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Shift of reference point and implications on behavioral reaction to gains and losses

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Abstract It is widely recognized that individual decision-making is subject to the evaluation of gains and losses around a reference point. The estimation of discrete choice models increasingly use data from stated choice experiments which are pivoted around a reference alternative. However, to date, the specification of a reference alternative in transport studies has been fixed, whereas it is common to observe individuals adjusting their preferences according to a change in their reference point. This paper focuses on individual reactions, in a freight choice context, to a negative change in the reference alternative values, identifying the behavioural implications in terms of loss aversion and diminishing sensitivity. The results show a significant adjustment in the valuation of gains and losses around a shifted reference alternative. In particular, we find an average increase in loss aversion for cost and time attributes, and a substantial decrease for punctuality. These findings are translated to significant differences in the willingness to pay and willingness to accept measures, providing supporting evidence of respondents' behavioural reaction.

Keywords Willingness to pay · Gains and losses · Freight choice · Reference alternative

Introduction

The importance of considering the individual's choice behaviour as a decision based on the distinction between positive (gains) and negative (losses) deviations from a specific individual reference value (typically a well-experienced alternative) has been formulated in

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prospect theory (Kahneman and Tversky 1979), and introduced in both risky choices (Kahneman and Tversky 1979; Tversky and Kahneman 1992) and risk-less choices (Tversky and Kahneman 1991). In this context, prospect theory defines two fundamental assumptions involving the utility function, namely loss aversion, where individuals tend to evaluate losses higher than gains, and diminishing sensitivity where individuals show decreasing marginal values in both positive and negative domains.

Applications of prospect theory can be found in several economic fields such as, for example, financial markets (e.g., Benartzi and Thaler 1995), labour economics (e.g., Camerer et al. 1997), health economics (Samuelson and Zeckhauser 1988) and macro-economics (e.g., Shea 1995). Furthermore, the plausibility of prospect theory has been reinforced using a range of different data types and interview procedures, such as contingent valuation (Rowe et al. 1980) or laboratory experiments (e.g., Bateman et al. 1997).

The recent estimation of discrete choice models with a reference dependence specification has empirically reinforced the plausibility of prospect theory assumptions within the framework of reference pivoted experimental designs (see for example, Hess et al. 2008; Lanz et al. 2009; Masiero and Hensher (2010)). The utility function is expressed in terms of gains and losses around a reference alternative, without loosing the linearity in the parameters assumption underlying the Random Utility Model (McFadden 1974). Such a specification nests the commonly used specification obtained by imposing equality constraints between the absolute values of the parameter estimates associated with gains and losses.

The improved statistical performance of the reference dependence specification in terms of overall model fit, and the increasing use of reference pivoted experimental designs as techniques to add realism for respondents (Rose et al. 2008), are increasing the role played by the specification of the reference alternative in the model estimation process (see for example, Hess and Rose 2009; Rose et al. 2008). However, a crucial issue associated with the reference alternative is the specification of reference values in change contexts or in any framework that might involve a change in the initial values of the reference alternative (e.g., actual values versus expected values). Kahneman and Tversky (1979) note that:

> "… A change of reference point alters the preference order for prospect … A discrepancy between the reference point and the current asset position may also arise because of recent changes in the wealth to which one has not yet adapted …The location of the reference point, and the manner in which choice problems are coded and edited emerge as critical factors in the analysis of decision."

Very few studies have analysed the individual adaptation process followed by a change of the reference point. In this context, Arkes et al. (2008) conducted a survey to study the individual's adaptation after experiencing losses or gains in a stock price. Schwartz et al. (2008) illustrate an approach designed to identify, and hence adjust, the change in the utility perceived after a shift of the reference point in a medical decision making process. As far as we are aware, there are no studies that have investigated the implications on the utility function of changes in parameter estimates when the reference point is shifted.

The aim of this paper was to analyse the impact of a negative shift of the reference point on preference formation in terms of loss aversion and diminishing sensitivity, in a stated choice experiment framework. In particular, we refer to a pooled dataset consisting of two freight transport choice experiments with designs pivoted around two different reference alternatives, where one is the actual (or initial) reference alternative and the other is the expected (or shifted) reference alternative.[1] The identification of potential implications is based on the estimation and comparison of the marginal (dis)utilities associated with the gains and losses. We formulate and test different hypotheses of behavioural reaction and present the implications as willingness to pay and willingness to accept measures.

The paper is organised as follows. In "Data", we describe the two choice experiments and the context of the survey. "Methodology" provides an overview of the methodology developed as well as the hypotheses associated with behavioural reaction to a negative shift of the reference point. The results are presented and discussed in "Model results". Finally, in "Concluding comments and policy implications", we present the conclusions, some policy implications, and directions for further research.

Data

The data are centred around two stated choice experiments conducted in 2008 among logistics managers of medium to large manufacturing industries located in Ticino (Switzerland). The aim of the study was to evaluate the indirect freight transport costs associated with a temporary closure of the road Gotthard corridor, a crucial infrastructure in the European north/south transport connection, but also one highly vulnerable with respect to closure due to its geographical context and the presence of the 17-km-long two-lane tunnel.[2]

Logistics managers were contacted from eligible industries and asked for an appointment in their office to conduct the stated choice survey using a face-to-face computer assisted personal interview (CAPI). The managers that agreed to participate were asked about their general logistics and transportation structure and to describe a typical road transport activity along the road corridor under study. Information about cost, time and punctuality of the typical road transport trip were then used in order to create the design for the two experiments.

The first experiment involved a choice among three alternatives: road, piggyback (truck carried on train) and combined transport (combination of road and rail transport modes), respectively. The road alternative was set fixed across respondent choice situations (i.e., every choice situation contains a road alternative with all attributes at the observed levels) since it represents the reference alternative. The choice context was introduced, stressing the risk of frequent but short closures experienced currently along the road corridor. The second experiment hypothesised a temporary road closure by imposing a shift of the reference road alternative to the second-best road alternative, the San Bernardino road corridor. The magnitude of the imposed shift in terms of cost, time and punctuality of the transport service was obtained from a phone survey conducted with six of the most important shippers in Ticino. All the interviewed shippers indicated a high level of experience gathered from previous closures of the main road corridor, and reported very similar extra cost and time for a detour via the second best road alternative, which most often resulted in an increase of 300 CHF[3] and 5 h compared to the best road alternative. For punctuality, we assumed a decrease of 2% with respect to the original values, with a minimum level fixed to the lowest level considered, i.e., 96% of transport trips being

[1] The survey was conducted within the National Research Program NRP 54—Sustainable Development of the Built Environment—granted by the Swiss National Science Foundation.

[2] For more details about the study see Maggi et al. (2009) and Masiero and Maggi (2009).

[3] Approximate exchange rate 1 CHF = 0.964 USD.

Table 1 Attribute ranges in the stated choice design

	First experiment (initial scenario)			Second experiment (shift scenario)		
	Cost	Time	Punctuality	Cost	Time	Punctuality
Level 1	−10%	−10%	100%	−10%	−10%	100%
Level 2	−5%	−5%	98%	−5%	−5%	98%
Level 3	Reference cost	Reference time	96%	Transitional cost	Transitional time	96%
Level 4	+5%	+5%		+5%	+5%	
Level 5	+10%	+10%		+10%	+10%	

punctual. This statement has been confirmed by the shippers interviewed, in particular if we consider the high volume of flows that occur in a similar situation. The four alternatives included in the second experiment are the second-best road, the regulated road,[4] piggy-back, and combined transport.

