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Welfare Analysis of Informal Transit Services in Brazil
and the Effects of Regulation

by

Aaron David Golub

B.S. (Virginia Polytechnic Institute and State University) 1994
M.S. (Massachusetts Institute of Technology) 1996

A dissertation submitted in partial satisfaction of the

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Committee in charge:

Professor Martin Wachs, Co-chair
Professor Robert Cervero, Co-chair
Associate Professor Elizabeth Deakin
Professor Samer Madanat

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Abstract

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Doctor of Philosophy
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Engineering – Civil and Environmental Engineering

University of California, Berkeley

Professor Martin Wachs, Co-chair
Professor Robert Cervero, Co-chair

In Brazil, the recent explosion of informal transport activity is having profound effects on

formal, regulated transport systems and is the source of great controversy in the urban passenger

transportation arena. A variety of policies are being proposed to manage what has been an

uncontrolled growth of the sector. This study seeks to understand the advantages these systems

have for users who choose them, and how proposed policies will impact these benefits.

A corridor in Rio de Janeiro with substantial informal activity was used as a case study

and field trips were made to gather basic data and perform travel surveys. Standard measures of

welfare changes in a discrete choice framework were used to measure the proposed policies'

welfare impacts on users. Eleven candidate policies were evaluated, ranging from the eradication

of the informal modes and investment in formal modes, to the legalization and regulation of the

informal modes. Benefits were compared with costs to discuss policies' efficiencies, and the

distribution of benefits across income classes was explored.

Net benefits from some policies were found to be substantial, on the order of hundreds of

dollars per year per commuter, a significant share of the typical yearly earning of 2000 dollars

(US). Legalizing the informal sector was found to benefit users only slightly but further

investments in the sector are probably inefficient. Users benefited most from improvements in

formal mass transit modes (trains and buses), on the order of 50 to 100 dollars per commuter per year. Finally, policies to foster a competitive environment for the delivery of both informal and formal services was shown to benefit users, on the order of 50 dollars per commuter per year.

These best policies are discussed in light of current and past management practices in the sector. High costs of investments, an environment resistant to and unfamiliar with open and competitive bidding for concessions, and difficulties in the enforcement of regulations will threaten the successful implementation of these policies.

To Mom, Dad and Jen,

for always being here for me.

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Preface. "O Bonde" (Excerpt): A Song about Poverty and Transportation

"O Bonde" (The Streetcar) by José de Ribamar Viana, a.k.a. Papete (1967)

Da gente que trabalha no centro e mora no subúrbio

Tudo mundo escutou tão tristonho o murmúrio

Um grito de saudade que encheu a cidade

De infelicidade

> *From the people that work downtown and live in the suburbs*
>
> *Everyone heard the murmur so sad*
>
> *A cry of longing that filled the city*
>
> *Of sadness*

E o velho, o menino, a senhora, o alfaiate, o padeiro,

O padre, o guarda, o moleque, o leiterio

Que moram aqui, a colá, não sei onde

> *And the old man, the boy, the woman, the tailor, the baker,*
>
> *the priest, the guard, the child, the milkman*
>
> *Who live out here, at the end, who knows where*

Sentiram e choraram a falta do bonde

Do bonde, tão lerdo, mais que era transporte

De quem nesta vida não teve a sorte

De ter papai rico, ter muito tostão

Para ter cadillac, pagar lotacao

E tudo essa gente que mora em barraco

Choupana e buraco

Que não tem dinheiro para comprar um trapo

Ficou com a triste dor no coração

They felt the cry of the disappearance of the streetcar

The streetcar, so slow, but it was transportation

For those who have no luck in this world

To have a rich father, to have a lot of dough

To have a Cadillac, or pay for the taxi

And all these people living a hole, hut or ditch

That can't afford a rag

Were overcome with a sad pain in their hearts

Quando, por necessidade

O dono da cidade se esqueçeu da pobreza

Do choro, da dor, da mágoa e da tristeza

Tirando o bondinho da circulação

When, out of necessity

The owner of the city forgot the poor

And the cries of pain, of hurt, and of sadness

Removing the streetcar from circulation.

Tudo mundo chorou

Quando o bonde morreu

Gente vão rezar

Para o bonde voltar

Para tristeza acabar

Para ninguém mais chorar

Para alegria voltar

Para o bondinho voltar…

Everyone cried,

When the streetcar died

People will pray

For the streetcar to return

For sadness to end

For no one to cry anymore

For happiness to return

For the streetcar to return…

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Chapter 1. Introduction

1.1 Objectives

During the past decade, in dozens of cities across Brazil, rising unemployment, worsening public transit services, and rising public transit fares have combined to set off an explosion of informal public transit activity using small vans and minibuses. Today, tens of thousands of Brazilians have turned to providing public transit services as a means of livelihood. The poor, already subjected to agonizingly long commutes in crowded buses and trains, have largely embraced the new options. The highly ordered, concentrated and regulated public transit sector in Brazil, for decades the focus of national industrial development policy, could not contrast more with the small artisan-style operators entering the long-time monopolized and guarded public transit markets.

This growth of informally provided collective taxi services or "jitneys," commonly called "vans" or "clandestine" transit, is having profound effects on formal, regulated transport systems and is the subject of great controversy in urban passenger transportation. Policies are being proposed to come to grips with what has been uncontrolled growth of this sector. Thus far, discussions and proposals have focused on the supply side effects of these policies – effects on traffic congestion and traffic operations, the financial state of the formal transit service suppliers, as well as ideological discussions concerning the proper role of informality in the urban economy. No formal attention has been given, however, to the effects of proposed policies on the consumers of transit services. Consumers of informal transit services are often in precarious economic situations, traveling long distances from outlying residences to low wage jobs, or are transit dependent with poor access to jobs and services. The growth in demand for informal

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transit services means that they are in some ways benefiting the consumers and offering advantages over the formally administered modes.

Informality is defined as the unregulated, often "underground" and illegal provision of services ranging anywhere from housing to commerce. It relies more heavily than the formal sector on traditional knowledge and resources, family labor and ownership, small-scale operation, labor intensive techniques, and offers low barriers to entry for potential participants. [Rakowski, 1994, p. 17] It is as important as it is prevalent in the urbanized areas of developing countries. Urban passenger transportation is one of the largest sectors prone to informal delivery in the developing world, and is manifested by services that are not regulated and often officially prohibited in contrast with formally regulated transit services. For varying reasons, there is a struggle on the part of policy makers, politicians, and other urban actors to control informality in the transportation sector. This work will study some of the possible effects of attempts to deal with informal transportation.

This study seeks to understand and quantify the benefits accruing to users from the various policies proposed to address the problem. More specifically, some of the key questions to be investigated are: Will regulating the informal modes negate their advantages in the marketplace and result in a likely loss of patronage? What characteristics of transit services most affect the welfare of users? Will the process of regulation drastically affect the welfare of users of these transport modes? The main question is: how do each in a range of policy options affect the welfare of users, and which, in turn, is most beneficial?

The research investigates several hypotheses. A simple one is that restricting van use will harm users, by restricting their choice set. Simple legalization might have some positive effect for the small number of users who avoid the vans purely because of their illegal status and will probably improve welfare. It is likely, however, that none of the policies treating the informal vans will have the same magnitude of effects as those treating the buses and trains, given the

small use of the vans and the huge latent demand for better mass transit. Improving vans will never be able to deliver the welfare effects that improving the mass transit modes can deliver.

1.2 Products

This work will evaluate policies and make policy recommendations to address the issues of rising informality in Brazilian cities. To accomplish this, a specific travel corridor in Brazil was chosen for study and data were collected by surveying travelers in the corridor. The data allow the calibration of the choice model and formulation of the welfare calculation. These welfare impacts, or "benefits", are the standard compensating variation measure of consumers' economic benefits from a policy intervention applied to the discrete choice model. The time frame of the policies' impacts is the short term – long enough for travel behavior to change, but not long enough to affect residential or job location decisions. An estimate was made of the welfare impact of each of several policy scenarios, with results in units of dollar amounts per trip and summed for the population for one year. The distribution of benefits to different income groups is also presented for each policy.

The results of this work apply directly to the current debate concerning the costs, benefits and regulation of informal transport services in the Brazilian context, but they can have much wider applications. It is rare that a study focuses solely on the travel behavior of the poor, and its results might be applicable to other urban areas in Brazil and other countries. Urbanization rates are high in developing countries, and similar long distance periphery-to-center travel patterns are significant in numerous growing cities. Understanding travel behavior under these conditions could be informative for applications in other cities. In particular, the modes' utility functions can reveal factors that might be useful in other transportation related studies. Furthermore, the last 10 years have seen a growing concern for exploding personal vehicle use in large developing countries including China, Thailand, India and Brazil. Understanding how travelers accept new medium-capacity systems offering viable alternatives to personal vehicles could be useful in

working towards solutions to motorization problems. There may even be applications to cities in the developed world where traffic congestion is becoming as large a problem, or where access to rail systems could be facilitated through the use of paratransit services.

1.3 Organization of the Dissertation

This dissertation is organized into eight chapters including this introductory chapter. The second chapter discusses the motivation behind this work and reviews some of the literature about informal transportation in the developing world. It introduces some of the basic concepts of transit regulation, including some past cases of informal transit regulation. The third chapter outlines the methodology used in the study. This includes how the choice model is constructed and used to determine the utility functions, and how the welfare model is derived to perform the policy analysis. The fourth chapter covers the current rise of informality in Brazil, and the specifics of Rio de Janeiro. Details about the Baixada-Fluminense to Central Station travel corridor are then introduced. Chapter five presents the transit riders' surveys and summarizes the data gathered. It then presents the estimation of the mode choice models and the resulting welfare model. The sixth chapter presents the results of the welfare calculations and an analysis and interpretation of the eleven policy scenarios. Chapter seven discusses the implications of the results of the analysis for real policy options, and some of the issues involved in implementing these options. Chapter eight concludes the work with a discussion of some of the problems of the study, some potential applications of the results and other future work.

Chapter 2. Motivation and Background

2.1 Urban Transportation in the Developing World

Over the past four decades, heightened rates of urban-rural migration have exploded the sizes of urban centers of developing countries. These high rates of growth place great pressures on public services and infrastructure to supply the growing populations with means to work, study, shop, and live. Dense urban cores, low incomes, and heavily concentrated areas of

The skyline of São Paulo, Brazil seems to never end. [Golub]

Employment, commerce and services make public transportation systems essential elements of these urban areas. Lower-income and sprawling peripheral areas make commute distances for the

poor to downtown jobs and other services excessively long. Everyday, hundreds of millions of people endure these long commutes on hot and crowded trains and buses crawling through the typical morass of urban traffic congestion.

In many cities in developing countries regular public transportation systems don't meet all of the demands of the marketplace. The reasons for this shortfall vary. It can result from an insufficient response to constantly changing travel and settlement patterns, poor attendance to service niches (speeds, levels of service, ease of storage of personal items, etc.), or purely from a lack of total capacity. Regular transit services normally employ full size vehicles, many times are poorly connected and coordinated, and these vehicles can't always serve residential areas with narrow entryways, poor roads or difficult terrain [Cervero, 1991]. For private operators, many times fares are set too low by city regulators to foster investment in the system and services remain unreliable, unsafe, dirty and unattractive. On the other hand, many public operators are supported by subsidies and become overstaffed, extremely inefficient and massive bureaucracies, unresponsive to patron's needs and the changing transportation demands [ECLAC, 1992].

In many of these cases paratransit modes illegally enter the market to fill these gaps in the supply left open by the regular public transit system. The remaining sections in this chapter describe these paratransit modes, the problems they pose for urban transportation systems, and some of the ways regulators have responded to their growth.
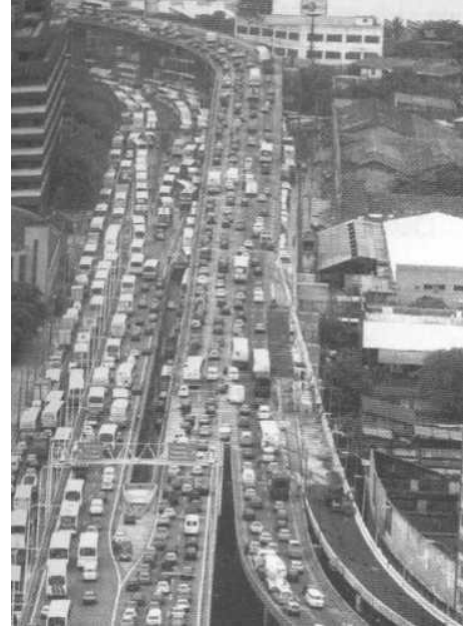
Poorly managed roadways and public transit systems plague cities in developing countries.
[Left: Lee Schipper, Right: Journal do Brasil, Feb 27, 2000, p. 25]

2.2 The Informal Transport Sector

The terms "paratransit" and "informality" are sometimes used interchangeably, and indeed in many contexts, they overlap. Paratransit refers to the technology and type of service involved, and formality refers to institutional arrangements by which it is provided. Almost always, however, the informal sector delivers paratransit-type services, while the formal sector can deliver both paratransit and fixed services. Paratransit and informality, in varied combinations, are found in cities all over the world, from the poorest cities of Asia and Africa to some of the wealthiest of North America and Europe.

Paratransit modes range from small human-powered cycle taxis to 18 passenger minibuses and differ from formal transit systems because they lack a rigid schedule or route, and sometimes even lack a preset fare. In some cases, paratransit services are formally organized and regulated by the city agencies, but many times, the systems are informal and operate without licenses or recognition by the city. In the developing world, paratransit services tend to include vehicles used in a shared taxi arrangement, hailed at the curbside or loaded at a fixed terminal or

curbside stand. They tend to complement regular transit services, serve areas or populations not traditionally serviced by regular services, and they can be extremely efficient and responsive to market demands and changes. They are criticized for their effects on traffic congestion and air quality. Paratransit normally serves lower class and poorer populations, sometimes in far off and otherwise poorly accessible settlements.

