J.M. Rose, L. Masiero

A comparison of prospect theory in WTP and preference space

Quaderno N. 10-06

Decanato della Facoltà di Scienze economiche
Via G. Buffi, 13 CH-6900 Lugano

A comparison of prospect theory in WTP and preference space

John M. Rose and Lorenzo Masiero

*John M. Rose**
The University of Sydney
J.Rose@itls.usyd.edu.au

Lorenzo Masiero[a]
The University of Sydney
L.Masiero@itls.usyd.edu.au

a. Also, University of Lugano, Switzerland.
Lorenzo.masiero@usi.ch

Version: 4 October 2009

Abstract

The importance of willingness to pay (WTP) and willingness to accept (WTA) measures in the evaluation of policy measures has led to a constant stream of research examining survey methods and model specifications seeking to capture and explain the concept of marginal rates of substitution as much as possible. Stated choice experiments pivoted around a reference alternative allow the specification of discrete choice models to accommodate the prospect theory reference dependence assumption. This permits an investigation of theories related to loss aversion and diminishing sensitivity, and to test the discrepancy between WTP and WTA, widely documented within the literature. With more advanced classes of discrete choice models at our disposal, it is now possible to test different preference specifications that are better able to measure WTP and WTA values. One such model allowing for utility to be directly specified in WTP space has recently shown interesting qualities. This paper compares and contrasts models estimated in preference space to those estimated in WTP space allowing for asymmetry in the marginal utilities by estimating different parameters according to reference, gain and loss values. The results suggest a better model fit for the data estimated in WTP space, contradicting the findings of previous researches. The parameter estimates report significant evidence of loss aversion and diminishing sensitivities even though the symmetric specification outperforms the asymmetric ones. Finally, the analysis of the WTP and WTA measures confirms the higher degree of WTA compared to WTP, and highlights the appeal of the WTP space specification in terms of plausibility of the estimated measures.

Keywords: choice experiments, willingness to pay space, preference asymmetry

1. Introduction

According to prospect theory (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991), individual choice behaviour is subject to a concept referred to as reference dependency. This concept, when framed within the idea of utility maximization, suggests that when evaluating different outcomes, individuals tend to distinguish differently between positive (gains) and negative (losses) deviations from some base reference alternative. This result leads to the notion that utility should be centred on this base reference point and then be defined in terms of domains of gains and losses surrounding this reference point. In this context, two fundamental findings have been found to characterize individual's utility functions; that individuals i) experience loss aversion (i.e., they evaluate higher weights for losses than for gains), and ii) experience diminishing sensitivity to both gains and losses (i.e., decreasing marginal values in both positive and negative domains). The implications of these two characteristics when considered together, imply firstly the marginal utility of individuals for gains and losses are different and secondly, that these marginal utilities can be considered as non-linear. In turn, this implies that the demand curves for individual respondents should be considered to be kinked with the elbow of the kink centred at the site of the reference alternative.

Since the formalization of prospect theory, reference dependence has been tested in several studies through the use of different interview procedures, with particular reference to contingent evaluation (e.g., Bishop and Heberlein, 1979; Rowe et al., 1980), laboratory experiments (e.g., Bateman et al., 1997) and more recently, stated choice experiments (e.g., De Borger and Fosgerau, 2008; Hess et al., 2008; Hjorth and Fosgerau, 2009; Lanz et al., 2009; Masiero and Hensher, 2009). In all cases, independent of the specific methodology employed, reference dependency has been found to exist.

Stated choice experiments (SCE) currently represent the primary method for collecting data for the purpose of analysing and understanding choice behaviour. These experiments present surveyed respondents with hypothetical choice situations with the resulting model estimation relying on the Random Utility Model framework (McFadden, 1974). The need to firstly, approximate the reality as much as possible in order to increase the behavioural meaning of the results and secondly, accommodate the prospect theory reference dependence assumption, has resulted in increasing attention being given not only towards modelling the impacts of prospect theory, but also towards generating SCE designs that are pivoted around individual specific reference alternatives (see, for example, Hensher, 2008; Rose et al., 2008). According to a pivot-design the utility function associated to each hypothetical alternative can then be specified in terms of gains and losses around the reference alternative values, either in terms of absolute levels or percentages. In this context, Hess et al. (2008) highlight the presence of loss aversion identifying asymmetric preferences in a car traveller study. Lanz et al. (2009) test loss aversion and diminishing sensitivity in an environmental water supply choice experiment, while Masiero and Hensher (2009) in a freight transport framework.

In modelling consumer preferences, the marginal rate of substitution plays a fundamental role since it expresses the willingness to pay (WTP), or its counterpart willingness to accept (WTA), for both market and non-market goods. Indeed, in the analysis of travel demand, particular research emphasis has been placed on the estimation of the trade-off between time and cost, commonly referred to as the value of travel time saving (VTTS). The VTTS is of significant importance to transport modellers and planners as it often represents a key input in the evaluation of infrastructure projects (e.g., cost-benefit analysis) or policy measures in general. In this regard, the consistent discrepancy between WTP and WTA measures observed within the literature, where WTP results have been systematically found to be greater than WTA (see Horowitz and McConnell, 2002 for a review), has been shown by Bateman et al. (1997) to be a consequence of loss aversion[1]. According to this evidence, De Borger an Fosgerau (2008) introduce a theoretical model of reference dependence based on the trade-off between travel cost and travel time conditional upon loss aversion and diminishing sensitivity. This same approach has been followed by Hjorth and Fosgerau (2009), which apply a fixed effect logit estimator in order to explain how loss aversion varies with individual characteristics.

The use of advanced discrete choice modelling in order to take into account for taste heterogeneity over the sample has led to complications in the derivation of the WTP measures. In particular, the introduction of the mixed multinomial logit (MMNL) model which allows for the estimation of random parameter distributions which reveal preference heterogeneity within a sampled population, has meant that the marginal rates of substitution may become a ratio of two random distributions, namely the coefficient of the attribute of interest over the cost coefficient. Therefore, the resulting WTP distribution will follow a distribution that depends on the two distributions specified for the random parameters. In such cases, the resulting distribution may produce a number of undesirable properties, not the least of which are extremely low or large WTP values[2]. Indeed infinite or near infinite WTP values may occur where the random parameter associated with the cost attribute is not bounded either side of zero.

In order to overcome this issue, a number of possible solutions have been attempted in the past. The most obvious method is to treat the cost coefficient as a fixed parameter (Revelt and Train, 1998; Hensher et al., 2004). In this case, all values from the random parameter in the numerator are divided by the same value, the cost coefficient, which therefore acts simply as a scaling facture. As such, for models in which the cost coefficient is treated as non-random, the shape of the WTP distribution will remain the same as the distribution specified for the parameter used in the numerator with only the population moments changing. Other researchers have employed bounded distributions for randomly specified cost coefficients such as log Normal or constrained triangular distributions. In taking this approach, the analyst prevents the cost coefficient taking the value of zero, and hence prevents the possibility of an infinite WTP value being observed. Unfortunately, such distributions often come at a cost, with log Normal distribution producing large tails (and hence may result in very small WTP values being observed) and the constrained triangular distribution forcing the spread of the distribution to be a function of the mean (which may not uncover the true extent of any preference heterogeneity that may exist in the sampled population).