The two choice experiments were undertaken sequentially with each respondent by explaining the context of the research and making sure they fully understood the survey procedure. The experimental design was built following a reference pivoted approach,[5] for cost and time attributes. Specifically, in the first experiment, the cost and time levels were pivoted around the reference alternative described by each respondent during the preliminary survey, whereas in the second experiment they were pivoted around the second-best road alternative consisting of the reference alternative augmented by the detour values according to the values indicated by the shippers in the phone survey. Punctuality was expressed in absolute values for both experiments. Hereafter, the first experiment is referred to as the "initial" scenario, and the second experiment as the "shift" scenario.

Table 1 shows the range and the number of levels used for generating the hypothetical alternatives in terms of the three attributes included in the experiments, namely cost, time and punctuality. The selection of the attributes and their levels is based on past experience in stated choice experiment surveys with logistics and transport managers (see for example, Danielis et al. 2005; Maggi and Rudel 2008). In order to distinguish between the two reference alternatives across the two experiments, and given the temporary nature of the second experiment, the second-best road values are named transitional, and formally expressed as follows:

$$\text{Transitional cost} = \text{reference cost} + 500\,\text{CHF} \tag{1}$$

$$\text{Transitional time} = \text{reference time} + 5\,\text{h} \tag{2}$$

$$\text{Transitional punctuality} = \min(\text{reference punctality} - 2,\, 96) \tag{3}$$

The typical transport service described by logistic managers is reported in Table 2. As expected, cost and time vary substantially since they are characterized by the distance between an origin and destination (O–D) and by the weight of the shipment, whereas

[4] The regulated road alternative simulates a congestion free San Bernardino alternative by assuming a priority policy for trucks which allows the original punctuality to be maintained.

[5] Within a reference pivoted approach, attribute levels for all hypothetical alternatives presented are based on the attribute levels of the reference alternative. In this context, the reference alternative can either be included as an available alternative to choose or not. In the experiments, the reference alternative was included in the choice set.

Table 2 Sample descriptive statistics of typical transport service

Variable	Mean	Median	SD	Minimum	Maximum
Cost (CHF)	1,300	1,000	1,152	136	5,400
Time (h)	33.35	24	27.30	2	96
Punctuality (%)	96.52	98	3.04	90	100
Weight (ton)	7.1309	5.50	7.17	0.04	25
Distance O–D (km)	474	300	332	92	1,360

Table 3 Example of choice card for the first experiment (initial scenario)

Suppose a situation where the road Gotthard corridor is going to be closed for a maximum of two consecutive days every month. Which of the following alternatives would you prefer?

Road	Combined transport	Piggyback
Reference cost	5% more than reference cost	5% less than reference cost
Reference time	10% more than reference travel time	5% more than reference travel time
Reference punctuality	100% punctuality	96% punctuality

Table 4 Example of choice card for the second experiment (shift scenario)

Suppose a situation where the road Gotthard corridor is closed for 2 weeks. Which of the following alternatives would you prefer?

Second best road	Piggyback	Combined transport	Regulated second best road
Transitional cost	10% less than transitional cost	5% less than transitional cost	10% more than transitional cost
Transitional travel time	10% more than transitional travel time	10% more than transitional travel time	Equal to transitional travel time
Transitional punctuality	98% punctuality	96% punctuality	100% punctuality

punctuality is very homogenous, and apart from two cases stating a 90% of punctuality in the transportation services, all others are between 95 and 100%. This is in line with previous studies (see, for example, Bolis and Maggi 2003; Maggi and Rudel 2008) and confirms the high level of importance that a logistics manager places on a quality attribute like punctuality.

In both experiments, 15 choice situations (randomly generated) were presented to each logistics manager. Tables 3 and 4 give an example of a choice card for the first and second experiment, respectively.[6]

In the 2005 census,[7] the Ticino region included 101 medium (50–249 employees) and 16 large (more than 249 employees) firms corresponding to an employee share of 38 and

[6] The attributes levels for the hypothetical alternatives were presented in terms of percentage deviations. This is common practice in a freight transport choice experiment context given that logistics managers are familiar with percentage deviations. However, logistics managers were assisted during the experiment (face-to-face interview) with the possibility to visualize numerical values.

[7] Swiss Federal Statistical Office, Neuchâtel.

23%, respectively. In total, 60 firms were contacted and asked for their participation in the survey, resulting in a final sample of 27 firms (18 medium and 9 large in size). The two experiments were completed from the entire final sample, representing 810 choice observations.

Methodology

The utility function, associated with respondent n and alternative j for choice situation s is typically assumed to be linear in parameters, and represented as follows:

$$U_{njs} = \alpha_{j,d} + \sum_{k=1}^{K} \sum_{d=1}^{2} \beta_{kd} x_{njskd} + \varepsilon_{njs} \tag{4}$$

where α_j is the alternative-specific constant associated with alternative j and ε_{njs} is the random term assumed to be independent and identically distributed (IID) extreme value type 1. The k coefficients can be specified as dataset-specific, hereafter coded as $d = 1$ for the initial scenario and $d = 2$ for the shift scenario.[8] Within the mixed logit class of models, the entire or a subset vector of coefficients associated with the observed variables x_{njk}, are expressed as Eq. 5.

$$\beta_{nkd} = \beta_{kd} + \eta_{nkd} \tag{5}$$

η_{nkd} is a random disturbance drawn from some assumed distribution[9] which captures individual preference heterogeneity. The reference dependence model specification is obtained by specifying the utility function in terms of deviations from the reference values such that

$$U_{njs} = \alpha_{j,d} + \sum_{k=1}^{K} \sum_{d=1}^{2} \beta_{nkd}(dec) x_{njskd}(dec) + \sum_{k=1}^{K} \sum_{d=1}^{2} \beta_{nkd}(inc) x_{njskd}(inc) + \sum_{p=1}^{P} \sum_{d=1}^{2} \phi_{npd} z_{np} + \varepsilon_{njs} \tag{6}$$

where "dec" and "inc" stand for "decrease" and "increase", respectively, and $x_{njskd}(dec) = max(x_{ref} - x_{jd}, 0)$ and $x_{njskd}(inc) = max(x_{jd} - x_{ref}, 0)$,[10] where x_{ref} refers to observed levels for $d = 1$ and transitional levels for $d = 2$. The utility function associated with the reference alternative does not include any attribute parameters; however, the firm-specific characteristics (z_{np}) that enter the utility functions are treated as in any conventional symmetric model.

The specification in Eq. 6 allows us to test for loss aversion, which is verified if the coefficient associated with a loss (increase for cost and time and decrease for punctuality attributes) is larger in absolute value than the coefficient associated with a gain (decrease for cost and time and increase for punctuality attributes). However, in order to test for diminishing sensitivity, a form of nonlinearity has to be introduced in the utility function.

[8] This distinction leads to the estimation of both unrestricted and restricted models. The restricted model is obtained by estimating common coefficients across the two datasets.

[9] The most popular distributions are normal, triangular and lognormal. See Hensher and Greene (2003) for details.

[10] A reference-dependent specification is not new (see for example, Hess et al. 2008). However, to the best of our knowledge there are no applications focussed on a shift of reference point framework.

