

# **A Convergent Validity Test of the Parameter Updating Method: Proof of Concept Project**

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## ABSTRACT

Economists working on natural resource damage assessments frequently need project-specific benefits to support public decisions regarding restoration but often have insufficient time or money to develop them. They are often forced to rely on the benefit transfer approach to nonmarket valuation because of its low cost relative to other approaches. The main disadvantage of benefit transfer is that numerous evaluations of the approach have found it to be inaccurate (Barton, 2002; Chattopadhyay, 2000; Delavan and Epp, 2001; Downing and Ozuna, 1996; Loomis et al., 1995; Loomis, 1992). In the context of oil spills, inaccurate estimates of lost economic benefits due to natural resource injuries lead to incorrectly scaled restoration projects that may over-compensate or under-compensate for the economic damages resulting from the injury. Public agencies, including natural resource trustees, need improved benefit transfer methods to provide accurate benefit information for economic policy analyses at low cost.

This proof of concept research study applied a new benefit transfer method – the parameter updating method – to estimate the welfare loss due to a hypothetical closure of the beaches in the Padre Island National Seashore. The parameter updating method attempts to take important site differences into account when transferring benefits by adapting the “constant updating” concept used in the transportation literature on model transferability. That idea is expanded here to account for commodity and population characteristics that are (1) predicted to affect welfare estimates and (2) vary across sites. The parameters on these characteristics are updated and then the updated model is transferred. The updating reflects the commodity, population, and substitutes at the application site and, theoretically, generates more accurate benefit transfer welfare estimates. The parameter updating method has been applied only once before, using stated preference valuation data (Poulos 2000). This proof of concept application was the first to use revealed preference data. It also built on the previous application by examining the sensitivity of the parameter updating method to sampling variation and model specification.

This proof of concept study tested the method by measuring welfare losses due to beach closures in National Seashores in two regions of the United States. The results show that, on average, the parameter updating variant of the model transfer method performed better than the simple transfer or model transfer methods in terms of predictive validity, but that parameter updating results were sensitive to sampling variation and model specification.

The study tested five specifications of the parameter updating model to examine the effects of updating different numbers and types of parameters, and the results were sensitive to the parameter updating model specification. For four of the parameter updating model specifications, the majority of the replications (51-70%) had better predictive validity than the simple or model transfer methods, suggesting that the parameter updating method would improve benefit estimates in most cases. The first three parameter updating models all outperform simple and model transfers at least slightly. The other two parameter models perform worse than the simple and model transfer methods.

The proof of concept study results do not indicate that the parameter updating method is unambiguously superior to other benefit transfer methods. One explanation for the relatively poor performance of several models is that the site choice models estimated with the small

samples included fewer variables than the original model and are vulnerable to omitted relevant variable bias. Additional evidence of potential bias is seen in the per trip value estimates from the small samples, which were almost one-half the size of the “true” per trip loss. This suggests that the application site models be as fully specified as possible to minimize this source of bias.

Finally, predictive validity was improved when larger application site samples were used, and the range of the predictive validity measures was also narrower among the larger sample sizes.

**Keywords:** benefit transfer, value of beach access, value of national seashore

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## 1.0 INTRODUCTION

Economists working on natural resource damage assessments (NRDAs) frequently need project-specific benefits to support public decisions regarding restoration but often have insufficient time or money to develop them. They are often forced to rely on pre-existing benefits to stand in for the needed estimates. Using pre-existing benefit estimates “off the shelf” to measure benefits at a new project site is known as the benefit transfer approach to nonmarket valuation. The main advantage of benefit transfer is its low cost relative to other approaches. The main disadvantage of benefit transfer is that numerous evaluations of the approach have found it to be inaccurate (Barton, 2002; Chattopadhyay, 2000; Delavan and Epp, 2001; Downing and Ozuna, 1996; Loomis et al., 1995; Loomis, 1992). In the context of oil spills, inaccurate estimates of lost economic benefits due to natural resource injuries lead to incorrectly scaled restoration projects that either under-compensate or over-compensate the public for the economic damages resulting from the injury. Public agencies, including natural resource trustees, need improved benefit transfer methods to provide accurate benefit information for economic policy analyses at low cost.

In particular, benefit transfer evaluations have noted problems due to differences in conditions between the policy and study sites, as well as problems due to violations of utility theory (e.g., Costanza et al., 1997). These problems arise because the most commonly used benefit transfer methods—the simple transfer method and benefit function transfer methods—imply very restrictive assumptions about similarities in the study and policy sites and do not impose budget and production constraints implied by the underlying utility model. The simple transfer method transfers a point estimate and/or the confidence interval of benefits from the original study site (referred to as the “original site”) to the site of interest (referred to as the “application site”). The benefit function transfer method (Loomis, 1992; Desvousges et al., 1992) combines the benefit model from the original site (including functional form, model specification, and parameter estimates) with site-specific data describing the population and other characteristics of the application site.

To overcome some of the observed shortcomings in existing benefit transfer methods, economists have turned to other methods, including structural benefit transfer (e.g., preference calibration and, structural meta-analysis) and Bayesian benefit transfer methods. Both of these methods involve data combination, where results from previous studies are systematically combined with each other or with data from the policy site of interest to generate benefit estimates.

By addressing some of the problems underlying inaccurate benefit transfers, these newer methods are promising, but there have been relatively few applications. This proof of concept project demonstrates and tests one of these new methods – the parameter updating method – in a new application. There are three motivations for this proof of concept project: (1) to extend the usefulness of a new benefit transfer method to new policy questions; (2) to continue to develop and refine the method; and (3) to illustrate how to apply this method to the natural resource damage assessment community.

Data on the demand for saltwater beach recreation provide opportunities to demonstrate and test the parameter updating method, as well as measure welfare impacts of interest for natural resource damage assessment economists. Understanding beach recreation demand and

benefits is policy-relevant because economic benefits are lost when beaches are closed due to oil and hazardous materials releases. Losses from spills are included in natural resource damage assessments conducted under the Oil Pollution Act of 1990 and other statutes.

Deacon and Kolstad (2000) and Parsons and Massey (2003) conclude that the information needed to measure these losses and incorporate them in economic analyses is incomplete and outdated. Several recent random utility model (RUM) studies have measured the losses due to water quality advisories (Murray, Sohngen, and Pendleton, 2001; Hanemann et al., 2005) and beach closures (Parsons and Massey, 2003; von Haefen, Phaneuf, and Parsons, 2004; Lew and Larson, 2005). These studies provide a rich characterization of recreation demand for a limited number of geographic areas: mid-Atlantic beaches (Parsons and Massey, 2003; von Haefen et al., 2004), the Texas Gulf Coast (Parsons et al. 2009), and Southern California (Hanemann et al., 2005; Lew and Larson, 2005).

Demand for beach recreation and the economic losses due to beach closures are not nearly as well understood along the remaining stretches of the U.S. coastline. Therefore, without new large scale primary data collection efforts, benefit transfer methods relying on results from other areas will be needed to assess benefits in these areas. The parameter updating method is one benefit transfer method that may help address this information gap.

This report summarizes the results of this proof of concept research project to apply the parameter updating method to measure the economic value of access to saltwater beaches. The next section describes the background and research objectives of the study. The third section describes the methods used in the project, including the valuation scenario, the theoretical model, the parameter updating method and strategy, and information on the application and original sites. The fourth section presents the results of the research and the fifth section discusses the results and their implications for natural resource damage assessments. The sixth and seventh sections describe the technology transfer and dissemination of results that has taken place under this proof of concept grant.

## **2.0 BACKGROUND AND RESEARCH OBJECTIVES**

### **2.1 Background**

The Oil Pollution Act of 1990 (OPA) requires that natural resources lost or injured in an oil spill be restored to the state that they would be in, but for the spill, and to compensate for interim lost human use and ecological services (33 U.S.C. 2702 to 2761). Nonmarket valuation (NMV) methods are used to measure the magnitude of interim lost human use; if financially and technically feasible, they might also be used to determine the value of services generated by planned restoration projects. Often, however, the value of losses obtained through nonmarket methods is used to determine the necessary expenditure on restoration.

Analysts frequently need project-specific benefits to support NRDA's but rarely have sufficient time or money to develop them. Using pre-existing benefit estimates "off the shelf" to measure benefits at a new project site, i.e., using the benefit transfer approach to NMV is a key economic tool when conducting low-cost damage assessments and restoration plans for small- and medium-sized spills and releases. It is used more often than any other NMV method to estimate benefits for NRDA's (Willis and Garrod 1995). The process begins by identifying a set of studies of similar commodities, either through a literature search or using databases developed

to facilitate benefits transfers (e.g., the Environmental Valuation Resource Inventory [EVRI, <http://www.evri.ec.gc.ca/evri>], and the New South Wales EPA's Envalue, <http://www.epa.nsw.gov.au/envalue/>). The nonmarket benefit estimates from these studies are candidates for benefit transfers.

The main advantage of the benefit transfer approach is its cost relative to other approaches. Since benefit transfer makes use of secondary data in estimating the benefits at a new site, it is less expensive and time intensive than primary research. The main disadvantage of the benefit transfer approach is that numerous studies have concluded that the approach can produce flawed estimates that do not always pass convergent validity tests. (Convergent validity tests assess whether different measures of the same concept are similar or highly correlated with one another [Cook and Campbell 1979]. Convergent validity is based on the notion that good measures of the same concept should have a high intercorrelation with each other.) These studies evaluate benefit transfer methods by testing whether the benefit transfer benefit estimates are the same as benefit estimates generated from other methods (typically methods that rely on primary data collection). The fact that the method has failed numerous convergent validity tests has led to conclusions that benefit estimates are biased.

This has implications for NRDA, which frequently uses benefit transfer for damage assessment and scaling restoration. If benefit estimates used to scale a restoration project are biased, then the restoration projects will be inappropriately sized or designed relative to the true economic damages. Projects may be either too large and over-compensate the public for the injury, or too small and under-compensate for the injury. Selecting an alternative nonmarket valuation method is not straightforward because they are more costly, involving primary data collection and more time to implement. When the spill is large and/or the injury has long-term impacts, as may be the case for injuries under the Comprehensive Environmental Response, Compensation, and Liability Act or the National Marine Sanctuaries Act, then primary data may be justified. But for the many smaller spills pursued under OPA, selecting methods that are more expensive than benefit transfer is unrealistic.

Thus, the priority area for spill research and development addressed by this proof of concept project is valuing restoration. This project has national significance, because it tests the validity of an economic methodology that could potentially be applied to any damage assessment and restoration planning effort in any geographic location.

Few of the validity studies acknowledge that benefit transfer's flaws are due to the specific methodologies used to implement the benefit approach, rather than the approach itself. The logic of the benefit transfer approach is deceptively simple: measure the value of restored human services at a planned restoration site by (1) finding studies that measured the benefits of the same (or similar services), and then (2) using those benefit estimates to measure the benefits of services expected at the restoration site. In this report, we refer to the site where the study was originally done as the "original site", while the restoration site is referred to as the "application site."

The most commonly used benefit transfer methods fall into two categories – the simple transfer method and model transfer method. Both methods imply very restrictive assumptions. The simple transfer method transfers a point estimate and/or the confidence interval of benefits from the original study site to the a site. The method implicitly assumes that the commodity, the

available substitutes and complements, and the socioeconomic characteristics of the population are identical at the original study site and the application site (Parsons and Kealy 1994).

The model transfer method (Loomis 1992; Desvousges *et al.* 1992) (a.k.a., the benefit function transfer method) combines the benefit model from the original study site (including functional form, model specification, and parameter estimates) with site-specific data describing the population and other characteristics of the application site. Then, the benefits at the application site are simulated. By replacing data on population and site characteristics in the original study site benefit function with data from the application site benefit function, the model transfer method accounts for some of the differences in site characteristics. However, the model transfer method assumes that the commodity and the available substitutes and complements are identical.

In reality, there are variants of these benefit transfer methods because analysts make numerous types of ad-hoc adjustments to account for the many differences between original study sites and application sites. For example, one practice is to use the ratio of average income at the application site to the average income at the original study site to scale point estimates for transfer (e.g., Alberini *et al.* 1997).

Another, rarely used, approach for benefit transfer is Bayesian benefit transfer. Two types of Bayesian benefit transfer have been discussed in the economics literature. The first is described by Atkinson (1992) and Parsons and Kealy (1994) and involves Bayesian updating of the parameters of a behavioral function, which can subsequently be used to assess the benefit measure of interest for the policy. The second approach is discussed by León *et al.* (2002) and involves Bayesian updating of the non-market value directly.

#### *Literature on the Convergent Validity of Benefit Transfer*

A number of studies find that some benefit transfer estimates fail convergent validity tests (Parsons and Kealy 1994, Downing and Ozuna 1996, Loomis 1992, Kirchoff *et al.* 1997, Loomis *et al.* 1995, Cameron 1993, Alberini *et al.* 1997, Atherton and Ben-Akiva 1976, Watson and Westin 1975, Talvitie and Kirshner 1978, Galbraith and Hensher 1982, VanderHeijden and Timmermans 1988, Stopher and Wilmot 1980; Rosenberger and Loomis 2003; Shrestha and Loomis 2001). These studies assess whether different measures of the same concept are similar or highly correlated with one another (Cook and Campbell 1979). Benefit transfer estimates demonstrate convergent validity when they are equivalent to estimates obtained using other methodologies applied at the application site. The tests require pre-existing benefit estimates from each site.

The convergent validity tests of the simple transfer method involve testing for differences in the mean or median benefit estimates from the original study site and application site. Overall, the simple transfer method does not fare well in these tests (Exhibit 1).

The model transfer method also fails many convergent validity tests (Exhibit 1). Two different tests have been used for model transfers. One tests the statistical equivalence of models from original study site and the application site by performing (1) log-likelihood tests of overall model equivalence and (2) t-tests of the equivalence of model coefficients. The other is to evaluate the convergent validity of the transferred model by using the original model to predict the benefits or choices observed at the application site. The predicted benefits or choices are then

compared to other estimates of benefits or observed behavior in order to measure the transferability of the original model.

### *Innovations in Benefit Transfer Methods*

It is well-understood by environmental economists that these methods impose restrictive assumptions about the similarity of benefits at the original study site and the injury or restoration site. In most cases benefit estimates that are being transferred should be adjusted because there are relevant differences between the original study site and the application site. In general, there are three main determinants of benefit estimates: (1) the type and magnitude of human service losses (or, the commodity), (2) the availability of substitutes and complements for the commodity, and (3) the socioeconomic characteristics of the sample. Most benefit transfer methods and convergent validity tests either assume that all determinants are identical at the original study site and the application site, or account for differences in the socioeconomic characteristics only. While the commodity and the availability of substitutes and complements routinely vary between the sites, standard benefit transfer methods and convergent validity tests fail to take this variation into account.

Because of these restrictive assumptions, the prevalent benefit transfer methods are blunt measurement instruments that permit only crude adjustments in benefit estimates and these adjustments are not linked to, or constrained by, the underlying economic model of behavior or the ecological realities.

In recent years, researchers have developed several alternative benefit transfer methods. Structural benefit transfer, described in Smith, Van Houtven, and Pattanayak (2002) and Smith and Pattanayak (2002), relies on a common theoretical (a.k.a. structural or preference model) model to link behavior data and benefit estimates from different nonmarket valuation methods. The analyst specifies a model of individual preferences as the structural model and derives expressions for behavior (e.g., trip demand, property demand) and/or benefit measures (e.g., Marshallian consumer surplus, compensating variation) that are functions of preference model parameters. By linking results from different studies to a common preference model, Structural benefit transfer imposes on benefit transfers the budget and production constraints that are central to individual utility maximization. Thus, Structural benefit transfer constrains benefit transfer estimates to be consistent with the underlying economic model of behavior. These adjustments better reflect the conditions that exist at the application site and they constrain these adjustments to be consistent with the underlying economic model of behavior.

There are three benefit transfer methods that are based on the structural benefit transfer approach: preference calibration, structural meta-analysis, and parameter updating. In preference calibration, a limited number of summary welfare or behavioral estimates from the literature can be used to calibrate parameter values that are consistent with the assumed structure. These summary measures, such as average consumer surplus and average willingness-to-pay (WTP) for sample populations, can be referred to as “macro” data, to distinguish them from the individual-level micro data from which they are derived. Smith, Van Houtven, and Pattanayak (2000) illustrate preference calibration using results from three studies that value a change in water quality—a hedonic property study, a contingent valuation study, and a travel cost study. Using a single preference model to derive the welfare measures estimated by each study (marginal WTP, Hicksian compensating variation, and Marshallian consumer surplus, respectively), they are able to link the studies’ benefit estimates to one another and use algebra to solve for the parameters of the underlying preference model. Rather than using existing studies or evidence to measure WTP

directly (as, for example, in simple benefit transfers), it uses existing studies to solve for the parameters of the preference function. In other words, it uses existing studies to “calibrate” a preference structure and, therefore, a WTP function. The calibrated WTP function can, in principle, be transferred and applied to evaluate different degrees of environmental quality changes that are relevant for policy purposes.

An alternative approach is “structural meta-analysis.” This approach requires a sufficiently large number of macro-level estimates from the literature to allow for econometric estimation (rather than calibration) of the preference parameters. Smith, Van Houtven, and Pattanayak (2002) introduce, and Smith and Pattanayak (2000) illustrate this strategy. In contrast to more traditional meta-analytic approaches applied to nonmarket valuation estimates (Viscusi and Aldy, 2003; Van Houtven et al., 2007), structural benefit transfer imposes functional forms on the estimating equations. These functional forms are directly derived from the preference specification. In addition, it often requires combining and jointly estimating parameters using different functional forms corresponding to different welfare estimates. These equations can be stacked with common parameters providing cross-equation restrictions.

The third and newest structural benefit transfer method is the parameter updating method, and it combines elements of the preference calibration method, the model transfer method, and the constant updating method. The constant updating method, which is used in the literature on transferability of transportation choice models, attempts to adapt the transferred model to account for differences in the unobserved characteristics at two sites. The method, used by Atherton and Ben-Akiva (1976) and Koppelman and Wilmot (1985), replaces the constant parameter from the original site with an estimate of the constant parameter from the application site. The disadvantage of this “constant updating” approach is that it is an ad hoc, atheoretical approach that does not provide information on which characteristics account for differences at the two sites. The parameter updating method addresses this limitation by using the structural model to identify which parameters in the benefit function should be updated based on information about the conditions at the original and application sites.

Poulos (2000) introduced the method and applied it stated preference studies to measure the benefits of malaria prevention in Africa. That application provides preliminary evidence that the parameter updating method may improve the convergent validity of benefit transfer. However, Poulos (2000) used only one sample size when simulating data collection from the application site and used datasets that had nearly identical measures from different study sites. In order to determine whether this method is, in fact, a step forward, more work is needed to determine efficient sample sizes and sampling strategies, as well as settings in which the model performs well. The parameter updating method has never been applied to estimating the benefits of recreation services supported by natural resources, nor has it been applied using revealed preference data.

By addressing some of the problems underlying inaccurate benefit transfers, these newer benefit transfer methods are promising, but there have been relatively few applications. This proof of concept grant research will illustrate how the parameter updating method can be used with revealed preference data on saltwater beach recreation and it will test whether the application of the method yields valid estimates of the economic benefits of beach access.

## 2.2 Research Objectives

This proof of concept project has four objectives:

1. Apply the parameter updating method to measure the economic damages of saltwater beach closures, which are components of many NRDA.
2. Test the convergent validity of the parameter updating method in this application.
3. Compare the benefit estimates from the parameter updating method to other benefit transfer methods to assess practical significance of using the parameter updating method in place of traditional benefit transfer methods. The parameter updating method is more costly than other benefit transfer methods, but less costly than other nonmarket valuation methods. This question will address whether these additional costs would be justified by significant changes in restoration plans.
4. Evaluate the potential for applying the parameter updating method in the NRDA context.

The project is closely related to the Coastal Response Research Center's goals as articulated in the request for proposals and in Oil Spill Workshop Report on Research and Development Priorities (NOAA and UNH 2004) because it tests a low-cost nonmarket valuation method often used in natural resource damage assessments. The results would impact the natural resource damage assessment decision-making in two ways.

First, as described in Section 2.1, numerous studies have concluded that benefit transfer can generate biased benefit estimates. If this is true for applications to specific NRDA cases, then restoration projects are inappropriately scaled. Thus, if this research project informs the selection of NMV methods, it will affect the scale of future restoration projects. Second, the results of this project could affect the NMV methods chosen for NRDA by introducing a new tool into NRDA economists' toolkit.

Further, this project has the potential to affect monitoring and evaluation of restoration projects. Benefit transfer could be used to monitor whether ongoing restoration projects provide the expected level of human services. To use benefit transfer in this application would require data on the services provided over time. Improvements in the benefit transfer method may permit natural resource trustees to periodically value changes in natural resource services at restoration sites to inform the need for mid-course corrections. If the parameter updating method generates more accurate benefit estimates, these evaluations could help trustees ensure compensation for natural resource injuries.

