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Car drivers' preferences for ISA policy measures

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Intelligent Speed Adaptation (ISA), an in-vehicle system that can either warn the driver or directly limit the vehicle's speed when the speed limit is reached, is generally believed to have a large potential to increase road safety. However, policy makers hesitate to take policy measures that may increase ISA use. Public acceptance of ISA or policy makers' perception of it is regarded to play an important role in this. This paper aims to increase this insight by reporting car drivers' preferences for ISA policy measures based on stated choice experiment conducted in the Netherlands. Respondents made choices between various implementation strategies (mandatory ISA and voluntary ISA with financial incentives) given a chosen policy measure. The policy measure describes which drivers group (speed offenders, professional drivers or all drivers) is targeted and which ISA type (warning or limiting) is stimulated. The results point out that car drivers especially prefer that policy makers would impose ISA on speed offenders and to a lesser extent also on professional drivers, while they prefer a voluntary ISA for themselves. Use of voluntary ISA can be stimulated by offering financial incentives, of which purchase subsidy is preferred above annual tax cuts. Furthermore, car drivers prefer warning ISA for themselves and also for professional drivers, while they prefer limiting ISA for speed offenders. In addition, the results indicate that females and the older age group prefer ISA policy measures more than males and young drivers, but overall car drivers' preferences seem to be rather homogeneous.

Keywords: *Intelligent Speed Adaptation, policy measures, implementation strategy, stated choice experiments.*

1. Introduction

Intelligent Speed Adaptation (ISA) systems have been studied as a policy instrument to increase road safety for the past thirty years. In essence, an ISA system can either warn the driver when the speed limit is reached (warning ISA) or directly limit the vehicle's speed (limiting or restrictive ISA). Research has suggested that ISA has a very large potential to contribute to road safety (e.g. Carsten and Tate, 2005; Tate and Carsten, 2008) as it can contribute to a lower occurrence of speeding, which is expected to reduce the number and severity of crashes (e.g. Salusjärvi, 1981; Joksch, 1993; Hiramatsu et al. 1997; Sala et al. 1997; Marchau et al. 2005). Despite the level of interest in ISA research as illustrated by a recent special issue in Accident Analysis and Prevention (September 2012), implementation is rather slow (Carsten, 2012). Van der Pas et al. (2012) argued that the lack of implementation is due to the many uncertainties that are related to ISA, such as the uncertainty about ISA implementation strategies (e.g. voluntary implementation, incentive giving, mandatory implementation).

Successful implementation of ISA as an effective instrument to maintain speed limits is largely dependent on its acceptance. Carsten (2012, p.2) states that 'acceptance or public acceptance as

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perceived by politicians would seem to be the obstacle of deployment'. ISA acceptance has therefore received substantial attention in the literature (e.g. Jamson, 2006; Molin and Brookhuis 2007; Vlassenroot et al. 2010, 2011). Consistent findings show that warning systems tend to have higher acceptance rates than limiting (restrictive) systems and that acceptance is lower among the youngest drivers, males and the higher educated (De Waard and Brookhuis, 1997; Young et al. 2004; Rienstra and Rietveld, 1996; Piao et al., 2005). The results of several studies (e.g. Rienstra and Rietveld, 1996; Jamson, 2006; Garvill et al. 2003) suggest, however, that the drivers that are most inclined to exhibit speeding behaviour are least likely to use ISA voluntarily. This result suggests that implementation strategies that solely focus on voluntary use may not realize ISA's full safety potential. To achieve the latter, governments may choose for a strategy that imposes ISA on all vehicles.

However, as most ISA acceptance studies focus on voluntary use of ISA systems, not much is known about the acceptance of an implementation strategy that imposes ISA on all drivers or on specific driver groups. Van der Pas et al. (2012) even conclude that the effects of different implementation strategies on acceptance are unknown. What has received some attention in the literature is whether financial incentives can increase acceptance of voluntary ISA use. Vlassenroot et al. (2011b) found that drivers are not sensitive to financial incentives, while Chorlton et al. (2012) found that part of them are but that much heterogeneity exist. Lahrman et al. (2012) could not find a sufficient number of young drivers to participate in a study on the effects of insurance premium reductions on ISA use, suggesting a very low impact of financial incentives at least for this group.

A complete other factor that may affect ISA use is suggested by Vlassenroot et al. (2007), who found that drivers would be more willing to use ISA if certain other groups used it too. This suggests that ISA acceptance may benefit from the implementation of mandatory ISA for specific target groups, such as speed offenders or professional drivers. However, as the acceptance of ISA policy measures aimed at specific target groups has not received much attention in the literature, the acceptance of such policy measures among car drivers is still uncertain.

This paper aims to contribute to the literature on ISA acceptance by examining the preferences of car drivers for different ISA policy packages. To that effect, a stated choice experiment is conducted, in which car drivers are requested to make choices between two basic ISA implementation strategies, that is, voluntary ISA, which leaves the driver in control of purchasing and using ISA and mandatory ISA, which is imposed on all vehicles or those of certain driver groups. Furthermore, it is examined to what extent voluntary ISA use can be increased by two financial incentives, more specifically by a purchase subsidy and by annual tax cuts. We are especially interested how the choices between the implementation strategies differ with the driver group that is targeted and with ISA type, that is whether ISA has a warning or a limiting functionality. To examine this, a Multi-Nominal Logit model is estimated based on the choices observed in the stated choice experiment. Furthermore, preference heterogeneity is examined by segmentation based on mainly socio-demographic variables.