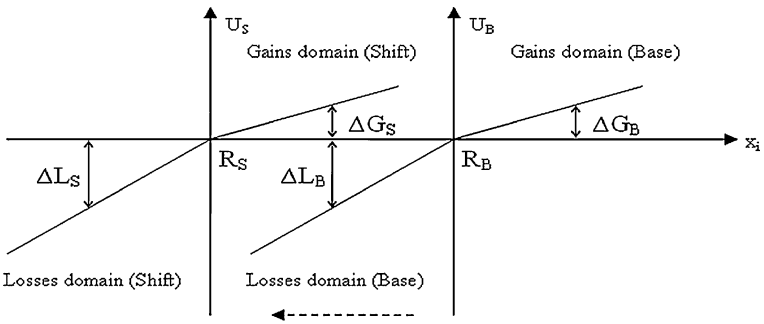

Fig. 1 Adaptation hypothesis

In this context, several nonlinear specifications have been used in past studies, including the power and exponential functions (Lanz et al. 2009), and a logarithmic transformation (Rose and Masiero 2009). However, in order to reflect the discrete nature of the attribute levels, we follow the same approach applied in Masiero and Hensher (2010)—a piecewise linear function defined in each range of the attribute levels. The generic utility function form that allows us to test for diminishing sensitivity is then expressed as Eq. 7.

$$U_{njs} = \alpha_{j,d} + \sum_{k=1}^{K}\sum_{d=1}^{2}\beta_{nkd}(dec-)x_{njskd}(dec-) + \sum_{k=1}^{K}\sum_{d=1}^{2}\beta_{nkd}(dec--)x_{njskd}(dec--) + \sum_{k=1}^{K}\sum_{d=1}^{2}\beta_{nkd}(inc+)x_{njskd}(inc+) + \sum_{k=1}^{K}\sum_{d=1}^{2}\beta_{nkd}(inc++)x_{njskd}(inc++) + \sum_{p=1}^{P}\sum_{d=1}^{2}\phi_{npd}z_{np} + \varepsilon_{njs}$$

For the cost and time attributes, $x_{njskd}(inc+)$ and $x_{njskd}(inc++)$ represent deviations from the reference value for increases of 5 and 10%, respectively. The same logic applies for the two cost and time decrease attributes levels. For punctuality, $x_{njskd}(dec–)$ refers to decreases from 3 up to 4%, $x_{njskd}(dec–)$ to decreases up to 2%, $x_{njskd}(inc\ +)$ to increases up to 2%, and $x_{njskd}(inc++)$ to increases from 3 up to 10%.

The investigation of a shift in the reference values, and its impact on the perception of gains and losses, implies the comparison between marginal (dis)utilities across the two experiments presented in the previous section. A graphical representation is given in Fig. 1. Let R_B and R_S denote the attribute reference points for the initial (i.e., base) and shift scenarios in utility space.[11] A shift in the losses domain reflects a left-side shift of the reference point from R_B to R_S. The consumer reaction to gains and losses in respect to the new reference point depends on the ability to adjust his perception towards the occurred change (Kahneman and Tversky 1979; Tversky and Kahneman 1992). In this context, a full adaptation to the new scenario would maintain unaltered the change in the utility associated with gains and losses experienced either in the initial or in the shift scenario. This condition can formally be tested through the following hypotheses:

[11] The graph is built according to desirable goods (i.e., travel punctuality). Note that in case of undesirable goods (i.e., travel cost and travel time), the direction of the x-axis is opposite-oriented.

$$\text{Adaptation hypothesis} \begin{cases} \Delta G_S = \Delta G_B \rightarrow H_0 : \beta_{nk2}(inc) = \beta_{nk1}(inc) \\ \Delta L_S = \Delta L_B \rightarrow H_0 : \beta_{nk2}(dec) = \beta_{nk1}(dec) \end{cases} \tag{8}$$

where the marginal utility (ΔG_i) and marginal disutility (ΔL_i), associated with a given attribute level in the gains and losses domains, respectively, are identified as the coefficients associated with increases and decreases in the utility functions (Eqs. 6 and 7).[12]

However, different reactions other than the adaptation hypothesis might occur if the individual has not completely adapted to the changed reference values. For example, we could expect a larger impact in the utility for gains in the shift scenario than in the initial scenario if the decision maker is trying to recover the initial loss. Formally,

$$\text{Gains recovery hypothesis} \begin{cases} \Delta G_S > \Delta G_B \rightarrow H_0 : \beta_{nk2}(inc) > \beta_{nk1}(inc) \\ \Delta L_S = \Delta L_B \rightarrow H_0 : \beta_{nk2}(dec) = \beta_{nk1}(dec) \end{cases} \tag{9}$$

Conversely, we might suppose a further increase in the loss aversion experienced from the decision maker as prevention to additional losses.

$$\text{Additional losses prevention hypothesis} \begin{cases} \Delta G_S = \Delta G_B \rightarrow H_0 : \beta_{nk2}(inc) = \beta_{nk1}(inc) \\ \Delta L_S > \Delta L_B \rightarrow H_0 : \beta_{nk2}(dec) > \beta_{nk1}(dec) \end{cases} \tag{10}$$

The estimation of the utility parameters associated with gains and losses, and their comparison across the two scenarios, allow us to test the hypotheses formulated, as well as any other pattern not discussed.

Given the panel structure of the data collected from the two stated choice experiments and the use of the mixed logit class of models, the estimation of the utility parameters is derived from the maximization of the following simulated log likelihood:

$$LLn = \sum_n \ln \frac{1}{R} \sum_r \prod_s \frac{\exp\left(\alpha_j + \beta_n' \mathbf{x}_{njs} + \varphi_n' \mathbf{z}_n\right)}{\sum_j \exp\left(\alpha_j + \beta_n' \mathbf{x}_{njs} + \varphi_n' \mathbf{z}_n\right)} \tag{11}$$

where $s = 1,\ldots, S$ represent the number of choice situations, and $r = 1,\ldots, R$ refers to the number of draws. Within the Random Utility Model framework, the coefficients are estimated along with the scale parameter, which reflects the variance of the unobserved component of the utility. Since different data sets have potentially different variances for unobserved utility, the comparison of the magnitude of the coefficients is possible only if the scale difference between the two data sets is taken into account. In this context, several techniques have been proposed in order to cope with difference in scale in jointly estimated choice models that use revealed preference (RP) and stated preference (SP) data (see for example, Swait and Louviere 1993; Hensher and Bradley 1993; Ben-Akiva et al. 1994). In this paper we refer to the approach recently used by Hensher (2008) which takes into account difference in scale by estimating the scale parameter for one of the two datasets considered in the pooled data.[13] According to Bhat and Castelar (2002), the scale parameter is expressed as follows:

[12] The introduction of nonlinearity in the utility functions does not alter the logic of the hypotheses assumed.