## 3.0 METHODS

### 3.1 Valuation Scenario

The following scenario is the basis for our test of the parameter updating method. Suppose that an oil spill event on the Texas Gulf Coast has resulted in a closure of the Padre Island National Seashore (PAIS). To estimate the economic damages, which will inform the scale of potential restoration projects, the NRDA economist seeks to estimate the lost economic value due to PAIS beach closures.

We will measure the economic value of access to PAIS beaches by the per trip value (see Parsons 2003) estimates from multiple site travel cost studies. Per trip value measures the compensating variation per day of use. Morey (1994) shows that this value multiplied by the

predicted number of days each year to the site in the original state is both a lower bound and a linear approximation to the seasonal CV.

### 3.2 The parameter updating method

Implementation of the parameter updating method can be accomplished in four stages. It begins by following Boyle and Bergstrom's (1992) suggestion to assess the applicability of the original study to the application site. The applicability depends whether the policy issue at the original site is sufficiently similar to the policy issue at the application site in terms of commodity definition and desired benefit measure. Another consideration is whether the original site dataset includes measures of the economic features that must be adapted in the benefit function.

Suppose the NRDA economist reviews the beach valuation literature and finds that there are no previous studies of the value of beach recreation at PAIS. However, Parsons and Massey (2003) and Parsons (2003) report the results of a 2005 study of beach recreation in the Mid-Atlantic— a study area that includes Assateague Island National Seashore (ASIS). The presence of a National Seashore in the Mid-Atlantic study suggests that the per trip value estimates may be appropriate for estimating the value of beach recreation at PAIS and the NRDA economist chooses to use this study in a benefit transfer study to measure the value of beach recreation at PAIS.

Exhibit 2, which illustrates how the parameter updating method works, shows that the analyst has chosen the Mid-Atlantic study as the original site (Box B). The application site is PAIS, which we assume has been closed due to an oil spill (See Section 3.1). Box B shows that the Mid-Atlantic study (an existing benefit study) has a benefit function that computes loss per trip for ASIS as a product of the Mid-Atlantic sample and site characteristics  $X_o$  (e.g., income, water quality, infrastructure at recreation sites), and the vector of parameter estimates from the original Mid-Atlantic study,  $\hat{\beta}$ . The subscript  $o$  denotes that the characteristics describe the original site and its respondents. The usual benefit transfer methods would transfer the point estimates (the simple transfer method) from this study, or replace the  $X_o$ , with  $X_a$ , (the subscript  $a$  denotes the characteristics of the application site and respondents) and compute WTP (the model transfer method).

In the second stage, data from the application site are collected from a small sample of respondents and a benefit function is estimated using the application site data. The specification of that benefit function is as similar as possible to the original site benefit function. This step, represented in Box A, illustrates a key difference between the usual benefit transfer methods and parameter updating. The parameter updating requires a small dataset from the application site. The number of observations necessary to implement the method is an empirical question, but there should be sufficient observations and data to estimate a benefit function with the same (or similar) specification as the original study (in Box B). These data may be acquired by conducting a small-scale survey (perhaps using the survey instrument used for the original study) or from existing datasets (conditional on the datasets having the appropriate variables). This requirement for micro-level data can increase the costs of benefit transfer relative to the simple or model transfer methods. However, since the dataset is small and it is possible to use existing datasets,

the method is expected to cost less than other nonmarket valuation methods that rely on primary data collection. Indeed, it may be possible to collect micro-level data on some variables and aggregate level data on others.

Box A shows that a small dataset will be collected from the application site in Texas and the arrow from Box A to Box C indicates that these data will be used to estimate a benefit function with the same or a similar specification as the Mid-Atlantic study (in Box B). Loss per trip is the product of the characteristics of the PAIS sites,  $X_a$ , and a vector of PAIS site parameters,  $\hat{\alpha}$ . Since the sample for the original site (Mid-Atlantic) would be larger than the application site sample (Texas), the parameters in the original study's benefit function are assumed to be estimated with greater precision than those in the application site benefit function. Therefore, the original study's benefit function parameters are superior estimates of the some of the parameters, as described below.

In the third stage, the benefit function is adapted by replacing some of the parameters in the original study's benefit function with the corresponding parameters from the application site's benefit function. The selection of parameters that are updated relies on the underlying theoretical model (Box D) predictions concerning which differences (between original and application site) will affect welfare. Finally, in the fourth stage, this adapted, or updated, benefit function and the application site sample are combined to transfer benefit estimates. The arrows leading to Box E show that the benefit function that will be transferred is created from the Mid-Atlantic benefit function (Box B), the Texas benefit function (Box C), and the underlying structural model (Box D).

The crux of the parameter updating method is to distinguish differences in sample characteristics that lead to different benefit functions (or, affect the magnitude of benefit function parameters) from those that do not. The latter category of differences between the original and application sites are controlled for by using application site data to compute values – just as they are in the model transfer method. With respect to the former differences – differences that affect the benefit function – the benefit function is adapted to reflect the fact that the economic features at the application site influence values differently than the corresponding characteristics in original sites. That is, the parameters from the Mid-Atlantic benefit function,  $\hat{\beta}$ , are selectively replaced with parameters from the Texas site benefit function,  $\hat{\alpha}$ . This selection is based on the underlying structural model – the WTP expression derived from the underlying individual utility model.

Note that, for this proof of concept grant, the implementation of the parameter updating method differs from a “real-life” application in that we do *not* collect any primary data from the application site (Texas Gulf Coast beaches). Rather, we simulate this and related steps by using data from a study of Texas Gulf Coast beaches that was completed for the National Park Service (and reported in Parsons et al. 2009). So, instead of developing a survey, drawing a sample of Texas Gulf Coast residents, and administering the survey to this sample, we draw a random sample of participants – and their survey data – from the NPS study. Also, we use a theoretical model based on random utility and the statistical models we rely on are multiple site choice random utility models. These are described in more detail below.

Exhibit 3 lists and briefly describes the steps we follow to implement and test the parameter updating method. The list is modified from Parsons' (2003) list of the steps in estimating a random utility model. The first step is to identify the impacts to be valued. As

discussed in Section 3.1, the study will value the closure of PAIS beaches as the product of the per trip value for PAIS beaches and the number of days the beaches are closed. For this research project, we focus on just estimating the per trip value.

The second step is to define the population of users to be analyzed. The population is households who use Texas Gulf Coast beaches, including beaches in PAIS. In this application, the population is that represented by the NPS study of Texas Gulf Coast beaches. The Texas study used random digit dialing to draw a sample of residents of Texas counties within 200 miles of the Texas Gulf Coast.

The third step is to define the choice set. The choice set will include PAIS beaches, as well as substitute sites. Again, this decision is determined by the availability of the NPS study, in which the choice set includes 65 Texas Gulf Coast beaches.

The fourth step is to define a sampling strategy. In this application, the population is the NPS study sample (a random sample of 884 residents of counties within 200 miles of the Texas Gulf Coast). To apply the parameter updating method, we draw random samples from this population. The sample size is an important variable for the cost of the parameter updating method, however, for this proof of concept we were limited to drawing two different sample sizes: 100 and 200.

The fifth step is to specify the estimation model. The Mid-Atlantic study estimates a nested logit model. Thus, we estimate a nested logit model with a similar specification using the small samples drawn from the NPS study sample. The nesting structure used to estimate the NPS models was the same one that was used in Parsons et al. (2009).

The sixth step is to gather site characteristic data. These data will be the site characteristic data that were collected for the NPS study. The seventh step is to decide on the treatment of multiple purpose trips, which can be challenging to model in recreation studies. For this application, we limit our analysis to day trips.

The eighth step would be to design and implement the survey, which is unnecessary in this case because we will rely on the survey conducted for the NPS study. The ninth step, measuring the trip cost, entails estimating the travel costs for each study participant from their residence to the beaches they visit. These costs have already been estimated for the NPS sample.

The tenth step is to select the parameters in the estimation model that will be updated. This step combines information on the theoretical model, the differences between site and population characteristics at the two sites, and the valuation scenarios. The key is to use these sources of information to identify differences that are expected to affect welfare estimates. These judgments will guide the identification of a set of parameters, corresponding to variables that are different across the datasets, to “update” – that is, estimated parameters in the Mid-Atlantic nested logit model that will be replaced with estimated parameters from the Texas model.

The eleventh step is to estimate the Texas Gulf Coast nested logit model using the small random sample(s) of respondents from the Texas study. To test of the effect of different sample sizes, and sampling variation, this will be replicated 100 times for each of the two small sample sizes.

The twelfth and thirteenth steps are to update the parameters in the Mid-Atlantic and compute the per trip value for PAIS. The Mid-Atlantic welfare function will be updated by replacing selected parameters (see step 11) with corresponding parameters from the nested logit

model estimated with the small Texas samples. The per trip value for PAIS will be computed using the small random samples from the Texas dataset and the updated benefit function.

### 3.3 Theoretical Model

The theoretical model underlying the multiple site choice models used for Mid-Atlantic and Texas sites is the random utility model (RUM) (see Freeman 2003). According to the RUM, the utility ( $v$ ) provided by a beach depends on the trip cost and the characteristics of the site:

$$v_i = \beta_{tc}tc_i + \beta_q q_i + \varepsilon_i \quad (1)$$

where  $i$  denotes one of  $C$  beaches ( $i=1,2,\dots,C$ ),  $tc_i$  is trip cost to site  $i$ ,  $q_i$  is a vector of site characteristics of site  $i$ ,  $\varepsilon_i$  is a random error term that captures preferences leading to the beach choice that are not observed by the researcher, and the  $\beta$ s are parameters measuring the marginal utility of the trip cost and site characteristics.

If a person decides not to take a trip to the beach on a given choice occasion, the RUM assumes that the no-trip utility is higher than any site utility. No-trip utility is:

$$v_0 = \beta_0 + \beta_z z + \varepsilon_0 \quad (2)$$

where  $z$ , individual or household characteristics, captures differences in participation among the population are entered as utility shifters:

On a given choice occasion, *e.g.*, a day, a person considers  $C+1$  alternatives -- visiting one of  $C$  beaches denoted as  $i=1,2,\dots,C$  or taking no trip. According to the RUM, on any given choice occasion, the individual makes the choice that provides the highest utility:

$$u^* = \max \{v_0, v_1, \dots, v_C\}. \quad (3)$$

Now, suppose an oil spill results in the closure of one of the sites – site 1. RUM theory can be used to value access to site 1. First, equation (3) is the choice occasion utility without a spill – because all sites are open – or,  $u^*$  (*baseline*). The utility with the spill is:

$$u^*(spill) = \max\{v_0, v_2, v_3, \dots, v_C\}, \quad (4)$$

which excludes site 1 because it is closed after the spill. The change in utility,  $\Delta u^*$ , is:

$$\Delta u^* = u^*(spill) - u^*(baseline). \quad (5)$$

The welfare loss per choice occasion, or utility change measured in monetary terms, is  $\Delta u^*$  divided by the marginal utility of money, which is measured by the negative of the parameter on trip cost:

$$\Delta w = \frac{[\max\{v_0, v_2, v_3, \dots, v_C\} - \max\{v_0, v_1, \dots, v_C\}]}{-\beta_{tc}}. \quad (6)$$

The welfare loss per trip per person is:

$$\hat{t} = \frac{\frac{T \times POP}{N} \sum_{j=1}^N [\max\{v_0, v_2, v_3, \dots, v_C\} - \max\{v_0, v_1, \dots, v_C\}]}{TRIPS} / -\beta_{tc} \quad (7)$$

where  $j$  denotes the individual ( $j=1, 2, \dots, J$ ),  $T$  is the total number of choice occasions per season,  $POP$  is the population of users and potential users, and  $TRIPS$  is the total number of day trips by the relevant population.

For a nested logit model,  $\hat{t}$  is:

$$\hat{t} = \frac{\frac{T \times POP}{J} \sum_{j=1}^J \left[ \ln \left( \sum_{m=1}^K a_m \left[ \sum_{i=1}^{C+1} \exp \left( \frac{v'_i}{\theta_m} \right) \right]^{\theta_m} \right) - \ln \left( \sum_{m=1}^K a_m \left[ \sum_{i=1}^{C+1} \exp \left( \frac{v_i}{\theta_m} \right) \right]^{\theta_m} \right) \right]}{TRIPS} / -\beta_{tc} \quad (8)$$

where  $v'_i$  is the utility with the spill,  $v_i$  is the utility without the spill,  $m$  denotes the  $K$  nests, and  $\theta_m$  is the inclusive value parameter (Haab and McConnell 2002). Given equations 1 and 2, Equation 8 implies that per trip loss is a function of:

- individual characteristics ( $z$ )
- site characteristics ( $q$ )
- trip cost ( $tc$ )
- parameters of the no-trip utility ( $\beta_0, \beta_z$ )
- parameters of the site utility ( $\beta_{tc}, \beta_q$ )
- total number of trips ( $TRIPS$ )
- population ( $POP$ ), and
- number of choice occasions in the season ( $T$ ).

In the very unlikely event that two beaches had identical values for all of these variables, then the per trip loss would be expected to be identical. However, no two sites would have identical values for these variables and there will be aspects of the choice decision not catalogued by the researcher. Differences in any of these variables would affect welfare estimates.

The parameter updating method is based on (1) judging which of the differences between two sites are relatively more important in determining the welfare loss and (2) accounting for these relatively more important differences in the benefit transfer.

### 3.4 The Original Study Site: Mid-Atlantic Data and Results

Having chosen to use the benefits from the Mid-Atlantic study in a benefit transfer (see Section 3.1), this section summarizes the study, sites, sample, and results. In this study, George Parsons and Matt Massey collected beach day trip data from Delaware residents in 1997. More detailed information can be found in Parsons (2003), Parsons and Massey (2003), and Haab and McConnell (2002). The Mid-Atlantic beaches in this study include all of the 62 ocean beaches in New Jersey, Delaware, and Maryland. The study population includes residents of Delaware.

A random mail survey of 1,000 Delaware residents was conducted the fall of 1997. (Exhibit 4) The survey collected data on days trips the study participants made in the summer of 1997. Data on 565 respondents (400 respondents took beach trips) were analyzed using a nested logit model. Site characteristic data was gathered from state departments, field trips, tourist guides, maps, websites, and other sources. The site and individual characteristics measured by the study are shown in Exhibits 5 and 6, respectively.

The data were modeled using a three-level nested logit model (Exhibit 7). At the first level, a person decides to visit a beach or take no beach trip. If the person takes a beach trip, then at the second level he chooses a region, that is, he decides to go to a beach in New Jersey or Delaware/Maryland. In the third level, this person decides which site to visit. The site utility and no trip utility models were:

$$v_i = \beta_1 tc_i + \beta_2 length_i + \beta_3 bwalk_i + \beta_4 amuse_i + \beta_5 private_i + \beta_6 park_i + \beta_7 wide_i + \beta_8 narrow_i + \beta_9 AC_i + \beta_{10} surf_i + \beta_{11} highrise_i + \beta_{12} parkwi_i + \beta_{13} fac_i + \beta_{14} prkng_i \quad (10)$$

$\forall i \in \{1, 2, \dots, C\}$  and

$$v_0 = \beta_{18} + \beta_{19} \ln age_j + \beta_{20} kidsu10_j + \beta_{21} kidsu16_j + \beta_{22} flexm_j + \beta_{23} vpin_j + \beta_{24} vpout_j + \beta_{25} retired_j + \beta_{26} student_j + \beta_{27} parttime_j + \beta_{28} workhome_j + \beta_{29} volunt_j \quad (11)$$

The site characteristic parameters ( $\beta_1 - \beta_{14}$ ) indicate the marginal effect of the variable on site utility and the individual characteristic parameters ( $\beta_{18} - \beta_{29}$ ) indicate the marginal effect on the utility of not taking a trip. The variable definitions and regression results are presented in Exhibit 8.

The equation for ASIS (site 62) welfare per choice occasion is:

$$w_{62} = \left[ \ln \left( \left[ \sum_{i=1}^{46} \left( \exp(v'_i)^{\beta_{15}/\beta_{17}} \right)^{\beta_{17}} \right] + \left[ \sum_{i=47}^{61} \left( \exp(v'_i)^{\beta_{16}/\beta_{17}} \right)^{\beta_{17}} \right] + \exp(v'_{63}) \right) \right] \beta_{tc}^{-1} \quad (12)$$

$$- \ln \left( \left[ \sum_{i=1}^{46} \left( \exp(v_i)^{\beta_{15}/\beta_{17}} \right)^{\beta_{17}} \right] + \left[ \sum_{i=47}^{62} \left( \exp(v'_i)^{\beta_{16}/\beta_{17}} \right)^{\beta_{17}} \right] + \exp(v_{63}) \right)$$

where sites 1-46 are New Jersey beaches, sites 47-62 are Delaware and Maryland beaches, site 62 is ASIS,  $v_{63}$  is no-trip utility,  $\beta_{15}$  is the inclusive value for New Jersey beaches,  $\beta_{16}$  is the inclusive value for New Jersey beaches, and  $\beta_{17}$  is the inclusive value for all beaches. The equation for per trip loss at ASIS (site 62) is:

$$\hat{t} = \frac{\bar{w}_{62} \times T \times POP}{TRIPS} \quad (13)$$

where  $\bar{w}_{62}$  is the sample mean per choice occasion value (-0.26),  $T$  is the number of choice occasions in the season (250),  $TRIPS$  is the total number of trips to ASIS during the season (1,581), and  $POP$  is the sample size (565).

Using the nested logit results, we compute the per trip welfare loss for ASIS to be \$25.71 in 2001 dollars (\$23.30 in 1997 dollars). The average number of trips to ASIS in the summer of 1997 was 1,581. Thus, a closure of ASIS for one day would result in \$40,655 (2001 dollars; \$36,844 in 1997 dollars) in welfare losses for the population of Delaware.

### **3.5 The Application Site: Considering the Texas Gulf Coast**

The next step is to consider the application site, PAIS, and how it relates to the original site. In a true application of the parameter updating method, the analyst would start this process by collecting site and population characteristics using secondary data sources. These data will be used to (1) assess the differences in site and individual characteristics between the application site and the original site and inform (2) judgments about which of these differences are likely to be relevant for benefit transfer. That is, which differences between the sites would be expected to influence the per trip losses. These differences will be accounted for in the parameter updating model.

Sources of data on site characteristics include state departments, field trips, tourist guides, maps, satellite data, websites, chambers of commerce, interviews with scientists working in the area, existing or secondary data sources, and other sources. Sources for individual characteristics – or aggregates of these characteristics – include census data and other secondary data sources that may be maintained by state departments or tourism organizations. Primary data using small samples may be used to collect information on individual characteristics.

In this application, rather than collect these site and individual characteristics using primary or secondary data collection, we rely on the Parsons et al. 2001 study of beach recreation on the Texas Gulf Coast to provide information on these characteristics. The site and individual characteristics measured by the study are shown in Exhibits 5 and 6, respectively.

Exhibits 5 and 6 show that there are few measures that appear in both datasets. Only four site characteristics appear in both datasets: trip cost, beach length, whether the beach is a park, and whether the beach has facilities (including restrooms and food concessions). Also, only four individual characteristics appear in both datasets: age, percentage of households with children, percentage of households that own vacation homes, and the percentage of respondents who are retired.

The average trip cost is 15% higher in Mid-Atlantic (2001 \$134) than in Texas (\$118). (Exhibit 9) All values are expressed in terms of 2001 dollars, unless otherwise stated. The average beach in the Texas Gulf cost (5.35 miles) is nearly three times as long as the average beach length in the Mid-Atlantic region (1.86 miles). Nearly 10% of beaches in the Mid-Atlantic region are state or federal parks, while about 15% of beaches in the Texas Gulf Coast are state or federal parks. About 39% of beaches in Mid-Atlantic have restrooms and/or food concessions, while 57% of beaches in Texas have restrooms.

Exhibit 10 shows the descriptive statistics for the samples in the two regions, which are proxies for the population characteristics in these two regions. The average age of respondents in the two sites was similar (46 years in Mid-Atlantic and 41 years in Texas). The percentage of households with children (49% in Texas and up to 49% in Mid-Atlantic) and the percentage of households owning a beach vacation home (7% in Texas and 8% in Mid-Atlantic) are similar in the two sites. There were nearly three times as many retired respondents in Mid-Atlantic (24%) as there were in Texas (9%).

Finally, Exhibit 4 shows that the population in the Mid-Atlantic region takes more beach trips (an average of 23 per person in the summer of 1997) than the population in Texas Gulf Coast region (an average of 5 per person in the summer of 2001). While this may reflect a difference in opportunities and preferences for beach recreation, it may also reflect a variety of different influences, such as differences in economic conditions between these two years. Unfortunately, the studies cannot identify the reason for this difference in beach trip frequency.

Parsons et al. (2009) report that the per trip value of PAIS is about \$30 in 2001 dollars. This is the “true” WTP estimate against which the benefit transfer estimates will be compared.

