of this route leads along a two-way highway with a smooth surface and without closures. There is little traffic (no traffic jams) on the highway when you drive to and from work. So you can drive most of the way at any speed without having to overtake slower cars or dodge faster ones.

If you drive at the maximum legal speed of 130 km/hour on the highway, the journey will take you approximately 8 minutes. There is a tunnel with a road toll on the planned route. If you take a detour around this tunnel, you will not have to pay the toll, but each of your journeys to and from work will take three quarters of a minute longer.

How many crowns would the annual fee for passing through the tunnel have to cost (how many crowns would you have to save) for you to choose to take the detour around the highway tunnel?

The decision sheet below shows possible amounts you could save if you bypass the highway tunnel highway all year round. Please select the lowest amount for which you would be willing to take a detour to avoid the tunnel.