[13] It should be noted that in our context the aim is different from a typical RP and SP joint estimation. We are not interested to enrich the data with additional and complementary information, but we are instead looking at the comparison of coefficient magnitudes from different datasets.

$$\lambda_{njs} = \left[\left(1 - \delta_{njs,SPd}\right)\lambda_j\right] + \delta_{njs,SPd} \quad d = 1,2 \tag{12}$$

where $\delta_{njs,SPd}$ is a dummy variable that takes the value 1 for the observations associated with the dataset with the scale parameter normalised to 1, and zero otherwise. The parameter λj is derivable by introducing in one of the two data sets (arbitrarily selected) a set of alternative-specific constants (ASC) that have a zero mean and free variance (Brownstone et al. 2000). In fact, the following relationhip holds:

$$\lambda j = \pi \Big/ \sqrt{6}\sigma_{ASCj} = 1.28255 / \sigma_{ASCj} \tag{13}$$

where σ_{ASCj} are the standard deviations of the alternative-specific constants introduced in data set d. In our case we estimate the scale parameter associated with the first data set, referring to the initial scenario, consisting of three alternatives, two hypothetical alternatives and the reference alternative, respectively. From a preliminary analysis we noticed that the ASCs associated with the two hypothetical alternatives were not statistically different to one another. We decided then to nest the two hypothetical alternatives by constraining the estimation of only two additional ASCs, one for the reference alternative, and the other for the two hypothetical alternatives.[14]

Model results

We estimated three pairs of panel mixed logit models using 500 Halton draws[15] (from a triangular distribution) with results summarised in Table 5. The first pair of models (M1 and M2) refers to linear symmetric specifications given in Eq. 4; that is the classic form of specification commonly used in discrete choice modelling. We then introduce the reference dependence models M3 and M4, defined in Eq. 6, that allows us to test for loss aversion. The last pair of models (M5 and M6) is of the form in Eq. 7, and still based on the reference dependence specification, but with the integration of attribute piecewise transformations in order to capture potential nonlinearities that are compatible with the diminishing sensitivity prospect theory assumption.

The difference within each pair of models is that the first model has common coefficient estimates across the two dataset (a restricted model), whereas in the second model the coefficients are treated as dataset-specific (an unrestricted model).

In terms of goodness of fit we report the log-likelihood at convergence, the McFadden pseudo ρ^2 and the Akaike's Information Criterion (AIC) (normalised for sample size) (see Table 5). The best model in explaining the data is model M6 which reports a McFadden pseudo ρ^2 of 0.600 and an AIC index of 1.626 versus a McFadden pseudo ρ^2 of 0.542 and an AIC index of 1.820 obtained for model M2 which shows the poorest model fit measures among the six models estimated. Introducing nonlinearity in the reference dependence specification (models M5 and M6) increases, in general, the goodness of model fits in respect to the linear asymmetric specifications (models M3 and M4), and both specifications outperform substantially the symmetric ones (models M1 and M2). However, a first interesting result is provided from the comparison, within the three pairs of models, of the

[14] Note that the assumption of having different variance among alternatives leads to the estimation of a heteroskedastic choice model. In our case, we normalize the variance in respect to the four alternatives associated to the second dataset obtaining a constrained heteroskedastic choice model.

[15] See Train (2003) for details about Halton sequence. All models were estimated using a pre-release version of Nlogit 5.

Table 5 Estimation result for panel mixed logit model (500 Halton draws)

	M1		M2		M3		M4		M5		M6	
	Symmetric linear		Symmetric linear		Asymmetric linear		Asymmetric linear		Asymmetric piecewise		Asymmetric piecewise	
	Adaptation		Non-adaptation		Full adaptation		Non-adaptation		Full adaptation		Non-adaptation	
	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio
Means for non-random and random parameters												
ASC piggyback (initial)	−1.0952	−1.64	−1.3330	−1.99	−0.6247	−0.93	−0.2047	−0.24	−1.4228	−1.74	−0.6047	−0.81
ASC combined transport (initial)	−0.8815	−1.33	−1.1233	−1.69	−0.4092	−0.61	−0.0056	−0.01	−1.2207	−1.50	−0.4280	−0.57
ASC road (shift)	0.0585	0.17	0.0722	0.21	0.4697	1.20	0.5132	1.23	−0.1824	−0.43	−0.0804	−0.18
ASC piggyback (shift)	−0.2702	−0.77	−0.2597	−0.74	0.0949	0.24	0.1042	0.24	−0.5856	−1.35	−0.5445	−1.21
ASC combined transport (shift)	−0.3251	−0.94	−0.3159	−0.90	0.0052	0.01	−0.0047	−0.01	−0.5883	−1.37	−0.5036	−1.13
Km REFs (origin–destination distance)	0.0008	1.95	0.0008	1.98	0.0009	1.83	0.0011	1.98	0.0005	0.98	0.0008	1.38
Weight REFs (weight of the transport)	−0.0787	−2.90	−0.0782	−2.89	−0.0620	−2.22	−0.0551	−1.98	−0.0763	−2.58	−0.0649	−2.27
Cost	−0.0056	−10.69	–	–	–	–	–	–	–	–	–	–
Cost (initial)	–	–	−0.0056	−6.02	–	–	–	–	–	–	–	–
Cost (shift)	–	–	−0.0057	−8.86	–	–	–	–	–	–	–	–
Cost decrease	–	–	–	–	0.0051	5.20	–	–	–	–	–	–
Cost increase	–	–	–	–	−0.0103	−7.45	–	–	–	–	–	–
Cost decrease (initial)	–	–	–	–	–	–	0.0058	3.33	–	–	–	–
Cost increase (initial)	–	–	–	–	–	–	−0.0075	−3.56	–	–	–	–
Cost decrease (shift)	–	–	–	–	–	–	0.0055	4.14	–	–	–	–
Cost increase (shift)	–	–	–	–	–	–	−0.0126	−6.61	–	–	–	–
Cost decrease −	–	–	–	–	–	–	–	–	0.0065	3.47	–	–
Cost decrease − −	–	–	–	–	–	–	–	–	0.0055	5.42	–	–
Cost increase +	–	–	–	–	–	–	–	–	−0.0117	−5.25	–	–
Cost increase ++	–	–	–	–	–	–	–	–	−0.0098	−6.82	–	–

Table 5 continued

	M1		M2		M3		M4		M5		M6	
	Symmetric linear		Symmetric linear		Asymmetric linear		Asymmetric linear		Asymmetric piecewise		Asymmetric piecewise	
	Adaptation		Non-adaptation		Full adaptation		Non-adaptation		Full adaptation		Non-adaptation	
	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio
Cost decrease − (initial)	–	–	–	–	–	–	–	–	–	–	0.0086	2.44
Cost decrease − − (initial)	–	–	–	–	–	–	–	–	–	–	0.0061	3.34
Cost increase + (initial)	–	–	–	–	–	–	–	–	–	–	−0.0078	−2.17
Cost increase ++ (initial)	–	–	–	–	–	–	–	–	–	–	−0.0079	−3.42
Cost decrease − (shift)	–	–	–	–	–	–	–	–	–	–	0.0071	2.67
Cost decrease − − (shift)	–	–	–	–	–	–	–	–	–	–	0.0065	4.65
Cost increase + (shift)	–	–	–	–	–	–	–	–	–	–	−0.0174	−4.51
Cost increase ++ (shift)	–	–	–	–	–	–	–	–	–	–	−0.0116	−5.79
Time	−0.1109	−6.45	–	–	–	–	–	–	–	–	–	–
Time (initial)	–	–	−0.0970	−3.30	–	–	–	–	–	–	–	–
Time (shift)	–	–	−0.1180	−5.56	–	–	–	–	–	–	–	–
Time decrease	–	–	–	–	0.0668	1.66	0.0767	1.87	0.0674	1.57	0.0762	1.75
Time increase	–	–	–	–	−0.2157	−4.72	–	–	–	–	–	–
Time increase (initial)	–	–	–	–	–	–	−0.1061	−1.74	–	–	–	–
Time increase (shift)	–	–	–	–	–	–	−0.3061	−4.93	–	–	–	–
Time increase +	–	–	–	–	–	–	–	–	−0.3783	−4.22	–	–
Time increase ++	–	–	–	–	–	–	–	–	−0.1896	−4.19	–	–
Time increase + (initial)	–	–	–	–	–	–	–	–	–	–	−0.2460	−1.88
Time increase ++ (initial)	–	–	–	–	–	–	–	–	–	–	−0.0842	−1.35
Time increase + (shift)	–	–	–	–	–	–	–	–	–	–	−0.4726	−4.04
Time increase ++ (shift)	–	–	–	–	–	–	–	–	–	–	−0.2768	−4.32