### **3.6 Parameter Updating Strategy**

As described earlier, the parameter updating method attempts to account for three important differences between original and application sites. The first is the commodity, or the type and magnitude of human service losses. In this case, the commodity that the NRDA analyst seeks to value at the application site is the closure of the PAIS, which results in the loss of beach services. The commodity valued at the original site is similar – the closure of the ASIS. While there are likely to be economically relevant features of these two National Seashores that are different, e.g., water temperature, species of bird and fish present, we consider these two commodities to be similar enough to justify the choice of the Mid-Atlantic study as the basis of a benefit transfer.

The second difference that the parameter updating method attempts to account for is the availability of substitutes and complements for the commodity. If there are good substitutes for the beaches at PAIS, then the loss of services at that site will result in lower economic damages than if there were no good substitutes. If there are strong complements to the use of non-park beaches, such as ownership of a beach vacation home at a beach outside of PAIS, this will also tend to reduce economic damages. To assess differences in substitutes and complements between the original and application sites, we consider the differences between site characteristics. Section 3.5 and Exhibit 9 show that there are three differences in site characteristics that may indicate differences in substitutes between the two sites. First, while the average beach length is longer in Texas than in the Mid-Atlantic, we do not have data on the distribution of lengths that would reveal whether the length varies significantly across Texas beaches. However, given this large difference, beachgoers in Texas may engage in different types of activities and have different preferences. Second, there are more beaches in Texas that are part of a State or Federal Park than in the Mid-Atlantic region. This may indicate that there are more substitutes for the PAIS in Texas than there are for the ASIS in the Mid-Atlantic. Finally, there are more beaches with facilities, including restrooms and food concessions in Texas than there are in Mid-Atlantic. This indicates that there are more substitutes for sites with these facilities in Texas than in Mid-Atlantic. Finally, the average trip cost is somewhat higher in Texas than in Mid-Atlantic. Since trip cost is such an important variable, we will account for these differences in our analyses.

The third difference that the parameter updating method attempts to account for is the socioeconomic characteristics of the sample. The main difference between the samples in Texas and Mid-Atlantic is the percentage of respondents who are retired. This may reflect actual differences in the populations in these two regions, or they may reflect the fact that different sampling methods were used (Exhibit 4).

The model described in Section 3.3 indicates which site and population characteristics affect utility, including site and individual characteristics. Exhibits 9 and 10 show that, based on available data, the following beach and individual characteristics are different in the Mid-Atlantic and Texas Gulf Coast regions:

- Percentage of beaches that are parks;
- Length of beaches;
- Percentage of beaches with facilities (e.g., restrooms); and
- Percentage of people living in counties near the coast who are retired

To estimate parameters for Texas to use in updating the Mid-Atlantic benefit function, we need to draw a small sample of households from Texas in order to estimate a site choice model similar to the Mid-Atlantic model. To simulate this step, we draw random samples of households from the Parsons et al. Texas dataset and estimate a site choice model. While in actual practice, only a single small sample would be drawn from Texas, we replicate this step 100 times in order to examine the effect of sampling variation on study results. For each small sample drawn, we estimate a simple site choice model that includes all of the variables from the Texas dataset that correspond to variables in the Mid-Atlantic dataset and additional variables relevant to the specific Texas locations. The small sample site utility model is:

$$v_i = \alpha_1 tc_i + \alpha_2 length_i + \alpha_3 Padre_i + \alpha_4 park_i + \alpha_5 fac_i + \alpha_6 north_i + \alpha_7 central_i + \alpha_8 south_i \quad (14)$$

where  $tc_i$  is travel cost,  $length_i$  is beach length,  $park_i$  is a dummy variable indicating whether or not the beach is located within a park,  $fac_i$  is a dummy variable indicating whether or not the site has restrooms or not,  $north_i$  is a dummy variable indicating whether the beach is northern region of Texas,  $central_i$  is a dummy variable indicating whether the beach is central region of Texas, and  $south_i$  is a dummy variable indicating whether the beach is southern region of Texas. The no-trip utility model is:

$$v_0 = \alpha_9 \ln age_j + \alpha_{10} child_j + \alpha_{11} cottage_j + \alpha_{12} retired_j \quad (15)$$

where  $\ln age_j$  is the log of the respondent's age in years,  $child_j$  is the number of children under 16 in the household,  $cottage_j$  is a dummy variable indicating whether or not the respondent has a vacation property on the Texas Gulf Coast, and  $retired_j$  is a dummy variable indicating whether or not the respondent is retired. This was estimated as a nested logit model using the nesting structure in Parsons et al. (2009).

We drew small samples of two sizes: 100 households and 200 households. This allows us to assess how sensitive the results are to different sample sizes, and different levels of precision in application site parameter estimates and measures of individual and site characteristics. These sample sizes were selected to balance two competing objectives in the estimation. First, we selected samples that are smaller than many primary data collection studies to explore the effect of using small sample sizes on the validity of the method. We assume that these datasets would be produced using a mail or telephone-mail-telephone survey. Second, we wanted to select sample sizes for this proof of concept study that would produce sample sizes that were large enough to produce relatively robust and precise estimate of parameters. A full study would explore a broader range of sample sizes.

For each sample size (100 households and 200 households), we replicated the draw and the model estimation 100 times. The per trip losses estimated using these samples are shown in Exhibits 11 and 12. The per trip value estimates from the small samples are \$16.53 for samples of 100 and \$16.09 for samples of 200. These are almost one half of the “true” per trip value of about \$30 (Parsons et al. 2009). We discuss these results more below.

The parameter estimates for each draw are summarized in Exhibits 13 and 14 compare the parameter estimates on variables that are common to the Texas and Mid-Atlantic studies. In these exhibits, the point on each vertical line represents the point estimate or average parameter estimate and the vertical lines represent the 95% confidence interval. In many cases, the vertical lines are not visible because the ranges are not large. The parameters on the following variables have 95% confidence intervals that do not overlap:

- Travel cost, or price;
- Facilities;
- Retired;
- Beach length; and
- Log of age in years.

The non-overlapping confidence intervals indicate that these variables affect utility differently in the two sites. This is one of the criteria used to select parameters for updating (in addition to differences in site and individual characteristics in the two sites). The parameters on the number of children and ownership of vacation property are different, but difficult to compare because these are measured by two separate variables in the Mid-Atlantic study. We do not update these parameters because it would require some ad-hoc transformation of data between the datasets to make the variables comparable. (The parameter estimates and per trip values estimated using each of the replications are presented in Exhibits A-1 and A-2 in Appendix A.)

We propose to account for the differences in site and individual characteristics and for differences in how they affect utility by updating the parameters that correspond to these variables in the Mid-Atlantic equation for per trip loss and using policy-site-specific (Texas) data. Specifically, we use five different models, each with different numbers of updated parameters, to calculate the per trip loss for PAIS using Equation 13. Exhibit 15 shows five different models that will be tested. The ASIS benefit function was modified by (1) replacing (or updating) the parameter estimates from the Mid-Atlantic study with parameters estimated using small samples drawn in Texas and (2) replacing data on site and individual characteristics from the Mid-Atlantic study with average site and individual characteristics from small samples drawn in Texas. For example, in the first model, the Mid-Atlantic benefit function will be updated using Texas parameters on price ( $\hat{\alpha}_{price}$ ), beach length ( $\hat{\alpha}_{lgth}$ ), whether the beach is a park ( $\hat{\alpha}_{park}$ ), whether the beach has facilities ( $\hat{\alpha}_{facil}$ ), and whether the individual is retired ( $\hat{\alpha}_{Retired}$ ). In addition, the benefit function will be updated with the Texas data on the percentage of Texas beaches that are parks (*park*), the percentage of Texas beaches that have restrooms (*facil*), and the percentage of individuals in Texas that are retired (*Retired*). Thus, these three variables (i.e., *park*, *facil*, and *Retired*) are constants in the calculation of per trip loss. The other strategies vary in terms of the number of parameters and variables that are updated.

A complication arises from the fact that the utility function parameters from random utility models are confounded with the scale term (Louviere et al. 2000). That is, the parameter estimates are the ratio of the marginal effect on utility to the scale, or the standard error of the data. The scale refers to the standard deviation of the unobserved components of the dataset and it affects the value of the estimated parameters (Louviere et al. 2000). Because of potential scale differences in any two choice datasets, one cannot directly compare parameters from different choice studies (Louviere et al. 2000). Thus, transferring parameter estimates from Mid-Atlantic to Texas involves the implicit assumption of equal scale between the two applications. To avoid this, we propose reformulating the parameters in WTP space as described by Train and Weeks (2005). We transfer the ratio of parameters  $\beta/\beta_{tc}$ , where  $\beta$  is the parameter on site or individual characteristics and  $\beta_{tc}$  is the parameter on travel cost. This entails reformulating the utility function from:

$$U = \beta tc + \beta_q q + \varepsilon \quad (16)$$

to

$$U = \beta_{tc}tc + \beta_{tc}\omega q + \varepsilon \quad (17)$$

where  $\omega=\beta/\beta_{tc}$  is the marginal WTP for an incremental change in  $q$ . While equation 17 is equivalent to equation 16, this form has the advantage that the ratio of parameters is independent of scale, and therefore is comparable (and transferable) across studies. We rescale the Texas parameters to the Mid-Atlantic data by multiplying  $\omega$  by the Mid-Atlantic parameter on travel cost before updating.

Specifically, we calculated per trip loss using equations (12) and (13). An example of the specific updated utility models,  $v_{i,MA}^{updated}$  and  $v_{0,MA}^{updated}$ , were updated as follows:

$$\begin{aligned} v_{i,MA}^{updated} = & \beta_{1,MA} tc_{i,MA} + \beta_{2,MA} (\beta_{2,TX}/\beta_{1,TX}) length_{i,MA} + \beta_{3,MA} bwalk_{i,MA} \\ & + \beta_{4,MA} amuse_{i,MA} + \beta_{5,MA} private_{i,MA} + \beta_{6,MA} (\beta_{6,TX}/\beta_{1,TX}) park_{i,TX} \\ & + \beta_{7,MA} wide_{i,MA} + \beta_{8,MA} narrow_{i,MA} + \beta_{9,MA} AC_{i,MA} \\ & + \beta_{10,MA} surf_{i,MA} + \beta_{11,MA} highrise_{i,MA} + \beta_{12,MA} parkwi_{i,MA} \\ & + \beta_{13,MA} (\beta_{13,TX}/\beta_{1,TX}) fac_{i,TX} + \beta_{14} prkng_{i,MA} \end{aligned} \quad (18)$$

and

$$\begin{aligned} v_{0,MA}^{updated} = & \beta_{18,MA} + \beta_{19,MA} \ln age_{j,MA} + \beta_{20,MA} kidsu10_{j,MA} + \beta_{21,MA} kidsu16_{j,MA} \\ & + \beta_{22,MA} flextm_{j,MA} + \beta_{23,MA} vpin_{j,MA} + \beta_{24,MA} vpout_{j,MA} \\ & + \beta_{25,MA} (\beta_{25,TX}/\beta_{1,TX}) retired_{j,TX} + \beta_{26,MA} student_{j,MA} \\ & + \beta_{27,MA} parttime_{j,MA} + \beta_{28,MA} work home_{j,MA} + \beta_{29,MA} volunt_{j,MA} \end{aligned} \quad (19)$$

The subscripts MA and TX indicate that the parameter or variable was taken from the Mid-Atlantic or Texas datasets, respectively.<sup>1</sup>

<sup>1</sup> Equations (18) and (19) correspond to Model 1 in Exhibit 15.

Testing alternative specifications will allow us to assess how sensitive the method is to alternative benefit function (or utility model) specifications and whether updating more parameters and data lead to better benefit estimates. As mentioned above, we will also test the performance of the method using two different sized samples from Texas – 100 households and 200 households – to assess how sensitive the results are to different sample sizes and different levels of precision.

## 4.0 RESULTS

According to the Parsons et al. (2009) analysis of the full Texas dataset, per trip value for PAIS is about \$30, while per trip loss for ASIS is about \$26 (in 2001 dollars). Thus the per trip loss estimate for ASIS is 86% of the per trip loss estimate for PAIS. To our knowledge, neither study estimated the standard deviation of any of the welfare estimates (e.g., per choice occasion welfare loss), thus we do not test the statistical differences between the per trip value estimates.

### *Simple Transfer Method*

Exhibit 16 shows how the simple transfer method, which would use the per trip loss for ASIS to estimate the per trip loss for PAIS, would fare in terms of two measures of predictive validity -- root mean square error (RMSE) and percent deviation of predicted mean from the “true” mean. RMSE, which has been used in transportation studies to compare forecasting accuracies (Koppelman and Wilmot 1985), is the square root of the average of the squared values of the prediction errors. Since there is only one per trip value estimate per sample, the RMSE in this case is the square root of the squared value of the prediction error. The RMSE is 4.29 and the percent deviation is -14%.

### *Model Transfer Method*

The model transfer method predicts welfare estimates using the benefit function specification and parameter estimates from the Mid-Atlantic study and the site and individual characteristics from the Texas site. We implement this approach by using Texas beach site characteristic data on variables that appear in the Mid-Atlantic site utility model and individual characteristic data on variables that appear in the Mid-Atlantic no-trip utility model. There are only four variables that appear and are comparable in both datasets and each is included in the model transfer application (Park, Facilities, Ln(age), and Retired). The model transfer method estimate of the per trip value is \$26.53. This estimate is 88% of the “true” per trip value. (Exhibit 16)

There are two pieces of evidence concerning validity of the model transfer method. First, Exhibit 17 shows the 95% confidence intervals around the utility model parameter estimates for variables that appear in both the Mid-Atlantic and Texas studies reported in Parsons and Massey (2003) and Parsons et al. (2008). The exhibit shows that tests of the statistical equivalence of the individual parameter estimates from the Mid-Atlantic and Texas full models would reject the statistical equivalence of all of these individual parameters at the 5% level. This comparison is important because benefit transfer using unit values or model transfers implicitly assume that the underlying utility function is the same at the two sites. Exhibit 17 implies that this assumption is untrue and that validity tests based on this assumption would reject the validity of these benefit transfer methods. Exhibits 13 and 14 compare the parameter estimates from the full Mid-Atlantic study with the average parameter estimates from the small sample analyses and show similar

results. These results suggest that the model transfer method might not lead to valid benefit estimates.

Second, we compare the per trip value from the model transfer method to the “true” per trip value from Parsons et al. (2008). Exhibit 16 summarizes the measures of predictive validity of the per-trip loss estimates from the model transfer method. The results suggest that the predictive validity of transferred models is just a little better than the predictive validity of the simple transfer method (RMSE=3.47, percent deviation=-12%).

### *Parameter Updating Method*

As described in section 3.6, to implement the parameter updating method, we simulated the implementation of small-scale policy-site studies to collect data for updating by randomly selecting small samples from Parsons et al.’ (2009) full Texas dataset. Two different sample sizes – 100 households and 200 households – were used to generate beach and individual descriptive statistics, to estimate site choice model parameters, and to calculate per trip loss. The results of these replications are shown in Exhibits 11, 12, 13, and 14.

On average, Exhibit 18 shows that the small-scale parameters on trip price, facilities, length, and percentage of households with children were similar to the Texas parameters from the full dataset. The parameters on percentage of beaches that are parks, percentage of households with retirees, average logged age, and percent of households that own vacation property are different for the small samples than for the full dataset. These patterns are the same for both the 100 household and 200 household small samples. These results, combined with the large differences between per trip values for the full dataset and the small samples (Exhibits 11 and 12) suggest that by limiting the transfer models to include variables present in both datasets, these models may omit relevant variables that may be correlated with other explanatory variables. This would lead to omitted variable bias. We proceeded with these parameter estimates for the parameter updating application and discuss the implications of potential omitted variable bias in the next section.

The parameter updating method results are summarized in Exhibit 16. Each row summarizes the maximum, minimum, and mean per trip value for the 100 replications of each model specification/sample size combination. For model specifications 1, 2 and 3, the average per trip value from 100 replications is closer to the “true” value than the estimates from either the simple or model transfer methods. Exhibit 18 also shows that the per trip values from the parameter updating applications are closer to the “true” per trip value than the small sample estimates. The average RMSE and percent deviations are also smaller, indicating that the parameter updating estimates are closer to the “true” value than the estimates from the simple and model transfer methods. Model 4 performs slightly worse than either the simple transfer or model transfer methods, on average. On the other hand, Model 5, which has the most updated parameters and uses the most site-specific data, performs the worst. This result is counter-intuitive and is driven by the difference in the parameter on *Lnage*. The difference between Model 1, which outperforms the simple and model transfer methods, and Model 5 is that Model 5 updates the parameter on *Lnage* and uses Texas data on average *Lnage*. The average *Lnage* parameter for the small Texas samples is much higher than the parameter estimates by Parsons et al. (2009) using the full Texas sample (see Exhibits 13, 14, and 17). We discuss the implications of these differences in model specification in the next section.

So far, the results indicate that, on average, the parameter updating method may improve benefit transfer by generating estimates of per trip values that are closer to true values. However, the range of results in Exhibit 16 show that sampling variation can affect the performance of the method. For most models, the results vary such that the parameter updating method may do much better or much worse than the simple transfer or model transfer method, depending on the sample drawn and the site specific data (on characteristics and parameters) that that sample yields. However, Exhibits 19 and 20 show that the majority of the replications of the parameter updating method has smaller percent deviations than the simple or model transfer methods.

These results also show that the predictive validity is somewhat improved and the sampling variability is reduced when the larger sample is used.

## **5.0 DISCUSSION AND IMPORTANCE TO OIL SPILL RESPONSE/RESTORATION**

This proof of concept research study applied a new benefit transfer method – the parameter updating method– to estimate the welfare loss due to a hypothetical closure of the beaches in the PAIS. The parameter updating method attempts to take important site differences into account when transferring benefits by adapting the “constant updating” concept used in the transportation literature on model transferability. That idea is expanded here to account for characteristics that are (1) predicted to affect welfare estimates and (2) vary across sites. The choice of parameters to be updated would be made based on whether there were significant differences between the site characteristics, individual characteristics, or utility parameters at the two sites. The parameters on these characteristics are updated and then the updated model is transferred. The updating reflects the commodity, population, and substitutes at the application site and in theory should generate more accurate benefit transfer welfare estimates. The parameter updating method has been applied only once before, using stated preference valuation data (Poulos 2000). This proof of concept application was the first to use revealed preference data. It also built on the previous application by examining the sensitivity of the parameter updating method to sampling variation and model specification.

This proof of concept study tested the method by measuring welfare losses due to beach closures in National Seashores in two regions of the United States. Section 3.3 describes the utility model underlying the welfare estimates and uses it to predict which differences in beach and population characteristics might influence the magnitude of welfare estimates. Section 3.5 compares the beach and population characteristics for the Texas Gulf Coast region (as measured by Parsons et al. (2009) to those for the Mid-Atlantic region (as measured by Parsons and Massey 2003). Among the variables that appear in both datasets, we found differences in the length of beaches, the percent of sites that are parks, the percent of beaches with facilities (restrooms), and the percent of households with a retired adult. We tested several alternative parameter updating model specifications to examine the effect of adapting the benefit function for different combinations of these variables. Since the parameter updating method requires the collection of data from the application site, we also examined the effect of two different application site sample sizes – 100 households and 200 household – on the predictive validity of the parameter updating method. Finally, we replicated each parameter updating model specification 100 times to examine the effect of sampling variation on the performance of the parameter updating method.

The results show that, on average, the parameter updating variant of the model transfer method performed better than the simple transfer or model transfer methods in terms of predictive validity, but that parameter updating results were sensitive to sampling variation and model specification. For four of the model specifications, the majority of the replications (51-70%) had better predictive validity than the simple or model transfer methods, suggesting that the parameter updating method would improve benefit estimates in most cases. However, it is not possible for practitioners to determine the influence of sampling variation in any single application, which represents a weakness of the parameter updating method.

The results were sensitive to the parameter updating model specification. The first three models all outperform simple and model transfers at least slightly. The fourth model updates only the travel cost parameter and performs slightly worse than the simple and model transfer methods. The fifth model includes the most updated parameters, but yields very inaccurate welfare estimates due to updating the parameter on age (measured by the natural log of the respondent's age, *Lnage*), which is much different for the Texas small samples than either the Mid-Atlantic sample or the full Texas sample. One explanation is that the site choice models estimated with the small samples were not the same specification as the model reported in Parsons et al. (2009) – they included fewer variables and are vulnerable to omitted relevant variable bias. Additional evidence of potential bias is seen in the per trip value estimates from the small samples, which were almost one-half the size of the “true” per trip loss for PAIS. This suggests that the application site models be as fully specified as possible to minimize this source of bias.<sup>2</sup>

Finally, predictive validity was improved when larger application site samples were used, and the range of the predictive validity measures was also narrower among the larger sample sizes.

In addition to the potential omitted variable bias in the small sample estimates, this application was also limited by the fact that the Mid-Atlantic and Texas studies had not estimated the variance of the welfare estimates. Simulating these measures for these two datasets, in two different statistical programs, was beyond the scope of this proof of concept grant. Without measures of variability, we were not able to perform tests of statistical equivalence of the per trip values. Instead, we rely on measures of predictive validity.

