DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS AND POLICY
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

WORKING PAPER NO. 965

ANALYZING THE IMPACT OF BEACH CLOSURES, INTERSITE SUBSTITUTION AND INTERTEMPORAL SUBSTITUTION VIA A MODEL OF ATTENDANCE AT FIVE ORANGE COUNTY BEACHES

by

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July 8 2001

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8 July 2001

Western Economic Association International

76th Annual Conference, San Francisco, California

ABSTRACT

This paper explores the impact on beach attendance of beach closures and the intersite and intertemporal substitution that may follow beach closures. A model of beach attendance is developed that builds on a model constructed by Paul Ruud to support the State of California's claim to damages after the American Trader oil spill off the coast of Orange County, southern California. Newly gathered data on beach closures is combined with data on daily attendance from 1985-1993. Variables are constructed to test for intersite substitution (the shifting of beach recreation in space, i.e. from a closed beach to another beach) and intertemporal substitution (the shifting of demand for recreation at a particular beach over time). The method of non-linear least squares is used to estimate a system of five seemingly unrelated regression equations. For each equation, Breush-Pagan tests for heteroskedasticity fail to reject the null hypothesis of homoscedasticity and modified Breush-Godfrey tests for autocorrelation fail to reject the null hypothesis of no autocorrelation. The analysis produces only weak evidence to support rejection of null hypotheses that there are no effects due to beach closures, intertemporal substitution, or intersite substitution. For example, just two of six coefficients on closure variables are statistically significant. The lack of stronger evidence of casual effects likely reflects at least in part the fact that (1) the attendance data that form the foundation for analysis only extend from December to March and (2) people can still visit the beach when it is "closed" since the closures considered here pertain only to water contact. Such closures will likely have a greater effect during summer when air and water temperatures are higher and more people will want to engage in water-based recreation.

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TABLES

1. INTRODUCTION

In 1990, the steam tanker American Trader spilled over 400,000 gallons of crude oil offshore of Huntington Beach in southern California. This oil spill caused widespread closures of some of the world's most fabled beaches. The State of California's effort to secure compensation for damages due to the oil spill was disputed. The core of the State's claim was the value of beach recreation lost due to the oil spill, which was estimated in work done by Ruud (1994) and Hanemann (1994). Paul Ruud developed a model of attendance at six beaches in Orange County, which was used to forecast the attendance level that would have been expected in the absence of the oil spill. Prof. Michael Hanemann then used this estimate of lost recreational use and the non-market valuation technique of benefits transfer to calculate the welfare losses due to the spill. Almost eight years later, the State of California earned a $18 million verdict in a precedent-setting decision (Chapman et al. 2000a, 2000b).

The work done here builds on the model Professor Ruud constructed for the American Trader trial. In particular, new data is added to enable investigation of the effects of beach closures and the related effects of intersite substitution (the diversion of beach recreation from a closed beach to another beach) and intertemporal substitution (the shifting over time of demand for recreation at a particular beach). If people response to a beach closure by simply going to a different beach or by waiting to go until another day, then the attendance effect and the associated welfare impact of a beach closure will be reduced. The objectives of this work are a better understanding of the impacts of beach closures and advancement of methods for modeling beach attendance when no data on individual beach use is available.

2. DATA DESCRIPTION AND SUMMARY STATISTICS

In this section, existing data on attendance at Orange County beaches are first discussed. These data were originally collected for the American Trader trial. Next, newly gathered data on beach closures are surveyed. Weather data are not covered here in detail, but play an important causal role in the analysis. The next section on variables included in the model explain the particular weather data that are incorporated.

Attendance Data

The core of the dataset is attendance data collected for the American Trader trial. This daily attendance data falls within the time interval 1 January 1985 to 31 December 1993. Since the American Trader oil spill occurred in February, it was decided to focus on developing a model for the winter season. Each season of attendance data run from the beginning of December to the end of March for the most part.[1] There are nine full seasons of attendance data. Seasonality and cyclical trends are discussed further below. The six beaches included the sample are, listed from north to south, Bolsa Chica State Beach, Huntington City Beach, Huntington State Beach, Newport Beach, Crystal Cove State Beach, and Laguna Beach.

[1] These mostly run from December to March. The attendance data start on a January, so the first season does not include December. The season at the end of the time interval consists of only the month of December 1993. The two seasons of 1984-5 and 1985-6 include the month of April.

Missing attendance observations appear throughout the data set, but these appear to be randomly rather than systematically distributed (Ruud 1994). In estimation, data from the February 7 – March 31, 1990, time period are excluded as this was the time of closings due to the American Trader oil spill. Usually, county officials order beach closures. However, closures after the oil spill were ordered by state authorities, and there exists no accurate record of where and when these closures occurred.

Table 1 shows that attendance can be high at these beaches even during the winter when these data were collected. Newport Beach averages almost 10,000 visitors a day.

Table 1. Summary Statistics on Beach Attendance

Beach	Number of missing observations	Mean Attendance	Standard deviation	Minimum	Maximum
Bolsa Chica	163	1720	2553	4	28510
Huntington City	0	5533	7846	352	78769
Huntington State	187	2118	3038	7	32029
Newport	212	9452	15290	50	100000
Crystal Cove	91	489	739	15	7768
Laguna	231	2947	4961	15	35000

Lifeguards at each beach collect attendance data. The approach to estimating attendance, in general terms, is to count the number of cars in beach parking lots and use a conversion factor in order to estimate the people arriving by car. A conversion factor is also used in order to estimate the number of "walk ins," people who do not arrive by car. For city-operated beaches, an estimation technique is also employed to estimate visitors who have parked in areas that are not monitored.

Beach Closure Data

Beach closure data were collected to complement the existing attendance data. The Orange Country Environmental Health Department, the agency responsible for closing beaches when tests of coastal waters indicated that health standards have been violated, provided data on closures. Appendix 3 gives a detailed overview of beach closure data. In addition to the simple fact of whether or not a closure occurred, the extent, i.e. shoreline length, of the closure was also determined.[2] One important issue is this spatial mismatch between closure and attendance data. That is, in almost every case the spatial unit for which attendance is reported does not match the spatial extent of the beach closure. Table 2 illustrates this phenomenon. It shows that the problem is particularly acute at Laguna Beach, where most of the closures occurred (77%). At Laguna Beach the average closure length was only 1800 feet on a beach of approximately 6.2 miles in total shoreline length.

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[2] In most cases, but not all, the Orange Country Environmental Health Department's records indicated the extent of the beach closures. In the few instances where closure length was not shown, Monica Mazur, the responsible official, provided this information.

*Table 2. Summary Statistics for Complete Set of Beach Closures**

Beach name	Total Beach Length	Number of Days with Some Shoreline Closed	Average Closure Length
Huntington State	2.2 miles	20	7300 feet/closure (1.4 miles)
Newport	6.2 miles	20**	6600 feet/closure (1.2 miles)
Laguna	6.4 miles	134	1800 feet/closure (0.35 miles)

*Source: Orange Country Environmental Health Department

**Six additional closure days were recorded in 1985, but attendance data for Newport Beach is missing in that year so there is no way to include these.