Table 5 continued

	M1		M2		M3		M4		M5		M6	
	Symmetric linear		Symmetric linear		Asymmetric linear		Asymmetric linear		Asymmetric piecewise		Asymmetric piecewise	
	Restricted		Unrestricted		Restricted		Unrestricted		Restricted		Unrestricted	
	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio
Punctuality	0.3556	11.02	–	–	–	–	–	–	–	–	–	–
Punctuality (initial)	–	–	0.3644	6.52	–	–	–	–	–	–	–	–
Punctuality (shift)	–	–	0.3511	8.84	–	–	–	–	–	–	–	–
Punctuality decrease	–	–	–	–	−1.3070	−7.27	–	–	−1.2655	−6.99	–	–
Punctuality increase	–	–	–	–	0.5757	6.10	–	–	–	–	–	–
Punctuality decrease (initial)	–	–	–	–	–	–	−1.3186	−6.63	–	–	−1.2481	−6.18
Punctuality decrease (shift)	–	–	–	–	–	–	−1.3699	−2.61	–	–	−1.3623	−2.59
Punctuality increase (initial)	–	–	–	–	–	–	0.1401	1.85	–	–	–	–
Punctuality increase (shift)	–	–	–	–	–	–	0.9878	5.51	–	–	–	–
Punctuality increase +	–	–	–	–	–	–	–	–	0.8458	7.15	–	–
Punctuality increase ++	–	–	–	–	–	–	–	–	0.5216	6.81	–	–
Punctuality increase + (initial)	–	–	–	–	–	–	–	–	–	–	0.7100	1.96
Punctuality increase ++ (initial)	–	–	–	–	–	–	–	–	–	–	0.2144	2.31
Punctuality increase + (shift)	–	–	–	–	–	–	–	–	–	–	0.9553	7.06
Punctuality increase ++ (shift)	–	–	–	–	–	–	–	–	–	–	1.0505	4.19
Standard deviations for random parameters												
Time decrease	–	–	–	–	0.0668	1.66	0.0767	1.87	0.0674	1.57	0.0762	1.75
Punctuality increase	–	–	–	–	0.5757	6.10	–	–	–	–	–	–
Punctuality increase (initial)	–	–	–	–	–	–	0.1401	1.85	–	–	–	–
Punctuality increase (shift)	–	–	–	–	–	–	0.9878	5.51	–	–	–	–
Punctuality increase +	–	–	–	–	–	–	–	–	0.8458	7.15	–	–

Table 5 continued

	M1		M2		M3		M4		M5		M6	
	Symmetric linear		Symmetric linear		Asymmetric linear		Asymmetric linear		Asymmetric piecewise		Asymmetric piecewise	
	Restricted		Unrestricted		Restricted		Unrestricted		Restricted		Unrestricted	
	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio	Par.	*t* ratio
Punctuality increase ++	–	–	–	–	–	–	–	–	0.5216	6.81	–	–
Punctuality increase + (initial)	–	–	–	–	–	–	–	–	–	–	0.7100	1.96
Punctuality increase ++ (initial)	–	–	–	–	–	–	–	–	–	–	0.2144	2.31
Punctuality increase + (shift)	–	–	–	–	–	–	–	–	–	–	0.9553	7.06
Punctuality increase ++ (shift)	–	–	–	–	–	–	–	–	–	–	1.0505	4.19
Scale parameters (initial to shift scenario)[a]												
Piggyback and combined transport	0.5284	1.71	0.5385	1.68	0.3406	3.01	5.1699	−0.98	0.4347	2.58	1.0749	−0.12
Road (reference alt)	0.6179	1.17	0.6066	1.26	3.2904	−1.51	0.3726	2.76	0.7230	0.76	0.3698	2.65
Model fits												
Number of observations	810											
Log-likelihood at zero	−1,576.19											
Log-likelihood at convergence	−722.424		−721.989		−659.339		−644.269		−642.834		−630.602	
Number of parameters	12		15		15		20		19		28	
AIC	1.813		1.820		1.665		1.640		1.634		1.626	
McFadden pseudo $\rho 2$	0.542		0.542		0.582		0.591		0.592		0.600	

[a] *t* ratio for the hypothesis that the scale parameters are statistically equal to one

AIC index which in its calculation accounts for both a reduction in the log-likelihood and an increase in the number of parameters estimated. According to the AIC index, model M1 is preferred to M2, suggesting that there are no overall significant differences between the coefficients associated with the initial and shift scenarios. We observe exactly the opposite result once we introduce the reference dependence specifications, where models M4 and M6 outperform models M3 and M5, respectively.[16]

For each of the six models, we have estimated the scale parameters for the three alternatives associated with the initial scenario, with the aim of levelling any unobserved variance difference between the two datasets, making possible the comparison between coefficient estimates. From the scale parameters that are statistically significant different from one at a confidence level of 0.1, we observe that they all are smaller than one, suggesting a greater variance of the unobserved effects for the initial scenario than for the shift scenario. Although it is plausible to expect a difference in scale between two datasets, we had no expectation about the magnitude associated with the stated preferences structure of the experiment in both scenarios. However, when pooling stated and revealed preference data, a common practice is to hypothesise that the stated preference data hold a greater part of unobserved variance, even if it is not always verified. In this context, Hensher (2008), for example, does not report any statistically significant differences between stated and revealed preferences in terms of scale parameters.

Looking at the parameter estimates that are in common to all the six models, we notice substantial homogeneity over models in the alternative-specific constants and the two firm-specific characteristics. Given that the ASC for the reference alternative is normalised to zero in both the initial and shift scenarios, the results show a negative propensity to switch towards rail-based alternatives, while the only other road alternative proposed in the experiments shows a positive sign for models M1 to M4, and a negative sign for models M5 and M6. However, most ASCs are not statistically significant at the alpha level of 0.10, with the exception of the constants referring to the initial scenario and those associated with the piggyback alternative in models M1, M2 and M3 and combined transport in model M2. The firm-specific variables are introduced in the utility of the two reference alternatives without distinguishing between the scenarios, since no significant differences were found from preliminary modelling. The first variable refers to the origin–destination distance (Km REFs) and shows a positive relationship between the reference alternative and travel distance meaning that logistics managers show an increasing preference to maintain the reference road alternative as the transport distance increase. On the contrary, the firm-specific variable that refers to the weight of the transport (Weight REFs), indicates a preference of hypothetical alternatives proportional to the weight of the shipment. In particular, logistics managers' preference towards rail-based transport alternatives increases as the shipment weight increases.