The results reported in this paper are based on the choices made by 180 car drivers in the Netherlands. Although it would be of interest to examine and compare preferences for ISA implementation strategies of various target groups, this paper explores only the preferences of car drivers, as this is the largest driver group and therefore probably of most interest to policy makers that have to decide on ISA policy measures. To summarize, this study provides insight into car drivers' preferences for different ISA implementation strategies, that is mandatory ISA and voluntary ISA combined with two different financial incentives, and to what extent this depends on the specific driver group that is targeted and on ISA type (warning or limiting).

2. Methodology

2.1 The choice task

To examine the preferences for ISA implementation strategies, a Stated Choice (SC) experiment was constructed (e.g. Louviere et al. 2000). SC experiments usually involve the construction of a series of choice sets, each consisting of a small number of choice alternatives. The choice alternatives are constructed by the researcher and can be completely hypothetical, which makes it especially convenient for examining preferences with respect to implementation of ISA policy packages.

Typically, SC experiments are applied to observe choices for products or services meant for an individual's own benefit or use, on the assumption that a respondent will choose in each choice set the alternative that maximizes his or her utility. In order to increase the validity of the observed choices, it is widely acknowledged that choice tasks need to be constructed in such a way that it resembles as much as possible choice situations that respondents may encounter in real life. The choice task in this study faces at least three challenges in this respect. First, car drivers are not themselves in the position to choose between implementation strategies, which is the domain of policy makers. Second, car drivers cannot freely choose one of the alternatives, that is mandatory ISA, as this is an alternative that is imposed on them. Third, part of the policy measures examined are targeted at driver groups to which the respondents (car drivers) do not belong themselves, hence, respondents are requested to choose between policy measures that do not only affect themselves but also other road users.

These challenges are addressed as follows in this study. Figure 1 presents an example of the choice task as shown to the respondents. The first sentence stresses that the task is about the choices the respondent would make. Then a specific policy measure is presented, that is, it is specified which driver group is targeted by the policy measure and which ISA type it aims to stimulate, that is either warning or limiting. Hence, respondents have to assume that those decisions are already taken by policy makers. The text proceeds by making clear to respondents that they have to assume that politicians need to make a choice between three implementation strategies (mandatory ISA, voluntary ISA with purchase subsidy, voluntary ISA with annual tax cuts, which is explained below) for the policy measure they have chosen. *(Note that the choice alternatives are called 'policy measures' in the experiment, whereas in this paper we call them 'implementation strategies' to distinguish these from the policy measures, that is target group and ISA type).* Respondents then indicate which implementation strategy politicians should make in their opinion.

By framing the choice task as respondents telling what politicians should choose, we believe that a choice situation is created that is realistic in the sense that it resembles behaviour in real life. Many people are involved in actions to express their opinion on what politicians should do, such as writing letters to politicians or newspapers, signing a petition, taking part in a protest march, or more modern actions as blogging or twittering. Furthermore, this framing provides a solution for the three challenges introduced before. The task makes explicit that the actual decision on ISA policies is made by politicians and not by the respondent, which reflects the actual situation. We believe this created a choice situation that respondents can belief in and which makes credible that the choice set includes an alternative, mandatory ISA, that they cannot choose in real life as it is imposed upon them. Moreover, it creates a choice environment in which it is credible that the choices they make would not only affect themselves but also other road users.

In the following we ask you to make a choice between different policy measures. Assume that:

The target group of these measures is: ***all drivers***
The ISA type that is stimulated is: ***Restrictive ISA*** (costs: €250 to €300)

Imagine that politicians need to make a choice between the following three policy measures for the target group and ISA type as described at the top of this page. In your opinion, which policy measure should they choose?"

0 Alternative 1: Mandatory implementation
0 Alternative 2: €75 purchase subsidy
0 Alternative 3: An annual €75 road tax cuts

Should the politicians actually make the decision to implement the policy measure you have chosen, or rather take no policy measure at all?

0 the policy measure chosen above
0 no policy measure

Figure 1. Example of measurement task

The choice among the three alternatives reflects the preferences of car drivers for implementation strategies assuming that the decision that ISA will be implemented is already taken. Hence, it does not tell whether the respondents actually prefer that policy makers should take any policy measure at all. To gain this insight, respondents are asked a second question, which involves indicating whether in their opinion politicians should actually implement the chosen alternative or rather not implement it.

The next subsection discusses the attributes and the choice alternatives in more detail.