Another approach that may be promising is to adjust the original site sample so that it matches the application site sample on sample characteristics that are not updated in the parameter updating method. Then, estimate the original site model on this matched sample, update the relevant parameters, and predict benefits for the application site. This approach, which is similar to the case-control study design used in epidemiology studies, would ensure that the distributions of sample characteristics at the application site are reflected in the parameter estimates. These extensions to the analysis are beyond the scope of this study.

Additional issues, regarding the conditions under which the parameter updating method is promising, deserve mention. The first set of issues concerns the information necessary to

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<sup>2</sup> There are likely omitted variables at both study sites that might be explain differences in visitation and values. While parameter updating may account for some of these unobserved differences, if these variables are not measured in either dataset, it is not possible to account for them. This would also affect other methods of benefit transfer.

implement the parameter updating method and the second set concerns the costs of the parameter updating method.

The parameter updating method requires information from both the original site and the application site. It requires an original site dataset or benefit function with sufficient information to provide a basis for adaptation. Larger datasets that measure more sample characteristics have an advantage because they provide more opportunities for adaptation to a broader range of application sites. Indeed, with a large, high quality study at the original site, analysts can mount small-scale field “studies” to collect the application site information necessary to adapt the original site benefit function. Another advantage of larger original site datasets is that they allow the analyst to estimate a properly specified model for transfer. When the data on relevant explanatory variables are not available in both sites and the model specification is limited by the dataset with the least information (see also Loomis 1992; Kirchoff et al. 1997; Watson and Westin 1975). Since omitting relevant variables may lead to inconsistent parameter estimates (Greene 1993) and weakens model transferability (Koppelman and Wilmot 1985), it is likely that benefit transfers will perform better when datasets are more complete. The results of the estimation using the small samples from Texas (parameter estimates and per trip values) suggest that the reduced specification models estimated with the small samples may be biased.

A reviewer made the observation that there may be a tradeoff between collecting additional variables at the application (to match the information available at the original site) and the sample size at the application site. Perhaps the increased precision due to having fewer omitted variables outweighs the increased precision of larger sample sizes at the application site. Another consideration is the tradeoff between spending a fixed budget for application site data collection on increasing the number of variables measured or on increasing the sample size. Examining the effect of smaller sample sizes on the parameter estimates would help understand these tradeoffs. This was beyond the scope of this proof of concept study.

If future work confirms that the parameter updating method improves the reliability of benefit transfer, analysts may consider conducting larger studies as a starting point for parameter updating. However, these large studies are not necessary to implement the approach – it may be implemented with any existing nonmarket valuation dataset. In fact, existing secondary datasets (e.g., National Survey of Recreation and the Environment, Marine Recreational Fisheries Statistics Survey) could possibly be used to collect application site data for a benefit transfer application. This is being explored in other EPA-sponsored grant research being conducted by Christine Poulos, George Parsons, and others.

The second set of issues, the costs of the parameter updating method, arise because any reliability improvements that accompany the parameter updating method come at the cost of additional application site data requirements. Analysts must consider whether the benefits of additional reliability that are possible with the parameter updating method are worth the cost. There are a number of considerations.

The first is whether there are important differences between sites that the parameter updating method could take into account. If not, the underlying assumption of the simple or model transfer method applies, and there is no need to use the parameter updating method.

The second consideration is the costs of parameter updating relative to original research. The parameter updating method may be preferred when the costs of collecting a small dataset for updating are appreciably lower than the costs of collecting data for a full original study. These

conditions may be found when the model is transferred within a country or region so that adaptation of the questionnaire is not required. They may also be found when the labor costs associated with interviewing are high (i.e., in-person interviews in more developed countries), so that small datasets represent a significant cost savings.

The costs also depend on the type and amount of data required. Some transportation studies (Atherton and Ben-Akiva 1976) update models use aggregate data for updating. This paper uses disaggregate data and benefit functions from multiple site choice models. This type of data might require some small scale primary data collection. In our previous survey research in the United States, we have used internet panel surveys that cost approximately 35 to 45 dollars per interview. The advantages of using these internet panels is that there is often information available on panel members, such as the location of residence, their participation in outdoor recreation, and socioeconomic characteristics that can be used to draw a sample. Also, these samples can be used to collect data on people who visit beaches and people who do not, so that the participation decision can be modeled. Another alternative is to intercept beach-goers at the beach. In our experience, these surveys are more expensive and they cannot collect data from individuals who do not participate in beach recreation. A recent estimate for the costs of intercept surveys in coastal North Carolina were about \$90 per completed survey. Assuming that the main incremental cost of the parameter updating method relative to other benefit transfer methods is the collection of application site data, the internet panels offer a low-cost approach to collecting the required data. The cost of collecting data similar to the data we used here would be between \$3,500 and \$9,000 for samples of 100 households (\$7,000 to \$18,000 for samples of 200 households).

Other types of nonmarket valuation methods that rely on observable behavior (i.e., zonal travel cost models, averting behavior models) may be amenable to the use of aggregate data for updating.

A third consideration is the cost of benefit estimation relative to the cost of the project. The costs of original research may be justifiable for large-scale high-cost projects, while benefit transfer in general and parameter updating in particular will be more attractive when evaluating low cost projects or whenever the budget for evaluation is more limited.

The fourth consideration concerns the practical implications of improving the accuracy of benefits. That is, relative to using other benefit transfer methods or relative to performing original research, will more accurate benefit measurements improve efficiency or social welfare by supporting the scaling of restoration projects that compensate the public for economic damages due to oil spills or chemical releases? In the application studied in this proof of concept grant, the simple and model transfer methods both underestimate the per trip losses and would lead to insufficient restoration. On average, parameter updating would lead to better estimates of welfare losses, which could lead to more appropriately scaled restoration projects. However, the results of this project show that these results are sensitive to sampling variation and model specification, implying that the accuracy of welfare loss estimates and restoration depends on the samples that are drawn at the application site.

In short, the parameter updating method is most promising where there is a large dataset from the original site and where there is either an existing sampling frame or dataset from the application site, or the resources to collect primary data. Where the costs of obtaining the small application site sample are high, the parameter updating method may be impractical.

Additional limitations of this study should not be overlooked. First, there are data limitations due to differences in the variables available in each dataset for model estimation and transfer. The data on relevant explanatory variables are not available in both sites and the model specification is limited by the dataset with the least information. Since omitting relevant variables may lead to inconsistent parameter estimates and weakens model transferability, it is likely that benefit transfers will perform better when datasets are more complete.

Another limitation applies to all similar tests of benefit transfer. These tests compare two *estimates* of economic value, but implicitly assume that each *estimate* is a measure of *true* benefits. In fact, limitations of theory and data, like those discussed here, may have a significant influence on the outcome. Therefore, judgment on the importance of these limitations must be used in interpreting the results.

While the main objective of this proof of concept study was to demonstrate that the parameter updating method may be applied to multiple site choice data, it also provides the first evidence concerning whether the parameter updating method might be a reliable and cost-effective tool for NRDA. Because this study was only the second application of the parameter updating method of benefit transfer and the first proof of concept application of the method to revealed preference data, the conclusions regarding these two could be suggestive at best. Additional evidence from other studies would be required to build evidence from different settings and contexts.

The results of this study do not provide unambiguous evidence about the validity of the parameter updating method that would support a recommendation to use this method in NRDA and they do not support the use of parameter updating in NRDA without additional research to understand the tradeoffs among sample size, more accurate and precise benefit estimates, and the effects on restoration scaling. The results indicate that sampling variation is a significant influence on the results and sampling variation alone may lead to benefit transfer results that perform worse than simple and model transfer results. While larger sample sizes reduce this effect, this proof of concept study was only able to examine the influence of two different sample sizes.

Further, the difference between the per trip value estimates from the parameter updating method and the simple and model transfer approaches were as large as 20% when more parameters were updated (e.g., Models 1 and 2 in Exhibit 3) and as small as 3-6% when fewer parameters were updated (e.g., Models 3 and 4). While a 20% change in per trip values may have a significant effect on restoration scaling, it is unlikely that a 6% change in values would justify the effort of implementing the parameter updating method.

Applying parameter updating to a RUM presented a number of challenges. Using stated-preference surveys for the proof of concept would have greatly simplified the entire exercise. In addition, if all the steps in parameter updating were performed, the data for the Texas site would have been collected with the same instrument as was used in the Mid-Atlantic site. Having identical sets of variables from the two sites should improve the results from parameter updating. Also, all benefit transfer methods would benefit from a better understanding of the variables that affect WTP and how these variables interact with each other. Ideally, existing studies or meta-analyses could be reviewed to produce a list of site, commodity and population variables that have a consistently significant impact on WTP. Future research should examine whether increases in the sample size might reduce the sampling variation and improve accuracy and

precision such that the parameter updating method is unambiguously better than other benefit transfer methods. The tradeoffs between larger sample sizes, predictive validity, and study costs should be explored to examine whether improvements in the accuracy of benefit estimation are worth it in terms of the costs of data collection and the scaling of restoration projects.

## **6.0 TECHNOLOGY TRANSFER**

The information generated under this proof of concept grant has not been disseminated to date.

## **7.0 ACHIEVEMENT AND DISSEMINATION**

There have been no manuscripts or conference presentations prepared based on this proof of concept research to date. These results may provide the basis for a manuscript, either alone or in combination with the previous, stated preference, application of the parameter updating method. There were no graduate students who worked on this study.

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## EXHIBITS

Exhibit 1. Results of Tests of the Validity of the Simple Benefit Transfer Approach and the Model Transfer Approach

|                                       | Benefit Transfer Approach                   |                         |   |
|---------------------------------------|---|-------------------------|---|
|                                       | Simple Transfer Approach                    | Model Transfer Approach |   |
| Measure of Transferability            | Equivalence of Measures of Central Tendency | Statistical Equivalence | Predictive Validity   |
| Recreation Studies                    |   |                         |   |
| Parsons and Kealy (1994)              | Rejected                                    | Rejected                | Mixed   |
| Downing and Ozuna (1996)              | Rejected                                    | Rejected                | Rejected  |
| Loomis (1992)                         | Mixed                                       | Rejected                | Mixed   |
| Kirchhoff <i>et al.</i> (1997)        | Rejected                                    | Rejected                | Mixed   |
| Loomis <i>et al.</i> (1995)           | Mixed                                       | Rejected                | Mixed   |
| Cameron (1992)                        | Mixed                                       | n.a.                    | Mixed   |
| Alberini <i>et al.</i> (1997)         | Mixed                                       | n.a.                    | Accepted  |
| Transportation Studies                |   |                         |   |
| Atherton and Ben-Akiva (1976)         | n.a.  | Accepted                | n.a.  |
| Watson and Westin (1975)              | n.a.  | Mixed                   | n.a.  |
| Talvitie and Kirshner (1978)          | n.a.  | Rejected                | n.a.  |
| Galbraith and Hensher (1982)          | n.a.  | Rejected                | Predicts individual behavior poorly, predicts aggregate behavior well |
| Van der Heijden and Timmermans (1988) | n.a.  | n.a.                    | Predicts aggregate behavior well                                      |
| Stopher and Wilmot (1981)             | n.a.  | Accepted                | n.a.  |

n.a. = not applicable

## Exhibit 2. Parameter Updating Method

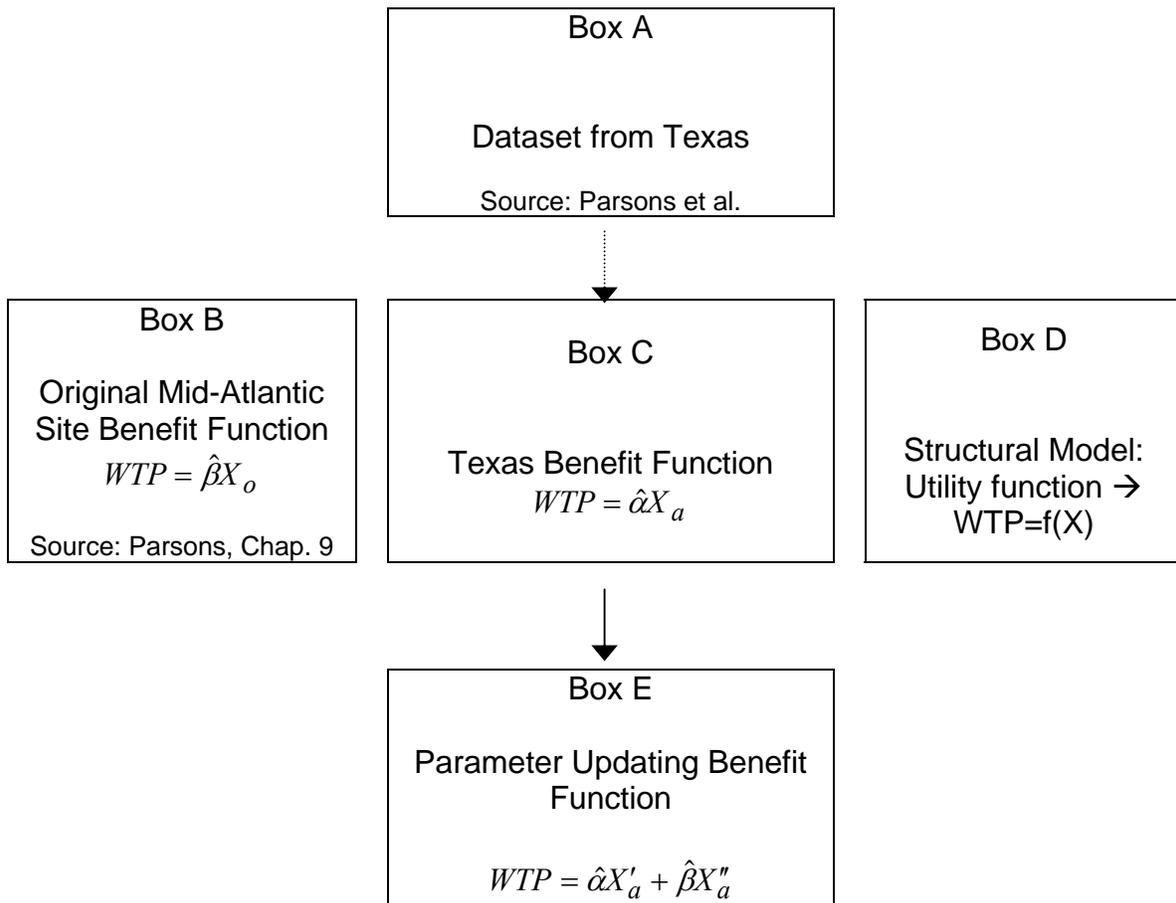


Exhibit 3. Steps to Implement this Application of the Parameter Updating Method<sup>†</sup>

| <b>Steps</b>   | <b>Description</b>  |
|--|---|
| <b>1. Identify impacts to be valued</b>                              | This study will value the closure of PAIS beaches.  |
| <b>2. Define the population of users to be analyzed</b>              | The population of users are residents of Texas counties within 200 miles of the Galveston Bay coast.  |
| <b>3. Define the choice set</b>                                      | The choice set includes 65 Texas Gulf Coast beaches.  |
| <b>4. Develop a sampling strategy</b>                                | The sample will be a random draw of the PAIS study – the sample includes Texas residents living in counties within 200 miles of the Gulf Coast. We implement the method by testing two different sample sizes (100 draws of each sample size): 100 and 200. |
| <b>5. Specify the model</b>  | Using these Texas samples, a nested logit model will be estimated with the same specification (or as similar as possible) as the Mid-Atlantic nested logit model.   |
| <b>6. Gather site characteristic data</b>                            | Site characteristics will be those currently available in the Texas dataset.  |
| <b>7. Decide on the treatment of multiple purpose trips</b>          | Only day trips will be used in the estimation   |
| <b>8. Design and implement the survey</b>                            | Done – using data collected using PAIS survey.  |
| <b>9. Measure trip cost</b>  | Done – using trip cost estimates for PAIS study.  |
| <b>10. Select parameters for updating</b>                            | Identify a set of parameters, corresponding to variables that are different across the datasets, to 'update'. That is, estimated parameters in the Mid-Atlantic nested logit model that will be replaced with estimated parameters from the Texas model.    |
| <b>11. Estimate model</b>  | Estimate the nested logit model using the small random sample(s) of respondents from the Texas dataset. This will be done for each of the small samples.  |
| <b>12. Calculate access value for Padre Island National Seashore</b> | Using the small random samples drawn from the Texas dataset and the parameter estimates for each of the small samples, calculate the per trip losses due to a closure of the CC national seashore.  |
| <b>13. Update parameters in Mid-Atlantic welfare function</b>        | Replace selected parameters in the Mid-Atlantic estimated nested logit with corresponding parameters from the Texas estimated nested logit.   |
| <b>14. Compute access value for Corpus Christi national seashore</b> | Using the small random samples from the Texas dataset and the updated benefit function, compute the per trip losses.  |

<sup>†</sup>The list is modified from Parsons' (2003) list of the steps in estimating a random utility model.

Exhibit 4. Summary of the Mid-Atlantic (Parsons 2003; Parsons and Massey 2003) and Texas Gulf Coast (Parsons et al. 2009) study

|               | <b>Mid-Atlantic</b>                                 | <b>Texas Gulf Coast</b>   |
|---------------|---|---|
| Mode          | Mail  | Phone-Mail-Phone  |
| Panel Survey? | No  | Yes   |
| Respondents   | 565 Delaware residents<br><br>400 took day trips    | 773 Texas residents living at most 200 miles from coast<br><br>485 took trips |
| Trips         | 9330<br>23 per person                               | 2350<br>5 per person  |
| Dates         | Data on Summer 1997 trips collected in October 1997 | May 1-September 30, 2001  |
| Sites         | 62  | 65  |

Exhibit 5. Beach Site Characteristic Data Available for Mid-Atlantic and Texas Gulf datasets

| Variables                | Mid-Atlantic <sup>1</sup>                               |            | Texas <sup>2</sup>   |                         |
|--------------------------|---|------------|--|-------------------------|
|                          | Definition  | Type       | Definition   | Type                    |
| Trip Cost                | Trip cost+time cost (1997) <sup>3</sup>                 | Continuous | Trip cost+time cost (2001) <sup>4</sup>  | Continuous              |
| Length                   | Length of beach in miles (logged)                       | Continuous | Length of beach in miles   | Continuous              |
| Boardwalk                | Boardwalk with shops and attractions present            | Dummy      | n.a.   |                         |
| Amusements               | Amusement park, etc. available or nearby                | Dummy      | n.a.   |                         |
| Park                     | State or federal park, or wildlife refuge               | Dummy      | Site located within State park<br>Site located within National park            | Dummy<br>Dummy          |
| Private                  | Private or limited access                               | Dummy      | n.a.   |                         |
| Wide                     | Beach width from dune toe to berm greater than 200 feet | Dummy      | n.a.   |                         |
| Narrow                   | Beach width from dune toe to berm less than 75 feet     | Dummy      | n.a.   |                         |
| Surfing                  | Recognized as a good location for surfing               | Dummy      | n.a.   |                         |
| High rise                | Highly developed  | Dummy      | n.a.   |                         |
| Park within              | Part of the beach is a park area                        | Dummy      | n.a.   |                         |
| Facilities               | Bathrooms, showers, food available just off the beach   | Dummy      | Restrooms at site<br>Concessions stand at site<br>Lifeguards at beach          | Dummy<br>Dummy<br>Dummy |
| Parking                  | Presence of adequate parking near beach                 | Dummy      | n.a.   |                         |
| Atlantic city            | Atlantic City   | Dummy      | n.a.   |                         |
| New Jersey               | Beach located in NJ                                     | Dummy      | n.a.   |                         |
| Gulf Beach               | n.a.  |            | Offers access to a beach on the Gulf Coast (as opposed to a saltwater bay)     | Dummy                   |
| Lifeguard                | n.a.  |            | Beach has lifeguards   | Dummy                   |
| Beach cleaning           | n.a.  |            | Beach is routinely manually cleaned<br>Beach is routinely mechanically cleaned | Dummy<br>Dummy          |
| Remote                   | n.a.  |            | Beach has remote location  | Dummy                   |
| Vehicle Free             | n.a.  |            | Vehicles not allowed on the beach  | Dummy                   |
| No fishing               | n.a.  |            | Not listed as a fishing area in 2002 <i>Texas Beach and Bay Access guide</i>   | Dummy                   |
| No swimming              | n.a.  |            | Not listed as a swimming area in 2002 <i>Texas Beach and Bay Access guide</i>  | Dummy                   |
| Red tide history         | n.a.  |            | Beach has a recent history of red tide   | Dummy                   |
| Advisory/closure history | n.a.  |            | Beach has a recent history of closures and/or advisories                       | Dummy                   |

<sup>1</sup> From Table 1 (Parsons and Massey 2002) <sup>2</sup> From Slide 88 in NPS briefing presentation and draft paper <sup>3</sup> Trip cost (includes tolls, beach fees, transit costs, and parking fees) + time costs. \$0.35 times the round trip distance to a site. Time cost: (1/3)X (annual income/ 2080 hours) X (round trip travel time in hours). Time on site assumed constant. <sup>4</sup> Travel cost calculated as (\$0.365 per mile) X (round trip mileage) + (beach entry fee), and time cost calculated as (annual household income/2000 hours) X (1/3) X (round trip travel time in hours).

