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The private (unnoticed) welfare cost of highway speeding behavior from time saving misperceptions

Stefan Tscharaktschiew

Technische Universität Dresden, Institute of Transport & Economics, Dresden 01062, Germany

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ABSTRACT

Our daily routines are cluttered with intuitive trade-offs, judgments and decisions. Unfortunately, even in case that individuals are aware of the fact that there might be potential sources of misperceptions, intuitive behavior within routines may lead us to biased judgments. As regards transport, research has demonstrated that many car drivers are subject to a 'time saving bias', reflecting the failure of individuals to correctly predict the right potential of speed to save journey time. The resulting overestimation of the time saving benefit from speeding leads travelers to drive faster than privately optimal and, as a consequence, causes excessive costs in particular due to higher fuel consumption and accident risk, thereby reducing personal well-being. This paper develops a framework to determine the individual welfare cost of (the private willingness to pay to avoid) the 'time saving bias' and exemplarily uses highway data for Germany to calculate the magnitude of the bias. We find that if novice drivers were aware of the bias and expect to travel a moderate annual highway kilometrage over their lifetime as active drivers, they could be willing to pay a cash-equivalent of around €500–1500 in order to avoid the bias, e.g. either by novel car equipment (inverted speedometer, autonomous car technology) or in the form of driving school training programs. If the avoidance of the bias could be realized by the latter, a mark-up of at least roughly one-third (but more likely two-thirds) on regular total driving school fees would be justifiable on average. On a per kilometer basis, the individual cost is in the order of at most 1.2 €-cents/km (upper bound prior to revenue recycling/use) for a representative driver. In the presence of costs of early or late arrival (schedule delay) it is far below 1.2 €-cents/km. Surprisingly, when additionally account is taken of tax revenue recycling due to excess fuel consumption, the individual burden due to the bias vanishes.

1. Motivation

Our daily routines are cluttered with intuitive trade-offs, judgments and decisions. Unfortunately, even in case that individuals are aware of the fact that there might be potential sources of misperceptions, intuitive behavior within routines may lead us to biased judgments (Gilovich et al., 2002; Kahneman and Tversky, 1973; O'Donoghue and Rabin, 1999; Svenson, 2009; Tversky and Kahneman, 1974). Moreover, recent findings from behavioral-decision research provide evidence that people are prone to systematic biases and therefore are in fact not always able to choose what yields the best outcome. People often fail to choose optimally, either because they fail to predict accurately which option in the available choice set will generate the best result or because they fail to base their choice on their e.g. evaluations of related previous experiences, or both (Hsee and Hastie, 2006; Thaler, 2016). Beyond doubt, choices or decisions about traveling (e.g. departure time from home in the morning, choice of travel mode, route choice, shopping nearby the residence or far away from home) are omnipresent in modern life. As regards traveling by car, when choosing their desired speed, drivers trade off additional private costs of driving faster against individual benefits (in particular time savings). As long as the costs and benefits of speeding are correctly appraised, drivers can be expected to choose privately optimal speed levels.[1] However, once drivers misperceive the actual impacts of driving speed such that one or more components of this trade-off are biased, they will choose speed levels that deviate from their privately optimal (utility maximizing) speed.

Research on average speed estimation indicates that people tend to make fundamental errors in calculating average speed (Lann and Falk, 2006; Svenson and Salo, 2010). This is because average speed is not simply the mean of two distinctive speed measurements, but the distance-weighted mean. Because of the tendency to misestimate the average speed of two journeys, it is not difficult to imagine that errors may also exist when trying to estimate the difference in journey times when trips are traveled at different speeds. Indeed, by conducting well-controlled experiments, research has demonstrated that many drivers

E-mail address: stefan.tscharaktschiew@tu-dresden.de.

[1] Importantly, this does not mean that they also choose a socially desirable speed level (see the discussion in the concluding section).

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are subject to a 'time saving bias', reflecting the failure of individuals to correctly predict the right potential of speed to save journey time (Eriksson et al., 2013, 2015; Fuller et al., 2009; Peer, 2010a, 2010b, 2011; Peer and Rosenbloom, 2013; Peer and Solomon, 2012; Svenson, 1970, 1971, 1973, 2008, 2009).

The 'time saving bias' arises when drivers fail to recognize the inverse relationship between speed and travel time, assuming that this relationship is (more) linear instead. For example, assuming a trip of 100 km length, then an increase in speed from 30 to 40 km/h will save 50 min of travel time (TT at 30 km/h: 200 min; TT at 40 km/h: 150 min). In contrast, increasing speed from 130 to 140 km/h saves only 3 min of travel time (TT at 130 km/h: 46 min; TT at 140 km/h: 43 min). Clearly, the marginal impact of speed to save journey time is smaller at higher speeds, leading to false estimations when assuming that the marginal effect is constant over the whole speed range. Svenson (1970) was the first to show that individuals are subject to a biased perception of the true inverse relationship between speed and travel time.[2]

The misleadingly assumed linearity implies that drivers overestimate potential time savings when increasing speed from an already high initial speed level. If (economic) motives such as reducing travel time and the cost of being late dominate, then the overestimation of the time saving benefit from speeding distorts speed choices towards higher speeds and, as a consequence, may cause excessive costs due to e.g. higher fuel consumption and accident risk, thereby reducing personal well-being. Interestingly, the analyses of Peer and Solomon (2012) and Svenson (2009) suggest that the existence and to some extent also the magnitude of the bias are quite robust even across heterogeneous individuals, more specifically, experience, formal education and training in physics/engineering do not eliminate the bias and thus do not avoid inappropriate speed choice due to the bias.