2.2 Attributes and choice alternatives

As discussed before, respondents make choices between implementation alternatives for a given ISA policy measure. The latter is specified in terms of the target group that is the specific driver group that is targeted and ISA type. Many different target groups could potentially be distinguished, however, to limit the number of possible policy measures, the following three driver groups were distinguished: all drivers, professional drivers and speed offenders. The group of professional drivers as a group of interest was suggested by Vlassenroot et al. (2011b). Although the latter driver group was not defined in the questionnaire, it is reasonable to assume that most respondents associate this group with the drivers of vehicles they most often encounter on the road besides other cars, such as truck drivers, taxi drivers, (delivery) service vans etc. The group of speed offenders is of interest as policy makers are considering the implementation of ISA for this group to prevent this group from further speeding behaviour. An example of the latter is the recent field experiment commissioned by the Dutch Government in which a mandatory ISA system was tested for drivers convicted for speeding (van der Pas, 2012). The final selected target group was 'all drivers'. Although this was not explicitly measured in the survey, it is reasonable to assume that almost all respondents belong to this group given the way respondents are recruited (see the sample subsection). Moreover, also both other target groups belong to this group, as it is not likely that policy measures are taken for car drivers which would not also apply to other driver groups.

Three different ISA types are usually distinguished (e.g., van der Pas et al., 2012): ISA can either warn the driver that the maximum speed is reached (e.g. with audio visual signals), ISA can assist the driver (e.g. with a haptic throttle, which provides resistance above the speed limit), or ISA can restrict the vehicle from going faster (e.g. a dead throttle which makes it impossible to go faster than the local speed limit). In essence, the haptic throttle is a limiting ISA: although it allows overruling the limitation to the speed limit, this can only be done for a short period. Therefore, we decided to focus only on two systems, that is 'warning ISA' and 'limiting ISA', which helps limiting the number of possible choice alternatives that need to be constructed.

These terms were explained to the respondents as follows. Warning ISA was explained as 'only provides a warning to the driver when the speed is exceeded, the drivers need to adapt the speed themselves'. Limiting ISA was explained as 'makes speed exceeding impossible, fuel injection is automatically limited when the speed limit has been reached'. Respondents were told that the price of a warning system is between 100 and 150 euro and the price of a limiting ISA is between 250 and 300 euro.

Since two ISA types were distinguished and three target groups, in total six different policy measures were constructed. Each new page in the experiment started with presenting one of these policy measures (see Figure 1). This was followed by three implementation strategy choice sets, that each consisted of three alternatives, that is mandatory ISA, voluntary ISA with purchase subsidy and voluntary ISA with annual tax cuts. An advantage of presenting three implementation strategy choice sets in a row while the policy measure does not change at the same time, is that this limits the task load for the respondents. The result is that more choice sets could be presented compared to a situation in which all variables would freely vary in each choice set.

As discussed before, we were interested in examining to what extent voluntary ISA use can be influenced by providing financial incentives. Two incentives that are under direct control of the government were included, that is a purchase subsidy and an annual subsidy effectuated by road tax cuts. Although annual subsidies often result in higher total financial gains in the long run, there is evidence in the literature that people prefer to have money now instead of saving some amount of money in the future (Peters and Büchel, 2010). In order to test this, both incentive types were included as alternatives in the choice set. The purchase subsidy varied between €75, €150 and €225, and the annual tax cuts varied between €25, €50 and €75. Hence, given that the price of the systems presented to the respondents is rather low, in several scenarios drivers would actually earn money if the proposed ISA would be installed in their vehicle. As mandatory ISA is imposed on the drivers, hence use does not have to be stimulated, no attributes were included for this alternative.

The three alternatives were explained to the respondents as follows. The first alternative, 'this is a mandatory introduction of ISA, all vehicles should have this system and no subsidy is provided.' The second alternative, 'a once-only subsidy offered at the purchase of ISA to make purchase more attractive. The choice of purchasing ISA is free, so it is not mandatory'. The third alternative, 'annual road tax cuts offered to make purchase more attractive. The choice of purchasing ISA is free, so it is not mandatory'. As for each voluntary ISA option three financial incentive levels are selected, in total nine possible ISA policy implementation choice sets were constructed.

Each respondent was presented all six constructed policy measures, each followed by three choice sets of ISA implementation strategies on the same page. Thus in total, 18 choices were observed for each respondent. Hence, each respondent was presented all choice sets twice but in combination with different policy measures. Across all respondents, all policy measures – implementation choice sets (6*9=54 combinations) were observed an equal number of times, resulting in a full factorial design, which is completely balanced and orthogonal. The order of the choice sets was randomized twice across the six target group – ISA combinations to avoid any order effects, resulting in six different versions of the choice experiment. Each respondent was randomly assigned to one version. Together with some background variables the experiment was implemented as a web questionnaire.

2.3 Sample

In total, 180 respondents completed the questionnaire. The vast majority of the respondents (155 respondents) was recruited using snowball sampling, where a respondent, after completing the questionnaire, is requested to send invitations to persons from their social network to participate in the research. The personal network of the second author of this paper formed the starting point

for this method. Ten respondents were recruited via announcements placed on two websites; one website involved a platform for discussions on various issues related to transportation and the other a platform for discussions on general science related matters. Finally, 15 respondents were recruited by distributing a letter of invitation with the website's address to about 75 houses in a part of a neighbourhood in Delft. In order to stimulate participation, respondents could win a €25 check for a popular Internet store.