Exhibit 6. Individual Characteristic Data Available for Mid-Atlantic and Texas Gulf datasets

| Variables             | Mid-Atlantic <sup>1</sup>                          |             | Texas <sup>2</sup>      |            |
|-----------------------|--|-------------|-------------------------|------------|
|                       | Definition   | Type        | Definition              | Type       |
| Age                   | Age in years (logged)                              | Continuous  | Age in years            | Continuous |
| Kidsu10               | Number of kids under 10 years of age               | Count       | Children under 17 years | Count      |
| Kidsu16               | Number of kids between 10 and 16 years of age      | Count       |                         |            |
| Flexm                 | Work flextime schedule                             | Dummy       | n.a.                    |            |
| Vpin                  | Own a beach vacation home in the Mid-Atlantic      | Dummy       | Own coastal property    | Dummy      |
| Vpout                 | Own a beach vacation home outside the Mid-Atlantic | Dummy       |                         |            |
| Retired               | Retired Worker                                     | Dummy       | Retire                  | Dummy      |
| Student               | Student  | Dummy       | n.a.                    |            |
| Workhome              | Work from home                                     | Dummy       | n.a.                    |            |
| Volunt                | Work as volunteer                                  | Dummy       | n.a.                    |            |
| County                | Respondents county of residence                    | Categorical | n.a.                    |            |
| Work Fulltime         | n.a.   |             | Work Fulltime           | Dummy      |
| High school           | n.a.   |             | High School             | Dummy      |
| College               | n.a.   |             | College                 | Dummy      |
| Graduate School       | n.a.   |             | Graduate School         | Dummy      |
| Spanish               | n.a.   |             | Spanish                 | Dummy      |
| Female                | n.a.   |             | Female                  | Dummy      |
| Own boat              | n.a.   |             | Own boat                | Dummy      |
| Own pool              | n.a.   |             | Own pool                | Dummy      |
| Own fishing equipment | n.a.   |             | Own fishing equipment   | Dummy      |

Exhibit 7. Nesting Structure for the Mid-Atlantic Model

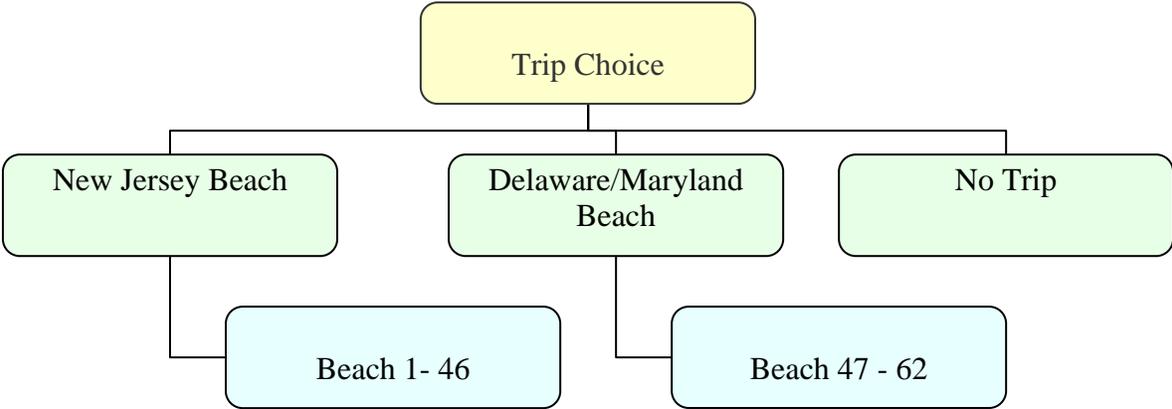


Exhibit 8. Nested Logit Model Estimates for Mid-Atlantic Beaches<sup>†</sup>

| Variable                             | Definition  | Parameter Estimate (t-stat) |
|--------------------------------------|---|-----------------------------|
| <b>Site Characteristics</b>          |   |                             |
| TC                                   | Travel plus time cost                             | -0.04 (63.9)                |
| LENGTH                               | Log of length of beach in miles                   | 0.13 (0.3)                  |
| BWALK                                | Boardwalk present=1                               | 0.41 (6.3)                  |
| AMUSE                                | Amusements nearby=1                               | 0.48 (15.4)                 |
| PRIVATE                              | Private or limited access beach=1                 | -0.17 (6.3)                 |
| PARK                                 | State or federal park=1                           | 0.04 (0.6)                  |
| WIDE                                 | Wide beach (=1 if >200 feet)                      | -0.33 (12.8)                |
| NARROW                               | Narrow beach (=1 if <75 feet)                     | -0.20 (5.4)                 |
| AC                                   | Atlantic City=1                                   | 0.42 (7.2)                  |
| SURF                                 | Good surfing=1                                    | 0.40 (15.5)                 |
| HIGHRISE                             | High rises present on beach=1                     | -0.30 (9.4)                 |
| PARKWI                               | Park located within beach=1                       | 0.25 (5.1)                  |
| FAC                                  | Bathhouse, restroom facilities present=1          | -0.05 (1.1)                 |
| PRKING                               | Parking available at beach=1                      | 0.13 (1.8)                  |
| <b>Inclusive Value Coefficients:</b> |   |                             |
| IV(NJ)                               | Inclusive Value on New Jersey beaches             | 0.51 (33.9)                 |
| IV(DE)                               | Inclusive Value on Delaware/Maryland beaches      | 0.49 (36.9)                 |
| IV(Beaches)                          | Inclusive Value on all beaches                    | 0.99 (38.7)                 |
| <b>Individual Characteristics</b>    |   |                             |
| CONSTANT                             |   | 2.06 (11.0)                 |
| Ln(age)                              | Log of age  | 0.25 (5.3)                  |
| KIDSU10                              | Number of children under 10 in the household      | 0.20 (7.0)                  |
| KIDSU16                              | Number of children between 10 and 16 in household | -0.26 (9.4)                 |
| FLEXTM                               | Flexible time available in work schedule=1        | -0.14 (3.4)                 |
| VPIN                                 | Own beach property in DE=1                        | -1.30 (25.5)                |
| VPOUT                                | Own beach property in NJ=1                        | -0.80 (16.4)                |
| RETIRED                              | Retired=1   | 0.53 (10.5)                 |
| STUDENT                              | Student=1   | -0.90 (19.5)                |
| PARTTIME                             | Work part time=1                                  | -0.56 (13.3)                |
| WORKHOME                             | Work at home=1                                    | 0.94 (12.0)                 |
| VOLUNTEER                            | Work as a volunteer=1                             | -0.16 (2.6)                 |
| SAMPLE SIZE                          |   | 565                         |
| Mean Log-Likelihood                  |   | -94.05                      |

<sup>†</sup>This table is from Parsons (2003).

Exhibit 9. Descriptive statistics for Mid-Atlantic and Texas Gulf Coast Beaches

| <b>Variables</b>   | <b>Mid-Atlantic Beaches<sup>1</sup></b> | <b>Texas Beaches<sup>2</sup></b>                      |
|--|---|---|
| Trip Cost (\$)   | \$135                                   | \$118 (to chosen site)                                |
| Length (Miles)   | 1.86                                    | 5.35  |
| Boardwalk  | 37%                                     | n.a.  |
| Amusements   | 13%                                     | n.a.  |
| Park   | 10%                                     | 6% state<br>9% federal                                |
| Private  | 26%                                     | n.a.  |
| Wide   | 24%                                     | n.a.  |
| Narrow   | 14%                                     | n.a.  |
| Atlantic city  | 2%                                      | n.a.  |
| Surfing  | 36%                                     | n.a.  |
| High rise  | 24%                                     | n.a.  |
| Park within  | 15%                                     | n.a.  |
| Facilities (restrooms, food concessions, and/or showers) | 39%                                     | 57% restrooms<br>23 % concession stand<br>32% showers |
| Parking  | 45%                                     | n.a.  |
| New Jersey   | 74%                                     | n.a.  |
| Gulf Beach   | n.a.                                    | 74%   |
| Lifeguard  | n.a.                                    | 26%   |
| Beach cleaning   | n.a.                                    | 51%   |
| Fishing pier   | n.a.                                    | 22%   |
| Vehicle free area  | n.a.                                    | 40%   |
| Remote   | n.a.                                    | 34%   |
| Manual cleaning  | n.a.                                    | 51%   |
| Machine cleaning   | n.a.                                    | 55%   |
| No fishing   | n.a.                                    | 5%  |
| No swimming  | n.a.                                    | 9%  |
| Red tide history   | n.a.                                    | 18%   |
| Advisory/closure history                                 | n.a.                                    | 17%   |

<sup>1</sup> The data in this column is from Parsons and Massey (2003). Parsons and Massey measured the average trip cost to be 1997 \$118. This cost was inflated to 2001 \$ using the Consumer Price Index.

<sup>2</sup> The data in this column is from Parsons et al. (2009). The trip cost is expressed in 2001 U.S. dollars.

Exhibit 10. Descriptive statistics for Individuals in the Mid-Atlantic and Texas Gulf Coast Regions

| Variables  | Mid-Atlantic <sup>1</sup> | Texas <sup>2</sup>                                       |
|--|---------------------------|--|
| Average Age (years)                                | 46                        | 41   |
| Have children under 10 years                       | 27%                       | 49% (Percent of households with children under 17 years) |
| Have children between 10 and 16 years              | 21%                       |  |
| Work flextime schedule                             | 58%                       | n.a.   |
| Own a beach vacation home in the Mid-Atlantic      | 4%                        | 7%   |
| Own a beach vacation home outside the Mid-Atlantic | 4%                        |  |
| Retired Worker                                     | 24%                       | 9%   |
| Student  | 5%                        | n.a.   |
| Work part time                                     | 10%                       | n.a.   |
| Work from home                                     | 6%                        | n.a.   |
| Work as volunteer                                  | 3%                        | n.a.   |
| Work Fulltime                                      | n.a.                      | 62%  |
| Completed High school                              | n.a.                      | 32%  |
| Completed College                                  | n.a.                      | 24%  |
| Completed Graduate School                          | n.a.                      | 10%  |
| Spanish-speaking                                   | n.a.                      | 9%   |
| Female   | n.a.                      | 60%  |
| Own boat   | n.a.                      | 24%  |
| Own pool   | n.a.                      | 24%  |
| Own fishing equipment                              | n.a.                      | 49%  |

<sup>1</sup> The data in this column is from Parsons and Massey (2003).

<sup>2</sup> The data in this column is from Parsons et al. (2009).

Exhibit 11. Per Trip Loss due to Closure of PAIS from Texas Small Samples : 100 Draws of 100 Households

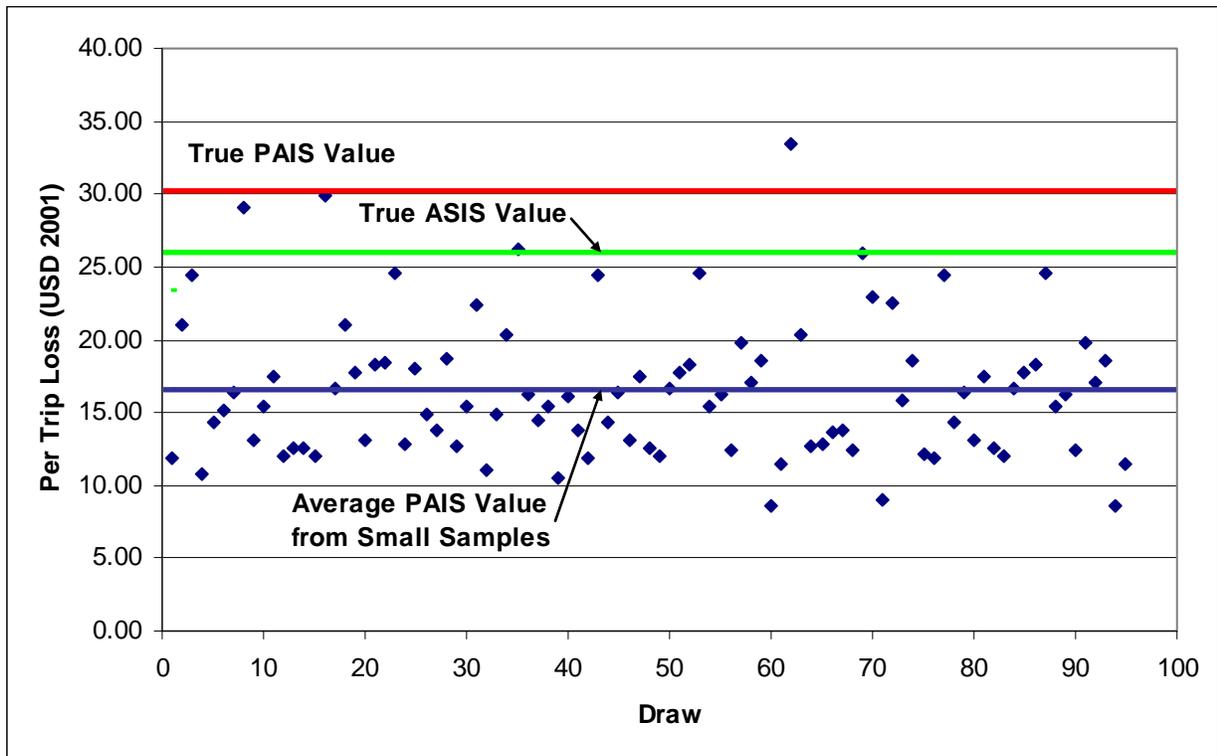


Exhibit 12. Per Trip Loss due to Closure of PAIS from Texas Small Samples : 100 Draws of 200 Households

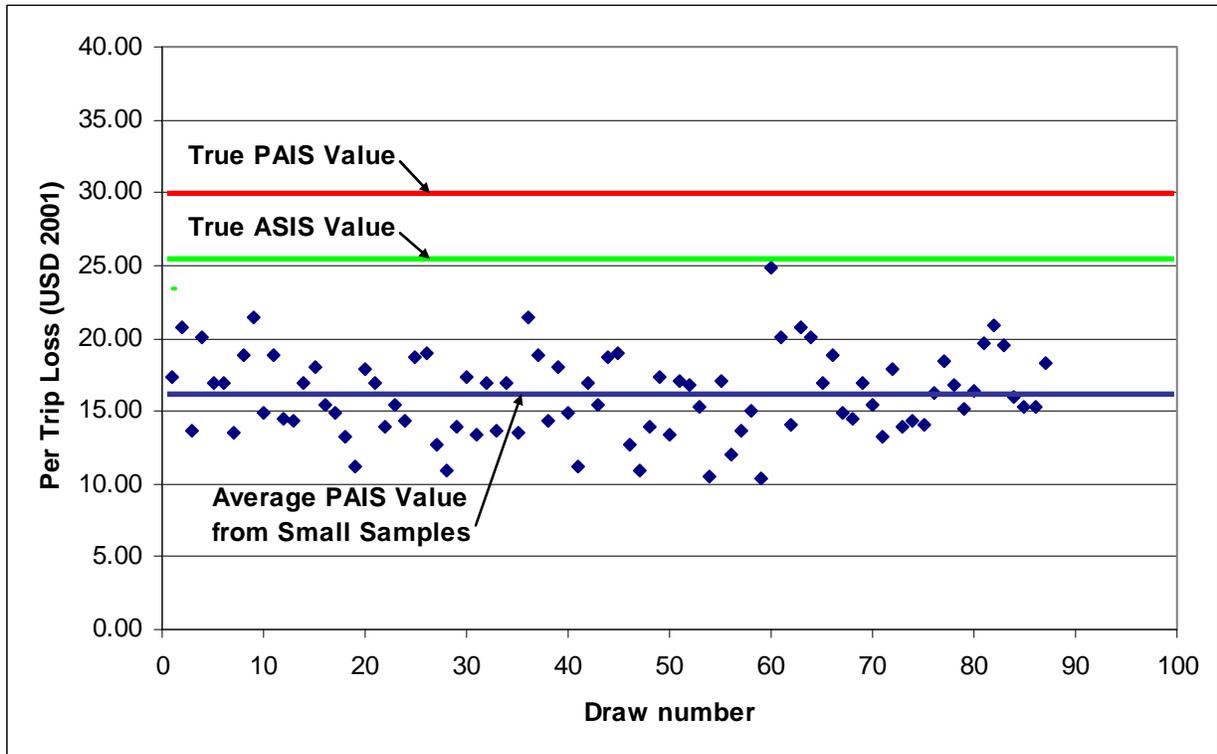


Exhibit 13. Parameter Estimates from Models from Texas Small Samples of 100 and Mid-Atlantic

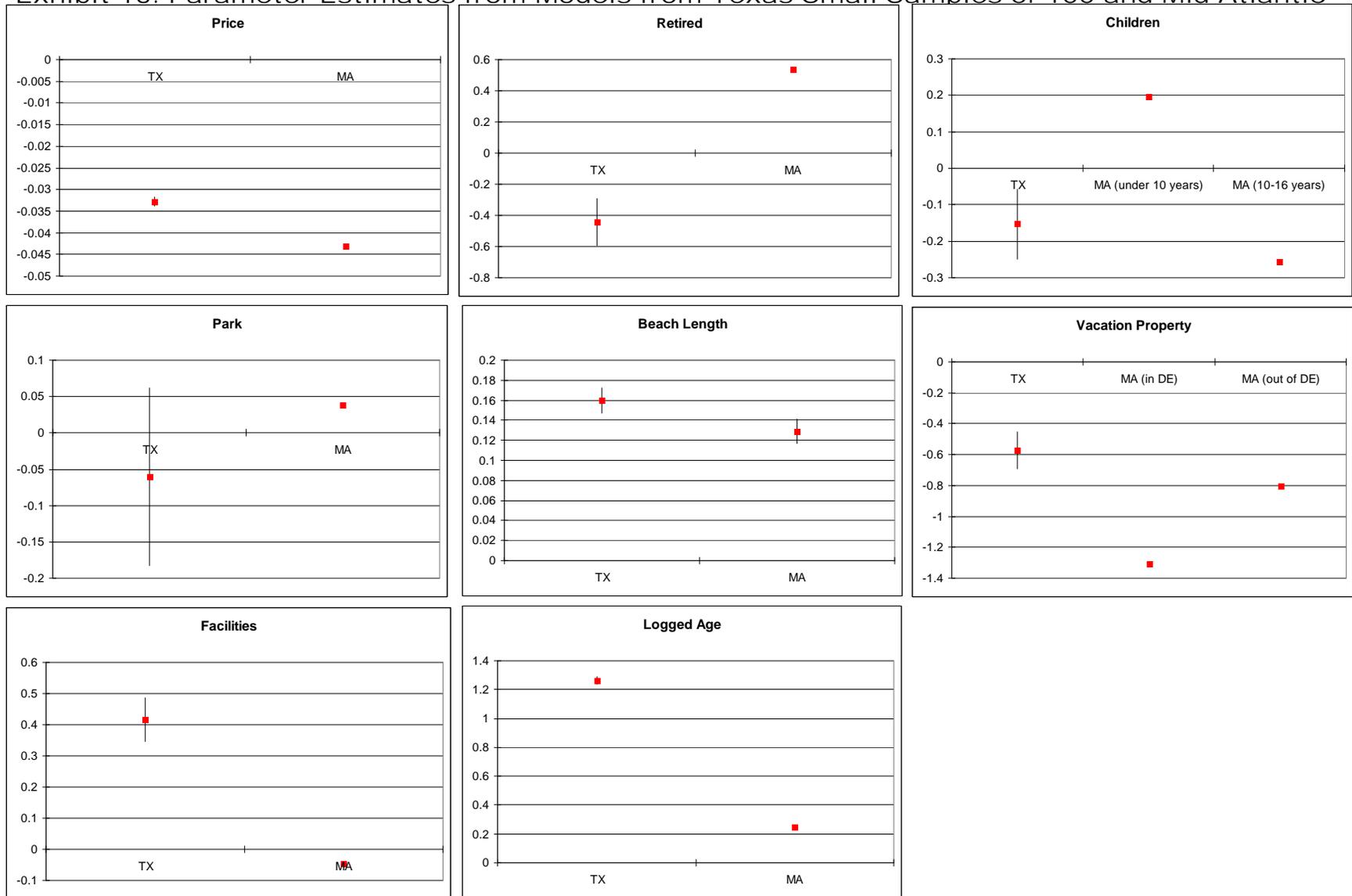


Exhibit 14. Parameter Estimates from Models from Texas Small Samples of 200 and Mid-Atlantic