Turning to the coefficient estimates associated with the three modal attributes, namely cost, time and punctuality, all of the coefficients are of the expected sign and statistically significant. Models M1 and M2 show negative signs for cost and time and positive signs for punctuality, whereas models M3, M4, M5 and M6 report signs of the coefficients consistent with the definition of gains and losses around the reference point, where gains are associated with positive signs and losses with negative signs. For models M3 to M6, a further subset of random parameters has been estimated[17] involving the coefficients

[16] More formal *t* tests are provided further in this section (see Table 4).

[17] Note that the ASCs introduced in order to estimate the scale parameters are actually random parameters with zero mean and normal standard deviation.

associated with gains in both time and punctuality, i.e., time decrease and punctuality increase, respectively. Since we are interested in comparing the means of the coefficients between the two scenarios, the exact empirical identification of the parameter's mean estimates has been tested.[18] The random parameters are distributed according to a triangular distribution. Since the comparison of willingness to pay and willingness to accept measures play an important role in the analysis, we chose to constrain the standard deviation of the random parameters to be equal to the mean to ensure the same sign of the coefficient within the distribution.[19] As shown in Table 5, the coefficient associated with gains in time (time decrease) does not distinguish between the initial and shift scenarios in models M4 and M6 (i.e., common time decrease coefficient across the two datasets). Furthermore, diminishing sensitivity has not been introduced in the gains domain of the time attribute (models M5 and M6). These constraints were necessary due to the statistical insignificance reported although the problem has been resolved only in part since the parameter associated to time decreases is significant only at the alpha level of 0.1 in models M3, M4 and M6 (and at the alpha level of 0.15 in model M5). Furthermore, we do not allow for nonlinearity in the loss domain of punctuality (punctuality decrease in models M5 and M6) due to the restriction imposed by the design for the shift scenario (see "Data"). Indeed, it was possible to estimate nonlinearity in the initial scenario, but for the sake of comparison it has been treated as asymmetric, but linear, in both scenarios.

Analysing the magnitude of the parameters associated with gains and losses in models with reference dependence specifications (M3, M4, M5 and M6), we notice that all the parameter means associated with losses are in absolute values greater than those referring to gains. This holds for both initial and shift scenarios, supporting the assumption that respondents actually experienced loss aversion. Indeed, evidence of loss aversion has been found by other recent studies and in different contexts (see for example, Hess et al. 2008; De Borger and Fosgerau 2008; Lanz et al. 2009; Hjorth and Fosgerau 2009; Bateman et al. 2009). From models M5 and M6, we can also investigate the presence of diminishing sensitivity by comparing the magnitude of the coefficients estimated within the gains and losses domains for different attribute levels. Diminishing sensitivity is clearly evident in model M5 for all the three attributes considered, where the absolute values of the coefficients decrease as the attribute levels increase. This pattern is still present in model M6, although some linearity is observed for the cost coefficients associated with losses in the initial scenario, and for the punctuality coefficients associated with gains in the shift scenario.

The main focus of the paper was to investigate respondents' behavioural changes in response to a shift in the reference values. In this context, we continue the analysis by performing a set of asymptotic *t*-ratio tests on the parameter estimates obtained for the unrestricted models M4 and M6, which allow us to test the hypotheses formulated in Eqs. 8–10. Formally, the asymptotic *t*-ratio test is defined, according to the null hypotheses, as follows:

[18] As an identification test, each model has been run with 500 and 1,000 Halton draws assuring the stability of both model fits and coefficients magnitude (see Chiou and Walker 2007).

[19] See Hensher and Greene 2003 for proofs and discussions on the use of constrained triangular distribution in discrete choice models. It should be noted that the estimation of the two cost parameters (gains and losses) makes the estimation of the model in the WTP space no longer desirable. However, recent findings (Hensher and Greene 2010) suggest the capability of constrained distributions in preference space in approximating WTP measures obtained from models estimated in WTP space.

Table 6 Adaptation hypotheses test (*t* ratio for null hypothesis in brackets)

	Cost	Time	Punctuality
MODEL M4: asymmetric linear			
Adaptation hypothesis			
Gains	**H_0 not rejected (0.13)**	**H_0 not rejected (–)**	H_0 rejected (−4.35)
Losses	H_0 rejected (1.80)	H_0 rejected (2.48)	**H_0 not rejected (0.09)**
MODEL M6: asymmetric piecewise			
Adaptation hypothesis			
Gains (+)	**H_0 not rejected (0.32)**	**H_0 not rejected (–)**	**H_0 not rejected (−0.63)**
Gains (++)	**H_0 not rejected (−0.15)**	**H_0 not rejected (–)**	H_0 rejected (−3.14)
Losses (−)	H_0 rejected (1.83)	H_0 not rejected (1.36)	**H_0 not rejected (0.20)**
Losses (–)	H_0 not rejected (1.21)	H_0 rejected (2.28)	–

The respondents' reaction is highlighted by marking in bold the hypotheses that are corroborated in terms of *t* ratio for both gains and losses domains

$$H_0' : \hat{\beta}_q = \hat{\beta}_r \rightarrow (\hat{\beta}_q - \hat{\beta}_r) \Big/ \sqrt{\mathrm{var}(\hat{\beta}_q - \hat{\beta}_r)}; \quad (q, r) \in d(1, 2) \tag{14}$$

where $\mathrm{var}(\hat{\beta}_q - \hat{\beta}_r) = \mathrm{var}(\hat{\beta}_q) + \mathrm{var}(\hat{\beta}_r) - 2\mathrm{cov}(\hat{\beta}_q, \hat{\beta}_r)$. We summarise the results in Table 6, distinguishing the cost, time and punctuality attributes in both asymmetric linear and nonlinear models. The respondents' reaction is highlighted by marking in bold the hypotheses that are corroborated in terms of *t* ratio for both gains and losses domains.

Interestingly, the negative shift of the reference point imposed in the second experiment shows a similar pattern for cost and time attributes which is, on the other hand, the mirror image of the punctuality attribute. In particular, looking at the results from model M4, we note that respondents experienced the same change in the utility after gains in cost and time attributes, either in the initial or in the shift scenario, since we cannot reject the null hypothesis that the coefficients are the same. We reject instead the null hypothesis in the losses domain, and since the coefficient estimates are larger in absolute value for the shift scenario, this implies that respondents tried to prevent further losses in terms of cost and time attributes (as in Eq. 10). Conversely, respondents show a strong desire to recover the initial loss that affected the punctuality of the transport service (as in Eq. 9). From Table 5, we can see that the coefficient associated with an increase in punctuality is 0.1401 for the initial scenario, and 0.9878 for the shift scenario. For the losses domain, we do not report statistically significant differences between the two scenarios for the punctuality attribute. As a result, respondents experienced a remarkable reduction (almost total) in loss aversion after a negative shift of the reference of the punctuality attribute.

A similar pattern is verified for model M6 for the cost and time attributes, although the *t* ratio for the second and first levels in the losses domain of cost and time attributes report a weak significance (1.21 and 1.36, respectively). The introduction of nonlinearity in model M6 gives an interesting result for the punctuality attribute. The *t* ratio (−0.63) does not suggest any statistical difference between the initial and shift scenarios for a 2% increase in the punctuality attribute. This can be explained by the high importance that this attribute represents for logistics managers (see also, Bolis and Maggi 2003; Maggi and Rudel 2008) who, even reporting a punctuality average of 98%, consider attractive a further increase of 2%.