Table 1 presents the sample distribution of the background variables as categorized into two groups used for the segmentation analyses presented later in this paper. More males (62.2%) responded than females (37.8%). Although this does not follow the distribution of gender in the Dutch population, it is probably more representative for car drivers given the fact that in the Netherland 54% of all persons with a driver licence is male and the fact that males on average drive more kilometres than females (20 versus 10 kilometres per day). Compared to the population distribution (not shown in the Table), the distribution of age shows only a slight overrepresentation of the youngest age group (<25) and a slight underrepresentation of the oldest age group (65+). With respect to level of education, the more highly educated sector (high vocational training and university) was clearly overrepresented (52% in the sample while only about 30% in the population) and the less educated underrepresented. Finally, the background variables *annual distance driven* and *main purpose of car use* have a distribution that closely matches the population distribution.

To summarize, though the more highly educated were clearly overrepresented in the sample, the distribution of all the other variables matched the distribution of those variables in the Dutch population fairly well. Although the sample must be considered a convenient sample given the way the respondents were recruited, a fairly heterogeneous sample was realized as all relevant categories are well represented.

Table 1. Sample distributions of background variables (N=180)

Background variables	First category	Second category
Gender	Males (62.2%)	Females (37.8%)
Age	≤ 45 years (51.1%)	> 45 Years (48.9%)
Level of Education	Low-Middle (48.3%)	High (51.7%)
Annual distance	< 10.000 km (39.4%)	> 10.000 km (60.4%)
Main car use purpose	Commute (51.1%)	Recreation (48.9%)

2.4 Model estimation

A multinomial logit (MNL) model was estimated to examine the extent to which the preferences for ISA implementation strategies (mandatory ISA, voluntary ISA with purchase subsidy, voluntary ISA with annual tax cuts), is influenced by financial incentives and policy measures, that is the targeted driver group and ISA type (warning or limiting). Only the two financial incentive variables are regular attributes in the sense that they are characteristics of the alternatives. As respondents made choices between the choice alternatives given a policy measure, the policy measure variables *target group* and *ISA type* do not vary among the choice alternatives within a choice set, thus are constants in each choice set but vary across choice tasks and respondents. More specifically, the following utility functions are estimated:

$$
\begin{aligned}
V_1 &= \beta_{ASC1} + \beta_{TG1}\cdot TG + \beta_{IT1}\cdot IT + \beta_{TG\_IT1}(TG\cdot IT)\\
V_2 &= \beta_{ASC2} + \beta_{TG2}\cdot TG + \beta_{IT2}\cdot IT + \beta_{TG\_IT2}(TG\cdot IT) + \beta_{PS}\cdot PS + \beta_{PS\_TG}(PS\cdot TG) + \beta_{PS\_IT}(PS\cdot IT)\\
V_3 &= \beta_{ASC3} + \beta_{TG3}\cdot TG + \beta_{IT3}\cdot IT + \beta_{TG\_IT3}(TG\cdot IT) + \beta_{TC}\cdot TC + \beta_{TC\_TG}(TC\cdot TG) + \beta_{TC\_IT}(TC\cdot IT)\\
V_4 &= 0
\end{aligned}
\qquad (1)
$$

Where:

- V_1, V_2, V_3 are the structural utilities for the three alternatives: 1: mandatory ISA; 2: voluntary ISA with purchase subsidy; 3: voluntary ISA with annual tax cuts;
- V_4 is the structural utility of the 'no implementation' alternative, which is the reference alternative and receives utility zero by definition;
- TG, IT, PS, TC, are the values of the variables varied in the choice experiment of Target Group, ISA Type, Purchase Subsidy, Tax Cuts respectively;
- β_{ASC1}, β_{ASC2}, β_{ASC3} are the alternative specific constants estimated for the three alternatives;
- β's are the alternative specific parameters to be estimated for either TG, IT, TG or PS or any interactions between these variables or with the constants.

The chosen alternative was registered by combining the responses observed for the two choice questions posed in each choice set. More specifically, if in response to the second question ('Should politicians actually make the decision to implement this policy measure, or rather take no policy measure at all?'), a respondent preferred that politicians actually implemented the respondent's preferred strategy, then the chosen implementation strategy as response to the first question was registered as his or her choice. If, on the other hand, the respondent preferred that politicians would rather not implement the implementation strategy, then the respondent's preferred implementation strategy was overruled and 'no implementation' was registered as the chosen alternative.

The elements varied in the experiment were coded as follows. The alternative specific constants are dummy coded and were all given the value 1, whereas the 'no implementation strategy' option was treated as the reference category and coded 0. In order to include categorical variables in the analysis and to standardize all variables, effects coding was applied (e.g. Louviere et al. 2000; Bech and Gyrd-Hansen, 2005). This involves that for each three level attribute, two indicator variables are constructed. A first indicator variable may code the first, second and third attribute level as 1, 0, -1 respectively, and a second indicator variable may code these levels as 0, 1, -1 respectively. If an attribute is coded in this way, the coefficient estimated for the first indicator variable denotes the contribution to utility derived from the first attribute level, and the coefficient estimated for the second indicator variable denotes the contribution to utility derived from the second attribute level. The utility contribution of the third level is then derived as the negative sum of the utility contributions of the first and of the second level. Consequently, the sum of the utility contributions of the levels of an attribute is equal to zero. Thus, for each three level attribute, two parameters are estimated, which implies that only two t-values per attribute are presented in the results table for each three-level attribute. To ease interpretation, we add to the table the utility contribution of the third level in italics to indicate that this value is not estimated but derived from other coefficients.