Another characteristic of closure data is that many of the Laguna Beach closures occurred in the vicinity of Aliso Creek, a relatively lightly visited stretch of the coast. Closures occurring in this area are excluded. All other closures of at least 2000 feet were included. Descriptive statistics of the closures included as explanatory variables follow in Table 3.

Table 3. Descriptive Statistics for Beach Closures Included as Explanatory Variables

Beach Name	Length of Shoreline Closed	Percentage of Beach Shoreline Closed	Date of Closure	Location of Closure
Huntington State	2.2 miles (12,000 feet)	100%	1/17-1/23, 1990	Entire beach
Huntington State	½ miles (2640 feet)	23%	2/12-2/21, 1992	½ mile north of Santa Ana River
Newport	2.6 miles (14,000 feet)	42%	1/17-1/23, 1990	Santa Ana river south to Newport Pier
Newport	½ miles (2640 feet)	8.1%	2/12-2/21, 1992	½ mile south of Santa Ana river
Laguna	0.38 miles (2000 feet)	5.9%	3/10-3/14, 1988	1000 feet north and south of creek at Emerald Bay
Laguna	0.67 miles (4000 feet)	11%	1/31-2/8, 1989	Laguna main beach

The symmetry between closures at Newport Beach and Huntington State Beach that can be seen in the above table reflects the fact that the Santa Ana River, which lies on the boundary between the two, was the common source of the pollution for the two closures at both of these beaches.

3. DESCRIPTION OF VARIABLES

The dependent variable for each of the five equations is daily beach attendance. Key explanatory variables are discussed below. A variety of different formulations and interaction effects was tested for each category. The different formulations and criteria for choosing among these is discussed further in a sub-section, "Explanation of Choices on Definition of Variables", found at the end of this section. The second to last part of this section, which has the heading "Overview of Variables," includes a table that gives precise definitions of all the variables included in the analysis.

Closure Variables

First, a few words on the nature of beach closures being studied here. Unlike the total closures that occurred after the American Trader oil spill, beach closure as defined here pertain only to prohibitions on water contact. During a "closure" people are still free to visit the beach though they are warned that water recreation could be hazardous. Notification of beach closures occurs primarily through posting of signage in the vicinity of the closure. With the exception of major events like the American Trader oil spill that are reported prominently, most closures are not widely or immediately known to the public. Therefore, in thinking about how to measure the effect of beach closures, some delayed response was expected. Beach users may not find out about the closure until they actually visit the beach themselves and find it closed, or talk to someone who has visited the beach since it has been closed.

A discrete (0/1) variable is used to indicate closures. The expected delayed response to a closure is captured by defining an affirmative value, e.g. a value of one (1), as indicating that the beach has experienced a closure over the past two days. Thus, the first day a beach is closed, the closure variable shows a value of zero (0). The next day the variable switches to a value of one (1) and would remain so for at least the next two days. And after a closure ends, there is a two-day lag before the closure variables switches back to a zero (0) value.

A distinction is made between whether the day in question is a weekend or a weekday based on the assumption that beach attendance will behave differently between these two categories. Thus, there are two discrete beach closure variables. One of these indicates whether or not it is a weekend day and whether or not there has been a closure over the past three days. The second closure variable indicates whether or not it is a weekday and whether or not there has been a closure over the past three days. Formulation of closure variables is borrowed from the approach used by Ward and Winkler (1999).

As the introduction to this section suggested, a variety of different specifications of variables based on beach closures were tested. One set of beach closure variables that was tested did not include any where there was not delayed response (this was just a zero/one variable based on whether or not the beach was closed on the this particular day).[3] Another set of beach closure variables that was tested reflected the fraction of the beach closed on that particular day. Other variable specifications tested the effect of using different lag times. In every case, the results of hypothesis testing for alternative variable formulations returned similar results or weaker results in terms of explanatory power. Therefore, we decided to go with the original formulation of the variable, as detailed above. A more in-depth discussion of choices on variable formulation comes at the end of this section.

Variables Constructed to Test Intersite Substitution

Recall the definition of intersite substitution as the contemporaneous diversion of beach recreation to another beach due to a beach closure. The discrete intersite substitution variables included in the model are similar to beach closure variables in that there is a distinction between weekend days and days during the workweek. In the model of attendance for a given beach, if

[3] In the absence of theoretical guidance, hypothesis testing results offer a guide to variable formulation. This is discussed further in section 4, Model Specification.

there is a closure at a beach for which the given beach is a substitute, the intersite substitution variable for that beach is "turned on," that is the discrete variable takes on a value of one (1). Put differently, suppose beach X is a potential substitute for beach Y. When a closure variable for beach Y has a value of one (1), the intersite substitution variable for beach X will have a value of one (1). More concretely, Huntington City Beach might serve as a substitute for Huntington State Beach. Thus, on a weekend day when the Huntington State Beach closure variable returns an affirmative value (1) the Huntington City Beach weekend intersite substitution variable also returns an affirmative value (1).

Travel cost is a factor in determining recreational demand, and so viewing the beaches nearest to those suffering a closure as potential substitutes may makes sense. On the other hand, people may worry that beaches to close to a closure will also may also be experiencing water contamination and so people may not want to divert themselves to a beach that is too nearby. Indeed, beaches very close to those where a closure has been ordered may themselves see reduced attendance if people worry that the contamination could migrate. The intersite substitution schema outlined in table 4 enables testing for intersite substitution at different distances and even for the potential for a negative spillover effect of closures to neighboring beaches. For example, Huntington City Beach is directly next to Huntington State Beach, and so if intersite substitution to nearby beaches occurs it may be found in the intersite substitution variables for Huntington City Beach. On the other hand, Laguna Beach is more than two miles from Newport Beach, so if intersite substitution diverts beach trips to beaches that are not too close to the beach where the closure has occurred, it may be evident in intersite substitution variables for Laguna Beach. Table 4 lists for each beach the beach for which it serves as a substitute.

Table 4. List of Beaches Serving as Substitutes in Case of Closures

Beach (listing north to south)	**Serves as a substitute for closure at "X" beach**
Bolsa Chica	Huntington State Beach
Huntington City	Huntington State Beach
Huntington State	Laguna Beach
Newport	Laguna Beach
Laguna	Newport Beach

Note that the closures at Huntington State Beach and Newport Beach were contiguous and occurred simultaneously, else each might have served as a good substitute for the other if proximity is a chief concern.

Variables Constructed to Test Intertemporal Substitution

Two types of intertemporal substitution variables are defined. One seeks to capture intertemporal substitution due to rain and the other seeks to capture intertemporal substitution due to beach closures.

For each of the three beaches where a closure occurred, a variable is created to test for intertemporal substitution after closures. These variables seek to answer the question of whether or not people dissuaded from visiting the beach during a closure have reallocated their consumption to a future time period. The structure of these variables is a linear trend in the week following a closure based on the number of days after closure has ended. More precisely, the intertemporal substitution "turns on," takes on a non-zero value, once the closure variables return to a zero value. Since the closure variables have a two day lag, this means that the third day after a closure has ended, the intertemporal substitution variable changes from a value of zero (0) to one(1), and it increases by one (1) unit each day until it reaches a value of seven (7). As with other variables, different formulations were tested. For example, a simple discrete variable (0/1) rather than a linear time trend was tested here. Again results were similar among different formulations, and so we chose the original variable definition.