We graphically illustrate the results on reaction hypotheses by plotting, in Fig. 2, the changes in the utility function according to the coefficient estimates obtained in models M4

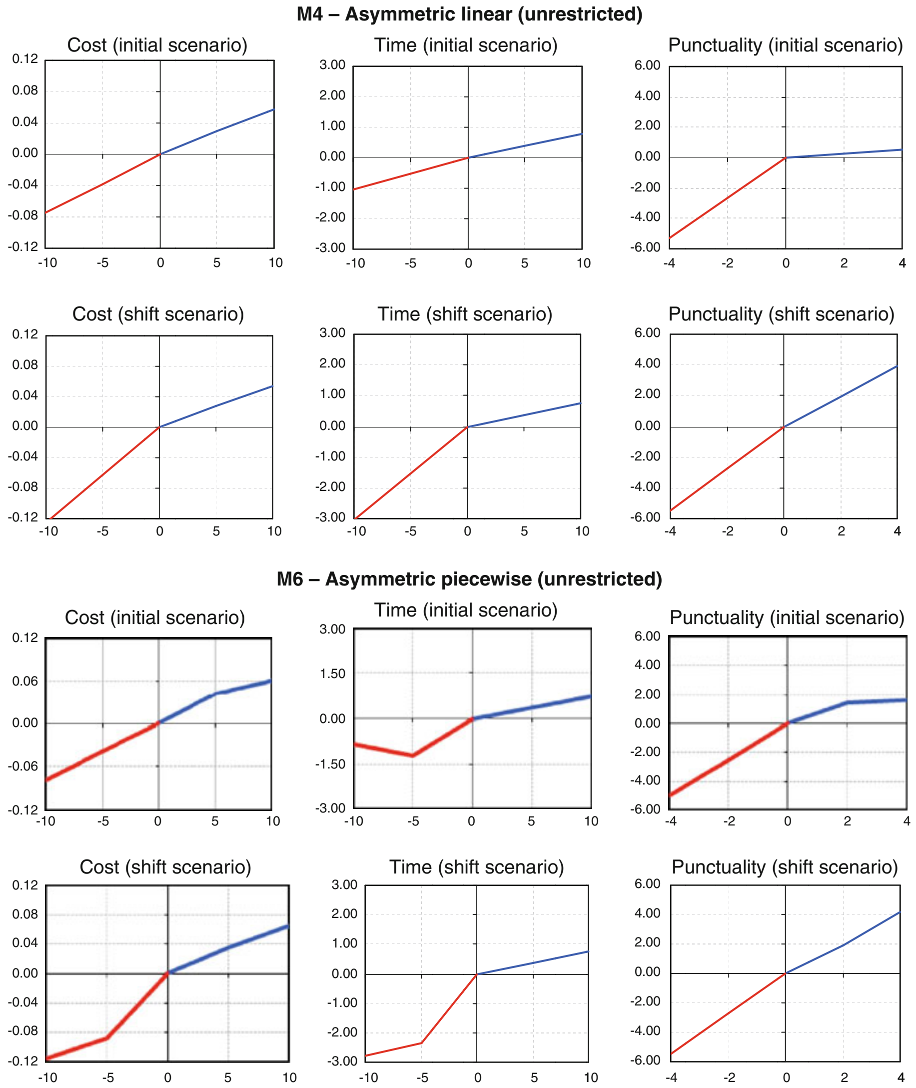

Fig. 2 Changes in utility for initial and shift scenarios (models M4 and M6)

and M6 for both the initial and shift scenarios. Indeed, from the charts related to model M4 (Fig. 2, first two rows), it is evident that there is an increase in loss aversion experienced by respondents for cost and time attributes as result of protecting themselves from further losses. On the other hand, the punctuality attribute shows an almost symmetric utility function in respect of gains and losses domains. The pattern for the initial scenario is characterised by a weak loss aversion in the cost and time attributes and by a particularly marked loss aversion for the punctuality attribute. In this context, it is relevant to emphasise the completely opposite pattern associated with the shift scenario. We observe similar findings for the unrestricted asymmetric piecewise model (Fig. 2, last two rows), which suggests a more pronounced loss aversion for the cost and time attributes in the shift scenario than in the initial scenario, but a substantial reduction in the punctuality attribute. Furthermore, we also note a change in the trend of diminishing sensitivity across the two scenarios, especially in the losses domains. In fact, the initial scenario registers a significant diminishing sensitivity for the punctuality attribute while the shift scenario reports significant diminishing sensitivity for cost and time attributes.

Table 7 summarises the willingness to pay (WTP) and willingness to accept (WTA) measures across the six models estimated, stressing the significant implication regarding a

Table 7 WTP and WTA measures (CHF/h for time and CHF/percentage point for punctuality)

	Symmetric linear		Asymmetric linear		Asymmetric piecewise	
	(restricted) M1	(unrestricted) M2	(restricted) M3	(unrestricted) M4	(restricted) M5	(unrestricted) M6
Willingness to pay measures in CHF per shipment (initial scenario)						
WTP time	19.63	17.32	6.47 (0.54)	10.22 (0.65)	–	–
WTP time (−)	–	–	–	–	6.49 (0.70)	9.85 (0.58)
WTP time (−−)	–	–	–	–	7.68 (0.83)	9.72 (0.57)
WTP punctuality	62.94	65.07	46.92 (21.17)	18.61 (1.62)	–	
WTP punctuality (+)	–	–	–	–	69.53 (20.90)	89.01 (17.51)
WTP punctuality (++)	–	–	–	–	47.42 (15.76)	25.70 (3.06)
Willingness to pay measures in CHF per shipment (shift scenario)						
WTP time	19.63	20.78	6.47 (0.54)	6.02 (0.71)	–	
WTP time (−)	–	–	–	–	6.49 (0.70)	4.37 (0.48)
WTP time (−−)	–	–	–	–	7.68 (0.83)	6.63 (0.74)
WTP punctuality	62.94	61.81	46.92 (21.17)	52.00 (37.60)	–	
WTP punctuality (+)	–	–	–	–	69.53 (20.90)	52.36 (19.46)
WTP punctuality (++)	–	–	–	–	47.42 (15.76)	58.50 (34.93)
Willingness to accept measures in CHF per shipment (initial scenario)						
WTA time	19.63	17.32	42.12	18.42	–	
WTA time (+)	–	–	–	–	58.26	28.76
WTA time (++)	–	–	–	–	34.68	13.73
WTA punctuality	62.94	65.07	255.28	228.88	–	
WTA punctuality (−)	–	–	–	–	213.22	174.66
Willingness to accept measures in CHF per shipment (shift scenario)						
WTA time	19.63	20.78	42.12	55.96	–	
WTA time (+)	–	–	–	–	58.26	66.19
WTA time (++)	–	–	–	–	34.68	23.88
WTA punctuality	62.94	61.81	255.28	250.46	–	
WTA punctuality (−)	–	–	–	–	213.22	200.64

Standard deviations are shown in parenthesis negative shift of the reference values. We base the comparison on the conditional estimates for the mean, reporting the sample standard deviation for the measures that involve random parameters. For the symmetric models (M1 and M2), although the model fits do not report a significant difference between the restricted and the unrestricted model specifications, the mean WTP measures for travel time savings in model M2 show an interesting difference across the two scenarios. In particular, the WTP for travel time savings is 17.32 CHF/h (approximately 16.10 USD/h) for the initial scenario, whereas it is 20.78 CHF/h (approximately 19.32 USD/h) for the shift scenario. The WTP measures for punctuality show a slighter difference. Regarding the symmetric model M2, the WTP measures obtained for the initial scenario are in line with previous studies in a freight transport stated choice experiment framework (see for example, Bolis and Maggi 2003; Zamparini and Reggiani 2007; Maggi and Rudel 2008).