An advantage of effects coding is that the estimated alternative specific constants can be interpreted as the average utility of that alternative. It should be noted that this is an average value, averaged across the six policy measures (hence, three target groups and two ISA type combinations). The estimated utility contributions express the contribution of each attribute level to the overall utility derived from an alternative, expressed as a deviation from the average utility (as estimated by the constant). Furthermore, for three level attributes, the estimated coefficients provide an easy test for linearity: if the coefficient of the second indicator variable is not statistically significant, it can be concluded that utility varies linearly with changing attribute levels. Note that if all attributes are effects coded, the strength of the estimated coefficients can be directly compared in terms of the impact the attributes have on overall utility.

The coefficients of the effects coded variables were derived by estimating a MNL model in Biogeme (Bierlaire 2003). The only adaptation of the earlier specified utility functions was that the

interaction effect of target group with ISA type was made generic, which simplified the model. This was justified as the three estimated alternative specific coefficients had about the same value. The estimated model significantly improved the Null model (LL_b=-3811.282, LL_0= -4591.407) and had a Rho-square value of 0.170. Furthermore, the extent to which estimates of the basic model vary with background variables was tested by adding interaction effects of the background variables with all the coefficients of the basic model. The background variables were categorized as presented in Table 1 and effects coded (-1,1). First, a series of models that each included the interactions of a single background variable with all model coefficients were estimated and insignificant variables were removed step by step. Then, the statistically significant interaction coefficients across all background variables were included in a single model. In total, 12 interactions with background variables turned out to be statistically significant, of which inclusion in the model significantly improved the model fit (LL_{b2}=-3586.385; Rho-square = 0.202.)

In addition, we tested whether any remaining heterogeneity could be identified after inclusion of the background variables. To that effect, we estimated standard deviations for each coefficient in a mixed logit model. However, as the model contains many coefficients and there is a limit to the number of standard deviations one can estimate in a mixed logit model, we cannot simply estimate all standard deviations in a single model. To explore for which coefficients heterogeneity exists, a series of mixed logit models were estimated, each estimating only a standard deviation for a single coefficient. Model estimation started with 100 Halton draws, which in following runs was constantly doubled until stable coefficients were found or the standard deviation was not statistically significant in two consecutive runs. None of the standard deviation coefficients were found to be statistically significant at both 100 and 200 Halton draws. Hence, no standard deviations were included in the final model.

Finally, as two voluntary ISA alternatives were included in the choice sets, that is with purchase subsidy and with annual tax cuts, it may be argued that these share unobserved components that they do not share with mandatory ISA. To test this, we added a joint error component to the utility functions of both voluntary ISA alternatives and estimated an error component model. This estimate was not statistically significant in the models estimated with both 200 and 400 Halton draws. From this result, we can conclude that unobserved effects of both voluntary implementation options are not correlated, thus that the IIA assumption holds for the estimated MNL model.

3. Results

Table 2 presents the coefficients of the estimated MNL model, which will be interpreted in this section.

3.1 Preferences for ISA implementation strategies and target group

The estimated alternative specific constants denote the average utility respondents derive from an implementation strategy alternative averaged across all presented 54 policy measure – implementation strategy combinations. The estimated average utilities can be compared to 'no policy measure option' which was the reference alternative and received a utility of zero by definition. All estimated alternative specific constant have a negative value, which indicates that car drivers generally prefer that politicians do not implement any ISA policy measure.

Comparing the constants of the two voluntary ISA alternatives (with purchase subsidy and with annual tax cuts) indicates that on average, purchase subsidy (-1.09) is preferred over annual tax cuts (-1.41). This confirms the hypothesis that money available now is preferred to a money gain at some point in the future, which is in line with Peters and Büchel (2010).

Mandatory ISA has a higher average utility (-0.23) than both voluntary ISA options (with purchase subsidy and with annual tax cuts). However, the estimated constant * target group

interactions indicate that especially preference for mandatory ISA strongly depends on the targeted driver group. A positive interaction effect is found for mandatory ISA and the target group *speed offenders* (0.94), which means that the average utility derived from the policy package *mandatory ISA for speed offenders* is positive (-0.23+0.94=0.71) and thus preferred above taking no policy measures. Furthermore, *mandatory ISA for professional drivers* has the same utility as the *no policy measure* option, whereas car drivers derive a very low average utility (-1.40) from *mandatory ISA for all drivers.* As all respondents are car drivers and thus belong to the latter target group (*all drivers*), this clearly indicates that car drivers dislike mandatory ISA for own use.

