National Library
of Canada

Acquisitions and
Bibliographic Services Branch

395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale
du Canada

Direction des acquisitions et
des services bibliographiques

395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Reproduction in full or in part of this microform is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30, and subsequent amendments.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

La reproduction, même partielle, de cette microforme est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30, et ses amendements subséquents.

Canada

A STATISTICAL ANALYSIS OF THE FACTORS INFLUENCING THE LEVEL OF SERVICE OF AIRPORT TERMINAL CURBSIDES

Mohammad Rashid Siddiqui

A Thesis

in

The Department

of

Civil Engineering

Presented in Partial Fulfillment of the Requirements

for the Degree of Master of Applied Science at

Concordia University

Montréal, Québec Canada

June, 1994

National Library
of Canada

Acquisitions and
Bibliographic Services Branch

395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale
du Canada

Direction des acquisitions et
des services bibliographiques

395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

THE AUTHOR HAS GRANTED AN IRREVOCABLE NON-EXCLUSIVE LICENCE ALLOWING THE NATIONAL LIBRARY OF CANADA TO REPRODUCE, LOAN, DISTRIBUTE OR SELL COPIES OF HIS/HER THESIS BY ANY MEANS AND IN ANY FORM OR FORMAT, MAKING THIS THESIS AVAILABLE TO INTERESTED PERSONS.

L'AUTEUR A ACCORDE UNE LICENCE IRREVOCABLE ET NON EXCLUSIVE PERMETTANT A LA BIBLIOTHEQUE NATIONALE DU CANADA DE REPRODUIRE, PRETER, DISTRIBUER OU VENDRE DES COPIES DE SA THESE DE QUELQUE MANIERE ET SOUS QUELQUE FORME QUE CE SOIT POUR METTRE DES EXEMPLAIRES DE CETTE THESE A LA DISPOSITION DES PERSONNE INTERESSEES.

THE AUTHOR RETAINS OWNERSHIP OF THE COPYRIGHT IN HIS/HER THESIS. NEITHER THE THESIS NOR SUBSTANTIAL EXTRACTS FROM IT MAY BE PRINTED OR OTHERWISE REPRODUCED WITHOUT HIS/HER PERMISSION.

L'AUTEUR CONSERVE LA PROPRIETE DU DROIT D'AUTEUR QUI PROTEGE SA THESE. NI LA THESE NI DES EXTRAITS SUBSTANTIELS DE CELLE-CI NE DOIVENT ETRE IMPRIMES OU AUTREMENT REPRODUITS SANS SON AUTORISATION.

ISBN 0-315-97646-2

Canada

DEDICATION

***I would like to dedicate this thesis to my beloved uncle,
Aftab Ahmed, who passed away recently, and to his wife
Farhat and two children Yousuf and Amenna.***

ABSTRACT

A STATISTICAL ANALYSIS OF THE FACTORS INFLUENCING THE LEVEL OF SERVICE OF AIRPORT TERMINAL CURBSIDES

Siddiqui, Mohammad Rashid

For airport planning and design, the procedures adopted have certain deficiencies. The first major deficiency is a genuine lack of understanding and an ambiguity concerning factors contributing to the formulation of user perception and acceptance level of service. The second is an absence of research on cost-effective service level, including social costs. This research for airport terminal curbside area addresses these two major deficiencies. Based on an attitudinal survey and data collected at Palm Beach International Airport, a relationship is developed between the actual service level at terminal curbside and the user perceived value of the service levels. This relationship is examined in light of the theory of utility of the curbside area. Also, based on utility theory and collected data, the cost-effectiveness of various service levels is determined graphically, provided that social cost are taken into account. This graphical method provides an excellent base for facility sizing design procedures. Charging policy, as a powerful tool in managing curb demand is described, and a system using computer based communication technologies is proposed to assist managers when applying this policy.

ACKNOWLEDGMENT

The author wishes to thank and foremost his thesis supervisor, Professor Gabriel Assaf and co-supervisor , Professor Semaan Sarraf, for their invaluable help, guidance and encouragement throughout this research. Their moral support and incredible patience are deeply appreciated.

Sincere appreciation is extended to Mr. Fred Gille, Senior Operation Manager, at Palm Beach International Airport, for his valuable cooperation, and to Elias Grivas for his help in editing the manuscript.

Appreciation is also accorded to friends and colleagues, in particular Illyas Choudry, Yousuf Ahmed, Ammena Ahmed, and Mohammad Afaque Siddiqui, for helping in conducting the surveys.

Last but not least, thanks to my elder brother Mohammad Tarique Siddiqui, acting as intermediary, Tony Rizakos for his encouragement, and very special thanks to my parents for their persuasive support throughout my studies.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Tables *Page*

CHAPTER 1

INTRODUCTION

1.1 - OVERVIEW

The overall effectiveness of every transportation facility depends on the ability of its constituent components to accommodate the demands placed upon it. In the case of an airport, both the operation and the level of service (LOS) are significantly affected by the functioning of the landside ground access system. It is recognized by planners that the terminal curbside area can be a bottleneck for the ground access system [Louviere, 1981]. Increasing traffic volumes in association with its peaking characteristics, and the complicated situation of people and vehicles merging, has resulted in extensive traffic congestion at the curbside area. This in turn, causes inconvenience, frustration, and delay for passengers at large airports. Recent research suggests that design standards developed in the past were largely arbitrary [Louviere, 1981]. Consequently, oversized or undersized facilities have been provided at a number of airports, resulting in unbalanced operations of the components of that facility. The airport community is therefore interested in a methodology that could lead to more rational standards.

The primary function of an airport terminal building is to facilitate the transfer of passengers and goods between ground and airborne transportation modes. The actual transfer between ground and air occurs at two points, the aircraft gate and the terminal curb [Mandle, 1982]. At curbside areas adjacent to the terminal, all arriving and departing air passengers board or disembark from ground transportation vehicles. Figure 1.1 illustrates the position of the terminal curb in an airport processing system.

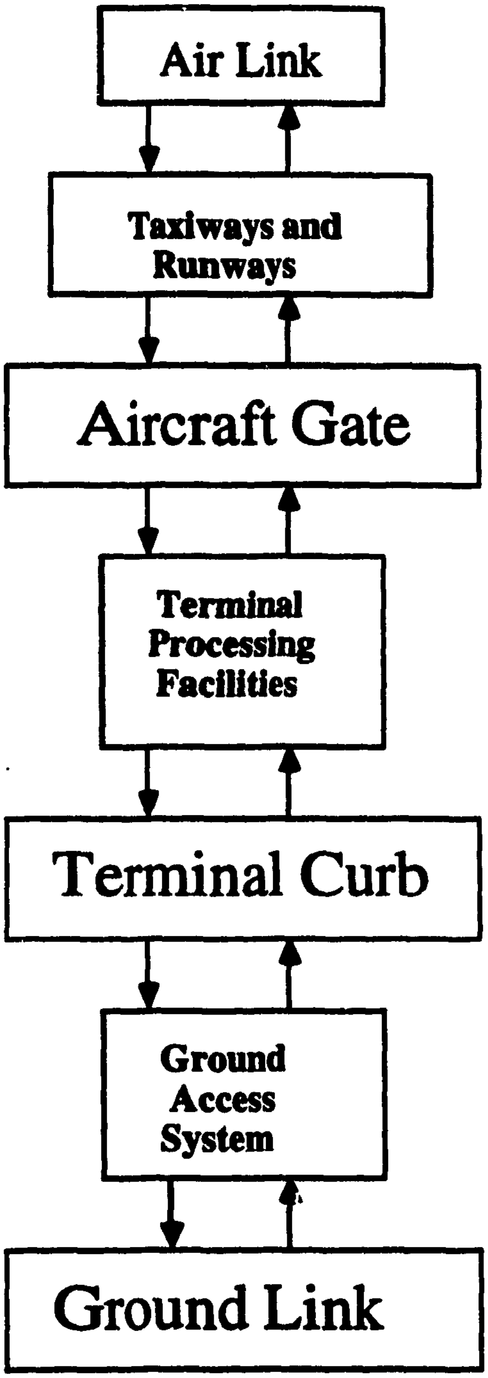


Figure 1.1 Transfer Function of Terminal Curb and Aircraft Gate Between Ground and Air Transportation Modes

A quick review of the relevant literature indicates that a large emphasis is placed on ground access planning. Since the terminal frontage road is part of the airport access system, designers should be more sensitive about this area which is recognized as a bottleneck for the whole access system. Recently, airport authorities have identified poor airport access as a potential threat to the growth of aviation [Gorstein, 1980]. It has been further observed that, as a determinant of air passenger choice of airport, ground accessibility plays a more significant role than air carrier LOS [Skinner, 1976].

1.2 - AIRPORT TERMINAL CURBSIDE AREA

The processing curb area is normally constructed linearly along the ground side of the air terminal building, and is connected by a roadway to the airport ground access road system. Terminal curbside is a temporary loading/unloading facility on the frontage road of the terminal building. This area, at most major airports, is divided into two distinct parts. The enplaning or the departure curb, which facilitates the arrival of users from the community while the deplaning or arrival curb serves those going into the community, after arriving on an incoming flight. Different designs of the terminal curbside can be observed at different airports as the departure and arrival curbs may be physically separated or may be designed in two levels [Turnbell, 1973].

1.3 - FUNCTIONS OF A CURBSIDE

The main function of a curbside is to transfer passengers from the ground transportation system to the terminal building. If this area does not operate properly then the entire ground/air linkage will be unbalanced.

Different activities take place in the processing curb area. The most important ones include:

- loading/unloading of vehicle passengers;
- loading/unloading of baggage to/from vehicles; and
- movement of pedestrians between the terminal building and the surface or the structured parking facilities.

Major activities at enplaning or deplaning curbside areas include loading/unloading of passengers and their luggages. For example, at a departure curbside this activity can be described as follows:

- A vehicle arrives at the airport roadway and joins the queue of vehicles. The driver searches for an appropriate unloading position near the curbside. In the process of finding this position, the user spends a short period of time and possibly experiences a delay which corresponds to the existing LOS. This period of time and the associated probable delay is the major indicator of user satisfaction. Perception of the level of service is a result of the comparison between actual user satisfaction and his/her acceptance level.
- The passenger finds a spot, parks his car and unloads the luggages under prevailing restrictions.
- The passenger crosses the distance between the unloading position and the terminal door. Because of the short distance, the user does not experience any long delay.
- The vehicle leaves the curbside as soon as traffic conditions permit.

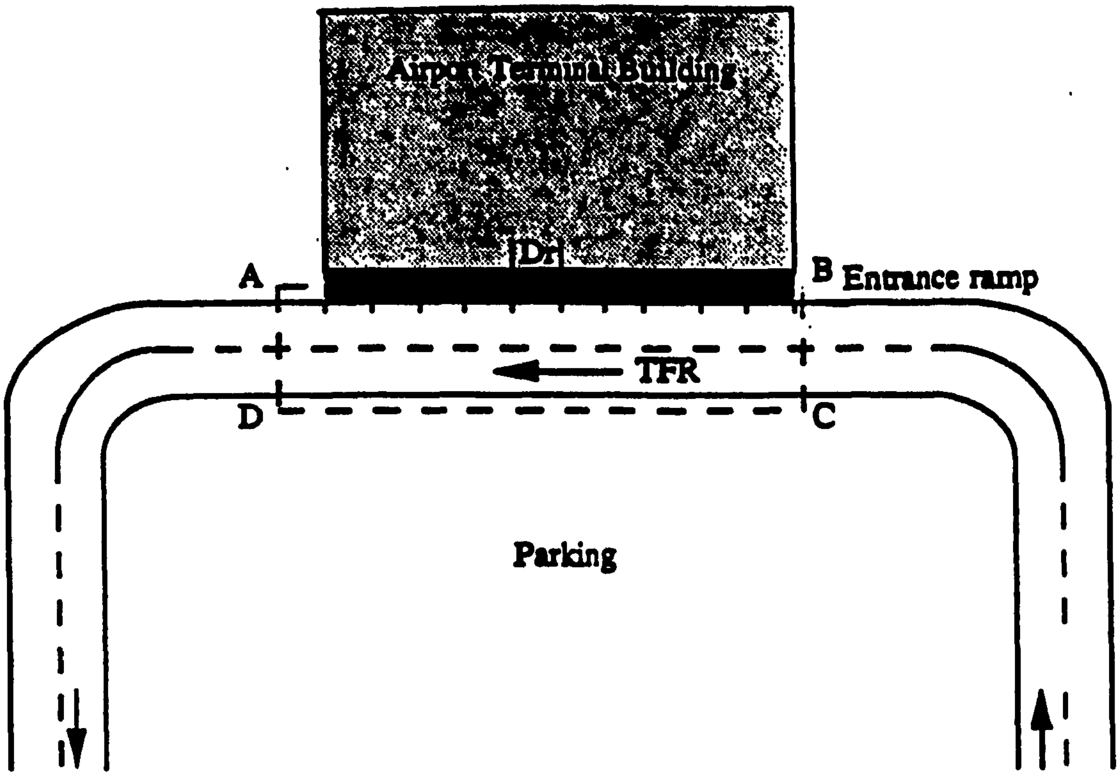
The process in the deplaning curb is almost the same. A user searches for an appropriate loading position, during a variable period of time, and parks his/her vehicle and walks the distance between the loading position and the terminal door. Again, a LOS will be perceived on the scale measuring user perception in reference to user acceeptable level.

1.4 - PROBLEM DEFINITION

The processing curbside area at a terminal building is defined as the set of frontage roads adjacent to the terminal building, located immediately after the sidewalk used for loading/unloading purposes. Figure 1.2 describes the system under consideration. For many years, approaches to LOS and capacity problems have dealt with vehicles rather than people. Similarly, the current approaches to curbside problems cover vehicle characteristics. Todays' management requires however the understanding and integration of passenger behavior and characteristics in curbside design. In fact, a curbside area is designed to ease the movement of passengers not vehicles. It is therefore necessary to establish LOS criteria and standards that integrate user/walker satisfaction.

It was also found that almost all standards set for different service levels for airport terminal curbsides are the result of professional judgment and are based on vehicle flow characteristics. A review of the literature also shows that most researchers and professionals have concentrated on how much space or linear meter of curb is available rather than how it is used. In short, the following major deficiencies exist in the approaches to the problem of terminal curbside capacity and service level:

- procedures for curbside design are proposed for vehicles and not people,
- perceptions of travelers are not included in LOS criteria and standards, although they are the real users,



ABCD = System (Curbside Area)
TFR = Terminal Frontage Road

Figure 1.2 Terminal Curbside System

- only time is included in LOS definition, while another major factor, distance, is ignored, and
- no specific service level is universally accepted as basic, to facility sizing, in planning and design procedures.

The question which is raised here is whether the curbside area is designed to facilitate movement of vehicles or passengers. If it is for people, then the LOS for this area should be defined in conjunction with user perception. Also, capacity analysis, planning, and design should be based on user perceived value.

1.4.1 - Scope of the Research

Before stating the objectives of this research, it should be mentioned that the approach to be developed should provide aids for managerial decision-making on supply side. There are two reasons for this orientation:

- seeking any increase in capacity or improving the LOS through facility expansion might be difficult due to space limitations, and
- user concerns should be taken into account, with emphasis on passenger needs.

It is also necessary to make the distinction between drivers and passengers, since their perceptions differ. A driver's perception is influenced by traffic flow, while a passenger's perception, in addition to traffic flow, results from the distance to walk and the environment. Furthermore, the real users of the curbside area are passengers. It is the passengers who are under pressure, and time seems more critical for them than it is for the driver. Often, it is only the passenger who covers the distance between unloading/loading positions and the terminal door, therefore the pivotal point of this study is the passenger and not the vehicle nor the driver.

In terms of location, this study intends to focus on both the enplaning and deplaning curbsides, defined in previous sections. It establishes a measure of the performance level of the terminal curbside area for any time of day from the users point of view.

1.4.2 - Objectives

The intent of seeking improvements in the planning and decision making process is to minimize cost and delay, and to maximize safety, comfort, and convenience for the users. The specific objectives of the present research are:

- to identify factors that should be considered in defining LOS criteria,
- to study the relationship of passengers' perceptions and the conditions in the terminal curbside area,
- to establish the cost effectiveness of various service levels, and
- to investigate the concept of and methods for charging users for the use of curb space.

Presently, two factors are believed to be important for defining LOS: the time required to locate an unloading/loading position and the walking distance from the curb to the terminal door.

1.4.3 - Constraints

- Since the system is designed for people and operational aspects on peoples behavior, the approach to the problem should be based on the perceptions and desires of these people.
- Time and distance in the curbside area is best perceived by passengers. As mentioned earlier, since the passenger is under pressure to meet the requirements of the air transportation system, the research approach should give priority to passenger perception.
- Different groups of people use airports for different purposes. Given that these groups have different perceptions of time and distance, any approach to LOS measurement or guidelines to establish LOS standards should consider the perceptions of different categories of users.

1.5 - JUSTIFICATION OF THE RESEARCH

Continued escalation of air passenger volume has created a burden on the existing curb frontage facilities at many terminals throughout the world; at the same time, anticipated growth of air travel in Canada and the United States is creating extra need for such facilities. Also, it is evident that limited funds do not permit large investments in the transportation infrastructure as has been the case in the past decades. Therefore, there is a high priority for research of those factors that can increase the efficiency and effectiveness of available or future facilities.

Basic to any decision making in this case is the LOS concept. The purpose of curbside LOS measurement is to enable a definition of capacity by relating it to the users' perception of quality. In view of the lack of research in this area, for airport terminal curbsides. This study develops an excellent base to a cost effective operations of curbsides.

The need for discussing LOS was raised in a report by Transport Canada entitled "Interim LOS Standards" [Transport Canada, 1979]. This report recognized that LOS can adequately be described by a combination of a set of factors which can be divided into three categories, as follows:

- congestion standards (time and space)
- flow standards (distance and comfort), and
- utilization standards (utilization and cost).

So far, developed standards and methodologies for curbside LOS have used only one criterion. In fact, most known studies have focused only on congestion parameters. Therefore, it is necessary to make the following improvements:

- to introduce time element as an indicator of congestion and distance, and
- to change the old definition of LOS from perception of drivers to perception of passengers.

The most powerful tool for managing demand and bringing it in balance with supply is the economic instrument or charging policy, which has been clearly ignored in the past. This policy, as a part of the approach to curbside management, should be taken into account.

1.6 - THESIS ORGANIZATION

This thesis will be organized into eight Chapters. So far, this chapter has provided a definition of the problem. Chapter 2 reviews related literature and explains the concepts related to the issue. The theory behind this research and its application along with survey design are the topics of Chapter 3. The analyses of the collected data and the development of the utility equations are shown in Chapter 4. The first major outcome of the analyses is established in Chapter 4 with regards to developing guidelines for LOS estimation in the terminal curb area as well as proposing some standards for LOS transitions. These materials are also discussed in Chapter 5. Chapter 6 illustrates the second major output of this research, which is a procedure for applying a charging policy in managing demand. Also, applications of computer based communications technologies in implementing a scheduling charging policy is shown in this chapter. The third major outcome is the graphical development of a procedure that identifies the most effective service level, which is a necessary element of facility sizing procedures. This will be described in Chapter 7. Finally, Chapter 8 summarizes the findings and provides with some recommendations.

CHAPTER - 2

CURBSIDE CAPACITY AND LEVEL OF SERVICE

2.1 - OVERVIEW

This study addresses a question which is logically the next link in the chain of research on LOS criteria standards. It is necessary however to first review previous LOS approaches. At this stage, it is also useful to go over the proposed methods for curb design to find out the extent to which LOS is included in the present design procedures.

2.2 - FUNDAMENTAL CONCEPTS

The most important concepts related to this research are capacity and LOS. Although the initial concern of this study is LOS, in view of the logical link between capacity and LOS, they are discussed together. The concept of utility is also fundamental to this work. A short introduction to this concept and an explanation of utility theory is provided in the next chapter.

2.2.1 - Capacity

In general, the term capacity refers to the maximum throughput of a facility under prevailing conditions [TRB-226, 1990]. Landside capacity is the capability of landside facilities to serve people, cargo, and vehicles. However, the capability to serve air passengers is of major interest [TRB-215, 1987].

Passengers impose a variety of demands on airport terminal facilities. These demand characteristics include time distribution of passenger arrivals and travel mode, trip purpose, parking facilities and many other factors. In response to these demands and in view of their complexity, some airport components are faced with crowding and congestion, which result in inadequate capacity.

More than two decades ago, professionals in different fields of transportation defined capacity in conjunction with LOS. In fact, estimation of capacity is not meaningful unless it is related to LOS. The recommended measure of landside is the highest service volume. Service volume refers to the number of passengers or vehicles that can be accommodated by any component, in a particular time period, relative to a particular demand, at a given service level [TRB-215, 1987].

Vehicle flow through the curbside area is limited in principle by the maximum rate at which the component can operate, i.e., loading/unloading of passengers and luggages. However, in practice, this maximum is typically sustained for brief periods of time, since such a high level of passenger demand produces significant delays, crowding, or other indications of declining service level that disrupt operations.

Actions which could be taken to obtain greater throughput and therefore increase capacity can be divided into three groups:

- change in facility size or building of new ones,
- change in the way of using existing facilities, and
- change in user behavior and social values.

The second item, which is increasingly referred to as demand management, is a more feasible solution and has the lowest negative impact on society, the economy, and the environment. This view point is a major consideration in this research.

2.2.2 - Level of Service

One of the reasons for developing the concepts of LOS is to incorporate the quality of the service factor in the design and analysis process of transportation facilities. Therefore, the LOS criterion is a necessary input in the design of every transportation facility. Once this concept is defined, it is possible to evaluate the performance of facilities under different load conditions. In fact, providing a measure of the comfort and convenience experienced by users under different operational conditions is a task of LOS. It is a subjective impression of the quality which is based upon several factors including time, distance, comfort, environment, cost, and many others. Unfortunately, researchers and designers in the air transportation field have not paid enough attention to the LOS concept, and there is no formal consideration of this concept in design procedures.

A definition of the LOS is vital for the capacity assessment process. Unfortunately, the airport planning process and investment decision making are not supported by sufficient research as is the case with ground transportation facilities. The ground transportation profession is familiar with the amount of research that resulted in the third generation of the Highway Capacity Manual. Obviously, there is a real need to define LOS criteria and standards for the design and evaluation of existing or future airport facilities. This is a concern today, in the light of the need to increase efficiency and cost-effectiveness of our infrastructures, to address new technical developments and increased knowledge of user preferences and behavior.

Clearly, given the increased complex nature of airport planning, design and investment decision making, the subjective treatment of capacity and LOS concepts is hardly surprising [TRB-215, 1987]. Therefore, it is more evident today that an improved knowledge of the interrelationship of capacity, cost, and LOS is necessary.

Some professionals believe that the LOS is developed to create necessary sensitivity in design procedures [Ashford, 1988], while others state that this concept is developed to incorporate the quality of service factors in design and analysis procedures [Hamazawi, 1989]. And these view point in accordance with this research, states that LOS is defined as a measure that describes user perceived operating conditions [Transport Canada, 1979]. Of course all these different view points have the same root and serve the same purpose.

2.2.2.1 - Level of Service Framework

To fulfill the above mentioned requirements, airport planners in Canada and the United States have adopted a LOS framework used for the design of highways; i.e., "LOS A to LOS F". The level of service framework shown in Figure 2.1 is important in this research. Other frameworks also exist, such as the three-level framework proposed by the Committee for the Airport Capacity Study, of the Transportation Research Board (TRB), which rates airport capacity on a scale of excellent, adequate, and poor [TRB-215, 1987]. Another similar "three level framework" has been proposed by Mumayiz and Ashford. They lather rates LOS on a scale of good, tolerable, and bad [Mumayiz, 1986]. However, there are a number of reasons for adopting the LOS framework "A to F". The main reason, from a planning and design perspective. is that there is a logical appeal to a reasonably wide gradation condition which can provide designers with sufficient flexibility.

LEVEL OF SERVICE

A	Excellent LOS, no delay, low density, no double parking, no queue, minimum walking distance between parking stall and terminal door,
B	High LOS, negligible double parking, no queue, very little chance of experiencing delay in finding desirable empty parking stall, acceptable walking distance between stall and terminal door,
C	Good LOS, acceptable level of density, negligible double or triple parking, little queue at entrance ramp, little chance of facing delay in finding empty parking stall, walking distance becoming unacceptable for some users,
D	Adequate LOS, high density, noticeable double parking, noticeable queue at entrance ramp, unacceptable walking distance for some of the users, moderate chance of experiencing delay, noticeable delay at entrance ramp, condition acceptable for short periods of time,
E	Unacceptable LOS, very high density, lots of triple parking, noticeable queue at entrance ramp or along the curb, unacceptable walking distance for most users, moderate chance of delay, represents limiting capacity, and
F	Unacceptable LOS, system breakdown, long queue at entrance ramp, very high chance of experiencing delay in finding empty parking stall.

Figure. 2.1 Level of Service Framework [Smith, 1980].

The experience of the highway transportation profession suggests that an inflexible framework is difficult to operate, due mainly to the absence of the continuum of varying service levels, as is the case with the framework based on the concept of "ultimate" and "practical capacities".

Here it should be noted that the problem of deficiencies regarding the LOS framework is twofold. The first is the absence of a universally accepted framework for airport subsystems. The second, which in fact is the more basic one, is the absence of understanding and well researched information on the subject.

2.2.2.2 - LEVEL OF SERVICE EVOLUTION

Throughout the years, the LOS concept in the area of highway analysis has evolved tremendously. The first major attempts were made in the context of defining capacity in three ways: basic capacity, possible capacity, and practical capacity. The earliest widespread use of LOS was initiated by the 1965 Highway Capacity Manual (HCM), where, for the first time, the six levels of the design diagram were introduced to define the basic relationship shown in Figure 2.2. In the mid 1980s, the HCM was updated to be more relevant to planning and analysis problems, but the basic LOS concept remained essentially unchanged.

Enormous improvements in highway capacity analysis and design procedures resulted from the LOS concept, which in turn led researchers to serve the needs of pedestrians. A major step in this area was taken in 1971, when Fruin attempted to apply the LOS methodology to design pedestrian spaces. Fruin stated that, in addition to traffic engineering principles, human convenience should be taken into consideration. Fruin showed that although the maximum capacity of pedestrain traffic streams can be attained

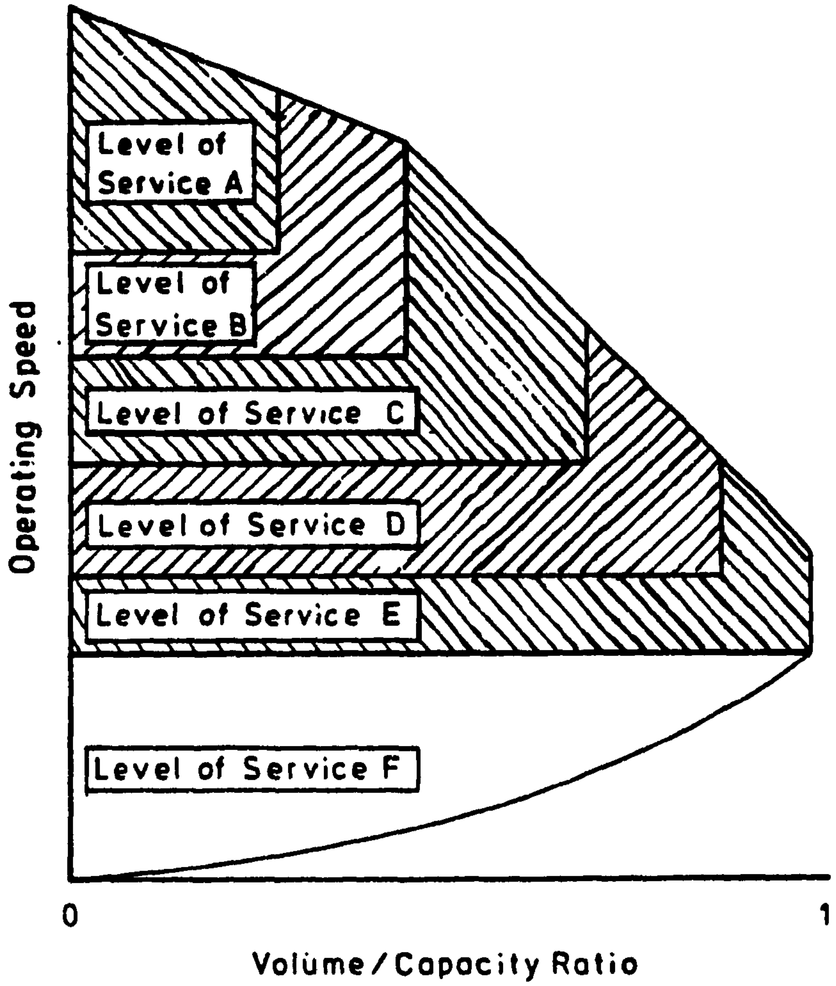


Figure 2.2 General Concept of Relationship of Level of Service to Operating Speed and Volume/Capacity Ratio.
(Ashford, 1988)

when there is a dense crowding of pedestrians, such crowding results in significant reduction in pedestrian comfort and convenience. This led Fruin to define pedestrian design standards based on a convenience-related scale. Figure 2.3 shows Fruin's final suggestion for walking design standards which are based on the relationship between pedestrian flow and the area provided per pedestrian. Also, it can be seen that the six service levels remained unchanged [Ashford, 1988].

2.3 - Airport Level of Service

The LOS concept was then extended into airport capacity analysis. Success with the use of the LOS concept for vehicle and pedestrian facilities gained considerable interest in the application of a somewhat similar methodology to airport facilities. However, the most significant research focused on the terminal building. In this area, the most comprehensive approach was suggested in 1979 by Transport Canada [Transport Canada, 1979]. This approach, which has subsequently been proposed by IATA as a method of determining passenger terminal service levels, relies on setting different levels of space provision with respect to the six levels of service "A to F". However, some researchers have pointed out that the linearity of the relationship between space provision and service level suggests that the provided value may not correspond with the LOS as perceived by users [Transport Canada, 1979]. It should be mentioned that, in spite of the considerable amount of research, there is no universal agreement on design service levels for airport terminal buildings.

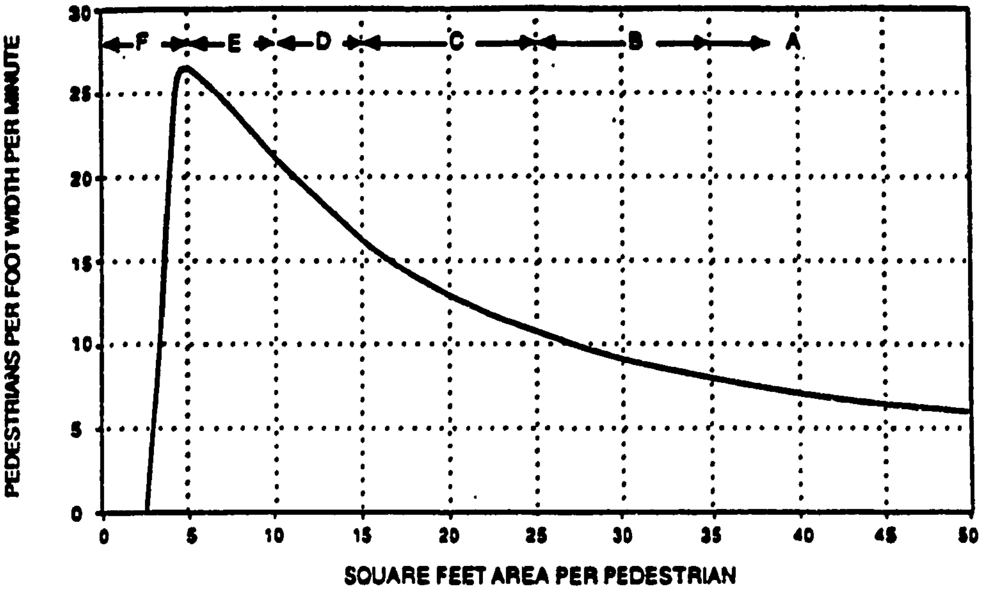


Figure 2.3 Pedestrain Flow Level Of Service [Ashford, 1988]

2.4 - Curbside Level of Service

Two major approaches in curbside measurement and design procedures have incorporated the quality of service concept.

The development of the first approach started with the attempt made by Tilles [Tilles, 1973] to introduce the LOS concept in the curbside analysis and design. In this effort, Tilles incorporated the probability of delay in the design procedure. Tilles developed a detailed queuing analysis to estimate curb space demand for a given vehicle arrival rate, estimated average dwell time, and acceptable probability of delay. This criterion of delay, in Tilles viewpoint, is based on the desired LOS. The monograph presented in Figure 2.4 is developed for use when applying this model. If it is acceptable to interpret the chance of experiencing delay as an indicator of LOS, then it can be deduced that Tilles has proposed a three range service level, as indicated on Table 2.1 below.

Table 2.1 Three Range of Service Level

Level I	Less than 10% probability of experiencing delay
Level II	Between 10% and 20% probability of experiencing delay
Level III	More the 20% probability of experiencing delay

The first attempt to define a wide range of service levels based on the framework accepted by HCM i.e., "LOS A to F", was reported by Transport Canada [Transport Canada, 1979]. In this approach, Transport Canada accepted the use of probability values to estimate the service levels. In the next section, the explanation of design procedures and methods will be discussed.

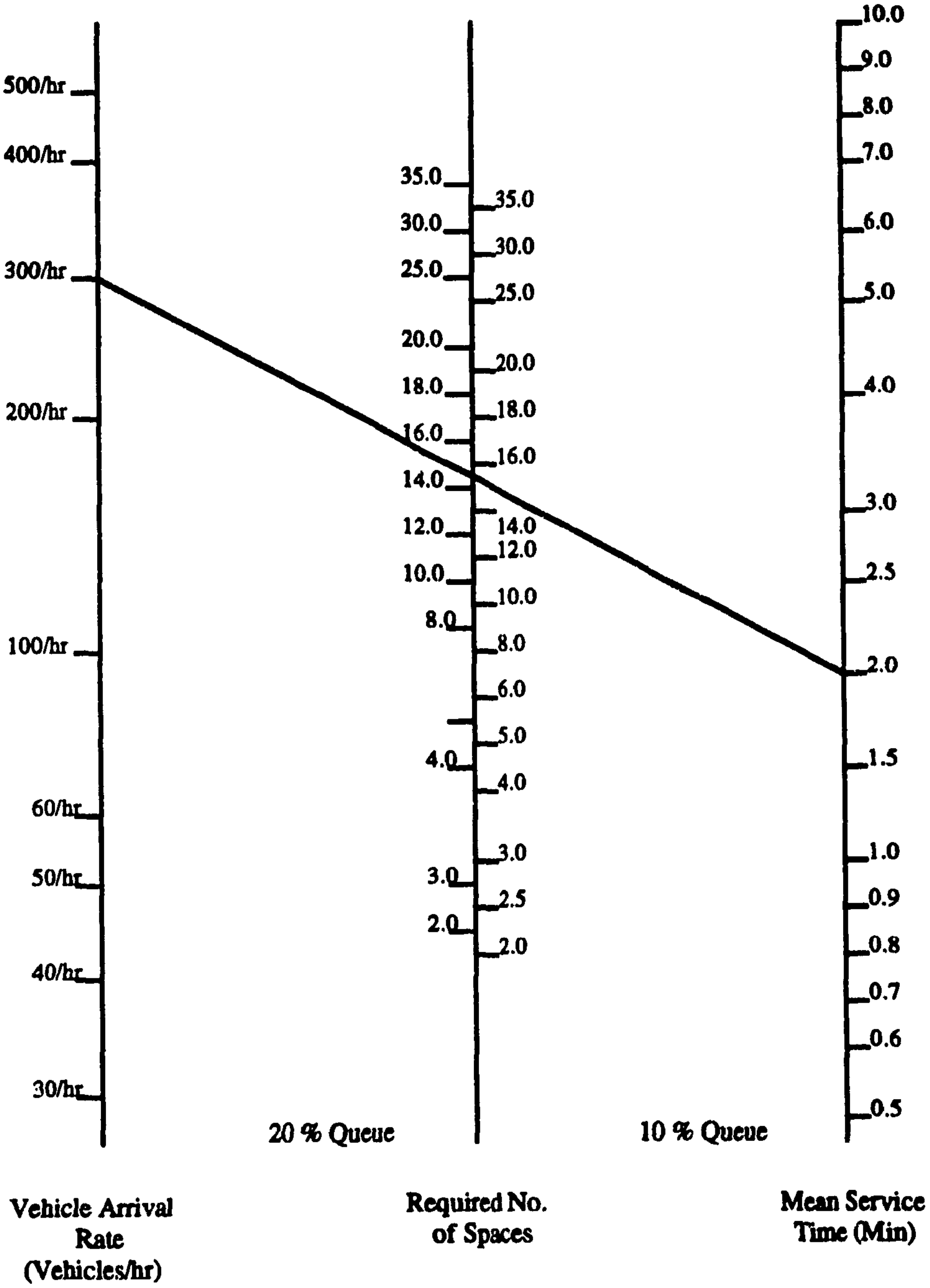


Figure 2.4 Nomograph for Space Computations [Tilles, 1973]

The second approach that has involved the LOS concept in curbside analysis and design related the LOS to some measure of congestion. Work on this method was initiated by Wilbur Smith and Associates [Smith, 1980]. In this method, based on HCM definitions, Smith and al developed a relation between LOS and percentage of double to triple parking. For this purpose, LOS was defined "as effective length of curb". This definition states that actual curb length may differ from effective curb length, due to double or triple parking or undesirable loading/unloading areas. In this viewpoint, effective length of curb is directly related to the LOS provided at the curb. The Wilbur Smith model characterizes each service level as shown in Figure 2.5. Also, corresponding to each service level, an adjustment factor is suggested which is applicable to the actual length of the curb. Wilbur Smith also provided information for relating curb length and accepted standards as used for highway LOS. Using data gathered from U.S. airports, Wilbur Smith developed a graph as indicated in Figure 2.6 for curb design. Continuation of this approach resulted in a clear definition of LOS for the curbside area based on the relationship between LOS and double to triple parking, with the consideration of the LOS definitions from HCM, which are as follows:

"LOS A"

represents vehicular operation at the curb where motorists experience free flow conditions i.e., no interference from other vehicles or pedestrians. Arriving drivers can stop immediately adjacent to the curb at a location of their choice.