The treatment of cost coefficients as fixed or non random parameters over sampled populations represents particularly strong assumption in terms of both scale homogeneity (Train and Weeks, 2005) and taste heterogeneity (Scarpa et al., 2008). The imposition of bounded distributions similarly offer disadvantages and may mask data issues and produce biased WTP responses if the distributions assumed do not reflect the reality of the data.

---

[1] To be noted that in a stated choice model that does not take into account preference asymmetry, the ratio of WTA to WTP is equal to one.

[2] For example, the ratio of two normal distributions results in a bimodal distribution. The Cauchy distribution is a special case where both the two means are zero.

An alternative solution to the above problem was proposed by Train and Weeks (2005) through the parameterization of MMNL model not in preference space but rather directly in WTP space[3]. Using this model formulation, the WTP distributions are estimated directly rather than being estimated post model estimation by taking the ratio of two parameters. In taking this approach, the analyst is able to select directly the appropriate WTP distribution rather than having limited control over it. In their paper, Train and Weeks (2005) observed a decrease in the amount of heterogeneity in the WTP estimates to a more behaviourally plausible amount although the model fit was found to decrease. Further papers dealing with different specifications of MMNL model in WTP space (Scarpa et al., 2008; Mabit et al., 2008; Hensher and Greene, 2009) confirmed the appeal of models estimated directly in WTP space over models in preference space, especially in terms of WTP interpretability and plausibility.

Although the specification in WTP space proposed by Train and Weeks (2005) overcomes the problem associated with taking the ratio of distributions and recognizes the two different forms of taste and scale heterogeneity, it is not specified to quantify the specific contribution of scale and taste. In this context, Fiebig et al. (2009) review different approaches to deal with scale heterogeneity and propose an alternative approach within the classical framework of MMNL models in WTP space, successively tested by Hensher and Greene (2009).

The aim of the paper is to compare models in preference and WTP space by integrating the prospect theory reference dependence assumption with the latest findings in scale and taste heterogeneity (Fiebig et al., 2009; Hensher and Greene, 2009). In particular, we analyse the difference between a MMNL model in preference space with a fixed cost coefficient and a MMNL model estimated in WTP space with scale heterogeneity in both symmetric and asymmetric specifications. We further provide an insight into WTP and WTA measures highlighting the implications associated to loss aversion and diminishing sensitivity.

The paper is organized as follows. In Section 2, we outline the methodology. In doing so, we discuss the differences between models estimated in preference space and WTP space. In Section 3 we outline the data used herein before Section 4 presents the model results. Section 5 presents concluding comments for the paper.

2. Methodology

Let U_{ntj} denote the utility of alternative *j* perceived by respondent *n* in choice situation *t*. U_{ntj} consists of two components, a modelled component V_{ntj} and an unobserved component ε_{nsj}, such that

$$U_{ntj} = V_{ntj} + \varepsilon_{ntj}. \quad (1)$$

As is common practice, we assume the modelled component of utility to be represented as a linear relationship of *k* attributes, *x*, related to each of the *j* alternatives and corresponding parameters weights such that

$$U_{nsj} = \alpha_j + \beta_{nc} c_{nsj} + \sum_{k=1}^{K} \beta_{nk} x_{nsjk} + \varepsilon_{ntj}. \quad (3)$$

[3] However, the intuition of directly estimate the WTP was already promoted (see for example, Hensher, 1976; Cameron and James, 1987).

$$U_{ntj} = \alpha_j + \sum_{k=1}^{K} \beta_{nk} x_{nsjk} + \varepsilon_{ntj}, \tag{2}$$

where α_j represents an alternative specific constant capturing the residual mean influence of the unobserved influences on choice for associated with alternative *j* and the unobserved component, ε_{nsj}, is assumed to be independently and identically (IID) extreme value type 1 (EV1) distributed.

Given that we are interested in establishing estimates of WTP, we further assume that Equation (2) is separable in price, c_{nsj} and other non price attributes x_{nsjk}, such that Equation (2) may be rewritten as

$$U_{nsj} = \alpha_j + \beta_{nc} c_{nsj} + \sum_{k=1}^{K} \beta_{nk} x_{nsjk} + \varepsilon_{ntj}. \tag{3}$$

The marginal willingness to pay for attribute k may then be calculated as

$$WTP = \frac{\frac{d}{dx_{nsjk}} \beta_{nk} x_{nsjk}}{\frac{d}{dc_{nsj}} \beta_{nc} c_{nsj}} = \frac{\beta_{nk}}{\beta_{nc}}. \tag{4}$$

In writing out the utility function as we have in Equations (2) and (3), the subscript *n* associated with the parameter weights implies a particular econometric model form will be estimated. In this case, and under the IID EV1 error term assumption, the utility function shown in Equation (2) implies the use of the MMNL model specification framework. The MMNL model allows for the analyst to specify that some or all of the parameter weights estimated be allowed to vary over the sampled population with density $f(\beta_{nk} \mid \Omega)$. Note that if a parameter is to be treated as non-random, the subscript *n* will simply cease to be associated with that parameter, as the parameter will be fixed or constant across individuals.

Equation (3) is defined in 'preference space' (see Scarpa et al., 2008, Sonnier et al., 2007 or Train and Weeks, 2005). It is possible to re-specify the utility function so as to estimate the WTP estimates directly. To do this, we rewrite Equation (3) as follows.

$$U_{nsj} = \alpha_j + \beta_{nc} \left[c_{nsj} + \frac{1}{\beta_{nc}} \sum_{k=1}^{K} \beta_{nk} x_{nsjk} \right] + \varepsilon_{ntj}. \tag{5}$$

In this case, the cost parameter, β_{nc}, simply becomes a normalising constant in the WTP representation.

In order to estimate the model in WTP space, we use the same specification outlined by Hensher and Greene (2009). In this formulation, we estimate $\beta_{nc} = (\bar{\beta}_c + \sigma_c w_n)$ where $\bar{\beta}_c$ represents the mean cost parameter for the sampled population, σ_c represents the standard deviation of preferences (or deviation from the mean) over the sampled population, and w_n random draws from a standard normal distribution. Likewise, non-price parameters that are treated as random parameters are estimated as $\beta_{nk} = (\bar{\beta}_k + \Gamma v_{nk})$ where $\bar{\beta}_k$ represents the mean of the parameter distribution, Γ a lower triangular Cholesky Matrix and v_{rk} random draws over the sampled population with covariance matrix *I*, so that $var(\beta) = (\Gamma\Gamma')$.

To estimate the model, β_{nc} is constrained such that $\beta_{nc} = \overline{\beta}_c e^{(\beta_{c*}+\tau w_n)}$. Given that the scale of β_{nc} is provided for by $\overline{\beta}_c$, β_{nc} is not identified. If we allow β_{nc} to be rewritten as $e^{(\ln\overline{\beta}_c+\beta_{c*}+\tau w_n)}$, then different combinations of $\overline{\beta}_c$ and β_{c*} will reproduce the same value of β_{nc}. To overcome this, Feibig et al. (2009) set $\beta_{c*} = \frac{-\tau^2}{2}$ so that $\beta_{nc} = \overline{\beta}_c e^{(\frac{-\tau^2}{2}+\tau w_n)}$. and consequently, $E[\beta_{nc}] = \beta_{c*}$.