Table 2. Estimated parameters (MNL model)

Constants - alternative specific	coefficient	t-value
No policy measure (reference)	*0.00*	
Mandatory ISA constant (MI)	-0.23**	5.01
Voluntary ISA with purchase subsidy constant (VIPS)	-1.09**	17.77
Voluntary ISA with annual tax cuts constant (VITC)	-1.41**	20.47
Constant * target group interactions		
MI * speed offenders	0.94**	15.62
MI * professional drivers	0.23**	3.75
*MI * all drivers #*	*-1.17*	
VIPS * speed offenders	-0.59**	5.77
VIPS * professional drivers	0.40**	4.95
*VIPS * all drivers*	*0.19*	
VITC * speed offenders	-0.46**	4.15
VITC * professional drivers	0.16*	1.70
*VITC * all drivers*	*0.30*	
Constant * ISA type interactions		
MI * warning ISA	0.10*	2.22
*MI * limiting ISA*	*-0.10*	
VIPS * warning ISA	0.15*	2.34
*VIPS * limiting ISA*	*-0.15*	
VITC * warning ISA	0.17**	3.02
*VITC * limiting ISA*	*-0.17*	
Constant * target group * ISA type interactions (generic)		
speed offenders * warning ISA	-0.18**	3.25
*speed offenders * limiting ISA*	*0.18*	
professional drivers * warning ISA	0.06	1.17
*professional drivers * limiting ISA*	*-0.06*	
*all drivers * warning ISA*	*0.12*	
*all drivers * limiting ISA*	*-0.12*	
Purchase subsidy (voluntary ISA)		
€ 75	*-0.32*	
€ 150	0.04	0.44
€ 225	0.28*	3.59
Purchase subsidy * target group interactions:		
€150 * speed offenders	-0.12	0.88
€150 * professional drivers	0.08	0.73
€225 * speed offenders	-0.06	0.48
€225 * professional drivers	0.00	0.03
Purchase subsidy * ISA type interactions:		
€150 * warning ISA	0.04	0.48
€225 * warning ISA	-0.02	0.32

Annual road tax cuts (voluntary ISA)		
€ 25	*-0.30*	
€ 50	0.02	0.24
€ 75	0.28*	3.22
Annual road tax cuts * target group interactions:		
€50 * speed offenders	0.04	0.29
€50 * professional drivers	-0.02	0.14
€75 * speed offenders	-0.23	1.55
€75 * professional drivers	0.12	1.03
Annual road tax cuts * ISA type interactions:		
€50 * warning ISA	-0.01	0.13
€75 * warning ISA	0.04	0.49

** Significant at the 0.05 level; * significant at the 0.10 level

The levels coded -1 are presented in italics: their utility contributions are not estimated but derived from the estimated utility contributions of the other levels. Note that these are only presented if one of the estimates for the other levels is statistically significant.

The interaction effects for target group with both voluntary ISA options (with purchase subsidy and with annual tax cuts) indicate that voluntary ISA decreases utility if speed offenders are targeted (-0.59 and -0.49), but increases utility if professional drivers and all drivers are targeted. Furthermore, these interactions indicate that utility derived from purchase subsidy is higher if professional drivers are targeted compared to all drivers, whereas the reverse is observed for annual tax cuts. Nevertheless, while taking into account the target group effects, car drivers still prefer a purchase subsidy (1.09+0.19=-0.90) above annual tax cuts (-1.41+0.30 = -1.11) for own use.

3.2 Preferences for ISA implementation strategies and ISA type

The estimated interactions for the constants * ISA type are statistically significant, but they influence the choice for implementation strategies to a much smaller extent than target group. A policy measure aimed to stimulate warning ISA increases the utility of all the three ISA implementation strategies by 0.10 to 0.17 utility points, while utility decreases if limiting ISA is stimulated.

In addition, also the estimated three-way interaction effects of target group with ISA type are statistically significant, suggesting that the effect of ISA type depends on the specific driver group that is targeted. Utility actually decreases by -0.18 utility points if warning ISA is stimulated for speed offenders, arriving at a negative net result (0.10-0.18=-0.08) for this target group. The latter implies that limiting ISA is preferred for speed offenders. The reverse effect is observed for all drivers, with a clear preference for warning ISA (0.17+0.12=0.29) and a dislike for limiting ISA (-0.29). The same effects are observed when professional drivers are targeted, however, the effects are somewhat smaller. That the three-way interactions are found to be generic across the three implementation strategies, means that car drivers do not derive additional utility from combining mandatory ISA with limiting ISA for speed offenders as one may have expected.

3.3 Financial incentives

As expected, utility derived from voluntary ISA implementation increases with the amount of financial incentives given. The varied range in purchase subsidy and in annual tax cuts have about the same impact on utility. Furthermore, the coefficients for both financial incentives that denote the effect of the middle values are not statistically significant, which indicates that the utility linearly increases with increasing financial incentives. None of the interactions of target group and ISA type with the financial incentives is statistically significant, from which can be concluded that the extent to which financial incentives can increase utility is the same for all distinguished target groups as well as for limiting and warning ISA.

3.4 Segmentation

Table 3 presents the statistically significant coefficients for the interactions of background variables with elements varied in the experiment. The results indicate that the utility of mandatory and both voluntary systems is higher for females and the older age group. This is in line with findings in earlier research (e.g., Rienstra and Rietveld, 1996; Jamson, 2006; Molin and Brookhuis 2007; Vlassenroot et al. 2010, 2011b).

