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Value of Time – A Citizen Perspective

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Abstract
The dominant empirical approach to infer Value of Time is based on experiments in which respondents are typically asked to make hypothetical travel choices as if they were paying travel costs from their own budget, in exchange for personal travel time gains. However, many scholars have argued that such travel choice decisions of individuals in their role of consumer of mobility are likely to be a poor proxy of how they in their role of citizen believe government should spend tax money to generate travel time gains for large numbers of travelers. So far, this possible deviation between what we call 'consumer VoT' and 'citizen VoT' has not been studied empirically. In this paper, we fill this gap, by designing a Stated Choice experiment with eight different frames; some representing a typical consumer choice situation, others gradually approaching a citizen perspective. We find that individuals' willingness to pay from previously collected tax money for travel time gains created by a government policy, is significantly higher than their willingness to pay, from their after tax income, for time gains obtained by choosing a different route. This result implies that citizen VoT is higher than consumer VoT. This difference does not stem from a stronger willingness to spend previously collected tax money compared to spending one's own income, but from a difference in the value attached to travel gains: a travel time gain resulting from government action is valued more than the same travel time gain obtained by one's own route choices. This and a range of other empirical results are discussed in depth, in light of the conceptual differences between preferences of individuals in a role of consumer or citizen.

1. Introduction

Without a doubt, the notion of a traveler's Value of Time (VoT) is one of the most important and well-researched concepts in transport economics. VoT is a key ingredient of Cost-Benefit Analyses of transport policies and infrastructure projects; it transforms travel time gains, which often constitute the large majority of benefits of policies and projects, into monetary benefit estimates which allows for a consistent comparison with project costs. Since the advent of choice models and stated choice (SC) data collection methods in the mid-1970s, hundreds, if not thousands, of SC-studies have been undertaken to derive travelers' marginal rate of substitution between travel time and travel costs (e.g. Abrantes and Wardman, 2011; Mackie et al., 2001). In the overwhelming majority of such experiments, individuals are asked to make a choice between different travel options with different travel times and travel costs (e.g. Axhausen et al., 2006; Börjesson and Eliasson, 2014; Ehreke et al., 2014; Fosgerau et al., 2007; Kouwenhoven et al., 2014; Mackie et al., 2003; Ramjerdi et al., 2010; UK Dept. for Transport, 2015). Crucially, in these experiments travelers are asked to make these choices as if they were paying travel costs from their own budget (whereas transport projects are paid by taxes), and as if the travel time is only experienced by themselves (whereas the benefits of projects are typically experienced by large numbers of travelers).

This so-called consumer sovereignty-based approach to estimate the monetary value of non-market goods such as travel time gains, has been contested by several economic-philosophers (e.g. Ackerman and Heinzerling, 2002, Kelman, 1981, Marglin, 1963, Nyborg, 2012; Sagoff, 1988; Sunstein, 2005). These scholars argue that decisions of individuals in their role as *consumers* (such as those observed in conventional SC-experiments into VoT) are likely to be a poor proxy of how the same individuals in their role as *citizens* believe that government should allocate tax payers' money. Critics of this 'citizen sovereignty-based approach' have in turn argued that although its supporters showcase a parade of appealing real world examples in which the assessment of an individual in her role as a consumer clearly deviates from the assessment in her role as a citizen, they fail to provide a convincing alternative for an assessment of government projects based on micro-economic theory (Hanley, 2009).

We observe that the heated debate concerning the usefulness of the 'consumer sovereignty-based approach' and the 'citizen sovereignty-based approach' for policy appraisal, has so far been purely normative. Especially arguments supporting the latter approach are based on thought experiments and normative value judgements. It is striking that so far, no empirical evidence has been put forward which scrutinizes whether 'consumer values' in fact *differ* from 'citizen values'. Also for the VoT it is unclear if and to what extent an individual's trade-off between time and money for her personal travel (i.e., her consumer VoT) would differ from her beliefs concerning how government should trade-off travel time and tax money when evaluating transport policies (i.e., her citizen VoT). In this paper, we fill this gap, by means of collecting and analyzing travel choice data in a series of carefully constructed SC experiments. More specifically, by careful use of wording in the experimental set-up, we are able to frame choice tasks as either a typical 'consumer' choice, a typical 'citizen' choice, and several in-between framings. Choice models are then estimated, and the implied VoTs obtained from these estimations are compared across frames. As we will show, this leads to valuable empirical – as opposed to normative – insights into the presence and meaning of differences between consumer- and citizen-VoTs.

Crucially, throughout this paper we adopt a completely agnostic standpoint regarding the above mentioned *normative* debate concerning whether 'consumer VoTs' or 'citizen VoTs'

should be used in evaluating transport policies. We merely aim to add *empirical* knowledge about the actual difference between these VoT-notions, which may help guide and shape this debate in the future. In section 2, we conceptualize and operationalize our different framings of consumer- and citizen-VoT. Section 3 discusses data collection and analysis. Subsequently, we present and interpret results in section 4. In section 5, we draw conclusions and raise further topics for discussion.

2. Conceptualization and operationalization of consumer- and citizen-VoT

In the broader Economics literature, it has been well-established that preferences of individuals in their role as consumers are restricted by their budget constraints (e.g. Fuguitt et al., 1999; Sagoff, 1988). In other words, observing consumer preferences involves observing how individuals allocate their after-tax income in (hypothetical) markets (Sagoff, 1988). On the contrary, observing preferences of individuals in their role as citizens involves observing their behavior in public social life (e.g. Kelman, 1981); individuals display their preferences as citizens supporting or opposing government policies in public spheres like elections, referenda, demonstrations and social media, etc. Although an analysis of the expressions of individuals in these public spheres is useful for eliciting the attitudes of citizens towards government policies, citizens' Willingness to Pay for specific aspects of a policy (e.g. her VoT in the context of a particular transport policy) cannot be directly derived from these expressions. To enable the derivation of citizen-VoT and facilitate a direct comparison with consumer-VoT, we adopt the SC data collection paradigm as one single empirical approach for both the citizen- and consumer-perspectives on VoT. Although the literature discusses many shortcoming of stated-preference surveys (e.g. Diamond and Hausman, 1994) there is considerable evidence for the external validity of the application of this approach in the transport domain. Louviere (1988) demonstrates that the predictions of models developed from SC studies correlate well with the observed behavior of aggregates of real people other than those who were studied. Moreover, regarding Value of Time studies, Wardman (1998) observed an encouraging level of similarity between Values of Time based on stated choices and revealed choices in a review of 105 British Value of Time studies.