In order to test specific issues related to prospect theory, a number of adaptations to the utility specification as outlined above are required. In order to test the hypothesis that respondents experience diminishing sensitivity to both gains and losses, it is necessary to apply non-linear transformations to the non-price attributes (we maintain a linear price parameter in order to allow for a simple comparison between models estimated in both preference and utility space. This assumption could be relaxed for models estimated in preference space, however given that models estimated directly estimated in WTP space use the price parameter as a normalising constant, having a non-linear price attribute and/or different price parameters representing gains or losses is not desirable). For the current paper, we attempted a number of attribute transformations, finally deciding upon a log transformation. Such an attribute transformation does not impact upon any of the discussion related to model estimation, however the WTP calculation shown as Equation (4) now becomes

$$WTP = \frac{\frac{d}{dx_{nsjk}}\beta_{nk}\ln(x_{nsjk})}{\frac{d}{dc_{nsj}}\beta_{nc}c_{nsj}} = \frac{\beta_{nk}\frac{1}{x_{nsjk}}}{\beta_{nc}}. \qquad (6)$$

Further, by directly modelling the marginal rate of substitution instead of the marginal utility we are assuming that the respondent has a reference willingness to pay other than a reference preference[4]. Indeed, the reference WTP measures are easily obtained by specifying reference specific coefficients in the utility function. Therefore, instead of working with deviations from the reference point (as in Hess et al. 2008; Lanz et al. 2009; Masiero and Hensher 2009) we specify the model in absolute values in order to allow the parameters for reference alternative to be estimated. The difference from the reference point is then computed in terms of marginal utilities.

3. Empirical data

Data for the current study was collected in Sydney in 2004 as part of a wider study designed specifically to obtain estimates of the VTTS for car drivers in the Sydney metropolitan area. For this study, we estimate models only on the commuting data segment, ignoring data dealing with non-commuting trips. Respondents were drawn from those in the population who had recently taken a trip along a route which could possibly have involved travelling along a proposed toll road to be built sometime in the future. Respondents were recruited using a computer aided telephone interview (CATI) with eligible respondents being drawn

[4] Other studies are based on the concept of reference WTP, see for example, De Borger and Fosgerau (2008); Hjorth and Fosgerau (2009).

from households that were stratified geographically within a large catchment area. Once recruited, a time and location was agreed upon for the survey to be undertaken using a face-to-face computer aided personal interview (CAPI). Quotas were imposed to insure a range of travel times over the sample; between 10 and 30 minutes, 31 to 60 minutes, and more than 61 minutes (capped at two hours). Trips of less than 10 minutes were excluded for both practical and theoretical reasons. From a practical perspective, it was felt that varying travel times and costs around a small base was not likely to produce levels which would be liable to induce a change of route in reality (e.g., a 10 percent reduction in a travel time of from two minutes is only 1.48 seconds, a saving of only 12 seconds). Secondly, within the Sydney context, shorter travel times are unlikely to attract road user charges, although this situation may be different in other cities, and may change in Sydney given advances in future technology.

Once recruited, respondents were asked information about their current trip to frame the context of the experiment. Based on the actual trip reported, respondents were given 16 choice scenarios, each with three route alternatives described by time spent in free flow and slowed down time travel conditions, travel time variability, running (petrol) costs and toll costs. The first alternative represented the respondent's current reported trip (a RP alternative) with the remaining two alternatives representing competing hypothetical routes (SC alternatives). The two SC alternatives represent unlabelled routes. The trip attributes associated with each route are free flow time, slowed down time, trip travel time variability, vehicle running cost (essentially fuel) and the toll cost. These were identified from reviews of the literature and supported by the effectiveness of previous VTTS studies undertaken by Hensher (2001). In addition, previous studies were used to establishing the priors (i.e., parameter estimates associated with each attribute) for designing the experiment. All attributes of the SC alternatives are based on the values of the current trip. Variability in travel time for the current alternative was calculated as the difference between the longest and shortest trip time provided in non-SC questions. The SC alternative values for this attribute are variations around the total trip time. For all other attributes, the values for the SC alternatives are variations around the values for the current trip. The variations used for each attribute are given in Table 1.

Table 1: Profile of attribute ranges in the SP design

	Free-flow time	Slowed down time	Variability	Running costs	Toll costs
Level 1	- 50%	- 50%	+ 5%	- 50%	- 100%
Level 2	- 20%	- 20%	+ 10%	- 20%	+ 20%
Level 3	+ 10%	+ 10%	+ 15%	+ 10%	+ 40%
Level 4	+ 40%	+ 40%	+ 20%	+ 40%	+ 60%

Over the course of the experiment, the RP alternative was invariant across the 16 choice situations with only the levels of the SC alternatives changing. Before commencing, respondents were given an example game to practice with. An example choice situation (taken from a practice game) is shown in Figure 1.

The experimental design has three versions (one for each trip segment) of 16 choice sets (games). The design has no dominance given the assumption that less of all attributes is better. The distinction between free flow and slowed down time is designed to promote the differences in the quality of travel time between various routes – especially a tolled route and a non-tolled route, and is separate to the influence of total time. Free flow time is interpreted with reference to a trip at 3am when there are no delays due to traffic.[5] An example of a stated choice screen, for the current trip (or reference) alternative and two design–generated combinations of actual attribute levels (based on a percentage variation from the reference alternative obtained from Table 1) is shown in Figure 1.

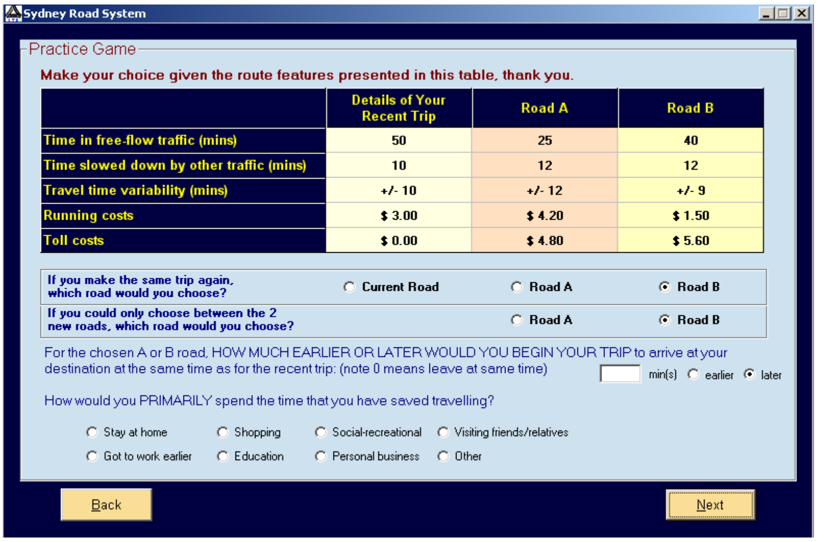

Figure 1: An example of a stated choice screen

The final commuter sample consisted of 300 respondents, representing 4800 choice observations. Of these 300 respondents, six respondents (representing 96 choice observations) always choose the current RP alternative irrespective of the attribute levels shown in the two SC alternatives. For this paper, these six respondents were removed from the analysis, leaving data from 294 respondents (4704 choice observations) from which to model.