"LOS B"

like LOS A, describes relatively free flow conditions; however, with LOS B, limited double parking can be observed at a primary demand location along

LEVEL OF SERVICE	CHARACTERISTIC	EFFECTIVE CURB LENGTH (m)
A	No traffic queue, negligible double parking	1.0
B	Some short traffic queues around service facilities, 30 percent or less double parking	1.1
C	Traffic queues, 70 percent of curb or less experience double parking	1.3
D	Intermittent breakdowns in operations, entire curb experience double parking	1.7
E	Breakdown in operations, long vehicle queue, 25 percent triple parking and double parking along curb face	2.0

Fig 2.5 Level of Service Adjustment Factors [TRB-215, 1987]

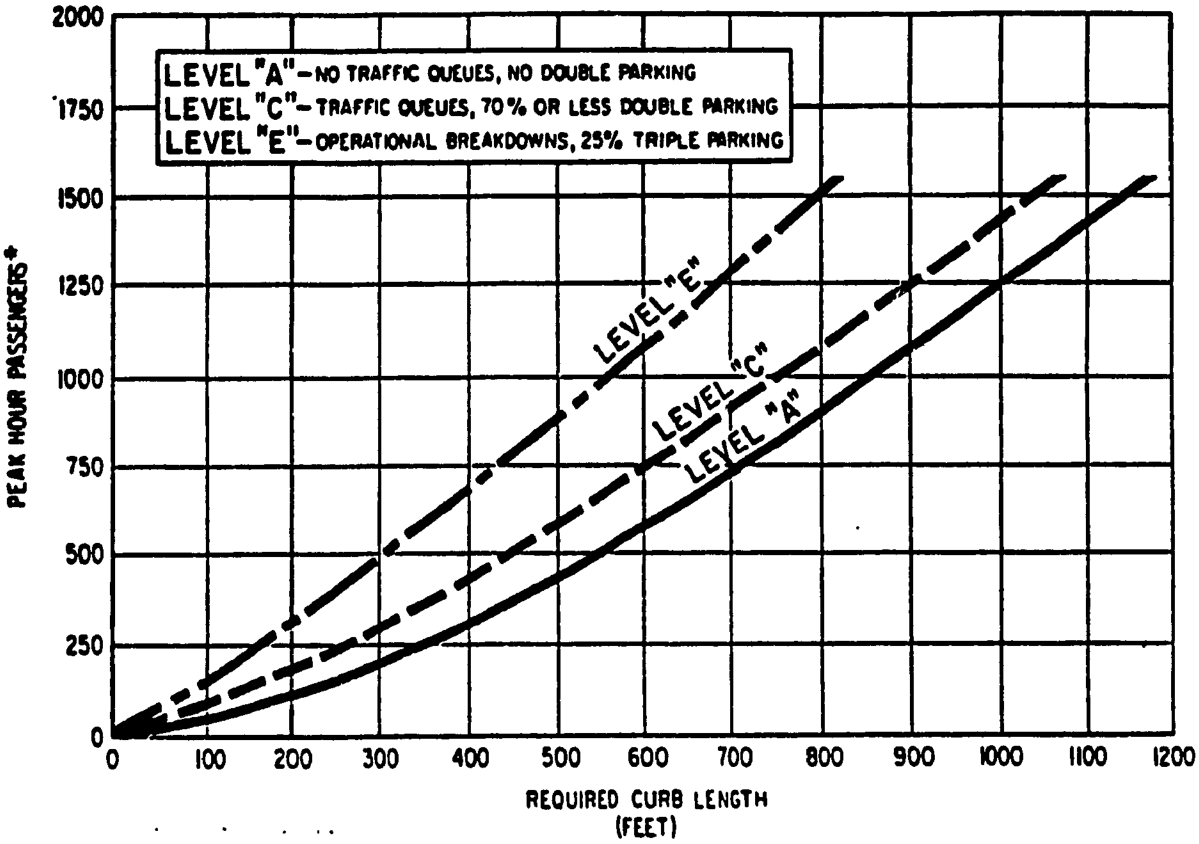


Figure 2.6 Suggested Method for Estimating Curb Space [Smith and Associates, 1980]

the curb frontage. The effective curb length is equal to 1.1 times the linear dimensions of usable curb space.

"LOS C"

is indicative of activity observed at most major airports during peak hours. It is suggested that LOS C is appropriate for peak period design conditions at major airports. LOS C represents operating conditions where double parking near doors is common, and some intermittent triple parking occurs. The effective curb length for this level is equivalent to 1.3 times the usable curb length.

"LOS D"

exhibits conditions where triple parking becomes more prominent and where vehicle maneuverability is somewhat restricted, i.e., queues of vehicles from the curb roadway to the entrance of the curb frontage road. The effective curb length of curb for LOS D is equal to 1.7 times the usable curb area.

"LOS E"

occurs at a curb when motorists experience significant delays and queues. Both congestion and multiple parking are evident throughput the entire terminal curb frontage area. Momentary breakdown in operation occurs as a flow of vehicles comes virtually to a halt. The effective length of curb under these conditions is equal to at least 2.0 times the actual linear footage of usable curb. Where usually wide curb frontage roadways exits, between 17 to 20 meter curb to curb width, this value can be increased to 2.5 [Mumayiz, 1991].

This approach defines the effective curb length for different service levels to be 1.1 to 2 times the curb length. The rationale behind these numbers is not obvious. Since the LOS is developed to reflect the perception of the travelers, defining and splitting the range of required factors to determine effective curb length i.e., 1.1, 1.3, 1.5, 1.7, and 2.0, should be based on some values that travelers put on them. Therefore, further research is needed to relate these numbers to user perception.

2.5 - REVIEW OF DESIGN PROCEDURES

The concept of LOS plays an essential part in the design process. However, as shown in the previous section, it was only in the past decade that the LOS concept was introduced in the curbside assessment process. Before further discussing the research on LOS criteria, it is worthy to examine the procedures proposed for the design of curbside areas.

A number of methodologies have been developed to assist the airport planner in sizing each airport component. Depending on the availability of survey information, these techniques vary in complexity from relatively crude "rule of thumb" techniques to fairly complex computer simulation models. The following section explains some of these design techniques which have been categorized in two groups. The first group consists of those design procedures that have not integrated the LOS concept whereas the second group consists of those that have.

2.5.1 - Estimation Procedures Incorporating the LOS Concept

As mentioned earlier, curbside design procedures in their simplest form use rules of thumb. This approach tries to relate the length of curb space with some available measure of airport activity. For example, Cherwony suggested four inches of curb length for each

1000 annual passengers [Cherwony, 1986]. Whitlock suggested one foot of curb space per hour 2.28 deplaning or 2.42 enplaning per persons [Whitlock, 1969]. Transport Canada, in a more developed form, presents a rule based on suggesting two simple equations which consider a waiting area in addition to loading/unloading spaces.

Clearly, these methods donot take into account the concepts of LOS and should therefore be considered only in the preliminary design.

Curbside design, in a more developed form, uses some deterministic approaches. For example, Whitlock, have tried to define supply in terms of foot-minutes to represent a composite measure of vehicle length and dwell time with considerations to modal split [Whitlock, 1969].

A more recently proposed approach also tries to define curb front supply and demand in terms of a time-distance variable expressed in foot-minutes [Cherwony, 1986]. The advantage of this method is that it considers curb length as the effective distance available to vehicles for passengers loading and unloading. In addition, it differentiates between theoretical capacity and practical capacity, which is estimated as 70% of theoretical capacity.

Another approach to design problems is based on a simulation type methodology. This approach has been employed in planning and design of curbside areas. Attempts have been made to develop simulation models to determine the efficiency of the curbside. It should be mentioned here that most of the airport ground transportation simulation models consider the curb area as a part of the overall terminal and roadway design. The Airport Landside Simulation Model developed by the U.S. Department of Transportation, (DOT) and the Airport Traffic Analysis Model developed by Transport Canada [Hamzawi, 1986] are two examples.

2.5.2 - Estimation Procedures with Incorporating the LOS Concept

This group consists of those attempts which have tried explicitly to introduce the LOS concept in their approach to the design and evaluation problems. Among these, two have gained some degree of national recognition, the Transport Canada method, and Mandle's method. These methods result from two different approaches to curb design procedures.

2.5.2.1 - Transport Canada Method

Transport Canada has identified several factors that influence the design of the curbside area. It uses a stochastic approach by applying queuing theory to the curb processing function. Factors which have an important impact upon the terminal curbside area are taken into account. The curb traffic operation has been approximated by a multi-channel queuing model, and the arrival pattern by a Poisson distribution. Also, service channels are assumed to have exponentially distributed service times following a first come-first served discipline [Turnbull, 1973]. The assumptions involved in applying this model to the curb area are given below:

- the vehicle stalled along the curb frontage is assumed to be a service channel,
- the service channels are assumed to have exponentially distributed service times. These follow a first come-first served discipline and are mutually independent, and
- the arrival pattern of vehicles at the curb area, during a design hour, can be approximated by a Poisson distribution.

By using of the multi-server queuing model, it is possible to determine the probability that a vehicle entering the curb area in the design hour will find a stall at the curb frontage. The probability, "P" is given by the following formula:

$$P = 1 - \frac{1}{\sum_{J=0}^{S-1}\left[\frac{R^J}{J!} + \frac{R^S}{J! + \left(1 - \frac{R}{S}\right)}\right]} X \frac{R^S}{S!\left(1 - \frac{R}{S}\right)}$$

where :

P = is the probability of finding a parking stall,

S = is the number of vehicle stalls in the curb area, and

R = is the flow density calculated by dividing the arrival rate by the service rate.

Because of the complexity of the formula, several charts as the one shown in Figure 2.7 have been constructed for the panning of the curbside. As shown in this figure, the required curb space was determined in terms of average delay probabilities, i.e., different probabilities of finding/not finding a space at the curb. This analysis and design approach and therefore LOS definition is based on two important assumptions:

- there is no preference for free available spaces, i.e., if more than one space is available, then the probability of choosing each space by drivers is equal;
- if the curb is totally occupied, then incoming vehicles will join a single queue to wait for a free space.

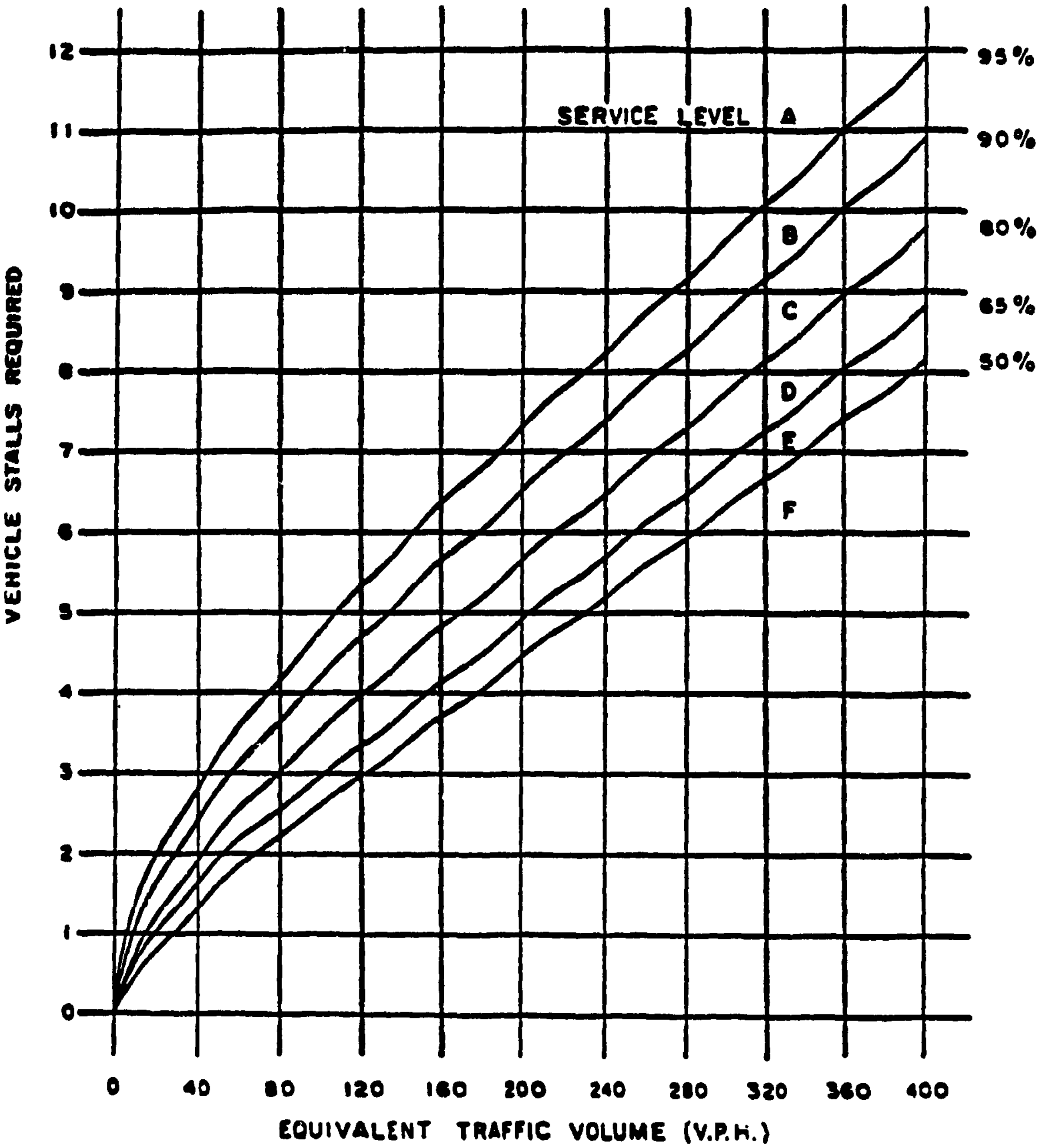


Figure 2.7 Vehicle Stall at Processing Curb VS. Equivalent Traffic Volume [Transport Canada, 1978]

It has been noted that both assumptions are frequently violated in practice. Definitely, there is some preference among users for different free spaces, such as those close to the preferred terminal door or desired airline. Although there are deficiencies involved, this approach may be considered as the most reasonable among those made in the past.

Major deficiencies in this approach are the following:

- The above mentioned assumptions are not verified, although it is believed that in most cases they are quite representative of the actual processes taking place.
- The correspondence probability of each service level should be determined with respect to traveler perception.
- The model has not differentiated between departure or arrival curb, while these two can exhibit different characteristics.

2.5 2.2 - Mandle's Method

Mandle's method tried to relate LOS to some measure of congestion. Mandle developed a reasonable relation between LOS and double to triple parking. He provided a better conbination of previous approaches and HCM definitions for LOS. Also using extensive data, he developed a more reasonable graph to incorporate LOS in curb design procedures as indicated in Figure 2.8. In his effort to differentiate between deplaning and enplaning curb requirements, he proposed different graphs corresponding to these areas. By using these graphs, the required amount of curb frontage can be estimated based on the desired service level. Conversely, based on a given curb length and volume of peak-hour air passengers, the service level of the curb frontage can be determined [Mandle, 1982].

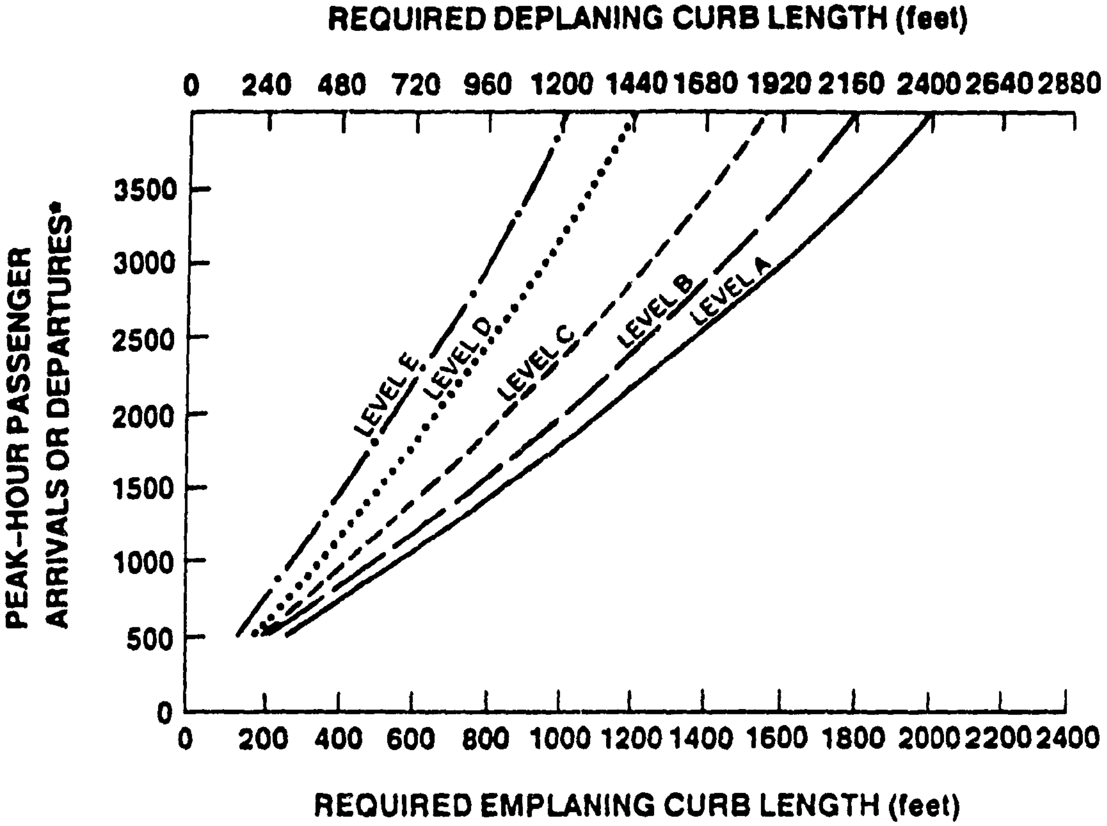


Figure 2.8 Suggested Method for Estimating Curb Frontage Need [TRB-215, 1987]

In Mandle's approach to analysis and design, the curb frontage requirements are based on the following formulas:

$$C = C_1 + C_2 \tag{3.2}$$

$$C_1 = \frac{(P.\frac{M}{V}).F}{(\frac{60}{D_1}).L_1} \tag{3.3}$$

$$C_2 = \frac{(P.\frac{M}{V}).A}{(\frac{60}{D_2}).L_2} \tag{3.4}$$

where:

C = curb frontage needs in linear feet for all vehicles,

C_1 = curb frontage needs in linear feet for private vehicles and taxis,

C_2 = curb frontage needs in linear feet for all other vehicles,

P = equivalent peak hour of air passengers arriving at curb, based on an assumed arrival distribution rate,

M = percentage of passengers using private vehicles and taxis,

V = vehicle occupancy of private vehicles and taxis,

F = percentage of private vehicles and taxis,

D_1 = combined average of vehicle dwell time for private vehicles and taxis, in minutes

D_2 = vehicle dwell time for all other vehicles, in minutes,

L = average vehicle berth space for private vehicle and taxis, equal to 25ft,

L = average vehicle berth space for all other vehicles, equal to 45 ft, and

A = ratio of other vehicles to combined total of automobile and taxis.

Mandle's work is probably the most refined in its area and is recommended by the Committee for Airport Capacity Study of the Transportation Research Board [TRB-215, 1987].

2.6 - AIRPORT PERFORMANCE EVALUATION

Evaluating the quality of service and operational performance of airport landsides is a major problem which faces airport operators today. Attempts have been made in the past to identify influencing factors and to study user-perceived LOS and behavioral aspects of landside operations. However, a study conducted jointly by the Transportation Research Board (TRB) and the Federal Aviation Administration (FAA) on measuring landside capacity concluded that there are no generally no accepted landside service levels [TRB-215, 1987]. In reality, capacity of the system or any of its components cannot be determined without reference to some measures of LOS.

A review of the literature showed that, in spite of all the research in airport environments, there have been no attempts in the past to measure the passenger perceived values of conditions. Interestingly, most of the researchers have focused on the terminal building [Mumayiz, 1986]. In this area major attempts were made to measure passenger perception of LOS. The methodologies adopted help to create LOS standards. One of these methodologies will be discussed in the next section.

2.7 - PERCEPTION RESPONSE (P-R) MODEL

Mumayiz and Ashford used the Perception Response (P-R) model to evaluate service levels [Mumayiz and Ashford, 1986]. The P-R model is "the graphical presentation of the collective attitudes of a category of passengers towards the range of operational service at a facility". This is expressed in terms of the perception of passengers of different values of the service measure and their response to the respective service conditions, classified into distinct levels of satisfaction.

The P-R model depicts the relationship between the percentage of passengers stating their level of satisfaction, and the value of a measure of service at a particular facility. The conceptual diagram for this model is shown in Figure 2.9.

The significance of the P-R model is that it can be practically implemented to derive and set service standards for airport processing facilities based on passengers' opinions and reactions towards operational services at those facilities.

The three curves that constitute the perception response graph represent the three states of passenger satisfaction with service i. e., Level I for good; Level II for tolerable; Level III for bad. These can be examined and the threshold values determined by measuring the dominant state of passenger satisfaction with services offered. The point at which there is a shift in the satisfaction of the majority of the population from one state to another identifies the boundary between two states, hence a change in LOS [Mumayiz, 1987].

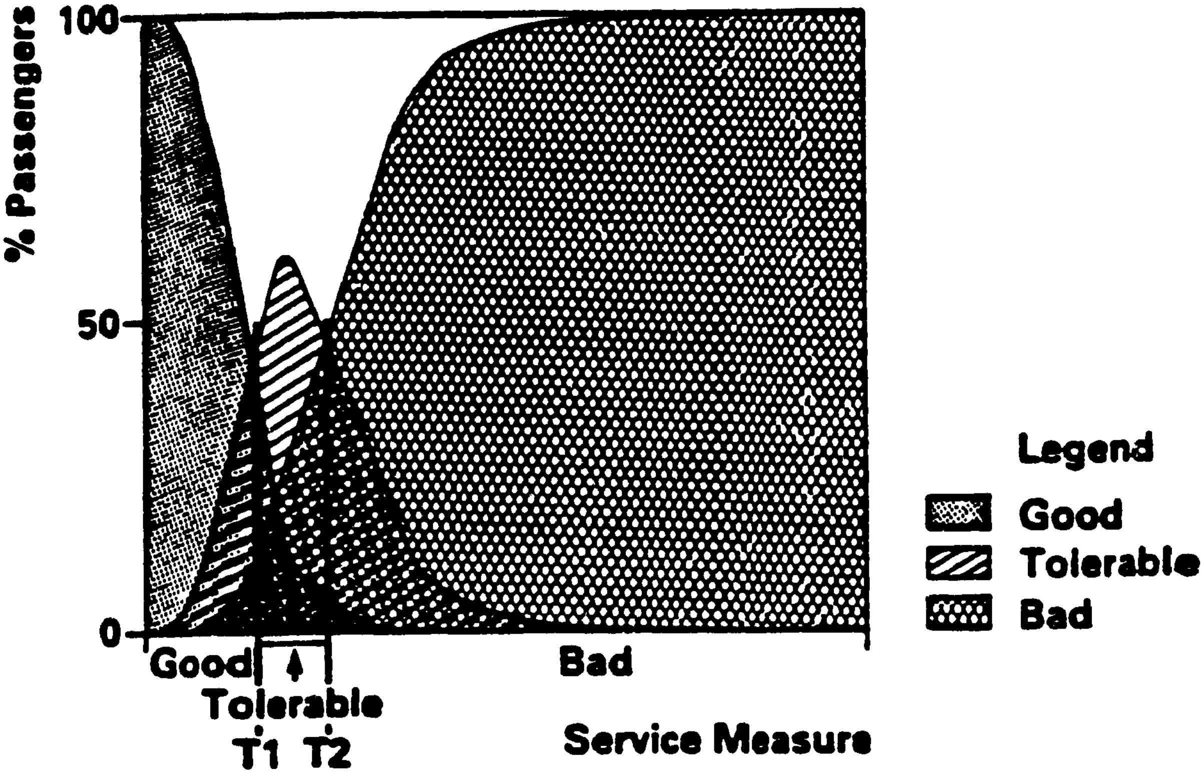


Figure 2.9 Concept of Perception-Response Model
[Mumayiz, 1991]

CHAPTER - 3

THEORY AND METHODOLOGY

3.1 - OVERVIEW

Fundamentals that provide the starting point for this research consist of behavioral theory and some assumptions. This chapter provides a brief summary of these fundamentals along with an introduction to the concept of linear transformation and weighting of factors. The methodology employed in the present research is also explained in this chapter.

3.2 - CONCEPT AND THEORY OF UTILITY

3.2.1- Concept

Actual satisfaction for a decision maker does not vary linearly with monetary gain or loss, yet there exists a situation in which he or she will act on the basis of some scale of value. Obviously this scale is different from the expected value. Even with the assumption of a linear relationship between satisfaction and gain or loss, the expected value criterion, which is developed to assist in handling tangible cases, is deficient in dealing with intangible cases. It would be desirable to have a scale which retains the computational simplicity of the expected value but can be applied to valuable considerations other than money, such as comfort and convenience, or even leisure and reputation.

If the decision maker evaluates his/her consequences on the basis of personal or subjective preferences, and if these personal preferences are ranked in a consistent and logical manner, then it can be shown that there exists a scale of value which has the desired properties. This scale of value, based solely on personal preferences of the decision maker, is called utility [Tang, 1972].

3.2.2 - Theory

It has been proven that under certain psychological assumptions concerning evaluation of consequences by decision makers, there is a measure of value called "U" or utility applicable equally to both tangible and intangible gains or losses [Fishburn, 1988]. In fact it has been proven that if an individual has tastes, which satisfy certain assumptions then there is a utility function "u" on the set of prospects to the set of numbers. That is, to each prospect P, there corresponds a number u(P) which is called the utility of the prospect P. This function has two important properties. This first property states that utility increases when the prospect improves, and the second states that utility can always be computed according to ordinary odds. These properties can be expressed in the following mathematical form.

. For every two consequences A_1 and A_2, the corresponding utility values U_1 and U_2 will have the relationship $U_2 > U_1$ only if the decision prefers A_2 over A_1.

. If an outcome O results in $\{ A_1, A_2\}$ with the known probabilities of $\{P_1, 1-P_1 \}$, then the utility of this outcome is defined as:

$$U(O) = P_1.U_1 + (1-P).U_2 \tag{3.1}$$

with:

$$P_1 + P_2 + \dots\dots\dots + P_n = 1 \tag{3.2}$$

With a utility function expressing the decision maker's own preference, the decision maker can evaluate the utility associated with any outcome. This theory is based on some basic axioms and assumptions which are beyond the scope of this test, but for the purpose of completeness they are briefly presented here.

3.2.2.1 - Assumptions of Utility Function

The concept of utility function is nothing but that of rational choice. Obviously, fundamentals of rational choice should be intuitively appealing as they set forth the kind of conditions, which common sense indicates, should surround a rational decision-making process. Following is a brief review of some axioms of utility theory:

- If a decision maker can compare and make consistent choices between alternatives, then, when faced with a pair of alternatives A and B, he/she will always prefer one over another or be indifferent to both.
- If a decision maker's choices are transitive, i.e., A>B, B>C then A>C.
- If the decision maker is indifferent to two choices, then they can be substituted for each other.
- If a potential choice has several possible outcomes, each with a particular probability, then it can be decomposed into more basic choices, or alternatively, using probability theory , more basic choices can be combined.
- If two alternatives A and B lead to the same outcomes, the decision maker will choose the alternative in which the preferred outcome has the greater probability.

It is worth mentioning that in practice these assumptions are frequently violated. Experiments have demonstrated that people find it difficult to be consistent, especially when choices are too close. This may cause some difficulties in determining utility functions.

3.3 - LINEAR TRANSFORMATION

During the process of utility theory application, some transformations of the utility function must be made. The transformations must keep the performance achievement structure intact as perceived by the users of the curb area. These transformations can be expressed as follows:

$$u(pm)=y.v(pm)+b \tag{3.3}$$

where:
u(pm) = the transformed value of performance measure,
v(pm) = the original value of performance measure, and
y and b= are constants of the transformation.

This equation yeilds different transformed value of performance measures for varying constants and original value of performance measures.

3.4 - WEIGHTING FUNCTIONS

Weighting functions are defined and used as a conceptual device by means of which explicit recognition is given to the existence of multiple objectives and attributes. These functions are necessary to indicate the perceived relative importance of satisfying the attribute itself vis-a-vis other attributes.

Since the relative importance of differing performance measures may vary, it is necessary in this research to define the weighting function based on passenger preference. This function can be expressed as follows:

$$U(O)=\sum W_g U_g(pmg) \tag{3.4}$$

where:

U(O) = the utility of each outcome state in relative value units,
u_g = the measured function on each performance, and
w_g = the relative weight which reflects the user preferences for the performance measures.

It should be mentioned, that the use of the weighting scheme is possible if certain relations are held. These are known as the concept of worth independence and are defined by the following statements [Rand, 1969]:

- The relative importance of satisfying separate attributes does not depend upon the various degree to which each attribute has itself been satisfied. Rather, their relative importance is conceived as being constant in this respect.

- The rate at which increased satisfaction of any given attribute contributes to overall worth is independent of the level of satisfaction already achieved on that and other attributes. Such rates are considered constant.

- The rate at which decision makers would be willing to trade off decreased satisfaction on one attribute for increased satisfaction on other attributes, so as to preserve the same overall worth, is independent of the level of satisfaction already achieved by any or all of the attributes.

Weighting functions have been used in the past to collect these opinions. Some researchers have made comparisons of methods available in collecting these judgments. Such a comparison was performed by Eckenrode [Eckenrode, 1965], who considered several techniques, including:

- Ranking
- Rating
- Paired comparisons
- Successive comparisons

In the process of making these comparisons, Eckenrode performed a series of tests to find out which method is the most suitable. His tests showed that ranking is the most efficient. Therefore, ranking will be used to determine user preferences, in addition to the rating method which will be used to measure perception.

The basics of the ranking method for obtaining user preferences and developing weighting factors can be explained as follows:

Consider criterion Cr, (i=1, 2, ..., q). There may be n judgments where n is any number 2 or greater.

Criteria Cr (1), Cr (2), ...Cr (i) .... Cr (q)
Judge (1): r (1,1), r (2,1), ...r (i,1) .... r (q,1)

Judge (k): r (1,k), r (2,k), ...r (i,k) .... r (q,n)
Judge (n): r (1,k), r(2,k), r (2,n), ...r (i,n) .... r (q,n)

where:

R(i, k) refers to the ranking of criterion (i) by judge k,

For each criterion (i), the converted rank R (i) is calculated as :

$$R(i)=\sum_{k=1}^{n} R\ (i,k), i = 1,q \qquad (3.5)$$

Thus the total criterion weight is given by:

$$W(i)=\frac{\sum_{k=1}^{n} R(i,k)}{\sum_{i=1}^{q} R(i)} \qquad (3.6)$$

where:

R (i) = the composite rank of criterion (i),

R (i,k) = the converted rank of criterion (i) established by judge k,

q = the total number of criteria, and

n = the total number of judges.

As stated above, since the relative importance of performance measures are not the same for all users, different individual utilities are expressed on different scales of measures. Once the weighting functions are developed, then by multiplying each utility by its respective weighting, all various utilities would be placed on a common scale of measure.

3.5 - APPLICATION OF UTILITY THEORY

This research relies on utility theory as a foundation for the development of a new approach that defines and quantifies LOS on airport curbs. This section provides an explanation of the application of utility theory to define and quantify LOS based on a set of surveys conducted at the Palm Beach International Airport (PBIA).

The user of the terminal curb, under prevailing conditions of traffic and service, perceives a state of the curb with a set of impacts. If performance measures are defined properly, then it is possible through a survey to ask users about their perception of the condition as well as their preference for different performance measures. The perceived values revealed by users, as the result of impacts of performance measures, can be transformed to utility numbers by means of functions which keep intact the performance achievement structures. From these utilities, the LOS offered by a facility under prevailing conditions can be inferred. This procedure is completed through the following four steps:

(1) passengers perceptions obtained from the survey are transformed through a linear transformation onto a 0 to 1 utility scale,

(2) passengers preferences, based on the ranking method [Eckenrode, 1965], can be changed into relative weights, which are necessary parameters for developing composite utility numbers,

(3) from a set of data and using regression analysis, it is possible to develop a relationship between utility numbers and the actual value of performance measures captured at the moment that users were realizing their perception of the condition. These utility numbers represent the prevailing LOS, and

(4) for a practically continuous range of various conditions of traffic studied at the curb, a plot of utility against the actual measure of performance can be drawn. Such plots may show some discontinuities referring to the transition between different service levels. In the absence of well defined thresholds, the judgment of airport officials can be used for appropriate gradation of the utility axis.

Since this methodology uses a moderate scale for satisfaction rating and a reasonable amount of data, it is not very sensitive to the ability of individual users to clearly distinguish between different levels of satisfaction. However, the present methodology is sensitive to two other factors, as some researchers have previously pointed out [Mumayiz, 1991].

These are:

- the way passengers are directed to state their perception, and
- the influence of past experiences with other airports [Mumayiz, 1991].

Also included in this survey is an attempt to find monetary values that users attribute to the physical and psychological comfort of different service levels. This aspect of attitudinal measuring, provides the basis for future cost-effectiveness evaluation of different performance levels and subsequently for determining the cost-effective facility sizes.

3.6 - SURVEY ELEMENTS

An important aspect of this research, as is the case in most transportation investigations, is the set of survey data collected to express some transport characteristic or user perception. The relevance of the conclusions of such investigations, resulting from analysis and interpretation of the data, depends both on the nature and the quality of the survey.

In accordance with the discussed theory, an attitudinal survey was designed to collect the perceptions of curb users with reference to time and distance. The survey was designed to match the actual value of the performance measure for each interviewed person, with the level of satisfaction expressed at the time of the interview. In this section, a brief review of survey techniques is provided. The different steps of the survey are discussed in the following sections.

3.6.1 - Survey Techniques

The choice of technique will be determined partly by the scale of the resources available and partly by the research context. This will be based on an informed evaluation of the alternatives.

In general, all techniques can be categorized in two large groups, observatory and participatory. These terms refer respectively to techniques in which observed objects are not affected in any way, and to those that involve participation of the observed objects. Our survey by nature is participatory, since we aim to record perceptions of users. However, observatory techniques, such as video taping, are employed for secondary information systems.

The participatory category includes different surveys e.g., forms to be returned by mail. Considering the factor altogether, it was decided to conduct in-person interviews at the curb side.

A number of techniques have been used in the past in the case of attitude measurements. These include uni-dimensional or multi-dimensional scaling techniques, and others in which users reveal their preferences by performing hypothetical choices. Uni-dimensional scaling techniques are the easiest to use, and also the best understood by the users.