Under the generic stated choice methodological umbrella, we carefully and systematically frame binary discrete choice tasks in a way that allows us to distinguish between consumer- and citizen-VoTs and in-between variants. Given the subtle nature of the framings, and also given that little guidance is available in the literature concerning the citizen frames, we performed an extensive pretesting of our survey, which involved pilot experiments and focus groups where respondents were interviewed about their understanding and perception of the different frames, and were explicitly asked if particular frames made sense to them. Since participants considered binary choice settings in which one of the alternatives represents the status quo to be the most meaningful and realistic design for the citizen frames, we adopted this format in our study. This format is also used in other important previous Value of Time studies such as the UK Value of Time study (e.g. Mackie et al., 2003; Ojeda-Cabral et al., 2016). Moreover, this format is one of the most commonly used preference elicitation formats and has a long history of use in survey research (Carson and Groves, 2007). We aspired to design frames that are incentive compatible, in the sense that a truthful response to the actual question asked constitutes an optimal strategy for the respondent (Carson and Groves, 2007). Our frames of citizen-VoT are inspired by three different argumentations that have been put forward in the normative debate which we summarized in the Introduction (note again that although we adopt

these criticisms in our experimental design, we do not wish to state our (dis-)agreement with any of these criticisms; this is an empirical paper).

1. In a consumer choice experiment the respondent is supposed to trade off time gains with money spent from her own budget, after taxes. In contrast, the vast majority of transport policy decisions involve the allocation of previously collected taxes.
2. In 'consumer' SC experiments respondents are confronted with a (hypothetical) route choice situation for their personal travels, involving small and individual time gains and travel costs. However, trade-offs that have to be made by government in real world transport policies involve huge benefits and costs, distributed amongst very large numbers of travelers and tax payers.
3. An individual in her role as consumer (in a typical SC-experiment) is typically supposed to make a fresh trade-off between travel time and travel costs every time she decides to make a trip. This contrasts with the notion that a government's transport policies and infrastructure investment decisions generally involve a onetime, lumpsum, allocation of (tax) money.

By combining elements from these three lines of criticism raised in normative debates, we designed eight different frames, which are all located at a different spot on the continuum between 'pure' consumers' and citizens' perspectives. The differences between the eight frames only echo through in the introductory text preceding the different choice tasks. That is, we kept the choice tasks themselves (in terms of the time gains and costs involved) identical across all frames, to allow for maximum consistency in our empirical comparisons. More specifically, this approach allows us to treat each frame as a context which may interact with the estimated VoTs, and to statistically infer how an individual's VoT differs between frames. Note also that we varied frames between, but not within participants; that is, to avoid confusion, every participant was only presented with 16 choice tasks for one single frame. Below, we present each frame in some detail; note that in the next Section, we will discuss how attribute levels and ranges were selected.

Frame 1: Consumer VoT – the classical approach

The design of Frame 1 resembles the frame that is used in conventional VoT studies (e.g. Mackie et al., 2003; Ojeda-Cabral et al., 2016), in that respondents were asked to choose between their current route and a faster but more expensive alternative.[1]

We ask you to choose one of the two routes:
Route A: the route you usually take for commuting.
Route B: an alternative route which is faster, but more expensive.

	Route A (Current commute)	Route B (Alternative Route)
Time savings, per trip	-	11 minutes
Extra costs, per trip	-	0.60 euro

FIGURE 1 Design of frame 1.

[1] Note that all choice tasks are WTP scenarios. In conventional VoT studies respondents also complete WTA scenarios. However, since for some of the frames WTA choice tasks were unrealistic we only presented respondents with WTP scenarios.

Frame 2: Consumer VoT in the context of a road expansion

The design of Frame 2 incorporates the first step away from a pure consumer perspective towards incorporating elements of a citizen perspective. More specifically, rather than framing the choice as being between two different routes, we now ask respondents in a referendum-type question whether or not they agree with a government intervention in the form of a road expansion which makes their commute faster, but more expensive.

We ask you to think of the following situation:
The government considers a road expansion aimed at reducing travel times.
We ask you whether you would choose for the road expansion, or not.
You can assume the following:

- You use the road for commuting and therefore would benefit from the road expansion;
- As a result of the road expansion your commute will be faster, but more expensive;
- No road expansion implies no costs and no travel time savings for you;
- The construction work will be carried out in the middle of the night, so you will not experience any nuisance.

	No road expansion	Road Expansion
Time savings, per trip	-	11 minutes
Extra costs, per trip	-	0.60 euro

FIGURE 2 Design of frame 2.

Frame 3: Citizen VoT in the context of a road expansion

In this frame, respondents are asked whether they support the allocation of previously collected taxes to a road expansion which decreases their personal travel time. Since the tradeoff which the respondent faces now involves previously collected taxes instead of her own after tax income, this task comes close to a pure citizen perspective.

We ask you to think of the following situation:
The government considers a road expansion aimed at reducing travel times.
We ask you whether you would choose for the road expansion, or not.
You can assume the following:

- The road expansion is financed out of tax money;
- **Total taxes do not increase** as a result of the road expansion. The investment is paid from previously collected taxes;
- The road expansion implies that less money is available for other government projects;
- For your convenience, we computed the total investment in terms of eurocents per trip;
- You use the road for commuting and therefore would benefit from the road expansion;
- No road expansion implies that there is no investment of tax money and no travel time savings for you;
- The construction work will be carried out in the middle of the night, so you will not experience any nuisance from it.

	No road expansion	Road Expansion
Time savings, per trip	-	11 minutes
Investment of previously collected taxes, per trip	-	0.60 euro

FIGURE 3 Design of frame 3.

Frame 4: Citizen VoT in the context of a road expansion from which 100,000 people benefit
The value which an individual in her role as citizen places on travel time savings accruing from a transport project, may be affected by the number of people who experience these travel time savings. To test this expectation, we informed respondents to Frame 4 that they are one of the 100,000 people who use the expanded road for commuting ("You are one of the 100,000 people who use this road for commuting. The other travelers make the same number of trips as yourself."). Otherwise, Frame 4 is identical to Frame 3. This additional assumption also implies a modification of the choice task, but not of the values presented therein. In Frame 4, respondents are presented with the following two attributes: "Time savings, per trip, for each of the 100,000 travelers (including yourself)" and "Investment of previously collected taxes, per trip, for each of the 100,000 travelers (including yourself)".