4. Model Results

Table 2 summarizes the results of six estimated models. Model 1 (M1) represents the base MMNL model estimated in preference space whilst Model 4 (M4) represents the equivalent model estimated in WTP space. Model 2 (M2) and 3 (M3), both estimated in preference space, allow for different marginal utilities for gains and losses. M3 differs to M2 in that M3 applies a log transformation to the free flow and slowed down time attributes. Models M5 and M6 are the equivalent models to M2 and M3 respectively, only estimated in WTP space. In terms of testing prospect theory, models M2, M3, M5 and M6 allow us to test the hypothesis that individuals experience loss aversion, whereas models M3 and M6 also allow us to explore whether they also experience diminishing sensitivity to both gains and losses. Note that given the experimental design applied, the travel time variability attribute only was presented to respondents simply as ± some value from the reference, rather than a plus in some games and a minus in others. As such, we could not test it in terms of prospect theory as it simultaneously represents both a gain and a loss, and hence we exclude it from the final models estimated.

---

[5] This distinction does not imply that there is a specific minute of a trip that is free flow per se but it does tell respondents that there is a certain amount of the total time that is slowed down due to traffic, and hence that a balance is not slowed down (i.e., is free flow, like one observes typically at 3am).

Table 2: Model Results

	M1 (Pref. Space MMNL)		M2 (Pref. Space Pros. Theory)		M3 (Pref. Space Log Pros. Theory)		M4 (WTP Space MMNL)		M5 (WTP Space Pros. Theory)		M6 (WTP Space Log Pros. Theory)	
	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)
Random parameters												
Free flow time (mean)	-0.081	(-11.32)	-0.064	(-6.12)	-0.060	(-5.13)	0.264	(37.12)	0.093	(3.25)	0.042	(2.40)
Free flow time (std dev.)	0.089	(12.64)	0.062	(5.16)	0.054	(5.74)	0.248	(54.41)	0.230	(7.41)	0.158	(6.03)
Slowed down time (mean)	-0.102	(-16.36)	-0.043	(-4.30)	-0.037	(-2.58)	0.346	(64.07)	0.032	(1.41)	0.012	(1.07)
Slowed down time (std dev.)	0.078	(9.27)	0.042	(6.68)	0.027	(2.00)	0.213	(36.48)	0.052	(1.75)	0.039	(2.59)
Free Flow time gain (mean)	-	-	0.046	(4.58)	0.286	(4.21)	-	-	-0.208	(-5.08)	-0.477	(-2.34)
Free flow time gain (std dev.)	-	-	0.077	(6.31)	0.457	(3.67)	-	-	0.260	(6.68)	0.988	(4.16)
Free flow time loss (mean)	-	-	-0.244	(-8.44)	-0.849	(-8.64)	-	-	0.937	(7.39)	1.985	(7.43)
Free flow time loss (std dev.)	-	-	0.186	(5.57)	0.685	(2.82)	-	-	0.903	(6.78)	1.022	(1.87)
Slowed down time gain (mean)	-	-	0.086	(10.39)	0.657	(9.26)	-	-	-0.362	(-8.81)	-1.526	(-5.29)
Slowed down time gain (std dev.)	-	-	0.060	(3.90)	0.553	(4.08)	-	-	0.255	(6.26)	1.558	(5.09)
Slowed down time loss (mean)	-	-	-0.286	(-11.61)	-1.006	(-10.96)	-	-	1.137	(9.51)	3.038	(6.46)
Slowed down time loss (std dev.)	-	-	0.198	(3.23)	0.791	(2.16)	-	-	0.993	(7.15)	2.763	(7.45)
Non-Random parameters												
Constant (reference alt.)	-0.111	(-2.34)	1.191	(4.11)	0.908	(2.77)	-0.116	(-3.85)	-0.958	(-4.90)	-0.611	(-5.59)
Constant (SP alt 1)	0.158	(3.30)	0.155	(3.23)	0.130	(2.72)	0.152	(4.13)	0.160	(3.22)	0.170	(3.95)
Cost	-0.338	(-31.78)	-0.244	(-25.97)	-0.237	(-25.79)	-	-	-	-	-	-
Cholesky Decomposition (diagonals)												
Free flow time	0.089	(12.64)	0.062	(5.16)	0.054	(5.74)	-	-	0.230	(7.41)	0.158	(6.03)
Slowed down time	0.066	(10.11)	0.077	(6.31)	0.013	(0.70)	-	-	0.042	(1.63)	0.028	(1.92)
Free flow time gain	-	-	0.123	(3.91)	0.211	(1.51)	-	-	0.254	(6.09)	0.181	(0.54)
free flow time loss	-	-	0.038	(5.88)	0.453	(2.43)	-	-	0.166	(1.15)	0.339	(0.46)
Slowed down time gain	-	-	0.037	(2.73)	0.048	(0.27)	-	-	0.058	(0.73)	1.106	(4.07)
Slowed down time loss	-	-	0.033	(0.49)	0.094	(0.29)	-	-	0.079	(0.29)	0.022	(0.02)
Cholesky Decomposition (off-diagonals)												
Slowed down: free flow time	-0.041	(-4.44)	0.000	(-0.01)	0.024	(3.24)	-	-	-0.031	(-1.20)	-0.027	(-1.76)
Free flow time gain: free flow time	-	-	0.019	(0.35)	-0.062	(-0.64)	-	-	0.015	(0.33)	0.361	(1.36)
Free flow time gain: slowed down time	-	-	-0.138	(-4.28)	0.400	(4.11)	-	-	-0.054	(-0.99)	0.902	(4.04)
Free flow time loss: free flow time	-	-	0.000	(-0.04)	-0.052	(-0.30)	-	-	-0.064	(-0.30)	-0.322	(-0.74)
Free flow time loss: slowed down time	-	-	-0.010	(-1.15)	-0.509	(-2.91)	-	-	0.668	(3.58)	-0.840	(-2.34)
Free flow time loss: free flow time gain	-	-	0.013	(1.37)	-0.043	(-0.11)	-	-	0.581	(3.76)	-0.347	(-1.11)
Slowed down gain: free flow time	-	-	-0.002	(-0.11)	-0.435	(-4.73)	-	-	0.130	(2.72)	0.611	(1.94)
Slowed down gain: slowed down time	-	-	-0.003	(-0.23)	-0.094	(-0.62)	-	-	-0.207	(-4.79)	0.890	(2.49)
Slowed down gain: free flow time gain	-	-	0.012	(0.82)	0.207	(1.45)	-	-	-0.020	(-0.36)	0.159	(0.42)
Slowed down gain: free flow time loss	-	-	-0.045	(-3.58)	-0.251	(-1.85)	-	-	0.036	(0.86)	-0.102	(-0.20)
Slowed down loss: free flow time	-	-	-0.062	(-1.17)	0.087	(0.58)	-	-	-0.017	(-0.09)	0.040	(0.11)
Slowed down loss: slowed down time	-	-	0.006	(0.15)	0.180	(0.98)	-	-	0.936	(6.27)	-0.444	(-0.76)
Slowed down loss: free flow time gain	-	-	-0.069	(-1.56)	-0.451	(-1.55)	-	-	0.139	(0.95)	-0.093	(-0.14)
Slowed down loss: free flow time loss	-	-	0.093	(1.85)	0.602	(2.95)	-	-	-0.175	(-0.91)	-0.068	(-0.08)
Slowed down gain: slowed down time loss	-	-	-0.144	(-2.54)	-0.103	(-0.35)	-	-	0.233	(0.95)	-2.725	(-7.19)