A separate variable is also developed to test for intertemporal substitution after rainfall. In particular, this variable is based on the notion that rainfall during one weekend may increase beach attendance the next weekend. The discrete variable returns an affirmative value (1) for a weekend day when there is no rain and when it rained at least one day the previous weekend.

Additional Variables

The analysis done here also utilizes lagged attendance data as was done by Paul Ruud in his original work for the American Trader trial. The value of the lagged attendance data variables equals the observation from the previous day or the day before that. Seasonal and cyclical variables are also included. Season dummies are included to account for systematic changes in attendance from year to year. Day of the week discrete variables for Friday, Saturday, and Sunday are included as well.

Overview of All Variables

A complete list and description of beaches follows in table 5.

Table 5. Detailed Description of Variables

Variable	**Description**
Abbreviation for beach names	Bc = bolsa chica Hs = Huntington State Hc = Huntington City N = Newport L = Laguna
New variables (Not in Ruud's original model). In every case below, "*beach*" is a placeholder representing one of the abbreviations defined above.	
*beach*_w	Beach closure weekend day: Discrete variable returns a value of 1 if it is a *weekend day* and the beach in question has been closed over any of the past 2 days.
beach _d	Beach closure week day: Discrete variable returns a value of 1 if it is a day during the week day and the beach in question has been closed over any of the past 2 days.
*beach*_is_w	Intersite substitution weekend day: Discrete variable returns value of 1 when any of the beaches for which the beach in question is a substitute has been closed over the past two days and it is a *weekend day.*

*beach*_is_d	Intersite substitution week day: Discrete variable returns value of 1 when any of the beaches for which the beach in question is a substitute has been closed over the past two days and it is a *day during the week.*
*beach*_pl	Intertemporal substitution due to beach closure: Variable takes on the value of the number of days after both closure variables return from one to zero due to end of a closure. Variable increases by 1 for each for one week (thus value ranges from 0 to 7). PL stands for post-closure linear trend.
*beach*_it	Intertemporal substitution due to rain variable: Discrete variable returns a value of 1 if (i) it is a weekend day, (ii) it is not raining and the beach is not closed, and (iii) it rained at least once last weekend. IT stands for intertemporal.
Variables in Ruud's original model	
beach	Daily beach attendance level.
l*beach*	The natural logarithm of daily beach attendance
*variable*_1	The previous day's observation on *variable.*
*variable*_2	The observation on *variable* from two days prior.
lag_sat	This is the lag of the dependent variable times a Saturday indicator. It equals Friday's observation of the dependent variable if the observation occurs on a Saturday and zero otherwise.
lag_mon	This is the lag of the dependent variable times a Monday indicator. It equals Sunday's observation of the dependent variable if the observation occurs on a Monday and zero otherwise.
day	Number of days past December 1^{st}—a linear time trend variable.
sinday, cosday	Seasonal periodicity variables – sin is sin(day*2*pi/365), with day indicating the number of days elapsed since December 1.
fri	This variable equals 1 if observation falls on a Friday.
sat	This variable equals 1 if observation falls on a Saturday.
sun	This variable equals 1 if observation falls on a Sunday.
tmpx_la	Daily maximum temperature at the LA Civic Center, Ponoma, and Pasadena weather stations.
tmpn_la	Daily minimum temperature at the LA Civic Center, Ponoma, and Pasadena weather stations.
rain_bch	Equals 1 if the maximum daily rainfall at Laguna, Long Beach, and Newport weather stations exceeded 0.25 inches of rain, which is roughly median rainfall.
rain_lag	The observation of rain_bch from the previous day.
xmas	Discrete variable equals one if local schools are on winter break
estr	Discrete variable equals one if local schools are on spring break
holiday	A different holiday indicator return value of 1 if observation falls on New Year's day, St. Patrick's Day, Martin Luther King Day, or President's Day
S1,...,S8	Separates data into winter seasons running December through March (or April for '85 and '86). S1 stands for season number 1.

Readers who want to go through the complete regression results listed in Appendix 1 are urged to refer the above table to assist in understanding variable labels.

Explanation of Choices on Definition of Variables
Before going the estimation results are discussed, some further justification of choices made with respect to definition of constructed variables is appropriate. This subsection discusses variable formulations considered but discarded due to the greater explanatory success of alternative formulations.

The idea of conceptualizing the beach closure variables as the proportion of beach closed holds intuitive appeal. Indeed, one of the notable aspects of the closure data is the extent to which many of the closures were relatively small, a tiny proportion of total beach shoreline. A proportional closure variable would seem to offer the chance to account for this spatial mismatch. However, this was not the case. Variables based on the proportion of beach closed exhibited little statistical significance. Proportional closure variables were defined and tested (1) based on the full set of closures and (2) based on the two largest closures at each of the three beaches where closures occurred, which have the additional favorable characteristic of occurring at popular areas for visitation, unlike the other closures. Results for proportional closure variables based on the second of these two examples are reported in Appendix 2. The discrete closure variable results ultimately included in the analysis perform better (with two statistically significant variables versus one). It may be that the performance of variables based on the proportion of beach closed suffers because there is not enough variation between the two closure incidents that occurred at each of the three beaches. But when a larger set of closures is included, the problem arises that closures on relatively unpopular stretches of beach are included and these appear to have little effect on attendance.

Another type of closure variable was developed to test the notion that closure effects may depend on the duration of the closure. It may be that the impact of a closure increases over time as more and more people learn about the closure and adjust their behavior. Such closure duration variables were found to have little explanatory value. In every case, testing failed to reject the null hypothesis of a zero coefficient on closure duration variables. Note that for both the proportional closure variables and the closure duration variables a variety of different formulations were tested, including (1) without accounting for day of the week, that is without a weekend/weekday distinction, (2) accounting for the day of the week affects via separate variables for weekdays and weekend days as is the case for the closure variables included in the analysis, and (3) accounting for day of the week effects through interactions with Friday, Saturday, and Sunday variables. In every case, testing suggests that the closure variables included in the final analysis have greater explanatory value.

Since the impact of closures seems likely to vary with weather, a variety of interaction variables were developed to test for this. Initial efforts at interaction effects based on rain revealed nothing because there was almost no rain during closure incidents. Next interaction effects based on daily maximum temperature were tested. This approach did not produce additional insight. The result is that the only statistically significant closure variable has a positive coefficient. Results for an example of this work with interaction effects, this one using closure-maximum temperature interactions, are reported in Appendix 2.

Different formulations for intersite and intertemporal substitution variables were also tested. In addition to the post-closure intertemporal substitution variable ultimately adopted, a simple discrete variable (0/1) was tested. This formulation returned similar results. That is, the Laguna Beach intertemporal substitution variable had a negative coefficient and was the only one variable that was statistically significant. Numerous different intersite substitution variables were tested, including (1) a simple discrete variable for a closure at a different beach for which the beach serves as a substitute (eliminating the weekend-weekday distinction, (2) a variable indicating the duration of the closure at a different beach for which the beach serves as a substitute, (3) a variable indicating the fraction of the beach closed for which the beach serves as a substitute. Interaction effects based on rainfall and maximum daily temperatures were also tested. None of these alternative formulations or interaction effects were found to have greater explanatory success than those ultimately included in the model.