Several rating scales which have been used in the past were considered. Among them, a three level scale (1 to 3), corresponding to good, tolerable, and bad, or a 1 to 10 scale are commonly used. However, for the purpose of this survey, it was decided to use a scale of 1 to 7 for the following reasons:

(1) it provides a mid anchor, which is 4,
(2) it has sufficient room for gradation at each side of mid anchor, and
(3) it is not challenging, because of the proper number of spaces provided, for the users to be able to provide reasonable gradations.

This scale is shown below:

1............ 2.............. 3.............. 4............. 5.............. 6.............. 7

Ranking of the performance measure by the corespondents was a requirement of this research. It was decided to ask users directly to rank their perception performance measures.

3.6.2 - Questionnaire Design

A poorly designed questionnaire or badly collected data may give rise to misleading results and conclusions. Therefore, to get precise responses, the following factors were considered important when designing the questionnaire:

- using common language and avoiding obscure or technical terminology,
- providing a "warm up" section before the main body,
- getting most of the information with minimum length, and
- making the interviewee feel that his/her contributions would help in finding a solution to the transportation problem.

The time factor was important in deciding on the length of the questionnaire. It is for this reason that a small questionnaire was prepared. The amount of time that was required to fill the questionnaire was on the average less than two minutes. This restricted the questionnaire to the most essential questions. The performance measures were selected and the ranges of perception from very satisfied to very dissatisfied were identified. A part of the questionnaire was devoted to recording information about date, time and space. It was designed to allow data to be easily and properly transformed to a computer data file. Also, the survey team, in particular the interviewers, were briefed on the proper methods of conducting field studies and interviews. The questionnaire forms are shown in Appendix B.

3.6.3 - Sample Size

Initially, the survey methodology was devised to ensure the statistical significance of observations. However, at the stage of conducting the survey, it was decided to acquire as much data as possible. This is an accepted method based on the "get as many as you can" principle [Louvieree, 1981], especially when persons interviewed exceed the original size of the intended sample. Therefore, it was decided that the sample size should be as large as possible. There were times during the survey where all potential respondents were interviewed, but there were also times where manpower was insufficient, rendering it impossible to connect with everyone.

3.6.4 - Performance Measures

The selected performance measures for measuring utility of the curbside area were time and distance. These are defined as follows:

- the time that each vehicle requires to find an unloading/loading position in the curb area, measured from the moment of passing the entrance ramp, and
- the distance that a user travels by foot, between the unloading/loading position and entrance door.

3.6.5 - Selection of Computer Facility

At the stage of analysis, "Shazam", a statistical package developed for econometric and social sciences, was implemented. Shazam is a powerful tool for analyzing the type of data collected during our survey. Its statistical procedures perform a wide range of analysis. The range of outputs provided by this package include frequencies, correlation coefficients, multiple regression analysis, and other basic statistical analysis.

3.6.6 - Level of Service

Most transportation professionals are familiar with LOS framework "LOS A-F", which is used for highway capacity analysis. It has also been adopted by Transport Canada for airport studies, hence is appropriate for this study. On the other hand, a three LOS framework is suggested by the Airport Study Committee of the National Research Council (NRC), (USA), [TRB-215, 1987].

3.6.7 - Choice of Airport

Initially, two airports were considered as sites for conducting the survey: The Dorval International Airport, in Montreal; and The Palm Beach International Airport, in Florida. Due to limited of resources, lack of personnel for conducting the survey in French, and restrictions posed by authorities, the research was confined to the Palm Beach International Airport, in Florida, USA.

3.6.8 - Survey Dates

Survey dates were selected after consulting airport authorities. Based on the advice of airport authorities regarding the study of the perception of business travelers, the third week of December was selected for conducting the survey:

> Tuesday December 21, 1993 on the departure curb (10 am till 12.30 pm) and,
> Tuesday December 21, 1993 on the arrival curb (1 pm till 3 pm).

CHAPTER - 4

DERIVATION OF UTILITY EQUATION

4.1 - OVERVIEW

In this section, the summary results of the information collected during the survey are presented. These results are categorized in two groups. The first group presents the data for the departure curb and the second group shows the data for the arrival curb. These data incorporate information collected through primary and secondary sources. Out of 231 persons interviewed, 122 were at the departure curb and 109 were interviewed at the arrival curb.

4.2 - SURVEY RESPONSES

4.2.1 Description of the Airport

The Palm Beach International Airport (PBIA), Florida, U. S. A., was selected for this research. As mentioned earlier, another airport was considered, but restrictions confined the research to the PBIA. The survey responses at the PBIA and the analysis of the information lead to satisfactory results. It was therefore concluded that surveys at other airports were unnecessary.

The PBIA is fairly large, handling domestic, transborder, and to a lesser extent, international flights. It is located southwest of the City of West Palm Beach and is easily accessible from Interstate 95. PBIA is one of the largest medium hub airports in the U.S.

The passenger terminal at PBIA is linearly shaped with a double storied curb. One floor serves as a departure curb and the other as an arrival curb. The curb is properly separated for commercial and private vehicles. Depending on the location, the curb serves enplaning and deplaning functions.

4.2.2 - Statistical Summary of the Responses

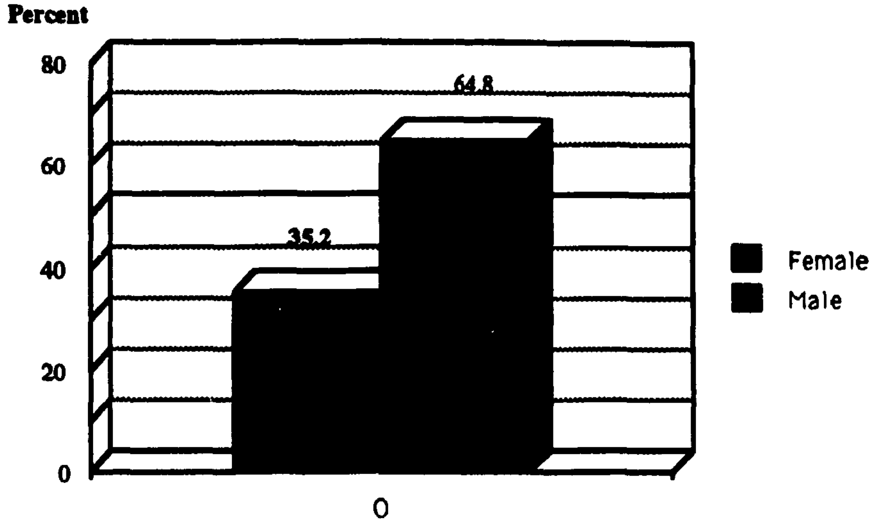
In this section, the survey results are presented in two categories: for the departure and the arrival curbs.

4.2.2.1 - Departure Curb

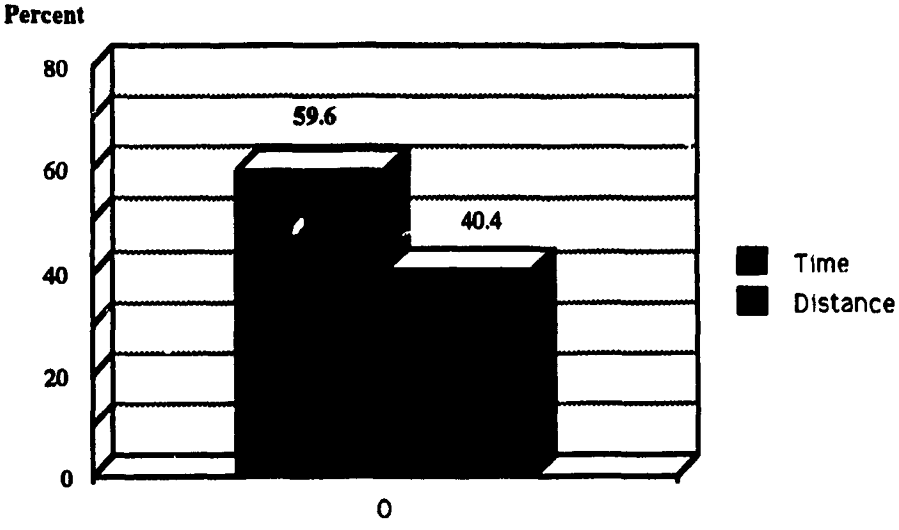
A total of 122 interviews were conducted on the departure curb. An examination of the questionnaire for the departure curb, is attached in Appendix B. The following paragraphs explain in detail the summary outcome of the information obtained.

Sex of the Respondents (DSX):
Of the total 122 respondents interviewed, 43 or 35.5 % were female and 79 or 64.8 % were male. Figure 4.1 illustrates the classification of users by sex.

Importance of Performance Measures (DIMP):
This variable represents the ranking of distance and time as indicated by the respondents. From the two variables of distance and time, interviewees were asked to chose the one that is more important to them. Given the 122 interviewees, 71 persons chose time as being more important than distance. Of these, 51 believed that short walking distance was more important than short waiting time.



Sex Respondents
Figure. 4.1 Classification of Users by Sex, PBIA-Departure Curb



Performance Measures
Figure. 4.2 Users Perceived Relative Importance, PBIA-Departure Curb

Figure 4.2 is a graphical representation of the relative importance of time and distance as indicated by respondents.

Trip Purpose: Business Trip, Non-Business Trip, and Combined Trip (DBUS, DNONBUS, DCOMB):

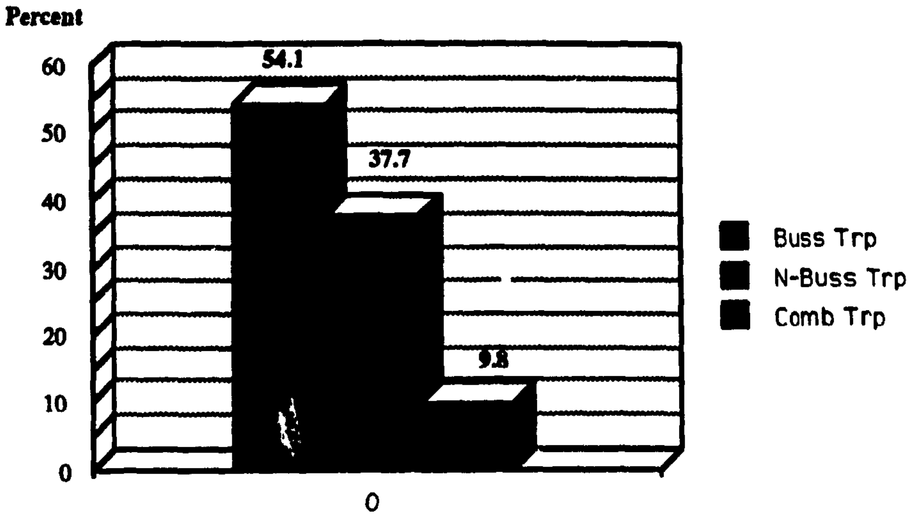
Classification according to trip purpose showed that, 66 or 54 % of the respondents were on a business trip, 46 or 37.7 % were on a non-business trip, and 12 or 10 % were on a combined trip. Figure 4.3 shows this classification.

Party Size (DSZE):

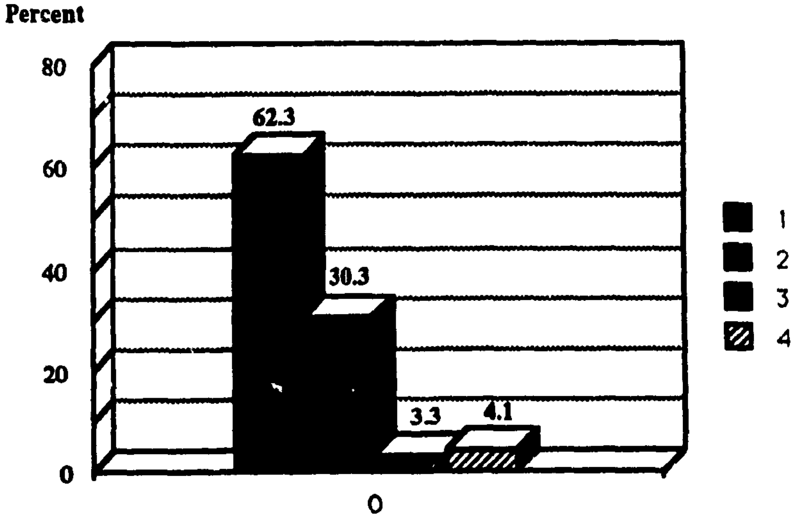
In this category, those who were traveling alone were the highest in number. From the total responses, 76 or 62.3 % were single travelers, 37 or 30.3 % were traveling in groups consisting of two passengers, 4 or 3.3 % were traveling in groups consisting of three persons, and the rest of them were traveling in groups consisting of 4 persons. The last group amounts to 4.1 % of the total respondents. Figure 4.4 provides a graphical representation of the above distribution.

Rating of Time by Respondents (RATTME):

This variable indicates the rating of the time spent at the departure curb as perceived by passengers while looking for a parking stall or getting out of their cars. The rating ranges were on a scale from 1 to 7 which represents very satisfied to very dissatisfied. In this area, 46 persons or 37.7 % were very satisfied with their waiting time for unloading, whereas 4 persons or 3.3 % were extremely dissatisfied. Figure 4.5 provides the graphical representation of the percentage of the responses on a scale of 1 to 7.



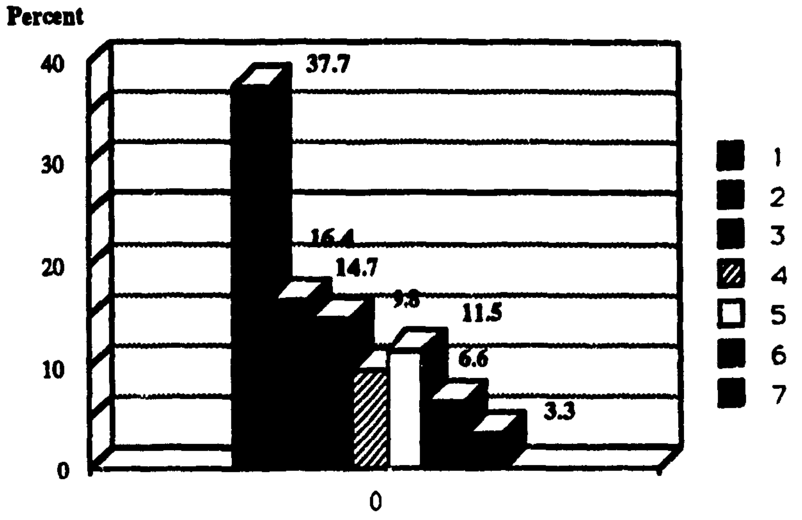
Trip Purpose
Figure. 4.3 Users Classification By Trip Purpose, PBIA-Departure Curb



Party Size
Figure. 4.4 Users Classification by Party Size, PBIA-Departure Curb

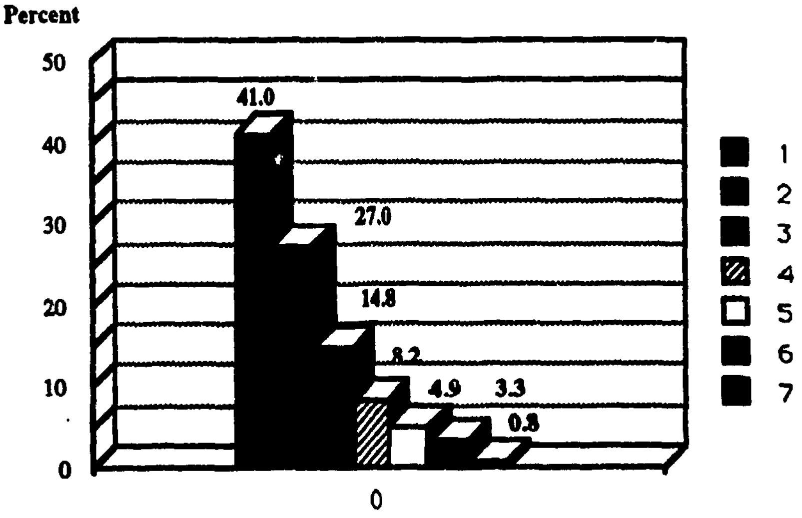
Rating of Distance by Respondents (RATDIS):

This variable represents the rating of the walking distance as perceived by the passengers. Again, the value of this ranges from 1 to 7, representing respectively very satisfied to very dissatisfied respondents. Among the total respondents, 50 persons or 41 % were very satisfied with the distance they walked, whereas one person or 0.8. % was very dissatisfied. Figure 4.6 provides the percentage of responses on a scale of 1 to 7.



Rating of Time

Figure. 4.5 Users Perception of Time, PBIA-Departure Curb



Rating of Distance

Figure. 4.6 Users Perception of Distance, PBIA-Departure Curb

4.2.2.2 - Arrival Curb

The types of information collected for analysis purposes at the arrival curb were the same as for the departure curb. This can be appreciated by examining the questionnaire. A total of 109 interviews were conducted on the arrival curb. The following paragraphs explain in detail the summary outcome of the information obtained through the survey.

Sex of the Respondents (DSX):

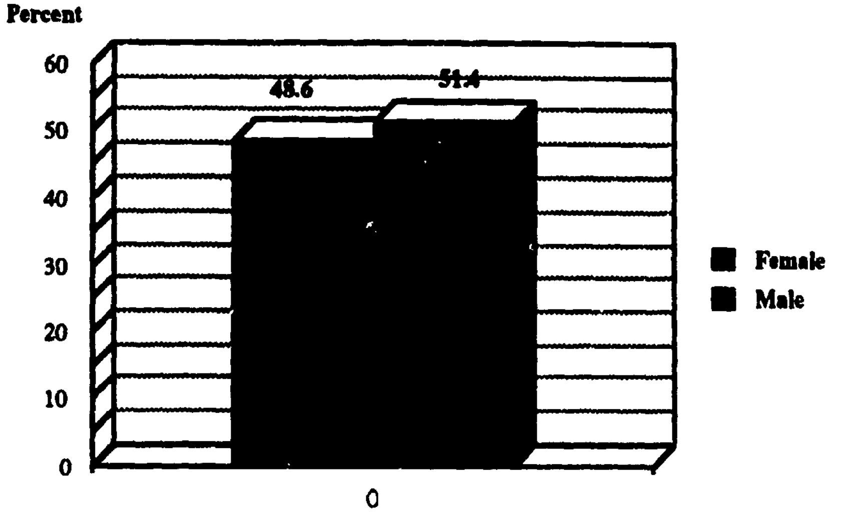
Of the total 109 respondents interviewed, 53 or 48.6 % were female and 56, or 51.4 % were male. These passengers are shown in Figure 4.7 in the form of a bar chart.

Importance of Performance Measure (DIMP):

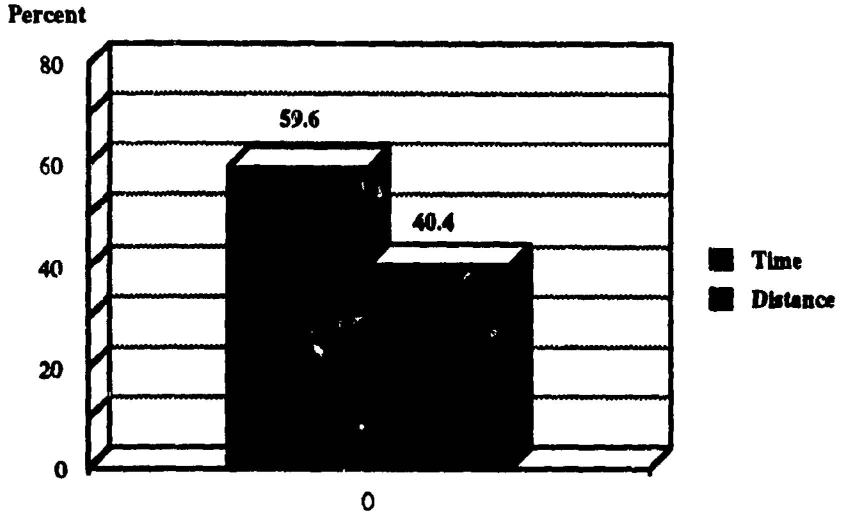
This variable represents the ranking of distance and time as indicated by respondents. Of the two variables, distance and time, interviewees were asked to chose the one which was more important to them. Given the 109 interviewees, 65 persons responded time to be more important than distance. The other 44 persons, believed short walking distance was more important than short waiting time. Figure 4.8 illustrates the passenger preferences.

Trip Purpose, i.e., Business Trip, Non-Business Trip, and Combined Trip(DBUS, DNONBUS, DCOMB):

This variable represents the purpose of each trip. Classification according to trip purpose showed that, 58 or 53.2 % of the respondents were on a business trip, 50 or 46 % were on a non-business trip, and 1 or 0.9 % were on a combined trip. Again, at the arrival curb, the business travelers group was the largest, exibiting the same trend as in the case of departure curb. Figure 4.9 gives the graphical illustration of trip purpose for the arrival curb.



Sex of Respondents
Figure 4.7 Users Classification by Sex, PBIA-Arrival Curb



Performance Measures
Figure. 4.8 Users Perceived Relative Importance PBIA-Arrival Curb

Party size (DZE):

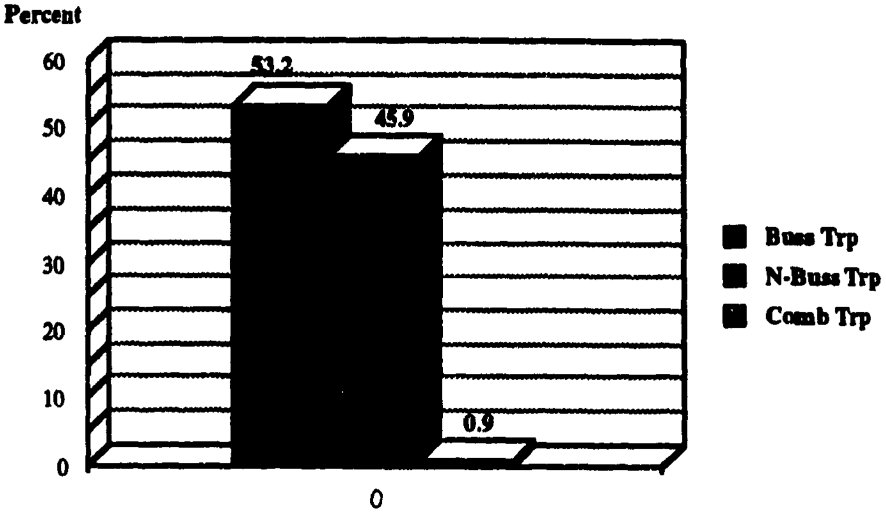
In the case of the arrival curb, as was the case for the departure curb, those who were traveling alone were the highest in number. In this category, 78 or 71.6 % were single travelers, and 25 or 23 % were traveling in groups consisting of two passengers. The rest were traveling in groups consisting of 3 persons. These passengers amounted to 5.5 % of the total respondents. Figure 4.10 provides a graphical illustration of this distribution.

Rating of Time (RATTME):

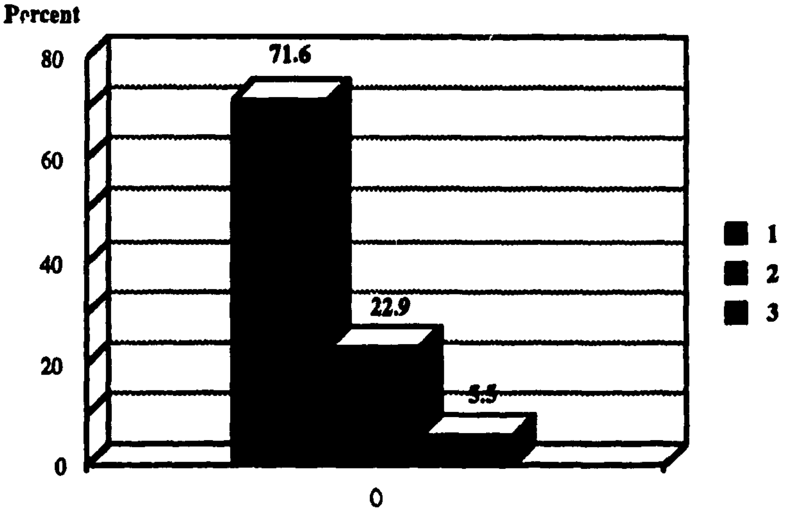
This variable indicates the rating of the time spent at the departure curb as perceived by the passengers while they were looking for a parking stall. As in the previous case, the range is from 1, which represents very satisfied, to 7 which represents very dissatisfied. In this case 50 persons or 46 % were very satisfied with the time they waited for unloading, whereas 3 persons or 2.8 % were very dissatisfied. Distribution of passengers perception of time is shown in Figure 4.11.

Rating of Distance (RATDIS):

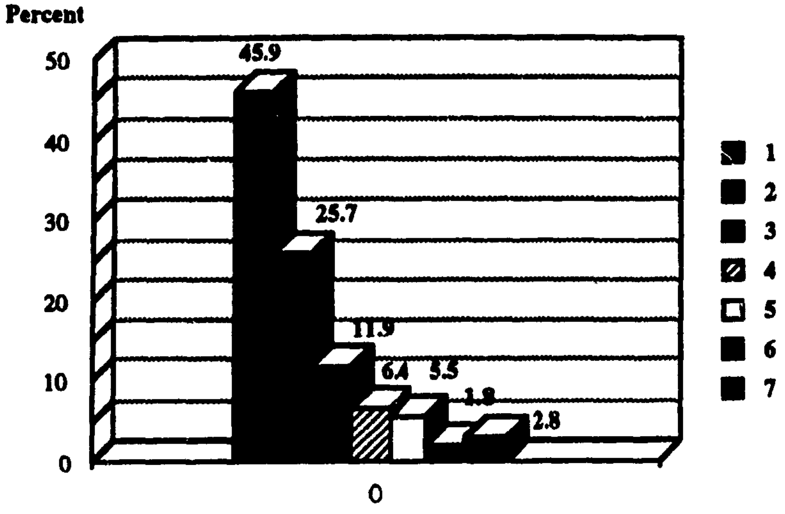
This variable represents the rating of the walking distance as perceived by the passengers. The value ranges from 1 to 7, representing respectively very satisfied to very dissatisfied. Among the total respondents, 33 persons or 30 % were very satisfied with the distance they walked, whereas 5 persons or 5 % were very dissatisfied. Figure 4.12 provides a graphical representation of the user responses.



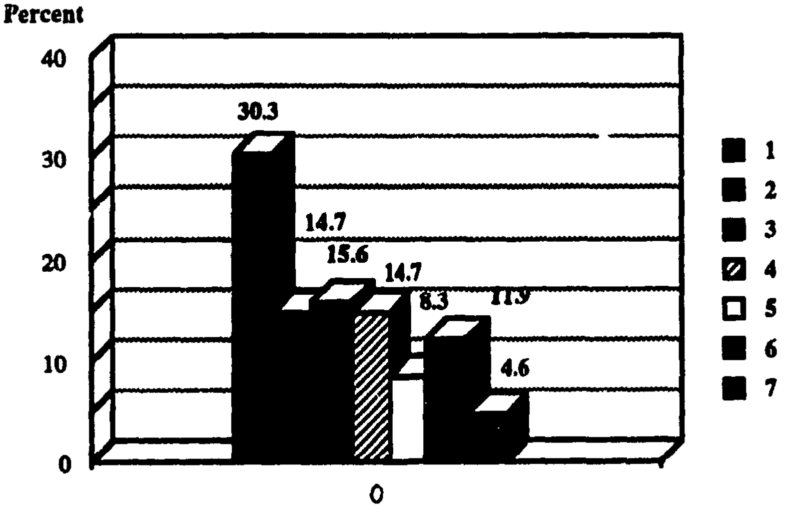
Trip Purpose
Figure. 4.9 User Classification by Trip Purpose, PBIA-Arrival Curb



Party Size
Figure.4.10 Users Classification by Party Size, PBIA-Arrival Curb



Rating of Time
Figure 4.11 Users Perception of Time, PBIA-Arrival Curb



Rating of Distance
Figure. 4.12 User, Perception of Distance, PBIA-Arrival Curb

4.3 - STATISTICAL ANALYSIS OF THE RESPONSES

This section presents the results and the data analysis process. Also, the performance measures which are selected for the derivation of composite utilities are discussed and the composite utility equation for departure and arrival curbs is derived. Following are the results of these analyses. The final result, which is a composite utility equation, is obtained through a set of successive regression. It should be mentioned that the results discussed here are merely a summary of the computer program output. The computer output can be found in Appendix D.

4.3.1 - Breakdown of Variables

The following tables illustrate the breakdown of the variables as analyzed by Shazam. Tables 4.1 through 4.5 show the breakdown for the departure curb and Tables 4.6 through 4.10 relate to the arrival curb. Each table is provided along with a brief explanation and discussion of results.

4.3.1.1 - Departure Curb

i) Relationship Between Data Collected For Performance Measures

Table 4.1 shows the correlation between the actual measured values for distance and time. Although these two variables were expected to have some degree of correlation, the results showed that they are not correlated. This is due to the fact that those who had experienced a long delay period did not necessarily experience a long walking distance.

Table 4.1 Correlation Between Walking Distance and Delay Time.

	DIS
TME	0.076 * 0.8030 **

Partial Correlation Coefficient *
t Ratio **

ii) Relationship Between Performance Measures and Users Perceptions

Table 4.2 demonstrates the internal relation between the performance measures and the perception of those measures as perceived by users. From this table, we see that there is a strong relation between user rating of time (RATTME) and time (TME) as well as between user rating of distance (RATDIS) and distance (DIS). There is also a fairly high correlation between user rating of time (RATTME) and rating of distance (RATDIS). Noting that time and distance were not correlated, it can be deduced that rating of time can affect rating of distance and vice versa.

Some degree of correlation between rating of time (RATTME) and distance (DIS) or between rating of distance (RATDIS) and time (TME) were expected. Although relation between distance and rating of time was found to be very weak, a fairly strong relation between time and rating of distance was observed.

Table 4.2 Correlation Between Performance Measures and User Perception.

	RATDIS (Distance-Rating)	RATTME (Time-Rating)	DIS (Actual)	TME (Actual)
RATDIS (Distance-Rating)	1			
RATTME (Rating of Time)	0.361 * 4.246 **	1		
DJS (Actual)	0.531 6.868	0.154 1.712	1	
TME (Actual)	0.183 2.038	0.665 9.765	0.076 0.830	1

Partial Correlation *
t Ratio **

iii) Relationship Between Dummy Variables

Table 4.3 shows the internal correlation between dummy variables. As can be seen, most of the pair-wise cofficients are low, which discounts the possibility of any relationship between these variables except for the following:

> A strong relationship between the size of groups (DZE) and purpose of travel (DBUS, DNONBUS, AND DCOMB). An examination of the data showed that those who were on business trips were mostly travelling alone, whereas non-business passengers were travelling individually as well as in groups.

A fairly high correlation between group size (DZE) and ranking of importance between time and distance (DIMP) exits. An Examination of the data showed that single travellers assign higher value to time than distance.

Table 4.3 Correlation Between Dummy Variables.

	DIMP	DSX	DBUS	DNONBUS	DCOMB	DZE
DIMP	1					
DSX	-0.140 * -1.549 **	1				
DBUS	0.076 0.840	-0.008 -0.083	1			
DNONBUS	-0.111 -1.220	0.102 1.123	-0.257 -2.913	1		
DCOMB	0.020 0.216	0.078 -0.856	-0.778 -13.59	-0.359 -4.208	1	
DCOMB	0.206 -2.311	0.093 1.021	0.778 0.580	-0.210 -2.356	-0.409 -4.911	1

Partial correlation *
t Ratio **

iv) Relationship Between Dummy Variables and Performance Measures.

Table 4.4 demonstrates the internal relationship between dummy variables and performance measures. As expected, all pair-wise correlation coefficients are low, and this shows the lack of any type of relationship between the variables.

Table 4.4 Correlation Between Dummy Variables and Performance Measures.

	DIMP	DSX	DBUS	DNONBUS	DCOMB	DSZE
TME	-0.0390	-0.072	-0.141	0.078	0.069	0.096
(Actual)	-0.0432	-0.0788	-1.558	0.956	0.752	-1.058
DIS	-0.107	0.119	-0.063	-0.070	-0.094	--0.028
(Actual)	-1.183	1.311	-0.692	--0.764	1.039	-0.315

Partial correlation *
t Ratio *

v) Relation Between Dummy Variables and User Rating of the Condition

Table 4.5 demonstrates the internal relationship between dummy variables, passenger rating of the condition, and the amount of money that they are willing to pay if disutility of distance and time were removed. As the table shows, most of the pair-wise partial correlation coefficients are low, demonstrating lack of any relation. However, coefficients in this case show that there is some degree of correlation between rating of time (RATTME) and time priority of performance measures. In addition, there exists a weak relationship between distance rating (RATTDIS) and trip purpose (DBUS), and between priority performance measures (DIMP) and user perceived value of disutility cost ((DMON).

Table 4.5 Corelation between Dummy Variables, Performance Measures, and User Perception

	DIMP	DSX	DBUS	DNBUS	DCOMB	DSZE
RATTME	-0.026	0.012	-0.130	0.094	0.076	-0.109
(Time-Rating)	-2.300	0.133	-1.439	1.029	0.830	-1.198
RATTDIS	-0.090	0.115	-0.169	0.046	0.121	-0.143
(Distance-Rating)	-0.995	1.267	-1.881	0.499	1.331	-1.585
DMON	-0.613	-0.004	-0.074	0.076	0.005	0.084
	-1.810	0.46	-0.809	0.832	0.49	0.923

Partial correlation *

t Ratio **

4.3.1.2 - Arrival Curb

The following table shows the breakdown of the variables at the arrival curb as processed by Shazam. These variables are categorized and their relationships are demonstrated in Tables 4.6 through 4.10 in the same way as were the departure curb variables. Here again, each table includes a brief discussion and explanation of the illustrated results.

i) Relationship Between Data Collected for the Performance Measures

Table 4.6 illustrates the correlation between distance (DIS) and time (TME) for the arrival curb. Again, as was the case for the departure curb, there is no relationship between these two variables. In fact, users facing long walking distances to walk does not necessairly mean long delay periods, and vice versa.

Table 4.6 Correlation Between Distance and Time

	DIS
TME	-0..060* -0.624 **

Correlation coefficient *
t Ratio **

ii) Relationship Between Performance Measures and Passenger Perception

Table 4.7 provides correlation coefficients between performance measures and perception of those measures by users. It is evident from the table that there is a strong relationship between time (TME) and user perception of time (RATTME), between user perception of distance (RATDIS) and the distance that the user actually walked (DIS), and also between distance (DIS) and rating of time (RATTME).

This shows that walking distance affects rating of time. In fact, those who experienced a long walking distance marked their perception of time higher when compared to those who did not experience such a walking distance. The results show that there is a relationship between time (TME) and rating of distance (RATTDIS): delay time has an effect on rating of distance. It was found that those who spent a long period of time in the curb area marked their perception of distance higher when compared to those who did not experience such a delay time. A fairly strong relationship between rating (RATTME) and rating of distance(RATDIS), as was the case for the departure curb, was also in the findings. In fact, these two variables affect each other.

Table 4.7 Correlation Coefficient Between Performance Measures and User Perception

	RATDIS (Distance-Rating)	RATTME (Tme-Rating)	DIS (Actual)	TME (Actual)
RATDIS (Distance-Rating)	1			
RATTME (Tme-Rating)	0.332 * 3.521 **	1		
DIS (Actual)	0.563 7.045	0.192 2.020	1	
TME (Actual)	0.234 2,484	0.601 7.781	-0.60 -0.624	1

Partial Correlation *
t Ratio **

iii) Relationship Between Dummy Variables

Table 4.8 shows the internal correlation between dummy variables. As can be noted, all the pair-wise partial coefficients are low, indicating weak relations, but there are some exceptions.

The strongest correlation exits between the size of the group (DZE) and the purpose of travel (DBUS or DNONBUS). Again, it shows that those who were on business trips were mostly travelling alone, whereas non-business passengers were travelling alone as well as in groups. The weakest correlation was found between the sex of the travellers (DSEX) and their trip purpose (DBUS). In fact, male travellers were mostly on business trips, while non-business travellers were both female and male. The degree of importance of time and distance (DIMP) is correlated with the purpose of trip (DNONBUS) to a much stronger extent than for the departure curb.