Frame 5: Citizen VoT in the context of a road expansion from which 100,000 people benefit, and is paid for by a onetime tax allocation
In this frame, the choice situation is converted into a onetime decision to allocate a particular sum of tax money per tax payer (rather than a tax per trip made by the individual) in pursuit of travel time savings for 100,000 people including herself.

We ask you to think of the following situation:
The government considers a road expansion aimed at reducing travel times.
We ask you whether you would choose for the road expansion, or not.
You can assume the following:

- The road expansion is financed out of tax money;
- **Total taxes do not increase** as a result of the road expansion. The investment is paid from previously collected taxes;
- The road expansion implies that less money is available for other government projects;
- For your convenience, we recalculated the total investment to euros per Dutch tax payer;
- You use the road for commuting and therefore would benefit from the road expansion;
- No road expansion implies that there is no investment of tax money and no travel time savings for you;
- You are one of the 100,000 people who use this road for commuting. The other travelers make the same number of trips as yourself;
- The construction work will be carried out in the middle of the night, so you will not experience any nuisance from it.

	No road expansion	Road Expansion
Time savings, per trip, for each of the 100,000 travelers (including yourself)	-	11 minutes
Investment of previously collected taxes per Dutch tax payer (including yourself)	-	60 euro

FIGURE 4 Design of frame 5.

Frame 6: Citizen VoT in the context of a road expansion from which 100,000 people benefit, and is paid for by a onetime tax allocation from the individual's own previous tax payments
Frame 6 is identical to Frame 5 with the exception that in Frame 6, the respondent is asked to decide if she wants to allocate taxes which she herself has paid in the past, to the road expansion project. This additional assumption also implies a modification of the choice task. In Frame 6 respondents are presented with the following two attributes: "Time savings, per trip, for each

of the 100,000 travelers (including yourself)" and "Investment of taxes previously paid by you".

Frame 7: Citizen VoT in the context of a road expansion from which 100,000 people benefit but she herself does not, and is paid for by a onetime tax allocation

In this frame, respondents were asked whether they would agree with a reassignment of tax money to a road expansion which does not affect their own commute, but from which 100,000 other travelers benefit in terms of travel time savings.

We ask you to think of the following situation:
The government considers a road expansion aimed at reducing travel times.
We ask you whether you would choose for the road expansion, or not.
You can assume the following:

- Every day 100,000 people use this road for commuting;
- **Note:** You do **not** use the road yourself;
- The road expansion is financed out of tax money;
- **Total taxes do not increase** as a result of the road expansion. The investment is paid from previously collected taxes;
- The road expansion implies that less money is available for other government projects;
- For your convenience, we recalculated the total investment to euros per Dutch tax payer;
- No road expansion implies that there is no investment of tax money and no travel time savings for the 100,000 people who use this road for commuting.

	No road expansion	Road Expansion
Time savings, per trip, for each of the 100,000 travelers	-	11 minutes
Investment of previously collected taxes per Dutch tax payer (including yourself)	-	60 euro

FIGURE 5 Design of frame 7.

Frame 8: Special case: Altruistic consumers

This frame is slightly special and a bit of an odd one out, compared to the previous seven frames: in this frame we asked a respondent whether she would be willing to pay a financial contribution from her after tax budget to facilitate a government project (road expansion) from which 100,000 travelers, but not she herself, experience travel time savings.

We ask you to think of the following situation:
You are asked for a financial contribution for a road expansion which will lead to travel time savings.
We ask you whether you would choose for the road expansion, or not.
You can assume the following:

- Every day 100,000 people use this road for commuting;
- **Note:** You do **not** use the road yourself;
- No road expansion implies that there is no costs for you and no travel time savings for the 100,000 people who use this road for commuting.

	No road expansion	Road Expansion
Time savings, per trip, for each of the 100,000 travelers	-	11 minutes
Your financial contribution	-	60 euro

FIGURE 6 Design of frame 8.

3. Data collection

The questionnaire consisted out of four parts. Firstly, respondents were asked whether they commute by car for three or more days per week. Respondents who gave a negative answer to this question were excluded from the remainder of the experiment. Secondly, after reading through an introductory text, respondents were asked to complete 16 choice situations. The choice situations were presented in random order across respondents, to prevent ordering effects. Since the text that precedes the choice tasks is of key importance for our study, we choose to repeat it for every single choice task for in case respondents wanted to re-read it. Thirdly, respondents were asked to provide some additional information concerning their usual commute. Fourthly, they were asked to evaluate the perceived ease and realism of the choice experiment and to report their evaluation of how effectively and efficiently the government is spending tax payers' money. The survey company provided us with information about the socio-demographic characteristics of each respondent (income, age, gender, social class).

The survey company recruited 719 respondents, each of which was assigned to one of the eight frames in such a way that differences in socio-demographic characteristics between different frames were minimized. Our own analyses show that both the socio-demographic characteristics as well as the answers given by the respondents in the third and fourth part of the questionnaire did not differ substantially between the eight subsamples (see Table 1), and as such do not play a role in explaining found differences in VoT between frames.

TABLE 1 Socio-demographics and answers to third and fourth part of questionnaire per context

	1	2	3	4		5	6	7	8
Average commute time (minutes)	32.88	30.22	32.42	32.60		32.93	33.38	41.63	30.83
Number of days travelling by car per week	4.51	4.53	4.59	4.45		4.46	4.60	4.48	4.48
I was convinced of my choices (0 = strongly agree, 4 = strongly disagree)	0.51	0.67	0.83	0.84		0.69	0.81	0.82	0.50
I found it difficult to trade-off the attributes (0 = strongly agree, 4 = strongly disagree)	2.67	2.78	2.23	2.13		2.36	2.20	2.24	2.68
I thought that the questionnaire was realistic (0 = strongly agree, 4 = strongly disagree)	2.07	2.08	1.96	1.67		1.49	1.53	1.55	2.22
I think that the government wastes taxpayers money (0 = strongly agree, 4 = strongly disagree)	2.51	2.64	2.43	2.02		2.10	2.26	2.20	2.66
I would like to receive the results of this study (0 = no, 1 = yes)	0.54	0.59	0.61	0.55		0.45	0.50	0.46	0.63
Age	43.03	43.75	44.05	42.65		42.67	41.58	41.41	43.06
Gender (1 = male, 2 = female)	1.23	1.29	1.24	1.29		1.31	1.27	1.31	1.36
Education (1 = primary school, 7 = academic)	4.81	4.41	4.60	4.69		4.74	4.50	4.67	4.44