4. MODEL SPECIFICATION

Approach

In econometric work it is preferable to start with the development of a utility theoretic model to assist in specification of the statistical model and interpretation of results. This approach was not taken here due to the lack of any individual-specific data. Methods for modeling individual decisions with respect to demand for recreation must incorporate some information about the price people are willing to pay for recreation or at least some individual specific data. The travel cost method is the primary approach used for modeling utility from and demand for recreation. The cost of travel borne by the user is taken as a measure of the user's willingness to pay for the marginal unit consumed. Alternatively, the nature of recreational demand may be explored via the method of contingent valuation where in potential users are questioned directly. In the absence of a utility framework, intuition, introspection, and anecdotal observation can assist in model specification, but ultimately the quality of the estimation fit and explanatory success based on hypothesis testing guide specification of the statistical model.[4]

As Professor Ruud's work illustrates, useful analysis can still be conducted in the absence of the preferred utility-theoretic framework. Exactly the type of analysis done here serves as the foundation for welfare impact analyses that utilize the method of benefits transfer, which was used to find the welfare impact for the American Trader trial. Among other agencies, the U.S. National Oceanic and Atmospheric Administration's Damage Assessment Office primarily uses such a benefits transfer approach to value the welfare effects of impacts on recreation. The benefits transfer approach avoids the costly process of collecting individual data on travel. In this manner it may be possible to capitalize on data already being collected, as is the case for this Orange County, California data.

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[4] Without a theoretical compass, when statistical significance becomes a guide, it is especially important remember that each additional test increases the potential for type I errors (rejection of a null hypothesis when their should in fact should be a failure to reject).

The question of how to model beach attendance remain particularly salient for the study area. The area's beaches are among the most popular in California and the problem of beach closures persist. In the summer of 1999 large portions of Huntington Beach were closed. The public, political and government leaders, and policy analysts continue to be concerned about the effects of water pollution at the particular beaches being studied.

Why a System of Seemingly Unrelated Equations?

The decision to construct a system of seemingly unrelated equations for each beach reflects the fact that (1) the primary goal of the work is to contribute to econometric methods for use in benefit transfer valuation work and (2) the beaches are substantially different in terms of the amenities they offer, location, and size. In econometric analysis to support benefit transfer valuation, the forecasting accuracy of the model is of tantamount interest. Further, differences among the five beaches means it may be reasonable to expect that the parameters on the same variables will vary from beach to beach. Estimating a separate equation for each beach will enable the most accurate forecasts. The parameters for such equations will necessarily reflect the idiosyncratic unobservable characteristics of each beach. To the extent that this enables more accurate prediction, this is an acceptable outcome. Differences among beaches is also the *justification for assuming no simultaneity* beyond the correlation among disturbance terms for the different equations. Future work will explore the idea of estimating a single equation by treating the data as cross-sectional, time series data. Such a single equation approach may enable more general conclusions to be drawn about beach closure and related effects.

Specific Functional Form

The choice of non-linear function form was made after estimation and testing of a log-linear model, which followed Ruud's initial specification, raised concerns about the possibility heteroskedasticity. All of the Breush-Pagan tests of beach attendance equations estimated with the log-linear form reject the null hypothesis of homoscedasticity.[5] In response, again following Ruud, a non-linear functional form is adopted. Unlike Ruud, the non-linear attendance equations for each beach are not viewed as isolated but are estimated as a system of Seemingly Unrelated Regression (SUR) equations. The SUR system of equations can be represented as:

$$\mathbf{y}_i = \exp(\mathbf{x}^T\boldsymbol{\beta}_i) + \boldsymbol{\varepsilon}_i$$

where: y = beach attendance
x = a vector of explanatory variables
β = a vector of parameters to be estimated for each beach i
ε = an unobservable random error term distributed $N(0, \sigma^2 I)$
i = 1,...5, identifies beaches Bolsa Chica to Laguna.

The assumption under SUR is that there cross-equation correlation among error terms, that is, $\rho(\varepsilon_i, \varepsilon_j) \neq 0$ for $i \neq j$. SUR estimation is more efficient than single equation non-linear least squares estimation if cross-equation correlation of error terms exists and is no less efficient if such cross-equation correlation does not occur. Note that the basis for the error term included in these equations is the measurement error expected in beach attendance data.

[5] The Chi-square test statistics and associated p-values for the beaches were Bolsa Chica— 3.79(0.002), Huntington City— 6.08 (0.000), Huntington State—6.02(0.000), Laguna— 4.54 (0.001), Newport 8.65 (0.000).

The choice of this non-linear SUR system is supported by the failure in every case to reject the null hypothesis of spherical disturbance terms. More specifically, testing of the assumptions of homoscedasticity and no autocorrelation is conducted (Greene 2000). For each of the five equations, a modified Breush-Godfrey test for first-order autocorrelation is employed and in each case there is a failure to reject the null hypothesis of no autocorrelation. Similarly, a Breush-Pagan test fails to reject the null hypothesis of homoscedasticity for each of the five beach equations. Detailed results of these hypothesis tests follow.

Table 6. Results of Modified Breush-Godfrey Test for Autocorrelation

Beach	**F-Statistic**	**p-value**
Bolsa Chica	0.47	0.4925
Huntington City	0.00	0.9967
Huntington State	0.16	0.9178
Newport	0.07	0.7895
Laguna	0.33	0.5631

Table 7. Results of Breush-Pagan Test for Heteroskedasticity

Beach	**Chi-Square Statistic**	**p-value**
Bolsa Chica	$1.9 * 10^{-4}$	0.999
Huntington City	$4.3 * 10^{-5}$	0.999
Huntington State	$8.2 * 10^{-5}$	0.999
Newport	$2.2 * 10^{-5}$	0.999
Laguna	$6.5 * 10^{-6}$	0.999

5. ESTIMATION RESULTS AND INFERENCE

The estimated equation fit the data very well. R-square values for the six beaches range from 0.71 to 0.85. The R-square values specific to each beach, as well as all other details, can be found in Appendix 1, which gives complete regression results. When beach closure and substitution variables were added, explanatory variables included in Professor Ruud's initial work still account for most of the regression equations' explanatory power. The parameter values associated with Ruud's original explanatory variables closely parallel his findings. As expected, rain at the beach significantly depresses attendance and warmer weather leads to greater beach attendance. Beach attendance is appreciably higher on Fridays, Saturdays, and Sundays. There is a linear time trend whereby attendance grows from December to March. Attendance is higher on holidays and during school breaks in the springtime and wintertime. The positive coefficients on lagged dependent variables indicate that high beach attendance one day is apt to be followed by high beach attendance the next day. Seasonal dummy variables exhibit significance, but there is not consistent pattern of increasing or decreasing attendance from year-to-year. A positive trend might have resulted due to increasing population in the area or a decreasing trend might have been evident due to increasing concerns about skin cancer and water pollution, but this isn't the case.