In many cities, paratransit modes carry a significant share of trips. Seventy percent of total public transit trips in Manila, Philippines, 50 percent in Jakarta, Indonesia, 40 percent in Kuala Lumpur, 55 percent in Mexico City, 30 percent in Hong Kong, 33 percent in Nairobi, Kenya, and 50 percent in San Juan, Puerto Rico are supplied by paratransit modes [Takyi, 1990]. The developed world has its own systems, most notably those regulated in Atlantic City, New Jersey, and Belfast, Ireland, and the unregulated van system in Brooklyn, New York [Cervero, 1997]. "Dial-a-ride" paratransit systems respond to a phoned request for a pick-up and operate in several cities in the US, serving mainly disabled, elderly and poor patrons. Airport shuttles or employer-based van pools are further examples of paratransit use in the U.S. [Cervero, 1997]. In Great Britain, since bus deregulation in 1985, the use of mini-buses and other more flexible services has grown dramatically [White, 1997; Banister, D. et al., 1990].

Informal transit services in Asia (left) and Latin America (right).
[L. Schipper]

Informal services are those operating without official endorsement. Most are distinguished by their operation by small-sized operators, the use of smaller and many times low-

performing, aging or unfit vehicles, and their flexibility in service characteristics. As previously stated, the informal sector almost always delivers paratransit-type services. Many times informal services have poor organization, causing them to compete vigorously for passengers at the curbside, overload vehicles, or load or unload vehicles away from designated areas, lowering the quality of service for all operators. Typically, the nexus of operation lies in owner-operators and the vast majority own and operate only one vehicle. Informal operators are often politically weak, poorly represented in the formal city democracy, and are more closely associated with traditional, as opposed to modern society [Cervero, 2000]. They are very labor intensive, low tech and structured horizontally among many independent operators, rather than vertically within a small number of large firms [Cervero, 2000]. Often, many small firms join together into cooperatives. The cooperatives might be related to specific areas of the city, or even a specific route, thereby called "route associations." Cooperatives and route associations serve to organize the member firms in ways to increase the total ridership and profit of the routes, while also insuring that all operators gain fairly equal shares of the total revenues. An overabundance of idle labor makes informal activities an extremely attractive opportunity for employment. The following paragraphs describe several representative informal transit systems in brief.

In Brooklyn, New York City, informal operators run a paratransit system along some of that borough's most important corridors. These operations are illegal and compete directly with formal city bus services, but are difficult to prevent. The system consists of utility vans ("Econoline" type) cruising the main boulevards and taking passengers from anywhere along the route for a flat fee (one dollar in 1996). The drivers can diverge from standard routes to avoid congestion, or to assist a passenger to a particular destination.

In Hong Kong, informal minibus operators began circulation illegally in the 1960s [Lee, 1990]. They were neither licensed nor insured for transit operations and competed directly with other formal city transit services. A strike by formal transit workers in 1967 brought the informal operators into consideration by regulators as a useful component of a comprehensive transit

system. The minibus system has since been "formalized" through a set of rules, allowing the operators to purchase licences for operation and undergo inspections, etc [Lee, 1990]. Today, the operators can search for passengers anywhere they prefer, though most stick to the main congested corridors of the city.

In Bangkok, Thailand, motorcycle taxis illegally congregate near bus stops or entranceways to large residential blocks to pick up passengers. They offer higher speeds than the prevailing congested vehicle traffic on Bangkok's roads, and can easily enter into difficult back roads and dense residential areas [Cervero, 2000].

In Mexico City in the 1960s, taxi drivers cruising to pick up multiple fares during the peak hours, called "Peseros," were originally tolerated by officials for their ability to serve some of the peak hour demand [Roschlau, 1981]. Today, they have grown to become the main transportation system for the federal region of roughly 20 million people. In the early 1970s, various problems led to a lack of capacity in the bus system, causing regulators to stimulate the growth of the Pesero system [Wirth, 1997]. Through the 1980s, the formal bus system slowly fell into disarray for political reasons [Wirth, 1997], and the Pesero system exploded in size to take up the demand and was legalized by city regulators. By 1990, minibuses (24 seaters and Volkswagen combis) accounted for 50% of the over 30 million motorized trips made in the region daily [Wirth, 1997], up from only 10% in 1980 [Roschlau, 1981]. With this explosion came political power among minibus operators and owners, and the entrance of informal pirate operators. Today, only about half of the operators are legitimately licensed and insured.

In Jakarta, Indonesia, a wide range of vehicles, from human powered pedicabs to minbuses offer passenger transportation services [Cervero, 2000]. Their pedicabs, called Becaks, offer passengers service over short distances, while "Ojeks", or motorcycle taxis, offer services over slightly longer distances. The hybrid three-wheeled motor-taxis, called "Bajajs" offer comfort closer to that of a car, while the larger three-wheeled "Bemos" and "Toyokos" can carry as many as 8 passengers. Finally, the larger Microlets and Minibuses carry 10 to 25 passengers.

The city attempts to confine the slower and smaller vehicles to certain areas of the city and certain road types, out of concern for safety and traffic discipline. The Bemos are actually registered by the district they serve, and are thus confined to a certain service areas. The Mini and Microbuses are more closely regulated by the City of Jakarta, especially regarding vehicle fitness, fares, and schedules [Cervero, 2000].

Kingston, Jamaica has lived with informal transport providers for about 30 years [Anderson, 1987]. In the 1970s, as ridership was declining, fares regulations kept fares too low for the private bus operators to maintain and improve services. This resulted in an influx of informal operators, called "robots" using minibuses and sedans to carry passenger, especially during the peak hours. Several attempts to regulate the "robots," first in 1982, and then again in 1990, have failed. The current plan is to municipalize the entire system with the hope than better route planning and integration can finally stem the tide of illegal operators [Cervero, 2000].

In Nairobi, Kenya, about 33% of the total public transport demand (about 600,000 trips per day) is served by "matutus," a general term for an informal transportation operator [Takyi, 1990]. Mututus use various types of vehicles, from minbuses and vans, to pickups, to transport passengers, and typically follow the formal bus routes. In 1984, recognizing their importance to the city's transportation system, the Matutus were legalized, though most of their service parameters remained unregulated [Takyi, 1990].

2.3 Problems of Informality in Transportation.

Unregulated provision of transportation by informal operators exhibits various problems resulting from financial constraints on operators, the nature of vigorous on-street competition, and the inexperience of operators and drivers. These problems are discussed in the paragraphs that follow.

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1. Erratic scheduling and service

The lack of adherence to a regulated schedule results in erratic headways between vehicles, especially during times of low demand. In Rio de Janeiro, on line-haul type routes, most van cooperatives send vans into service only after the vehicles are nearly filled. This can take up to 40 minutes during the off peak, though less than 3 minutes during the peak hour. The formal buses adhere to 15 to 20 minute headways during the off peak, as mandated by the regulating agencies. Users dependent on the vans are forced to wait.

2. Competition "in the market"

A second problem related to informal transportation operation is the existence of competition for passengers "in the market." Since revenues are wholly dependent on ridership, operators now are pushed to fight for waiting passengers at bus stops and in terminals. Driving becomes aggressive, erratic and dangerous. Safety is compromised because aggressive maneuvering at bus stops increases the likelihood of accidents between vehicles, and is also dangerous for those waiting on the curb. This cutting into traffic streams and lane changing also increases congestion around bus stops or terminals.

In general, congestion is increased with the shift in use to smaller vehicles. Assuming buses were utilized to a reasonable level, the number of small vehicles needed to replace them would be high. All of these small vehicles would contribute to congestion based purely on their greater numbers, especially around bus stops and transit terminals.

3. "Cream Skimming"

Many informal operators attempt only to operate during the peak hour because of perceived costs and higher ridership rates. This works out well if vehicles can be effectively scheduled for these shorter periods of service and labor can be hired in small units. Most formal

transit companies, however, spend a considerable part of their capital and operating budgets on covering the peaks. When formal operators take away a considerable portion of the peak hour demand, the opportunity is lost for formal operators to recoup their higher peak hour costs. Coordination between formal and informal agencies could correct this and allow the formal operators to reduce their investments in covering the peak hour, while informal operators, with better access to marginal (part-time) labor could more cost effectively provide the incremental peak hour services. This, in practice, doesn't happen and therefore, in street competition between formal and informal operators means losses for both, while consumers suffer from congestion, safety issues and erratic service.

4. Safety

Safety is compromised because of the driving behavior mentioned before, but also because of a lack of driver training, the use of inappropriate vehicles, and poor vehicle maintenance. Many drivers are unused to operating heavily loaded vehicles or larger vans with performance characteristics different from typical passenger vehicles. A significant share of the vehicles used are not designed for the loads and mileages experienced in use. After a short period the vehicles lose their stability as suspensions become worn out. Other maintenance issues can lead to break downs and other interruptions in service. Tire wear is especially a problem with heavily loaded vehicles.

5. Lack of accountability

The lack of official regulation leaves passengers no avenue for complaints about service. Complaints received from users may or may not be taken into account, but there is no recourse for discipline other than by the market. Regulation allows for a more reliable channel of complaints and accountabilities. New services or changed routing, etc. is normally made via petition to the city regulating agency. Private companies are of course interested in making a

profit wherever demand exists, and would be behooved to take on new routes or schedules where demand is present. Where demand is lower, however, the private operators will not be willing to provide any services. This lack of oversight and planning might not always provide for the entire population's needs.

6. Evasion of Taxes, Insurance, Social Security, etc.

The small businesses that provide the informal services are undocumented and can avoid paying the social security, taxes and other fees associated with doing business. In many cases, minimum salaries are also disregarded, and in some cases, family labor is not compensated at all. These lost tax and fee payments affect the municipal and federal government's income and the social security system revenues. Social security payments, mandatory paid vacations of 30 days per 12-months worked, mandatory yearly bonuses equal to 1 month's pay, and other fees can amount to nearly 50% of the take-home salary of the worker [Peixoto e Cury, 2002]. Avoiding these fees amount to a large share of the cost advantages informal operators hold over the formal sector.

7. Labor abuses

Several areas of labor abuse exist among informal operators, including the disregard for minimum salary laws and social security payments as mentioned above. Many times, underage labor is used, or family labor is used and paid only in kind. Any restrictions on total work hours or rest periods are ignored, making the job for many a 15 hour per day ordeal.

8. Inefficient business practices

The work of Araújo [2001] revealed that many of these companies lack even the most basic accounting practices. Control of costs, expenditures or receipts are poor, threatening the long term stability of the businesses. Indeed, it was this instability that prompted the movement to

foster larger bus firms decades ago. It was hoped that the larger firms would be more robust and able to survive oil price swings, inflation or other fluctuations in costs. It is doubtful, given the inefficient and weak business practices of these firms, that the system would be very reliable or robust in an unstable situation. In the case that the formal operators are put out of business, the long term reliability of the services becomes less sure.

9. Inadequate investments

Since these firms many times are operating on low margins of profitability, they attempt to minimize investments. This can result in the use of improper equipment, delays of scheduled maintenance, and poor compensation of workers. These lead, in general, to poor quality operating stock in the system, as well as in the social capital and entrepreneurial development of the company.

10. Lack of capacity

Finally, a system of small operators, many of whom challenge large bus operators for business in crowded line-haul type corridors, cannot carry all of the demand for some of the lines. Without the formal operators there would a collapse of the system. In some cases, neighborhoods generate over 4,000 bus trips during the afternoon's busiest hour. Sixty-seven large buses (assuming a load of 60 passengers per bus) or 400 10-passenger minivans would be needed during the peak hour to satisfy that demand. Assuming each bus consumes roadspace equal to 2.5 vans, the 67 buses would consume less than half of the terminal space consumed by the 400 vans. Given the constraints of many of the downtown terminals or bus stops, serving the 67 buses is difficult, while serving 400 vans would be next to impossible. The traffic constraints in the destination neighborhoods are sometimes even worse.

11. Other intangibles.

Beyond this list lie the difficult problems informality poses to administrations in general. These include such intangibles as the image of informality. Informality is seen as something of the third world, as being backwards or representing traditional, not modern or advanced, society. It is also seen as a challenge to administrations' control and power both in the real, material struggle with formal operators for space in the streets of the city, but also in rhetorical terms – informality shows that the city doesn't meet the needs of the people, and this must mean that the administration is unable to do so. It is seen as a failure to lead. These problems, while harder to define, and therefore, to make policy solutions for, are sometimes the true underlying reason for an administration's campaign against informal operations. Indeed, in Mexico City, while working with the current *Pesero* operators and upgrading the system's fleet might help to solve many of its air quality and safety problems, administrators, in a decade-old struggle with operators, refuse to deal with the system directly. Their plans, until only recently, consisted simply of eradicating the minibus mode and replacing it with buses, ignoring the important niches the mode had for passengers.

2.4 Responses to Informality

Wherever informal transit services spring up, they are subject to one or another form of official response. Cervero categorizes the available regulatory options as acceptance, recognition, prohibition, and regulation [Cervero, 2000]. Looking at some of these past cases reveals some of the key variables that have proven to be important in the regulation of informal transportation. This section will cover the main responses to informality, and then discuss regulatory options in more detail.

Acceptance

Acceptance is either an official act allowing the activity to remain without reaction or regulation, or an inability or lack of interest in enforcing any of the other options. Many systems are officially prohibited, but are openly tolerated. Indeed, many systems were begun during a time when administrations were willing to tolerate the new service, generally because of a need for additional services and/or a lack of funds to pay for them. Turning a blind eye to taxi drivers with multiple fares could raise peak hour capacity without requiring additional expenses.