Table 3. Background Variable Interactions

Background variable * attribute	coefficient	t-values
Gender		
males * mandatory ISA	-0.31	6.64
males * voluntary ISA with purchase subsidy	-0.32	5.58
males * voluntary ISA with annual tax cuts	-0.24	3.60
Age		
< 45 year * mandatory ISA	-0.25	5.55
< 45 year * voluntary ISA with purchase subsidy	-0.22	3.98
< 45 year * voluntary ISA with annual tax cuts	-0.56	8.46
level of education		
highly educated * voluntary ISA with purchase subsidy	-0.22	4.13
highly educated * voluntary ISA with annual tax cuts * speed offenders	-0.21	2.74
annual distance		
> 10,000 km per year * mandatory ISA * warning ISA	-0.11	2.64
> 10,000 km per year * voluntary ISA with purchase subsidy * warning ISA	0.14	2.55
main car use purpose		
commuting * voluntary ISA with purchase subsidy	0.19	3.63
commuting * amount of annual tax cuts	-0.21	2.77

The other significant effects indicate that the *highly educated* derive a lower utility from voluntary ISA with purchase subsidy and also from a voluntary ISA with annual tax cuts introduced for speed offenders. Furthermore, car drivers who drive more than 10,000 km per year derive a lower utility from a mandatory warning ISA system, whereas they derive a higher utility from voluntary ISA with purchase subsidy in combination with warning ISA. Finally, commuters derive a higher utility from voluntary ISA with purchase subsidy and have a stronger coefficient for the amount of annual tax cuts.

In general, from these results it can be concluded that differences between background variables are rather limited. Together with the earlier reported finding that in mixed logit estimations no significant standard deviations were found for any of the estimated coefficients, these results lead to the conclusion that rather homogeneous preferences exist for the elements varied in this experiment once background variables are included in the model.

3.5 Preferences for ISA policy packages

To get a feeling for preferences for complete ISA policy packages, these are predicted based on the coefficients of the estimated MNL model. Policy packages were constructed by combining each policy measure with an implementation strategy. In fact, all possible elements varied in the experiment, except for the middle values of the financial incentive attributes, were combined with each other. Predicted is the share of car drivers that prefers that politicians actually implement the ISA policy package rather than do nothing at all. Table 4 presents the predicted shares.

Among others, the results indicate that about two-thirds of the car drivers (68.8%) prefers that a mandatory limiting ISA is introduced for speed offenders. On the other hand, only 16.5% of the car drivers prefers that such a system is introduced for all car drivers, the group they belong to themselves. The results also indicate that car drivers prefer that mandatory ISA is imposed on professional drivers. Furthermore, it becomes clear that even with a maximum subsidy, a

voluntary warning ISA system for all drivers is only preferred by 41.8% of the car drivers. As the presented shares reflect the effects discussed in detail before, the results are not further discussed here.

Table 4. Predicted preference shares for various policy packages

		Mandatory ISA	voluntary ISA with purchase subsidy		voluntary ISA with annual tax cuts	
			€ 75	€ 225	€ 25	€ 75
speed offenders	warning	65.2%	11.8%	19.6%	8.7%	14.6%
	limiting	68.8%	16.1%	25.9%	12.0%	19.6%
professional drivers	warning	54.0%	31.4%	45.5%	18.4%	28.7%
	limiting	46.0%	28.9%	42.6%	16.7%	26.3%
all drivers	warning	23.5%	28.3%	41.8%	21.6%	33.0%
	limiting	16.5%	23.7%	36.1%	17.8%	27.9%

4. Conclusions

In this paper, car drivers' preferences for ISA policy packages are examined. In a stated choice experiment, the choices for three ISA implementation strategies (mandatory ISA, voluntary ISA with purchase subsidy and voluntary ISA with annual tax cuts) are observed given a policy measure, that is, a particular driver group that is targeted and whether warning ISA or limiting ISA is stimulated. To create a realistic choice task in order to include options that respondents cannot choose in real life, like mandatory ISA that is imposed on them, respondents were requested to express which policy measures politicians in their opinion should take.

The results suggest that preferences for ISA policy packages in particular vary with the specific driver group that is targeted, that is, speed offenders, professional drivers and all drivers. The policy package *mandatory limiting ISA for speed offenders* is most preferred by the car drivers (68.8%). This suggests that a policy that imposes a limiting ISA on speed offenders may receive wide approval from car drivers, the largest driver group. On the other hand, only 16.5% of the car drivers prefers that this package is implemented for own use.

Compared to target group, ISA type has a much smaller impact on ISA implementation choice. The results indicate that car drivers prefer policies that stimulate warning ISA for themselves and for professional drivers, while they prefer limiting ISA for speed offenders.

Furthermore, the results suggest that policy makers can increase voluntary ISA purchase by providing financial incentives. A purchase subsidy has a larger impact on voluntary ISA purchase than annual tax cuts. The results further suggest that by implementing financial incentives, especially the drivers who drive more kilometres than average and commuters may be motivated to voluntary purchase an ISA system, although the effects of this compared to the other drivers groups are rather limited.

Furthermore, the results indicate that females and the older age group have consistent higher preference for implementing ISA policy measures than males and younger drivers, which is in line with findings of previous research. Furthermore, once all background variables were included in the model, we were not able to detect any remaining heterogeneity in preferences in estimated mixed logit models. These results suggest that preferences among car drivers for the elements varied in this experiment are rather homogeneous. This is not in line with the results of Chorlton et al. (2012) who found substantial heterogeneity in willingness to pay for ISA systems. Possibly our finding of homogeneity is caused by the applied snowball sampling technique,

which may have led to a rather homogeneous sample. Another explanation may be that the utility function was well specified, hence, the relatively large number of estimated coefficients are able to capture the structural utility well. Nevertheless, preference heterogeneity remains an interesting topic for further research.