Results on Beach Closures

Now to the focus of this paper, the effect of beach closures and the related issues of intersite and intertemporal substitution. In general, there is only weak evidence that beach closures depress attendance and that intersite and intertemporal substitution occurs. Of six coefficients on closure variables, two are negative and significant at a 5% level. Thus, in only two cases are we able to reject the null hypothesis that the true coefficient associated with a closure variable is zero. Table 8 gives all results for closure variables.

Table 8. Results for Beach Closure Variables

Variable*	**Coefficient (Std. Error)**	**P-value**
Huntington State, weekend day	-.981781 (.296869)	***0.001***
Huntington State, week day	.064259 (.323812)	0.843
Newport, weekend day	-.153379 (.303636)	0.613
Newport, week day	-.455719 (1.10887)	0.681
Laguna, weekend day	-.506797 (.211142)	***0.016***
Laguna, week day	-1.23847 (1.41812)	0.382

* See Table 5 for definition of variables.

Another way to view these results is that two of three weekend variables exhibit statistical significance. One interpretation of this is that there is stronger evidence that weekend closures reduce attendance. The population visiting the beach on the weekend may be systematically different from those visiting on the weekday. Perhaps those visiting the weekend are more easily deterred from visiting while those who visit during the week are more committed. It may also be that weekend and weekday visitors use the beach for different activities. Perhaps weekend visitors are more likely to want to go in the water, and so will be more effected by a closure due to water pollution.

Results for Intersite Substitution Variables

Of six intersite substitution variables, only one is significant at a 5% level. For this variable, we reject the null hypothesis of a zero coefficient. The positive sign on this sole statistically significant variable suggests that intersite substitution due to a closure at Newport Beach increases attendance at Laguna beach.

Table 9. Results for Intersite Substitution Variables

Intersite Substitution Variable*	Coefficient (Std. Error)	P-value
Bolsa Chica, weekend	-.512146 (.360379)	0.155
Bolsa Chica, week day	-.231288 (.630342)	0.714
Huntington City, weekend	-.454652 (.453802)	0.316
Huntington City, week day	.230508 (.647761)	0.722
Huntington State, weekend	-.357857 (.325503)	0.272
Huntington State, weekend	-.115133 (.367683)	0.754
Newport, weekend	-.741338E-02 (.142685)	0.959
Newport, week day	-.651138 (.434939)	0.134
Laguna, weekend	.110322 (.303265)	0.716
Laguna, week day	.778148 (.343056)	***0.023***

* See Table 5 for definition of variables.

Results for Intertemporal Substitution Variables

As shown in Table 10, one of three coefficients on intertemporal substitution variables due to beach closures is significant at a 5% level. We reject the null hypothesis of no causal effect (a zero coefficient) for this variable.

Table 10. Variables Testing Intertemporal Substitution Due to Beach Closure

Intertemporal Substitution Variable*	Coefficient (Std. Error)	P-value
Huntington State	.052038 (.021305)	***0.015***
Newport	-.101903 (.079140)	0.198
Laguna	.012863 (.049244)	0.794

* See Table 5 for definition of variables.

As shown below in Table 11, results for intertemporal substitution due to rain are impressive for their uniformity. For all five variables we reject the null hypothesis of no causal effect. The positive coefficients on these variables suggest that attendance is higher on weekend days without rain when they fall on a weekend that follows a weekend that saw at least one day of rain.

Table 11. Variables Testing Intertemporal Substitution Due to Rain

Intertemporal Substitution Variable*	Coefficient (Std. Error)	P-value
Bolsa Chica, return one (1) if it is a weekend day, not raining, & rained one day last weekend	.574259 (.104623)	0.000
Huntington City, return one (1) if it is a weekend day, not raining, & rained one day last weekend	.520009 (.119730)	0.000
Huntington State, return one (1) if it is a weekend day, not raining, & rained one day last weekend	.553717 (.103343)	0.000
Newport, return one (1) if it is a weekend day, not raining, & rained one day last weekend	.509478 (.133129)	0.000
Laguna, return one (1) if it is a weekend day, not raining, & rained one day last weekend	.852394 (.133298)	0.000

* See Table 5 for definition of variables.

6. MARGINAL EFFECTS

In this section, predicted marginal effects of statistically significant variables are calculated in order to make more readily apparent how the analysis suggests that they affect beach attendance. In each case, the method for calculation is sample enumeration.

Of primary interest is the effect of beach closures. Analysis suggests that weekend closures in heavily visited areas, such as those included as explanatory variables, have a substantial effect on beach attendance at Laguna Beach and Huntington State Beach. Table 12 suggests that a weekend closure at Laguna Beach reduces attendance by approximately 24% and a weekend closure at Huntington State Beach reduces attendance by about 30%.

*Table 12. Marginal Effect of Weekend Closure Variables**

	Laguna Beach	Huntington State Beach
Mean fitted value when variable = 0 (no closures)	3176	2272
Mean fitted value when variable = 1 (all closures)	2398	1584
Marginal effect in absolute terms	-778	-688
Marginal effect in percentage terms (as % of mean value when there are no closures)	-24%	-30%

*As calculated by sample enumeration.

The marginal effects of intertemporal substitution due to rain, which exhibited statistical significance at a 1% level across the board, are even larger than those predicted for weekend closures. Table 13 details these predicted marginal effects.

Table 13. Marginal Effects of Variables Testing Intertemporal Substitution Due to Rain*

	Bolsa Chica	Huntington City	Huntington State	Newport	Laguna
Mean fitted value when variable = 0 (no intertemporal substitution)	1680	5656	2180	9411	2965
Mean fitted value when variable = 1 (with intertemporal substitution)	2457	8118	3154	9973	4439
Marginal effect in absolute terms	777	2462	974	562	1474
Marginal effect in percentage terms (as % of mean value with no sub.)	46%	43%	45%	6.0%	50%

*As calculated by sample enumeration.

In addition to the aforementioned variables, two other variables of particular interest are statistically significant. These are the intersite substitution variable and the intertemporal substitution due to closure variable for Laguna Beach. Since the intertemporal substitution variable increases linearly, that is to say it is not a discrete variable, we can interpret its marginal effect directly from the variable's coefficient. This coefficient says that for the week after a closure has ended each day's attendance increases by 5.2% over the previous day's attendance. Table 14 calculates the predicted marginal effect of a closure at Newport Beach on attendance at Laguna Beach, i.e. the marginal effect on Laguna's attendance due to intersite substitution.

Table 14. Marginal Effect of Intersite Substitution Variable for Laguna*

Mean fitted value when variable = 0 (no intersite substitution)	3085
Mean fitted value when variable = 1 (with intersite substitution due to Newport closure)	5560
Marginal effect in absolute terms	2475
Marginal effect in percentage terms (as % of mean value when there is no intersite substitution)	80%

*As calculated by sample enumeration.

7. CONCLUSION

There is only weak evidence that beach closures depress attendance and that intertemporal and intersite substitution occur in response to beach closures. In most cases, we fail to reject the null hypotheses that the variables developed for this analysis (beach closure, intersite substitution, and intertemporal substitution) have no effect on beach attendance. The lack of stronger evidence of casual effects likely reflects at least in part the fact that (1) the attendance data that form the foundation for analysis only exist for the time period December to March and (2) people can still visit the beach when it is "closed" since the closures considered here pertain only to water contact. Such closures will likely have a greater effect during summer when air and water temperatures are higher and more people want to engage in water-based recreation. This might be called the, "not many people swim in winter," explanation.