Recognition

Recognition legitimizes the system and takes away a bit of the uncertainty that remains with mere acceptance. At least the city has made some official and non-threatening response to the activity. In Mexico City, in the early years of *Peseros*, the services were allowed on some routes but were still left unregulated and unlicensed. The number of taxi medallions issued was increased to compensate for the defection of a large share of taxis to *Pesero* operation [Roschlau, 1981]. Recognition can also help operators in bargaining for business loans, for as it becomes assumed that the service will not be discontinued, loan sources might be more willing to back taxi or *Pesero* operations.

Prohibition

Prohibition involves a threat of fines, vehicle confiscations, and even arrests, in response to the continued operation of the illegal services. This is rarely done, mainly due to a lack of enforcement, manpower and political will. Most new informal systems are officially illegal, but rarely are they treated as criminal and actually prosecuted. In the United States, informal jitneys were driven off the streets with success. Arguably, the force of the substantial streetcar industry and a fairly developed legal and police system at the time facilitated this prohibition, something other countries in similar situations today, lack.

<u>Regulation</u>

The regulation option is more complex and costly. Generally, the city department already responsible for public transit regulation will add a new agency in charge of overseeing the regulation of the paratransit services [Cervero, 2000]. Urban public passenger transportation is a "public good" or a form of public utility and as such affects directly large groups of people, their safety, productivity and happiness, and uses public infrastructure and resources [Kahn, 1970]. The nature of demand for transportation, its use of shared space, its particular type of investments, among other things, mean urban public passenger transportation is prone to certain problems, many of these include the problems of informality presented in the last section. The following paragraphs discuss these general motivations for regulation of passenger transportation.

Monopoly – Collusion among operators, a natural monopoly or the existence of captive riders can all lead to monopoly conditions where service is restricted and prices are set above marginal costs. Social welfare (consumer surplus) is lost in this case compared to the competitive scenario. The goal of maximizing social welfare hinges upon deterring monopoly.

Externalities – The presence of externalities which are not factored into the prices of the services can be addressed through regulations. For instance, the lack of charges for congestion in terminals can lead to overcrowding. Regulating terminal use by entry limits of some kind would be one way to reduce congestion (though charging for terminal use based on congestion would be a better way to do it, and the money collected transferred back to the firms through terminal improvements, etc.) Roadway congestion, emissions, noise, and vibration are examples of externalities regulations might be able to mitigate.

Ruinous competition – in some cases, competition might lead to aggressive driving behavior in the marketplace (here, the streets), lowering service levels and leading to complaints, or worse, injuries and death. Competition can be regulated by physically coordinating where or

when different firms can pick up passengers, or by rewarding firms for mileage, and not ridership through some kind of collective distribution of fare receipts. These devices effectively move competition out of the street and into other spheres, such as through bidding for service contacts.

Coordination – many times the effective coordination of independent private firms is difficult or nonexistent, resulting in a piecemeal and poorly coordinated puzzle of different routes and operators. Effective coordination, such as the ability to make timed transfers or use system wide travel passes, greatly enhances the utility of transportations systems and most times demands a central regulatory and planning body.

Risk - Some forms of regulation help reduce risk and insure operators against volatility in demand. During economic crisis, disparate, small operators can sometimes be bankrupted by temporary losses in ridership. Regulating minimum entry firm size is a way to insure firms' health through periods of demand stagnation, while city agencies can also guarantee temporary loans or financial backing along with licensed operations. Insuring the city receives steady supply of transportation is another reason to license operations to only fit operators. If the city is dependent on poorly run firms, it might be left with no system in the presence of a crisis.

Moral reasons – transportation is seen as a social good, and has profound effects on social welfare. Many segments of the population are dependent on public transportation for their livelihood. There is a moral argument to have a degree of public regulation over the system so as to protect consumers from behavior resulting from purely competitive markets [Orrico Filho, et al., 1999].

Regulatory Instruments

The regulation of a market can vary in rigidity, from complete regulation of all parameters of the market, to complete deregulation, letting any firm so willing to enter the market, behaving in whichever way, using whichever equipment, and charging whatever fare.

There are certain tradeoffs, of course, between the two regimes. The regulatory instruments available to regulate the market can be grouped loosely along the following lines:

Fiscal – this can include setting fares or fare schedules, imposing taxes on operation, rewarding subsidies, reimbursing fuel taxes, imposing tolls on certain transportation links, etc. Fiscal regulation is an important and powerful form of regulation, as it can significantly alter the behavior of firms and customers in the marketplace. Indeed, strict fare regulation is likely the most widespread culprit behind failing private-monopoly transit providers in numerous cities around the world. Fares set too low by regulation will force firms to abandon investment and leave equipment in disrepair, while fares set too high force the poor onto alternative modes, such as walking, and is a detriment to their welfare. Fare setting is really an art form which attempts to balance repayment for sunk costs, with declining marginal social costs in order to provide private operators with motivation to offer decent service, while attempting to keep fares to a minimum for political and social welfare reasons [Kahn, 1970]. With no fare regulation, however, firms might collude and raise fares, as illustrated plainly in the deregulated case of Santiago, Chile [Darbéra, 1993]. Or on the other hand, a highly competitive environment will tend to lower fares very close to the short-run marginal costs [Kahn, 1970]. The problem of repayment of sunk costs remains, however, and this scenario can lead to a lack of investment and maintenance. Of course, niches with higher levels of service can arise to appease certain markets, but again, a competitive environment, even within the new niche, might push fares down to below long run marginal costs. When fares are regulated, a level of return on sunk costs can be guaranteed, either through subsidy or fare cap.

In the case without subsidy, there are two basic forms of fare determination. One is a fixed fare, sometimes indexed for inflation, and the other is set based on estimated costs plus profit ("Cost-Plus"). The first offers a disciplining mechanism, where firms attempt to minimize costs or maximize ridership in order to get as much profit out of the fixed fare that they can. The

latter offers less incentive for cost savings or service improvement, since the fare will always cover their costs even if costs rise or ridership declines.

Other fiscal measures like taxes, subsidies, fines and license fees, etc. can serve both to cover administrative costs or other standard fees for doing business, as well as to alter both firm and consumer behavior to achieve some other goal outside of the immediate market. Altering the market in this way is common in the developed world, where environmental concerns, peak hour congestion, or concern for the poor, have led policymakers to subsidize public transit fares in order to induce a mode shift away from private vehicle use. The economic efficiency of these methods is questionable, but fare subsidies are undoubtedly responsible for the continued patronage of many public transit systems in developed countries.

Entry and Operating Requirements – These requirements add barriers to entry by requiring participating firms to have certain qualifications before operation is allowed, such as specific safety requirements, vehicle technology, size, fitness, appearance or age, driver licensing, as minimum fleet size, off-street terminal space, etc. These can be established either through conditions for acquiring a license, or via the concession tendering process. Even in the most deregulated cases, entry requirements to ensure minimum safety, comfort and reliability are rarely excluded. High service quality requirements can be used to "benchmark" a service, in effect, forcing the fares to a certain level by requiring a certain minimum technical specification. Better services are more costly to provide, so operators, even with no fare regulations, will be forced to raise fares to pay for the service. This strategy can be used to protect formal bus services, which might run at a base fare, from direct on-street competition with informal operators by forcing the informal operators into a higher priced service

Market Size – Limits to the size of a market, via concessions, operating licenses or medallions, determines the number of firms in the market. Entry limits set much lower than the market would normally bear can lead to distorted fares or firm behavior. Entry and operating requirements can effectively shape the size of the market in the same way. Entry limits can be

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used for paratransit-type services to insure against congestion in key routes or force demand into other modes like metros or larger buses. Limits can also be placed on the spatial or temporal configuration of the market. For instance, regulators might want to confine paratransit to certain districts or corridors of the city, as feeders to other systems, as tourist circulators, or only to off peak or weekend operations.

Fostering "Self-Regulation" – Cooperatives and route associations create a form of internal regulation, which, while not exactly instruments of regulating agencies, can be stewarded by agencies to help achieve many of the goals of regulation. Cooperatives organize many individual informal transit operators together into defined routes or areas of operation so that, at the most basic level, they can all coordinate their schedules and services. Many cooperatives are more complex than this and use various schemes to organize their members' operations. Most fundamentally, cooperatives organize informal operators and help prevent the problems of ruinous, in-market competition. The two main goals of route associations are to even out profits among members and expand the total profits of the group.

The first goal is achieved by rotating member firms between profitable and less profitable routes, days, times of the day, etc. and by ensuring regular headways, terminal loadings, weekend and late night runs etc. are evenly spaced. In effect, cooperatives, in their search for maximum revenues and equal distribution, optimize service quality and regularity via cross subsidization within the association [ECLAC, 1992]. Associations vary greatly in the way they function. The most developed and complex, like those in Buenos Aires, have membership based on members' vehicles, though the vehicles are sometimes driven by subcontracted drivers. Each member is responsible for maintaining his or her vehicle, and reaps the profit from the operation of that vehicle [Martinez et al., 1996]. Individual owners, therefore, have an interest in the operations of the association and the orderly and even distribution of operating time for each vehicle. Other associations are looser groupings of largely autonomous firms who just share and protect a

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particular route or area of the city. In these, schedules are not mixed or coordinated among drivers, and they all take shares of peak hour loads in some civilized fashion.

The second goal of expanding profits of the group is achieved by offering good, dependable service, which might induce a growth in ridership or mode shift to the mode. The group as a whole benefits from its orderliness because potential customers trust the service, regardless of which member firm is providing it. Associations can order spare parts or even vehicles in higher quantities; handling relations with regulating authorities, media, insurance firms, vehicle and driver licensing agencies, etc.; contracting maintenance services; maintaining and sharing depot or terminal facilities; and monitoring for police checkpoints or other associations' vehicles [ECLAC, 1992; Cervero, 2000]. Some associations enforce strict driving rules and even discipline drivers internally for bad behavior. Many times associations take on a political role in fighting for the rights of its member firms. Mexico City's Pesero route associations lobbied steadily for the expansion and acceptance of their services, and ridership have now surpassed all other motorized modes in the city.

Associations solve many of the problems other forms of regulation aim to solve. Absent are the scheduling and driver behavior problems resulting from having multiple private firms in cut-throat competition. This makes the services safer, and more easily coordinated with other modes or routes. Accountability is increased via the association, which can serve to handle complaints, serve notices and discipline members. Associations can enter into contracts with cities for services and offer a great advantage to administrations hoping to privatize service but avoid the problem of multiple contractors on the same route [Kirby, 1987]. Since they are more visible, associations might have a harder time avoiding taxes and other licensing and fees. It can be presumed as well, that associations would help develop expertise in business and accounting practices among members, and help members better plan for investments, repairs and maintenance.

Associations can also contribute to problems. There is a potential for associations to stifle competition and, like cartels, raise prices and restrict services. There is much evidence that the Mexico City Peseros have done exactly this, though it was in lieu of a struggle with the city administration [Cervero, 2000; Wirth, 1987]. In Chile, cartelization contributed to (but was not entirely responsible for) rising fares during the period of complete deregulation [Darbéra, 1993].

Experiences with Regulation

Using these various responses and regulatory instruments, cities around the world have dealt with the informal sector in a variety of ways. Presented below are several cases from the United States, Asia and Brazil illustrating how some cities responded to informality and what legislation arose out of those responses. The legislation developed by the Federal District of Brasilia will be discussed in some detail in order to illustrate the specific kinds of rules used to add definition and control to regulatory regimes.

In the United States, the "Jitney Episode" of 1914-1915 saw some form of Jitney (a shared-ride taxi) service spring up in nearly every major city [Eckert et al., 1972]. Those systems were put down under a set of regulations effectively negating the advantages jitneys held over the electric streetcars. Vehicle safety and durability specifications made vehicles more expensive. Franchise and licensing requirements made single vehicle operation impossibly expensive. Insurance became incredibly expensive due to the high accident rates of the jitneys. Minimum service hours reduced average boardings per mile and decreased profit rates, and prescribed routes, schedules and itineraries negated the flexible door-to-door attractiveness of the service and forced the jitneys to operate on unprofitable routes. In essence, the regulations prevented this new flexible form of public transit from seriously challenging the fixed route paradigm of the streetcar [Eckert et al., 1972]. In several cities of the United States, however, regulations were more forgiving and allowed jitney systems to remain profitable.

The legalized system in Atlantic City is one example where jitneys were spared an insurmountable ban, and have thrived over the past 75 years [Cervero, 1997]. Originally starting informally as shared ride sedan taxis in 1915 during a trolley strike, the city quickly stepped in to regulate the system, limiting the number of vehicles to 190, and forcing them off the main street of the city. Since then, the system has moved to larger, 13 seat microbuses. Regulations specify that vehicles must be owner-operated and no subcontracting is allowed. The density and linear development of Atlantic City has made the jitneys relatively profitable and efficient, and casinos and clubs provide 24 hour patronage [Cervero, 1997].

In the Philippines, Manila's regulation of its "Jeepney" (refurbished military personnel transport vehicles) passenger transportation services is done through a city regulatory board. Operating licenses are given for operators showing financial stability, registration of an authorized vehicle, holding proper liability insurance, and drivers license. Additionally, license applicants must show they have access to off-street, overnight vehicle storage, though many fail to meet this requirement. [Cervero, 2000] Five-year franchises are granted for new operators on designated routes, and the route remains exclusive to the designated operator. The city also has helped to lease and provide terminal and parking areas for paratransit operators. Fares are open to be set by the operators.

Hong Kong experienced the growth of an informal transit sector in the mid-1960s. By 1969, these systems were officially recognized and regulated as so-called "Public Light Buses" (PLBs). Since then, two distinct "Red" and "Green" PLB systems were developed by the city government [Lee, 1989].