Table 2 (Cont'd)

	M1 (Pref. Space MMNL)		M2 (Pref. Space Pros. Theory)		M3 (Pref. Space Log Pros. Theory)		M4 (WTP Space MMNL)		M5 (WTP Space Pros. Theory)		M6 (WTP Space Log Pros. Theory)	
	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)	Par.	(*t*-ratio)
Parameter for Cost (WTP space)												
Cost parameter	-	-	-	-	-	-	-0.553	(-29.13)	-0.327	(-9.55)	-0.348	(-6.19)
Scale Parameter												
Variance Parameter in Scale (τ)	-	-	-	-	-	-	0.947	(32.30)	0.382	(1.93)	0.511	(2.23)
Covariances of random parameters with scale												
Free flow time	-	-	-	-	-	-	1.048	(48.44)	0.315	(3.17)	-0.063	(-0.47)
Slowed down time	-	-	-	-	-	-	-0.298	(-20.77)	-0.541	(-4.13)	0.878	(4.88)
Free flow time gain	-	-	-	-	-	-	-	-	-0.425	(-3.01)	-0.297	(-2.29)
free flow time loss	-	-	-	-	-	-	-	-	-0.134	(-0.51)	-0.297	(-2.29)
Slowed down time gain	-	-	-	-	-	-	-	-	-0.284	(-1.05)	0.575	(5.83)
Slowed down time loss	-	-	-	-	-	-	-	-	0.281	(1.15)	0.575	(5.83)
Sigma Parameter												
Sample Mean	-	-	-	-	-	-	1.486	-	1.388	-	2.014	-
Sample Std Dev.	-	-	-	-	-	-	2.523	-	1.489	-	4.185	-
Model Fits												
LL(0)	-5167.872		-5167.872		-5167.872		-5167.872		-5167.872		-5167.872	
LL(ASC)	-5151.471		-5151.471		-5151.471		-5151.471		-5151.471		-5151.471	
LL(β)	-3589.897		-3756.572		-3815.333		-3349.851		-3622.293		-3791.076	
K	10		36		36		12		45		45	
$\rho(0)$	0.305		0.273		0.262		0.352		0.299		0.266	
Adj. $\rho(0)$	0.304		0.267		0.256		0.350		0.292		0.259	
ρ (ASC)	0.303		0.271		0.259		0.350		0.297		0.264	
Adj. ρ(ASC)	0.302		0.265		0.254		0.348		0.290		0.257	
Number of Respondents	294		294		294		294		294		294	
Number of Observations	4704		4704		4704		4704		4704		4704	

Presented at the base of Table 2 are the model fit statistics. Two sets of overall goodness to fit statistics have been provided. The first compares the final model against the log-likelihood for a base model assuming all parameters are simultaneously equal to zero (i.e., $\rho(0)$). The second model fit statistic is against a model estimated allowing for alternative specific constants only (i.e., ρ(ASC)). Comparing the adjusted ρ(ASC) values, which correct for differences in the number of parameters estimated from each of the models, we find that the best model fit for the data is associated with model M4. This finding contradicts the findings of other researchers who have found that models estimated in WTP space typically produce worse model fits. Further, comparing models that are equivalent in how the attributes have been treated in their utility specifications (i.e., M1 to M4, M2 top M5 and M3 to M6), we note that the WTP models outperform their equivalent preference space models in each instant. We further note that the simple linear specification of utility rather than those that allow for loss aversion as well as for diminishing sensitivity to both gains and losses appear to perform better in terms of model fits. Comparing the model fits only for the models that allow us to test prospect theory, we find that both in preference space and WTP model forms, allowing for diminishing sensitivity to both gains and losses results in lower model fits, at least insofar as we have applied the correct attribute transformation.

In each of the models, we have also allowed for correlated random parameters via the inclusion of the Cholesky matrix. Examining the parameters associated with this matrix supports the fact that there does exist some form of correlation amongst the random parameter estimates, although the correlation structure revealed appears to change depending upon the utility specification and model form imposed. Nevertheless, the several significant parameters for the Cholesky matrix indicate that a specification that does not allow for such correlation would be inappropriate.

Examining the scale parameters (i.e., τ) for each of the WTP space models reveals that the parameter is highly significant for the non-prospect theory model (M4), statistically significant at the 0.06 percent level for model M5 and statistically significant at the 0.05 percent level for model M6. This suggests that scale heterogeneity exists in each model after accounting for correlation between the random parameters themselves. To breakdown this observed scale heterogeneity, we further allow for correlation between the random scale term and the random parameters. Once more, we find varied evidence across the three WTP models of such correlation existing.

Turning to the parameter estimates for free flow time and slowed down time, all parameters are of the expected sign and relative magnitude. As is to be expected, comparing the parameter estimates for the preference space models allowing for differences in losses and gains, we note that relative to the reference alternatives, the parameters related to gains are positive compared to the parameters associated with losses which are negative. Examining the absolute value of the magnitudes of the (mean) gain and loss parameter estimates, we note that magnitude of the loss parameters are significantly larger than those for the gains, providing supporting evidence of respondents, on average, having experienced loss aversion when completing the SC survey. Given a negative price parameter means that models estimated in WTP space should produce opposite signs for the non price parameters to those estimated in preference of the parameter estimates, we would expect that the WTP parameters for losses will be positive relative to the reference base and gain parameters to be negative. Examining Models M5 and M6, this is precisely what we observe with once more the relative absolute magnitudes of the gains and losses (at least for the mean of the random parameter distribution) conforming with what we would expect if prospect theory is true.

The main focus of the paper is to compare and contrast models estimated in preference space to those estimated in WTP space allowing for asymmetry in the marginal utilities for gains relative to losses. In Figure 2, we plot the WTP distributions for models M2, M3, M5 and M6. In order to construct confidence intervals around the individual WTP measures, we employ the Krinsky and Robb procedure to simulate the distributions. The Krinsky and Robb procedure is useful for constructing WTP confidence intervals in that it accounts not only for the population moments of the random parameter distributions in simulating the WTP distributions, but also accounts for the standard errors and covariances of each of the estimated parameters. Examination of the plots provides supporting evidence for the two primary hypothesised effects of prospect theory; that individuals experience loss aversion, as well as that they also experience diminishing sensitivity to both gains and losses (resulting, for models M3 and M4, in the asymmetric s-shape functional form hypothesised by prospect theory). Finally, it is also interesting to note the capability of a specification in WTP space to contain the spread of the confidence intervals around the individual WTP measures. The result is particularly evident for model M6, which is the equivalent in WTP space of model M3. This evidence supports the previously noted advantage of estimating models directly in WTP space, particularly over models estimated in preference space using non random price parameters, in avoiding the undesirable complications associated with WTP measures derived from ratio distributions.

5. Conclusions

This paper has investigated MMNL models estimated in both preference and WTP space under various assumptions that are derived under prospect theory; namely loss aversion and diminishing sensitivities to gains and losses. The comparison of the two main approaches was based on the estimation of three different pairs of models. Firstly, we introduced the analysis by specifying a classic symmetric model which provided a basic comparison between models estimated in preference and WTP space. Secondly, according to reference dependence theory, we specified different parameters for gain and loss values relative to individual specific reference cases through an asymmetric linear specification in both preference and WTP space models. In the third pair of models, we allowed for asymmetric nonlinearity in the utility function using a log transformation of the non-price attributes. The resulting six models were tested using data collected in Sydney in 2004 within a stated choice experiment study aimed at obtaining estimates of the VTTS for car drivers.