Table 4.8 Correlation Between Dummy Variables

	DIMP	DSEX	DBUS	DNONBUS	DSZE
DIMP	1				
DSEX	-0.135 -1.408	1			
DBUS	0.143 1.497	-0.173 -1.814	1		
DNONBUS	-0.188 -1.975	-0.173 -1.814	0.964 -37.41	1	
DSZE	0.037 0.386	0.058 0.602	0.381 4.261	-0.399 -4.493	1

Partial Correlation *
t Ratio **

iv) Relationship Between Dummy Variables and Performance Measures

Table 4.9 demonstrates the internal relationship between dummy variables and performance measures. As expected, all pair-wise correlation coefficients are low, and this rejects the existence of any type of relationship between the variables.

Table 4.9 Correlation Between Dummy Variables and Performance Measures

	DIMP	DSEX	DBUS	DNONBUS	DSZE
DIS	0.025	-0.039	0.090	-0.105	0.059
	0.258	-0.404	0.939	-0.096	0.612
TME	0.113	-0.067	0.075	-0.107	0.044
	1.181	-0.0697	0.774	-1.116	0.460

Partial Correlation *
t Ratio **

v) Relation Between Dummy Variables and User Rating of the Condition

Table 4.10 demonstrates the internal relationship between dummy variables, passenger rating of condition, and the amount of money that users are willing to pay if disutility of distance and time were removed. As the table shows, all the pair-wise partial correlation coefficients are low except in the case of money (DMON) and trip purpose (DBUS), as well as money and user priority (DIMP).

Table 4.10 Correlation Between Variables and User Perception

	DIMP	DSEX	DBUS	DNONBUS	DSZE
RATTME	0.115	-0.009	0.076	-0.104	-0.041
	1.194	-0.095	0.791	-1.085	0.583
RATTDIS	0.063	-0.109	0.087	-0.099	0.119
	0.655	-1.138	0.908	-1.027	1.238
DMONEY	0.185	-0.045	0.199	-0.161	0.097
	1.95	-0.461	2.105	--1.69	1.008

Partial Correlation *
t Ratio **

4.4 - DERIVATION OF UTILITY FUNCTIONS

This section deals with the derivation of individual utilities for selected performance measures, which are walking distance and time spent. These individual utilities are then combined to produce composite utilities for both arrival and departure curbs.

Based on the concept of linear transformation, as discussed in Chapter 2, the utilities for each performance measure are transformed from the perception of "1-7" to utility level "0-1". These transformations are as follows:

TABLE 4.11 Transformation Factors from Rating Scale to Utility Scale

Rating Scale (1 -7)	1	2	3	4	5	6	7
Utility Scale (0 - 1)	1.00	0.83	0.67	0.50	0.33	0.17	0.00

The transformed value of 1-7 on the 0-1 scale is the individual's utility of each performance. Some researchers in the past defined utilities as the multiplication of this transformed value by the actual amount of that performance measure, measured at the same moment that the respondent was releasing his or her perception. However, it does not seem necessary and may cause the appearance of some degree of correlation between passenger perception and performance measures which in turn would cause some inaccuracy in the process of analysis.

Once the linear transformations are carried out, and individual utilities for each performance measure are called, then based on the utility theory, these utilities of each performance would be combined to produce the composite utilities for each departure and arrival curbs.

4.4.1 - Individual Utilities

In this section, individual utilities for both performance measures are derived. Following the investigation of the effect of qualitative variables and presence of non-linearities, they are combined to produce composite utility equations.

a) Departure Curb

As described in previous chapters, two performance measures were selected, namely time and distance. The individual utility for each performance measure is derived as follows:

UTILITY (TME)	= - 0.0114 * TIME	+ 1.0058	
	- 9.765	27.49	t Ratio
	-0.665	0.929	Partial correlation

$R^2 = 0.443$

$F = 96.95$ $\quad F_{cr} = 3.95$

UTILITY (DIS)	= 0.00994 * DIS	+ 1.102	
	- 6.87	22.91	t Ratio
	- 0.531	0.902	Partial correlation

$R^2 = 0.282$

$F = 44.4$ $\quad F_{cr} = 3.92$

F_{cr} is calculated at 95 % confidence interval

b) Arrival curb

Selected performance measures for the arrival curb were the same as those for the departure curb. Again, high correlation coefficients and confidence intervals substantiate the existence of a relationship between user perception of the condition and performance measures.

The individual utility for each performance measure is derived as follows:

UTILITY (TME)	= - 0.01107 * TME + 1.0337		
	- 7,77	29.317	t Ratio
	- 0.600	0.943	Partial correlation
R^2	= 0.361		
F	= 59.1	F_{cr} = 3.93	

UTILITY (DIS)	= 0.008915 * DIS + 0.971		
	- 5.95	3.12	t Ratio
	- 0.499	0.289	Partial correlation
R^2	= 0.269		
F	= 39.7	F_{cr} = 3.93	

High correlation coefficients and high t ratios, which correspond to a confidence interval of more than 95 %, substantiate the existence of a relationship between the user perceptions of conditions experienced and performance measures.

4.4.1.1 - Check for Non-Linearities

a) Departure Curb

Although the above mentioned regression equations illustrate the relation between user perceptions of the condition and measured amount of performance, there may be some type of non-linearities present which have been omitted from the equation. In other words, user perceptions may be better expressible in terms of nonlinear forms of performance measures. To check for non-linearities, the La-grange Multiplier Test was used. Residuals of the original regression are regressed against non-linear forms of performance measures, and statistical coefficients for example, t and F are carefully examined to investigate the presence of any form of non-linearity in the utility equation. The rationale behind this is that, if some form of non-linearities should be present in the utility equation which are omitted, then the effect of those omitted variables must yield high correlation coefficients and high t ratios.

Successive regression of residuals against nonlinear forms of performance and associated calculations and tests led to the rejection of the presence of non-linearities in expressing passenger perceptions of performances. A computer output for this is shown in Appendix D.

b) Arrival Curb

The presence of any non-linearity in the form of performance measures in the arrival curb was also checked, and finally, involvement of any type of non-linearity was rejected. The process for this investigation was the same as for the departure curb and the basic test used was the La-grange Multiplier Test. Computer outputs for the arrival curb are shown in Appendix D.

4.4.1.2 - Check for Dummy Variables

a) Departure Curb

A natural question is whether marginal effects on the perceptions of utility of time spent or walking distance depend on trip purpose, gender, or number of travelers in the group. In other words, does an extra minute of time or an extra meter of distance, for example, contribute more towards the perception of a male than toward that of a female? To check for this and other effects of dummy variables, a set of regression analyses was done. Once again, the basic test for finding the candidate of inclusion was the La-grange Test. Although the initial regression of residuals against dummy variables showed that some of the new variables should be considered, the successive regressions showed that none of them are significant at a reasonable level. Using the same method, the interaction of dummy variables with (TME) and (DIST) were also checked. Again, none of the interactions was found to be significant.

b) Arri al Curb

The effect of qualitative variables on marginal perceptions of utility of time or distance was investigated at the arrival curb. Here the basic test for finding a candidate for inclusion was the La-grange Test as well. In spite of the results of initial regression of residuals against dummy variables, further analyses showed that none of them are significant at a reasonable level. As in the departure curb mentioned above, the interaction of dummy variables with (TME) and (DIS) was checked and found to be insignificant.

4.4.2 - COMPOSITE UTILITIES

Shazam was used to run the multiple regression analysis. Based on the tests done in previous chapters, non-linearity or interactions of variables were found to be present in the composite utility equations. These equations are derived separately for departure and arrival curbs, and the results are shown in the following sections:

4.4.2.1 - Departure Curb

The following utility equation is the result of multiple regression analysis for the departure curb:

$$\text{UTILITY} = -0.00792 * \text{TME} - 0.00464 * \text{DIS} + 1.095$$

- 8.68	-3.65	22.78	t Ratio
- 0.623	-0.310	0.902	Partial correlation

$R^2 = 0.439$

$F = 116.7$ $\quad F_{cr} = 3.07$

Degrees of Freedom = 120

Degrees of Freedom for Residuals = 2

4.4.2.2 - Arrival Curb

The following utility equation is the result of multiple regression analysis for the arrival curb:

$$\text{UTILITY} = -0.00842 * \text{TME} - 0.00524 * \text{DIS} + 1.0976$$

- 6.88	-5.61	25.251	t Ratio
- 0.555	-0.478	0.926	Partial correlation

$R^2 = 0.441$

$F = 84.4 \qquad F_{cr} = 3.07$

Degrees of Freedom = 107

Degrees of Freedom for Residuals = 2

CHAPTER - 5

GUIDELINES FOR DEVELOPING CURB STANDARDS

5.1 - APPLICATION OF UTILITY EQUATION

As mentioned in Chapter one, objective of this research is to establish guidelines for LOS standards. This can be achieved by using different approaches. Two of these are based on the utility equations developed in Chapter four, and a third is based on the P-R concept as proposed by Mumayiz and Ashford.

5.1.1 - Developing Curb Standards Compatible With Other Subsystems

Curb standards may results in imbalances between airport subsystems in cases where there is no correlation between the curb and other subsystems. It seems that there is a need to develop some curb standards that are harmonized with those of other airport subsystems. In fact, the optimum size determination concept highlights the importance of using uniform LOS standards for different airport subsystems. Therefore, a preferred suggestion for splitting the utility axis into LOS ranges should reflect standards for other airport subsystems as established by Transport Canada.

A research study conducted by Transport Canada [Transport Canada, 1980) resulted in the establishment of a set of utility numbers that serve as transitions between different service levels. These values were produced by assigning available LOS standards for different subsystems of an airport to the utility equations developed for those subsystems through the research done. In the above mentioned study, the values for each performance measure's LOS range was directly transplanted from the existing standards followed by various authorities, such as Transport Canada. Since Transport Canada standards were given preference, it can be said that these utility values are the most appropriate guides which reflect Transport Canada's LOS standards.

A summary of those transition utility values is provided in Table 5.1 is below:

Table 5.1 Airport Subsystem Utility Values for LOS Transitions

Subsystems	A to B	B to C	C to D	D to E	E to F
Check in	76.6	70.2	58.9	42.0	28.8
Preliminary Inspection Line	84.6	70.2	55.7	40.9	26.9
Baggage Claim	83.6	74.2	66.6	40.2	27.6
Boarding Lounge	86.2	71.2	58.1	41.2	26.3

As can be seen, utility values corresponding to LOS standards are close enough to encourage the author to develop a unique value for each service level transition, applicable to different airport subsystems.

The linear relationship between LOS standards for each airport subsystem, as established by Transport Canada, between utility values and performance measures imply that utility values corresponding to service levels can also be linearly related. To verify this, the numbers 1-5 are assigned to utility values corresponding to service levels A-E and utility values are regressed against those numbers. The following equation is the result of that regression analysis done by computer programming:

$$\text{Utility} = 98.822 - 14.107 * N^1$$

$$55.3 \qquad -26.18 \qquad \text{t Ratio}$$

$$R^2 = 0.9744 \qquad F = 3.90$$

High values for R^2 (0.9744), t Ratio (26.18), and F (4.0), which correspond to a reasonable confidence interval, confirm the availability of an almost perfect relationship between utility numbers. This leads the author to use a regression line to find a unique utility number corresponding to each LOS transition. These values are calculated as shown in Table 5.2.

Table 5.2 Suggested Utility Numbers For LOS Transitions

Level of Service	A to B	B to C	C to D	D to E	E to F
Utility Values	84.7	70.6	56.5	42.4	28.3

Assigning these utility values to different utility equations for individual performance measures, as developed in Chapter four, results in LOS standards for that performance measure. These standards are completely harmonized with Transport Canada's standards for other subsystems of the airport; the reason being that all these standards which correspond to different airport subsystems result in the same utility values, indicating similar perceptions. Developed standards for the departure and arrival curb are shown in Tables 5.3 and 5.4, respectively:

Table 5.3 Suggested Standards for LOS Transistions for Time and Distance at Departure Curb

Performance Measures	A to B	B to C	C to D	D to E	E to F
Time (Second)	13.9	26.3	38.7	51.0	63.4
Distance (Meter)	26.6	40.2	63.3	67.3	80.9

Table 5.4 Suggested Standards for LOS Transistions for Time and Distance at Arrival Curb

Performance Measures	A to B	B to C	C to D	D to E	E to F
Time (Second)	16.9	28.1	42.3	55.1	67.9
Distance (Meter)	13.9	29.7	45.5	61.4	77.1

5.1.2 - Perception Response Approach

Another approach is through the P-R diagram. As mentioned before, the P-R model is a graphical presentation of the collective attitudes of a category of passengers towards the range of operational services at a facility. The procedure of building these models for the curbside, based on the results of the survey, is summarized as follows:

At the beginning, the 1 -7 semantic scale is divided into three levels: good, tolerable, and bad. This is done by assigning "good" to 1 and 2, "tolerable" to 3 and 4, and finally "bad or unacceptable" to 5, 6 and 7. An interpretation of this is places service levels A and B in the good range, and service levels C and D in the tolerable range, and service levels E and F in the unacceptable range.

For each curb arrival or departure, the level of passenger satisfaction with service is shown in the form of three curves. These curves corresponds to three levels: good, tolerable, and bad. The threshold values are determined by tracing the dominant state of passenger satisfaction with service over the full range of the service measures. The points which correspond to shifts in the satisfaction of the majority of the population from one state to another represent a change in the LOS. Therefore, these can be defined as LOS transitions. These values for departure and arrival curbs are shown in tables 5.5 to 5.6, and graphically depicted in Figures 5.1 through 5.4 repetitively.

Table 5.5 Three Range LOS Standards for Time and Distance at Departure Curbside

	Time (Second)	Distance(Meter)
Good to Tolerable	27.1	31.6
Tolerable to Bad	40.8	45.6

Table 5.6 Three Range LOS Standards for Time and Distance at The Arrival Curbside

	Time (Second)	Distance(Meter)
Good to Tolerable	30.6	31.4
Tolerable to Bad	40.8	45.6

The method used above is quote simple. As passengers proceeded through the airport processing points on both the arrival and departure curbs, they were asked to rate the service as good to tolerable and tolerable to bad. The respondents rating was plotted against distance and time. Conceptually, it was expected that the graph would form the shape of a P-R diagram. Unfortunately, such attempts failed, indicating that passengers were unable to distinguish very close levels of service.

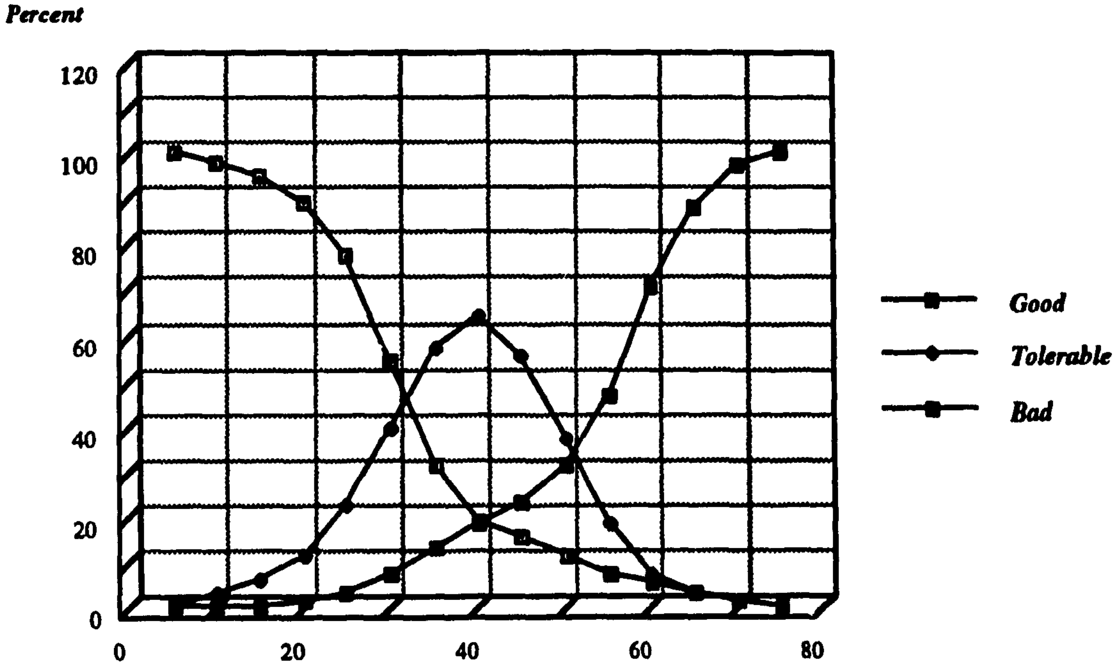


Figure 5.1 P-R Model for Distance, PBIA-Departure Curb

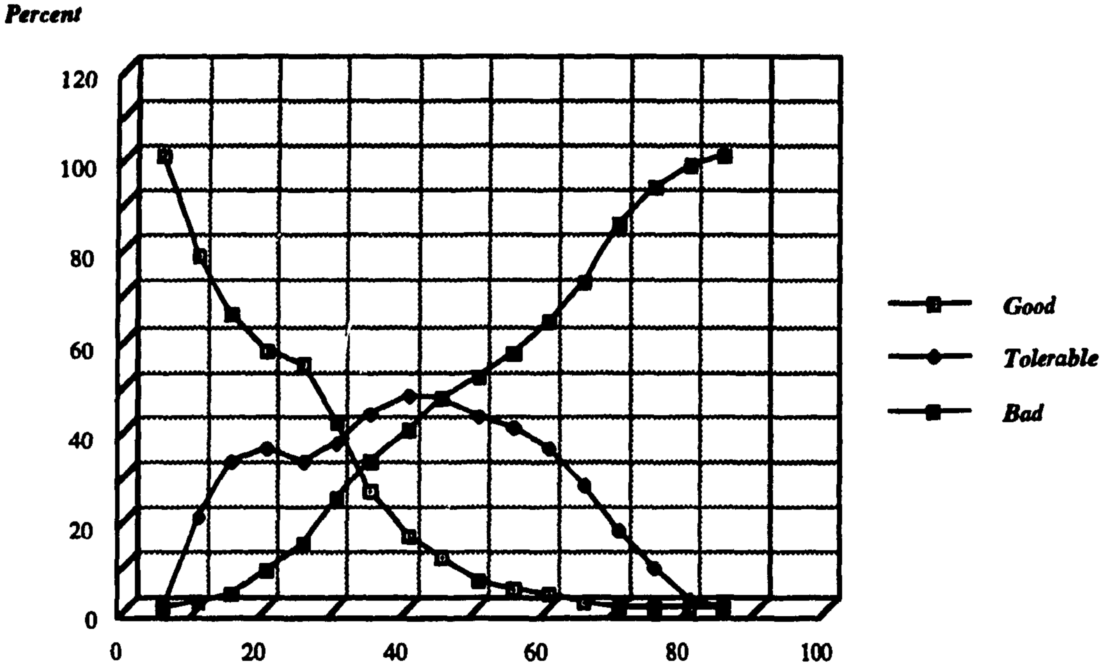


Figure 5.2 P-R Model for Distance, PBIA-Arrival Curb

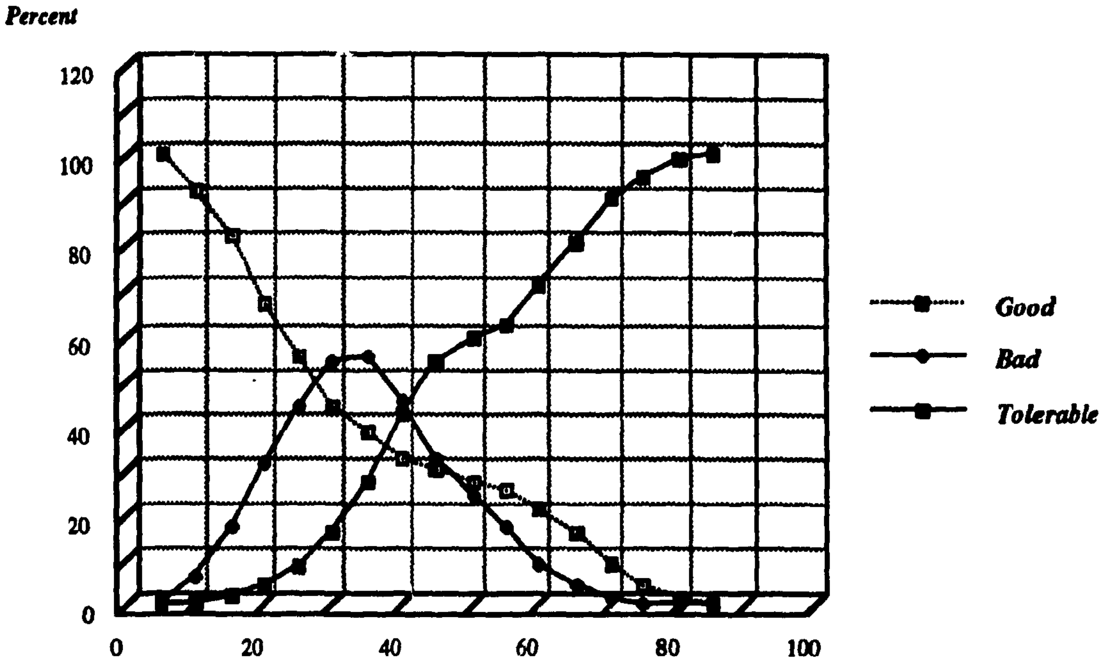


Figure 5.3 P-R Model for Time, PBIA-Departure Curb

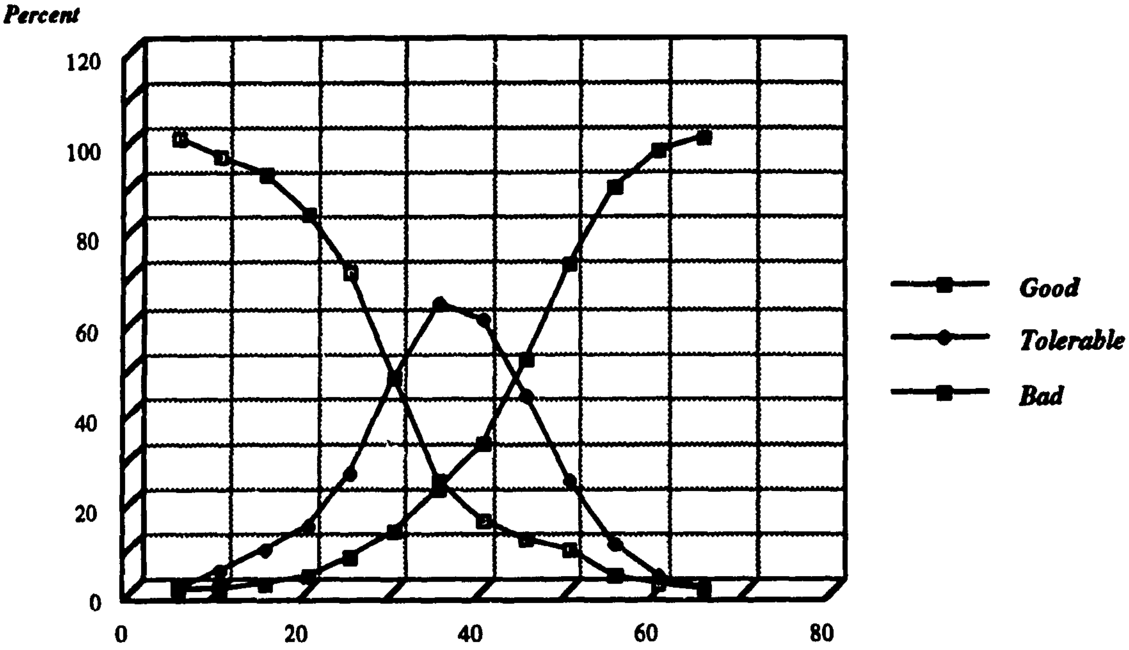


Figure 5.4 P-R Model for Time, PBIA-Arrival Curb

CHAPTER - 6

CURB DEMAND MANAGEMENT BY CHARGING POLICY

6.1 - OVERVIEW

There are certain improvements that, if implemented, can result in improved use of available capacity and better service levels. These improvements can be categorized into two major groups, physical and operational.

As mentioned earlier, physical improvements are less attractive because of high costs and long implementation time. Managerial and operational improvements, however, are gaining more and more popularity. An effective consideration in this category is charging users for using transportation infrastructures, especially for highways. Road pricing has been accepted for some time as one of the methods for managing and alleviating traffic congestion. However, this idea has not yet been applied to the airport terminal curbside. The policy of charging would reduce demand for curbside area, as a result of a reduction in the attractiveness of using the paid curbside area when compared to short term parking facilities. This would make the charging policy a powerful tool for bringing demand in balance with capacity.

6.2 - AN APPROACH TO CHARGING POLICY

Introduction in Chapter one was the idea of taking measures to investigate concepts and principles for charging the users of the curbside. Since the new idea of charging curb users arises from a high increase in demand for curb use and reduced service levels, this policy should be directed toward reducing demand or altering its profile i.e., reducing peak hours and shifting traffic to the parking area. This led the author to develop charging concepts and principles so that this objective could be fulfilled. In order to develop the charging policy a clear idea of curbside capacity factors and causes of congestion is required.

6.2.1 Curbside Capacity Factors

The capacity of service level at the terminal curb is influenced by a series of principle demands or operational factors and conditions. These factors may in turn affect the supply or the demand. Factors affecting supply belong to one of the following groups:

- enforcement policies, and
- facility location.

Factors affecting demand fall into one of the following groups:

- airport level of service,
- user characteristics, and
- vehicle characteristics.

The National Research Council Committee for Airport Capacity Study (USA), has summarized these factors as shown in Figure 6.1 [TRB-215, 1987].

6.2.2 - Causes of Congestion

Operational problems encountered at the terminal curbside are attributable to a complex collection of factors. Although in general, airports exhibit similar characteristics, it is

Factors Influencing LOS and Capacity of the Terminal Curb

FACTORS	DESCRIPTION
Available frontage	Length of curb modified by the presence of obstruction and assigned users e.g., airport limousines only, taxis only, separation of departures and arrivals.
Frontage roads and pedestrains paths	Number of traffic lanes feeding to and from frontage area; pedestrians crossing vehicle lanes.
Management policy	Stopping and dwell regulations, enforcement practices, commercial acccess control, public transport dispatching.
Passenger characteristics and motor	Passenger choice of ground transport mode, average vehicle fleet mix occupancy of vehicles, dwell times at curb passenger pattern of arrival before scheduled departure, baggage loads.
Flight Schedule	Basic determination of number of people arriving and departing in given area.

Figure 6.1 Level of Service and Capacity [TRB-215, 1987]

known that different airports serve different passengers traveling for different purposes. These different categories exhibit different demand patterns and characteristics, hence the type of problems differ from airport to airport. Having this complexity in mind, the problem can be summarized as follows:

- imbalances between the available capacity on the airside sector and the landside area,
- surges due to the arrival or departure of passengers to and from high capacity aircrafts,
- uneven distribution of passengers load the curbs, due to the parking patterns of individual airlines,
- activity concentrations at terminal doors and baggage check-in locations, resulting in imbalances in available space and demand,
- lack of strict enforcement on parking duration restrictions along the curb, resulting in vehicles remaining at the curbs for longer periods than desirable, and
- perceived difficulties in recirculating from the curb area back to parking, from parking stall back to curb or, when unable to find a parking at curb, back again to curb [Mandle, 1982].

Having a clear idea of curbside capacity factors and causes of congestion, it is possible to investigate charging principles and concepts.

6.3 - CHARGING PRINCIPLES AND CONCEPTS

For any policy making to be successful, it is necessary first to observe user behavior and characteristics carefully. Therefore, based on the results of this research and past studies, it is suggested that charging policies be developed with the following factors taken into consideration:

- users e.g., behavior, preferences, acceptance level, and perceptions,
- traffic pattern e.g., dwelling time and peaking characteristics,
- vehicle e.g., occupancy rate, size and type such as commercial, private,
- design e.g., curbside layout, interaction of curb and terminal, and curbside capacity , and
- operation e.g., curb effectiveness.

Although charging curb users can be considered a source of revenue, from the viewpoint of this research, there is another important aspect: it is a tool for managing traffic and bringing demand in balance with capacity. As some professionals have already pointed out, a good LOS for most of the users and an acceptable LOS for the rest of them should be provided. Also, it should not be ignored that although this policy can reduce demand for curbside, at the same time it would increase the users' expectations of the service level.

One of the approaches to the achievement of the stated objectives for effecting a charging policy should be developing an increased effectiveness of the curb area or alternatively, developing a smooth and uniform distribution of traffic along the curbside. A charging schedule thus has the strongest relation to the present distribution of traffic in curb area. This requires development of a model which can predict traffic along the curb. Therefore, the survey and data collection were designed to enable the development of such a model. Collected data on traffic distribution along the curb area are tabulated in Appendix C.

6.3.1 - Curb Traffic Distribution Model

A review of the literature shows that several traffic distribution models have been developed in the past. A model developed in 1976 [Braaksma, 1978], on the basis of field observation and data collection, postulated that the percentage distribution of curb traffic during the peak hour follows a mathematical function. This function is expressed as a negative exponential of the desired walking distance from the edge of the sidewalk at various sections of curb area, and rank order of 25 feet (8 meters) sections from the entrance ramp. This model, in mathematical form, can be expressed as:

$$Y_i = K e^{(-\alpha X_1)} e^{(-\beta X_2)} X_3^{-\gamma} e^{\mu} \tag{6.1}$$

where:

Y_i = percentage of distribution of curb traffic at the i_{th} section from the entrance ramp,

X_1 = desired minimum walking distance from the center of an individual section to the nearest processing facility or entrance door,

X_2 = the rank order of 25 feet (8 meter) sections from the entrance ramp,

X_3 = a correction factor which is the ratio of practical walking distance to desired minimum walking distance. It is equal to one for the general model,

e^u = multiplicate random error term, and

$K, \alpha, \beta, \gamma, \mu$ = Unknown parameters to be estimated.

The above traffic distribution model was developed to simulate user' behaviour with respect to a particular geometric configuration of curb and terminal building. Unfortunately, this model concentrates only on the departure curb. The review of literature shows that no attempt was made to develop any model for predicting arrival curb traffic distribution.

At this stage, it was an important requirement to verify whether or not traffic distribution at the arrival curb follows patterns similar to those at the departure curb. Therefore, based on the collected data, an attempt was made to develop such a model for the arrival curb.

Available data showed that this traffic distribution can at best be described using an inverse relation with total distance from the entrance ramp and a negative exponential function of walking distance between vehicle position and terminal entrance door. This model, in mathematical form, would be written as:

$$Y_i = K\,(X_1)^{-\alpha}\,e^{(-\beta X_2)} \qquad (6.2)$$

where:

Y_i = percentage of distribution of curb traffic at the i_{th} section from the entrance ramp,

X_1 = total distance from the entrance ramp,

X_2 = desired minimum walking distance from the center of an individual section to the nearest processing facility or entrance door, and

K,α,β = unknown parameters to be estimated.

By an appropriate transformation, this model has been changed into a linear equation, and a multiple regression analysis procedure using least square method has been used to find unknown parameters. The final statistical parameters that have resulted from this regression analysis are as follows:

$F = 23.2 \qquad Fcr = 4.74$

The results of this regression analysis show that the model is able to predict user behavior and preferences at the arrival curb and therefore may be proposed as a base for decision making when charging policies have to be set.

Here it should be mentioned that the development of this model is based on very limited data at a single airport. A further comprehensive data acquisition and analyses are required to confirm this model or to develop another one.

6.3.2 - Factors Influencing Charging Schedule

6.3.2.1 - User Behavior and preferences

If it is acceptable that the percentage of peak hour traffic distributed along the curbside reflects driver behavior and preferences, then the developed model for arrival curb traffic distribution would be a good reference for making one of the principles of charging policy. As shown earlier, user preference for loading/unloading positions at the arrival curb has a direct negative exponential relation to distance from the preferred entrance door, an inverse relationship with distance from the entrance door and an inverse relationship with distance from the entrance ramp. Therefore, in the ideal case, charging prices at this area should have an inverse relation to that of the negative exponential function, calibrated specially for the airport, as well as an inverse relationship with the total distance from the entrance ramp. Also, in the case of the departure curb, again by choosing a model for traffic distribution and following the same procedure, the base fare for different parts of the departure curb can be calculated.

The user acceptance level for walking or waiting time will also be considered in this section. It can be shown that charging policies affect these levels. The combination of two influencing factors in the arrival curb traffic distribution model (X_1 and X_2), shows that in general, spaces have descending priority the further they are located from entrance doors. The same relationship can be seen at the departure curb by referring to either of the previously mentioned models for this area. It was also shown that people are more reluctant to walk distances farther than 40 meters. In order to use the charging policy to change an undesirable position, one located far away, to a desirable and acceptable one, it is suggested that loading/unloading positions farther than a certain limit from the last entrance door should be free of charge for a specific period of time.

6.3.2.2 - Traffic Pattern

As long as traffic patterns and their characteristics are considered, dwelling time has been shown to have the highest influence on demand in the curb area. For this reason, the highest priority should be assigned to those policies which can reduce dwelling time. Therefore, it is suggested that the charging schedule should have a minimum free loading/unloading time to increase the propensity of users to leave the curb as soon as possible. Past studies have shown trip purpose has an influence on dwell time [Tilles, 1973]. Such studies have indicated that business users show much lower dwelling time. This phenomenon should be considered properly when setting charging policies. Recent research has also shown hourly, daily and monthly variations in air travel demand. These variations are different for different airports and hence each airport needs it own schedule. Although all of these variations in demand have some important aspects, the hourly variations are the center of focus. Different airport authorities have tried to reduce the load of travellers during hourly peaks by scheduling flights in off peak periods, but no efforts have yet been made to involve charging policies at curbsides in an effort to achieve similar results. It is suggested that a charging schedule provide, off-peak free loading/unloading positions to encourage prior to peak period arrival for those who are going to travel during the peak period.

6.3.2.3 - Vehicles

The most influential factor in this section is the occupancy rate. If by some means, an airport can double this factor a reduction of up to 50 percent of traffic can be expected. It has been suggested that vehicles with a minimum number of occupants should be admitted free or with little charge. This would encourage employees and passengers to share a ride when it is possible.

Another important factor is the type of vehicle, private or commercial. The type and size of automobile can increase curb demand. On the other hand, the charging policy can influence the balance of passengers using public transportation. Therefore, this policy in terms of vehicle type should improve the situation or should increase the use of public transportation and the number of passengers in private vehicles. Special emphasis should be placed on the encouragement of high occupancy public vehicles, and this can best be done by exempting them from fee payment or providing for them a desirable unloading/loading position. Also, the length of vehicles is a major factor to be considered when setting charging schedules.

6.3.2.4 - Curbside

When the curbside layout and the interaction of curb and terminal building is considered, it is evident that the distribution of vehicles along the curbside, in addition to user desire, is a reflection of the layout of the location and type of signs and parking patterns of individual airlines across the curbside. This interaction can cause certain problems. This is evidenced for example, when an airline with a high share of air passengers uses a smaller portion of curb length. This would cause a congestion problem to arise, especially when the airline is located at the beginning of the curb length and can result in sections of the curbside ahead being left unused. Therefore, in an ideal case, users of such airlines and loading/unloading positions should be charged more than for less attractive positions. In general, location of airline signs or other points of interest should be harmonized with desirable traffic distribution along the curb.

6.4 - APPLICATION OF NEW TECHNOLOGY FOR CHARGING CURBSIDE USERS

The impressive growth of computer-based technologies applicable in transportation management has induced research on the application of these technologies to airports. Some airport authorities in the United States [Koelle, 1991], Canada [Robert, 1990] and other countries around the world have begun studies on the application of Intelligent Vehicle/Highway System (IVHS) technologies to intra-airport access systems [Lampe,1993]. As far as ground transportation and the internal access system of airports are connected, terminal frontage roads have special roles, and, as mentioned earlier, these have been investigated as bottlenecks. Due to an enormous growth in computer communication technologies, it could be made possible to have some of these technologies implemented for curbside traffic control and management. Although all possible applications of such technologies have not been investigated completely, the Los Angeles airport is in the process of installing an Automated Vehicle Identification System for improving the use of scarce spaces at terminals [Lampe, 1993]. On the other hand, a policy of charging users of curbside, if designed as a management tool, may need a complicated schedule. If it is to be implemented, it may seem unfeasible if not properly supported by new technologies. In the next section, a short study will be presented which demonstrates how the new technology of traffic control and management can be employed to facilitate the charging of curb users at the terminal building.

6.4.1 Functions of the Needed System

Advanced technology can play an important role in the process of charging users of the curb. This can make the most complicated charging schedules possible. If users are provided with sufficient information, then proper results in terms of better LOS, which are more efficient and function smoothly, would be expected. Some individual technologies, if properly connected, can yield an advanced system for control and management of a charging system.