5. Discussion

One could argue that framing the measurement task as respondents telling politicians which choices they need to make might have induced respondents to take political considerations into account as if they were a politician making this choice. However, by explicitly stressing to the respondents that the choice is about their own opinion, we believe that the probability that the observed choices reflect political considerations is negligible and we assume that the observed choices actually reflect the respondents' own preferences. Whether this assumption is indeed justified may be examined in future methodological research.

The results point out that car drivers prefer that policy makers do not impose ISA on all drivers, which is in line with earlier research (e.g. Piao, 2005). The results also suggest that less than half of the car drivers prefer that policy makers adopt any policy measure to stimulate voluntary ISA use for all drivers. The latter is not in line with earlier research that suggests higher acceptance levels of about 70% (Piao, 2005) or even higher (Vlassenroot, 2011b). Part of the lower rates found in this study may be explained by an overrepresentation of males, higher educated and young respondents in the sample, for which consistently lower acceptance levels were reported in the literature (and also partly in this study). Another reason for the difference may be that our study focused on policy measures, whereas other studies asked respondents whether they would like to have or would prefer an ISA system. Hence, many car drivers may regard ISA as a device offered by car manufacturers as a voluntary option which they may consider purchasing. Consequently, they do not consider it a task for policy makers to interfere with this, which may explain the lower acceptance levels found in this study.

Yet another alternative explanation for this difference may be related to recruitment of respondents. There is the general tendency that persons who are more interested in a topic are also more inclined to participate in a study related to that topic. It is likely that the more someone considers speeding a problem, the more inclined he or she is to participate in a study on speeding or more specifically on intelligent speed adaptation. Those persons may also be more in favour of ISA. If this is indeed the case, it could be argued that the estimated acceptance levels reported in the literature are systematically too high. Although it could be argued that this study also suffers from self-selection bias, it can be argued that this is less the case in this study than in other studies. The reason for this is that the vast majority of the respondents were recruited by snowball sampling starting with the personal network of one of the authors. Because potential respondents are invited by someone they know, it is likely that a large number of the respondents agreed to participate in the study as doing a favour to the person who invited them. Hence, it can be argued that the realised sample suffers less from self-selection bias than other studies, which may (at least partly) explain the lower acceptance levels of voluntary ISA found in this study. A possible way to avoid self-selection bias is to recruit respondents with no reference to the topic, hence, with no reference that the questionnaire is either about ISA, speeding or road safety in general. Thus, a more valid way of estimating the level of ISA acceptance would be to include questions on ISA acceptance in an omnibus questionnaire, which is a questionnaire that poses questions on a range of different topics.

Based on the low reported preference levels for ISA policy packages in this paper, politicians may consider taking accompanying policies that may increase these rates. For some possibilities in this respect, we refer to a paper by Molin and Brookhuis (2007). On the other hand, the results suggest that a relatively large share of the car drivers (69%) prefers that politicians actually adopt

a policy package that imposes a limiting ISA on speed offenders. Politicians have an interest in this option, given an experiment commissioned by the Dutch government recently conducted in the Netherlands, in which a speed limiter was imposed on convicted speed offenders. However, a side effect of imposing ISA on speed offenders may be that it affects ISA acceptance in a negative way for those who do not speed as ISA then becomes associated with notorious speed offenders, something that other car drivers may not wish to be associated with. To what extent this is the case is a question for further research.

This study also has its limitations, which pose challenges for further research. The response group was relatively small and though the distributions of most background variables matched those of the population fairly well, the sample cannot be considered to be representative of the Dutch population given the way respondents were recruited. Hence, to make more conclusive statements on car drivers' preferences for ISA policy packages, future research should aim for larger and more representative samples. Furthermore, respondents were only recruited among car drivers, further research may additionally recruit respondents from other target groups.

Another limitation is that in this study only three target groups were distinguished, hence, further research may include more target groups such as the youngest age group (e.g. Lahrmann et al. 2012). A further limitation is that the two voluntary ISA options (with purchase subsidy and with annual tax cuts) always provide subsidy, the voluntary ISA options are in fact always cheaper than mandatory ISA in this experiment. Hence, reported preferences also reflect the price difference. However, given the strength of the financial incentive coefficients and the relatively small price differences, this effect may have been rather limited. Likewise, different prices were introduced for limiting and warning ISA, hence, preference difference between these two ISA types may partly also reflect price differences. A final limitation we like to mention is the way the choice alternatives were presented to respondents, hence first presenting a target group and ISA type and then requesting a choice between mandatory and the two voluntary ISA options, may have been too complicated for respondents. The gain in reducing task load was partly lost by a need for a longer explanation of the choice task. Moreover, it made the estimated utility function more complex. It would have been simpler to just present choice tasks with complete policy packages as in regular stated choice experiments.

It is hoped that these considerations help improving further ISA acceptance research.

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