The Red PLB system, marked by red colored bands on the vehicles, is an unscheduled service with no route planning, official fares, timetables, hours of operation, etc. These variables are left entirely to the drivers' discretion. Fares are lower in the off-peak and comparable to the fixed route buses, while they are much higher during the peak hour. Entry is via a limited number

of operating licenses. Red PLBs are mostly operated by vehicle owners who compete fiercely for passengers, sometimes crowding around rail or subway stations and cruising popular corridors.

Green minibuses are franchised for service on routes and schedules planned by the Department of Transport [Lee, 1989]. Green PLB services are basically fixed route transit services similar to formal bus systems, and are designed explicitly to feed rail stations, augment other formal modes in key corridors, improve important connections or serve districts that are difficult to access. Franchises are for packaged groups of routes, so that less profitable routes can be internally cross subsidized within the same firm. Fares and timetables are set by the Department of Transport, but can be altered slightly by applications of franchisees, fares are typically about 80% higher than buses for the same distance [Lee, 1989].

The Red PLBs are extremely sensitive to market forces, and operators attempt to attract patrons in several ways. Vehicle turnover is fairly high (average age was 4.6 years in 1988 [Lee, 1989]), so as to keep vehicles clean, quiet and new-looking. Over 90% of the vehicles had air conditioning, compared to less than 50% for the Green franchised PLBs. Even though Red PLBs are successful in delivering high quality paratransit, they are slowly being converted into Green PLBs in order for the administration to achieve greater control over the system [Lee, 1989].

Several cities in Brazil integrated informal paratransit systems into their formal transit services, the most notable of which are Porto Alegre, and the Federal District of Brasilia. Porto Alegre, in the late 1970s, began developing a limited stop express bus service to wealthier areas in an effort to curb growing car use for work trips [Brasileiro, et al., 1999]. This service met with little success due to high costs and limited demand, but it sparked a movement by the city-planning agency, Transcol, in 1976, to open concessions for a smaller collective-taxi service, called "Taxi-Lotação," meaning "shared-taxi." In early 1977, a call for bids was issued for service contracts specifying various entry fitness and labor rules, including fares, acceptable routes and operating times, restrictions on standees, and the concomitant schedule of fines and penalties. The vehicle sizes in the first phase were limited to 4 seat sedans, but soon the operators

pushed for slightly larger Volkswagen buses. By 1980, the standard was opened to 17-seat vans, and finally, in 1994, 21-seat microbuses were allowed and the service was renamed "Lotação." Modifications were made along the way in terms of appearance, boarding stops, and minimum work days, etc. In the beginning, fares for were calculated similarly to common taxis, but as vehicle sizes have grown, fares are now calculated using the same methods used for bus fares. The current legislation links bus fares and Lotação fares: as bus fares rise, Lotação fares rise as well. There are two "Lotação" fares, one for longer routes, and one for shorter routes, equaling the bus fare (a flat fare) plus 70% and 90% respectively. A majority of users are female (65%), are between 19 and 39 (57%), and are "upper income" (55%) [Brasileiro, et al., 1999, p 364]. Over time, the service has become a successful and important part of the city's transportation system, with very high levels of service, air conditioning, and on-board public cell phones. Indeed, in a recent volume on special cases in urban transportation in Brazilian cities, one of Porto-Alegre's distinguishing features was its unique use of paratransit [Brasileiro, et al., 1999].

The Federal District of Brasilia experienced extreme growth in the number of informal paratransit operators in the late 1980s, some time before the current and widespread wave began in earnest. Population growth in the Federal District in the 1980s was heavy and easily outpaced all projections. Much of this growth was in peripheral areas where transportation planning and supply failed to keep pace or configuration with the changing demand [Ribeiro, et al., 1998]. Informal paratransit operators began meeting these demands in competition with formal city bus services. To control this growth, protect formal operators, and rationalize the two competing formal and informal systems, a series of laws instituted the Serviço de Transporte Público Alternativo do Distrito Federal (Alternative Public Transit Service of the Federal District), or STPA. This agency oversees the planning and development of the system, develops and enforces a set of rules, taxes participating operators, and impose fines and penalties. Here, extracted from the full set of rules are some of the more important points with implications for entry limits, fares, and vehicle and driver qualifications [Camara Legislativo do Distrito Federal, 1991]:

Art. 1. The operation of the Service of Alternative Public Transport of the Federal District - (herein, STPA) will be regulated by the Government of the Federal District through the Metropolitan Department of Urban Transportation (herein, DMTU), in areas where convensional transportation shows inadequate attendance of demand according to economic-financial, geographic, time of day measures.

Art. 3, §2. The planning of the services of the Alternative Public Transport of the Federal District will be executed in cooperation with the representatives (coopoeratives) of the concessionaires.

Art. 4. The concessions will be delegated by the DMTU. Concessionaires are authorized to subcontract to third parties, conditional on approval with the DMTU.

§ 1. Each concessionaire will be allowed to register of only 1 (one) vehicle

§ 2. The concessionaires will have to satisfy the following conditions:

I. be proprietor of the vehicle;

II. be a resident in the Federal District for at least 2 (two) years;

III. be carrying of National Driver's Licence, category "D", forwarded from the Department of Transit of the Federal District (herein, DETRAN);

IV. be self-employed;

V. have a licenced and registered vehicle in the Federal District;

VI. to present legal documents of inspection of the vehicle, forwarded from the DETRAN, and from the DMTU;

VII. not withholding any other authorization, concession or concession for commercial ends of the Government of the Federal District;

§ 3. The transfer of the concession is allowed after one (1) year of operation, and the return of the concessionaire will only be allowed after one (1) year.

Art. 5. the DMTU, after evaluating impacts on service, will authorize the interruption of the concession granted. The interruption of the service will not be able to exceed a maximum of 30 (thirty) days, nor to harm the attendance of the users of the area. If the service is interrupted without approval, the concession is ended.

Art. 7. The DMTU will establish the criteria of embarkment and disembarkment of the users of the STPA in all the sectors of the Federal District and Region of the Entorno, to insure the flow of traffic and guarantee of user safety and security.

§ 1. the number of vehicles in the STPA will be fixed at 30% (thirty percent) of the total conventional bus fleet of the Public Transit System of the Federal District (herein, STPC).

§ 2. the number of openings for concessions will be reevaluated every 6 (six) months.

Art. 8. Rights of concessionaires:

I. to register up to 2 (two) substitute drivers for each vehicle. The main concessionaire should operate the vehicle for at least 30% (thirty percent) of the time of operation for each day.

II. to register up to 3 (three) fare collectors for each vehicle in service.

III. to participate actively, by means of its representatives (cooperatives), of the planning of the services.

Art. 9. the vehicle age, counted from the date of manufacture, will not be more than 6 (six) years.

Art. 10. the concessionaire must follow the maintenance plan outlined by the technical staff of DMTU.

Art. 11. vehicles must have at least 4 (four) doors, with a minimum seated capacity of 9 (nine) and a maximum of 12 (twelve) people, observing the safety and the comfort of the users.

§ 1. will only be allowed to use a substitute vehicle in service which meet all of the cited standards and is of equal or smaller age than the vehicle it is substituting.

§ 2. the required inspection of vehicles will occur every 4 (four) months

§ 3. all vehicles must be insured, with coverage for civil liability, bodily injuries and collateral.

§ 4. Prior to operation, vehicles must pass the inspection of the DMTU. The specific requirements of the STPA must be verified, especially the visual standardization and the equipment standards.

Art. 12. All vehicles in operation must show, in an easily visible place, the route that it is authorized to cover and the authorization sticker, and any other information determined by the DMTU.

Art. 13. The fares for the STPA will be approved by the Governor of the Federal District.

§ 1. Fares will be based on the effectiveness of the services and will take into consideration the social aspect, operational costs and the costs of improvements.

§ 2. the lowest STPA fare will be always greater than the highest fare charged in the respective lines of the conventional bus system of the Federal District.

§ 3. the fares of the STPA will be readjusted in accordance with the fares for the conventional bus services of the Federal District.

§ 4. concessionaires will pay to the DMTU, 2% (two percent) of its operating receipts.

Art. 16. The concessionaires will be able to organize themselves in cooperatives.

Art. 17. Eligible concessionaires must be current with any taxes owed to the Federal District.

Art. 18. The following penalties and fines apply progressively to offenses by concessionaires:

I. warning;

II. fines, increasing with each case;

III. driving course, administered by DETRAN or DMTU;

IV. suspension of the vehicle;

V. lock-down of the vehicle;

VI. apprehension of the vehicle;

VII. suspension of the concession, and

VIII. cessasion of the concession

§ 1. the penalties will be regulated by Council on Resources and Infractions (herein, JARI) of the DMTU, enabling their application to be cumulative.

§ 3. the penalties specified will be applied to the improvement of the control, fiscalization and infrastructure of the STPC.

§ 4. cooperatives of the concessionaires of the STPA will have a representative in the JARI.

Art. 19. The standards of advertising in the vehicles in the STPA will be set in accordance with the norms of the DMTU.

Art. 28. The collective transport of passengers, remunerated without previous concession or authorization of the Government of the Federal District, or registration through the DMTU, constitutes fraud and will be prosecuted as such.

§ 1. The use of an unauthorized vehicle constitutes fraud and will be prosecuted as such.

§ 2. In case of fraud, the following penalties of cumulative character will be applied:

I - fines of a minimum value of 1 (one) and maximum of 10 (ten) Standard Unit of the Federal District (herein UPDF).

II. enrollment in a special training course produced by the DMTU or DETRAN.

III. subject to vehicle inspection by the DMTU or DETRAN.

IV. suspension of the concession by DMTU.

V. cessasion of the concession;

§ 7. the apprehended vehicles can be liberated only after the all fines, to either DMTU or DETRAN, are paid in full.

This set of rules is fairly straightforward. Interesting points include the restriction of operation to small businesses, which, whether well devised or not, is included to prevent the monopolization of the services by larger firms. It is thought that if any bus firms are allowed to operate vans, they would under-price (via cross-subsidization) van drivers out of the market. The mention of operator associations is probably a means to ease control and communication between regulators and operators, and induce some of the organizational structures associations can bring as was discussed earlier. Rules concerning vehicle fitness, maintenance and age, and driver licensing are standard. Central planning of routes and allowable terminals and stops negates much of the comparative advantages operators held over fixed route operations, and limits their control and ability to respond to market conditions. The flexibility of this planning process and how inclusive it can be to operator inputs will be important to preserving the paratransit mode as a challenger to both the automobile and the fixed route bus system in the Federal District.

2.5 Conclusion

Informality in the provision of urban services is most prevalent to the developing world, but can be found to varying degrees in cities all over the world. Informally delivered paratransit services have both assisted and plagued urban transportation systems for decades, and in some cities deliver the bulk of the supply of public transportation. The current nation-wide spread of informality in Brazil is the subject of this dissertation, and will be studied in more detail using a case study and policy analysis. To add some perspective to later discussions, this chapter highlighted the "problem" of informality in transportation provision and presented descriptions of particular systems in several cities. Based on the basic principals, motivations and instruments for transit regulation, some regulatory responses to informality were outlined. Cases in the United

States, Asia and Brazil illustrate how various cities have dealt with such activities, and how varied responses could be in this current development in Brazil. These cases can help illustrate specific regulatory instruments to explore in this policy analysis.

Chapter 3. Methodology and Field Work

3.1 Introduction

The central analytical part of this work is to estimate the economic effects on users' of regulating the informal operators. From there, larger statements can be made about implications for policies, the implementation of these policies and effects on the operation of the system, firm behavior and realistic expectations of outcomes. The economic estimation involves the following steps:

1. Statistically model the users' choice process, revealing the "utility function" of the users.

2. Calculate the benefit based on the utility function.

3. Express policies based on the variable inputs to the utility function.

4. Perform benefit calculation for each proposed policy.

The economic estimation of effects on users uses a standard utility theory measure of welfare change called the compensating variation, which in turns depends on the demand for the good or service in question. This chapter outlines the approach for the calculation of the compensating variation and estimating the required choice model. A case study will be used as the framework in which to evaluate the various policy scenarios. Operational characteristics of the case study corridor will be gathered from a review of the literature, field research, and interviews and workshops with practitioners, transit operators, and academics familiar with the case corridor. The field trips made to do this research is described in the last section of this chapter, and the results of this field research will be presented Chapters 4 and 5. The survey work

done to estimate the choice model as well as the results of the model estimation will be discussed in Chapter 5.

3.2 Model of Welfare Change

The concept of consumer welfare used here is the microeconomic measure of the consumers' well-being derived from their income and the qualities and prices of goods available to them in the marketplace. Policies change the characteristics of the transportation choices, resulting in welfare changes, or "benefits," for the users. The magnitude of these benefits depends on the decision making process of the users and the magnitude of changes in the characteristics of the transportation choices. In the following sections, utility theory and discrete choice modeling are introduced, followed by the calculation of benefits. Finally, these calculations are applied to the present policy analysis and the general approach to making these calculations is presented.

Consumers of transportation derive satisfaction, or "utility" from each of the transportation choices available to them. The utility to the consumer is a function of the characteristics and prices of the transportation modes. That is, for consumer n, the utility derived from mode choice i, can be represented as:

$$(1) \qquad V_{in} = V_{in}(X_{in}, Z_n),$$

where V is called the indirect utility function, X_{in} are attributes of the mode (such as fare or travel time) and the particular trip (such as time of day or weather conditions), and Z_n are consumer's socioeconomic characteristics (such as age, income or gender) [Ben-Akiva et al., 1985].

The logit model is one particular form of utility maximizing choice model and is used in this work. The probabilities of choice for each mode i, for consumer n, depend on the relative

magnitudes of the utility of each choice:

$$(2) \qquad P_{in} = \frac{\exp(V_{in})}{\displaystyle\sum_{i=1}^{I} \exp(V_{in})},$$

where I is the index for the set of discrete mode choices available to consumer n [Ben Akiva et al., 1985].