Even if we had aggregate beach attendance data for the whole year, we should recognize the limitations of this approach. Much more can be learned about demand for beach recreation with information on the price people face and other individual data. Further, even with individual data collected for a travel cost type valuation approach, there are limits to what such revealed preference data can tell us about the characteristics of demand. Where natural variation is lacking, contingent valuation methods, which use direct questioning to elicit willingness to pay, can contribute to a more fully characterized demand curve. In the Southern California Beach Project, we have beach use data on a bi-monthly basis over a year for a sample of 500-600 Los Angeles metropolitan area residents. We have collected contingent behavior data in which we ask what the respondent would do if a beach they would otherwise go to was closed. We also asked about willingness to pay for improvements in water quality. Besides these contingent behavior questions, other questions covered (1) expenditures on beach trips, (2) perceptions of sand, water, and parking quality, and (3) health following beach trips. With such a range of data, a better representation of the demand function can be achieved.

A final word on behalf of the aggregate beach attendance modeling approach. The reason a benefits transfer approach relying on modeling with aggregate data was chosen to support the State's case in the American Trader trial will likely be true in other situations. Aggregate data can be collected at lower cost and more quickly, at least in a place like southern California where such records are kept. We hope that the results of the Southern California Beach Project are well received enough that our finding on the value of a beach trip will assist in the welfare calculation step of benefits transfer valuation methodology applications. As for the task of modeling attendance with aggregate data, the work presented in this paper suggests that the variables included in Ruud's original model capture most of the key causal factors, which include weather, day of week, time of year, and holidays. The intertemporal substitution due to rain variable added in this paper does exhibit important explanatory power. Despite the lack of such a finding here, future work may yet show that beach closures and related substitution effects can contribute to more accurate forecasting of beach attendance.

ACKNOWLEDGEMENTS

We are thankful for comments provided by George Akerlof, Kathy Baylis, Jeffrey Lafrance, Elisabeth Sadoulet, Guanming Shi, and participants in the econometrics seminar in the Department of Agricultural and Resource Economics at the University of California at Berkeley. Despite this wise counsel, errors certainly remain, and the authors are responsible for these.

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APPENDIX 1. COMPLETE REGRESSION RESULTS

SEEMINGLY UNRELATED REGRESSION

LAGUNA BEACH EQUATION

Parameter	Estimate	Standard Error	t-statistic	P-value
Ones	3.40069	2.41540	1.40792	[.159]
Day	.013827	.032869	.420674	[.674]
Sinday	-.283631	.765357	-.370586	[.711]
Cosday	-.046468	1.96741	-.023619	[.981]
Fri	.682832	.145569	4.69079	[.000]
Sat	2.99783	.504911	5.93733	[.000]
Sun	.771027	.170045	4.53425	[.000]
Tmpx_la	.028225	.602517E-02	4.68448	[.000]
Tpmn_la	-.050735	.983453E-02	-5.15885	[.000]
Rain_bch	-2.58926	1.48375	-1.74507	[.081]
Rain_lag	1.07968	.245632	4.39551	[.000]
Xmas	-.108204	.329326	-.328562	[.742]
Estr	.901122	.161042	5.59559	[.000]
Holiday	-.994687	.228657	-4.35014	[.000]
S1	-1.28411	.198661	-6.46382	[.000]
S2	-.287835	.216873	-1.32720	[.184]
S3	-.065051	.205220	-.316980	[.751]
S4	-.313394	.183285	-1.70987	[.087]
S5	-.731377	.336218	-2.17530	[.030]
S6	.338037	.191868	1.76182	[.078]
S7	-.115320	.177548	-.649515	[.516]
Lag_sat	-.242221	.057569	-4.20752	[.000]
Lag_mon	-.017850	.019450	-.917697	[.359]
Llagun_1	.452554	.054253	8.34156	[.000]
Llagun_2	-.079767	.049547	-1.60991	[.107]
Lhunst_1	-.330561	.051976	-6.35989	[.000]
Lhunst_2	-.098075	.073204	-1.33975	[.180]
Lbolsa_1	-.136357	.066478	-2.05117	[.040]
Lbolsa_2	.089570	.060350	1.48418	[.138]
Lnewpo_1	.673492	.072523	9.28657	[.000]
Lnewpo_2	-.298879	.066399	-4.50126	[.000]
Lcryst_1	-.067879	.063033	-1.07688	[.282]
Lcryst_2	.148389	.051686	2.87095	[.004]
L_it	.852394	.133298	6.39467	[.000]
L_w	-.506797	.211142	-2.40027	[.016]
L_d	-1.23847	1.41812	-.873316	[.382]
L_pl	.052038	.021305	2.44250	[.015]
L_is_w	.123042	.303320	.405651	[.685]
L_is_d	.819237	.345111	2.37384	[.018]

Number of observations = 451
Dependent variable: LAGUN
Mean of dep. var. = 3147.65
Std. dev. of dep. var. = 5128.03
Sum of squared residuals = .352257E+10
Variance of residuals = .781058E+07
Std. error of regression = 2794.74
R-squared = .707662

NEWPORT BEACH EQUATION

Parameter	Estimate	Standard Error	t-statistic	P-value
Ones	3.61106	1.88302	1.91769	[.055]
Day	-.026241	.025176	-1.04228	[.297]
Sinday	1.18603	.627089	1.89132	[.059]
Cosday	-1.93744	1.53486	-1.26229	[.207]
Fri	.312384	.097396	3.20736	[.001]
Sat	1.51591	.164066	9.23964	[.000]
Sun	.596255	.125002	4.76995	[.000]
Tmpx_la	.022993	.473036E-02	4.86062	[.000]
Tmpn_la	-.325266E-02	.837037E-02	-.388592	[.698]
Rain_bch	-.536694	.536997	-.999435	[.318]
Rain_lag	.616227	.271734	2.26776	[.023]
Xmas	.225238	.273339	.824023	[.410]
Estr	.733063	.104271	7.03039	[.000]
Holiday	.226942	.176431	1.28629	[.198]
S1	-.593220	.201930	-2.93776	[.003]
S2	.725392	.202442	3.58321	[.000]
S3	.670558	.187603	3.57434	[.000]
S4	.763207	.177958	4.28870	[.000]
S5	.639431	.315558	2.02635	[.043]
S6	.160679	.193140	.831930	[.405]
S7	-.856112	.278755	-3.07120	[.002]
Lag_sat	-.106866	.014874	-7.18475	[.000]
Lag_mon	-.680335E-02	.972933E-02	-.699262	[.484]
Lnewpo_1	1.02787	.055230	18.6107	[.000]
Lnewpo_2	-.045013	.048210	-.933676	[.350]
Lhunst_1	-.196227	.041893	-4.68395	[.000]
Lhunst_2	-.140692	.055609	-2.53005	[.011]
Lbolsa_1	-.201960	.052534	-3.84440	[.000]
Lbolsa_2	-.029498	.051334	-.574626	[.566]
Lcryst_1	-.040424	.039217	-1.03077	[.303]
Lcryst_2	-.334998E-02	.038268	-.087539	[.930]
N_it	.509478	.133129	3.82695	[.000]
N_d	-.153379	.303636	-.505142	[.613]
N_d	-.455719	1.10887	-.410974	[.681]
N_pl	-.101903	.079140	-1.28763	[.198]
N_is_w	-.741338E-02	.142685	-.051956	[.959]
N_is_d	-.651138	.434939	-1.49708	[.134]