The WTP decrease drastically when the utility function is specified according to the reference dependence assumption, which allows us to take into account the WTA/WTP discrepancy (see, Horowitz and McConnell 2002 for a review). Focusing on model M4, the initial scenario indicates a WTP for travel time savings of 10.22 CHF/h and a WTA of 18.42 CHF/h, setting the WTA/WTP ratio at 1.80, whereas we observe a WTP of 6.02 CHF/h and a WTA of 55.96 CHF/h for the shift scenario, which results in a ratio of 9.29. A similar structure for the WTP and WTA for travel time is outlined by model M6, although the diminishing sensitivity reported for time and cost attributes reveals a larger WTA/WTP discrepancy in the proximity of the reference values, both within and across the initial and shift scenarios. The consequence of a negative shift of the reference point suggests, therefore, a significant and substantial increase of the WTA/WTP ratio for travel time, where respondents experienced a lower WTP and a higher WTA with respect to the initial scenario. Reflecting the reaction hypotheses, the behavioural response to a negative shift of the reference value in terms of WTP and WTA for transport service punctuality shows an opposite pattern. In fact, the WTA/WTP discrepancy exhibits a general reduction changing from a ratio of 12.29 for the initial scenario in model M4 to 4.81 for the shift scenario. It is interesting to note the change in the respondents' behaviour highlighted by the introduction of nonlinearity in model M6. In this case, for the initial scenario, the WTP for punctuality is particularly high for an increase of two percentage points (89.01 CHF/percentage point), but decrease dramatically for larger increases (25.70 CHF/percentage point), reflecting the very high sample median of 98% for the reference transport service. Nevertheless, we observe a levelling of these two values for the shift scenario (52.36 and 58.50 CHF/percentage point, respectively) which imposed a reduction of two percentage points over the reference alternative values.

Concluding comments and policy implications

This paper has investigated the reaction experienced by decision makers facing a negative shift of the reference point within a reference pivoted stated choice experiment framework. The analysis has been based on two choice experiments conducted amongst logistics managers, and collected in Switzerland in 2008. The experiments were designed to identify the indirect freight transport costs associated with a temporary closure of the main reference road alternative. The first experiment reflected the initial conditions, and hence was designed around the typical (or initial) reference alternative. We then introduced the hypothesis of road closure and updated the initial reference alternative values according to the second best road alternative (shifted or expected reference alternative) values which were then used to pivot the design of the second stated choice experiment.

Under an assumption of prospect theory, a change in the reference point affects the structure of individuals' preferences. In order to investigate any potential reaction within the sample interviewed, we pooled the data from the two experiments and estimated three pairs of models. Within each pair of models, the distinction has been made by performing the restricted and unrestricted model specifications, where the restriction involved the specification of common coefficient values across the two datasets. The first pair of models assumed a symmetric specification. We introduced the reference dependence specification in the second pair of models, and estimated different parameters for gains and losses. In the third pair of models, we further allowed for asymmetric nonlinearity in gains and losses domains by estimating, through a piecewise transformation, different parameters for different attribute levels.

The model results for the two reference-dependent specifications indicate that respondents experienced a significant reaction when facing a negative shift of the reference point. The unrestricted version of the models outperforms the restricted one, providing significant support to the prospect theory assumption regarding the alteration of respondent preference structure. From a comparison of the parameter estimates after a negative shift of the reference point, we observed that respondents, on average, increased their loss aversion for cost and time attributes reflecting a willingness to prevent further losses. On the contrary, for the punctuality attribute, we registered a decrease in the loss aversion due to a considerable increase in the marginal utility associated with gains reasonably explained as the propensity to recover the initial loss. These results not only confirm the relevance of the punctuality attribute within the logistics managers' choice of freight transport services but also indicate that a small decrease in the punctuality quality has a high impact on preference formation, even for a limited timeframe, as supposed in our study.

The results obtained for the symmetric specifications do not indicate any statistically significant reaction in terms of model performance. We note therefore a clear difficulty of the classic discrete choice model specification in capturing changes in behaviour under a shift reference point context, although this is not surprising given the symmetric structure of these specifications.

The estimates of WTP and WTA measures from the reference dependence models report a WTA substantially higher than the WTP, which is in line with expectations. Comparing the two scenarios, the results suggest that a negative shift of the reference point causes a reduction in the WTP and an increase in the WTA for travel time, and an overall increase of the WTP, and a slight increase of the WTA for transport service punctuality. The significance of the differences in terms of WTP and WTA measures across the two scenarios is a relevant finding.

Based on our findings, the VTTS decreases if the reference alternative has been subjected to a negative shift. The VTTS accounts for up to 60% of user benefits (Hensher 2001) in the economic appraisal of transport related infrastructure. Therefore, we would have biased estimates for the user benefits of a given investment. In particular, not considering a negative shift of the reference point (when applies) leads to the overestimation of the total user benefits (of a given investment). Our findings on the shift refer to a temporary shift (i.e., 2 weeks), hence we are not able to derive any implication for permanent shifts, a topic for future research. However, it is reasonable to expect larger differences between the two scenarios in a case of a permanent shift (for example, a more marked decrease of the VTTS).

Policy makers should therefore consider the consumers potential reactions in any context involving a shift of the reference point. For example, given the growing interest in alternative road pricing schemes (i.e., the charge level, the regime—cordom, km-based etc.), the same logic used herein could be implemented for a choice experiment involving a permanent (road pricing) shift. It would be sufficient to adjust the scenario and make the setting consistent with the hypothesis of a permanent shift. In practice, the respondent would face a first experiment describing the actual scenario and consequently a second experiment describing the permanent shift. Another way could be the use of a choice experiment where the respondent is asked to make two choices per each choice situation. The difference between the two choices would relate to the availability of the reference alternative. This type of choice experiment is widely used by researchers. However, the experiment should be designed carefully in order to avoid dominant alternative(s) and the "non-trader problem" in the choice situation where the reference alternative is part of the choice set.

Further research is suggested in order to support these findings in different empirical contexts. Given that our study was based on a shift of the reference point in the short run and limited in time, we recognise the relevance of these findings in choices affecting everyday life concerning transitional road detours for infrastructures maintenance, and we advise the implementation of cost benefit analysis studies in this direction. Nevertheless, in a case where the individual is faced with frequent shifts of the reference point, it can be debated whether a point can still be called a reference point once it starts shifting itself.[20] This is indeed material for further research. However, we also suggest the need for further investigation in a context involving a permanent shift of the reference point, such as the introduction of pricing schemes. Finally, the analysis of a positive shift of the reference point would be of interest in order to support recent findings (e.g., Arkes et al. 2008), noting that individuals tend to adapt more completely to gains (positive shifts) than to losses (negative shifts).

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