Before starting to search for appropriate technologies and systems, it is essential to have a clear understanding of the necessary functions of such systems. In conceptual terms, the functions necessary to manage the demand for the terminal curbside area by charging users include:

- identification of special vehicles as they arrive at curbside,
- locating continuously identified vehicles while at curbside,
- checking on the duration of the use of spaces at curbside, and
- remote information collection on traffic flow for future use and refining the schedule.

It should be noted that, from an overall system perspective, it is essential that the design be made flexible and expandable.

6.4.2 New Technologies for Traffic Control

The passage or presence of any vehicle at a given location is detected by using either an Automatic Vehicle Identification(AVI) system [Fukui, 1989] or an Automatic Vehicle

Location (AVL) system [Perlstein, 1989]. The suggested proposal for new technologies is based on these two systems.

There have been a variety of such systems developed in the past to serve different purposes. To have a better understanding, a brief explanation of AVI, AVL and related technologies is provided here.

An AVL system provides the airport authority with real time information related to the location of the desired vehicle in the field. Several AVL systems have been proposed. These are based on different technologies, such as :

- dead-reckoning system
- ground based radio-determination system, and
- low earth orbit satellite-based system.

AVL systems developed in the past have been very complicated, as they require complex on-board micro processors. Today however, new technologies have emerged rendering the system much simpler. One of the newest involves the use of passive identification, which will be discussed later in this section.

An AVI system assists authorities in identifying passages of specially tagged vehicles. This system is formed by some electronic tags mounted on the passing vehicles; readers installed at the proper sites detect the identification numbers of the mounted tags. Therefore, AVI systems are essentially composed of three functional elements:

- vehicle mounted transponder,
- roadside user unit, and

- communication system with associated antennas or sensors.

For either system, different technologies such as sensors or detecting devices have been proposed. These technologies may be further divided into active, semi-active, and passive systems according to the source of power used by the vehicle-mounted tag [Kogstas, 1991].

These categories differ as described below:

- active systems use an electric transponder which takes its power supply from the vehicle on which it is mounted,
- semi-active systems use an internal battery to provide power, and
- passive systems use an electronic tag which is energized by power transmitted from the reading sensor.

Some researchers have classified the transponders or tags based on their type of action, as passive or active. According to these definitions from the transport management authority's viewpoint, a passive tag is a "read-only" device. In an active system, a two way communication is established between the roadside equipment and the read or write tag. Also, from the telecommunication authority's viewpoint, an electronic tag can be classified as passive if it does not have a complete RF (Radio Frequency) transmitter [Jefferson, 1989].

Passive systems are made by using different technologies. One method employed is based on the Surface Acoustic Wave (SAW) technology. In this method, the reader repeatedly transmits pulsed signals. The tag is simply an antenna and a SAW device. The pulses received by tag antenna are encoded by the SAW device with the analog equivalent of a binary number, then returned to the antenna. The amplitude modulation of the echo signal is detected by the reader as the identification of the tag [Robert, 1989]. In this system, the tag requires a powerful supply.

Passive transponders are also designed from semiconductor devices. For such a system, the tag receives a Continuous Wave (CW) signal from the reader, modulates this signal with an identification code stored in its memory, and transmits the modulated signal back to the reader. Recently, read and write systems have been proposed allowing identification tags to be used as smart cards for a wide range of applications [Bright, 1988].

6.4.3 Proposed System

So, far, a brief and clear definition of the related technologies necessary to design a charging system has been provided, If we can follow and monitor carefully all the actions taken by a vehicle as it arrives at a curbside area and as departs the loop, then it is possible to charge the driver based on those actions, even with the most complicated charging schedules. Based on what was mentioned in the previous section, "passive identification is defined as the unique identification of a passive vehicle using local sensors and non-transmitting transponders, typically with Radio Frequency (RF) signals" [Redding, 1988]. For passive vehicle identification, the vehicle has to be equipped with a transponder. As the vehicle passes through the RF field of a sensor, the transponder merely reflects the incoming signals in such a way that a unique code stored in the transponder is conveyed to the sensor. By providing the curbside with a complete cover of the RF field, it is possible to monitor different positions that each vehicle has taken and the corresponding time periods involved at different sections of the curbside. All these signals would be transferred to a central computer and processing unit, where a simple software program easily calculates the charge based on the display of a computer monitor. Calculation of the amount would take place using software which takes into consideration the time of day as well as other important parameters such as occupancy rate or vehicle type.

This system requires all cars to be equipped with transponders. If the cars are not equipped, as is the case today, the transponders at arrival time can be attached to arriving vehicles in the form of a magnetic tag, or can be picked up automatically in the form of electronic tickets supplied through an automatic ticket supplier. Both electronic tickets or magnetic tags are collected at the exit and can be reused for economical purposes. An operator situated at the entrance of the curbside area can introduce necessary parameters, and vehicle characteristics in the form of codes, into tags or charging software. At the exit time these tags would be used automatically to calculate the charge.

6.4.4 - An Alternative Technical Method for Implementing Charging Policy

An alternative way of putting charging policies is through Electronic Road Pricing (ERP) technologies [Menon, 1993]. During the past decade, several ERP systems were commercially developed. An ERP system consists of three main components, namely, an Automatic vehicle Identification (AVI) system, a camera enforcement system, and a computer network. The AVI system is formed by the readers installed at the toll sites to detect the identification numbers. The enforcement camera has to take a photograph of the vehicle in case the reader fails to detect the valid identification number of the passing vehicle. A computer is employed for processing the data captured by the AVI equipment, controlling the enforcement camera, and communicating with the central computer. The ERP system described above is commonly used at highway toll gates or other similar places, but no record was found regarding application of this system for an airport terminal curbside.

To implement this system, the curbside should be divided into free charging zones. Charging zones in turn can be divided into different rate zones. At the beginning of each zone, the reader that detects the identification number attached to the side window or the top of the vehicle is placed at the side walk or above the road. As the vehicles pass each successive reader location or zone border, the vehicle's identification number is detected and the central computer is informed. This computer can monitor and calculate periods of time that the vehicle has spent in each zone. Considering all other contributing factors such as time and season, a charge is attributed to each period. Accumulated charges as the vehicle passes or stops at different zones would be calculated and displayed at the exit, where the driver may be charged through his/her credit card/account or pay cash.

CHAPTER - 7

COST - EFFECTIVENESS OF DESIGN

7.1 - OVERVIEW

The ultimate purpose of a design is to achieve efficient operation and to be as economical as possible. Therefore, in selecting the size of the facility to be provided, balancing all components is very important. Traditionally, investment decisions about transportation have employed only system-specific criteria. Satisfaction of observed demand, capital cost, and profitability were used as measures of transportation system performance in terms of criteria relevant to the workings of the system. For many years, transportation planning studies have attempted to estimate the magnitude of costs and benefits that would generate public investment in transportation facilities. The criterion for accepting an alternative for improvement of a system is that the total quantifiable benefits exceed the total quantifiable costs.

The above approach was clearly ignoring the wider external effects of transportation. A more comprehensive approach necessitates some degree of sensitivity to the social costs and benefits of the action. Recently, secondary effects on the different impact groups have become a focal point of interest. As a result, some researchers have initiated studies on how these impacts are perceived and evaluated by the individuals who make up these groups.

In spite of all the above mentioned sensitivities, procedures developed for evaluating airport design in terms of impacts are deficient. A major deficiency in this area is a lack of well researched user perceptions and acceptance levels, which is a major objective in the present research. However, this is not the only deficiency. To have a better appreciation of these deficiencies, a short review of design elements is required.

7.2 - REQUIREMENTS FOR FACILITY DESIGN AND EVALUATION

Necessary elements of a design procedure can be explained by referring to Figure 7.1. This design procedure is outlined, as follows:

- to establish cost-effective size and configuration,
- to ensure efficient interchanges between facilities, and
- to meet other required criteria, e.g., safety and security.

7.2.1 - Design Volume

As it appears, a facility is designed to serve a certain traffic load at peak periods. However, there is no standard method for choosing a design passenger volume, and there is little agreement about an approach to this traffic level. Among existing methods, the nth percentage traffic, the nth highest hour in the year, and the n^{th} percentage busy hour rate are the most familiar ones. For these three criteria, 90th percentile, 30th busiest hour, and 5% busy hour rate have been the most used ones [TRB-215, 1987]. After choosing an approach to design volume, there is another problem which designers face, and that is predicting the demand profile.

Experience gained from airport studies suggests that characteristics of such profiles, especially those which peak, are largely airport-specific, depending upon many factors such as location of the airports within the network. Of course, this phenomena can be influenced by different policies, marketing, and scheduling factors.

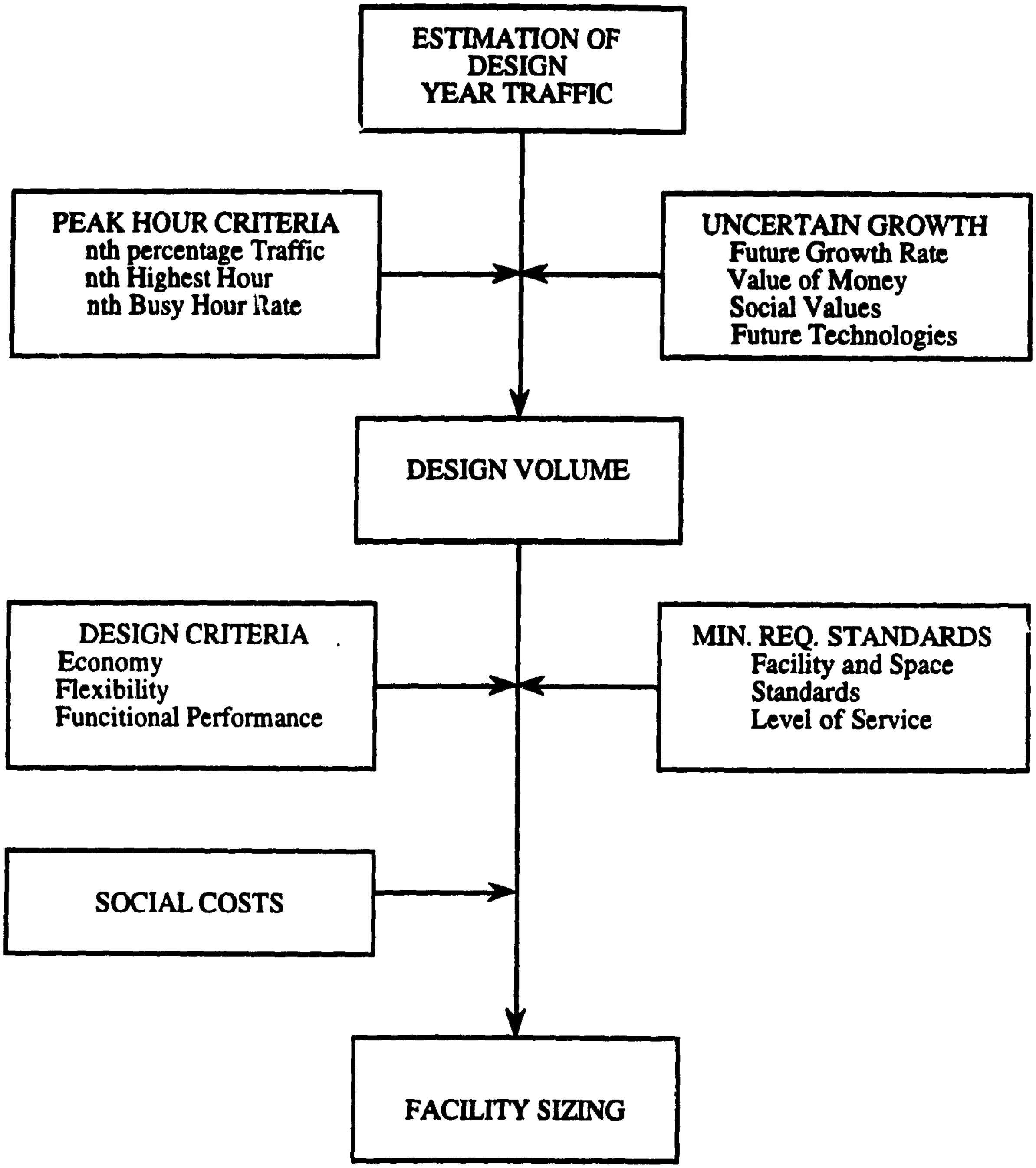


Figure 7.1 Design Criteria

7.2.2 - Facility Sizing

After reaching an agreement on the design volume approach, there are other decisions that designers must make on design criteria. There exits, today, wide body of knowledge containing guidelines and criteria for planning and design often enough, these are revised or updated by various agencies and institutions. Different professionals have looked at the issues of design criteria from different viewpoints and hence have developed different approaches [Rand, 1969]. These can be categorized as:

- functional performance,
- flexibility, and
- economy.

Functional performance criteria covers factors such as operational effectiveness, comfort, convenience, and even safety and security. Obviously the major intention is providing a smoothly operating as well as safe, secure, comfortable and convenient facility. Different requirements in this category have been fulfilled to varying extents in the past, as they were at different importance levels. It is important to mention that universal agreements on some standard levels, as well as their measures have not been achieved. An example of this would be the measures and standard levels for comfort and convenience.

Flexibility and keeping options open are primarily dictated by uncertainty of the future. Growth patterns as well as their distributional effects on different parts of airports cannot be predicted accurately for long periods of time. This is why many professionals have pointed to the concept of growth of a time phased strategy [TRB-215, 1987]. Hence, the interest is with the potential to respond to growth, interchanges with other airport facilities, future technologies, and operating policies.

The criterion of economy is an overriding one, given economic constraints for capacity expansion and facility modernization. There is an increasing trend towards the use of economic efficiency or cost-effectiveness as the basis for investment decisions. Also, there is some interest in traveler costs since they relate to capacity and LOS decisions [Govt. Canada, 1986].

It is worth noting that some of these criteria may seem to represent opposing objectives. For example, it may seem that the economy criterion, which requires minimum total cost and service level, a constituent part of functional performance, require trade-offs. In this research, it will be illustrated that it is possible to improve LOS in a cost-effectiveness manner.

7.2.3 - Design Service Level

Even if international agreement on the approach to design volume is reached, and a balance between different design criteria is chosen, there is still one more question left unanswered; is that of design service level. Poor attention has been given in the past to the problem of choosing a LOS as one of the requirements of facility sizing. Today, many authorities and professionals have pointed to the problem of oversupply or excessive service level in the past. This problem was due to the luxury nature of air travel during its initial rapid growth after the Second World War. A recent review of airport planning has concluded that service level and unit cost of providing that service in airport subsystems is excessive. The review also emphasized that a significant reduction in LOS could be achieved with minimum impact on air travelers and air carrier industries [Govt. Canada, 1986]. However, this discussion does not apply equally to all subsystems of airports, and should not distract from the proper concern of various interest groups about insufficient capacity to serve the rapidly rising demand. While excessive supply of some subsystems is noted, bottlenecks in others are apparent. An important objective in airport planning is to seek a balance between demand and supply at a minimum cost to society.

7.3 - NEED FOR A BETTER APPROACH TO FACILITY SIZING

The present engineering criteria have been severely criticized on some grounds. An important issue is the current use of arbitrary standards without examination of the benefits and costs involved. For example, since 1974, the 90th percentile has been used as the planning standards, while there has been no consideration of whether or not it is too generous. Transportation investments always involve decisions made under uncertainty. The problems posed by complex systems, open to change in many directions, have given rise to newer and broader sets of issues. The uncertainties due to political, social, environmental, and service quality criteria have compounded almost without limit. Of these, two of the most significant are future demand and user level of acceptance. Today, it is believed that over-estimation has caused excess capacity to be built at high cost. Also, some authorities agree that the size of some facilities may be reduced without much reduction in service levels [Govt. Canada, 1986]. This discussion points to a need for relating facility sizing procedures with service levels and economic parameters to ensure that cost-effectiveness evaluation will not be overruled by the use of technical criteria for the development of curbside facilities.

7.4 - COST-EFFECTIVENESS ANALYSIS

As noted earlier, for many years the economy of a design was measured in terms of capital, operation, and maintenance costs. It was ignored that the economy of design also depends on how a facility is used, and what the social costs/benefits associated with that use are. Today, the proposed evaluation criterion is cost-effectiveness. The need for considering effectiveness in relation to cost is more perceptible than ever before.

In airport planning and design, cost-effectiveness analysis is useful for understanding and comparing different performance levels by providing an estimate of cost with possible pay-offs. In the process of cost-effectiveness evaluation, a major question is the proper definition for measures of effectiveness. Choices of measures of effectiveness is a difficult task, because it must have two conflicting characteristics. First and most important it must be relevant; secondly, but less important, it should be measurable. These objectives are conflicting because the most relevant factors are often very difficult to measure.

Existing effectiveness evaluation of the terminal curbside involves mostly subjective judgments due to the

- lack of qualitative measures of effectiveness,
- lack of understanding of level of user's acceptance, and
- lack of understanding of the interaction between the terminal building layout and curb utilization.

The understanding of how people perceive different performance levels, recognition of factors that contribute to this perception, and determining user level of acceptance, as covered in previous chapters, provide an excellent base for cost-effectiveness evaluation of various performance levels of the terminal curbside area. Time and distance are also appropriate measurable factors and have served as performance measures in previous stages. This leads us to believe that they can be properly used at this stage as well.

7.5 - COST-EFFECTIVE SERVICE LEVEL

As mentioned earlier, the search for a cost-effective and efficient service level has been clearly ignored in the past. There is a real need for a procedure which can yield the most efficient facility size to avoid problems of over-and-under supply. Also, proper expansion of the curbside area would result in a better acceptance of the subsystem users. On the other hand, this expansion requires more capital investment and would increase operation and maintenance costs. Figure 7.2, shows these relationships conceptually for a continuous range of facility sizing. In this graph, increasing and decreasing curves for different levels of performance represents the cost of facility provision. It seems logical that the best facility size should minimize total cost. This minimum total cost corresponds to a specific size of facility, which in turn corresponds to a specific service level. Obviously, this is a more cost-effective service level. In the following section, using data collected at PBIA, this cost effective service level will be determined.

7.6 - COST-EFFECTIVE EVALUATION OF VARIOUS SERVICE LEVELS

This area of study is intended to establish the cost effectiveness of various performance levels at the PBIA curbside area, and consequently to find the most cost-effective service level. In order to compare the cost effectiveness of various performance levels as was defined in previous sections and shown in Figure 7.2, two cost items are required. These are, cost of facility provision and the associated social cost. Here, the cost items for the terminal curbside area at PBIA are calculated and the cost-effectiveness of different performance levels is established. Using this procedure, the most cost-effective LOS is determined.

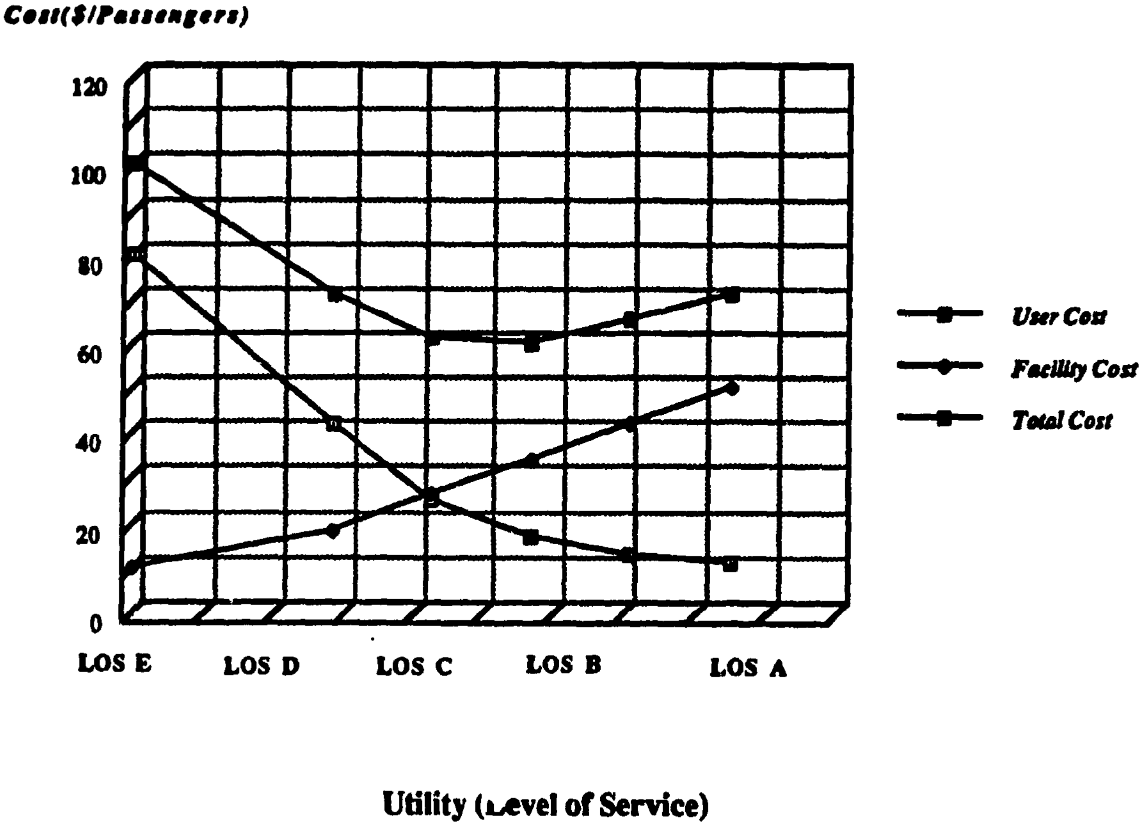


Figure 7.2 Cost-Effectiveness Evaluation (Conceptual Diagram)

7.6.1 - Costs

Total costs attributable to the operation of the curbside area can be divided into two categories. The first is the cost of providing, maintaining, and operating the facility. The second is the equivalent monetary cost of physical and psychological discomfort perceived by users i.e., user costs. These two categories of costs for the terminal curbside are calculated by methods discussed in the following sections.

7.6.1.1 - Cost of Facility Provision at Present Service Level

The cost of facility provision consists of two distinct elements:

- capital cost, and
- operating and maintaining costs.

There are two methods for cost estimation that are very common. One of them is based on statistical techniques and the other is the engineering unit cost method [Morlock, 1987].

Statistical cost models are based on the relationship between costs and output variables. The relationship could be for a single system over many years or for many different systems over a specific time. In these types of cost models, all output variables are estimated after examining the actual cost data of the representative system. For many reasons, one being difference in costing environments for different systems, the statistical cost approach gives only approximate results. This approach is useful, in preliminary planning of facilities, for obtaining a probable cost range.

The second approach is based on engineering unit cost models which are used when a specific system is to be evaluated. The cost estimate is based on unit costs, therefore this type of model can be adjusted to a variation of costing items. If the unit cost of various items relating to capital as well as operating costs are known, then the most accurate cost estimate can be obtained by using this approach.

To calculate the cost of the curb provision accurately, it is divided into capital cost and operating cost. These are then further divided into their respective components. The exact cost of each item was provided by related departments at the PBIA or estimated wherever exact items were not available. These cost items were then converted to cost per person and discounted at a interest rate of 6% over their respective lives wherever necessary. The final result of this analysis showed that the cost of providing, maintaining, operating the curbside area at present service level "LOS A" and the present dollar term is equal to 80.1 cents/person. The calculation process is summarized in Appendix E.

7.6.1.2 Cost of Facility Provision at Different Service Levels

In the previous section, the cost of provision and operation of the curbside area at PBIA was determined. This cost corresponds to "LOS A", and was verified to be the operating level of the terminal curbside at PBIA. To verify the cost-effectiveness of various performance levels, it is necessary to have an estimation of this cost corresponding to the different service levels "LOS A" to "LOS E". To provide these items, it is necessary to find out the required expansion percentages that can improve performance level of the curb area from "LOS E" to "LOS A". These percentages can be calculated through mathematical procedures and statistical considerations. As mentioned earlier, for each specific facility size, the probability of finding an empty parking stall upon arriving at the curbside can be found through equation 3.1. Conversely, having probabilities, it is possible to calculate required facility size to maintain that certain probability of delay. These facility sizes for terminal curbside are calculated and shown in Table 7.1. All sizes are calculated ralative to "LOS A" which as a base is assigned number "100".

Table 7.1 Relative Curbside Size Corresponding to Different Service Levels.

Level of Service Transitions

	A to B	B to C	C to D	D to E	E to F
Curb Size[4]	100	89.5	77.9	69.0	62.5

Since the facility provision cost per person at level of service "A" is known, by assuming a linear relationship between provision cost and facility size, within reasonable dimensions it is possible to calculate the cost corresponding to different service levels. The costs for the curbside area at PBIA are calculated and shown in table 7.2.

Table 7.2 Facility Provision and Operating Costs at Different Service Levels

Level of Service Transitions

	A to B	B to C	C to D	D to E	E to F
Cost ($/Persons)	.801	.874	.842	.889	.986

---

[4] Relative sizes are calculatrd at 227 V.P.H.

7.6.1.3 - Social Cost

Estimating social costs i.e., the cost of physical and psychological discomfort, is extremely difficult, due to the nature of these perceptions. In order to simplify and to make the calculation practical, it was decided in this research to define this cost as the monetary value of perceived disutility of users. This cost can be deduced from the appropriate combination of primary and secondary data.

As each passenger enters the terminal curbside area, he/she is faced with an unspecified amount of time and distance which together may cause a specific disutility perceived by the passenger. The amount of money that the user is willing to pay to be relieved of this discomfort of time and distance can be estimated from the questionnaire responses. This research focuses on defining this amount of money as the user cost attributed to perceived disutility of spent time and/or covered distance in the curbside area. This money comprises the user cost/person corresponding to a certain utility number, or, equally to a, service level.

To express this relationship in a mathematical form, the utility numbers for different individuals are regressed against the amount of money that they are willingly to pay if disutility is relieved. The results of this regression for the departure and arrival curbs are as follows:

$M = 1.059 - 0.00763 * U \quad R = 0.302 \quad F = 12.1 \quad F_{cr} = 3.92$ (Arrival)

$M = 0.850 - 0.00578 * U \quad R = 0.236 \quad F = 6.3 \quad F_{cr} = 3.93$ (Departure)

where:

M = Stands for money that user is willing to pay, and

U = Stands for perceived utility number.

To find out user costs corresponding to different levels of performance, utility values corresponding to these levels would be assigned to the above mentioned equations. After taking into account probabilities (introduced by Transport Canada) and relative weights of performance measures (assigned by users), user costs corresponding to different service levels can be calculated. These costs are calculated and tabulated in Table 7.3. As can be seen facility provision costs and the total costs are also recorded for different service levels. This process of calculating user costs is shown in appendix E.

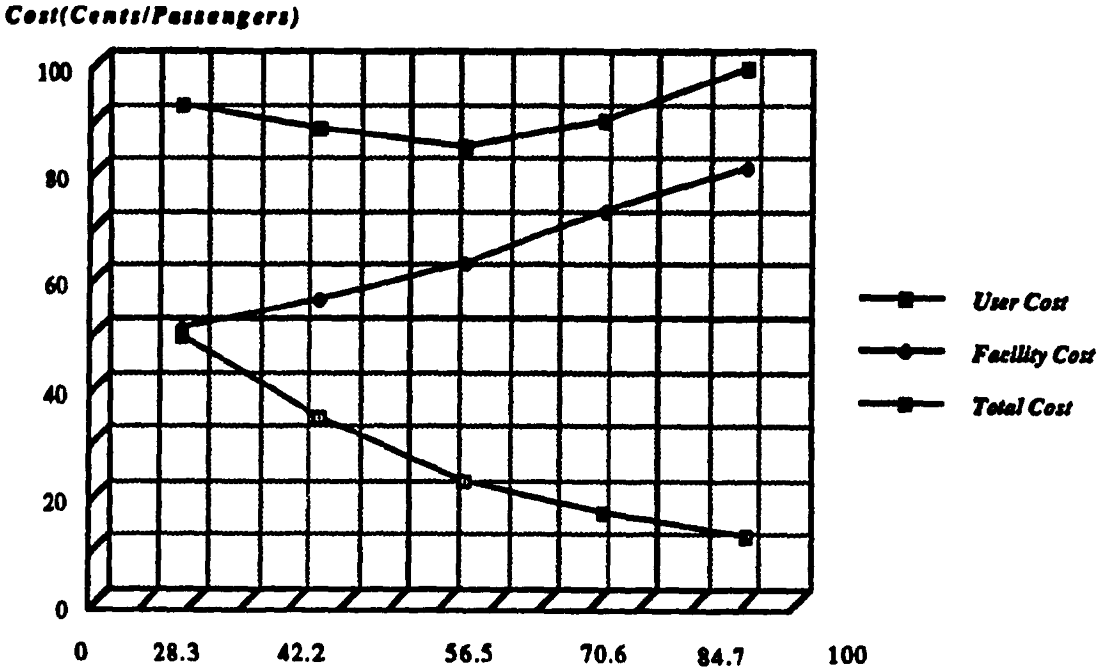
Table 7.3 Different Costs Corresponding to Different Performance levels

Level of Service Transitions

	AtoB	B to C	C to D	D to E	E toF
User costs	.116	.159	.219	.336	.485
Facility Provision Costs ($/persons)	.801	.717	.623	.552	.501
Total Costs ($/persons)	.917	.876	.842	.888	.986

7.6.1.2 - Cost Effectiveness Evaluation.

After calculating all necessary cost items, it is possible to graphically evaluate cost-effectiveness of various service levels. This graph for the terminal curbside at the PBIA is developed and shown in Figure 7.3. As it appears on the graph, the first curve represents a variation of user costs for different performance levels. The second curve shows the cost of the facility provision, and the third curve, which is the result of adding curves one and two, illustrates the cost-effectiveness of various service levels. It is evident that the level of service "C" corresponds to the lowest costs and consequently can be suggested as the most cost-effective service level.



Utility Number-Level of Service

Figure 7.3 Cost-Effectiveness Evaluation, Terminal Curb, PBIA

CHAPTER - 8

8.1 - OVERVIEW OF THE RESEARCH WORK CONCLUSION AND RECOMMENDATIONS

Until recently, research on the "LOS A" criteria and standards for the design and evaluation of landside facilities has ignored user perception of the criteria and standards. It was just a few years ago that some limited attempts were initiated in measuring user perception, and even that was restricted to the terminal building. Additionally, user cost has not yet been incorporated in planning and design procedures. No record attempt has been made to determine a cost effective level of service to provide a base for facility size determination. This genuine lack of understanding of user perception and the ignorance of the social cost of providing the facilities has resulted in arbitrary service standards, and over or under supply of airport facilities. The present research work was initiated in response to this deficiency and lack of understanding of demand and supply issues in the terminal curbside area.

In this research, LOS criteria for the curbside area, based on the concept of the utility of performance measures as perceived by users, are established. The user value of performance measures, related to the curbside, were directly assessed through an attitudinal survey, and individual as well as composite utility equations have been calculated. These equations have resulted in LOS standards for the curbside area.

Furthermore, user perception of the LOS was related to a monetary value, that users attributed to associated psychological and physical utilities. A method has been established to take into account social costs in design procedures. The cost effective LOS, taking into account social costs, was found through a graphical method.

Charging policy as a powerful tool for demand management at the curbside area has been analyzed, and finally, a computer based communications method to implement a charging policy and manage traffic demand in the curbside area is established.

8.2 - CONCLUSIONS

The proposed methodology for measuring user perception and defining LOS is based on the user preferences and desires in response to the necessity of incorporating user values in airports. The approach developed in this research may be used to deal more realistically with user perception in the curbside area. The inclusion of user and other costs in the process of planning and design serves as a guideline for taking human values into consideration.

The specific conclusions of this research work may be summarized as follows:

- Time and distance are two important factors which contribute to the LOS perception by users. Consequently, the curbside area can be defined in terms of these two contributing factors,
- Utility theory can be successfully applied to measure users perception and to establish LOS standards,
- Utility theory can be successfully applied to determine the cost of physical or psychological disutilities and subsequently to establish cost effectiveness of various performance levels,

- If social costs are taken into account, the most cost effective LOS is "C".

- Users in general, are willing to pay more money if they are provided with a better LOS,

- There is a good potential to successfully apply charging policy in managing demand for curbsides and to bring traffic into balance with capacity,

- There are situations in which increasing the curb length does not necessarily improve the LOS, since users dismay long walks, and

- Terminal layout, location of doors, and other design decisions significantly affect LOS . Curb expansion, regardless of the terminal layout, is not necessarily the solution for LOS.

8.3 - RECOMMENDATIONS

Although this research has illustrated that utility theory is applicable to the curbside area for measuring user perception, and consequently for determining offered LOS, further and comprehensive data acquisition activities are required to establish or verify findings of this study at other airports in North America. On the basis of this limited survey and associated studies and analyses, the following recommendations can be formulated:

- An airport landside capacity manual is needed for planning and design,

- The LOS of the curbside might be applied to other airport subsystems. Any shift from this framework is not recommended because transportation professionals are alredy familiar with this concept and framework due to their experience with highway and pedestrian planning,

- Airport authorities should be made aware of the sensitivity of users to waiting or delay time and walking distance as curbside performance measures, which in turn affect LOS,
- Further surveys would result in more accurate utility numbers and improved understanding of user values. Also, surveys at more congested airports are necessary to verify and refine established standards,
- To avoid over or under supply of airport facilities, the "LOS C" is recommended as the basis of size determination. For projects with a long life cycle or high rate of demand increase, "LOS B" might be considered,
- Social costs are an inseparable part of the total cost and should not be underestimated in planning and design procedures,
- Charging policy is a powerful tool in managing curb demand and might be successfully applied for congested curbs,
- User behaviour, trade-offs of LOS and cost factors should be considered in curb design procedures,
- Further studies and innovative layouts are necessary to minimize walking distance and waiting time at curbside areas, and

- Available computer-based communication technologies can provide dynamic charging schedules. These technologies, when properly integrated, facilitate the management of traffic in airport ground transportation systems.

REFERENCES

1) Alfred, L. K., West, T. M., and Rentz, W. F., "***Engineering Economics***", McGraw-Hill Ryerson Limited., 1993.

2) "***Airport System Capacity***", Transportation Research Record, Transportation Record Board, Special Report 226, Washington D.C., 1990.

3) "***Airport Terminal Building - Processing Curb Methodology***", Construction Engineering and Architectural Branch, Transport Canada, 973

4) Ashford, N., "***Level of Service Design Concept for Airport Terminals***", Transportation Planning and Technology, Vol. 12, U. K., 1988.

5) Braaksma, J. P., and Chee-Yun, M., "***Effectiveness Measures for Airport Departure Curbs***",Transportation Engineering Journal of ACSE, Vol 104, No TES, 1978.

6) Bright, R. "***Smart Cards: Principles, Practices, Applications***", Ellis Horwood Ltd., Publisher, Chicester, London, U.K., 1988.

7) Brog, W., "***New Survey Methods in Transport***", Transportation Research Record 1199, Transportation Research Board, Washington D.C., 1988.

8) Cherwony W., and Zabawski F., "***Airport Terminal Curb Front Planning***", Abrams-Cherwony and Associates, Philadelphia, Pennsylvania, 1986.

9) "***Curb Activity Study Report***", AK-67-09-246, Airport Facilities Branch, Service Structure Division, Transport Canada, Ottawa, 1978.

10) Eckenrode, R. E., "***Weighting Multiple Criteria***", Management Science, Vol. 12, No. 3, USA., November, 1965.

11) Fishburn, P. C., "***Nonlinear Preferences and Utility Theory***", John Hopkins Press, Baltimore, 1988.

12) Gieck, K., ***"Engineering Formulas"***, Secound Edition, McGraw-Hill Book Company, New York, 1979.

13) Gorstein, M., ***"Airport Ground Planning Guide"***, Transportation System Centre, Cambridge, Massachusetts, July, 1980.

14) Goverment of Canada, ***"Transportation Programs, Economic Growth, A Study Term to Task Force Review"***, Ottawa, 1986.

15) Hamazawi, S.G.,***"Airport Traffic Analysis Model"***, User's Guide, Report 3935, AK 41-02-300, Transport Canada, Ottawa, 1986.

16) ***"Highway Capacity Manual"***, Special Report-209, Transportation Research Board, National Research Council, Washington, D.C., 1985

17) Hoel, L., ***"Public Transportation : Planning Operations and Management"***, Englewood Cliffs, N.J., Prentice Hall, 1979.

18) Jefferson, R. L., ***"Low Energy Microwave Automatic Communications Systems"***, IEE Proceeding of the Secound International Conference on Road Traffic Monitoring Feburary, 1989.