The "compensating variation" (CV) is a particular estimate of welfare change resulting from a change in the choices available to a consumer and is the most appropriate measure to use in this study. The CV measures the change in the monetary wealth of an individual when there is a change in their economic state, such as induced by a policy, but when their utility is held constant to its original level. The calculation assumes consumer's utility remains unchanged after implementation of the policy, but their expenditures have changed to address the new set of prices and characteristics of their choice set. It asks: how much a consumer would have to pay after a policy change to remain at the same utility level, or how much they would have to accept after a policy change to remain at the same level. Equivalently, the CV is described as the amount one must compensate the consumer for the change after a policy occurs to bring her back to her original utility level [Haneman, 1985]. For example, given a rise in transit prices, the consumer's expenditure rises to retain the same number of trips as before. In this case, one must compensate the rider for this rise in fares in order to maintain the rider's original utility level, which in this simple example, is a function of transit prices and the number of trips the rider needs to take. This needed compensation (in units of money) is called the compensating variation, CV, and is widely used as a measure of user benefits from a policy intervention.

The CV was derived for a discrete choice demand situation and in effect, it computes the change in the "expected utility" of a consumer before and after the implementation of a policy

[Small et al., 1981]. The standard derivation of the *CV* within the logit discrete choice formulation results in the widely used "log-sum" measure. Here, the expected *CV* for consumer *n* is:

$$(3) \qquad E[CV_n] = \frac{1}{\lambda_n} \left\{ \ln \sum_{i=1}^{I^1} \exp(V_{in}^1) - \ln \sum_{i=1}^{I^0} \exp(V_{in}^0) \right\},$$

where λ_n is the marginal utility of money for consumer *n*, *i* is the index of choices in the choice set, and where superscript 1 and 0 are the indexes after and before the policy, respectively [Small et al., 1981]. The "log-sum" terms,

$$(4) \qquad \ln \sum_{i=1}^{I_1} \exp(V_{in}^S),$$

are the "expected maximum utility" for the consumer for state S. The *CV* is effectively calculating the difference between the expected utilities in the two scenarios. Dividing by the marginal utility of money converts units of "utils" into units of money. Note that the total *E[CV]* for the population would be the sum of the *E[CV]_n* for the *n* = 1 to N consumers, and that this formulation assumes the λ_n is known for each consumer. The treatment of λ is addressed in more detail next.

It is common in practice to assume a constant marginal utility of money, λ, for an entire population, and sum the *E[CV]*s for each individual, or a representative individual. One problem with doing this for a large population is that the λ can vary, sometimes greatly, between different portions of the population [Morey et al., 2001]. The formulation for *E[CV]_n* above assumes the λ of each consumer is known. An easier approach is to make an approximation by dividing the

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population into more homogeneous groups, within which it can be assumed that λ does not vary greatly. A common finding is that λ is a strong function of income [Jara-Diaz, 1989b]. Dividing the population into groups by income and using a separate λ for each group will help reduce errors due to heterogeneity in λ in the population. The calculation of *E[CV]* becomes:

$$(5) \qquad E[CV] = \sum_{j=1}^{J} E[CV_j] = \sum_{j=1}^{J} \left\langle \frac{1}{\lambda_j} \sum_{n=1}^{N} \delta_j \left\{ \ln \sum_{i=1}^{I^1} \exp(V_{inj}^1) - \ln \sum_{i=1}^{I^0} \exp(V_{inj}^0) \right\} \right\rangle,$$

where *j* is the income class for each person, n. It should also be noted that λ also appears within the utility function, *V*, and therefore *V* is indexed by *j* as well [Karlstrom, 2001]. Dividing the CV calculation by income group was appropriate for the kind of income class data gathered for this study and the level of detail being sought [Morey et al., 2001a].

The resulting benefit measure can be expressed in several ways. The *CV* calculation is made for one trip for each person. Summing this over the population and dividing by the population will give an average benefit in dollars per trip. This can then be summed over the number of total trips (inbound and outbound) per day and multiplied by the number of workdays per year to get a net yearly benefit measure in dollars. Furthermore, instead of summing all the benefits over the entire population, they can be summed and averaged for subgroups so that distributional arguments can be made [Morey et al., 2001a; Karlstrom, 2002].

State "1" is the state of the market 6 months after the policy scenario being tested has been implemented. State "0" is the state of the market for the no-policy (status quo) scenario after 6 months. 6 months as used because it was presumed that it was just long enough for travel behavior to change, but not long enough for residential or job locations to change. Even in the status quo case, the market is presumed to change after 6 months. Figure 3.1 shows graphically

how some market characteristic might change under the no-policy and "Policy A" scenarios. The CV is taken between states "0" and "1" at the 6-month point in the figure.
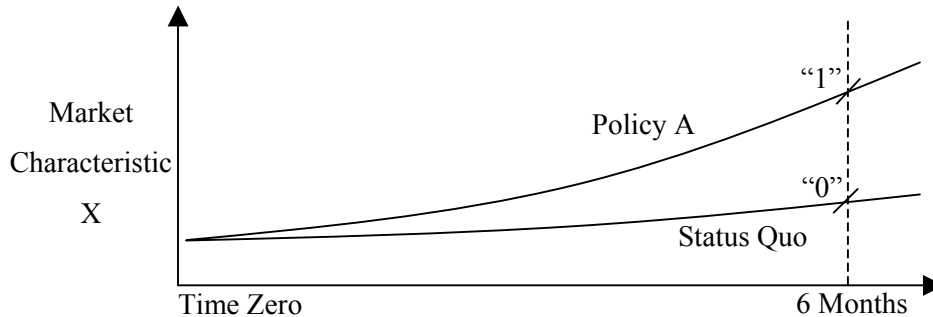
Figure 3.1. The CV for policy A is measured at states "1" and "0", 6 months after time zero.

An important assumption being made here is that total demand is fixed. That is, the elasticity of overall demand for trips in the corridor is set equal to zero – changes in individual modes' prices, travel times, etc affect the mode split, but not the overall demand. This was done partly to simplify the calculations and partly because it is not unreasonable. The corridor studied (to be described in the next chapter) is mainly for commuters. Over 90% of all trips in the survey sample are to and from work, meaning that for most travelers, the number of trips would probably not change if fares were to change. Furthermore, the out of pocket costs are very high for most of the travelers, meaning that their elasticity of demand is nearly zero regardless of trip purpose. In other words, if they could make even less trips, they would: they are currently making the maximum number that they can afford. By assuming a constant number of trips, the estimated CVs are actually lower bounds of the estimates – positive CVs presented here are underestimating the CVs slightly, while negative CVs are overstating the magnitude of disbenefits slightly. Given that the main objective here is to estimate these benefits to a reasonable degree of confidence, the errors introduced by these approximations should not change the results dramatically.

In order to evaluate policies using the expected CV calculation as presented, two things need to be known a priori. First, the utility functions, V_i, for the population must be derived for

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the mode choices available. Second, how the policies affect the terms of the utility function must be known.

3.3 Model of Mode Choice

The specification of a discrete choice model for application to the modal choice problem is a standard procedure for determining the relationship between attributes of modes and mode choices. Discrete choice models compare the utilities consumers derive from the different choices available to them in order to predict the choice the consumer will make. The logit form of the discrete choice model will be used here, and was presented in Equation 2. The statistical estimation of the model works backwards, using choices consumers actually made to reveal the utility they derive from the characteristics of those choices. This estimation requires compiling data about many different trips, which is described in more detail in Chapter 5.

Constructing a choice model requires a process combining theory and trial and error. The overall form of the model determines how the different choices are compared to each other. The trial of different forms is informed by the results of past choice modeling efforts both in Brazil and elsewhere, traveler interviews conducted by the author, and from previous studies. Preliminary traveler interviews were performed with van operators and riders to determine the most likely model specification, including the overall choice set and the variables to consider, and to determine the most important information to be gathered in the user surveys. This exploratory process will be described in more detail in Chapter 5.

A utility function that is a linear function of its parameters was assumed. As stated earlier, these variables can reflect attributes of the user, the trip, the mode, or other environmental factors. Study of travel behavior shows that significant factors in mode choice, and hence the utility function, include travel and waiting times, out of pocket costs, environmental variables like density of land use and access costs, as well as other factors such as proxies for taste variations such as income, age, gender, or possibly proxies for household role or employment status.

Numerous utility function specifications were tested when using the final survey data. All of the data and variables gathered to estimate the model will be described in Chapter 5. The final specification of the utility function is important, as the only way policies influence the expected *CV* is via the terms of the utility function. For example, if a policy changes the vehicle size of one of the modes, but "vehicle size" does not appear in the utility function of that mode, the policy will have no effect on the expected utility and therefore the expected *CV* will be zero. In this study, this is acceptable, as the statistical estimation of the choice model showed that indeed, vehicle size, was not important to the choice process.

Of similar importance to the contents of the utility functions is determining how the policies affect them. In essence, policy instruments must be translated into their effects on the modes' or trips' characteristics, so that the expected utilities can be calculated before and after the policy change as shown in Equations 3 and 4. This translation necessitates some knowledge of the relationship between the specific variables in the utility functions, and the specific policy instruments being tested. For example, suppose a policy stipulates that boarding and alighting can only take place within 10 meters of street corners. This will affect out-of-vehicle travel time and distance, vehicle travel time, and other things. Or, suppose informal operators are legalized. The established, formal bus companies might respond by lowering fares, or offering better services. Assumptions and estimates will be made of how these variables are affected by each of the policies. This process will be presented in more detail in Chapters 4 and 5.

3.4 Field Work

To conduct the field research and surveys, trips were made to Rio de Janeiro in July of 2000, October of 2000, July of 2001, and February of 2003. During these trips, the students, faculty and staff at the Transportation Engineering Program of the Federal University of Rio de Janeiro, most notably, graduate students Ayres Araújo, Eric A. Ferreira, and professors Ronaldo Balassiano and Romulo Dante Orrico Filho helped tremendously with the work. They arranged

office space for my work, the use of computers and access to the group's library. The first trip was made to gather background data and literature concerning the corridor and the informal and formal systems. Small-group interviews were held with van riders, drivers and van cooperative leaders to begin to design the survey instrument. Operational characteristics of the vans were gathered through a review of the literature, field research and interviews with drivers and van leaders, transit operators, and academics familiar with the case corridor. The second trip was made chiefly to design and execute the rider surveys. Details about the survey instrument and process and the results of the surveys are presented in the chapter 5.

A third trip was made in the summer of 2001, sponsored by a grant from the Tinker Foundation and the Latin American Studies Department of the University of California at Berkeley, to conduct further interviews with academics and policy makers, make field trips to gather or estimate still lacking supply side data and get feedback on work completed to that point. A final trip was made in 2003 to present the final modeling results to the students and faculty involved with the work. Valuable feedback was received that helped with the final analysis, and more materials from the Brazilian literature were gathered.

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Chapter 4. Informal Transportation in Brazil
and the Case of Rio de Janeiro

4.1 Introduction

This chapter will describe informal transportation in Brazil, some of the policies being recommended to deal with its growth and some of the main reasons for its growth. The second section presents the informal systems in Rio de Janeiro as a specific case of the current wave of informality in Brazil. Finally, getting more geographically specific, the corridor used in this study in the northern suburbs, called the Baixada-Fluminense, of Rio de Janeiro is introduced.

4.2 Urban Transportation in Brazil and the Current Van Problem

Urban transportation systems in Brazil have undergone extensive changes in the past century. Until the 1930s, most cities relied heavily on privately run streetcars, with buses running on peripheral routes [Dourado, 1994]. By the 1950s, urban growth had far overreached the extensive streetcar networks, and the United States-originated model of expanding rubber-tire and road based technologies combined with suburban rail systems became more attractive to the Brazilian leaders. At this time, most bus services were provided by small operators. National road building and management agencies were born, and road infrastructure was a primary component of national urbanization and industrialization plans during the 1950s and 1960s. Rising incomes from the Brazilian "economic miracle" and added road capacities together created a growing demand for urban mobility, and concomitantly, for millions of private automobiles.

A fall in demand for public transit, combined with the oil-price shocks in the early and late 1970s led to a fall in demand, rising costs and a period of crisis and bankruptcies for the fragile bus industry. In response to this crisis, in hopes of preventing future ones, and in keeping with the magnitude to which every other industrial sector was being developed, national policy began promoting an increase in the size and strength of the bus companies. Mergers and conglomerations of smaller transit companies were encouraged. In the late 70s, new national and state-level regulatory bodies were created to oversee this new and more centralized model of urban transportation administration. A national suburban train administration was created in 1984. Minimum fleet requirements for bus firms were adopted and peaked in 1983 at 240 vehicles per firm [Dourado, 1994]. By the mid-eighties, however, due to a growing economic crisis, the federal urban transportation company was abandoned. New methods of fare calculations, route assignments, and terms of entry into the market were created, and control was largely passed to the states and cities. The last federal public transit policy initiative to remain from that era is the Vale-Transport (Commuter Voucher) law, which will be discussed later in this section. The combination, these various forces and biases resulted in heavy concentration in the bus industry. This power further increased the firms' ability to rival public agencies for control of the regulatory process [Dos Santos, 1999].

The current wave of informal paratransit activity in Brazil began around 1994 and has experienced a steady rate of growth. While numerous cities in the past experienced growth of informal sectors, the current wave is more national in character. It is having profound effects on the ridership levels of the formal transport systems in many cities simultaneously around the country. By the beginning of 2000, about 70% of cities with populations exceeding 300,000 were experiencing some informal transportation activities. In about 60% of the cities, the informal systems were experiencing growth at that time [NTU, 2001]. Table 4.1 shows the market shares for larger Brazilian cities surveyed in 2000. Some particular routes or corridors might be even

Table 4.1. Public transit market share of informal operators in cities with populations exceeding 300,000 in 2000 [NTU, 2001].