Attribute levels were selected as follows: for the first four frames which expressed costs and travel time savings on a per trip base, we choose the following four time gain levels (2, 5, 8, and 11 minutes) and cost levels (0.20, 0.60, 1.00 and 1.40 euro); these were selected to be in line with time gains and costs presented in previous SC-experiments held in Northwest European countries. The attributes for the lumpsum reallocation of tax money (Frames 5 through 8) were selected in a way which ensures maximum consistency (in terms of the implied Net Present Value) with the per trip-costs of the frames 1 through 4. To illustrate, 1 euro per

trip equals an NPV of 954,79 million euros assuming a discount rate of 5.5%, a time horizon of 100 years – both assumptions are standard practice in the Netherlands, see Dutch Ministry of Infrastructure and the Environment (2012) – and assuming that each traveler makes 500 commuting trips (i.e., 250 trips to work, and 250 return trips) each year. Consequently, assuming that 10 million people (out of a population of about 17 million) pay tax in the Netherlands, the corresponding lumpsum payment should be 95.48 euro per tax payer, and we rounded this to 100 euro. Hence, to resemble the per trip cost levels used in Frame 1-4, of 0.20, 0.60, 1.00 and 1.40 euro, lumpsum cost levels of 20 euro, 60 euro, 100 euro and 140 euro per tax payer were used in Frames 5-8. In terms of experimental design, an orthogonal design was chosen which supports efficient testing of all main effects, leading to 16 choice tasks per participant. Respondents were evenly distributed across frames. After removing missing values, 10,910 cases were obtained, from 719 individuals. Biogeme software (Bierlaire, 2003) was used to estimate the discrete choice models from which VoTs were derived.

4. Models and Results

In modeling utilities of choice alternatives, we follow the 'Willingness to Pay space' approach as it allows us to directly infer the standard error (SE) of the Value of Time.[2] The utility of the reference alternative (i.e., 'current route', or 'no road expansion') was fixed at zero, for normalization purposes. The utility of the other alternative was specified as:

$$U^k = \beta_p^k \cdot \Delta p - \beta_p^k \cdot VoT^k \cdot \Delta t + \varepsilon$$

Here, k refers to a particular frame where $k \in \{1,2, \dots ,8\}$, β_p^k is a frame-specific cost parameter, Δp gives the difference in cost between the quicker route (or: situation with road expansion) and the current route (or: situation without road expansion); this difference is positive by design. A negative sign is thus expected for β_p^k. Term Δt gives the difference in travel time between the quicker route (or: situation with road expansion) and the current route (or: situation without road expansion); this difference is negative by design. VoT^k gives the frame-specific Value of Time, representing the worth in monetary terms of a particular travel time gain; a positive sign is expected. Finally, ε is i.i.d. Extreme Value Type I distributed across alternatives, observations and frames. Note that in Logit-form, this specification is fully equivalent to a specification in so-called 'utility-space', where $U^k = \beta_p^k \cdot \Delta p - \beta_t^k \cdot \Delta t + \varepsilon$, with β_t^k being a frame-specific travel time gain parameter (with expected positive sign), implying that $-\beta_t^k / \beta_p^k = VoT^k$. Biogeme software Version 1.8 (Bierlaire, 2003) was used to estimate the discrete choice models. Before presenting and discussing estimation results, we first highlight the role of constants, and unobserved heterogeneity.

[2] Alternatively and equivalently, in the context of a choice model estimated in 'utility-space' the Deltamethod could have been used to indirectly infer the SE of the VoT from the SEs of the estimates for beta(travel time) and beta(travel cost).

4.1. The role of contstants

The aim of this study is to explore how individuals, in their role as citizen, believe that the government should spend tax money on travel time gains; and to compare this with how they would spend their own after tax income on travel time gains. It can be easily seen that given this research aim, a model without constant is needed to capture the right trade-offs: consider the situation where the government proposes a road expansion project which will lead to a travel time gain of X minutes. The question we ask is then: what is the maximum amount Y of tax money which the government can spend on such a project, before the individual would oppose the road expansion. In other words, we want to infer the amount Y of tax money spent by the government to obtain a travel time gain of X minutes, in order for the individual to become indifferent between the situation where the government implements the project and the situation where it does not do so. This is how we conceptualize the individual's 'citizen VoT'. In case we would also estimate a constant (e.g. to represent an intrinsic dislike by the individual of road projects initiated by the government), this would blur our results and their interpretation. Consider the situation where we would find a negative constant of size Z, implying a general dislike of road projects financed with tax money. The VoT which would then be estimated in the context of such a model with constant Z, would no longer represent the amount Y of tax money that can be spent by the government on obtaining a travel time gain of X minutes, in order for the individual to become indifferent between the situation where the government does (not) implement the project. Rather, such a VoT would represent the amount Y of tax money spent by the government on obtaining a travel time gain of X minutes, in order for the individual to *return to her initial dislike of government initiated road projects of size* Z. This latter interpretation does not correspond with the notion of citizen VoT as we conceptualize it in this paper. Moreover, it is incongruent with government decisions (based on Cost-Benefit Analsyes) whether or not to pursue a given transport policy.

As an aside: frame 1, as explained above, does not feature a government initiated road project, but rather a standard route choice situation where the individual is put in a role of consumer. There are two compelling reasons why we forego the use of constants in this frame as well: first, there is the obvious reason that we want to compare VoTs across frames, and therefore want to use the exact same conceptual and operational modeling framework for every frame. In the first frame this means that we want to infer what travel time difference is needed, at a given level of cost difference, for the traveler to become indifferent between routes. Second, important previous VoT-studies such as the UK VoT study (Mackie et al., 2003; Cabral et al., 2016) have also used no-constant models to infer VoT in the context of the exact same route choice situation as ours, featuring a current route, and an alternative with improved travel time and higher travel cost. Our approach is therefore in line with previous studies, which enhances its comparibility across studies.