19) Khan, A. M., ***"Ground Transportation Remote Traffic Monitoring"***, Transport Canada Document AK-67-09-373, Ottawa, Canada, 1986.

20) Kostagas, G. Z., and Christos, D., ***"Integrating Geographic Information System (GIS) and Automatic Vehicle Location (AVL) Technologies for Improving the Emergency Response Capabilities of Electric Utilities"***, Proceeding, 1991 Vehicle Navigation & Information System Conference, Vol. 1, Published by Society of Automotive Engineers Inc., USA., 1991.

21) Koelle, A. R., ***"Advances in Practical Implementation of AVI Systems"***, Proceeding, 1991 Vehicle Navigation & Information System Conference, Vol. 2, Published by Society of Automotive Engineers Inc., USA., 1991.

22) Lampe, A. J., *"Effects of Road Access Pricing at Los Angeles Airport: A Case Study"*, Institute of Transportation Engineers. Washington, D.C., 1993.

23) Leong, R., *"An Unconventional Approach to automatic Vehicle Location and Control for Urban Transit"*, Proceeding, 1989 Vehicle Navigation and Information System Conference, Vol 1., Published by Society of Automotive Engineers Inc., Canada, 1989.

24) Louviere, J. J., *"Laboratory-Simulation Verses Revealed-Perferences Methods for Estimating Travel Models"*, Transportation Research Record 794 Transportation Research Board Washington D. C., 1981.

25) Mandle P.B., Whitlock E.M., Lamagna F., *"Airport Curbside Planning and Design"*, Transportation Research Record, Transportation Research Board.,USA., 1982.

26) Menon, A.P., Lam, S. H., and Fan, S. L., *"Singapore's Road Pricing System: Its Past, Present, and Future"*, Journal of Institute of Transportation Engineers, Washington. D.C., December, 1993.

27) *"Measuring Airport Landside Capacity"*, Transportation Research Record, Special Report 215, Transportation Research Board, Washington D.C., 1987.

28) Montgomery., D. C., and Peck., E. A., *"Introduction to Linear Regression Analysis"*, John Wiley and Sons, New York, 1982.

29) Morlok, E. K., *"Introduction to Transportation Engineering and Planning"*, McGraw-Hill Book Company, 1978.

30) Mumayiz, S., *"Evaluation Performance and Service Measures for Airport landside"*, Transportation Research Record 1296, Transportation Research Board, Washington D.C., 1991.

31) Mumayiz S., and Ashford N., ***"Methodology for Planning and Operation Management of Airport Facilities"***, Transportation Research Record 1094, Transportation Research Board, Washington D.C., 1986.

32) Neufville, R, De., ***"Demand for Acess services"***, Traffic Quaterly, The Eno Foundation for Transportation, Wesport Connecticut, October, 1973.

33) Perlstein, D., ***"Automatic Vehicle Systems: A Tool for Computer Aided Despatch System of the Future"***, Proceeding, 1989 Vehicle Navigation and Information System Conference, Vol 1, Published by Society of Automotive Engineers Inc, Canada, 1989.

34) Rand Coroporation Memorandum, RM-5869-DOT, ***"Measurement and Evaluation of Transportation System Effectiveness"***, September, 1969.

35) Ronald, E. W., and Myers, R. H., ***"Probability and Statistics for Engineers and Scientists"***, Macmillian Publishing company, New York, 1989.

36) Rudding, R., ***"Technological Options for Passive Identification of Urban Buses"***, Proceeding of the International Conference on Automatic Vehicle Location in Urban Transit Systems, September, 1988.

37) Shane., R. M., and Tung., A., ***"Fundamentals of System Engineering: Probabilistic Models"***, Addison-Wesley Publishing company, Reading, Massaachusetts, 1990.

38) Skinner, R. E.,***"Airport Choice: an Empirical Study"***, Transportation Engineering Journal. Vol 102, No. 4, 1976.

39) ***"The Airport Landside Simulation Model"***, U.S. Department of Transportation, Transportation System Centre, Cambridge, Massachusetts, 1980.

40) Tilles. R., ***"Curb Space at Airport Terminals"***, Traffic Quarterly. The ENO. Foundation for Transportation, Wesport Connecticut, October, 1973.

41) Transport Canada, *"Interim Level of Service Standards"*, C.A.S.E. 1977, AK-14-06-500, Ottawa., January, 1979.

42) Transport Canada, *"A Discussion Paper on Level of Service Definition and Methodology for Calculating Airport Capacity"*, Airport Service Branch, Ottawa, April, 1979.

43) Turbbell, A., *"Airport Terminal Building: Processing Curb Methodologies"*, Ministry of Transport, 1973.

44) Whitlock E.M. and Cleary E.F., *"Planning Ground Transportation Facilities for Airports"*, Highway Research Record 274, Transportation Research Board, Washington D.C., 1969.

LIST OF APPENDICES

DATA

COMPUTER OUTPUTS

D.1 - STATISTICAL ANALYSIS

D.2 - DERIVATION OF UTILITY EQUATIONS

D.3 - NON - LINEARITIES

D.4 - EFFECT OF QUALITATIVE VARIABLES

D.5 - REGRESSION OF (DMON) AGAINST UTILITY NUMBERS

CALCULATIONS

APPENDIX -A

APPENDIX - A.1

GLOSSARY

Airside	Airport facilities associated with aircraft movements to transport passengers and cargo, used primarily for landing and take-off, e.g., runways, taxiways,
Capacity	Capability of the lanside or its functional components to accommodate passengers, cargo, ground transport vehicles, and aircraft.
Curbside Area	The road and roadside alighting area immediately in front of the passenger terminal building.
Delay Time	The time that each vehicle experiences in the process of finding an unloading or loading position in the curb.
Demand Characteristics	Number of air passengers and aspects of their behavior that materially affect the ability of a functional component or group of components to accommodate them. Such factors as the timing of passenger arrivals at the airport, age, trip purpose, fare paid are often important.
Deplaning Curbside	The curbside area which is used by passengers who leave the airport for their land destination.

Double Parking	Short term stopping when two vehicles in separate lines are parallel to each other at more or less the same curb space.
Enplaning Curbside	The curbside area which is used by passengers boarding aircraft from landside.
Entrance Ramp	A length of roadway connecting the access road to the enplaning curbside used by enplaning passengers.
Landside	Refers to those facilities such as, ground access, parking and check-in that interact to serve air passengers and cargo within the airport.
Maximum Throughput	Maximum rate at which passengers or aircraft, ground transport vehicles, pieces of baggage, etc, can be processed by functional component or group of components.
Mixed Curb Use	The curbside is used on a free competitive basis for all ground transport modes, i.e., there is no dedicated space for a particular mode.
Peak	A defined period of time when the highest numbers of volume are experienced.
Performance Measures	Factors that can measure level of performance of functional components.

Rank Order	The number of eight meter (25 feet) spaces, measured from the entrance ramp.
Service Level	The quality and conditions of service of a functional component or group of components as experienced
Service Time	Time required, excluding waiting time, to process a passenger at a functional component.
Service Volume	Number of passengers or aircraft, ground transportation vehicle, etc, with particular demand characteristics that can be accommodated by a functional component or group of components during an analysis period at a given service level.
User	Broadly understood to include passengers, airlines, cargo shippers, concessionaires, and others who use airport landside facilities and services. In this research passengers are the principal users.
Walking Distance	Distance that user should walk between unloading/loading position to entrance door.

APPENDIX - A.2

NOMENCLATURE

D_1	Total distance from ramp.
D_2	Desired minimum walking distance from center of individual section to nearest processing facility or entrance door.
DBUS	Variable representing passengers who were on a combined trip, i.e., recreational and business.
DF	Degree of Freedom
DNONBUS	Variable representing passengers who were on a non-business trip.
DIMP	Variable representing ranking of distance and time as indicated by respondents.
DZE	Variable representing sex of the respondents.
e	Multiplicate random error term.
FAA	Federal Administration Aviation.
HCM	Highway Capacity Manual

IVHS	Intelligent Vehicle highway System
LOS	Level of Service
r	Correlation Coefficient
RATTME	Variable that indicates the rating of delay time to find a loading/unloading position in departure or arrival curb as perceived by the users while they were looking for a parking stall to get out of the car. This rating ranges from 1 to 7 which represents very satisfied to very dissatisfied.
RATDIS	variable representing rating of walking distance between loading/unloading position and terminal door as perceived by users. The value of this variable ranges from 1 to 7, representing very satisfied to very dissatisfied.
TC	Transport Canada
X_1	Desired minimum walking distance from center of individual section to nearest processing facility or entrance door.
X_2	The rank order of 25 ft. sections from the entrance ramp.
X_3	A correlation factor which is the ratio of practical walking distance to desired minimum walking distance. It is equal to one for the general model.

Y_i	Percentage of distribution of curb traffic at i_{th} section from the entrance ramp.

APPENDIX - B

FOR BETTER LIVING

CONCORDIA UNIVERSITY
PASSENGER SURVEY AT W. PALM BEACH (FLORIDA) AIRPORT CURBSIDE

Madam/Sir:

I am from Concordia University, Montreal, and conducting a survey of level of service. Could you please complete this questionnaire?

Is the arriving passenger travelling alone, if not number of persons in the party? Alone ☐ Together ☐ Party size	**For Office Use Only** **F** ☐ **M** ☐ **License Plate Number**__________ **Entrance DoorNumber**__________
Trip Purpose? Business ☐ Non Business ☐ Combined ☐	**Parking:** **Immediately** ☐ **Delayed** ☐ **Single** ☐ **Double** ☐
Flight Type? Domestic ☐ International ☐ Transborder ☐	**Stall No.** .... **Time.** ....

On a scale of one to seven, 1 for very satisfied and 7 for very dissatisfied, how do you rate the distance between where you have waited for your party and where you wished to be?

1..........2.........3..........4..........5..........6.......7

On a scale of one to seven, 1 for very satisfied and 7 for very dissatisfied, how do you rate the waiting time to find the parking to pick up your passenger?

1..........2.........3..........4..........5..........6.......7

Among the following two factors, please check the one which is more important to you.

Short waiting time to locate the parking stall (loading position) ☐

Short distance (from entrance door to loading position) ☐

How much would be willing to pay if you were provided with a loading/unloading position close to the terminal door immediately after your arrival ? Please check one

less than $1 ☐ $1 ☐ $2 ☐ $ 3 ☐ more than $3 ☐

For office use only : Initials .... Date .... Airport .... Terminal .... No ....

YOUR COOPERATION IS VERY APPRECIATED

APPENDIX - C

DATA COLLECTION

APPENDIX - C.1

COLLECTED DATA AT PBIA DEPARTURE CURB

The following defines each column number in the data table to follow:

Column No.	*Symbol*	*Definition*
1	*NO*	Rank order
2	*DSX*	Dummy variable time interviewed users had waited.
3	*TME*	Actual measured time representing sex of the respodents.
4	*RATTME*	Variable representing rating of delay time in finding a loading/unloading position in arrival curb as percieved by the users. The value of this variable ranges from 1 to 7, representing very satisfied to very dissatisfied.
5	*UTTME*	Transformed value of time rating to a 0 to 100 utility axis
6	*RATDIS*	Variable representing rating of walking distance between loading/unloading position and terminal door as percieved by the users. The value of this variable ranges from 1 to 7, representing very satisfied to very dissatisied.
7	*UTDIS*	Transformed value of distance rating to a utility axis.
8	*DIS*	Actual measured distance that interviewed users had walked.
9	*DIMI*	Dummy variable representing ranking of distance and time as indicated by respondents.

10	***COMUTME***	Composite utility number calculated with an attributed weighting function for time.
11	***COMUTDIS***	Composite utility number calculated with an attributed weighting function for distance.
12	***COMUTIMP***	Composite utility number calculated with an attributed weighting function for preference between time and distance.
13	***DMON***	Variable representing amount of money that users are willing to pay if disutilities of distance and time are removed.
14	***DBUS***	Dummy variable representing passengers who were on a business trip.
15	***DNONBUS***	Dummy variable representing passengers who were on a non business trip.
16	***DCOMB***	Dummy variable representing passengers who were on a combined trip, recreational and business, .
17	***DSZE***	Variable representing number of travelers in each party.

Data Table for Departure Curb

1	1	15	1	100	2	83	58	1	94	100	92.9	0	0	0	1	1
2	0	0	1	100	2	83	29	0	94	100	92.9	0	1	0	0	1
3	1	15	2	83	1	100	17	1	89	83	90.1	0	1	0	0	1
4	0	15	2	83	1	100	22	0	89	100	90.1	0	0	0	1	0
5	0	45	5	33	4	50	44	0	39	50	40.1	1	0	0	1	1
6	1	60	5	33	4	50	40	1	39	33	40.1	2	0	0	1	0
7	0	15	1	100	1	100	29	1	100	100	100	0	0	0	1	0
8	1	40	1	100	1	100	17	1	100	100	100	1	1	0	0	1
9	1	20	2	83	1	100	26	1	89	83	90.1	0	0	0	1	0
10	1	20	2	83	1	100	22	0	89	100	90.1	0	0	1	0	1
11	0	60	6	17	1	100	26	0	44	100	51.7	1	1	0	0	1
12	1	60	7	0	1	100	22	0	33	100	41.8	1	0	0	1	0
13	1	0	4	50	4	50	17	0	50	50	50	1	0	0	1	0
14	0	20	4	50	4	50	44	1	50	50	50	1	0	0	1	0
15	0	35	3	67	3	67	31	1	67	67	67	0	0	0	1	1
16	1	30	3	67	3	67	31	0	67	67	67	1	0	0	1	1
17	0	55	1	100	1	100	26	1	100	100	100	0	0	0	1	0
18	0	15	1	100	1	100	26	1	100	100	100	0	0	0	1	0
19	0	10	1	100	2	83	22	1	94	100	92.9	1	1	0	0	1
20	0	35	4	50	6	17	40	1	45	50	36.2	0	0	0	1	0
21	0	15	1	100	2	83	26	0	94	100	92.9	2	0	0	1	1
22	1	50	6	17	3	67	40	0	33	67	37.9	2	0	0	1	1
23	0	55	6	17	3	67	31	1	33	17	37.9	2	0	0	1	0
24	0	10	1	100	2	83	31	0	94	100	92.9	0	0	0	1	0
25	1	50	5	33	5	33	31	1	33	33	33	2	0	0	1	0
26	1	25	5	33	5	33	58	0	33	33	33	2	0	0	1	1
27	0	10	1	100	1	100	18	1	100	100	100	1	1	0	0	1
28	0	5	1	100	1	100	26	0	100	100	100	1	1	0	0	1
29	0	0	2	83	1	100	18	1	89	83	90.1	0	0	0	1	0
30	0	50	2	83	1	100	18	1	89	83	90.1	0	0	0	1	1
31	0	5	2	83	1	100	21	1	89	83	90.1	0	1	0	0	1
32	0	20	1	100	2	83	26	0	94	100	92.9	1	1	0	0	1
33	0	5	1	100	1	100	26	1	100	100	100	1	1	0	1	1
34	0	10	1	100	1	100	17	1	100	100	100	0	0	0	1	0
35	0	15	1	100	1	100	26	0	100	100	100	1	1	0	0	1
36	1	15	2	83	1	100	26	1	89	83	90.1	3	1	0	0	1
37	0	15	2	83	1	100	26	1	89	83	90.1	3	1	0	0	1
38	0	30	4	50	2	83	26	1	61	50	63.8	1	0	0	1	1
39	1	15	3	67	1	100	58	0	78	100	80.8	1	1	0	0	1
40	1	45	1	100	2	83	22	0	94	100	92.9	1	0	0	1	1
41	0	15	2	83	1	100	58	1	89	83	90.1	1	1	0	0	1
42	0	15	1	100	1	100	18	1	100	100	100	0	1	0	0	1
43	1	40	5	33	5	33	31	0	33	33	33	3	0	1	0	1
44	0	10	1	100	4	50	40	1	83	100	79.1	1	1	0	0	1
45	0	45	4	50	2	83	17	1	61	50	63.8	1	0	0	1	0
46	1	35	4	50	2	83	26	1	61	50	63.8	1	0	1	0	0
47	0	35	4	50	2	83	29	0	61	83	63.8	1	0	0	1	1
48	1	10	1	100	2	83	31	1	94	100	92.9	1	1	0	0	0
49	0	15	1	100	1	100	40	0	100	100	100	0	0	0	1	1
50	0	15	1	100	1	100	26	1	100	100	100	0	0	0	1	0
51	0	10	1	100	1	100	26	0	100	100	100	0	0	0	1	1
52	1	5	1	100	2	83	29	1	94	100	92.9	1	0	0	1	0
53	0	55	1	100	2	83	17	1	94	100	92.9	0	0	0	1	0
54	0	15	1	100	2	83	26	1	94	100	92.9	0	0	1	0	0
55	1	0	1	100	2	83	26	0	94	100	92.9	0	0	0	1	1
56	0	35	7	0	3	67	22	1	22	0	28.0	2	1	0	0	1

57	0	45	6	17	5	33	44	0	22	33	23.7	2	0	0	1	1
58	0	45	6	17	6	17	58	1	17	17	17	2	0	0	1	0
59	0	60	7	0	7	0	58	0	0	0	0	1	0	0	1	0
60	1	15	1	100	2	83	26	1	94	100	92.9	1	1	0	0	1
61	1	10	1	100	2	83	22	1	94	100	92.9	0	1	0	0	1
62	0	15	1	100	2	83	22	1	94	100	92.9	0	1	0	0	1
63	0	10	1	100	1	100	29	1	100	100	100	1	1	0	0	1
64	0	20	2	83	1	100	22	0	89	100	90.1	1	1	0	0	1
65	1	10	1	100	2	83	18	1	94	100	92.9	0	0	0	1	0
66	1	10	1	100	2	83	58	0	94	100	92.9	0	0	0	1	0
67	0	10	1	100	2	83	22	0	94	100	92.9	0	1	0	0	1
68	0	20	1	100	1	100	44	1	100	100	100	0	0	0	1	0
69	1	0	1	100	4	50	58	1	83	100	79.1	2	1	0	0	1
70	1	10	2	83	3	67	29	1	81	100	76.3	2	0	0	1	1
71	0	20	2	83	3	67	31	1	81	83	76.3	2	0	0	1	1
72	1	45	2	83	3	67	31	1	81	83	76.3	2	1	0	0	1
73	0	20	4	50	4	50	31	0	50	50	50	1	1	0	0	1
74	0	20	3	67	3	67	40	1	67	67	67	1	0	0	1	0
75	0	25	3	67	3	67	40	0	67	67	67	1	0	0	1	0
76	0	10	1	100	6	17	44	0	73	17	65.3	2	0	1	0	0
77	1	40	5	33	3	67	26	0	44	67	47.2	2	0	0	1	0
78	0	50	5	33	1	100	17	0	55	100	61	1	0	0	1	0
79	0	45	3	67	2	83	22	1	72	67	73.7	1	0	0	1	0
80	0	20	3	67	2	83	22	0	72	83	73.7	1	1	0	0	1
81	1	25	2	83	6	17	58	1	78	83	65.4	2	1	0	0	0
82	0	55	5	33	2	83	29	0	50	83	53.9	1	1	0	0	1
83	1	0	1	100	1	100	18	1	100	100	100	0	1	0	0	1
84	0	10	1	100	1	100	17	1	100	100	100	0	0	0	1	0
85	0	60	1	100	1	100	17	1	100	100	100	0	1	0	0	1
86	0	15	4	50	1	100	22	1	66	50	70.9	0	0	0	1	0
87	0	40	3	67	2	83	29	1	72	67	73.7	2	0	0	1	0
88	1	10	2	83	5	33	58	0	72	33	62.1	2	0	0	1	1
89	1	50	6	17	4	50	44	0	28	50	30.8	2	0	1	0	0
90	1	10	1	100	1	100	58	0	100	100	100	0	0	0	1	1
91	0	50	1	100	1	100	31	1	100	100	100	0	0	1	0	0
92	0	30	5	33	2	83	29	1	50	33	53.9	1	1	0	1	1
93	0	45	5	33	2	83	26	0	50	83	53.9	1	0	1	0	0
94	0	20	2	83	2	83	22	1	83	83	83	0	0	0	1	1
95	0	55	2	83	2	83	58	1	83	83	83	1	1	0	0	1
96	0	15	2	83	2	83	29	0	83	83	83	0	0	0	1	1
97	0	20	2	83	1	100	17	1	89	83	90.1	0	0	0	1	0
98	0	10	1	100	1	100	29	1	100	100	100	1	1	0	0	1
99	1	15	1	100	1	100	21	0	100	100	100	1	1	0	0	1
100	0	50	3	67	3	67	40	1	67	67	67	2	0	0	1	0
101	1	15	3	67	4	50	40	0	62	67	67	1	1	0	0	1
102	0	30	3	67	4	50	44	1	62	67	67	1	1	0	0	0
103	0	25	4	50	1	100	22	1	66	50	70.9	2	1	0	0	1
104	0	50	5	33	3	67	17	1	44	33	47.2	1	1	0	0	1
105	1	55	6	17	2	83	26	0	47	83	44.6	1	1	0	0	1
106	1	50	6	17	2	83	22	1	47	17	44.6	1	1	0	0	1
107	0	55	7	0	1	100	22	1	33	0	41.8	3	0	1	0	0
108	1	35	3	67	1	100	18	0	78	100	80.8	0	0	1	0	1
109	0	50	3	67	3	67	31	0	67	67	67	1	0	0	1	1
110	0	10	3	67	1	100	22	0	78	100	80.8	0	0	0	1	0
111	0	55	4	50	1	100	58	1	66	50	70.9	0	0	0	1	0
112	0	30	4	50	5	33	58	1	44	50	42.9	1	0	0	1	0
113	1	35	5	33	1	100	58	0	55	100	61	2	1	0	0	1
114	0	50	5	33	1	100	22	0	55	100	61	0	0	0	1	0
115	1	5	1	100	3	67	31	1	89	100	86.2	1	0	0	1	0

116	1	15	1	100	3	67	26	0	89	67	86.2	0	0	0	1	0
117	0	10	1	100	3	67	29	1	89	100	86.2	1	0	1	0	0
118	1	10	3	67	1	100	18	0	78	100	80.8	0	0	1	0	0
119	0	30	3	67	1	100	17	0	78	100	80.8	1	1	0	0	1
120	1	45	3	67	1	100	17	1	78	67	80.8	2	0	0	1	1
121	0	50	5	33	3	67	44	0	44	67	47.2	2	1	0	0	1
122	0	0	3	67	1	100	20	1	78	67	80.8	0	0	0	1	0

DBUS	1 = Business	0 = Otherwise
DNONBUS	1 = Non-business	0 = Otherwise
DCOMB	1 = Combined	0 = Otherwise
DSX	1 = Female	0 = Otherwise
DIMP	1 = Time	0 = Distance

APPENDIX - C.2

COLLECTED DATA AT PBIA ARRIVAL CURB

The following defines each column number in the data table to follow:

Column No.	*Symbol*	*Definition*
1	*NO*	Rank order
2	*DSX*	Dummy variable representing sex of the respondents.
3	*RATTME*	Variable representing rating of delay time in finding loading/unloading position and terminal door as perceived by the users. The value of this variable ranges from 1 to 7, representing very satisfied to very dissatisfied.
4	*UTDIS*	Transformed value of distance rating to a 0 to 100 utility axis
5	*DIS*	Actual measured distance that interviewed users had walked.
6	*TME*	Actual measured distance that interviewed users had waited.
7	*UTTME*	Transformed value of distance rating to a 0 to 100 utility axis
8	*RATDIS*	Variable representing rating of walking distance between loading/unloading position and terminal door as perceived by users. The value of this variable ranges from 1 to 7, representing very satisfied to very dissatisfied.

9	***COMUTME***	Composite utility number calculated with an attributed weighting function for time.
10	***COMUTDIS***	Composite utility number calculated with an attributed weighting function for distance.
11	***COMUTIMP***	Composite utility number calculated with an attributed weighting function for preference between time and distance.
12	***DIMP***	Dummy variable representing ranking of distance and time as indicated by respondents.
13	***DBUS***	Dummy variable representing passengers who were on a business trip.
14	***DNONBUS***	Dummy variable representing passengers who were on a non business trip.
15	***DCOMB***	Dummy variable representing passengers who were on a combined trip, recreational and business.
16	***DMON***	Variable representing amount of money that users are willing to pay if disabilities of distance and time are removed.
17	***DSZE***	Variable representing number of travelers in each party.

Data Table for Arrival Curb

1	1	1	100	16	55	100	1	100	100	100	0	0	1	0	0	1
2	0	1	100	45	10	100	1	100	100	100	1	1	0	0	1	0
3	0	2	83	45	20	83	2	83	83	83	1	0	1	0	1	0
4	1	2	83	28	15	100	1	93.1	83	94	0	1	0	0	0	0
5	0	1	100	28	15	83	2	89.9	100	89	0	0	1	0	0	0
6	1	1	100	28	0	83	2	89.9	83	89	1	1	0	0	1	1
7	1	1	100	22	20	83	2	89.9	100	89	0	1	0	0	1	1
8	0	2	83	16	10	100	1	93.1	100	94	1	0	1	0	0	1
9	1	7	0	72	5	83	2	49.5	0	56	0	0	1	0	1	0
10	1	7	0	45	15	83	2	49.5	83	56	1	1	0	0	1	1
11	0	1	100	16	15	100	1	100	100	100	0	0	1	0	0	0
12	1	2	83	72	10	100	1	100	100	94	1	0	1	0	0	0
13	1	7	0	72	55	0	7	0	0	0	1	1	0	0	2	1
14	0	6	17	45	15	100	1	66.5	100	73	1	0	1	0	0	1
15	0	4	50	37	10	100	1	79.8	100	84	1	1	0	0	1	1
16	0	6	17	37	40	33	5	26.5	17	28	0	0	1	0	0	0
17	1	3	67	28	55	0	7	27.1	0	22	1	1	0	0	1	1
18	0	4	50	16	20	100	1	79.8	50	87	0	1	1	0	1	0
19	1	2	83	28	10	83	2	83	83	83	1	0	1	0	0	1
20	1	4	50	37	20	100	1	79.8	50	84	0	0	1	0	1	0
21	1	3	67	45	10	100	1	86.7	100	89	1	0	1	0	0	0
22	1	3	67	28	35	67	3	67	67	67	1	1	0	0	1	1
23	0	3	67	37	15	100	1	86.7	100	89	1	0	1	0	1	1
24	0	4	50	72	45	33	5	39.9	33	39	1	1	0	0	0	1
25	0	6	17	45	35	67	3	46.8	67	51	1	0	1	0	1	1
26	0	6	17	37	30	50	4	36.7	50	51	1	1	0	0	0	1
27	0	2	83	22	10	50	4	63.3	83	61	0	0	1	0	0	1
28	1	2	83	22	20	83	2	83	83	83	1	0	1	0	1	1
29	0	5	33	72	15	67	3	53.3	33	56	0	1	0	0	0	1
30	1	2	83	22	35	83	2	83	83	83	1	0	1	0	0	0
31	0	3	67	30	0	100	1	86.7	67	89	0	1	0	0	0	1
32	0	3	67	23	20	100	1	86.7	67	89	0	0	1	0	0	1
33	0	2	83	16	50	83	2	83	83	83	0	1	0	0	0	1
34	0	5	33	45	15	100	1	72.9	100	79	1	1	0	0	1	1
35	0	7	0	37	20	33	5	19.7	33	22	1	0	1	0	0	1
36	0	4	50	28	50	0	7	20.2	0	17	1	1	0	0	1	1
37	1	6	17	72	25	50	4	36.7	17	39	0	1	0	0	1	1
38	0	2	83	22	20	83	2	83	83	83	0	1	0	0	0	1
39	1	4	50	28	15	100	1	59.6	100	84	1	1	0	0	1	1
40	0	1	100	28	35	67	3	80.3	67	79	1	1	0	0	1	1
41	0	3	67	45	15	100	1	86.7	100	100	1	1	0	0	1	1
42	0	3	67	22	15	83	2	76.5	83	78	1	0	1	0	0	1
43	0	1	100	37	25	67	3	80.3	67	78	1	1	0	0	2	1
44	1	3	67	45	10	67	3	67	67	67	1	1	0	0	0	0
45	0	3	67	37	0	100	1	86.7	100	89	1	1	0	0	0	1
46	0	4	50	23	10	100	1	79.8	50	84	0	0	1	0	0	0
47	0	4	50	37	20	100	1	79.8	100	84	1	1	0	0	1	1
48	0	3	67	72	15	83	2	76.5	83	78	1	1	0	0	1	1
49	1	3	67	16	20	83	2	76.5	83	78	0	0	1	0	0	0
50	1	2	83	45	25	83	2	83	83	83	0	0	1	0	0	1
51	0	1	100	22	15	100	1	100	100	100	0	0	1	0	0	1
52	1	1	100	22	0	83	2	89.9	83	89	1	0	1	0	1	1
53	1	3	67	16	20	100	1	86.7	100	89	1	1	0	0	0	1
54	1	5	33	72	15	83	2	62.8	83	67	1	0	1	0	1	0
55	0	6	17	45	35	50	4	36.7	50	39	1	1	0	0	0	1

56	1	4	50	45	45	17	6	30.3	50	28	0	0	1	0	1	1
57	1	6	17	22	45	50	4	36.7	50	39	1	1	0	0	1	1
58	1	4	50	23	20	100	1	79.9	50	84	0	0	1	0	0	0
59	1	1	100	22	20	100	1	100	100	100	1	0	1	0	1	1
60	1	1	100	28	20	67	3	80.3	100	79	0	1	0	0	0	1
61	1	1	100	16	10	100	1	100	100	100	0	0	1	0	0	1
62	0	1	100	16	15	100	1	100	100	100	0	1	0	0	0	1
63	0	4	50	72	15	83	2	69.7	83	72	1	0	1	0	1	1
64	0	1	100	28	15	100	1	100	100	100	0	0	1	0	0	0
65	1	1	100	16	10	67	3	80.3	100	79	0	0	1	0	0	1
66	1	3	67	22	20	83	2	76.5	83	78	1	1	0	0	0	1
67	0	5	33	28	15	100	1	72.9	33	79	0	1	0	0	1	1
68	1	2	83	28	35	67	3	73.5	67	72	1	0	1	0	0	0
69	0	5	33	23	35	100	1	72.9	100	79	1	1	0	0	1	1
70	1	5	33	72	20	100	1	72.9	33	79	0	1	0	0	1	1
71	0	2	83	16	15	83	2	83	83	83	1	0	1	0	0	0
72	1	4	50	22	10	100	1	79.8	50	84	0	0	1	0	0	1
73	0	4	50	45	20	100	1	79.8	100	84	1	1	0	0	0	1
74	0	7	50	72	10	100	1	59.6	100	84	1	1	0	0	2	1
75	1	5	33	22	15	83	2	62.8	33	67	0	0	1	0	0	1
76	1	2	83	22	30	33	5	53.2	33	50	1	1	0	0	0	0
77	1	5	33	37	10	83	2	62.8	83	67	1	1	0	0	0	1
78	0	1	100	28	10	83	2	89.9	83	89	1	1	0	0	1	0
79	1	4	50	16	25	50	4	50	50	50	1	0	1	0	0	0
80	1	1	100	22	15	100	1	100	100	100	1	0	1	0	0	1
81	0	1	100	22	15	100	1	100	100	100	1	1	0	0	0	1
82	1	1	100	16	5	100	1	100	100	100	1	1	0	0	0	1
83	1	1	100	72	25	100	1	100	100	100	1	0	1	0	0	1
84	1	1	100	22	15	100	1	100	100	100	0	0	1	0	0	0
85	1	1	100	22	10	100	1	100	100	100	0	1	0	0	0	1
86	0	4	50	45	45	50	4	50	50	50	0	1	0	0	0	1
87	0	1	100	22	40	67	3	80.3	67	78	1	0	1	0	0	0
88	0	6	17	72	35	17	6	6.9	17	17	1	1	0	0	1	1
89	1	1	100	16	5	100	1	100	100	100	1	1	0	0	0	1
90	1	6	17	45	15	67	3	46.8	17	51	0	0	1	0	0	1
91	0	3	67	22	20	100	1	86.7	100	89	1	1	0	0	0	1
92	1	3	67	45	10	100	1	86.7	67	89	0	0	1	0	2	0
93	1	1	100	16	15	100	1	100	100	100	0	0	1	0	0	1
94	0	1	100	22	10	100	1	100	100	100	0	1	1	0	1	1
95	0	1	100	28	15	100	1	100	100	100	1	1	0	0	0	1
96	1	1	100	22	10	100	1	100	100	100	1	1	0	0	0	0
97	1	1	100	30	5	100	1	100	100	100	0	1	0	0	0	1
98	0	6	17	72	15	100	1	66.5	17	73	0	1	0	0	1	1
99	0	6	17	45	10	83	2	56.3	83	61	1	0	1	0	0	0
100	0	1	100	25	0	100	1	100	100	100	1	1	0	0	1	1
101	0	1	100	22	20	100	1	100	100	100	1	1	0	0	0	1
102	1	5	33	72	10	83	2	62.8	33	67	0	1	0	0	0	1
103	1	1	100	28	25	83	2	89.9	83	89	1	0	1	0	0	1
104	0	6	17	37	55	83	2	56.3	83	61	1	1	0	0	0	1
105	0	2	83	30	0	33	5	53.2	33	50	1	0	1	0	0	0
106	1	4	50	22	30	67	3	60.1	50	61	0	1	0	0	0	1
107	0	6	67	72	35	67	3	46.8	67	67	1	0	1	0	1	0
108	1	3	67	45	45	83	2	76.5	67	78	0	0	1	0	1	0
109	0	2	83	22	55	33	5	53.2	83	50	0	1	0	0	0	1

DBUS	1 = Business	0 = Otherwise
DNONBUS	1 = Non-business	0 = Otherwise
DCOMB	1 = Combined	0 = Otherwise
DSX	1 = Female	0 = Otherwise
DIMP	1 = Time	0 = Distance
DSZ	1 = Individual	0 = Group

APPENDIX - C.3

Traffic Counts Vehicle/15 min, On Arrival Curb PBIA *

TIme										Total	Percent
	1	2	3	4	5	6	7	8	9		
10:00-10:15	2	2	2	1	2	4	1	2	1	17	7.9
10:15-10:30	1	0	2	2	2	0	1	1	2	11	5.1
10:30-10:45	3	2	5	4	4	5	4	2	2	31	14.3
10-45-11:00	5	4	4	6	4	3	3	3	2	34	15.7
11:00-11-15	4	3	5	4	3	4	4	4	1	32	14.9
11:15-11:30	5	4	4	5	5	4	2	2	3	34	15.7
11:30-11:45	5	4	4	3	2	2	2	1	2	25	11.6
11:45-12:30	4	1	4	2	1	3	2	2	1	20	9.3
12:30-12:45	2	0	2	3	3	0	1	1	0	12	5.5
Total	31	20	32	30	26	25	20	18	14	216	*
Percent	14.4	9.3	14.8	13.9	12.0	11.6	9.3	8.3	6.5	*	100