Number of observations = 451
Dependent variable: NEWPO
Mean of dep. var. = 10846.3
Std. dev. of dep. var. = 17820.7
Sum of squared residuals = .359975E+11
Variance of residuals = .798170E+08
Std. error of regression = 8934.04
R-squared = .756300

HUNTINGTON STATE BEACH EQUATION

Parameter	Estimate	Standard Error	t-statistic	P-value
Ones	2.72560	1.27601	2.13603	[.033]
Day	-.370681E-02	.017148	-.216167	[.829]
Sinday	.388858	.472058	.823751	[.410]
Cosday	-.696335	1.03166	-.674964	[.500]
Fri	.152062	.084684	1.79564	[.073]
Sat	1.24715	.128215	9.72701	[.000]
Sun	.780130	.083447	9.34881	[.000]
Tmpx_la	.039433	.383983E-02	10.2696	[.000]
Tmpn_la	-.032753	.605528E-02	-5.40905	[.000]
Rain_bch	-.402500	.308942	-1.30284	[.193]
Rain_lag	.212316	.204596	1.03774	[.299]
Xmas	.303499	.171918	1.76537	[.078]
Estr	1.25077	.093680	13.3514	[.000]
Holiday	.187313	.141461	1.32413	[.185]
S1	-.088605	.265137	-.334184	[.738]
S2	1.58010	.274800	5.74999	[.000]
S3	1.57329	.271410	5.79672	[.000]
S4	1.49294	.266055	5.61139	[.000]
S5	1.58897	.303964	5.22752	[.000]
S6	1.34473	.271336	4.95597	[.000]
S7	.504951	.274814	1.83743	[.066]
Lhunst_1	-.077679	.014428	-5.38389	[.000]
Lhunst_2	-.012020	.913884E-02	-1.31530	[.188]
Lhunct_1	.073484	.043786	1.67826	[.093]
Lhunct_2	-.241699	.039927	-6.05354	[.000]
Lbolsa_1	-.219748	.083148	-2.64286	[.008]
Lbolsa_2	.202320	.079644	2.54031	[.011]
Lnewpo_1	-.182516	.042662	-4.27814	[.000]
Lnewpo_2	-.073130	.041427	-1.76526	[.078]
Lcryst_1	.515085	.042146	12.2215	[.000]
Lcryst_2	.038155	.038013	1.00375	[.315]
Hs_it	.553717	.103343	5.35804	[.000]
H_w	-.981781	.296869	-3.30712	[.001]
H_d	.064259	.323812	.198446	[.843]
H_pl	.012863	.049244	.261204	[.794]
H_is_w	-.357857	.325503	-1.09940	[.272]
H_is_d	-.115133	.367683	-.313131	[.754]

Number of observations = 451
Dependent variable: HUNST
Mean of dep. var. = 2524.76
Std. dev. of dep. var. = 3641.88
Sum of squared residuals = .947231E+09
Variance of residuals = .210029E+07
Std. error of regression = 1449.24
R-squared = .847074

HUNTINGTON CITY BEACH EQUATION

Parameter	Estimate	Standard Error	t-statistic	P-value
Ones	9.20491	1.68298	5.46943	[.000]
Day	-.056726	.023140	-2.45146	[.014]
Sinday	1.09672	.572433	1.91590	[.055]
Cosday	-4.69018	1.41020	-3.32590	[.001]
Fri	.363023	.085031	4.26931	[.000]
Sat	1.29821	.122817	10.5703	[.000]
Sun	.349588	.104632	3.34112	[.001]
Tmpx_la	.753577E-02	.435658E-02	1.72975	[.084]
Tmpn_la	-.022135	.646045E-02	-3.42631	[.001]
Rain_bch	-.638665	.318255	-2.00677	[.045]
Rain_lag	.465298	.203855	2.28249	[.022]
Xmas	-.374851	.329893	-1.13628	[.256]
Estr	.966979	.090643	10.6680	[.000]
Holiday	-.657037	.189714	-3.46331	[.001]
S1	-.598986	.207410	-2.88793	[.004]
S2	.660399	.218738	3.01913	[.003]
S3	1.09593	.201501	5.43884	[.000]
S4	.811516	.194273	4.17719	[.000]
S5	.758394	.327490	2.31578	[.021]
S6	.872600	.194579	4.48455	[.000]
S7	-.367205	.201527	-1.82211	[.068]
Lhunct_1	-.076204	.011486	-6.63436	[.000]
Lhunct_2	-.578640E-02	.871890E-02	-.663663	[.507]
Lhunst_1	.130176	.073966	1.75995	[.078]
Lhunst_2	-.264643	.082539	-3.20626	[.001]
Lbolsa_1	-.276851	.041017	-6.74974	[.000]
Lbolsa_2	-.035837	.055707	-.643301	[.520]
Lnewpo_	-.180880	.048895	-3.69934	[.000]
Lnewpo_2	-.044852	.049519	-.905762	[.365]
Hc_it	.520009	.119730	4.34319	[.000]
Hc_is_w	-.454652	.453802	-1.00187	[.316]
Hc_is_d	.230508	.647761	.355854	[.722]

Number of observations = 451
Dependent variable: HUNCT
Mean of dep. var. = 6631.56
Std. dev. of dep. var. = 9762.83
Sum of squared residuals = .934786E+10
Variance of residuals = .207270E+08
Std. error of regression = 4552.69
R-squared = .806831

BOLSA CHICA STATE BEACH EQUATION

Parameter	Estimate	Standard Error	t-statistic	P-value
Ones	-.391375	1.38154	-.283290	[.777]
Day	-.270174E-02	.018128	-.149036	[.882]
Sinday	-.161357	.553751	-.291390	[.771]
Cosday	-.127981	1.08172	-.118313	[.906]
Fri	.402755	.107085	3.76107	[.000]
Sat	1.07652	.131399	8.19279	[.000]
Sun	.584435	.107551	5.43400	[.000]
Tmpx	.042412	.429111E-02	9.88360	[.000]
Tmpn_la	-.014479	.722272E-02	-2.00470	[.045]
Rain_bch	-.420122	.336920	-1.24695	[.212]
Rain_lag	-.038024	.290843	-.130737	[.896]
Xmas	.303291	.145491	2.08461	[.037]
Estr	.782136	.097592	8.01434	[.000]
Holiday	.278726	.191368	1.45649	[.145]
S1	1.08966	.308484	3.53231	[.000]
S2	1.67692	.320254	5.23622	[.000]
S3	1.50380	.305960	4.91503	[.000]
S4	1.51677	.303003	5.00579	[.000]
S5	1.42324	.321469	4.42730	[.000]
S6	1.63561	.309086	5.29175	[.000]
Lag_sat	-.017253	.014471	-1.19225	[.233]
Lag_sun	-.038697	.013600	-2.84536	[.004]
Lbolsa_1	-.030818	.047873	-.643745	[.520]
Lbolsa_2	.070368	.045182	1.55745	[.119]
Lhunst_1	-.175202	.039913	-4.38965	[.000]
Lhunst_2	-.084693	.046536	-1.81997	[.069]
Lhunct_1	.188154	.102011	1.84445	[.065]
Lhunct_2	.060754	.095684	.634944	[.525]
Lnewpo_1	.447689	.047709	9.38374	[.000]
Lnewpo_2	-.086141	.047555	-1.81140	[.070]
BC_it	.574259	.104623	5.48884	[.000]
B_is_w	-.512146	.360379	-1.42113	[.155]
B_is_d	-.231288	.630342	-.366925	[.714]