4.2. Unobserved heterogeneity

We present the results of estimated Logit-models. The reasons why we choose not to present the results of Mixed Logit models which may capture heterogeneity in unobserved utility, are as follows: first, we tried a variety of distributions to model unobserved heterogeneity in VoT

(such as the Uniform, LogNormal, and Normal distribution), and observed that the choice of distribution significantly affected VoT estimates. This strong sensitivity of VoT with respect to the chosen distribution in Mixed Logit models is well known (e.g. Börjesson and Eliasson, 2014; Hensher and Greene, 2003; Hess et al., 2005; UK Dept. for Transport, 2015), and usually the ultimate selection of a distribution is done, based on a combination of estimation results (goodness of fit), the analyst's experience and a priori expecations of what constitutes a 'reasonable' VoT. However, in this first, and therefore by definition explorative study of 'citizen VoT', we do not have strong *a priori* expectations concerning what would constitute a reasonable citizen VoT, making us hesitant to select a particular distribution based on merely theoretical expectations. Furthermore, we ran into model convergence issues for different frames in combination with different distributional assumptions: a particular distribution would work well in the context of one frame, but less so or not at all on another. In general, many of our Mixed Logit models struggled to converge and stabilize for increasing numbers of Halton draws, and across different starting values and optimization algorithms. Such convergence issues are also well known and have been observed in earlier Mixed Logit models of VoT (e.g. Significance, 2013).

In light of these observations – see Rouwendal et al. (2010; page 136) for a similar observation – and since our aim is to infer and compare differences between consumer VoT and citizen VoT across different frames, rather than identifying levels of heterogeneity for particular frames, we choose to forego the optimization of Mixed Logit models for particular frames and instead opt to base our comparisons on conventional Logit models.

4.3. Results and interpretation

Table 2 presents, per frame: its main characteristics; the estimated β_p^k and its SE;[3] the estimated VoT^k and its SE; and the implied β_t^k (which equals $-\beta_p^k \cdot VoT^k$). Note that the data were pooled and the model was estimated in one go, using dummies to identify different frames (it was checked that this lead to the same results as estimation of a separate model for each frame). The model's Null-LogLikelihood (based on 10,910 cases from a total of 719 individuals) equals –7562, and its final LogLikelihood equals –5971, implying a (adjusted) rho-squared of 0.210 (0.208).

[3] Note again that each individual made 16 choices: we used robust standard errors in acknowledgement of the panel nature of our data.

TABLE 2 Model estimation results

Frame	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Route choice / road expansion	Route choice	Road expansion	Road expansion	Road expansion	Road expansion	Road expansion	Road expansion	Road expansion
After tax budget / tax money	After tax budget	After tax budget	Tax money	Tax money	Tax money	Tax money ('own' taxes)	Tax money	After tax budget
Mentioning of benefits to other road users	No	No	No	Yes	Yes	Yes	Yes	Yes
Payment per trip / lumpsum	Per trip	Per trip	Per trip	Per trip	Lumpsum	Lumpsum	Lumpsum	Lumpsum
User / non-user	User	User	User	User	User	User	Non-User	Non-User
VoT^k (frame 1-4: ct/min) (frame 5-8: euro/min)	5.00	3.20	10.3	10.8	11.10	12.80	7.51	1.12
SE(VoT^k)	1.19	0.611	1.35	1.25	1.16	1.33	1.01	0.527
β_p^k (frame 1-4: ct) (frame 5-8: euro)	-.0170	-.0236	-.0160	-.0111	-.0178	-.0160	-.0194	-.0403
SE(β_p^k)	.00202	.00284	.00188	.00117	.00195	.00174	.00218	.00416
implied β_t^k (min)	.0850	.0757	.165	.120	.199	.205	.146	.0453

A first inspection of results shows that all parameters have the expected sign and are highly significant (an exception is the VoT for frame 8, which is significantly different from zero at a 5% level, but not at a 1% level, having a p-value of 0.03). In terms of comparisons across frames, the following results are obtained (note that we focus on those comparisons which are conceptually interesting and meaningful in the context of our paper's research aims):

- Frame 2's VoT is lower than that of Frame 1, suggesting that individuals' willingness to pay for travel time gains created by a government policy, but from their own after tax income, is lower than their willingness to pay, from their after tax income, for time gains

obtained by choosing a different route. The difference in VoT however, is not significant at a 5% level (t-ratio = -1.89); and the same holds for the difference in the penalty for travel cost (t-ratio = -1.35).[4]

- Frame 3's VoT is significantly higher than that of Frame 1 (t-ratio = 2.95), suggesting that individuals' willingness to pay from previously collected tax money for travel time gains created by a government policy, is higher than their willingness to pay, from their after tax income, for time gains obtained by choosing a different route. In the terminology adopted in this paper, this result implies that citizen VoT is higher (in fact, more than twice as high) as consumer VoT. Importantly, a comparison between cost parameters shows that this higher citizen VoT does not stem from a stronger willingness to spend previously collected tax money compared to spending one's own income: the two cost parameters are significantly indistinguishable (t-ratio = 0.36), suggesting that participants treat a euro of previously collected tax money as carefully as a euro of their own after tax income. We consider this to be a striking result. The difference in VoT stems from a difference in the value attached to travel gains: a travel time gain resulting from government action is valued more than the same travel time gain obtained by one's own route choices.
- Frame 4's VoT is slightly higher than that of Frame 3, but not significantly so (t-ratio = 0.27). In other words, a citizen's willingness to pay for travel time gains from previously collected tax money does not increase significantly, when she is informed that besides her, 100,000 other travelers will benefit from the travel time gain.
- Frame 6's VoT is slightly higher than that of Frame 5, suggesting that individuals who are informed that the travel time gains they experience as a result from the government project are paid for by their 'own' previously payed taxes, have a higher VoT than those individuals who assume that the project is paid for by previously collected taxes in general. The direction of this difference is expected, as people might feel that they deserve to benefit themselves from their 'own' share of previously payed taxes. The difference in VoT however, is not significant (t-ratio = 0.96); and the same holds for the difference in the penalty for travel cost (t-ratio = 0.69).
- Frame 7's VoT is lower than that of Frame 5, suggesting that individuals' willingness to pay (from previously collected taxes) for travel time gains decreases when they themselves do not experience these gains. The direction of this difference is as expected, and significant (t-ratio = -2.33). Note that this difference in VoT does not so much stem from a difference in the travel cost penalty (-.0194 vs. -.0178; t-ratio = -0.55), but from a lower value attached to the travel time gain (.146 vs. .199), which makes perfect sense.
- Frame 8's VoT is much lower than that of Frame 7, suggesting that individuals' willingness to pay from their own after tax budget for travel time gains which are experienced only by other travelers, is much lower than their willingness to use previously collected tax money to pay for such time gains. Hence, individuals have different preference orderings in their role as 'consumer' and 'citizen' when valuing travel time savings for other people. The