* DATE: December 21st, 1994

APPENDIX - D

D.1 - STATISTICAL ANALYSIS

D.2 - DERIVATION OF UTILITY EQUATIONS

D.3 - NON - LINEARITIES

D.4 - EFFECT OF QUALITATIVE VARIABLES

D.5 - REGRESSION OF (DMON) AGAINST UTILITY NUMBERS

Appendix D.1 Statistical Analysis

D.1.1 Departure Curb

```
|_FILE 11 B:\DEP1.DAT
 UNIT 11 IS NOW ASSIGNED TO: B:\DEP1.DAT
 |_READ (11) NO DSX TME RATTME UTTME RATDIS UTDIS DIS DIMP COMUTTME COMUTDIS
COMUTIM DMON DBUS DNONBUS DCOMB DSZ

 ...SAMPLE RANGE IS NOW SET TO:          1         122
 |_SAMPLE 1 122


 |_OLS RATDIS RATTME

 REQUIRED MEMORY IS PAR=    21 CURRENT PAR=  129
  OLS ESTIMATION
       122 OBSERVATIONS      DEPENDENT VARIABLE = RATDIS
 ...NOTE..SAMPLE RANGE SET TO:     1,  122

  R-SQUARE =    0.1306      R-SQUARE ADJUSTED =    0.1234
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.7752
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.3324
 SUM OF SQUARED ERRORS-SSE=   213.02
 MEAN OF DEPENDENT VARIABLE =   2.2213
 LOG OF THE LIKELIHOOD FUNCTION = -207.111


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 RATTME     0.28298    0.6665E-01   4.246     1.000 0.361     0.3614     0.3488
 CONSTANT    1.4466    0.2187       6.613     1.000 0.517     0.0000     0.6512

 |_OLS RATDIS DIS

 REQUIRED MEMORY IS PAR=    21 CURRENT PAR=  129
  OLS ESTIMATION
       122 OBSERVATIONS      DEPENDENT VARIABLE = RATDIS
 ...NOTE..SAMPLE RANGE SET TO:     1,  122

  R-SQUARE =    0.2822      R-SQUARE ADJUSTED =    0.2762
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.4657
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.2107
 SUM OF SQUARED ERRORS-SSE=   175.89
 MEAN OF DEPENDENT VARIABLE =   2.2213
 LOG OF THE LIKELIHOOD FUNCTION = -195.427

 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 DIS       0.59749E-01 0.8700E-02   6.868     1.000 0.531     0.5312     0.8268
 CONSTANT  0.38475     0.2890       1.331     0.907 0.121     0.0000     0.1732

 |_OLS RATDIS TME

 REQUIRED MEMORY IS PAR=    21 CURRENT PAR=  129
  OLS ESTIMATION
       122 OBSERVATIONS      DEPENDENT VARIABLE = RATDIS
```

```
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0335     R-SQUARE ADJUSTED =    0.0254
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.9735
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.4048
SUM OF SQUARED ERRORS-SSE=   236.83
MEAN OF DEPENDENT VARIABLE =   2.2213
LOG OF THE LIKELIHOOD FUNCTION = -213.572

VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME        0.14409E-01 0.7069E-02   2.038     0.978 0.183     0.1829     0.1720
CONSTANT    1.8392     0.2265       8.120     1.000 0.595     0.0000     0.8280

|_OLS DMON DIMP

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0008     R-SQUARE ADJUSTED =   -0.0075
VARIANCE OF THE ESTIMATE-SIGMA**2 =   0.69621
STANDARD ERROR OF THE ESTIMATE-SIGMA =   0.83439
SUM OF SQUARED ERRORS-SSE=    83.545
MEAN OF DEPENDENT VARIABLE =   0.89344
LOG OF THE LIKELIHOOD FUNCTION = -150.014


VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP     -0.48329E-01 0.1532     -0.3156    0.376-0.029    -0.0288    -0.0315
CONSTANT  0.92157     0.1168       7.888    1.000 0.584     0.0000     1.0315


|_OLS DSX DMON

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0316     R-SQUARE ADJUSTED =    0.0236
VARIANCE OF THE ESTIMATE-SIGMA**2 =   0.22470
STANDARD ERROR OF THE ESTIMATE-SIGMA =   0.47402
SUM OF SQUARED ERRORS-SSE=    26.963
MEAN OF DEPENDENT VARIABLE =   0.35246
LOG OF THE LIKELIHOOD FUNCTION = -81.0286


VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DMON      0.10264     0.5184E-01   1.980    0.975 0.178     0.1779     0.2602
CONSTANT  0.26076     0.6314E-01   4.130    1.000 0.353     0.0000     0.7398


|_OLS DIS DIMP

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
```

```
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.0115     R-SQUARE ADJUSTED =   0.0033
VARIANCE OF THE ESTIMATE-SIGMA**2 =   159.52
STANDARD ERROR OF THE ESTIMATE-SIGMA =   12.630
SUM OF SQUARED ERRORS-SSE=   19142.
MEAN OF DEPENDENT VARIABLE =   30.738
LOG OF THE LIKELIHOOD FUNCTION = -481.505


VARIABLE  ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME   COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP     -2.7418      2.318     -1.183    0.120-0.107    -0.1073    -0.0519
CONSTANT  32.333      1.769      18.28    1.000 0.858     0.0000     1.0519

|_OLS DIS DSX

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.0141     R-SQUARE ADJUSTED =   0.0059
VARIANCE OF THE ESTIMATE-SIGMA**2 =   159.10
STANDARD ERROR OF THE ESTIMATE-SIGMA =   12.613
SUM OF SQUARED ERRORS-SSE=   19092.
MEAN OF DEPENDENT VARIABLE =   30.738
LOG OF THE LIKELIHOOD FUNCTION = -481.344


VARIABLE  ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME   COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSX       3.1345      2.390      1.311    0.904 0.119     0.1189     0.0359
CONSTANT  29.633      1.419      20.88    1.000 0.886     0.0000     0.9641

|_OLS DNONBUS DIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.0048     R-SQUARE ADJUSTED =  -0.0035
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89727E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.29955
SUM OF SQUARED ERRORS-SSE=   10.767
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -25.0325


VARIABLE  ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME   COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS     -0.16448E-02 0.2153E-02 -0.7641   0.223-0.070    -0.0696    -0.5140
CONSTANT 0.14892     0.7151E-01  2.083    0.980 0.187     0.0000     1.5140
```

```
|_OLS DCOMB DIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS     DEPENDENT VARIABLE = DCOMB
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0089     R-SQUARE ADJUSTED =    0.0007
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25021
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50021
SUM OF SQUARED ERRORS-SSE=   30.025
MEAN OF DEPENDENT VARIABLE =  0.54098
LOG OF THE LIKELIHOOD FUNCTION = -87.5892


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS        0.37340E-02 0.3594E-02   1.039     0.850 0.094     0.0944      0.2122
CONSTANT  0.42621      0.1194       3.569     1.000 0.310     0.0000      0.7878

|_OLS DBUS DIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0040     R-SQUARE ADJUSTED =  -0.0043
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23785
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48770
SUM OF SQUARED ERRORS-SSE=   28.542
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -84.4992


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS      -0.24236E-02 0.3505E-02 -0.6916     0.245-0.063    -0.0630     -0.1976
CONSTANT  0.45154     0.1164        3.879     1.000 0.334     0.0000      1.1976

|_OLS DNONBUS DMON

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0057     R-SQUARE ADJUSTED =  -0.0025
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89646E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.29941
SUM OF SQUARED ERRORS-SSE=   10.758
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -24.9774


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
```

```
DMON       0.27252E-01  0.3274E-01  0.8323     0.797 0.076     0.0758     0.2475
CONSTANT   0.74012E-01  0.3988E-01   1.856     0.967 0.167     0.0000     0.7525


|_OLS DCOMB DMON

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DCOMB
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0317     R-SQUARE ADJUSTED =    0.0237
VARIANCE OF THE ESTIMATE-SIGMA**2 =   0.24444
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49441
SUM OF SQUARED ERRORS-SSE=    29.333
MEAN OF DEPENDENT VARIABLE =   0.54098
LOG OF THE LIKELIHOOD FUNCTION = -86.1675


VARIABLE   ESTIMATED   STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DMON      -0.10724     0.5407E-01  -1.983    0.025-0.178    -0.1782    -0.1771
CONSTANT   0.63680     0.6586E-01   9.669    1.000 0.662     0.0000     1.1771


|_OLS DMON DSZ

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0216     R-SQUARE ADJUSTED =    0.0134
VARIANCE OF THE ESTIMATE-SIGMA**2 =   0.68176
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.82569
SUM OF SQUARED ERRORS-SSE=    81.811
MEAN OF DEPENDENT VARIABLE =   0.89344
LOG OF THE LIKELIHOOD FUNCTION = -148.735


VARIABLE   ESTIMATED   STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR      120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ        0.24528     0.1508       1.626    0.947 0.147     0.1469     0.1553
CONSTANT   0.75472     0.1134       6.654    1.000 0.519     0.0000     0.8447


|_OLS RATTME DIS

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0238     R-SQUARE ADJUSTED =    0.0157
VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.2506
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.8030
SUM OF SQUARED ERRORS-SSE=    390.08
MEAN OF DEPENDENT VARIABLE =    2.7377
LOG OF THE LIKELIHOOD FUNCTION = -244.012
```

```
 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS        0.22184E-01 0.1296E-01   1.712     0.955 0.154     0.1544     0.2491
CONSTANT    2.0558     0.4304       4.777     1.000 0.400     0.0000     0.7509

|_OLS RATTME TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.4428     R-SQUARE ADJUSTED =   0.4381
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.8555
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.3622
SUM OF SQUARED ERRORS-SSE=   222.66
MEAN OF DEPENDENT VARIABLE =   2.7377
LOG OF THE LIKELIHOOD FUNCTION = -209.811


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.66934E-01 0.6854E-02   9.765     1.000 0.665     0.6654     0.6483
CONSTANT  0.96286     0.2196       4.384     1.000 0.372     0.0000     0.3517

|_OLS DIS TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.0057     R-SQUARE ADJUSTED =  -0.0026
VARIANCE OF THE ESTIMATE-SIGMA**2 =   160.46
STANDARD ERROR OF THE ESTIMATE-SIGMA =   12.667
SUM OF SQUARED ERRORS-SSE=   19255.
MEAN OF DEPENDENT VARIABLE =   30.738
LOG OF THE LIKELIHOOD FUNCTION = -481.863


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.52881E-01 0.6374E-01  0.8296     0.796 0.076     0.0755     0.0456
CONSTANT   29.335       2.043       14.36     1.000 0.795     0.0000     0.9544

|_OLS DIMP DSX

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.0196     R-SQUARE ADJUSTED =   0.0114
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24249
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49243
SUM OF SQUARED ERRORS-SSE=   29.099
```

```
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -85.6773


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSX      -0.14454     0.9332E-01  -1.549    0.062-0.140     -0.1400    -0.0875
CONSTANT  0.63291     0.5540E-01   11.42    1.000 0.722      0.0000     1.0875

|_OLS DIMP DBUS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0058      R-SQUARE ADJUSTED =  -0.0024
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24589
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49587
SUM OF SQUARED ERRORS-SSE=   29.507
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -86.5272


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DBUS      0.77803E-01 0.9263E-01  0.8399    0.799 0.076      0.0764     0.0504
CONSTANT  0.55263     0.5688E-01   9.716    1.000 0.664      0.0000     0.9496

|_OLS DIMP DNONBUS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0123      R-SQUARE ADJUSTED =    0.0040
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24431
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49427
SUM OF SQUARED ERRORS-SSE=   29.317
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -86.1327


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS  -0.18333     0.1503      -1.220    0.112-0.111     -0.1107    -0.0310
CONSTANT  0.60000     0.4713E-01   12.73    1.000 0.758      0.0000     1.0310

|_OLS DIMP DCOMB

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:     1,   122
```

```
 R-SQUARE =    0.0004     R-SQUARE ADJUSTED =  -0.0079
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24724
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49723
SUM OF SQUARED ERRORS-SSE=   29.669
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -86.8611


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DCOMB     0.19481E-01 0.9034E-01  0.2156    0.585 0.020     0.0197     0.0181
CONSTANT  0.57143     0.6645E-01  8.600     1.000 0.618     0.0000     0.9819

|_OLS DIMP DSZ

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.0426     R-SQUARE ADJUSTED =   0.0346
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23680
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48662
SUM OF SQUARED ERRORS-SSE=   28.416
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -84.2297


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ      -0.20536     0.8888E-01  -2.310    0.011-0.206    -0.2064    -0.1996
CONSTANT  0.69811     0.6684E-01   10.44    1.000 0.690     0.0000     1.1996

|_OLS DSX DBUS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.0001     R-SQUARE ADJUSTED =  -0.0083
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23202
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48169
SUM OF SQUARED ERRORS-SSE=   27.843
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.9860


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DBUS     -0.74371E-02 0.8998E-01 -0.8265E-01 0.467-0.008   -0.0075    -0.0080
CONSTANT  0.35526     0.5525E-01  6.430     1.000 0.506     0.0000     1.0080

|_OLS DSX DNONBUS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
```

```
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =   0.0104     R-SQUARE ADJUSTED =    0.0022
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.22962
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.47919
SUM OF SQUARED ERRORS-SSE=   27.555
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.3514


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS    0.16364     0.1457       1.123     0.868 0.102       0.1020     0.0457
CONSTANT   0.33636     0.4569E-01   7.362     1.000 0.558       0.0000     0.9543

|_OLS DSX DCOMB

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =   0.0061     R-SQUARE ADJUSTED =   -0.0022
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23063
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48024
SUM OF SQUARED ERRORS-SSE=   27.675
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.6182


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
DCOMB    -0.74675E-01 0.8725E-01 -0.8559     0.197-0.078     -0.0779    -0.1146
CONSTANT   0.39286     0.6417E-01   6.122     1.000 0.488       0.0000     1.1146

|_OLS DSX DSZ

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =   0.0086     R-SQUARE ADJUSTED =    0.0003
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23004
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.47962
SUM OF SQUARED ERRORS-SSE=   27.605
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.4621


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ        0.89418E-01 0.8760E-01   1.021     0.845 0.093       0.0928     0.1435
CONSTANT   0.30189     0.6588E-01   4.582     1.000 0.386       0.0000     0.8565
```

```
|_OLS DBUS DNONBUS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS      DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0660     R-SQUARE ADJUSTED =    0.0582
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.22303
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.47226
SUM OF SQUARED ERRORS-SSE=   26.764
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -80.5749


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS  -0.41818     0.1436      -2.913     0.002-0.257    -0.2570     -0.1091
CONSTANT  0.41818     0.4503E-01   9.287     1.000 0.647     0.0000      1.1091

|_OLS DBUS DCOMB

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS      DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.6033     R-SQUARE ADJUSTED =    0.6000
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.94733E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.30779
SUM OF SQUARED ERRORS-SSE=   11.368
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -28.3440


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DCOMB    -0.75541     0.5592E-01  -13.51     0.000-0.777    -0.7767     -1.0839
CONSTANT  0.78571     0.4113E-01   19.10     1.000 0.867     0.0000      2.0839

|_OLS DBUS DSZ

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS      DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.3358     R-SQUARE ADJUSTED =    0.3303
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.15861
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.39826
SUM OF SQUARED ERRORS-SSE=   19.033
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -59.7821


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
```

```
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ        0.56658     0.7274E-01   7.789     1.000 0.579     0.5795     0.8499
CONSTANT  0.56604E-01 0.5470E-01   1.035     0.849 0.094     0.0000     0.1501

|_OLS DNONBUS DCOMB

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.1286      R-SQUARE ADJUSTED =    0.1213
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.78571E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.28031
SUM OF SQUARED ERRORS-SSE=   9.4286
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -16.9336


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DCOMB    -0.21429     0.5093E-01  -4.208     0.000-0.359    -0.3586    -1.1786
CONSTANT  0.21429     0.3746E-01   5.721     1.000 0.463     0.0000     2.1786

|_OLS DNONBUS DSZ

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.0442      R-SQUARE ADJUSTED =    0.0363
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.86177E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.29356
SUM OF SQUARED ERRORS-SSE=   10.341
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -22.5699


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ       -0.12633     0.5362E-01  -2.356     0.010-0.210    -0.2103    -0.7264
CONSTANT  0.16981     0.4032E-01   4.211     1.000 0.359     0.0000     1.7264

|_OLS DCOMB DSZ

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DCOMB
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.1674      R-SQUARE ADJUSTED =    0.1604
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.21021
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.45849
SUM OF SQUARED ERRORS-SSE=   25.225
MEAN OF DEPENDENT VARIABLE =  0.54098
```

```
LOG OF THE LIKELIHOOD FUNCTION = -76.9633


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ      -0.41127     0.8374E-01  -4.911     0.000-0.409     -0.4091     -0.4300
CONSTANT  0.77358     0.6298E-01   12.28     1.000 0.746      0.0000      1.4300


|_OLS DIMP TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =    0.0016     R-SQUARE ADJUSTED =   -0.0068
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24695
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49694
SUM OF SQUARED ERRORS-SSE=   29.634
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -86.7900


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.10803E-02 0.2501E-02 -0.4320     0.333-0.039     -0.0394     -0.0492
CONSTANT  0.61061     0.8013E-01   7.620     1.000 0.571      0.0000      1.0492


|_OLS DIMP RATTME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =    0.0427     R-SQUARE ADJUSTED =    0.0342
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23689
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48672
SUM OF SQUARED ERRORS-SSE=   28.427
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -84.2535


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME   -0.55998E-01 0.2435E-01  -2.300     0.012-0.205     -0.2055     -0.2634
CONSTANT  0.73527     0.7991E-01   9.202     1.000 0.643      0.0000      1.2634


|_OLS DIMP RATDIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =    0.0082     R-SQUARE ADJUSTED =   -0.0001
```

```
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24531
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49529
SUM OF SQUARED ERRORS-SSE=   29.438
MEAN OF DEPENDENT VARIABLE =  0.58197
LOG OF THE LIKELIHOOD FUNCTION = -86.3837


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS   -0.31479E-01 0.3164E-01 -0.9949     0.161-0.090     -0.0904    -0.1202
CONSTANT  0.65189     0.8337E-01   7.819     1.000 0.581      0.0000     1.1202


|_OLS DSX TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0051     R-SQUARE ADJUSTED =  -0.0031
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23084
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48046
SUM OF SQUARED ERRORS-SSE=   27.701
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.6749


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.19042E-02 0.2418E-02 -0.7876     0.216-0.072     -0.0717    -0.1433
CONSTANT  0.40295     0.7747E-01   5.201     1.000 0.429      0.0000     1.1433


|_OLS DSX RATTME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0001     R-SQUARE ADJUSTED =  -0.0082
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23200
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48167
SUM OF SQUARED ERRORS-SSE=   27.840
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.9805


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME    0.31999E-02 0.2410E-01  0.1328     0.553 0.012      0.0121     0.0249
CONSTANT  0.34370     0.7908E-01   4.346     1.000 0.369      0.0000     0.9751


|_OLS DSX RATDIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
```

```
     122 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0132     R-SQUARE ADJUSTED =    0.0050
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.22898
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.47852
SUM OF SQUARED ERRORS-SSE=   27.477
MEAN OF DEPENDENT VARIABLE =  0.35246
LOG OF THE LIKELIHOOD FUNCTION = -82.1800


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS    0.38705E-01 0.3057E-01   1.266     0.896 0.115     0.1148     0.2439
CONSTANT  0.26648     0.8055E-01   3.308     0.999 0.289     0.0000     0.7561


|_OLS DBUS TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0198     R-SQUARE ADJUSTED =    0.0116
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23407
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48380
SUM OF SQUARED ERRORS-SSE=   28.088
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -83.5209


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.37918E-02 0.2434E-02  -1.558     0.061-0.141    -0.1408    -0.2667
CONSTANT  0.47759     0.7801E-01   6.122     1.000 0.488     0.0000     1.2667


|_OLS DBUS RATTME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0170     R-SQUARE ADJUSTED =    0.0088
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23475
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48451
SUM OF SQUARED ERRORS-SSE=   28.170
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -83.6986


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME   -0.34870E-01 0.2424E-01  -1.439     0.076-0.130    -0.1302    -0.2532
CONSTANT  0.47251     0.7954E-01   5.940     1.000 0.477     0.0000     1.2532
```

```
|_OLS DBUS RATDIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0286     R-SQUARE ADJUSTED =    0.0205
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23196
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48162
SUM OF SQUARED ERRORS-SSE=   27.835
MEAN OF DEPENDENT VARIABLE =  0.37705
LOG OF THE LIKELIHOOD FUNCTION = -82.9693


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR      120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS   -0.57873E-01 0.3077E-01  -1.881     0.031-0.169    -0.1692    -0.3409
CONSTANT  0.50560     0.8107E-01   6.237     1.000 0.495     0.0000     1.3409
```

```
|_OLS DNONBUS TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0076     R-SQUARE ADJUSTED =   -0.0007
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89483E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.29914
SUM OF SQUARED ERRORS-SSE=   10.738
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -24.8662


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR      120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.14383E-02 0.1505E-02  0.9555     0.829 0.087     0.0869     0.3877
CONSTANT  0.60223E-01 0.4823E-01   1.249     0.893 0.113     0.0000     0.6123
```

```
|_OLS DNONBUS RATTME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0087     R-SQUARE ADJUSTED =    0.0005
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89376E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.29896
SUM OF SQUARED ERRORS-SSE=   10.725
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -24.7930


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR      120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
```

```
RATTME    0.15384E-01 0.1496E-01   1.029       0.847 0.093       0.0935        0.4282
CONSTANT  0.56244E-01 0.4908E-01   1.146       0.873 0.104       0.0000        0.5718


 |_OLS DNONBUS RATDIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =   0.0021     R-SQUARE ADJUSTED =  -0.0062
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.89977E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.29996
SUM OF SQUARED ERRORS-SSE=   10.797
MEAN OF DEPENDENT VARIABLE =  0.98361E-01
LOG OF THE LIKELIHOOD FUNCTION = -25.2020


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS    0.95675E-02 0.1916E-01  0.4993      0.691 0.046       0.0455        0.2161
CONSTANT  0.77108E-01 0.5049E-01   1.527      0.935 0.138       0.0000        0.7839


 |_OLS DCOMB TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DCOMB
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =   0.0047     R-SQUARE ADJUSTED =  -0.0036
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25127
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50127
SUM OF SQUARED ERRORS-SSE=   30.153
MEAN OF DEPENDENT VARIABLE =  0.54098
LOG OF THE LIKELIHOOD FUNCTION = -87.8485


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.18969E-02 0.2522E-02  0.7520      0.773 0.068       0.0685        0.0930
CONSTANT  0.49068     0.8083E-01   6.071      1.000 0.485       0.0000        0.9070


 |_OLS DCOMB RATTME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DCOMB
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =   0.0057     R-SQUARE ADJUSTED =  -0.0026
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25102
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50102
SUM OF SQUARED ERRORS-SSE=   30.122
MEAN OF DEPENDENT VARIABLE =  0.54098
LOG OF THE LIKELIHOOD FUNCTION = -87.7862
```

```
VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME    0.20799E-01 0.2506E-01  0.8299    0.796 0.076     0.0755     0.1053
CONSTANT  0.48404     0.8225E-01   5.885    1.000 0.473     0.0000     0.8947

|_OLS DCOMB RATDIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DCOMB
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.0146     R-SQUARE ADJUSTED =    0.0063
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24879
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49878
SUM OF SQUARED ERRORS-SSE=   29.854
MEAN OF DEPENDENT VARIABLE =  0.54098
LOG OF THE LIKELIHOOD FUNCTION = -87.2411

VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS    0.42418E-01 0.3186E-01   1.331    0.907 0.121     0.1206     0.1742
CONSTANT  0.44676     0.8396E-01   5.321    1.000 0.437     0.0000     0.8258

|_OLS DSZ TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.0092     R-SQUARE ADJUSTED =    0.0010
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24749
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49748
SUM OF SQUARED ERRORS-SSE=   29.698
MEAN OF DEPENDENT VARIABLE =  0.56557
LOG OF THE LIKELIHOOD FUNCTION = -86.9215

VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.26493E-02 0.2503E-02  -1.058    0.146-0.096    -0.0962    -0.1242
CONSTANT  0.63582     0.8022E-01   7.926    1.000 0.586     0.0000     1.1242

|_OLS DSZ RATTME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.0118     R-SQUARE ADJUSTED =    0.0036
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24684
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49683
SUM OF SQUARED ERRORS-SSE=   29.621
```

```
MEAN OF DEPENDENT VARIABLE =  0.56557
LOG OF THE LIKELIHOOD FUNCTION = -86.7626


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME   -0.29783E-01 0.2485E-01  -1.198     0.117-0.109     -0.1087    -0.1442
CONSTANT  0.64711     0.8157E-01   7.934     1.000 0.587      0.0000     1.1442


|_OLS DSZ RATDIS

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0205      R-SQUARE ADJUSTED =    0.0123
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24467
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49465
SUM OF SQUARED ERRORS-SSE=   29.361
MEAN OF DEPENDENT VARIABLE =  0.56557
LOG OF THE LIKELIHOOD FUNCTION = -86.2248


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS   -0.50079E-01 0.3160E-01  -1.585     0.058-0.143     -0.1432    -0.1967
CONSTANT  0.67681     0.8326E-01   8.129     1.000 0.596      0.0000     1.1967


|_OLS DSZ DIS

REQUIRED MEMORY IS PAR=    21 CURRENT PAR=   129
 OLS ESTIMATION
     122 OBSERVATIONS      DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0008      R-SQUARE ADJUSTED =   -0.0075
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24959
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49959
SUM OF SQUARED ERRORS-SSE=   29.951
MEAN OF DEPENDENT VARIABLE =  0.56557
LOG OF THE LIKELIHOOD FUNCTION = -87.4378


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS      -0.11310E-02 0.3590E-02 -0.3150     0.377-0.029     -0.0287    -0.0615
CONSTANT  0.60034     0.1193       5.034     1.000 0.418      0.0000     1.0615
```

Appendix D.1.2 Arrival Curb

```
 |_FILE 11 B:\ARR1.DAT
 UNIT 11 IS NOW ASSIGNED TO: B:\ARR1.DAT
 |_READ (11) NO DSX RATDIS UTDS DIS TME UTTME RATTME COMUTDIS COMUTTME COMUTIMP
DIMP DBUS DNONBUS DCOMB DMON DSZ

 ...SAMPLE RANGE IS NOW SET TO:          1        109
 |_SAMPLE 1 109


 |_ols dis tme

 REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
  OLS ESTIMATION
      109 OBSERVATIONS      DEPENDENT VARIABLE = DIS
 ...NOTE..SAMPLE RANGE SET TO:     1,   109

  R-SQUARE =    0.0036      R-SQUARE ADJUSTED =  -0.0057
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    325.20
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    18.033
 SUM OF SQUARED ERRORS-SSE=   34796.
 MEAN OF DEPENDENT VARIABLE =   34.991
 LOG OF THE LIKELIHOOD FUNCTION = -468.907


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 TME        0.78882E-01 0.1264     0.6241     0.733 0.060      0.0602      0.0465
 CONSTANT   33.363      3.129      10.66      1.000 0.718      0.0000      0.9535


 |_ols dis dsz

 REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
  OLS ESTIMATION
      109 OBSERVATIONS      DEPENDENT VARIABLE = DIS
 ...NOTE .SAMPLE RANGE SET TO:     1,   109

  R-SQUARE =    0.0000      R-SQUARE ADJUSTED =  -0.0093
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    326.38
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    18.066
 SUM OF SQUARED ERRORS-SSE=   34923.
 MEAN OF DEPENDENT VARIABLE =   34.991
 LOG OF THE LIKELIHOOD FUNCTION = -469.105


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 DSZ        0.77337E-01  3.836     0.2016E-01 0.508 0.002      0.0019      0.0016
 CONSTANT   34.935       3.245     10.77      1.000 0.721      0.0000      0.9984


 |_ols tme dsz

 REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
  OLS ESTIMATION
```

```
     109 OBSERVATIONS     DEPENDENT VARIABLE = TME
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =    0.0067     R-SQUARE ADJUSTED =  -0.0026
VARIANCE OF THE ESTIMATE-SIGMA**2 =    188.96
STANDARD ERROR OF THE ESTIMATE-SIGMA =    13.746
SUM OF SQUARED ERRORS-SSE=   20219.
MEAN OF DEPENDENT VARIABLE =   20.642
LOG OF THE LIKELIHOOD FUNCTION = -439.320


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ         2.4752     2.919      0.8481     0.801 0.082      0.0817     0.0858
CONSTANT    18.871     2.469       7.643     1.000 0.594      0.0000     0.9142

|_ols ratdis dimp

REQUIRED MEMORY IS PAR=    19 CURRENT PAR=   129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =    0.0040     R-SQUARE ADJUSTED =  -0.0053
VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.6851
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.9197
SUM OF SQUARED ERRORS-SSE=   394.31
MEAN OF DEPENDENT VARIABLE =   3.1009
LOG OF THE LIKELIHOOD FUNCTION = -224.740


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP       0.24545     0.3748     0.6550     0.743 0.063      0.0632     0.0472
CONSTANT    2.9545     0.2894      10.21     1.000 0.702      0.0000     0.9528

|_ols rattme dsz

REQUIRED MEMORY IS PAR=    19 CURRENT PAR=   129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =    0.0018     R-SQUARE ADJUSTED =  -0.0076
VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.3233
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.5242
SUM OF SQUARED ERRORS-SSE=   248.59
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -199.597


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ        0.14061     0.3236     0.4345     0.668 0.042      0.0420     0.0465
CONSTANT    2.0645     0.2738      7.541     1.000 0.589      0.0000     0.9535
```

```
|_ols ratdis dsz

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.0058     R-SQUARE ADJUSTED =  -0.0035
VARIANCE OF THE ESTIMATE-SIGMA**2 =   3.6785
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.9179
SUM OF SQUARED ERRORS-SSE=   393.60
MEAN OF DEPENDENT VARIABLE =   3.1009
LOG OF THE LIKELIHOOD FUNCTION = -224.642


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSZ        0.32134     0.4072     0.7891    0.784 0.076      0.0761     0.0742
CONSTANT    2.8710     0.3445      8.334    1.000 0.627      0.0000     0.9258


|_ols dsz dmon

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.0057     R-SQUARE ADJUSTED =  -0.0036
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.20615
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.45404
SUM OF SQUARED ERRORS-SSE=   22.058
MEAN OF DEPENDENT VARIABLE =  0.71560
LOG OF THE LIKELIHOOD FUNCTION = -67.5914


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DMON      0.60212E-01 0.7720E-01  0.7799    0.781 0.075      0.0752     0.0355
CONSTANT  0.69019     0.5434E-01   12.70    1.000 0.775      0.0000     0.9645


|_ols dmon dbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.0398     R-SQUARE ADJUSTED =    0.0308
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.31039
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.55713
SUM OF SQUARED ERRORS-SSE=   33.212
MEAN OF DEPENDENT VARIABLE =  0.42202
LOG OF THE LIKELIHOOD FUNCTION = -89.8943


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
```

```
DBUS      0.22542      0.1071      2.105      0.981 0.199      0.1994      0.2891
CONSTANT  0.30000      0.7879E-01  3.808      1.000 0.345      0.0000      0.7109

|_ols dmon dnonbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =    0.0260     R-SQUARE ADJUSTED =    0.0169
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.31484
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.56111
SUM OF SQUARED ERRORS-SSE=   33.688
MEAN OF DEPENDENT VARIABLE =  0.42202
LOG OF THE LIKELIHOOD FUNCTION = -90.6699


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS  -0.18185      0.1076     -1.690     0.047-0.161     -0.1612     -0.2056
CONSTANT  0.50877      0.7432E-01  6.846     1.000 0.552      0.0000      1.2056

|_ols dsx dmon

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =    0.0020     R-SQUARE ADJUSTED =  -0.0073
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25398
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50396
SUM OF SQUARED ERRORS-SSE=   27.175
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -78.9617


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DMON     -0.39523E-01 0.8569E-01 -0.4612     0.323-0.045     -0.0445     -0.0343
CONSTANT  0.50292     0.6031E-01   8.338     1.000 0.628      0.0000      1.0343

|_ols dmon dimp

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =    0.0342     R-SQUARE ADJUSTED =    0.0251
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.31220
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.55875
SUM OF SQUARED ERRORS-SSE=   33.405
MEAN OF DEPENDENT VARIABLE =  0.42202
LOG OF THE LIKELIHOOD FUNCTION = -90.2107
```

```
VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP       0.21224    0.1091      1.946    0.973 0.185     0.1849      0.2999
CONSTANT   0.29545    0.8423E-01  3.508    1.000 0.321     0.0000      0.7001

|_ols dsz dimp

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =   0.0038     R-SQUARE ADJUSTED =  -0.0055
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.20654
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.45446
SUM OF SQUARED ERRORS-SSE=   22.099
MEAN OF DEPENDENT VARIABLE =  0.71560
LOG OF THE LIKELIHOOD FUNCTION = -67.6931

VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP      0.56643E-01 0.8872E-01  0.6384   0.738 0.062     0.0616      0.0472
CONSTANT   0.68182    0.6851E-01  9.952    1.000 0.693     0.0000      0.9528

|_ols dsz dsx

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =   0.0061     R-SQUARE ADJUSTED =  -0.0031
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.20605
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.45393
SUM OF SQUARED ERRORS-SSE=   22.047
MEAN OF DEPENDENT VARIABLE =  0.71560
LOG OF THE LIKELIHOOD FUNCTION = -67.5644

VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSX      -0.70755E-01 0.8699E-01 -0.8134   0.209-0.078    -0.0784     -0.0481
CONSTANT   0.75000    0.6066E-01  12.36    1.000 0.767     0.0000      1.0481

|_ols dsz dbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =   0.1593     R-SQUARE ADJUSTED =   0.1515
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.17429
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.41749
SUM OF SQUARED ERRORS-SSE=   18.649
```

```
MEAN OF DEPENDENT VARIABLE =  0.71560
LOG OF THE LIKELIHOOD FUNCTION = -58.4430


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DBUS       0.36136    0.8025E-01   4.503    1.000 0.399     0.3991      0.2733
CONSTANT   0.52000    0.5904E-01   8.807    1.000 0.648     0.0000      0.7267


|_ols dsz dnonbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSZ
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.1728     R-SQUARE ADJUSTED =    0.1651
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.17149
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.41411
SUM OF SQUARED ERRORS-SSE=   18.349
MEAN OF DEPENDENT VARIABLE =  0.71560
LOG OF THE LIKELIHOOD FUNCTION = -57.5582


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS   -0.37551    0.7941E-01  -4.729    0.000-0.416    -0.4157     -0.2503
CONSTANT   0.89474    0.5485E-01   16.31    1.000 0.845     0.0000      1.2503


|_ols ratdis rattme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.1038     R-SQUARE ADJUSTED =    0.0955
VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.3157
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.8209
SUM OF SQUARED ERRORS-SSE=   354.78
MEAN OF DEPENDENT VARIABLE =    3.1009
LOG OF THE LIKELIHOOD FUNCTION = -218.982


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME     0.40631    0.1154       3.521    1.000 0.322     0.3223      0.2837
CONSTANT    2.2212    0.3047       7.290    1.000 0.576     0.0000      0.7163


|_ols ratdis dis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:    1,  109
```

```
 R-SQUARE =   0.3169     R-SQUARE ADJUSTED =   0.3105
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.5275
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.5898
SUM OF SQUARED ERRORS-SSE=   270.44
MEAN OF DEPENDENT VARIABLE =   3.1009
LOG OF THE LIKELIHOOD FUNCTION = -204.189


VARIABLE  ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME   COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       0.59935E-01 0.8507E-02   7.045     1.000 0.563     0.5629     0.6763
CONSTANT   1.0038     0.3344       3.002     0.998 0.279     0.0000     0.3237

|_ols rattme tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =   0.3614     R-SQUARE ADJUSTED =   0.3554
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.4863
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.2191
SUM OF SQUARED ERRORS-SSE=   159.04
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -175.253


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.66492E-01 0.8545E-02   7.781     1.000 0.601     0.6011     0.6339
CONSTANT  0.79260     0.2115       3.747     1.000 0.341     0.0000     0.3661

|_ols ratdis tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =   0.0545     R-SQUARE ADJUSTED =   0.0457
VARIANCE OF THE ESTIMATE-SIGMA**2 =   3.4981
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.8703
SUM OF SQUARED ERRORS-SSE=   374.30
MEAN OF DEPENDENT VARIABLE =   3.1009
LOG OF THE LIKELIHOOD FUNCTION = -221.901


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.32569E-01 0.1311E-01   2.484     0.993 0.234     0.2335     0.2168
CONSTANT   2.4286     0.3245       7.484     1.000 0.586     0.0000     0.7832

|_ols rattme dis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
```

```
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0367     R-SQUARE ADJUSTED =    0.0277
VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.2419
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.4973
SUM OF SQUARED ERRORS-SSE=   239.88
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -197.654


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       0.16183E-01 0.8012E-02   2.020     0.977 0.192     0.1916     0.2615
CONSTANT   1.5989      0.3149      5.077     1.000 0.441     0.0000     0.7385

|_ols rattme tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.3614     R-SQUARE ADJUSTED =    0.3554
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.4863
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.2191
SUM OF SQUARED ERRORS-SSE=   159.04
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -175.253


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.66492E-01 0.8545E-02   7.781     1.000 0.601     0.6011     0.6339
CONSTANT  0.79260     0.2115       3.747     1.000 0.341     0.0000     0.3661

|_ols dis tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0036     R-SQUARE ADJUSTED =   -0.0057
VARIANCE OF THE ESTIMATE-SIGMA**2 =    325.20
STANDARD ERROR OF THE ESTIMATE-SIGMA =    18.033
SUM OF SQUARED ERRORS-SSE=   34796.
MEAN OF DEPENDENT VARIABLE =   34.991
LOG OF THE LIKELIHOOD FUNCTION = -468.907


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.78882E-01 0.1264      0.6241     0.733 0.060     0.0602     0.0465
CONSTANT   33.363      3.129      10.66      1.000 0.718     0.0000     0.9535
```

```
|_ols dimp dsx

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0182     R-SQUARE ADJUSTED =   0.0090
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24076
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49067
SUM OF SQUARED ERRORS-SSE=   25.761
MEAN OF DEPENDENT VARIABLE =  0.59633
LOG OF THE LIKELIHOOD FUNCTION = -76.0491


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DSX       -0.13241    0.9403E-01  -1.408    0.081-0.135   -0.1349    -0.1080
CONSTANT  0.66071     0.6557E-01   10.08    1.000 0.698    0.0000     1.1080

|_ols dimp dbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0205     R-SQUARE ADJUSTED =   0.0114
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24019
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49009
SUM OF SQUARED ERRORS-SSE=   25.700
MEAN OF DEPENDENT VARIABLE =  0.59633
LOG OF THE LIKELIHOOD FUNCTION = -75.9203


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DBUS       0.14102    0.9421E-01   1.497    0.931 0.143    0.1432     0.1280
CONSTANT   0.52000    0.6931E-01   7.503    1.000 0.587    0.0000     0.8720

|_ols dimp dnonbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0352     R-SQUARE ADJUSTED =   0.0262
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.23660
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.48641
SUM OF SQUARED ERRORS-SSE=   25.316
MEAN OF DEPENDENT VARIABLE =  0.59633
LOG OF THE LIKELIHOOD FUNCTION = -75.0987


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
```

```
  NAME     COEFFICIENT   ERROR      107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS  -0.18421      0.9328E-01  -1.975    0.025-0.188    -0.1875     -0.1474
CONSTANT  0.68421      0.6443E-01   10.62    1.000 0.716     0.0000      1.1474

|_ols dsx dbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0298     R-SQUARE ADJUSTED =   0.0208
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24689
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49688
SUM OF SQUARED ERRORS-SSE=   26.417
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -77.4199

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT   ERROR      107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DBUS      -0.17322     0.9551E-01  -1.814    0.036-0.173    -0.1727     -0.1928
CONSTANT  0.58000      0.7027E-01   8.254    1.000 0.624     0.0000      1.1928

|_ols dsx dnonbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0186     R-SQUARE ADJUSTED =   0.0095
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24974
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49974
SUM OF SQUARED ERRORS-SSE=   26.722
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -78.0442

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT   ERROR      107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS   0.13664      0.9583E-01   1.426    0.922 0.137     0.1365      0.1341
CONSTANT  0.42105      0.6619E-01   6.361    1.000 0.524     0.0000      0.8659

|_ols dbus dnonbus

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.9289     R-SQUARE ADJUSTED =   0.9283
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.17973E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.13406
SUM OF SQUARED ERRORS-SSE=   1.9231
MEAN OF DEPENDENT VARIABLE =  0.54128
```

```
LOG OF THE LIKELIHOOD FUNCTION =  65.3752


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DNONBUS  -0.96154     0.2571E-01  -37.40    0.000-0.964    -0.9638    -0.8475
CONSTANT   1.0000     0.1776E-01   56.32    1.000 0.984     0.0000     1.8475

|_ols dimp tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0006     R-SQUARE ADJUSTED =  -0.0087
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24507
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49504
SUM OF SQUARED ERRORS-SSE=   26.222
MEAN OF DEPENDENT VARIABLE =  0.59633
LOG OF THE LIKELIHOOD FUNCTION = -77.0158


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.89692E-03 0.3470E-02  0.2585    0.602 0.025     0.0250     0.0310
CONSTANT  0.57782     0.8590E-01   6.727    1.000 0.545     0.0000     0.9690

|_ols dimp dis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0129     R-SQUARE ADJUSTED =    0.0036
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24206
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49200
SUM OF SQUARED ERRORS-SSE=   25.901
MEAN OF DEPENDENT VARIABLE =  0.59633
LOG OF THE LIKELIHOOD FUNCTION = -76.3439


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       0.31096E-02 0.2633E-02   1.181    0.880 0.113     0.1134     0.1825
CONSTANT  0.48752     0.1035       4.711    1.000 0.415     0.0000     0.8175

|_ols dimp ratdis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DIMP
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0040     R-SQUARE ADJUSTED =  -0.0053
```

```
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24424
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.49421
SUM OF SQUARED ERRORS-SSE=   26.134
MEAN OF DEPENDENT VARIABLE =  0.59633
LOG OF THE LIKELIHOOD FUNCTION = -76.8318


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS    0.16268E-01 0.2484E-01  0.6550    0.743 0.063      0.0632     0.0846
CONSTANT  0.54588     0.9040E-01   6.038    1.000 0.504      0.0000     0.9154

|_ols dsx tme

REQUIRED MEMORY IS PAR=    19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS      DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =    0.0015      R-SQUARE ADJUSTED =   -0.0078
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25409
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50408
SUM OF SQUARED ERRORS-SSE=   27.188
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -78.9870


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.14265E-02 0.3533E-02 -0.4038    0.344-0.039     -0.0390    -0.0606
CONSTANT  0.51568     0.8747E-01   5.896    1.000 0.495      0.0000     1.0606

|_ols dsx dis

REQUIRED MEMORY IS PAR=    19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS      DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =    0.0045      R-SQUARE ADJUSTED =   -0.0048
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25333
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50332
SUM OF SQUARED ERRORS-SSE=   27.106
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -78.8234


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS      -0.18759E-02 0.2693E-02 -0.6965    0.244-0.067     -0.0672    -0.1350
CONSTANT  0.55188     0.1059       5.213    1.000 0.450      0.0000     1.1350

|_ols dsx rattme

REQUIRED MEMORY IS PAR=    19 CURRENT PAR=  129
 OLS ESTIMATION
```

```
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0001     R-SQUARE ADJUSTED =  -0.0093
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25446
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50444
SUM OF SQUARED ERRORS-SSE=   27.227
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -79.0654


VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME    -0.30209E-02 0.3197E-01 -0.9451E-01 0.462-0.009     -0.0091    -0.0135
CONSTANT   0.49278     0.8441E-01   5.838     1.000 0.492      0.0000     1.0135

|_ols dsx ratdis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DSX
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0119     R-SQUARE ADJUSTED =   0.0027
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25144
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50144
SUM OF SQUARED ERRORS-SSE=   26.904
MEAN OF DEPENDENT VARIABLE =  0.48624
LOG OF THE LIKELIHOOD FUNCTION = -78.4149


VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS   -0.28666E-01 0.2520E-01  -1.137     0.129-0.109     -0.1093    -0.1828
CONSTANT  0.57513     0.9173E-01   6.270     1.000 0.518      0.0000     1.1828

|_ols dbus tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0082     R-SQUARE ADJUSTED =  -0.0011
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25087
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50087
SUM OF SQUARED ERRORS-SSE=   26.843
MEAN OF DEPENDENT VARIABLE =  0.54128
LOG OF THE LIKELIHOOD FUNCTION = -78.2910


VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.32970E-02 0.3511E-02  0.9391     0.825 0.090      0.0904     0.1257
CONSTANT  0.47323     0.8691E-01   5.445     1.000 0.466      0.0000     0.8743
```

```
|_ols dbus dis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0056     R-SQUARE ADJUSTED =  -0.0037
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25153
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50153
SUM OF SQUARED ERRORS-SSE=   26.914
MEAN OF DEPENDENT VARIABLE =  0.54128
LOG OF THE LIKELIHOOD FUNCTION = -78.4341


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS        0.20772E-02 0.2684E-02  0.7740     0.780 0.075      0.0746     0.1343
CONSTANT   0.46860     0.1055       4.443     1.000 0.395      0.0000     0.8657

|_ols dbus rattme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0058     R-SQUARE ADJUSTED =  -0.0035
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25147
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50147
SUM OF SQUARED ERRORS-SSE=   26.907
MEAN OF DEPENDENT VARIABLE =  0.54128
LOG OF THE LIKELIHOOD FUNCTION = -78.4209


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME     0.25125E-01 0.3178E-01  0.7907     0.785 0.076      0.0762     0.1005
CONSTANT   0.48688     0.8391E-01   5.803     1.000 0.489      0.0000     0.8995

|_ols dbus ratdis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0076     R-SQUARE ADJUSTED =  -0.0016
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25100
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50100
SUM OF SQUARED ERRORS-SSE=   26.858
MEAN OF DEPENDENT VARIABLE =  0.54128
LOG OF THE LIKELIHOOD FUNCTION = -78.3206


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
```

```
RATDIS    0.22849E-01 0.2518E-01  0.9074      0.817 0.087      0.0874       0.1309
CONSTANT  0.47043     0.9165E-01   5.133      1.000 0.445      0.0000       0.8691


|_ols dnonbus tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0111     R-SQUARE ADJUSTED =    0.0019
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25132
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50131
SUM OF SQUARED ERRORS-SSE=   26.891
MEAN OF DEPENDENT VARIABLE =  0.47706
LOG OF THE LIKELIHOOD FUNCTION = -78.3879


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.38514E-02 0.3514E-02  -1.096     0.138-0.105     -0.1054     -0.1666
CONSTANT  0.55656     0.8699E-01   6.398     1.000 0.526      0.0000      1.1666


|_ols dnonbus dis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0115     R-SQUARE ADJUSTED =    0.0023
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25121
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50121
SUM OF SQUARED ERRORS-SSE=   26.880
MEAN OF DEPENDENT VARIABLE =  0.47706
LOG OF THE LIKELIHOOD FUNCTION = -78.3658


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS      -0.29930E-02 0.2682E-02  -1.116     0.133-0.107     -0.1073     -0.2195
CONSTANT  0.58179     0.1054       5.519     1.000 0.471      0.0000      1.2195


|_ols dnonbus rattme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0109     R-SQUARE ADJUSTED =    0.0016
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25137
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50137
SUM OF SQUARED ERRORS-SSE=   26.897
MEAN OF DEPENDENT VARIABLE =  0.47706
LOG OF THE LIKELIHOOD FUNCTION = -78.3997
```

```
VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATTME   -0.34483E-01 0.3177E-01  -1.085    0.140-0.104    -0.1044    -0.1565
CONSTANT  0.55172     0.8389E-01   6.577    1.000 0.537     0.0000     1.1565


|_ols dnonbus ratdis

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DNONBUS
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =    0.0098     R-SQUARE ADJUSTED =    0.0005
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.25166
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.50166
SUM OF SQUARED ERRORS-SSE=   26.927
MEAN OF DEPENDENT VARIABLE =  0.47706
LOG OF THE LIKELIHOOD FUNCTION = -78.4622


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
RATDIS   -0.25885E-01 0.2521E-01  -1.027    0.153-0.099    -0.0988    -0.1683
CONSTANT  0.55733     0.9177E-01   6.073    1.000 0.506     0.0000     1.1683
```