The comparison between models in preference and WTP space suggest an overall and significant improvement in the model fit when the data are estimated in WTP space rather than preference space (in both symmetric and asymmetric specifications). This evidence contrasts with previous findings that models estimated in WTP space typically produce worse model fits (see for example, Train and Weeks, 2005; Hensher and Greene, 2009). However, Scarpa et al. (2008) show that the specification in WTP space can statistically outperforms its equivalent in preference space in a revealed preference data study. Indeed, results might be affected by the different nature of the dataset used (stated versus revealed preference) or even by the different context of the study. Since the literature in discrete choice models estimated in WTP space is still limited, further studies are needed in order to support these findings.

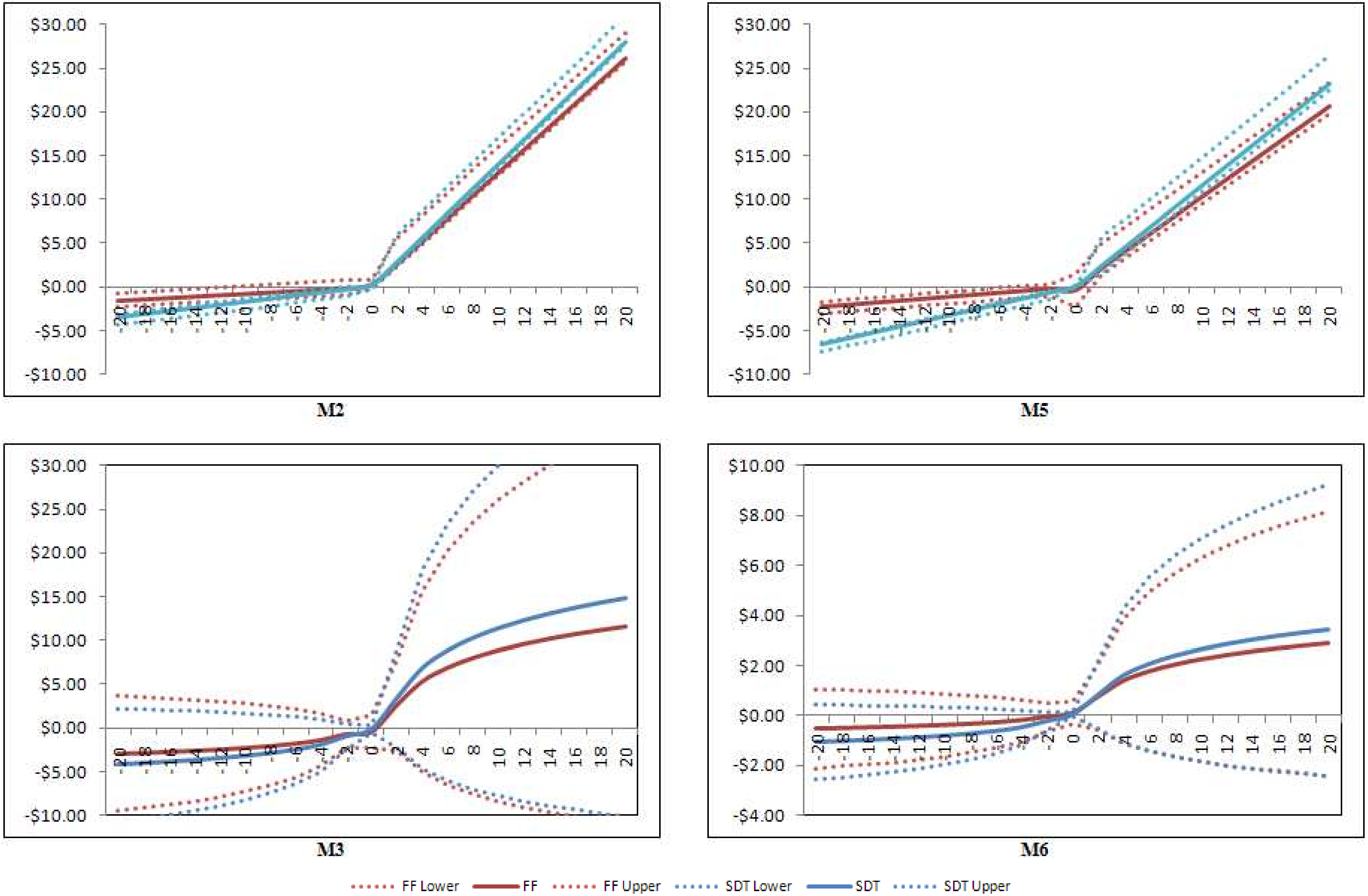

Figure 2: WTP plots

The results obtained from the parameters associated with gains and losses are statistically significant and coherent with loss aversion and diminishing sensitivity assumptions, in both preference and WTP space models. Nevertheless, according to the model fits, the symmetric specifications are preferred to the reference dependence specifications. This is unexpected since previous studies report increases in the model fit consistently with the statistically significance of the reference dependence specifications (see for example, Hess et al., 2008; Masiero and Hensher, 2009). A possible explanation might be that we do not consider the cost parameter as asymmetric as in previous studies. Unfortunately, this constraint was necessary in order to allow for a full set of comparisons between preference and WTP space models using a reference dependence utility specification.

Finally, with this paper we provide a further insight in the growing topic of discrete choice models linked to prospect theory assumptions. Furthermore, we show that the combination of a reference dependence specification with a model in WTP space increases the plausibility of the WTP measures and captures the divergence in between WTA and WTP. We encourage further research in the investigation of models in WTP space that could encompass the considerable potential of a reference dependence utility specification.

References

Bateman, I., Munro, A., Rhodes, B., Starmer, C., Sugden, R., 1997. A test of the theory of reference-dependent preferences. *Quarterly Journal of Economics* 112, 479–505.

Bishop, R.C., Heberlein, T.A., 1979. Measuring values of extramarket goods: are indirect measures biased? *American Journal of Agricultural Economics* 61, 926–930.

Cameron, T., James, M., 1987. Efficient estimation methods for closed-ended contingent valuation survey data. *Review of Economics and Statistics* 69, 269-276.

De Borger, B., Fosgerau, M., 2008. The trade-off between money and travel time: a test of the theory of reference-dependent preferences. *Journal of Urban Economics* 64, 101-115.

Fiebig, D., Keane, M., Louviere, J., Wasi, N., 2009. The generalized multinomial logit: accounting for scale and coefficient heterogeneity. *Marketing Science*, published online before print July 23, 2009, DOI: 10.1287/mksc.1090.0508.

Hensher, D.A., 1976. Valuation of commuter travel time savings: an alternative procedure. In: Heggie, I.G. (Ed.), *Modal Choice and value of Travel Time*. Oxford University Press, Oxford.

Hensher, D.A. 2001. The Sensitivity of the Valuation of Travel Time Savings to the Specification of Unobserved Effects. *Transportation Research Part E* 37 (2-3), 129-142.

Hensher, D.A., 2008. Joint estimation of process and outcome in choice experiments and implications for willingness to pay. *Journal of Transport Economics and Policy* 42 (2), 297-322.