[4] The t-ratio for the difference between VoTa and VoTb = $\left(\widehat{VoTa} - \widehat{VoTb}\right) / \left(\sqrt{SE\left[\widehat{VoTa}\right]^2 + SE\left[\widehat{VoTb}\right]^2}\right)$.

direction of this difference is as expected, and highly significant (t-ratio = -5.61). This difference in VoT stems from a higher cost penalty in combination with a smaller value attached to the travel time gain.

- Based on the comparison between Frame 7 and Frame 8 it can be concluded that the value of travel time gains accruing to others than oneself is significantly larger than zero at a 5% level, irrespective of whether tax money or personal income is involved. This finding is in line with results reported in previous work that people can assign value to transport infrastructure even if they don't benefit from it themselves (e.g. Laird et al., 2009; Manville and Cummins, 2015). Manville and Cummins (2015) found that many non-transit users in the United States where willing to pay additional taxes in support of a public transport system, for reasons of broader societal concerns.

Given that our results are based on one particular – although defensible – model specification (i.e., a Logit model without constants), we provide an additional descriptive empirical analysis of our data in the Appendix to assess the validity of our estimation results. More specifically, we report – for each frame – the share of participants who accepted the implicit 'Price of Time' which is embedded in each of the 16 choice tasks. For example, if a particular choice task features a choice between one's current route and a route which is 11 minutes faster and 60 cents more expensive, this implies an offer to 'buy' time at a price of 5.45 cent/minute or 3.27 euro/hour; this is what we here call the 'Price of Time'. By comparing – across frames and for each choice task – the shares of accepted offers to buy time at particular prices, differences between frames in terms of individuals' Value of Time can be inferred. Note that the implicit 'Price of Time' embedded in choice tasks did not differ across frames, which allowed us to directly compare shares across frames. Results of this descriptive analysis, presented in the Appendix, are fully in line with the above presented estimation results and our interpretation thereof. This lends further credibility to our conclusions, which we will present below.

5. Conclusions, discussion and policy implications

The analyses presented in this paper serve to provide an empirical footing underneath a hitherto largely normative debate concerning which valuation of non-market goods (such as travel time) to use for the evaluation of (transport) policies. Previous studies have criticized the 'consumer sovereignty' paradigm implicitly adopted in most Stated Choice experiments. In these experiments, respondents are typically asked to make a series of hypothetical travel choices as if they were paying travel costs from their own budget (whereas projects are paid by taxes), and as if the travel time is only experienced by themselves (as opposed to being experienced by all travelers using a particular travel option). Many scholars have argued that the valuation of non-market goods derived from such experiments cannot or should not serve to inform policy-making, as they are a poor proxy of how respondents believe that government should spend tax money in pursuit of travel time gains for potentially very large numbers of travelers. Rather than taking a stand in this normative debate, we in this paper choose to put some of its most important premises to the test empirically, in the context of the most prominently featuring non-market good in Transportation: travel time. We did so by designing a SC-experiment with different frames, some representing the conventional consumer-perspective, others gradually approaching a so-called citizen perspective. Obtained results allow us to draw a number of relevant conclusions.

5.1. Conclusions

A first important conclusion of this study is that we find that individuals' willingness to pay from previously collected tax money for travel time gains created by a government policy, is significantly higher than their willingness to pay, from their after tax income, for time gains obtained by choosing a different route. This result implies that citizen VoT is higher as consumer VoT. Hence, we found proof, statistically speaking, for the often used normative argument that preferences of individuals in their role as consumers (concerning how they should spend their resources) are likely to be a poor proxy for the preferences of individuals in their role as citizens (concerning how government should spend its resources). A comparison between cost parameters shows that this higher citizen VoT does not stem from a stronger willingness to spend previously collected tax money compared to spending one's own income: participants treat a euro of previously collected tax money as carefully as a euro of their own after tax income. The difference in VoT stems from a difference in the value attached to travel gains: a travel time gain resulting from government action is valued more than the same travel time gain obtained by one's own (hypothetical) route choices. A second important conclusion is that a citizen's willingness to pay for travel time gains from previously collected tax money does not increase significantly, when they are made aware of the fact that 100,000 travelers would benefit from the project, compared to the situation where the individual receives no explicit information about whether (and if so, how many) other people would benefit from the project besides herself. A third important conclusion is that individuals' willingness to pay (from previously collected taxes) for travel time gains strongly decreases when they themselves do not experience these gains. Hence, the value that individuals in their role as citizen assign to travel time savings accruing from a government project appears to be influenced by whether or not they themselves benefit from the project. The difference in VoT does not so much stem from a difference in the travel cost penalty, but from a lower value attached to the travel time gain.

5.2. Discussion on methodology: Incentive compatibility and meaningful budget constraints

As outlined in section 2, we aspired to design binary discrete choice tasks that are incentive compatible (Carson and Groves, 2007). Theoretically speaking, Frame 2 is not incentive compatible, since respondents are asked whether they are willing to provide a voluntary private contribution for a public good (the road expansion).[5] Economic theory predicts that a rational respondent will always say 'yes' to a (binary) survey question involving voluntary contributions for public goods, since in case the government indeed decides to provide the public good, the respondent has the opportunity to profit from the good, but always has the option to renounce his voluntary contribution to the public good (Carson and Groves, 2007). However, despite the fact that respondents participating in Frame 2 had an incentive to over-pledge, the Frame 2 VoT is lower than the Frame 1 VoT (this survey setting is incentive compatible and closely resembles Frame 2). This is a good indication that respondents participating in Frame 2, in fact, did not over-pledged their VoT.