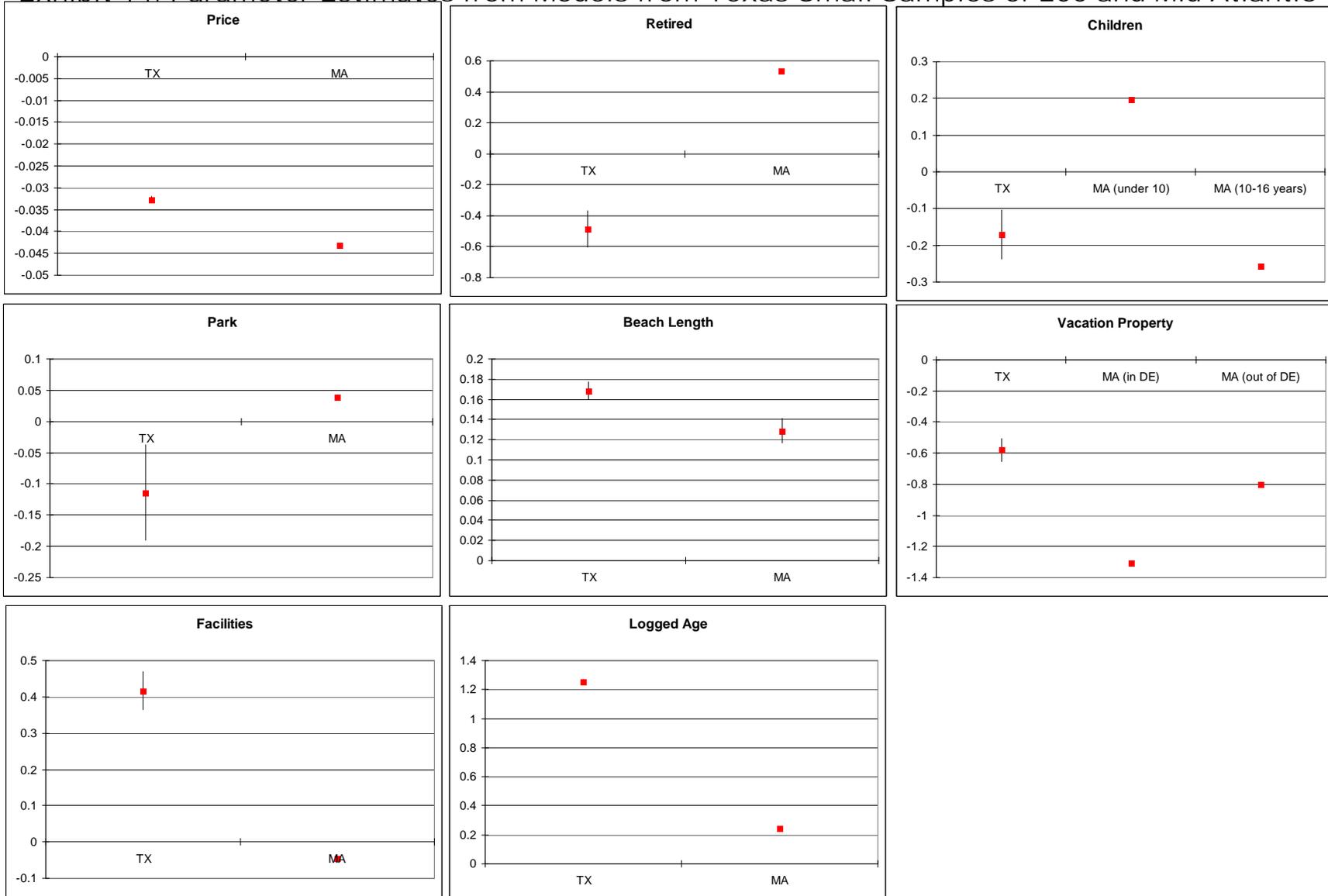


Exhibit 15. Five Parameter Updating Model Specifications: Texas Data and Parameters that will replace Mid-Atlantic information in the Mid-Atlantic benefit function

|                     | <b>Mid-Atlantic Parameters will be replaced by the following Texas Parameters:</b> |   | <b>Mid-Atlantic Data will be replaced by the following Texas Data:</b> |                                  |
|---------------------|--|---|--|----------------------------------|
| <b>Model Number</b> | <b>Site Utility Model Parameters</b>   | <b>No-Trip Utility Model Parameters</b> | <b>Beach Data</b>  | <b>Individual/Household Data</b> |
| <b>1</b>            | Trip cost<br>Length<br>Park<br>Facilities (restrooms)                              | Retired                                 | Park<br>Facilities<br>(restrooms)                                      | Retired                          |
| <b>2</b>            | Trip cost<br>Length<br>Facilities (restrooms)                                      | Retired                                 | Facilities<br>(restrooms)  | Retired                          |
| <b>3</b>            | Trip cost<br>Park  | Retired                                 | Park   | Retired                          |
| <b>4</b>            | Trip cost  | None                                    | None   | None                             |
| <b>5</b>            | Trip cost<br>Length<br>Park<br>Facilities (restrooms)                              | Retired<br>Lnage                        | Park<br>Facilities<br>(restrooms)                                      | Retired<br>Lnage                 |

Exhibit 16. Benefit Transfer Estimates of Per Trip Value and Predictive Validity of Estimates: Simple Transfer, Model Transfer, and Parameter Updating Transfer Methods

|                    | <b>t</b> | <b>RMSE</b> | <b>Percent Deviation</b> |
|--------------------|----------|-------------|--------------------------|
| Simple Transfer    | 25.71    | 4.29        | -14%                     |
| Model Transfer     | 26.53    | 3.47        | -12%                     |
| Parameter Updating |          |             |                          |
| Max                |          |             |                          |
| Min                |          |             |                          |
| Average            |          |             |                          |
| Model 1 (n=100)    | 47.98    | 17.98       | 59.93%                   |
|                    | 23.00    | 0.06        | -23.34%                  |
|                    | 32.45    | 3.44        | 8.18%                    |
| Model 1 (n=200)    | 40.27    | 10.27       | 34.22%                   |
|                    | 26.39    | 0.01        | -12.03%                  |
|                    | 32.80    | 3.17        | 9.33%                    |
| Model 2 (n=100)    | 47.86    | 17.86       | 59.53%                   |
|                    | 23.02    | 0.02        | -23.28%                  |
|                    | 32.47    | 3.42        | 8.24%                    |
| Model 2 (n=200)    | 40.47    | 10.47       | 34.89%                   |
|                    | 26.37    | 0.00        | -12.10%                  |
|                    | 32.85    | 3.21        | 9.52%                    |
| Model 3 (n=100)    | 35.50    | 8.02        | 18.33%                   |
|                    | 21.98    | 0.03        | -26.73%                  |
|                    | 28.14    | 2.18        | -6.20%                   |
| Model 3 (n=200)    | 32.45    | 5.12        | 8.15%                    |
|                    | 24.88    | 0.07        | -17.08%                  |
|                    | 28.16    | 2.01        | -6.15%                   |
| Model 4 (n=100)    | 62.54    | 32.54       | 108.48%                  |
|                    | 24.47    | 3.01        | -18.44%                  |
|                    | 27.53    | 4.55        | -8.22%                   |
| Model 4 (n=200)    | 26.93    | 4.75        | -10.24%                  |
|                    | 25.25    | 3.07        | -15.85%                  |
|                    | 26.23    | 3.77        | -12.57%                  |
| Model 5 (n=100)    | 4.76     | 29.39       | -84.13%                  |
|                    | 0.61     | 25.24       | -97.97%                  |
|                    | 1.74     | 28.26       | -94.21%                  |
| Model 5 (n=200)    | 8.78     | 29.38       | -70.73%                  |
|                    | 0.62     | 21.22       | -97.94%                  |
|                    | 3.22     | 26.78       | -89.25%                  |

Exhibit 17. Parameter Estimates from Models from Texas Full Dataset and Mid-Atlantic Full Dataset

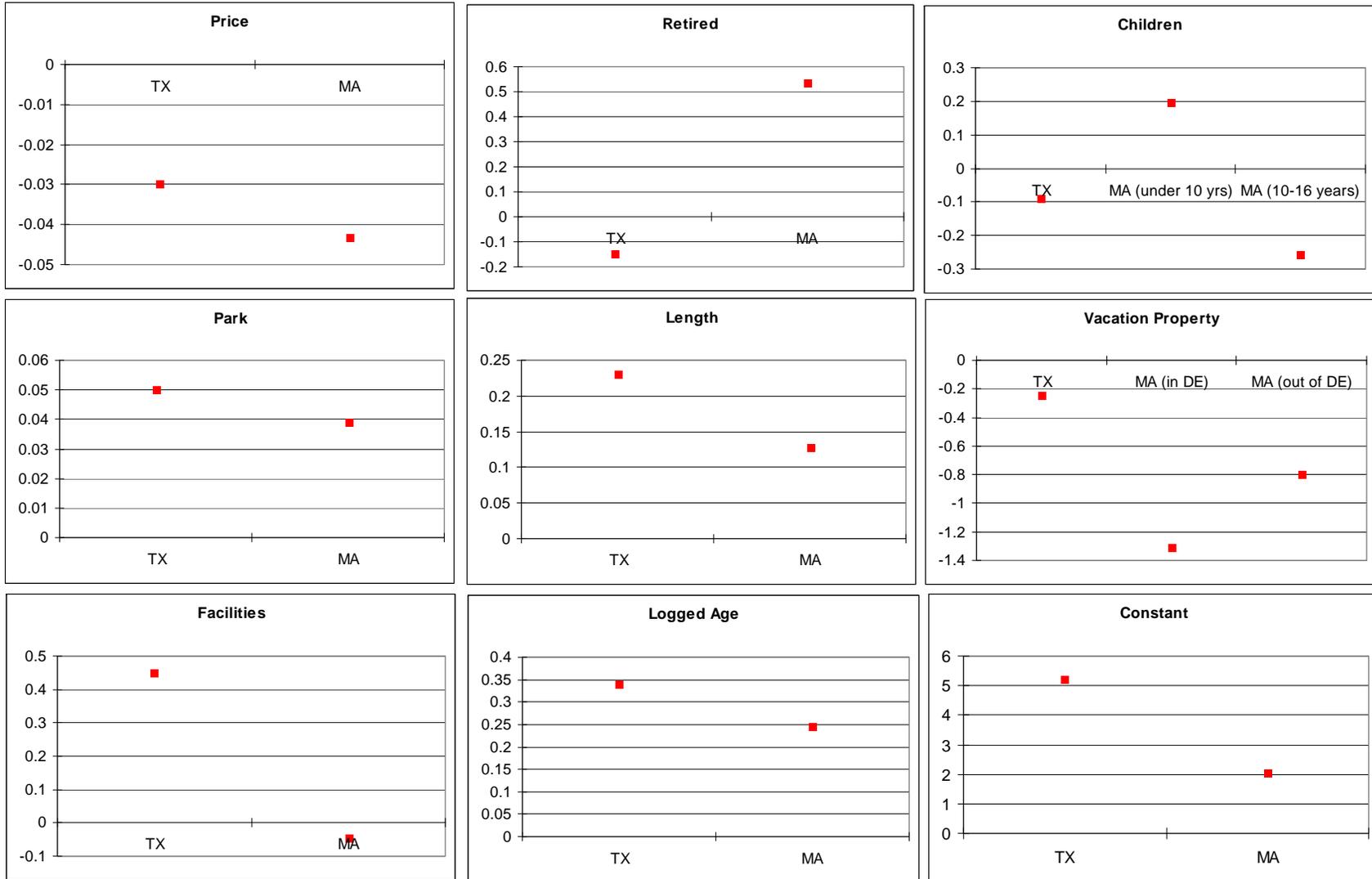


Exhibit 18. Estimated Per Trip Value from Parameter Updating Models and Texas Small Sample Models: Minimum, Average, Maximum

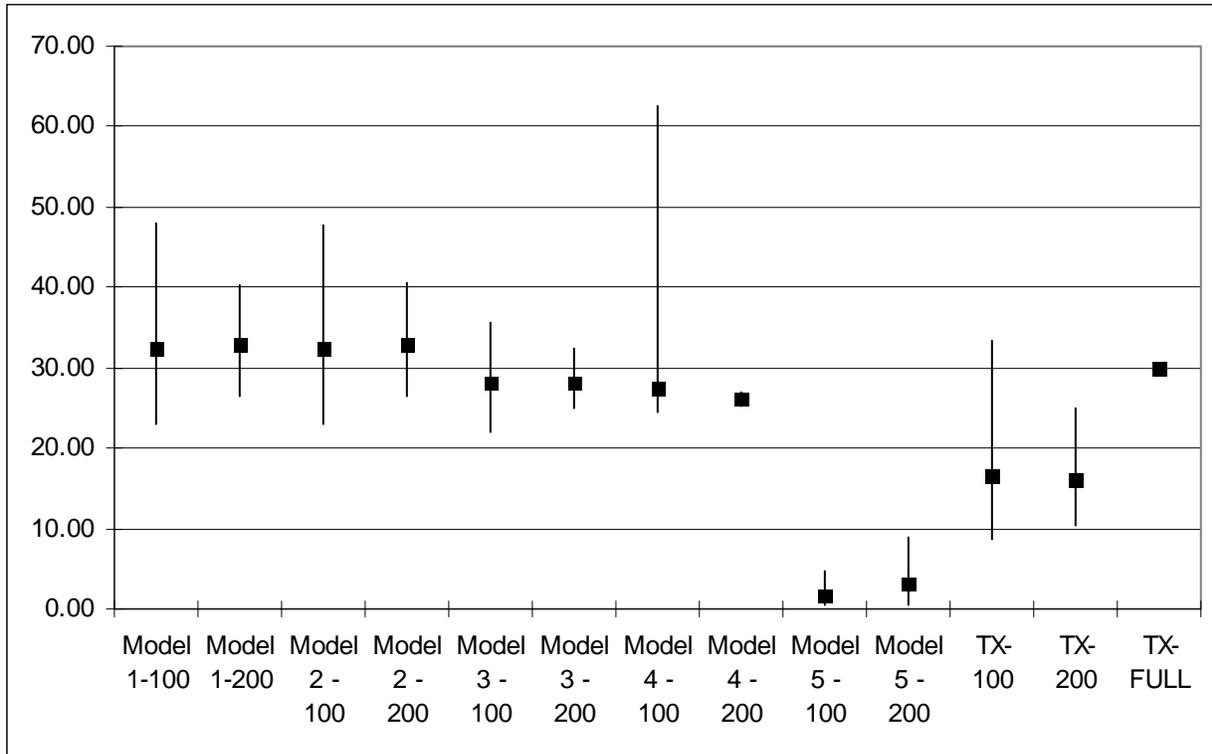


Exhibit 19. Percent Deviation between Parameter Updating Per Trip Value Estimates and True Per Trip Value for PAIS using Small Samples of 100 Households

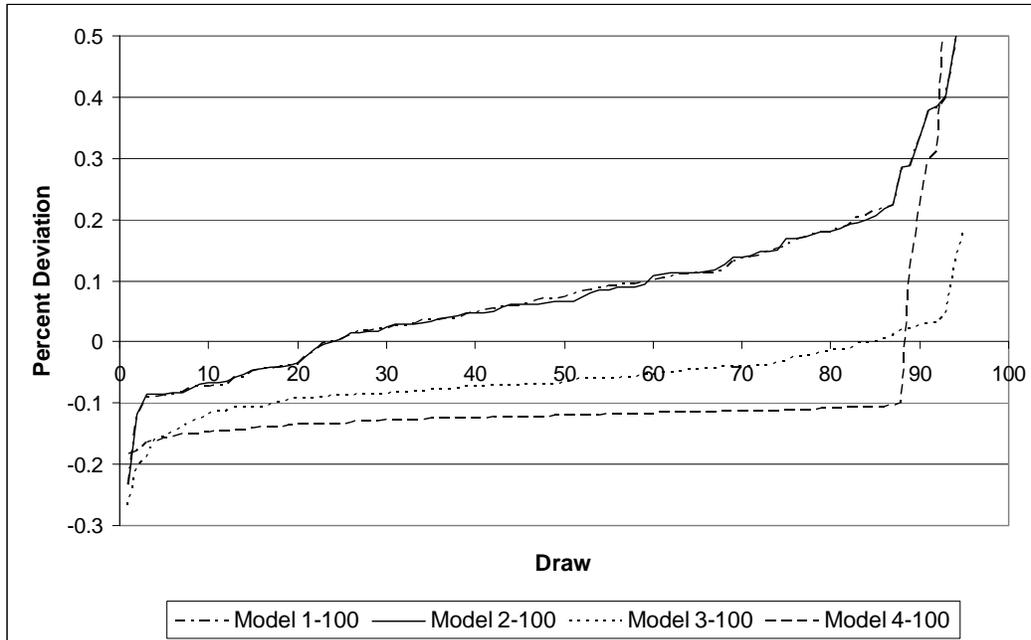
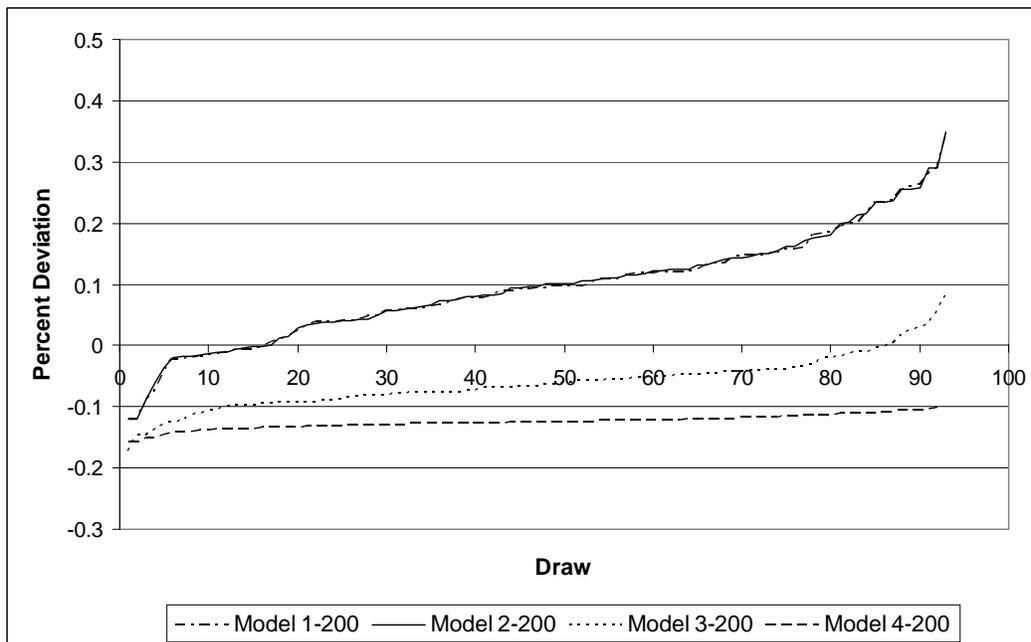


Exhibit 20. Percent Deviation between Parameter Updating Per Trip Value Estimates and True Per Trip Value for PAIS using Small Samples of 200 Households