Number of observations = 451
Dependent variable: BOLSA
Mean of dep. var. = 1982.00
Std. dev. of dep. var. = 2858.54
Sum of squared residuals = .743813E+09
Variance of residuals = .164925E+07
Std. error of regression = 1284.23
R-squared = .805568
****

APPENDIX 2. RESULTS FOR SOME ALTERNATIVE VARIABLE DEFINITIONS

RESULTS FOR FRACTION CLOSED WEEKEND/WEEKDAY

	Estimate	Standard Error	t-statistic	P-value
LAGUNA FRACTION CLOSED WEEKEND	-1.87860	3.29839	-.569550	[.569]
LAGUNA FRACTION CLOSED WEEKDAY	-17.2964	25.9878	-.665556	[.506]
NEWPORT FRACTION CLOSED WEEKEND	-.048320	.864408	-.055900	[.955]
NEWPORT FRACTION CLOSED WEEKDAY	-2.59694	5.58713	-.464807	[.642]
HUNTINGTON STATE FRACTION CLOSED WEEKEND	-.929354	.345289	-2.69152	[.007]
HUNTINGTON STATE FRACTION CLOSED WEEKDAY	-.498318	.864612	-.576349	[.564]

RESULTS WITH INTERACTIONS BETWEEN CLOSURES AND MAXIMUM TEMPERATURE

	Estimate	Standard Error	t-statistic	P-value
LAGUNA CLOSURE WEEKEND/WEEKDAY				
WEEKEND	.063013	.022047	2.85820	[.004]
WEEKDAY	.249858	.299165	.835184	[.404]
LAGUNA CLOSURE (WEEKEND /WEEKDAY) INTERACTION WITH MAX TEMP				
WEEKEND	.046547	.035748	1.30209	[.193]
WEEKDAY	-.027469	.149488	-.183751	[.854]
HUNTINGTON STATE CLOSURE WEEKEND/WEEKDAY				
WEEKEND	7.11881	5.71000	1.24673	[.212]
WEEKDAY	-.914231	18.8458	-.048511	[.961]
HUN. STATE CLOSURE (WEEKEND/WEEKDAY) INTERACTION WITH MAX TEMP				
WEEKEND	-.093570	.075732	-1.23554	[.217]
WEEKDAY	.233037E-02	.238758	.976040E-02	[.992]
NEWPORT CLOSURE WEEKEND/WEEKDAY				
WEEKEND	.715468	4.94234	.144763	[.885]
WEEKDAY	-9.71594	6.86550	-1.41518	[.157]
NEWPORT CLOSURE(WEEKEND/WEEKDAY) INTERACTION WITH MAX TEMP				
WEEKEND	-.022753	.065901	-.345261	[.730]
WEEKDAY	.121957	.082151	1.48455	[.138]

APPENDIX 3. DETAILED BEACH CLOSURE DATA

Beach attendance data runs from 1985-1993 and covers six beaches: Newport, Laguna, Huntington State, Huntington City, Crystal Cove and Bolsa Chica. Since the attendance data run from January to March and then December for each year, closures outside of these months have not been listed below.

1993: There were no closures on the six beaches over the 12/1/92-3/31/93 time period.

1992 (to 3/31)

Beach	Date of Closure	Extent (ft.)	Description
Laguna Beach	1/1-1/13	400	400 ft. at Vacation Village
Laguna Beach	1/8-1/13	1000	1000 ft. at Aliso Creek
Newport Beach	2/12-2/21	2640 (1/2 mile)	1/2 mile north of Santa Ana River
Huntington State Beach	2/12-2/21	2640 (1/2 mile)	1/2 mile south of Santa Ana River
Laguna Beach	2/26-3/31	3000	Treasure Island Trailer Park to Camel Point
Laguna Beach	12/7-12/11	1000	Picnic Beach/Heisler Park area
Laguna Beach	12/7-12/11	200	Cleo St. Beach (100' N & S of drain/ocean interface)
Laguna Beach	12/7-12/14	1000	1000 ft. at Aliso Creek
Laguna Beach	12/14-12/17	1000	Vacation Village south to St. Ann's Dr.

1991 (to 3/31)

Beach	Date of Closure	Extent (ft.)	Description
Laguna Beach	3/19-3/28	1000	1000 ft. at Ruby St.
Laguna Beach	12/31	400	400 ft. at Vacation Village

1990 (to 3/31)

Beach	Date of Closure	Exent (ft.)	Description
Huntington State Beach	1/17-1/26	12,000 (2.2 miles)	Beach Boulevard to Newport Pier (from 1/24-1/26, closure was only for 200ft W of Santa Ana River)
Newport Beach	1/17-1/26	14,000 (2.6 miles)	Santa Ana River to Newport Pier (from 1/24-1/26, closure was only for 200ft E of Santa Ana River)
Laguna Beach	12/12-12/17	1000	Treasure Island, south to Camel Point, Aliso Beach

1989 (to 3/31)

Beach	Date of Closure	Exent (ft.)	Description
Laguna Beach	1/20-1/30	2000 (200)	2000 ft. at Aliso Creek (1/25-1/30, reduced to 200 ft.)
Laguna Beach	1/31-2/8	4000	4000 ft. Laguna Main Beach (Myrtle to Cleo)
Laguna Beach	3/3-3/8	200	200 ft. at Crescent Bay
Laguna Beach	3/28-4/21	2000 (1250)	2000 ft. at Aliso Creek (3/30, reduced to 250' N of creek, for 1250' total. Other reductions after 4/1 beyond attendance data interval.)

1988 (to 3/31)

Beach	Date of Closure	Extent (ft.)	Description
Laguna Beach	3/1-3/7	2000	2000 ft. at Aliso Creek
Laguna Beach	3/10-3/14	2000	1000' N & S of creek at Emerald Bay

1987 (to 3/31)

Beach	Date of Closure	Extent (ft.)	Description
Laguna Beach	3/26-3/30	600	600 ft. at Aliso Creek

1986 (to 4/30)

Beach	Date of Closure	Extent (ft.)	Description
Laguna Beach	3/21-3/31	100	Aliso Creek – surf zone interface

1985 (to 4/30)

Beach	Date of Closure	Extent (ft.)	Description
Newport Beach	12/6-12/11	1000	1000 ft. south of Santa Ana River