Another potential cause for respondents overstating their willingness to pay for a public and private good addressed in the literature (e.g. Arrow et al., 1993) is the absence of a

[5] The reason for including the incentive incompatible Frame 2 in our study is that, in case a different VoT would have been found between Frame 1 (consumer VoT) and Frame 3 (citizen VoT), Frame 2 VoT would have enabled us to determine the extent to which this difference could be explained by the consumer versus citizen framing or the fact that the survey setting in Frame 1 involved a route choice and Frame 3 a referendum-type question regarding a public good.

meaningful budget constraint. Respondents may answer survey questions without thinking carefully about how much disposable resources they have available to allocate to all causes, public and private (e.g. Kemp and Maxwell, 1992). To iron out this issue, Arrow et al. (1993) recommend analysts to remind respondents that their willingness to pay for the public good in question would reduce their expenditures for private goods or public goods. This reminder should be more than perfunctory, but less than overwhelming (Arrow et al., 1993). In our study, we followed this recommendation by reminding the respondents participating in the citizen Frames (Frames 3 through 7) that an allocation of taxes to the road expansion implies that less money is available for other government projects. Further research may scrutinize the merits of other approaches for emphasizing the budget constraint. Moreover, it is interesting to study the extent to which respondents participating in conventional value of time studies (such as Frame 1) appropriately consider their economic constraints when completing the questionnaire.

5.3. Implications for policy evaluation, further research

The conclusions of this study lead to a number of implications for scholars and policy-makers. First, the fact that we find a significant difference between individuals' monetary valuation of travel time gains accruing from government projects and the same travel time gains obtained from (hypothetical) route choices, can be taken as a first sign of empirical evidence that the classical consumer VoT differs from the citizen VoT. Since the Value of Time is one of the most crucial concepts in transport infrastructure appraisal, the outcomes of appraisal studies might change significantly when transport infrastructure projects are evaluated from a citizen perspective instead of a consumer perspective (to the extent that our findings are replicated in follow up work). This implies that the normative debate which we highlighted in our Introduction is a very consequential one which deserves more attention than it currently receives in the transportation community.

Note that an interesting avenue for further research would be to explore the transferability of our conclusions towards other non-market goods that play an important role in transport policy evaluation, such as safety and recreational opportunities. Moreover, it seems very worthwhile to replicate this study (both inside and outside The Netherlands) with more respondents, to see whether this will lead to substantial differences.

Due to the explorative character of our study the above conclusions and implications should be considered building blocks for a fruitful academic discussion, rather than definitive statements, set in stone. The most fundamental discussion that we are hoping to fuel with the empirical results of this study is whether or not the conventional consumer VoT is the single most relevant metric for the valuation of travel time savings in the appraisal of transport projects. Once again we wish to emphasize here, that in this paper we adopt an empirical standpoint, and refrain from arguing which perspective (consumer versus citizen) should be used.

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Appendix: Empirical distribution of accepted offers (i.e., choices for the fastest and more expensive route, or choices for the road expansion project)

Figure A.1 presents the share of participants who accepted the implied 'Price of Time' embedded in particular choice tasks, for frames 1 (diamond), 2 (square), 3 (triangle) and 4 (cross). For this purpose, choice tasks were ordered in increasing (embedded) Value of Time: task 1 represented an embedded Price of Time of 1.8 cent per minute (or 1.08 euro per hour), and task 16 represented an embedded Price of Time of 70 cent per minute (or 42 euro per hour). Figure A.2 presents a graph of the same data, but now with the actual Price of Time used in the X-axis. It is easily observed that, as expected, the share of individuals accepting an offer generally decreases when the Price of Time embedded in the offer becomes larger. More importantly, and in line with the estimation results of estimated Logit models, we find that the share of accepted offers is lowest for frame 2, higher for frame 1, and still higher for frame 3 and 4 (with no clear difference between the latter two). This corroborates the conclusions drawn from our estimation results.

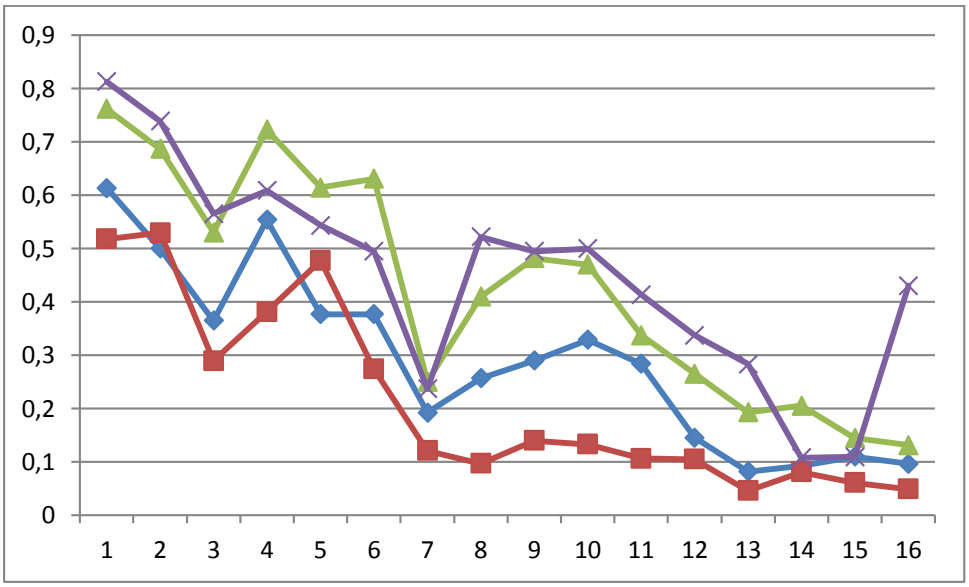

Figure A.1: Share of accepted offers (frame 1-4)

(choice tasks ordered from low to high embedded Price of Time).