Apart from driving speed choice, the 'time saving bias' also emerges in other fields. Svenson (2008) shows that the bias can also be present in the planning of health care, to be exact in decisions about which one of two clinics to reorganize to save more of a doctor's time for personal contacts with patients. This generalization of the bias describes people's overly optimistic forecasts about the time a task or a project will need to be completed (see also Svenson, 2011 and Svenson et al., 2014 for related studies on a firm's resource savings following an increase in production speed). Besides, de Langhe and Puntoni (2016) point to the existence of the 'time saving bias' in consumer decision-making. Marketplaces are replete with productivity metrics that relate units of output to one unit of time (e.g. megabits per second). They find that consumers have incorrect intuitions about the impact of productivity increases on time savings, i.e. they do not sufficiently realize that productivity increases at the high end of the productivity range imply smaller time savings than productivity increases at the low end of the productivity range. Peer (2014) shows that the willingness to pay to use toll roads does not necessarily correspond to time savings when using such roads. In this study (hypothetical) road users were willing to pay, on average, considerably more for toll roads that offered increases from relatively higher speeds than for toll roads that offered increases from lower speeds, although the latter actually saves more time than the former.

These examples can be considered as the mirror picture of the driving speed choice related 'time saving bias'. As regards driving speed, the bias leads to e.g. excess accident risk while in the other cases it (i) induces decisions of improving an already fast health care unit instead of a slower unit with a greater potential to become overall more effective, (ii) causes a biased excess willingness to pay for products and services that offer productivity increases based on an already high productivity level, or (iii) results in an overpayment when toll roads offer increases in speed from relatively high initial speed levels and underpayment when toll roads offer increases from lower initial speeds.

Despite the various fields the 'time saving bias' can basically evolute, behavioral research has mainly focused on its relation to driving speed choice. Surprisingly, although the bias has been found to be one of the most influential factors in explaining individual speeding behavior,[3] to the best of our knowledge, no attempt has been made to provide an economic assessment of the 'time saving bias' and to calculate its excessive costs. Against this background, by developing an economic model of individual speed choice and speeding behavior, and applying the approach exemplarily to the case of Germany, this paper links research strands from several directions related to speed choice[4] and estimates the individual welfare cost highway drivers face due to the 'time saving bias' (put differently the willingness to pay to avoid the bias). In doing so the study makes the 'time saving bias' for the first time economically visible and e.g. complements recent research on novel car equipment aiming at debiasing a driver's time saving misperception. It also contributes to general economic decision theory by showing how and at what cost behavioral anomalies can evolve in the field of transportation.[5] In the present model a representative driver chooses (optimal) speed levels to maximize utility by trading off speed induced changes in fuel consumption and accident risk against changes in time costs (travel time savings and scheduling delay). The 'time saving bias' distorts speed choice which causes a deviation from the private optimum and, as a consequence, reduces utility. In order to assess the reduction in utility quantitatively, we derive a wide range of relevant representative travel data and rely on empirically verified relationships between speed and its impact on the costs and benefits of traveling.

The remainder of the paper is organized as follows: Section 2 describes the model, derives the condition for the privately optimal speed choice and explains how misperceptions in regard to travel time savings affect this choice. In Section 3 we calculate a highway driver's welfare cost associated with the 'time saving bias' using data for Germany. Finally, Section 4 evaluates and discusses the quantitative finding and outlines need for further research.

2. The model

To demonstrate the (economic) consequences of the 'time saving bias', we build upon the basic idea of Loewenstein et al. (2003) who formalized another behavioral distortion, the so-called 'projection

[2] In the seminal paper students were confronted with sets of stimulus slides, each containing an initial speed, a higher speed and the travel distance. Students were asked to estimate the time that can be saved when traveling at higher speed, compared to the initial speed. Importantly, the time students had to complete the task did not allow them to make formal calculations (see also Peer, 2011).

[3] Even more influential than sociodemographic variables such as age, gender, education or income, and former involvement in road crashes (Peer, 2011). Interestingly, even if drivers are characterized by the desire to experience thrill and sensation from speeding, the 'time saving bias' is nevertheless found to have a stronger role in explaining speeding behavior (Peer and Rosenbloom, 2013).

[4] The literature dealing with various facets of speed choice is predominantly concerned with the manifold economic and environmental implications and the impacts on traffic safety (e.g. Abdel-Aty et al., 2006; Ashenfelter and Greenstone, 2004; Bolderdijk et al., 2011; Castillo-Manzano et al., 2014; Delhaye, 2006; Delhaye et al., 2007, 2015; Dementyeva and Verhoef, 2016; Elvik, 2013; Friedman et al., 2007; Liu et al., 2015; Madireddy et al., 2011; Nitzsche and Tscharaktschiew, 2013; Ossiander and Cummings, 2002; Patterson et al., 2002; Rietveld and Shefer, 1998; Rotemberg, 1985; Tarko, 2009; van Benthem, 2015; Van Ommeren and Dargay, 2006; Verhoef and Rouwendal, 2004; Wong et al., 2005). The behavioral research strand comes from psychology and mainly focuses on rationales and personality traits related to speeding behavior (De Pelsmacker and Janssens, 2007; Haglund and Åberg, 2000; Schmidt-Daffy, 2014; to name only a few in addition to the papers of e.g. Fuller et al., 2009; Peer, 2010a; Svenson, 2009 mentioned above).

[5] Another rare integration of behavioral biases into transportation science provides the study of Koster et al. (2015). They show how limited cognitive abilities of commuters (e.g. limited memory of past travel times, difficulty in retrieving more distant experiences of commutes, expectations base upon exogenous anchors) may result in sub-optimal scheduling decisions.