## APPENDIX A

Exhibit A-1. Parameter Estimates from Small Samples: Results of 100 Random Draws of Samples of 100 from Texas Data

| Draw number | $\hat{\alpha}_{price}$ | $\hat{\alpha}_{lg\ lth}$ | $\hat{\alpha}_{padre}$ | $\hat{\alpha}_{park}$ | $\hat{\alpha}_{facil}$ | $\hat{\alpha}_{ln\ age}$ | $\hat{\alpha}_{child}$ | $\hat{\alpha}_{cot\ tage}$ | $\hat{\alpha}_{Re\ tired}$ | $\hat{\alpha}_{north}$ | $\hat{\alpha}_{central}$ | $\hat{\alpha}_{south}$ | Per Trip Value for PAIS |
|-------------|------------------------|--------------------------|------------------------|-----------------------|------------------------|--------------------------|------------------------|----------------------------|----------------------------|------------------------|--------------------------|------------------------|-------------------------|
| 2           | -0.042                 | 0.188                    | 1.409                  | -0.577                | 1.022                  | 1.044                    | 0.235                  | -0.878                     | 0.763                      | 0.345                  | 0.429                    | 0.438                  | 11.88                   |
| 3           | -0.028                 | 0.117                    | 1.280                  | -0.267                | 0.087                  | 1.245                    | 0.246                  | 0.508                      | -0.134                     | 0.224                  | 0.522                    | 0.710                  | 21.08                   |
| 4           | -0.028                 | 0.190                    | 1.212                  | 0.133                 | 0.381                  | 1.529                    | -0.585                 | -1.026                     | -1.278                     | 0.386                  | 0.626                    | 0.917                  | 24.44                   |
| 5           | -0.041                 | 0.177                    | 1.126                  | -0.259                | 0.932                  | 0.961                    | 0.833                  | -0.920                     | 1.160                      | 0.369                  | 0.389                    | 0.849                  | 10.75                   |
| 6           | -0.035                 | 0.185                    | 2.718                  | -0.144                | 0.681                  | 1.375                    | -0.859                 | -0.519                     | -0.809                     | 0.560                  | 0.368                    | 0.465                  | 14.29                   |
| 7           | -0.031                 | 0.070                    | 1.011                  | -0.137                | 0.570                  | 1.209                    | -0.024                 | -0.630                     | 2.030                      | 0.827                  | 0.416                    | 1.167                  | 15.14                   |
| 8           | -0.030                 | 0.048                    | 1.021                  | -0.304                | 0.540                  | 1.421                    | -0.259                 | -1.339                     | -0.342                     | 0.293                  | 0.443                    | 0.718                  | 16.40                   |
| 9           | -0.027                 | 0.186                    | 1.466                  | 0.079                 | 0.394                  | 1.384                    | -0.111                 | -0.732                     | -0.334                     | 0.340                  | 0.712                    | 0.526                  | 29.02                   |
| 10          | -0.034                 | 0.169                    | 1.948                  | 0.539                 | 0.243                  | 1.117                    | 0.119                  | -0.703                     | -0.185                     | 0.495                  | 0.362                    | 0.672                  | 13.14                   |
| 11          | -0.037                 | 0.242                    | 1.534                  | 0.364                 | 0.699                  | 1.134                    | -0.476                 | 0.391                      | -0.546                     | 0.291                  | 0.494                    | 0.668                  | 15.46                   |
| 12          | -0.034                 | 0.162                    | 1.250                  | 0.010                 | 0.480                  | 1.174                    | -0.475                 | -1.266                     | -0.480                     | 0.546                  | 0.532                    | 0.671                  | 17.52                   |
| 13          | -0.040                 | 0.282                    | 0.897                  | -0.725                | 0.718                  | 1.038                    | 0.272                  | -0.611                     | 0.213                      | 0.428                  | 0.429                    | 0.458                  | 12.01                   |
| 14          | -0.031                 | 0.137                    | 1.333                  | -0.247                | 0.230                  | 1.109                    | 0.015                  | 0.187                      | -1.212                     | 0.838                  | 0.331                    | 0.622                  | 12.57                   |
| 15          | -0.030                 | 0.181                    | 0.255                  | -0.791                | 1.839                  | 1.494                    | 0.703                  | 1.804                      | -1.859                     | 0.681                  | 0.354                    | 0.497                  | 12.51                   |
| 16          | -0.032                 | 0.112                    | 1.011                  | 0.256                 | 0.925                  | 1.237                    | 0.473                  | -0.870                     | -0.120                     | 0.791                  | 0.339                    | 0.697                  | 11.95                   |
| 17          | -0.024                 | 0.127                    | 0.359                  | -1.277                | 0.554                  | 1.352                    | 0.229                  | -1.549                     | -0.173                     | 0.427                  | 0.686                    | 0.711                  | 29.90                   |
| 18          | -0.034                 | 0.178                    | 1.427                  | 1.022                 | -0.081                 | 1.224                    | 0.170                  | 0.521                      | -1.231                     | 0.219                  | 0.503                    | 0.608                  | 16.67                   |
| 19          | -0.025                 | 0.194                    | 0.522                  | -0.147                | 0.395                  | 1.424                    | -0.119                 | -0.323                     | -1.965                     | 0.183                  | 0.488                    | 0.659                  | 21.07                   |
| 20          | -0.037                 | 0.125                    | 1.500                  | 0.126                 | 0.100                  | 1.296                    | -0.465                 | -0.977                     | -0.712                     | 0.256                  | 0.583                    | 0.556                  | 17.72                   |
| 21          | -0.036                 | 0.209                    | 1.157                  | -0.491                | 0.588                  | 1.331                    | -0.989                 | -0.811                     | -0.251                     | 0.353                  | 0.426                    | 0.572                  | 13.12                   |
| 22          | -0.036                 | 0.100                    | 1.694                  | -0.143                | 0.098                  | 1.253                    | -0.035                 | -0.333                     | -0.890                     | 0.371                  | 0.581                    | 0.452                  | 18.31                   |
| 23          | -0.030                 | 0.159                    | 1.712                  | -0.118                | 0.185                  | 1.263                    | 0.347                  | -1.213                     | -0.409                     | 0.374                  | 0.469                    | 0.580                  | 18.43                   |
| 24          | -0.023                 | 0.178                    | 1.134                  | 0.371                 | 0.323                  | 1.449                    | -0.350                 | -0.543                     | -0.280                     | 0.305                  | 0.509                    | 0.630                  | 24.63                   |
| 25          | -0.039                 | 0.287                    | 1.638                  | -0.091                | 0.368                  | 1.271                    | -0.979                 | -1.045                     | -0.930                     | 0.431                  | 0.420                    | 0.730                  | 12.84                   |
| 26          | -0.030                 | 0.200                    | 1.229                  | -0.156                | 0.377                  | 1.474                    | -0.648                 | -1.206                     | -1.042                     | 0.195                  | 0.485                    | 0.745                  | 18.03                   |
| 28          | -0.033                 | 0.028                    | 1.822                  | -0.254                | 0.432                  | 1.149                    | 0.688                  | -0.504                     | -0.645                     | 0.262                  | 0.410                    | 0.980                  | 14.84                   |
| 30          | -0.038                 | 0.214                    | 1.562                  | 0.152                 | 0.801                  | 1.167                    | -0.116                 | -0.929                     | -0.074                     | 0.664                  | 0.447                    | 0.707                  | 13.76                   |
| 31          | -0.031                 | 0.277                    | 1.318                  | 0.780                 | 0.254                  | 1.357                    | -0.178                 | -0.687                     | -0.048                     | 0.431                  | 0.524                    | 0.744                  | 18.75                   |
| 32          | -0.040                 | 0.181                    | 1.658                  | -0.074                | 0.903                  | 1.216                    | -0.636                 | -0.456                     | 0.563                      | 0.251                  | 0.434                    | 0.405                  | 12.64                   |
| 33          | -0.031                 | 0.164                    | 2.254                  | 0.025                 | 0.454                  | 1.282                    | -0.542                 | -0.302                     | -2.490                     | 0.667                  | 0.375                    | 0.718                  | 15.44                   |

|    |        |       |       |        |        |       |        |        |        |       |       |       |       |
|----|--------|-------|-------|--------|--------|-------|--------|--------|--------|-------|-------|-------|-------|
| 34 | -0.027 | 0.128 | 1.156 | -0.170 | 0.002  | 1.380 | -1.126 | -1.085 | -1.043 | 0.656 | 0.553 | 0.624 | 22.45 |
| 35 | -0.029 | 0.169 | 0.787 | -0.935 | 0.497  | 1.458 | -0.769 | 0.099  | -0.082 | 0.755 | 0.287 | 1.016 | 11.01 |
| 36 | -0.033 | 0.141 | 0.826 | -0.283 | 0.283  | 1.220 | -0.638 | -0.481 | -1.828 | 0.485 | 0.450 | 0.673 | 14.91 |
| 38 | -0.030 | 0.145 | 1.514 | 0.622  | -0.309 | 1.254 | -0.731 | -0.601 | -0.700 | 0.636 | 0.542 | 0.579 | 20.40 |
| 39 | -0.024 | 0.063 | 1.542 | 0.041  | 1.198  | 1.378 | -0.078 | 0.323  | 1.370  | 0.463 | 0.550 | 1.546 | 26.22 |
| 40 | -0.033 | 0.161 | 1.370 | -0.526 | 0.729  | 1.237 | -0.273 | -1.207 | 0.820  | 0.590 | 0.471 | 0.615 | 16.22 |
| 41 | -0.034 | 0.046 | 0.857 | -1.601 | 0.598  | 1.254 | 0.119  | -1.287 | -0.305 | 0.418 | 0.451 | 0.898 | 14.41 |
| 42 | -0.034 | 0.336 | 1.433 | -0.648 | 0.650  | 1.133 | 0.678  | 0.299  | 0.177  | 0.289 | 0.455 | 0.606 | 15.48 |
| 43 | -0.038 | 0.286 | 1.465 | 0.295  | 0.718  | 1.232 | 0.376  | -0.004 | -1.886 | 0.379 | 0.333 | 0.613 | 10.45 |
| 44 | -0.035 | 0.216 | 0.826 | 0.231  | 0.354  | 1.199 | -0.440 | -0.778 | -0.315 | 0.917 | 0.519 | 0.480 | 16.16 |
| 45 | -0.034 | 0.100 | 1.664 | 0.077  | 0.115  | 1.291 | -0.266 | -0.435 | -0.720 | 0.385 | 0.403 | 0.816 | 13.82 |
| 46 | -0.042 | 0.188 | 1.409 | -0.577 | 1.022  | 1.044 | 0.235  | -0.878 | 0.763  | 0.345 | 0.429 | 0.438 | 11.88 |
| 47 | -0.028 | 0.190 | 1.212 | 0.133  | 0.381  | 1.529 | -0.585 | -1.026 | -1.278 | 0.386 | 0.626 | 0.917 | 24.44 |
| 48 | -0.035 | 0.185 | 2.718 | -0.144 | 0.681  | 1.375 | -0.859 | -0.519 | -0.809 | 0.560 | 0.368 | 0.465 | 14.29 |
| 49 | -0.030 | 0.048 | 1.021 | -0.304 | 0.540  | 1.421 | -0.259 | -1.339 | -0.342 | 0.293 | 0.443 | 0.718 | 16.40 |
| 50 | -0.034 | 0.169 | 1.948 | 0.539  | 0.243  | 1.117 | 0.119  | -0.703 | -0.185 | 0.495 | 0.362 | 0.672 | 13.14 |
| 51 | -0.034 | 0.162 | 1.250 | 0.010  | 0.480  | 1.174 | -0.475 | -1.266 | -0.480 | 0.546 | 0.532 | 0.671 | 17.52 |
| 52 | -0.031 | 0.137 | 1.333 | -0.247 | 0.230  | 1.109 | 0.015  | 0.187  | -1.212 | 0.838 | 0.331 | 0.622 | 12.57 |
| 53 | -0.032 | 0.112 | 1.011 | 0.256  | 0.925  | 1.237 | 0.473  | -0.870 | -0.120 | 0.791 | 0.339 | 0.697 | 11.95 |
| 54 | -0.034 | 0.178 | 1.427 | 1.022  | -0.081 | 1.224 | 0.170  | 0.521  | -1.231 | 0.219 | 0.503 | 0.608 | 16.67 |
| 55 | -0.037 | 0.125 | 1.500 | 0.126  | 0.100  | 1.296 | -0.465 | -0.977 | -0.712 | 0.256 | 0.583 | 0.556 | 17.72 |
| 56 | -0.036 | 0.100 | 1.694 | -0.143 | 0.098  | 1.253 | -0.035 | -0.333 | -0.890 | 0.371 | 0.581 | 0.452 | 18.31 |
| 57 | -0.023 | 0.178 | 1.134 | 0.371  | 0.323  | 1.449 | -0.350 | -0.543 | -0.280 | 0.305 | 0.509 | 0.630 | 24.63 |
| 58 | -0.032 | 0.108 | 1.387 | 0.572  | 0.840  | 1.128 | 1.325  | -0.483 | 0.377  | 0.212 | 0.435 | 0.517 | 15.40 |
| 59 | -0.029 | 0.158 | 1.292 | -0.040 | 0.238  | 1.195 | -0.216 | -0.426 | -0.548 | 0.424 | 0.411 | 0.597 | 16.19 |
| 60 | -0.035 | 0.137 | 1.485 | 0.214  | 0.233  | 1.047 | 0.414  | -0.007 | -0.167 | 0.583 | 0.371 | 0.992 | 12.48 |
| 61 | -0.024 | 0.136 | 1.250 | -0.396 | -0.111 | 1.214 | 0.080  | -0.679 | -0.065 | 0.504 | 0.401 | 0.887 | 19.82 |
| 62 | -0.032 | 0.066 | 2.003 | -0.065 | 0.224  | 1.303 | -0.628 | 0.195  | -1.602 | 0.382 | 0.463 | 0.621 | 17.08 |
| 63 | -0.029 | 0.230 | 1.758 | -1.845 | 0.304  | 1.293 | 0.021  | -0.335 | 0.129  | 0.566 | 0.448 | 0.628 | 18.52 |
| 64 | -0.047 | 0.250 | 2.296 | 0.880  | 0.011  | 1.207 | -0.659 | -1.466 | 0.191  | 0.232 | 0.319 | 0.742 | 8.56  |
| 65 | -0.039 | 0.122 | 2.487 | 1.278  | 0.598  | 1.402 | -0.380 | -1.053 | -1.013 | 0.540 | 0.339 | 0.329 | 11.51 |
| 66 | -0.026 | 0.116 | 0.795 | -0.093 | 0.271  | 1.499 | -0.763 | -0.973 | -0.529 | 0.111 | 0.843 | 0.723 | 33.46 |
| 67 | -0.031 | 0.126 | 0.964 | 0.391  | 0.430  | 1.293 | -0.269 | -0.286 | 0.008  | 0.237 | 0.591 | 0.758 | 20.36 |
| 68 | -0.042 | 0.207 | 1.482 | -0.643 | 0.571  | 1.062 | -0.199 | -0.138 | -0.209 | 0.398 | 0.478 | 0.471 | 12.76 |
| 69 | -0.038 | 0.242 | 1.284 | 0.004  | -0.057 | 1.227 | -0.639 | -1.951 | -0.066 | 0.296 | 0.434 | 0.479 | 12.79 |

|      |        |       |       |        |        |       |        |        |        |       |       |       |                      |
|------|--------|-------|-------|--------|--------|-------|--------|--------|--------|-------|-------|-------|----------------------|
| 70   | -0.036 | 0.241 | 2.328 | 0.053  | 0.083  | 1.293 | -0.618 | 0.025  | -1.141 | 0.208 | 0.380 | 0.411 | 13.70                |
| 71   | -0.038 | 0.185 | 1.376 | -1.654 | 0.795  | 1.309 | -0.237 | -0.482 | -0.257 | 0.457 | 0.455 | 0.499 | 13.73                |
| 72   | -0.034 | 0.057 | 1.390 | 0.333  | 0.377  | 1.264 | 0.043  | -1.197 | -0.649 | 0.402 | 0.369 | 0.513 | 12.44                |
| 73   | -0.026 | 0.213 | 0.859 | 0.135  | 0.413  | 1.289 | 0.096  | 0.266  | -0.736 | 0.455 | 0.612 | 0.802 | 25.87                |
| 74   | -0.027 | 0.036 | 1.598 | -1.813 | -0.296 | 1.293 | -0.179 | -0.208 | -1.025 | 0.387 | 0.543 | 0.732 | 22.90                |
| 75   | -0.042 | 0.290 | 2.674 | 0.435  | 0.515  | 1.236 | -0.409 | -1.044 | -1.155 | 0.195 | 0.277 | 0.402 | 8.99                 |
| 76   | -0.025 | 0.110 | 1.681 | 0.086  | 0.053  | 1.337 | -0.566 | 0.365  | -0.353 | 0.777 | 0.483 | 0.475 | 22.53                |
| 77   | -0.028 | 0.109 | 1.506 | -0.154 | 0.942  | 1.300 | -0.390 | -0.557 | -0.543 | 0.337 | 0.385 | 0.630 | 15.83                |
| 79   | -0.029 | 0.252 | 1.386 | -0.412 | 0.108  | 1.268 | 0.398  | -1.027 | 1.209  | 0.254 | 0.475 | 0.718 | 18.54                |
| 80   | -0.037 | 0.154 | 1.695 | -0.446 | 0.514  | 1.136 | 0.041  | -1.118 | 0.483  | 0.499 | 0.382 | 0.438 | 12.18                |
| 81   | -0.042 | 0.188 | 1.409 | -0.577 | 1.022  | 1.044 | 0.235  | -0.878 | 0.763  | 0.345 | 0.429 | 0.438 | 11.88                |
| 82   | -0.028 | 0.190 | 1.212 | 0.133  | 0.381  | 1.529 | -0.585 | -1.026 | -1.278 | 0.386 | 0.626 | 0.917 | 24.44                |
| 83   | -0.035 | 0.185 | 2.718 | -0.144 | 0.681  | 1.375 | -0.859 | -0.519 | -0.809 | 0.560 | 0.368 | 0.465 | 14.29                |
| 84   | -0.030 | 0.048 | 1.021 | -0.304 | 0.540  | 1.421 | -0.259 | -1.339 | -0.342 | 0.293 | 0.443 | 0.718 | 16.40                |
| 85   | -0.034 | 0.169 | 1.948 | 0.539  | 0.243  | 1.117 | 0.119  | -0.703 | -0.185 | 0.495 | 0.362 | 0.672 | 13.14                |
| 86   | -0.034 | 0.162 | 1.250 | 0.010  | 0.480  | 1.174 | -0.475 | -1.266 | -0.480 | 0.546 | 0.532 | 0.671 | 17.52                |
| 87   | -0.031 | 0.137 | 1.333 | -0.247 | 0.230  | 1.109 | 0.015  | 0.187  | -1.212 | 0.838 | 0.331 | 0.622 | 12.57                |
| 88   | -0.032 | 0.112 | 1.011 | 0.256  | 0.925  | 1.237 | 0.473  | -0.870 | -0.120 | 0.791 | 0.339 | 0.697 | 11.95                |
| 89   | -0.034 | 0.178 | 1.427 | 1.022  | -0.081 | 1.224 | 0.170  | 0.521  | -1.231 | 0.219 | 0.503 | 0.608 | 16.67                |
| 90   | -0.037 | 0.125 | 1.500 | 0.126  | 0.100  | 1.296 | -0.465 | -0.977 | -0.712 | 0.256 | 0.583 | 0.556 | 17.72                |
| 91   | -0.036 | 0.100 | 1.694 | -0.143 | 0.098  | 1.253 | -0.035 | -0.333 | -0.890 | 0.371 | 0.581 | 0.452 | 18.31                |
| 92   | -0.023 | 0.178 | 1.134 | 0.371  | 0.323  | 1.449 | -0.350 | -0.543 | -0.280 | 0.305 | 0.509 | 0.630 | 24.63                |
| 93   | -0.032 | 0.108 | 1.387 | 0.572  | 0.840  | 1.128 | 1.325  | -0.483 | 0.377  | 0.212 | 0.435 | 0.517 | 15.40                |
| 94   | -0.029 | 0.158 | 1.292 | -0.040 | 0.238  | 1.195 | -0.216 | -0.426 | -0.548 | 0.424 | 0.411 | 0.597 | 16.19                |
| 95   | -0.035 | 0.137 | 1.485 | 0.214  | 0.233  | 1.047 | 0.414  | -0.007 | -0.167 | 0.583 | 0.371 | 0.992 | 12.48                |
| 96   | -0.024 | 0.136 | 1.250 | -0.396 | -0.111 | 1.214 | 0.080  | -0.679 | -0.065 | 0.504 | 0.401 | 0.887 | 19.82                |
| 97   | -0.032 | 0.066 | 2.003 | -0.065 | 0.224  | 1.303 | -0.628 | 0.195  | -1.602 | 0.382 | 0.463 | 0.621 | 17.08                |
| 98   | -0.029 | 0.230 | 1.758 | -1.845 | 0.304  | 1.293 | 0.021  | -0.335 | 0.129  | 0.566 | 0.448 | 0.628 | 18.52                |
| 99   | -0.047 | 0.250 | 2.296 | 0.880  | 0.011  | 1.207 | -0.659 | -1.466 | 0.191  | 0.232 | 0.319 | 0.742 | 8.56                 |
| 100  | -0.039 | 0.122 | 2.487 | 1.278  | 0.598  | 1.402 | -0.380 | -1.053 | -1.013 | 0.540 | 0.339 | 0.329 | 11.51                |
| UCI  | -0.032 | 0.172 | 1.552 | 0.062  | 0.488  | 1.287 | -0.057 | -0.452 | -0.291 | 0.474 | 0.477 | 0.689 | Min=8.56<br>Max=33.4 |
| LCI  | -0.034 | 0.147 | 1.356 | -0.183 | 0.346  | 1.236 | -0.248 | -0.694 | -0.596 | 0.400 | 0.437 | 0.614 | 6                    |
| MEAN | -0.033 | 0.160 | 1.454 | -0.060 | 0.417  | 1.262 | -0.152 | -0.573 | -0.443 | 0.437 | 0.457 | 0.652 | Mean=16.<br>5272     |