(diamond = frame 1; square = frame 2; triangle = frame 3; cross = frame 4)

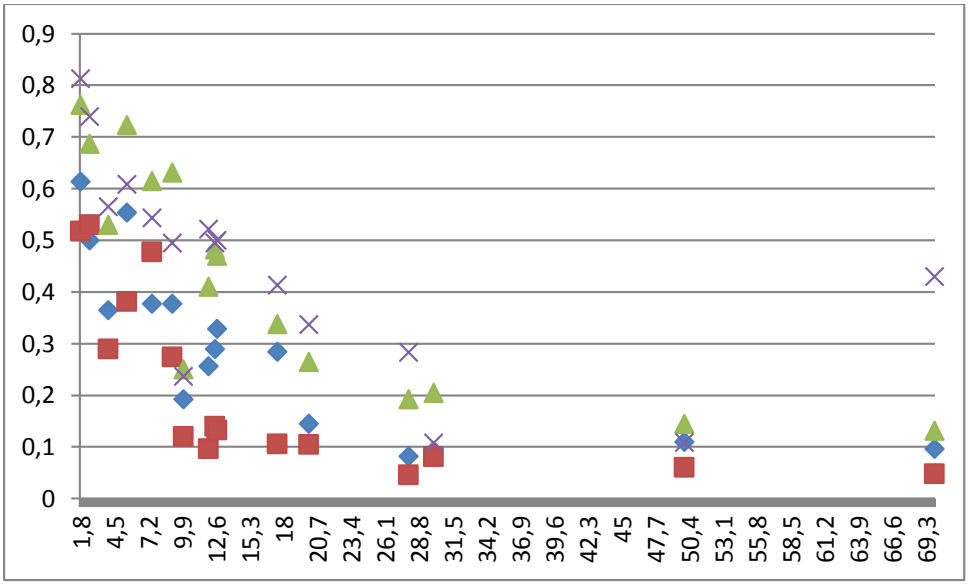

Figure A.2: Share of accepted offers (frame 1-4)

(As a function of actual embedded Price of Time).

(diamond = frame 1; square = frame 2; triangle = frame 3; cross = frame 4)

Figure A.3 presents the share of participants who accepted the implied Price of Time embedded in particular choice tasks, for frames 5 (diamond), 6 (square), 7 (triangle) and 8 (cross). For this purpose, choice tasks were ordered in increasing (embedded) Price of Time: task 1 represented an embedded Price of Time of 1.8 euro per minute (or 108 euro per hour), and task 16 represented an embedded Price of Time of 70 euro per minute (or 4200 euro per hour). Figure A.4 presents a graph of the same data, but now with the actual Price of Time used in the X-axis. It is easily observed that, as expected, the share of individuals accepting an offer generally decreases when the Price of Time embedded in the offer becomes larger. More importantly, and in line with the estimation results of estimated Logit models, we find that the share of accepted offers is lowest for frame 8, much higher for frame 7, and still higher for frame 6 and 5 (with no clear difference between the latter two). This corroborates the conclusions drawn from our estimation results.

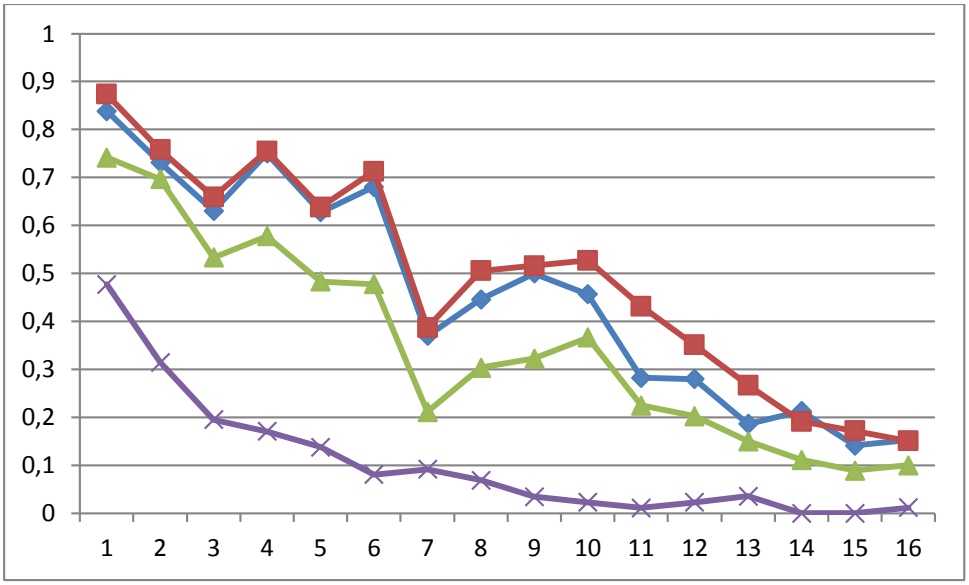

Figure A.3: Share of accepted offers (frame 5-8)

(choice tasks ordered from low to high embedded Price of Time).

(diamond = frame 5; square = frame 6; triangle = frame 7; cross = frame 8)

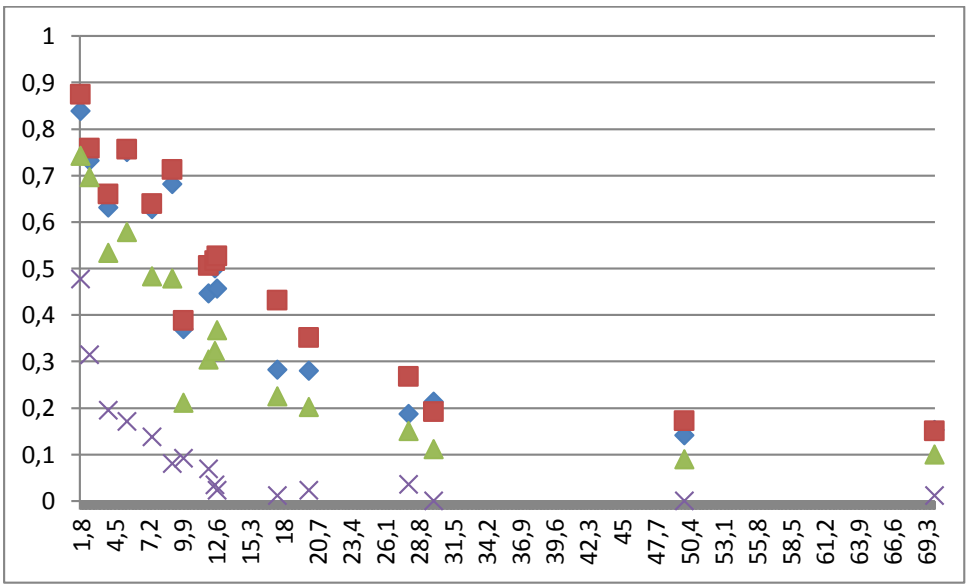

Figure A.4: Share of accepted offers (frame 5-8)

(As a function of actual embedded Price of Time).

(diamond = frame 5; square = frame 6; triangle = frame 7; cross = frame 8)