Market Share of Public Transit Trips	Share of cities
< 5 %	48 %
5 to 10 %	16 %
10 to 20 %	12 %
20 to 40 %	16 %
> 40 %	8 %

more heavily impacted, and numerous were witness to the complete failure and bankruptcy of the formal operators.

These new systems include vans, moto-taxis and combies. The "vans" typically seat 8 to 12 seated passengers and are newer Japanese or Korean-made minivans. Vans are used for both neighborhood circulation and suburb to center, line haul, services. These routes either compete directly with formal bus or rail routes, might serve areas previously underserved by transit, or behave as feeder services to other formal modes. About two-thirds of the vans are owned and maintained by its driver, a quarter are rented from it owners, and the remainder, about 8%, are driven by drivers hired by the owner and paid monthly [Almeida Júnior et al., 1999]. For intermunicipal, line-haul services, fares vary by route based on distance, do not include any provision for transfers, and are about 5 to 10% higher than bus fares for the same route. Vans within municipalities charge a flat fare close to the flat fare of the formal buses, and are often times cheaper.

Van drivers here wait to fill their van before departing (left) while a van pulls in to a van terminal within meters of the formal bus terminal in Rio's Central Station (right).
[left: A. Golub, right: R. Cervero]

Motorcycle taxis (moto-taxis) have appeared mainly in the cities of the north-east like Fortaleza and Natal and did not exist in a large amount in the southern cities surveyed for this study. In Rio, they have a small niche market serving some of the Favelas (informal housing areas). Combies are older Volkswagen buses and provide mostly local neighborhood circulation services, but are also found on a small number of longer distance routes. This study is concerned solely with the intermunicipal van services.

"Combies" (left), here seen stealing passengers at a bus stop, provide local circulation. Vans (right) compete with large buses for longer distance passengers.
[left: R. Cervero; right: Jorge Nunes]

In contrast to the informal services, formally provided public transportation in Brazil is highly regulated. Nearly all services are delivered by private firms operating under service concessions from public agencies. Regulations exist governing fares, routes, schedules, labor rules, curbside operations, market entry standards, maintenance and equipment specifications. For service within one municipality regulations are made and enforced by the municipal governments, and for inter-municipal transport, state governments. Most large metropolitan regions in Brazil are conurbations of multiple municipalities (the Rio de Janeiro metropolitan region has over 10), meaning that various regulatory agencies are responsible for regulating public transit of one geographic region.

Unlike many public transit firms found in the developed world, in Brazil, the bus companies are highly profitable, capitalized, modernized and organized [Orrico Filho, 1995]. Concessions for services are typically granted by route, or packages of routes, to the private firms for a period of 10 to 20 years. Most firms employ various modern labor and fleet management, data analysis, and accounting practices.

Because of generally dense urban environments, the density of demand for bus transit in Brazil is very high, typically averaging around 2.5 to 3 boardings per km, with many lines experiencing more than 5 boardings per km [Brasileiro et al, 1999]. In many cases, the municipal and state regulatory agencies are poorly funded, poorly organized and lack the technical capacity to the effectively manage the large bus companies. Franchisees are viewed by many in the political and academic arenas to be a self-regulated cartel with low levels of contestability from other potential operators. This in turn has created a popular sentiment generally in opposition to the large bus companies, which are seen as colluding and bullying [NTU, 1997]. The process of firm concentration differs slightly from city to city, and details about the specific case of Rio de Janeiro and bus fare inflation are presented later in this chapter.

Most large cities in Brazil rely also on subways and/or commuter rail systems. The commuter rail systems tend to be slow, inexpensive, infamous for petty theft and peak-hour

crowding. Most connect poorer residential areas with downtown job centers. Commuter rail systems, until recently, were owned and operated by the federal government. In the 1990s, Brazil underwent a period of privatization and devolution, and many of these systems were devolved to the states. This created problems for some states, and many sought help from the private sector for managing and operating the systems. Subways are generally owned and managed by states, but many were privatized during the nineties. The two prominent Brazilian subways, in Rio and São Paulo, offer world-class service and cleanliness.

The federal commuter voucher program, "Vale-Transporte" (transportation coupon, herein abbreviated VT), mentioned earlier, is a huge demand-side subsidy to public transit riders, and in turn, suppliers. Businesses with more than 50 employees are supposed to augment workers' income by issuing them VT. The value of the tickets are set according to the worker's salary so that the worker spends no more than 6% of his or her salary on transportation. For instance, a worker making 10 Reais per day is allowed a 60 cent total expenditure. If their round trip bus fare were 2 Reais, the worker would receive a VT for R1.40 per day (in two tickets of 70 cents each). The worker then pays the bus fare by combining these tickets with cash. The higher an employee's income, the less VT they are eligible for. If this worker earned 33 Reais per day, they would receive no VT. The value of the VT also depends on the mode the worker takes from home, as it is calculated using the exact fare the worker reports paying from home. The VT will have some implications later for the demand for informal modes.

Factors Behind National Growth of Vans

The National Association of Urban Transportation Companies (NTU, a think tank and industrial policy formation group made up of the larger urban public transit, mostly bus, operators in Brazil) reviewed the situation of what they called "the crisis of informal transit" in 1997 and again in 2000 [NTU, 1997; NTU, 2001]. The studies attributed the growth of the informal transport sector to many factors. The most important are thought to be the low quality of

transit service, poor route connections, low levels of comfort and safety, rising transit fares in real terms, and long and increasing waiting and travel times. The latter two factors are related to growing congestion due to rising personal automobile use in Brazilian cities since the start of currency stabilization in 1994 and the lowering of import tariffs on durable goods including automobiles.

Another significant factor was found to be poor management of transit services, including poor intermodal connectivity, and the lack of enforcement of regulations, which permits the influx of unregulated activity in the first place. High rates of unemployment were cited as an important factor inducing drivers to enter into the van business. Another factor was the changing nature of urban settlement patterns, giving rise to new commuting patterns, and expanding and altering areas of demand for transport. Bus companies, because of long concession periods and low contestability for concession renewals, have been slow to respond to changing markets and spatial travel patterns. The last factor was found in the vans themselves. The higher comfort, lower waiting and travel times and greater perceived security and safety draw riders from the buses. Additionally, the operators have been very active in expanding service levels, as operation has proven to be lucrative. Finally, the increased use of vans has spurred additional demand solely through word of mouth as people have become accustomed to the new mode [NTU, 1997].

The Associação Nacional de Transportes Publicos [National Association of Public Transportation, 2001] issued a compilation of reports and articles by academics, regulators and practitioners. The volume largely reiterated the sentiments of the NTU report. Growing congestion from automobile traffic, poor management and regulation of the formal systems, and a reliance on old perceptions of demand and seemingly captive riders, have led to a decline in service qualities. This created a prime opportunity for informal operators, which threatens the ordered systems in place today.

A joint article by the labor organizations, The Central Única de Trabalhadores (The Workers' Center, CUT) and the Confedração Nacional de Trabalhadores em Transportes

(National Confederation of Transportation Workers, CNTT) blames both macroeconomic policies and practices within the sector for the rise in informality [CUT/CNTT, 1999]. Free trade policies implemented by President Fernando Henrique Cardoso increased imports of both automobiles and small vans. Some of this increase was due to better terms of trade for consumers resulting from currency stabilization, while some was due to long-term understandings that manufacturers would be installing manufacturing facilities in Brazil. Though many of these agreements have yet to come to fruition, the importation of minivans rose steadily through the late 1990s. The CNT/CNTT find it remarkable how these multinationals hope to ferment informality to increase markets, without giving notice to the impacts this has on local transportation service or implications for overall sector health. The article finally implicates the formal bus sector itself in fostering an environment for the growth of the informal sector. According to the CNT/CNTT, quality of formal transit services has declined over the past decade to very poor levels. Meanwhile, the private bus sector at large has been busy campaigning to privatize the last of the public urban bus services throughout the country, challenging the power of regulatory and managing agencies both at a local and national level. Furthermore, the urban bus industry supported the wave of privatization in Brazil in general which laid off thousands of workers in various sectors.

Competition between Vans and Buses

The entry of the informal vans into the market poses new forms of competition for the existing formal bus operators. Based on some trends from the past 5 years, along with the basic dimensions and costs of the different modes in question, there are several actions the formal bus operators will take to attempt to compete with the informal operators.

1. **Compete on price** – The extremely wealthy bus firms could freeze or even lower fares in order to price the vans out of the market. The vans, by attempting to match the bus fares,

are operating close to their marginal costs, and according to some estimates [Ferreira, et al 2003], a small bit under. The wealth of the private bus operators, for years reaping super-profits, could fund competition on price for some time. The effects of such competition would be a substantial transfer of wealth from the operators to the commuter group, albeit only temporarily.

2. **Compete on service** – The bus firms could, through petition to regulators, begin to offer air conditioning, automatic transmission, more padded seats, etc. through new vehicle purchases. This would greatly negate any advantages the vans have in this area of consumer choice. It is already questionable how these characteristics factor into the users' choice, and the data gathered for this study did not show any overall tendency to rate vans higher than the other modes, after accounting for the correlation with user choice. Bus firms could also run minibuses on some routes, though this is open to regulators' discretion. Doing this could appeal to the part of users' mode choice which might prefer a smaller vehicle, while also lowering costs for operators on routes of times of day with lower demand.

3. **Compete on Schedule** – Van firms' great advantages in the market are their higher frequencies, due to their smaller vehicles. But, in terms of total seats offered per hour, the buses still offer a huge advantage. If buses increased departure frequency, especially during the peak hour, this advantage could be even greater. This is an expensive option for bus firms as buses' capital costs are about 3 times as much as vans (25,000 versus 75,000 dollars). For destinations with higher demand, buses will always have a place in the market. In the smaller markets, with peak hour demand on the order of hundreds, buses might succumb entirely to vans because they cannot compete well enough on departure frequency.

Proposed Policy Responses

Several older informal systems in Brazil have undergone and survived regulation. Similar policy responses to the current wave of informal activity are being discussed. This section will review some of these recommendations. Specific recommendations in the Rio de Janeiro case will be discussed in section 4.3.

The NTU [1997] reported the conclusions of a national working group including prominent regulators, academics, business people and others with interests in transit regulation. The proposed policy responses to the van activities vary between acceptance, recognition, prohibition, and regulating the incorporation of the van services into the formal transport system. Prohibition would involve ticketing and the issuing of fines or even the confiscation of vehicles. Regulation would involve issuing service concessions to the private operators and/or enforcing a set of rules concerning hours, areas of operation, curbside behavior, vehicle specifications and labor rules. The city would probably license and monitor van operators as is done currently with buses. These could also include relegating vans to act as feeder services to the bus and train system to avoid direct competition. Proposals include putting vans to work, school and event related services, on bus lines with low demands or as off-peak vehicles. Other proposed policies included relaxing some of the "cost inducing" regulations (e.g. safety or labor rules) on the formal system in order to increase its competitiveness in the changing market. Supporting the bus mode with dedicated rights of way and better modal integration and terminals were also proposed to make the buses more competitive in the market.

The ANTP [2001] makes a firm stand against any de-regulation, and believes principally that bus firms can and should respond to van competition through offering better services and more service levels. Their concessions should be changed to allow bus firms to offer varying services, vehicle sizes, and more flexibility, but not to the point of allowing bus firms to offer a cheaper or more loosely regulated service. ANTP also feels that the technical capacity of transportation planners and regulators should be increased, giving them a better understanding of

system coordination and the changing needs of users. ANTP takes a firm stance against leaving the informal operations to the laws of the market. They see strong regulation as way of guaranteeing a return to better formal services and insuring more diverse and responsive services are delivered in the future [ANTP, 2001]. The case of deregulation in Santiago de Chile is upheld as what Brazilian officials should be attempting to prevent. Congestion, pollution, safety concerns, and disorderliness are brought up as characteristics of the deregulated markets, and it is argued that the vans are a movement towards deregulation.

On a more ideological level, the van services are seen by many in the public and the popular press as an expression of the poor, of small-scale entrepreneurship in the face of stagnant monopoly, and a relief to high rates of unemployment. To the bus monopoly, vans are a threat to their substantial power and wealth and their orderly collection of monopoly rents from citizens and the city and state governments, which subsidize transit vouchers for a large share of workers. Consequently, policy formation groups connected to large urban transport operators, like the NTU, are opposed to legalization of van service of any type which might compete directly with the bus or rail services. Most academics, while citing safety, emissions and congestion problems from using smaller vehicles for line haul services, support the legalization of the system [Balassiano, 1998; Cervero, 2000; Torres, A., 1998].

The CNT/CNTT [1999] made a series of recommendations regarding the informal sector, emphasizing that regulating the informal operators must come within a larger reorganization of all of the modes. The modes must be complementary and not directly competitive, respect traditional standards both for users and workers, and must receive appropriate attention, support and resources from the transportation agencies. The report emphasizes that the center of any response to informality must be the improvement of the formal sector, which includes both enforcement of rules on the part of agencies, as well better participation from users, workers and public commissions. Bus fares are a significant point of contention to the CNT. They cite the need for greater transparency in the fare calculations and cost reporting, for better stimulation of

efficiency via the terms of the concessions. CNT/CNTT urges more mechanisms facilitating private car users' subsidization of pubic transit costs, and a general and national vision for transportation that looks to reduce costs and improve quality across all modes.

4.3 Vans in Rio de Janeiro

Many of the most important and interesting aspects of informal transportation are exemplified in the city of Rio de Janeiro, and a case study in Rio de Janeiro will be used for the policy analysis in this dissertation. In this section, some general descriptions of informal operations in Rio are presented, with the specifics of the case study corridor in the next section.