Appendix D.2 Derivation of Utilities

D.2.1 Departure

Individual Utilities

```
|_OLS UTDIS DIS

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS     DEPENDENT VARIABLE = UTDIS
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =   0.2822     R-SQUARE ADJUSTED =   0.2762
VARIANCE OF THE ESTIMATE-SIGMA**2 =   405.87
STANDARD ERROR OF THE ESTIMATE-SIGMA =   20.146
SUM OF SQUARED ERRORS-SSE=   48705.
MEAN OF DEPENDENT VARIABLE =   79.598
LOG OF THE LIKELIHOOD FUNCTION = -538.470


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       -0.99428     0.1448    -6.868     0.000-0.531   -0.5312     -0.3840
CONSTANT   110.16      4.809      22.91     1.000 0.902    0.0000      1.3840

|_OLS UTTME TME

REQUIRED MEMORY IS PAR=   21 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS     DEPENDENT VARIABLE = UTTME
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =   0.4428     R-SQUARE ADJUSTED =   0.4381
VARIANCE OF THE ESTIMATE-SIGMA**2 =   514.77
STANDARD ERROR OF THE ESTIMATE-SIGMA =   22.688
SUM OF SQUARED ERRORS-SSE=   61772.
MEAN OF DEPENDENT VARIABLE =   71.016
LOG OF THE LIKELIHOOD FUNCTION = -552.969


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       -1.1148     0.1142     -9.765     0.000-0.665   -0.6654     -0.4162
CONSTANT   100.58      3.658      27.49     1.000 0.929    0.0000      1.4162
```

Composite Utilities

```
|_OLS COMUTTME TME DIS

REQUIRED MEMORY IS PAR=   22 CURRENT PAR=  129
 OLS ESTIMATION
      122 OBSERVATIONS     DEPENDENT VARIABLE = COMUTTME
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =   0.4391     R-SQUARE ADJUSTED =   0.4297
VARIANCE OF THE ESTIMATE-SIGMA**2 =   327.04
STANDARD ERROR OF THE ESTIMATE-SIGMA =   18.084
```

```
SUM OF SQUARED ERRORS-SSE=    38918.
MEAN OF DEPENDENT VARIABLE =    74.262
LOG OF THE LIKELIHOOD FUNCTION = -524.787

VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
 NAME     COEFFICIENT  ERROR     119 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       -0.79201    0.9126E-01  -8.679    0.000-0.623    -0.5975    -0.2828
DIS       -0.46368    0.1303      -3.558    0.000-0.310    -0.2450    -0.1919
CONSTANT   109.52      4.808       22.78    1.000 0.902     0.0000     1.4747
```

D.2.2 Arrival Curb

Individual Utilities

```
|_ols uttme tme

REQUIRED MEMORY IS PAR=   19 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = UTTME
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.3607     R-SQUARE ADJUSTED =   0.3547
VARIANCE OF THE ESTIMATE-SIGMA**2 =   412.91
STANDARD ERROR OF THE ESTIMATE-SIGMA =   20.320
SUM OF SQUARED ERRORS-SSE=   44181.
MEAN OF DEPENDENT VARIABLE =   80.523
LOG OF THE LIKELIHOOD FUNCTION = -481.921


VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME        -1.1067     0.1424    -7.770     0.000-0.601    -0.6006    -0.2837
CONSTANT    103.37      3.526     29.32     1.000 0.943    0.0000     1.2837
```

. Composite Utility

```
|_ols comutdis tme dis

REQUIRED MEMORY IS PAR=   20 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = COMUTDIS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.4411     R-SQUARE ADJUSTED =   0.4306
VARIANCE OF THE ESTIMATE-SIGMA**2 =   304.19
STANDARD ERROR OF THE ESTIMATE-SIGMA =   17.441
SUM OF SQUARED ERRORS-SSE=   32244.
MEAN OF DEPENDENT VARIABLE =   74.039
LOG OF THE LIKELIHOOD FUNCTION = -464.755


VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    106 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       -0.84221     0.1225    -6.877     0.000-0.555    -0.5003    -0.2348
DIS       -0.52409     0.9350E-01 -5.605    0.000-0.478    -0.4078    -0.2477
CONSTANT   109.76       4.346     25.26     1.000 0.926    0.0000     1.4825

|_ols comuttme tme dis

REQUIRED MEMORY IS PAR=   20 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = COMUTTME
...NOTE..SAMPLE RANGE SET TO:    1,  109
```

```
  R-SQUARE =    0.2568      R-SQUARE ADJUSTED =    0.2428
VARIANCE OF THE ESTIMATE-SIGMA**2 =    639.40
STANDARD ERROR OF THE ESTIMATE-SIGMA =    25.286
SUM OF SQUARED ERRORS-SSE=    67776.
MEAN OF DEPENDENT VARIABLE =    73.954
LOG OF THE LIKELIHOOD FUNCTION = -505.242


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     106 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       -0.74472    0.1776      -4.194    0.000-0.377    -0.3518   -0.2079
DIS       -0.55609    0.1356      -4.102    0.000-0.370    -0.3441   -0.2631
CONSTANT   108.78      6.301       17.26    1.000 0.859     0.0000    1.4710

|_ols comutimp tme dis

REQUIRED MEMORY IS PAR=    20 CURRENT PAR=   129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = COMUTIMP
...NOTE..SAMPLE RANGE SET TO:     1,   109

 R-SQUARE =    0.4325      R-SQUARE ADJUSTED =    0.4218
VARIANCE OF THE ESTIMATE-SIGMA**2 =    291.20
STANDARD ERROR OF THE ESTIMATE-SIGMA =    17.065
SUM OF SQUARED ERRORS-SSE=    30867.
MEAN OF DEPENDENT VARIABLE =    76.128
LOG OF THE LIKELIHOOD FUNCTION = -462.377


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     106 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       -0.88172    0.1198      -7.358    0.000-0.581    -0.5394   -0.2391
DIS       -0.43072    0.9148E-01  -4.708    0.000-0.416    -0.3451   -0.1980
CONSTANT   109.40      4.252       25.73    1.000 0.928     0.0000    1.4371
```

Appendix D.3 Nonlinearities

D.3.1 Departure

```
|_OLS RATDIS DIS / RESID=UHAT

REQUIRED MEMORY IS PAR=   22 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.2822     R-SQUARE ADJUSTED =    0.2762
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.4657
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.2107
SUM OF SQUARED ERRORS-SSE=   175.89
MEAN OF DEPENDENT VARIABLE =   2.2213
LOG OF THE LIKELIHOOD FUNCTION = -195.427


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       0.59749E-01 0.8700E-02   6.868     1.000 0.531      0.5312     0.8268
CONSTANT  0.38475     0.2890       1.331     0.907 0.121      0.0000     0.1732
|_GENR DIS2=DIS*DIS

|_OLS UHAT DIS2

REQUIRED MEMORY IS PAR=   23 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0015     R-SQUARE ADJUSTED =  -0.0068
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.4636
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.2098
SUM OF SQUARED ERRORS-SSE=   175.63
MEAN OF DEPENDENT VARIABLE = -0.88272E-16
LOG OF THE LIKELIHOOD FUNCTION = -195.335


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS2     -0.48481E-04 0.1145E-03 -0.4235    0.336-0.039     -0.0386 0.99309E+14
CONSTANT  0.53501E-01 0.1672      0.3200    0.625 0.029      0.0000 0.99309E+14
|_GENR DIS3=DIS2*DIS

|_OLS UHAT DIS2 DIS3

REQUIRED MEMORY IS PAR=   25 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:     1,   122

 R-SQUARE =    0.0820     R-SQUARE ADJUSTED =    0.0666
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.3568
```

```
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.1648
SUM OF SQUARED ERRORS-SSE=   161.46
MEAN OF DEPENDENT VARIABLE = -0.88272E-16
LOG OF THE LIKELIHOOD FUNCTION = -190.205


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     119 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS2      0.27542E-02 0.8743E-03  3.150    0.999 0.277    2.1945 -0.54117E+16
DIS3    -0.45099E-04 0.1396E-04  -3.231    0.001-0.284   -2.2511  0.38358E+16
CONSTANT -0.97290     0.3561     -2.732    0.004-0.243    0.0000  0.18059E+16


|_OLS RATTME TME / RESID=UHAT

REQUIRED MEMORY IS PAR=   24 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =   0.4428     R-SQUARE ADJUSTED =    0.4381
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.8555
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.3622
SUM OF SQUARED ERRORS-SSE=   222.66
MEAN OF DEPENDENT VARIABLE =   2.7377
LOG OF THE LIKELIHOOD FUNCTION = -209.811


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.66934E-01 0.6854E-02   9.765    1.000 0.665    0.6654     0.6483
CONSTANT  0.96286     0.2196       4.384    1.000 0.372    0.0000     0.3517
|_GENR TME2=TME*TME
|_GENR TME3=TME2*TME


|_OLS UHAT TME3  TME2  TME

REQUIRED MEMORY IS PAR=   28 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =   0.0302     R-SQUARE ADJUSTED =    0.0055
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.8301
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.3528
SUM OF SQUARED ERRORS-SSE=   215.95
MEAN OF DEPENDENT VARIABLE =  0.19656E-15
LOG OF THE LIKELIHOOD FUNCTION = -207.942


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     118 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME3    -0.49262E-04 0.2626E-04  -1.876    0.032-0.170   -2.3013  0.62783E+16
TME2      0.41174E-02 0.2342E-02  1.758    0.959 0.160    3.3983 -0.34199E+16
TME     -0.87297E-01 0.6022E-01  -1.450    0.075-0.132   -1.1626 -0.34374E+16
CONSTANT  0.38994     0.4380      0.8902   0.812 0.082    0.0000 -0.57905E+15
```

D.3.2 Arrival Curb

```
|_ols rattme tme / resid=uhat

REQUIRED MEMORY IS PAR=   20 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.3614     R-SQUARE ADJUSTED =   0.3554
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.4863
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.2191
SUM OF SQUARED ERRORS-SSE=   159.04
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -175.253


VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME        0.66492E-01 0.8545E-02   7.781     1.000 0.601      0.6011      0.6339
CONSTANT   0.79260     0.2115       3.747     1.000 0.341      0.0000      0.3661
|_genr tme2=tme*tme
|_genr tme3=tme*tme*tme


|_ols uhat  tme tme2 tme3

REQUIRED MEMORY IS PAR=   24 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.0994     R-SQUARE ADJUSTED =   0.0737
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.3641
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.1679
SUM OF SQUARED ERRORS-SSE=   143.23
MEAN OF DEPENDENT VARIABLE = -0.43798E-16
LOG OF THE LIKELIHOOD FUNCTION = -169.547


VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    105 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.19950      0.6000E-01  -3.326    0.001-0.309     -2.2577 0.70706E+16
TME2      0.79581E-02 0.2611E-02   3.048    0.999 0.285      5.1203 0.83710E+16
TME3     -0.86454E-04 0.3217E-04  -2.687    0.004-0.254     -2.9422 0.33909E+16
CONSTANT   1.2179      0.4153       2.932    0.998 0.275      0.0000 0.20904E+16


|_ols rattme tme  tme2 tme3

REQUIRED MEMORY IS PAR=   24 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.4249     R-SQUARE ADJUSTED =   0.4084
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.3641
```

```
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.1679
SUM OF SQUARED ERRORS-SSE=   143.23
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -169.547


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     105 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME      -0.13307     0.6000E-01  -2.218    0.014-0.212    -1.2031     -1.2687
TME2      0.79581E-02 0.2611E-02   3.048    0.999 0.285     4.0919      2.2525
TME3     -0.86454E-04 0.3217E-04  -2.687    0.004-0.254    -2.3512     -0.9124
CONSTANT   2.0105     0.4153       4.841    1.000 0.427     0.0000      0.9286

|_ols rattme tme tme2

REQUIRED MEMORY IS PAR=   23 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.3853     R-SQUARE ADJUSTED =    0.3737
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.4441
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.2017
SUM OF SQUARED ERRORS-SSE=   153.08
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -173.172


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     106 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.74763E-02 0.3025E-01  0.2472    0.597 0.024     0.0676      0.0713
TME2      0.10804E-02 0.5319E-03   2.031    0.978 0.194     0.5555      0.3058
CONSTANT   1.3487     0.3441       3.919    1.000 0.356     0.0000      0.6229

|_ols ratdis dis / resid=uhat

REQUIRED MEMORY IS PAR=   22 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.3169     R-SQUARE ADJUSTED =    0.3105
VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.5275
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.5898
SUM OF SQUARED ERRORS-SSE=   270.44
MEAN OF DEPENDENT VARIABLE =   3.1009
LOG OF THE LIKELIHOOD FUNCTION = -204.189


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       0.59935E-01 0.8507E-02   7.045    1.000 0.563     0.5629      0.6763
CONSTANT   1.0038     0.3344       3.002    0.998 0.279     0.0000      0.3237
|_genr dis2=dis*dis
|_genr dis3=dis*dis*dis
```

```
|_ols uhat dis dis2 dis3

REQUIRED MEMORY IS PAR=   25 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0456     R-SQUARE ADJUSTED =   0.0184
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.4581
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.5678
SUM OF SQUARED ERRORS-SSE=   258.10
MEAN OF DEPENDENT VARIABLE = -0.26482E-15
LOG OF THE LIKELIHOOD FUNCTION = -201.643


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME     COEFFICIENT  ERROR     105 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS       -0.21563     0.2400    -0.8986    0.185-0.087    -2.4504 0.29164E+17
DIS2       0.69419E-02 0.6222E-02  1.116    0.866 0.108     7.1253 0.41449E+17
DIS3      -0.60793E-04 0.4781E-04 -1.271    0.103-0.123    -4.7893 0.19388E+17
CONSTANT   1.8376      2.744      0.6696    0.748 0.065     0.0000 0.71029E+16
```

Appendix D.4 Effect of Qualitative Variables

D.4.1 Departure Curb

```
|_OLS RATTME TME / RESID=UHAT

REQUIRED MEMORY IS PAR=   26 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =    0.4428     R-SQUARE ADJUSTED =    0.4381
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.8555
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.3622
SUM OF SQUARED ERRORS-SSE=   222.66
MEAN OF DEPENDENT VARIABLE =   2.7377
LOG OF THE LIKELIHOOD FUNCTION = -209.811


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.66934E-01 0.6854E-02   9.765     1.000 0.665     0.6654     0.6483
CONSTANT  0.96286     0.2196       4.384     1.000 0.372     0.0000     0.3517


|_OLS UHAT DIMP DSX DBUS DNONBUS DSZ

REQUIRED MEMORY IS PAR=   30 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:     1,  122

 R-SQUARE =    0.0757     R-SQUARE ADJUSTED =    0.0359
VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.7742
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.3320
SUM OF SQUARED ERRORS-SSE=   205.81
MEAN OF DEPENDENT VARIABLE =  0.19656E-15
LOG OF THE LIKELIHOOD FUNCTION = -205.010


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     116 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP     -0.73973     0.2610     -2.834     0.003-0.254     -0.2701 0.65867E+15
DSX       0.16422     0.2571     0.6387     0.738 0.059      0.0581 0.96200E+15
DBUS      0.17450     0.3181     0.5486     0.708 0.051      0.0626 0.20004E+15
DNONBUS  -0.23901E-01 0.4258    -0.5613E-01 0.478-0.005     -0.0053 0.38399E+15
DSZ      -0.43189     0.3172     -1.362     0.088-0.125     -0.1585 0.52581E+15
CONSTANT  0.55345     0.2861      1.935     0.972 0.177      0.0000 0.52581E+15


|_OLS RATTME TME DIMP

REQUIRED MEMORY IS PAR=   27 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,  122
```

```
 R-SQUARE =   0.4750     R-SQUARE ADJUSTED =   0.4661
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.7631
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.3278
SUM OF SQUARED ERRORS-SSE=   209.81
MEAN OF DEPENDENT VARIABLE =   2.7377
LOG OF THE LIKELIHOOD FUNCTION = -206.182


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     119 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME        0.66222E-01 0.6687E-02   9.904    1.000 0.672     0.6584     0.6414
DIMP     -0.65874      0.2439     -2.701    0.004-0.240    -0.1795    -0.1400
CONSTANT   1.3651      0.2608      5.234    1.000 0.433     0.0000     0.4986


|_OLS RATDIS DIS / RESID=UHAT

REQUIRED MEMORY IS PAR=   26 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = RATDIS
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.2822     R-SQUARE ADJUSTED =   0.2762
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.4657
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.2107
SUM OF SQUARED ERRORS-SSE=   175.89
MEAN OF DEPENDENT VARIABLE =   2.2213
LOG OF THE LIKELIHOOD FUNCTION = -195.427


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     120 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIS        0.59749E-01 0.8700E-02   6.868    1.000 0.531     0.5312     0.8268
CONSTANT   0.38475     0.2890      1.331    0.907 0.121     0.0000     0.1732


|_OLS UHAT DIMP DSX DBUS DNONBUS DSZ

REQUIRED MEMORY IS PAR=   30 CURRENT PAR=  129
 OLS ESTIMATION
     122 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =   0.0391     R-SQUARE ADJUSTED =  -0.0023
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.4570
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.2071
SUM OF SQUARED ERRORS-SSE=   169.01
MEAN OF DEPENDENT VARIABLE = -0.88272E-16
LOG OF THE LIKELIHOOD FUNCTION = -192.993


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT  ERROR     116 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP     -0.10313     0.2365    -0.4360   0.332-0.040    -0.0424 0.10603E+15
DSX       0.15121     0.2330     0.6490   0.741 0.060     0.0602 0.96133E+14
DBUS     -0.20524     0.2883    -0.7120   0.239-0.066    -0.0828 0.17568E+14
DNONBUS   0.17122     0.3859     0.4437   0.671 0.041     0.0425 0.27154E+15
DSZ      -0.26248     0.2874    -0.9131   0.182-0.084    -0.1084 0.71935E+15
CONSTANT  0.21572     0.2592     0.8321   0.796 0.077     0.0000 0.44119E+15
```

D.4.2 Arrival Curb

```
|_ols rattme tme / resid=uhat

REQUIRED MEMORY IS PAR=   23 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATTME
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.3614     R-SQUARE ADJUSTED =   0.3554
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.4863
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.2191
SUM OF SQUARED ERRORS-SSE=   159.04
MEAN OF DEPENDENT VARIABLE =   2.1651
LOG OF THE LIKELIHOOD FUNCTION = -175.253


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
TME       0.66492E-01 0.8545E-02   7.781     1.000 0.601       0.6011      0.6339
CONSTANT  0.79260     0.2115       3.747     1.000 0.341       0.0000      0.3661
```

```
|_ols uhat dimp dsx dbus dnonbus dsz

REQUIRED MEMORY IS PAR=   27 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.0225     R-SQUARE ADJUSTED =  -0.0249
VARIANCE OF THE ESTIMATE-SIGMA**2 =   1.5093
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.2285
SUM OF SQUARED ERRORS-SSE=   155.45
MEAN OF DEPENDENT VARIABLE = -0.43798E-16
LOG OF THE LIKELIHOOD FUNCTION = -174.012


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    103 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP       0.27703     0.2492      1.112     0.866 0.109      0.1125 0.28401E+15
DSX        0.65876E-01 0.2430      0.2711    0.607 0.027      0.0273 0.56497E+14
DBUS      -0.57365     0.9092     -0.6309    0.265-0.062     -0.2366 0.53138E+15
DNONBUS   -0.66796     0.9164     -0.7289    0.234-0.072     -0.2762 0.52801E+14
DSZ       -0.91369E-01 0.2870     -0.3184    0.375-0.031     -0.0341 0.44119E+14
CONSTANT   0.49732      1.028      0.4838    0.685 0.048      0.0000 0.76300E+15
```

```
|_ols ratdis dis / resid=uhat

REQUIRED MEMORY IS PAR=   23 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = RATD1S
...NOTE..SAMPLE RANGE SET TO:     1,  109

 R-SQUARE =   0.3169     R-SQUARE ADJUSTED =   0.3105
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.5275
```

```
STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.5898
SUM OF SQUARED ERRORS-SSE=   270.44
MEAN OF DEPENDENT VARIABLE =   3.1009
LOG OF THE LIKELIHOOD FUNCTION = -204.189


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    107 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
DIS        0.59935E-01 0.8507E-02   7.045     1.000 0.563     0.5629     0.6763
CONSTANT    1.0038     0.3344      3.002     0.998 0.279     0.0000     0.3237

|_ols uhat dimp dsx dbus dnonbus dsz

REQUIRED MEMORY IS PAR=   27 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = UHAT
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =   0.0154      R-SQUARE ADJUSTED =  -0.0323
VARIANCE OF THE ESTIMATE-SIGMA**2 =   2.5851
STANDARD ERROR OF THE ESTIMATE-SIGMA =   1.6078
SUM OF SQUARED ERRORS-SSE=   266.26
MEAN OF DEPENDENT VARIABLE = -0.26482E-15
LOG OF THE LIKELIHOOD FUNCTION = -203.340


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR    103 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
DIMP     -0.43687E-01 0.3261    -0.1340    0.447-0.013    -0.0136 0.78499E+14
DSX      -0.24409     0.3180    -0.7675    0.222-0.075    -0.0775 0.46423E+15
DBUS      0.29304      1.190     0.2463    0.597 0.024     0.0927 0.64096E+15
DNONBUS    0.27099      1.199     0.2259    0.589 0.022     0.0859 0.58445E+15
DSZ       0.29398     0.3756     0.7827    0.782 0.077     0.0842 0.17944E+16
CONSTANT -0.35353      1.345    -0.2628    0.397-0.026     0.0763 0.16975E+16
```

Appendix D.5 Regression of (DMON) Against Utility Numbers

D.5.1 Departure

```
|_ols dmon comuttme

REQUIRED MEMORY IS PAR=   23 CURRENT PAR=  129
 OLS ESTIMATION
     109 OBSERVATIONS     DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:    1,  109

 R-SQUARE =    0.0356     R-SQUARE ADJUSTED =    0.0265
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.31175
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.55835
SUM OF SQUARED ERRORS-SSE=   33.357
MEAN OF DEPENDENT VARIABLE =  0.42202
LOG OF THE LIKELIHOOD FUNCTION = -90.1325


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     107 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
COMUTTME -0.36722E-02 0.1849E-02  -1.986     0.025-0.189    -0.1886    -0.6435
CONSTANT  0.69360     0.1468       4.724     1.000 0.415     0.0000     1.6435
```

D.5.2 Arrival

```
|_OLS DMON COMUTTME

REQUIRED MEMORY IS PAR=   26 CURRENT PAR=  129
 OLS ESTIMATION

     122 OBSERVATIONS     DEPENDENT VARIABLE = DMON
...NOTE..SAMPLE RANGE SET TO:    1,  122

 R-SQUARE =    0.2606     R-SQUARE ADJUSTED =    0.2544
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.51522
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.71779
SUM OF SQUARED ERRORS-SSE=   61.826
MEAN OF DEPENDENT VARIABLE =  0.89344
LOG OF THE LIKELIHOOD FUNCTION = -131.649


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     120 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
COMUTTME -0.17720E-01 0.2725E-02  -6.503     0.000-0.510    -0.5105    -1.4729
CONSTANT   2.2094     0.2125       10.40     1.000 0.688     0.0000     2.4729
```

Appendix D.6 Curb Traffic Distribution Model

```
|_FILE 11 B:\trafcon.DAT
UNIT 11 IS NOW ASSIGNED TO: B:\trafcon.DAT
|_READ (11) NO Total Percent Totdis

...SAMPLE RANGE IS NOW SET TO:          1          9
|_SAMPLE 1 9
|_Genr LP=LOG(PERCENT)
|_Genr LD=LOG(TOTAL)

|_OLS LP LD TOTDIS

REQUIRED MEMORY IS PAR=    2 CURRENT PAR=  129
 OLS ESTIMATION
       9 OBSERVATIONS     DEPENDENT VARIABLE = LP
...NOTE..SAMPLE RANGE SET TO:     1,     9

 R-SQUARE =    0.7693     R-SQUARE ADJUSTED =    0.6924
VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.24359E-01
STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.15607
SUM OF SQUARED ERRORS-SSE=  0.14615
MEAN OF DEPENDENT VARIABLE =   2.3753
LOG OF THE LIKELIHOOD FUNCTION =  5.77098


VARIABLE   ESTIMATED  STANDARD   T-RATIO         PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR       6 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
LD        -0.65120    0.27796    -2.3428     1.000 -0.6912    -0.72870     -0.93960
TOTDIS    -0.24460E-02 0.41912E-02 -0.58362  0.756 -0.2318    -0.18153     -0.11042
CONSTANT  4.8694      0.66896     7.2790     1.000  0.9478     0.0000e+00   2.0500
```

APPENDIX -E

APPENDIX - E

E.1 - Calculations of User Costs

Exact or estimated unit costs used for calculations, provided by Palm Beach International Airport, Florida.

Cost of providing the treminal curb, in 1988 Dollar = $2295 linear meter

Cost of providing the cover for the curb area in 1988 Dollar = $2295 linear meter

Cost of operrating and policy enforcement expenses estimated at = $112/per/day

Maintenance cosst, of the capital cost anually = 8%

Interest rate (i) = 6%

Design life of the curb and associated cover = 20 years

Total number of enplanning passengers (1992) = 2,856,979

Total number of deplanning passengers (1992) = 2,834,613

Percent of peak travellers = 55%

TABLE E.1 - CALCULATION OF USER COST

	A to B	B to C	C to D	D to E	E to F
Utility Numbers	84.7	70.6	56.5	42.4	28.3
Disutility Numbers	38.7	48.1	57.5	67.0	76.4
Time Contribution to Disutility Cost	38.7	48.1	57.5	67.0	76.4
Time Contribution (Considering Probalities)	1.3	3.2	7.6	15.7	25.6
Distance Contribution to Disutility Cost	28.4	35.4	43.2	49.1	53.5
User Cost	11.6	15.9	21.9	33.6	48.5
Facility Provision Cost	55.9	50.0	43.5	38.5	34.9
Total Cost	67.5	69.9	65.4	72.1	93.4