Exhibit A-2. Parameter Estimates from Small Samples: Results of 100 Random Draws of Samples of 200 from Texas Data

| Draw number | $\hat{\alpha}_{price}$ | $\hat{\alpha}_{lgth}$ | $\hat{\alpha}_{padre}$ | $\hat{\alpha}_{park}$ | $\hat{\alpha}_{facil}$ | $\hat{\alpha}_{ln\ age}$ | $\hat{\alpha}_{child}$ | $\hat{\alpha}_{cot\ tage}$ | $\hat{\alpha}_{Re\ tired}$ | $\hat{\alpha}_{north}$ | $\hat{\alpha}_{central}$ | $\hat{\alpha}_{south}$ | Per Trip Value for PAIS |
|-------------|------------------------|-----------------------|------------------------|-----------------------|------------------------|--------------------------|------------------------|----------------------------|----------------------------|------------------------|--------------------------|------------------------|-------------------------|
| 1           | -0.033                 | 0.132                 | 1.175                  | -0.616                | 0.805                  | 1.231                    | -0.134                 | -0.685                     | 0.073                      | 0.341                  | 0.525                    | 0.514                  | 17.34                   |
| 2           | -0.030                 | 0.198                 | 1.147                  | 0.137                 | 0.309                  | 1.334                    | -0.065                 | -0.214                     | -0.413                     | 0.285                  | 0.556                    | 0.786                  | 20.75                   |
| 3           | -0.034                 | 0.160                 | 1.719                  | -0.351                | 0.876                  | 1.217                    | -0.061                 | -1.339                     | 0.071                      | 0.486                  | 0.392                    | 0.620                  | 13.68                   |
| 4           | -0.027                 | 0.112                 | 0.970                  | 0.087                 | 0.689                  | 1.419                    | -0.537                 | -0.988                     | 0.010                      | 0.483                  | 0.493                    | 0.667                  | 20.07                   |
| 5           | -0.032                 | 0.170                 | 1.668                  | 0.175                 | 0.160                  | 1.197                    | 0.150                  | -1.054                     | -0.364                     | 0.413                  | 0.459                    | 0.570                  | 16.91                   |
| 6           | -0.035                 | 0.215                 | 1.285                  | 0.081                 | 0.679                  | 1.121                    | -0.107                 | -0.038                     | -0.610                     | 0.404                  | 0.532                    | 0.631                  | 16.93                   |
| 7           | -0.033                 | 0.169                 | 1.039                  | -0.266                | 0.436                  | 1.185                    | -0.047                 | -0.234                     | -0.766                     | 0.660                  | 0.394                    | 0.717                  | 13.53                   |
| 8           | -0.028                 | 0.137                 | 0.733                  | -0.185                | 0.782                  | 1.303                    | 0.411                  | -1.020                     | -0.305                     | 0.551                  | 0.477                    | 0.610                  | 18.82                   |
| 9           | -0.027                 | 0.182                 | 0.913                  | 0.558                 | 0.128                  | 1.364                    | 0.036                  | -0.352                     | -1.573                     | 0.191                  | 0.541                    | 0.696                  | 21.49                   |
| 10          | -0.037                 | 0.183                 | 1.237                  | -0.273                | 0.375                  | 1.331                    | -0.735                 | -0.892                     | -0.697                     | 0.276                  | 0.492                    | 0.541                  | 14.93                   |
| 11          | -0.032                 | 0.126                 | 1.716                  | 0.010                 | 0.163                  | 1.238                    | 0.164                  | -0.370                     | -0.553                     | 0.347                  | 0.521                    | 0.478                  | 18.78                   |
| 12          | -0.034                 | 0.249                 | 1.473                  | 0.038                 | 0.495                  | 1.193                    | -0.234                 | -0.386                     | -0.488                     | 0.437                  | 0.423                    | 0.513                  | 14.48                   |
| 13          | -0.031                 | 0.172                 | 1.040                  | 0.058                 | 0.436                  | 1.316                    | -0.212                 | -0.703                     | -0.609                     | 0.367                  | 0.398                    | 0.593                  | 14.31                   |
| 14          | -0.034                 | 0.200                 | 0.981                  | -0.724                | 0.507                  | 1.075                    | 0.144                  | -0.815                     | 0.584                      | 0.515                  | 0.524                    | 0.834                  | 16.87                   |
| 15          | -0.029                 | 0.066                 | 1.328                  | 0.093                 | 0.146                  | 1.175                    | 0.301                  | -0.478                     | -0.117                     | 0.400                  | 0.460                    | 0.981                  | 17.96                   |
| 16          | -0.033                 | 0.189                 | 1.602                  | -0.312                | 0.146                  | 1.254                    | -0.267                 | -0.681                     | -0.708                     | 0.349                  | 0.431                    | 0.546                  | 15.38                   |
| 17          | -0.035                 | 0.208                 | 1.647                  | -0.198                | 0.596                  | 1.188                    | 0.020                  | -0.621                     | 0.063                      | 0.639                  | 0.435                    | 0.601                  | 14.85                   |
| 18          | -0.037                 | 0.218                 | 1.715                  | 0.740                 | 0.158                  | 1.298                    | -0.522                 | -0.870                     | -0.020                     | 0.320                  | 0.417                    | 0.723                  | 13.28                   |
| 19          | -0.038                 | 0.148                 | 2.119                  | 0.525                 | 0.681                  | 1.259                    | -0.493                 | -0.609                     | -1.152                     | 0.330                  | 0.343                    | 0.399                  | 11.25                   |
| 20          | -0.030                 | 0.138                 | 1.661                  | -0.179                | 0.382                  | 1.319                    | -0.553                 | -0.612                     | -0.966                     | 0.447                  | 0.467                    | 0.593                  | 17.88                   |
| 21          | -0.033                 | 0.173                 | 1.232                  | -0.094                | 0.240                  | 1.220                    | -0.688                 | -0.068                     | -0.187                     | 0.451                  | 0.499                    | 0.712                  | 16.88                   |
| 22          | -0.033                 | 0.165                 | 1.069                  | -0.393                | 0.402                  | 1.231                    | -0.397                 | -0.500                     | -1.124                     | 0.514                  | 0.412                    | 0.599                  | 13.86                   |
| 23          | -0.034                 | 0.128                 | 0.797                  | -0.200                | 0.369                  | 1.219                    | -0.373                 | -1.236                     | -0.027                     | 0.340                  | 0.484                    | 0.630                  | 15.36                   |
| 24          | -0.035                 | 0.185                 | 2.254                  | 0.458                 | -0.148                 | 1.243                    | -0.620                 | -0.500                     | -0.850                     | 0.301                  | 0.409                    | 0.484                  | 14.32                   |
| 25          | -0.029                 | 0.110                 | 1.545                  | -0.319                | 1.113                  | 1.348                    | -0.052                 | -0.305                     | -0.059                     | 0.464                  | 0.477                    | 0.771                  | 18.77                   |
| 26          | -0.031                 | 0.127                 | 1.174                  | -0.400                | 0.231                  | 1.252                    | -0.096                 | -0.709                     | -0.223                     | 0.493                  | 0.523                    | 0.863                  | 19.02                   |
| 27          | -0.036                 | 0.252                 | 2.021                  | 0.097                 | 0.372                  | 1.269                    | 0.027                  | -0.857                     | -1.206                     | 0.342                  | 0.363                    | 0.525                  | 12.72                   |
| 29          | -0.037                 | 0.114                 | 1.693                  | -0.795                | 0.678                  | 1.159                    | 0.336                  | -0.903                     | 0.219                      | 0.406                  | 0.337                    | 0.435                  | 10.87                   |
| 30          | -0.034                 | 0.193                 | 1.436                  | -0.209                | 0.106                  | 1.240                    | -0.172                 | -0.454                     | -0.640                     | 0.280                  | 0.416                    | 0.495                  | 13.93                   |

|    |        |       |       |        |       |       |        |        |        |       |       |       |       |
|----|--------|-------|-------|--------|-------|-------|--------|--------|--------|-------|-------|-------|-------|
| 31 | -0.031 | 0.158 | 1.666 | 0.047  | 0.668 | 1.331 | 0.015  | -0.078 | -1.172 | 0.303 | 0.461 | 0.498 | 17.33 |
| 32 | -0.039 | 0.217 | 2.654 | -1.258 | 0.830 | 1.102 | 0.447  | -0.385 | 0.931  | 0.264 | 0.396 | 0.461 | 13.34 |
| 33 | -0.030 | 0.162 | 1.520 | -0.198 | 0.605 | 1.300 | -0.319 | -0.697 | -0.963 | 0.372 | 0.442 | 0.664 | 16.92 |
| 34 | -0.034 | 0.160 | 1.719 | -0.351 | 0.876 | 1.217 | -0.061 | -1.339 | 0.071  | 0.486 | 0.392 | 0.620 | 13.68 |
| 35 | -0.032 | 0.170 | 1.668 | 0.175  | 0.160 | 1.197 | 0.150  | -1.054 | -0.364 | 0.413 | 0.459 | 0.570 | 16.91 |
| 36 | -0.033 | 0.169 | 1.039 | -0.266 | 0.436 | 1.185 | -0.047 | -0.234 | -0.766 | 0.660 | 0.394 | 0.717 | 13.53 |
| 37 | -0.027 | 0.182 | 0.913 | 0.558  | 0.128 | 1.364 | 0.036  | -0.352 | -1.573 | 0.191 | 0.541 | 0.696 | 21.49 |
| 38 | -0.032 | 0.126 | 1.716 | 0.010  | 0.163 | 1.238 | 0.164  | -0.370 | -0.553 | 0.347 | 0.521 | 0.478 | 18.78 |
| 39 | -0.031 | 0.172 | 1.040 | 0.058  | 0.436 | 1.316 | -0.212 | -0.703 | -0.609 | 0.367 | 0.398 | 0.593 | 14.31 |
| 40 | -0.029 | 0.066 | 1.328 | 0.093  | 0.146 | 1.175 | 0.301  | -0.478 | -0.117 | 0.400 | 0.460 | 0.981 | 17.96 |
| 41 | -0.035 | 0.208 | 1.647 | -0.198 | 0.596 | 1.188 | 0.020  | -0.621 | 0.063  | 0.639 | 0.435 | 0.601 | 14.85 |
| 42 | -0.038 | 0.148 | 2.119 | 0.525  | 0.681 | 1.259 | -0.493 | -0.609 | -1.152 | 0.330 | 0.343 | 0.399 | 11.25 |
| 43 | -0.033 | 0.173 | 1.232 | -0.094 | 0.240 | 1.220 | -0.688 | -0.068 | -0.187 | 0.451 | 0.499 | 0.712 | 16.88 |
| 44 | -0.034 | 0.128 | 0.797 | -0.200 | 0.369 | 1.219 | -0.373 | -1.236 | -0.027 | 0.340 | 0.484 | 0.630 | 15.36 |
| 45 | -0.029 | 0.110 | 1.545 | -0.319 | 1.113 | 1.348 | -0.052 | -0.305 | -0.059 | 0.464 | 0.477 | 0.771 | 18.77 |
| 46 | -0.031 | 0.127 | 1.174 | -0.400 | 0.231 | 1.252 | -0.096 | -0.709 | -0.223 | 0.493 | 0.523 | 0.863 | 19.02 |
| 47 | -0.036 | 0.252 | 2.021 | 0.097  | 0.372 | 1.269 | 0.027  | -0.857 | -1.206 | 0.342 | 0.363 | 0.525 | 12.72 |
| 49 | -0.037 | 0.114 | 1.693 | -0.795 | 0.678 | 1.159 | 0.336  | -0.903 | 0.219  | 0.406 | 0.337 | 0.435 | 10.87 |
| 50 | -0.034 | 0.193 | 1.436 | -0.209 | 0.106 | 1.240 | -0.172 | -0.454 | -0.640 | 0.280 | 0.416 | 0.495 | 13.93 |
| 51 | -0.031 | 0.158 | 1.666 | 0.047  | 0.668 | 1.331 | 0.015  | -0.078 | -1.172 | 0.303 | 0.461 | 0.498 | 17.33 |
| 52 | -0.039 | 0.217 | 2.654 | -1.258 | 0.830 | 1.102 | 0.447  | -0.385 | 0.931  | 0.264 | 0.396 | 0.461 | 13.34 |
| 53 | -0.030 | 0.162 | 1.520 | -0.198 | 0.605 | 1.300 | -0.319 | -0.697 | -0.963 | 0.372 | 0.442 | 0.664 | 17.05 |
| 54 | -0.032 | 0.231 | 1.624 | -0.294 | 0.406 | 1.236 | 0.388  | -1.005 | -0.677 | 0.311 | 0.458 | 0.564 | 16.84 |
| 56 | -0.031 | 0.134 | 1.150 | -0.117 | 0.323 | 1.253 | 0.059  | -0.611 | -0.633 | 0.473 | 0.429 | 0.518 | 15.31 |
| 57 | -0.042 | 0.190 | 1.817 | -0.174 | 0.326 | 1.165 | -0.008 | -0.265 | -0.660 | 0.228 | 0.371 | 0.435 | 10.54 |
| 58 | -0.030 | 0.163 | 1.683 | -0.874 | 0.205 | 1.211 | 0.243  | -0.202 | 0.894  | 0.338 | 0.438 | 0.548 | 17.11 |
| 59 | -0.040 | 0.255 | 1.529 | -0.497 | 0.497 | 1.147 | -0.300 | -0.237 | -0.537 | 0.363 | 0.413 | 0.499 | 12.05 |
| 60 | -0.035 | 0.153 | 1.488 | 0.461  | 0.221 | 1.267 | 0.247  | -1.255 | -1.223 | 0.290 | 0.419 | 0.503 | 13.63 |
| 62 | -0.037 | 0.213 | 0.618 | -0.613 | 0.520 | 1.173 | -0.292 | -0.237 | -0.872 | 0.397 | 0.512 | 0.607 | 15.01 |
| 63 | -0.041 | 0.243 | 1.249 | 0.081  | 0.822 | 1.097 | 0.125  | 0.430  | -0.169 | 0.268 | 0.372 | 0.522 | 10.37 |
| 64 | -0.026 | 0.081 | 1.211 | 0.216  | 0.831 | 1.463 | -0.745 | -0.002 | -1.290 | 0.413 | 0.586 | 0.964 | 24.91 |
| 65 | -0.029 | 0.166 | 1.139 | 0.168  | 0.381 | 1.348 | -0.700 | -0.024 | -0.877 | 0.446 | 0.519 | 0.719 | 20.05 |
| 66 | -0.036 | 0.172 | 1.271 | -0.346 | 0.590 | 1.111 | 0.104  | -0.276 | 0.466  | 0.330 | 0.453 | 0.512 | 14.03 |
| 67 | -0.030 | 0.198 | 1.147 | 0.137  | 0.309 | 1.334 | -0.065 | -0.214 | -0.413 | 0.285 | 0.556 | 0.786 | 20.75 |
| 68 | -0.027 | 0.112 | 0.970 | 0.087  | 0.689 | 1.419 | -0.537 | -0.988 | 0.010  | 0.483 | 0.493 | 0.667 | 20.07 |

|      |        |       |       |        |        |       |        |        |        |       |       |       |            |
|------|--------|-------|-------|--------|--------|-------|--------|--------|--------|-------|-------|-------|------------|
| 69   | -0.035 | 0.215 | 1.285 | 0.081  | 0.679  | 1.121 | -0.107 | -0.038 | -0.610 | 0.404 | 0.532 | 0.631 | 16.93      |
| 70   | -0.028 | 0.137 | 0.733 | -0.185 | 0.782  | 1.303 | 0.411  | -1.020 | -0.305 | 0.551 | 0.477 | 0.610 | 18.82      |
| 71   | -0.037 | 0.183 | 1.237 | -0.273 | 0.375  | 1.331 | -0.735 | -0.892 | -0.697 | 0.276 | 0.492 | 0.541 | 14.93      |
| 72   | -0.034 | 0.249 | 1.473 | 0.038  | 0.495  | 1.193 | -0.234 | -0.386 | -0.488 | 0.437 | 0.423 | 0.513 | 14.48      |
| 73   | -0.034 | 0.200 | 0.981 | -0.724 | 0.507  | 1.075 | 0.144  | -0.815 | 0.584  | 0.515 | 0.524 | 0.834 | 16.87      |
| 74   | -0.033 | 0.189 | 1.602 | -0.312 | 0.146  | 1.254 | -0.267 | -0.681 | -0.708 | 0.349 | 0.431 | 0.546 | 15.38      |
| 75   | -0.037 | 0.218 | 1.715 | 0.740  | 0.158  | 1.298 | -0.522 | -0.870 | -0.020 | 0.320 | 0.417 | 0.723 | 13.28      |
| 76   | -0.030 | 0.138 | 1.661 | -0.179 | 0.382  | 1.319 | -0.553 | -0.612 | -0.966 | 0.447 | 0.467 | 0.593 | 17.88      |
| 77   | -0.033 | 0.165 | 1.069 | -0.393 | 0.402  | 1.231 | -0.397 | -0.500 | -1.124 | 0.514 | 0.412 | 0.599 | 13.86      |
| 78   | -0.035 | 0.185 | 2.254 | 0.458  | -0.148 | 1.243 | -0.620 | -0.500 | -0.850 | 0.301 | 0.409 | 0.484 | 14.32      |
| 79   | -0.033 | 0.138 | 1.277 | -0.149 | 0.616  | 1.247 | -0.153 | -0.813 | -0.021 | 0.480 | 0.411 | 0.587 | 14.06      |
| 80   | -0.032 | 0.182 | 1.398 | -0.160 | 0.440  | 1.181 | 0.452  | 0.210  | -0.712 | 0.263 | 0.454 | 0.502 | 16.20      |
| 81   | -0.030 | 0.140 | 1.133 | 0.122  | 0.337  | 1.254 | -0.505 | -0.274 | -0.832 | 0.555 | 0.499 | 0.534 | 18.47      |
| 83   | -0.033 | 0.177 | 1.425 | -0.211 | 0.292  | 1.237 | -0.019 | -0.609 | -0.337 | 0.473 | 0.479 | 0.763 | 16.76      |
| 84   | -0.032 | 0.237 | 1.914 | -0.397 | 0.325  | 1.283 | -0.081 | -0.795 | -1.414 | 0.398 | 0.397 | 0.524 | 15.22      |
| 85   | -0.034 | 0.192 | 1.580 | -0.434 | 0.297  | 1.214 | -0.460 | -0.486 | -0.624 | 0.501 | 0.484 | 0.523 | 16.43      |
| 86   | -0.027 | 0.192 | 0.598 | 0.138  | 0.093  | 1.244 | -0.176 | -0.449 | 0.517  | 0.369 | 0.500 | 0.821 | 19.67      |
| 87   | -0.026 | 0.168 | 0.741 | 0.172  | 0.250  | 1.294 | -0.176 | -0.729 | -0.404 | 0.469 | 0.492 | 0.792 | 20.86      |
| 88   | -0.029 | 0.069 | 1.568 | -0.373 | 0.274  | 1.376 | -0.327 | -0.799 | -1.361 | 0.503 | 0.499 | 0.588 | 19.53      |
| 90   | -0.036 | 0.157 | 0.564 | -0.423 | 0.610  | 1.140 | -0.003 | -0.086 | -0.272 | 0.371 | 0.549 | 0.677 | 15.94      |
| 91   | -0.037 | 0.155 | 1.567 | -0.152 | 0.065  | 1.218 | -0.420 | -0.861 | -0.487 | 0.370 | 0.492 | 0.458 | 15.30      |
| 92   | -0.028 | 0.114 | 1.410 | -0.090 | 0.056  | 1.362 | -0.464 | -1.381 | 0.012  | 0.523 | 0.371 | 0.643 | 15.24      |
| 93   | -0.032 | 0.131 | 1.470 | -0.019 | 0.279  | 1.264 | -0.346 | -0.572 | -0.899 | 0.298 | 0.526 | 0.538 | 18.30      |
| 95   | -0.022 | 0.171 | 1.006 | -0.017 | -0.055 | 1.356 | -0.270 | -0.529 | -0.199 | 0.356 | 0.789 | 0.886 |            |
| 96   | -0.037 | 0.146 | 1.227 | -0.282 | 0.526  | 1.219 | -0.249 | -0.689 | -0.373 | 0.381 | 0.421 | 0.650 |            |
| 97   | -0.036 | 0.172 | 1.453 | 0.184  | 0.334  | 1.386 | -0.957 | -0.683 | -1.753 | 0.378 | 0.420 | 0.544 |            |
| 98   | -0.027 | 0.126 | 1.402 | -0.266 | 0.238  | 1.367 | -0.289 | -0.100 | 0.062  | 0.261 | 0.548 | 0.689 |            |
| 99   | -0.027 | 0.157 | 1.522 | 0.241  | 0.102  | 1.376 | -0.589 | -0.837 | -1.275 | 0.380 | 0.544 | 0.730 |            |
| 100  | -0.036 | 0.253 | 1.752 | 0.652  | 0.533  | 1.500 | -0.847 | -0.980 | -1.465 | 0.372 | 0.377 | 0.443 |            |
| UCI  | -0.032 | 0.177 | 1.493 | -0.037 | 0.470  | 1.271 | -0.104 | -0.504 | -0.369 | 0.416 | 0.473 | 0.643 | Max=24.91  |
| LCI  | -0.033 | 0.160 | 1.326 | -0.190 | 0.364  | 1.237 | -0.238 | -0.652 | -0.603 | 0.375 | 0.445 | 0.589 | Min=10.37  |
| MEAN | -0.033 | 0.168 | 1.409 | -0.114 | 0.417  | 1.254 | -0.171 | -0.578 | -0.486 | 0.395 | 0.459 | 0.616 | Mean=16.09 |