As discussed earlier in this chapter, the national consolidation policies of the 1970s and 1980s resulted in bus systems supplied by what can be considered to be self-regulated cartels. In Rio de Janeiro, industry concentration is especially pronounced and results in harmful behavior [Dos Santos et al., 1999]. The bus fleet in the metropolitan area contains around 11,000 vehicles, carrying close to 10 million bus trips per day. The largest firm grouping (firms controlled by one holding company) has over 10% of the fleet, and the top three firm groups carry about 40% of the total bus travel demand [Dos Santos et al., 1999]. The city regulatory agencies are too weak to effectively manage the large bus companies. While service is satisfactory, according to several studies of the industry bus fares are higher by about 80% than they should be according to the rules of the concessions and the actual costs experienced by the bus firms [Orrico Filho, 1999; Ferraz et al., 1992]. Detailed estimates indicate that fares are inflated through liberally calculated cost items like depreciation and vehicles' residual values, general overcapitalization, and the blatant misrepresentation of ridership, vehicle mileage and maintenance costs [Orrico Filho, 1999; Ferraz et al., 1992]. Minimum capitalization requirements were originally intended to strengthen bus firms and to move away from artisan-style owner-operators towards more modern and efficient firm structures. Now, several firms operate more than 400 buses, and holding companies often control groups of large firms. The largest group controls 1350 buses, which, at

roughly 70 thousands dollars per bus, equals close to 100 million dollars worth of buses [Dos Santos et al., 1999]. Minimum fleet size requirements were ended in 1994, but were as high as 240 vehicles in the early 1980s [Brasileiro, et al, 1999]. Some researchers lament that market entry remains virtually closed politically, regardless of the fleet size requirements, and that removing those requirements has had no real effect on market entry [Orrico Filho, 1999; Brasileiro et al., 1999]. Extreme capitalization is further evident as the average bus age in the entire Rio system is just around 2.0 years, which is very low by any standards [Brasileiro et al., 1999]. The power of the bus firms' organization allows these practices to continue unchecked and any attempts to question this process would be met with strong opposition. These inflated fares will become important in later discussions.

The suburban rail system in Rio de Janeiro is fairly extensive, with about 250 kms of tracks on 4 lines radiating out into the northern suburbs, called the Baixada Fluminense, and western Rio de Janeiro from downtown (see map 4.2 on page 61). For years in disrepair and mismanaged, it suffered from a huge loss in ridership during the early nineties, down to only 350,000 boardings per day from around 1.2 million in the mid-eighties [Neto, 2000]. The lines were infamous for high rates of crime, unreliable service, and crush level loading conditions during the peak hours. The rail system passed from federal into state control in 1994, and three of the four lines were privatized in 1995. The reputation of the lines still suffers though service levels and cleanliness have improved and crime is down. Expansion of the system was written into the privatization contract, but continued financial crisis and less than predicted ridership growth have delayed those plans. The subway consists of 35 kms of tracks on two lines and offers excellent, fast service between downtown and the South Zone and the suburbs to the immediate northwest of downtown (see map 4.2 on page 61). The system was privatized in 1998 and has since been extended to one of the larger trip generators in the metropolitan region, the neighborhood of Copacabana in the South Zone.

There are legal and regulated alternative transportation services in the city of Rio de Janeiro. They include those connected to various schools, large employers, and shopping malls, and the tourist circulator service in the south zone of the city.

The unregulated, illegal services include "vans" and "combies." Some vans operate entirely within municipalities, while others duplicate bus routes connecting outlying regions of the Rio de Janeiro metropolitan area with downtown destinations. These generally serve the poorer northern suburbs of the Rio de Janeiro metropolitan area, called the Baixada Fluminense, though there are some van routes serving the outlying rich neighborhoods in the south zone. The combies generally operate circulation services within neighborhoods in the Baixada Fluminense, and rarely perform line haul type services. The line haul vans routes include some pick up and drop off circulation within the neighborhood and then enter the main arterials on their way to major downtown destinations. The vans pick up and drop off in the neighborhoods in a "hail and ride" fashion.

Total van ridership in the metropolitan region is about 150,000 trips per day, compared with 8 million trips by bus, and 350,000 each for suburban rail and metro. A large share of these trips by van, however, is concentrated in several important corridors linking downtown to the western suburbs and the Baixada Fluminense. In particularly impacted corridors, vans might carry up to half of all trips, while in a few, bus services might be abandoned completely because of competition from vans. There are roughly 30 different long distance van routes in the metropolitan region [Almeida Júnior et al., 1999].

Organization of Van Services

Van services in Rio are organized on 4 distinct levels: the van itself, the route, the terminal, and the umbrella organization. A description of each level follows, starting from the smallest to the largest.

Each van can be owned and operated by the driver, or rented from the owner by the driver. These rental relationships vary significantly from case to case and it was unclear how the maintenance responsibilities are divided between the van owner and the driver. An estimated 70% of the vans are owner-operated [Almeida Júnior, et al., 1999]. For owner operators, the vans are put into use whenever the driver feels like starting work that day. Most typically work 12-hour days. For drivers who rent, it is their imperative to get as much out of the vehicle as possible, and many work 18 hour days beginning at 4 o'clock in the morning, with naps taken between peak hours.

The vans traveling a particular route are generally organized into route cooperatives, some of which are more rigid and defined than others. Based on observation, it seemed that all of the key cooperative organizers were also van drivers or former drivers. The cooperatives help the vans maintain their pick up/drop off space at the downtown terminals, and might help with other services, such as maintenance, securing credit, or getting reduced costs for parts or labor for vehicles. They also protect the routes from piracy by nonmember vehicles through threats of force. Of course, belonging to a cooperative can help legitimize van operation in the eyes of new and cautious users. There are also physical protection services, called hitters, which travel the routes and attempt to protect vans from robbers or other problems that may arise en route [Almeida Júnior et al., 1999].

About two-thirds of all van services connect through, or very near Central Station, the main transit terminal in Rio for destinations to the far west zones of the city and the northern suburbs of the Baixada Fluminense. More specifics on some of these routes will be discussed in the next section. Each of the roughly dozen van terminals in the Central Station area operates differently according to the size of the terminal and the routes that use its facilities (see photos, page 45). For the larger terminals, as many as 6 or 7 routes share the facilities for rider drop off and pick up. The smaller terminals each serve only one route. The route cooperatives using the terminals pay a membership fee to maintain their space in the terminal. The terminals also charge

each van entering the facility. Among the terminals visited, this was done on a per diem basis, in this case, 8 Reais ($4.00), or a per entrance basis, in this case, 2 Reais ($1.00). There are possibly other arrangements at other terminals not visited. The space for each route is clearly marked with a sign displaying the name of the cooperative and the destination of the route, and usually has space for passengers to sit while waiting for the next departing van. The larger terminals have concession stands, public phones and bathrooms for waiting passengers. The terminals' "prancheteiros" help with keeping track of and organizing entering and departing vehicles and keep the terminal running smoothly. The terminals' "chamadores" or "callers" try to lure potential bus riders and other people passing by the terminal area into the vans.

The van cooperatives operating in the Central Station are all organized by an umbrella group called FECOTRAL (Federation of Alternative Transportation Cooperatives), to which they pay monthly dues. FECOTRAL acts both to regulate entry into the van business, and to protect and support current members. Acts of support include, among others, the following:

1. Handling media representation, press releases, dealing with politicians, and other outreach activities;
2. Contracting of studies concerning various aspects of the van business, including such things as reducing costs, accounting, or quality control;
3. Assistance with securing lines of credit;
4. Acquisition of parts and services for vehicles at reduced costs;
5. Maintenance of a collective insurance policy;
6. Funding and publication of a monthly newspaper covering the state of the business.

Van Users

A previous survey of van users made by Balassiano and Braga in Rio de Janeiro [1998a] gives a partial picture of how and why vans are being chosen by users, and gives a profile of typical users. The survey was done at several boarding areas in downtown Rio and 253 responses were included in the statistics. The results of the survey are summarized here:

Most (76.3%) van riders use the vans for a trip beginning or ending in the CBD. Of the riders, 63%, made trips to districts between 40 and 60 kms from the CBD.

Of the respondents to the survey, 32% waited less than 5 minutes for the vans, 27%, between 5 and 10 minutes, 33%, between 10 and 20 minutes, and 8%, over 20 minutes. Travel time was reported to be between 30 and 45 minutes for 43% of the respondents, and 45 and 60 minutes, for 32% of the respondents.

Of the respondents, 85% do not use any other mode in conjunction with the vans, while 9.5% used buses to complete their trips.

The ratings of van attributes by the respondents were favorable. Ratings were recorded on a scale from one to ten, with "comfort" rated 7.9, "safety", 6.9, "travel time", 7.7, "waiting time", 7.1, "fare", 5.5, "vehicle maintenance" (condition), 8.1, and "driver behavior", 7.2. An overall rating of bus service in Rio reported in a survey [FETRANSPOR, 1996] in 1996 was –37 on a scale from –100 to +100. It can be presumed that the 6s, 7s and 8s out of 10 are higher than the –37 on a –100 to +100 scale, which shows that there is a significant difference between the opinion of service for vans and buses.

As would be expected, combined with growing personal vehicle use, growing dispersion of urban growth and settlement patterns, and greater segmentation of travel demand, this growth of van use has begun to strongly affect formal public transit services. The private bus companies holding a position of power both locally and nationally sought to understand and stop this growth threatening the orderly control of the markets. In the most profound cases, the van services can capture over half of the former bus riders [Ferreira, 2000]. In Rio de Janeiro, the shift to vans is heavier along some corridors than others, and the estimate for overall metropolitan ridership is about 10%. In São Paulo, the estimate is closer to 25% [Balassiano et al., 1998].

Suggested Policy Responses

Ballasiano and Braga [1998, 1998a] argue that the system should be legalized, but regulated with safety a priority. They feel that in conjunction with a whole regime of policies and

investments including more modal integration, better network and service planning and coordination between the city of Rio de Janeiro and the municipalities of the Baixada Fluminense (the suburbs to the north of Rio de Janeiro), and stronger demand management strategies, vans can serve as an effective niche in the system and offer both healthy competition and support to the dominant bus system.

Torres [1998], of the Municipal Authority of Urban Transportation (the regulating body for Rio de Janeiro's bus system) recommends relegating vans to four basic roles within the formal transportation system; first, as a night service to augment the standard bus service offerings, second, as a tourist transport network, third, as a paratransit service for the disabled, and finally, for use on low demand routes or schedules in place of full size vehicles.

4.4 The Baixada Fluminense to Central Station Corridor Case Study

Growing informal van use in Brazil, as discussed earlier in this chapter, is a symptom of macroeconomic processes involving rising unemployment, falling real incomes, rising transit costs, and a rise in levels of peak hour congestion. In the urban areas of Brazil, the poor live in dispersed and job-poor suburbs and travel long distances to city centers for purposes including work, shopping, medical and other services. In order to study policy responses to the phenomena of informal transit growth, a case was sought which embodied most of these key issues, was easy to grasp and understand and minimized confounding variables like a very diverse mode choice set or dispersed destination choice set as best as any urban case study could. The corridor between the northern suburbs of the city of Rio de Janeiro, called the Baixada Fluminense, and the central business district was chosen.

The Baixada Fluminense of Rio de Janeiro (herein "the Baixada," meaning "lowlands" in Portuguese) is, in effect, one expansive residential area containing roughly 2.7 million people in an area of 1300 square kilometers. The development is concentrated along the rail corridors, with some neighborhood densities exceeding 50,000 per square kilometer (500 per hectare). It is

divided into the nine municipalities of Nilopolis, São João de Meriti, Duque de Caxias, Nova Iguaçu, Quemados, Japeri, Seropédica, Miguel Pereira, and Magé. Map 4.1 below shows a view of the region, including the city of Rio de Janeiro in the south and the Baixada Fluminense in the north.

Map 4.1. The Rio de Janeiro Metropolitan Area.
The cities of the Baixada Fluminense lie to the north-west of Rio's central business district and the wealthier areas along the south. [Europa-Technologies, 2003]

The Baixada suffers from high rates of unemployment and poverty, and a large share of its population is recent migrants who come from other areas of the country. Car ownership rates are less than 5%, and there is a high dependency on public transport. Four suburban heavy rail lines serve parts of the Baixada, though about half of the population uses the bus. An estimate of the modal split for travel between the Baixada and the center city is 5% auto/taxi, 5% van, 55% bus and 35% suburban rail. Because of the former importance of the suburban rail lines, most of the denser developments and neighborhoods surround rail stations.

Map 4.2. The suburban rail system linking Central Station and the Baixada Fluminense.
[Supervia, 2003]

From the Baixada, the downtown-bound buses and trains connect to the downtown transit terminal, called "Central Station". Central Station is the largest transit terminal in the city, serving about 1 million passenger trips (inbound plus outbound) per day and is the main gateway to the north and western suburbs and municipalities. It contains an underground metro connection (serving downtown and the southern neighborhoods of Rio), the central bus terminal serving Rio and dozens of lines to the Baixada, and 4 suburban rail lines to the Baixada and western Rio (see map above).

Buses make line-haul type trips starting with circulation in the various neighborhoods in the Baixada. These are "inter-municipal" lines and are regulated by a state transit agency. Fares are based on distance, and are typically between 2 and 3 Reais ($1.00 to $1.50). Free entry is allowed for students, elderly, and the Vale-Transporte tickets are redeemed as well. Local buses are also found in all of the municipalities and offer local circulation at a flat fare of normally about 40 cents.

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Suburban trains, vans and buses typical of those serving the Baixada-Central corridor.
[left: SECTRAN, 2003; center: R. Cervero; right: SECTRAN, 2003]

Suburban trains offer good services throughout the Biaxada Fluminense from Central Station. Indeed, Central Station was built as the main train terminal for downtown Rio for the original suburban train network in the 1950s. Peak hour headways are about 10 minutes, but rise to 20 to 30 minutes in the off peak. Travel times to the outermost neighborhoods can be about 90 minutes. Fares are flat at 80 centavos (40 cents) and free entry is allowed for students, elderly, and the Vale-Transporte tickets are redeemed as well.