Hensher, D.A., Shore, N., Train, K., 2005. Households' Willingness to Pay for Water Service Attributes. *Environmental and Resource Economics* 32, 509-531.

Hensher, D.A., Greene, W.H., 2009. Taming analytical distributions: valuation in wtp and utility space in the presence of taste and scale heterogeneity, *Institute of Transport and Logistics Studies*, University of Sydney, July.

Hess, S., Rose, J.M., Hensher, D.A., 2008. Asymmetric preference formation in willingness to pay estimates in discrete choice models. *Transportation Research* Part E 44(5), 847–863.

Hjorth, K., Fosgerau, M., 2009. Determinants of the degree of loss aversion. Paper selected for presentation at the *International Choice Modelling Conference* 2009, Leeds (UK).

Horowitz, J., McConnell, K.E., 2002. A Review of WTA-WTP Studies. *Journal of Environmental Economics and Management* 44, 426-47.

Kahneman, D., Tversky A., 1979. Prospect Theory: an analysis of decision under risk. *Econometrica* 47 (2), 263–291.

Lanz, B., Provins, A., Bateman, I., Scarpa, R., Willis, K., Ozdemiroglu, E., 2009. Investigating willingness to pay – willingness to accept asymmetry in choice experiments. Paper selected for presentation at the *International Choice Modelling Conference* 2009, Leeds (UK).

Mabit, S., Hess, S., Caussade, S., 2008. Correlation and willingness-to-pay indicators in transport demand modelling. Paper presented at the 87th Annual Meeting of the Transportation Research Board, Washington, D.C..

Masiero, L., Hensher, D.A., 2009. Analyzing loss aversion and diminishing sensitivity in a freight transport stated choice experiment, *Institute of Transport and Logistics Studies,* University of Sydney, July.

McFadden, D., 1974. Conditional logit analysis of qualitative choice behavior. In: Zarembka, P. (Ed.), *Frontiers in Econometrics*. Academic Press, New York.

Revelt, D., Train, K., 1998. Mixed logit with repeated choices. *Review of Economics and Statistics* 80, 647-657.

Rose, J.M., Bliemer, M.C., Hensher, Collins, A. T., 2008. Designing efficient stated choice experiments in the presence of reference alternatives. *Transportation Research* B 42(4), 395-406.

Rowe, R.D., D'Arge, R.C., Brookshire, D.S., 1980. An experiment on the economic value of visibility. *Journal of Environmental Economics and Management* 7, 1–19.

Scarpa , R., Thiene, M., Train, K., 2008. Utility in willingness to pay space: a tool to address confounding random scale effects in destination choice to the Alps. *American Journal of Agricultural Economics* 90(4), 994-1010.

Sonnier, G., Ainslie, A. and Otter, T. 2007. Heterogeneity distributions of willingness to-pay in choice models. *Quantitative Marketing Economics.* 5(3), 313–331.

Tversky, A., and Kahneman, D., 1991. Loss aversion in riskless choice: a reference-dependent model. *Quarterly Journal of Economics* 106, 1039–1061.

Train, K., Weeks, M., 2005. Discrete choice models in preference space and willingness-to-pay space. In: R. Scarpa and A. Alberini (Eds.), *Application of simulation methods in environmental and resource economics*. Springer Publisher, Dordrecht.

QUADERNI DELLA FACOLTÀ

1998:

P. Balestra, *Efficient (and parsimonious) estimation of structural dynamic error component models*

1999:

M. Filippini, *Cost and scale efficiency in the nursing home sector : evidence from Switzerland*
L. Bernardi, *I sistemi tributari di oggi : da dove vengono e dove vanno*
L.L. Pasinetti, *Economic theory and technical progress*
G. Barone-Adesi, K. Giannopoulos, L. Vosper, *VaR without correlations for portfolios of derivative securities*
G. Barone-Adesi, Y. Kim, *Incomplete information and the closed-end fund discount*
G. Barone-Adesi, W. Allegretto, E. Dinenis, G. Sorwar, *Valuation of derivatives based on CKLS interest rate models*
M. Filippini, R. Maggi, J. Mägerle, *Skalenerträge und optimale Betriebsgrösse bei den schweizerische Privatbahnen*
E. Ronchetti, F. Trojani, *Robust inference with GMM estimators*
G.P. Torricelli, *I cambiamenti strutturali dello sviluppo urbano e regionale in Svizzera e nel Ticino sulla base dei dati dei censimenti federali delle aziende 1985, 1991 e 1995*

2000:

E. Barone, G. Barone-Adesi, R. Masera, *Requisiti patrimoniali, adeguatezza del capitale e gestione del rischio*
G. Barone-Adesi, *Does volatility pay?*
G. Barone-Adesi, Y. Kim, *Incomplete information and the closed-end fund discount*
R. Ineichen, *Dadi, astragali e gli inizi del calcolo delle probabilità*
W. Allegretto, G. Barone-Adesi, E. Dinenis, Y. Lin, G. Sorwar, *A new approach to check the free boundary of single factor interest rate put option*
G.D.Marangoni, *The Leontief Model and Economic Theory*
B. Antonioli, R, Fazioli, M. Filippini, *Il servizio di igiene urbana italiano tra concorrenza e monopolio*
L. Crivelli, M. Filippini, D. Lunati. *Dimensione ottima degli ospedali in uno Stato federale*
L. Buchli, M. Filippini, *Estimating the benefits of low flow alleviation in rivers: the case of the Ticino River*
L. Bernardi, *Fiscalità pubblica centralizzata e federale: aspetti generali e il caso italiano attuale*
M. Alderighi, R. Maggi, *Adoption and use of new information technology*
F. Rossera, *The use of log-linear models in transport economics: the problem of commuters' choice of mode*

2001:

M. Filippini, P. Prioni, *The influence of ownership on the cost of bus service provision in Switzerland. An empirical illustration*
B. Antonioli, M. Filippini, *Optimal size in the waste collection sector*
B. Schmitt, *La double charge du service de la dette extérieure*
L. Crivelli, M. Filippini, D. Lunati, *Regulation, ownership and efficiency in the Swiss nursing home industry*
S. Banfi, L. Buchli, M. Filippini, *Il valore ricreativo del fiume Ticino per i pescatori*
L. Crivelli, M. Filippini, D. Lunati, *Effizienz der Pflegeheime in der Schweiz*

2002:

B. Antonioli, M. Filippini, *The use of a variable cost function in the regulation of the Italian water industry*
B. Antonioli, S. Banfi, M. Filippini, *La deregolamentazione del mercato elettrico svizzero e implicazioni a breve termine per l'industria idroelettrica*
M. Filippini, J. Wild, M. Kuenzle, *Using stochastic frontier analysis for the access price regulation of electricity networks*
G. Cassese, *On the structure of finitely additive martingales*

2003:

M. Filippini, M. Kuenzle, *Analisi dell'efficienza di costo delle compagnie di bus italiane e svizzere*
C. Cambini, M. Filippini, *Competitive tendering and optimal size in the regional bus transportation industry*
L. Crivelli, M. Filippini, *Federalismo e sistema sanitario svizzero*
L. Crivelli, M. Filippini, I. Mosca, *Federalismo e spesa sanitaria regionale : analisi empirica per i Cantoni svizzeri*
M. Farsi, M. Filippini, *Regulation and measuring cost efficiency with panel data models : application to electricity distribution utilities*
M. Farsi, M. Filippini, *An empirical analysis of cost efficiency in non-profit and public nursing homes*
F. Rossera, *La distribuzione dei redditi e la loro imposizione fiscale : analisi dei dati fiscali svizzeri*
L. Crivelli, G. Domenighetti, M. Filippini, *Federalism versus social citizenship : investigating the preference for equity in health care*
M. Farsi, *Changes in hospital quality after conversion in ownership status*
G. Cozzi, O. Tarola, *Mergers, innovations, and inequality*
M. Farsi, M. Filippini, M. Kuenzle, *Unobserved heterogeneity in stochastic cost frontier models : a comparative analysis*

2004:

G. Cassese, *An extension of conditional expectation to finitely additive measures*
S. Demichelis, O. Tarola, *The plant size problem and monopoly pricing*
F. Rossera, *Struttura dei salari 2000 : valutazioni in base all'inchiesta dell'Ufficio federale di statistica in Ticino*
M. Filippini, M. Zola, *Economies of scale and cost efficiency in the postal services : empirical evidence from Switzerland*
F. Degeorge, F. Derrien, K.L. Womack, *Quid pro quo in IPOs : why book-building is dominating auctions*
M. Farsi, M. Filippini, W. Greene, *Efficiency measurement in network industries : application to the Swiss railway companies*
L. Crivelli, M. Filippini, I. Mosca, *Federalism and regional health care expenditures : an empirical analysis for the Swiss cantons*
S. Alberton, O. Gonzalez, *Monitoring a trans-border labour market in view of liberalization : the case of Ticino*
M. Filippini, G. Masiero, K. Moschetti, *Regional differences in outpatient antibiotic consumption in Switzerland*
A.S. Bergantino, S. Bolis, *An adaptive conjoint analysis of freight service alternatives : evaluating the maritime option*

2005:

M. Farsi, M. Filippini, *An analysis of efficiency and productivity in Swiss hospitals*
M. Filippini, G. Masiero, K. Moschetti, *Socioeconomic determinants of regional differences in outpatient antibiotic consumption : evidence from Switzerland*

2006:

M. Farsi, L. Gitto, *A statistical analysis of pain relief surgical operations*
M. Farsi, G. Ridder, *Estimating the out-of-hospital mortality rate using patient discharge data*
S. Banfi, M. Farsi, M. Filippini, *An empirical analysis of child care demand in Switzerland*
L. Crivelli, M. Filippini, *Regional public health care spending in Switzerland : an empirical analysis*
M. Filippini, B. Lepori, *Cost structure, economies of capacity utilization and scope in Swiss higher education institutions*
M. Farsi, M. Filippini, *Effects of ownership, subsidization and teaching activities on hospital costs in Switzerland*
M. Filippini, G. Masiero, K. Moschetti, *Small area variations and welfare loss in the use of antibiotics in the community*
A. Tchipev, *Intermediate products, specialization and the dynamics of wage inequality in the US*
A. Tchipev, *Technological change and outsourcing : competing or complementary explanations for the rising demand for skills during the 1980s?*

2007:

M. Filippini, G. Masiero, K. Moschetti, *Characteristics of demand for antibiotics in primary care : an almost ideal demand system approach*
G. Masiero, M. Filippini, M. Ferech, H. Goossens, *Determinants of outpatient antibiotic consumption in Europe : bacterial resistance and drug prescribers*
R. Levaggi, F. Menoncin, *Fiscal federalism, patient mobility and the soft budget constraint : a theoretical approach*
M. Farsi, *The temporal variation of cost-efficiency in Switzerland’s hospitals : an application of mixed models*

2008:

Quaderno n. 08-01

M. Farsi, M. Filippini, D. Lunati, *Economies of scale and efficiency measurement in Switzerland’s nursing homes*

Quaderno n. 08-02

A. Vaona, *Inflation persistence, structural breaks and omitted variables : a critical view*

Quaderno n. 08-03

A. Vaona, *The sensitivity of non parametric misspecification tests to disturbance autocorrelation*

Quaderno n. 08-04

A. Vaona, *STATA tip : a quick trick to perform a Roy-Zellner test for poolability in STATA*

Quaderno n. 08-05

A. Vaona, R. Patuelli, *New empirical evidence on local financial development and growth*

Quaderno n. 08-06

C. Grimpe, R. Patuelli, *Knowledge production in nanomaterials : an application of spatial filtering to regional system of innovation*

Quaderno n. 08-07

A. Vaona, G. Ascari, *Regional inflation persistence : evidence from Italy*

Quaderno n. 08-08

M. Filippini, G. Masiero, K. Moschetti, *Dispensing practices and antibiotic use*

Quaderno n. 08-09

T. Crossley, M. Jametti, *Pension benefit insurance and pension plan portfolio choice*

Quaderno n. 08-10

R. Patuelli, A. Vaona, C. Grimpe, *Poolability and aggregation problems of regional innovation data : an application to nanomaterial patenting*

Quaderno n. 08-11

J.H.L. Oud, H. Folmer, R. Patuelli, P. Nijkamp, *A spatial-dependence continuous-time model for regional unemployment in Germany*

2009:

Quaderno n. 09-01

J.G. Brida, S. Lionetti, W.A. Risso, *Long run economic growth and tourism : inferring from Uruguay*

Quaderno n. 09-02

R. Patuelli, D.A. Griffith, M. Tiefelsdorf, P. Nijkamp, *Spatial filtering and eigenvector stability : space-time models for German unemployment data*

Quaderno n. 09-03

R. Patuelli, A. Reggiani, P. Nijkamp, N. Schanne, *Neural networks for cross-sectional employment forecasts : a comparison of model specifications for Germany*

Quaderno n. 09-04

A. Cullmann, M. Farsi, M. Filippini, *Unobserved heterogeneity and International benchmarking in public transport*

Quaderno n. 09-05

M. Jametti, T. von Ungern-Sternberg, *Hurricane insurance in Florida*

Quaderno n. 09-06

S. Banfi, M. Filippini, *Resource rent taxation and benchmarking : a new perspective for the Swiss hydropower sector*

Quaderno n. 09-07

S. Lionetti, R. Patuelli, *Trading cultural goods in the era of digital piracy*

Quaderno n. 09-08

M. Filippini, G. Masiero, K. Moschetti, *Physician dispensing and antibiotic prescriptions*

2010:

Quaderno n. 10-01

R. Patuelli, N. Schanne, D.A. Griffith, P. Nijkamp, *Persistent disparities in regional unemployment : application of a spatial filtering approach to local labour markets in Germany*

Quaderno n. 10-02

K. Deb, M. Filippini, *Public bus transport demand elasticities in India*

Quaderno n. 10-03

L. Masiero, R. Maggi, *Estimation of indirect cost and evaluation of protective measures for infrastructure vulnerability : a case study on the transalpine transport corridor*

Quaderno n. 10-04

L. Masiero, D.A. Hensher, *Analyzing loss aversion and diminishing sensitivity in a freight transport stated choice experiment*

Quaderno n. 10-05

L. Masiero, D.A. Hensher, *Shift of reference point and implications on behavioral reaction to gains and losses*

Quaderno n. 10-06

J.M. Rose, L. Masiero, *A comparison of prospect theory in WTP and preference space*