The informal services in the Baixada Fluminense include both "Vans" and "combies." The proceeding sections pertains to the operations typical of the vans operating in the Baixada Fluminense. The Volkswagen bus "combies" generally offer circulation services within neighborhoods in the Baixada Fluminense, though they are increasingly found in line-haul service as well. They queue up near train or bus station exits or in special off street terminals to load passengers. Boarding also takes place anywhere along the route, and fares are generally fixed and equal to the local bus fare of about 1 real (50 cents).

Suburban rail, seen departing from Central Station (left), is infamous for overcrowding and crime (right). [left: SECTRAN, 2003; right: unknown]

Late model Korean and Japanese 9 or 10 passenger minivans generally duplicate the long bus routes connecting the Baixada to the Central Station. These routes include some pick up and drop off circulation within the neighborhood and then enter the main arterials on their way to downtown. The fares are distance based, and similar to those of buses, typically between 2 and 3 Reais ($1.00 to $1.50). However, no free entry is offered to elderly or student riders, and Vale-Transporte transit coupons are redeemed at about 80% of their face value. This effectively widens the difference between the van fares and the other modes.

Chapter 5. The Baixada-Fluminense to Central Corridor: Survey and Modeling Results

5.1 The Corridor and Surveys

The Baixada-Fluminense neighborhood to Central Station corridor is an ideal case to study commuter mode choice. Vans compete with at least one, and sometimes two other modes, the bus and suburban rail systems. Since there is little car use on this corridor, and none of it passes through the central station, it is discarded from consideration. The mode choice set under consideration therefore includes Van, Suburban Rail, and Bus.

The layout of the Central Station facilitates easy connections between the three modes. The bus and train terminals lie within 50 meters of each other, and the van terminals line the edges of the bus terminals (See Map 5.1 below). This means that differences in walking distance
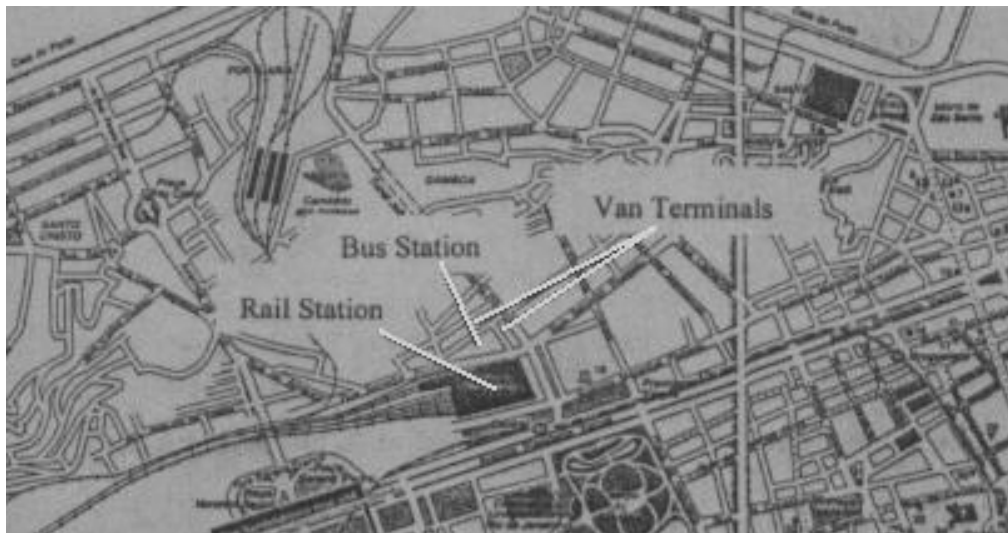
Map 5.1. The bus station and van terminals closely border the Central Station suburban train terminals.

or ease of access between the three modes are minimal. There are also two main entrances to the terminal through which most of the passengers must pass, which facilitated the random surveying of entering passengers.

About 50 meters separate the rail terminal to the bus terminals (left), while even less separates the edge of the bus terminal, marked by the fences in the foreground, and the van terminals (right). [Photos: A. Golub]

For the purposes of the survey and analysis, the study population was defined as all those traveling outbound from the Central Station to points in the Baixada during the hours of 3 pm and 8 pm on workdays.

Developing the passenger surveys required deciding which variables might play a role in mode choice in the corridor. A review was made of the literature concerning transportation mode choice in general and specific to Brazil. Significant determinants of mode choice include travel and waiting times, out of pocket costs, qualifications for discounts like government transit vouchers and youth passes, environmental variables like density of land use and access costs, as well as other factors such as proxies for taste variations such as income, age, gender, trip purpose

or possibly household role or employment status. [Abane, 1993; Bhat et al, 1998; Ben-Akiva et al., 1985; Jara-Díaz, 1991; Swait et al., 1984]

Field research was performed, including riding the vans, conversing with passengers, drivers, van terminal operators and senior van organizers. Surveys were developed with the help of the faculty and students at the Programa de Engenharia de Transportes (Transportation Engineering Program) at the Federal University of Rio de Janeiro. Surveys were pilot tested among the group. The final survey instrument took about 90 seconds to administer

A team of four students was hired to administer the surveys in the field under my supervision and assistance. The students had worked on a previous study at the Federal University of Rio de Janeiro and were recommended by the researcher. The survey instrument can be found in Appendix 5.1 at the end of this chapter. For four consecutive workdays, a Friday, Monday, Tuesday, and Wednesday, the team met at 3 pm at the Central Station lobby. Surveys were taken from about 3:15 until 8 pm, well after the end of the peak period. The students were situated near the main entrances of the terminal, through which most of the riders must pass. They chose a person at random and initiated contact with that person as they passed with approximately a 75% participation rate. Randomness could only be insured as long as the students didn't shy away from interviewing any particular class of person by gender, age, etc. Also, they were encouraged to stay in central thoroughfares and avoid doing interviews too close to any particular bus, van or train terminal. No extreme irregularities were found in the data warranting a suspicion of bias by destination neighborhood or age, income or gender group. The neighborhoods most common in the sample were also found to be the more populous neighborhoods in the Baixada Fluminense.

Besides data concerning trips and passengers' characteristics gathered through the surveys, data were needed concerning the transportation system itself. Passengers were not asked about the fares they paid nor the travel times they experienced, for example. That data was gathered independently through field observations, operator interviews, official information and

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records and schedules attained from the regulatory agencies. The data was used later to estimate

effects of different policy scenarios and to estimate and corroborate scheduled travel times

Table 5.1. List of data items.

Mode Characteristics	User and Trip Characteristics
Vehicle speeds	Income Class
Vehicle travel times	Age Class
System peak periods	Gender
Vehicle departure headways	Reception of Vale-Transporte
Operator's policy on treatment of special groups (government vouchers, youth, elderly, disabled)	Neighborhood and City of Destination
Fares, by route	Mode Choice Set
Travel Times, by route	Distance to Train if Train Choice exists
	Trip Purpose
	Opinion of Safety (1-5 rating)
	Opinion of Comfort (1-5 rating)

5.2 Sample Characteristics

Note that the data being reported here is for the entire sample, but that in the final choice

model calibration, some of the responses go unused because of missing data. A total of 640

interviews were conducted, with 588 being at least minimally complete and comprehensible. The

final choice model, because of missing data, is calibrated using 433 of the interviews.

A choice-based sampling technique was used to direct the surveys because of the very

low level of van use compared with the other modes. Compensation for this non-random

sampling technique will be made during the estimation of the mode choice model. The frequency

of choices in the final sample is shown in Table 5.2.

Table 5.2. Frequency of mode choice among all respondents

Choice	Frequency	Percent
Train	145	24.7
Bus	231	39.3
Van	212	36.1
Total	*588*	*100.0*

The actual choice set available to respondents is highly variable and will depend on their particular neighborhood in the Baixada, and their own familiarity with the transportation system. A few will only have one mode available while others will have a choice from all three. Table 5.3 presents the number of respondents in the survey who reported having each of the choice set combinations.

Table 5.3. Frequency of choice sets among respondents

Choice Sets	Train	Bus	Van	Frequency
(Modes available	X	X		165
to the respondents)		X	X	173
	X		X	0
	X	X	X	133
	X			13
		X		84
			X	20

Vehicle departure headways vary greatly between the off peak and the peak. During the peak hour, vans and buses depart as soon as they are filled, which can be very fast. Off peak, vans depart when they are filled, which can sometimes take up to 30 minutes, and buses have a fixed timetable. Table 5.4 shows average headways for the 3 modes during the peak and off peak.

Table 5.4. Average headways by mode, minutes.*

	Train	Bus	Van
Peak	20	12.9	5.6
Off-Peak	35	16	21.8

* This is the average line headway, not weighted by line ridership, and thus not a predictor of average waiting times.

Figures 5.1, 5,2 and 5.3 below show the distributions of headways experienced by the riders in the survey, and can reveal more of an average headway for all users of particular modes. Headways from peak and off peak periods are combined. Note that in the histograms shown in this chapter, the counts will be different because of the different number of riders choosing bus, train and van.

Figure 5.1. Train headways, minutes.

Std. Dev = 13.88
Mean = 30.3
N = 281.00

Frequency
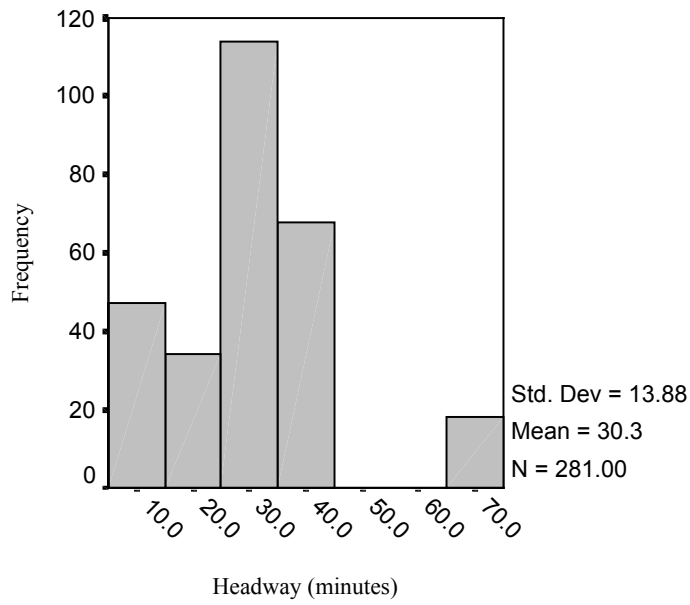
Headway (minutes)

Figure 5.2. Bus headways, minutes

Std. Dev = 7.66
Mean = 14.2
N = 555.00

Frequency

70
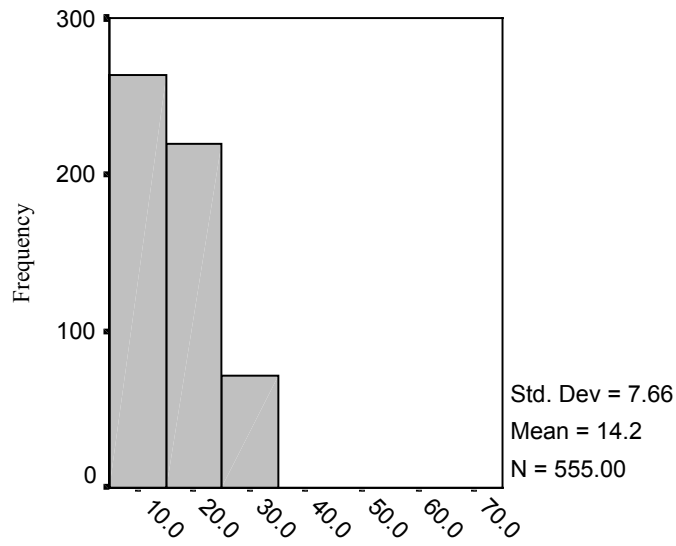
Figure 5.3. Van headways, minutes

Std. Dev = 8.30
Mean = 16.4
N = 326.00

Headway (minutes)
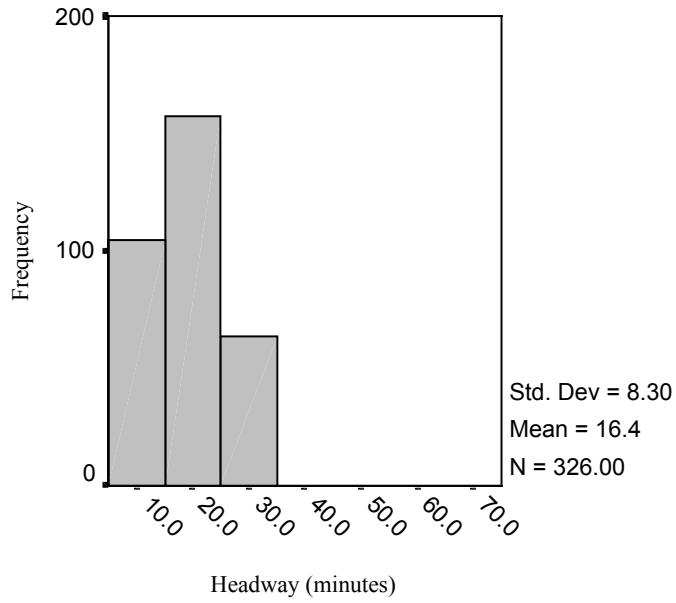
Fares for the trains are fixed at 80 centavos, or roughly 40 US cents. Bus fares vary by distance ranging from one real for the closest destinations to 2.5 reais (1.25 dollars) for the farthest, and van fares approximate bus fares, but are typically 5 to 10% higher. Figures 5.4, and 5.5 show the distribution of fares for vans and buses.

Figure 5.4. Bus fare. dollars.

Std. Dev = .29
Mean = .93
N = 555.00
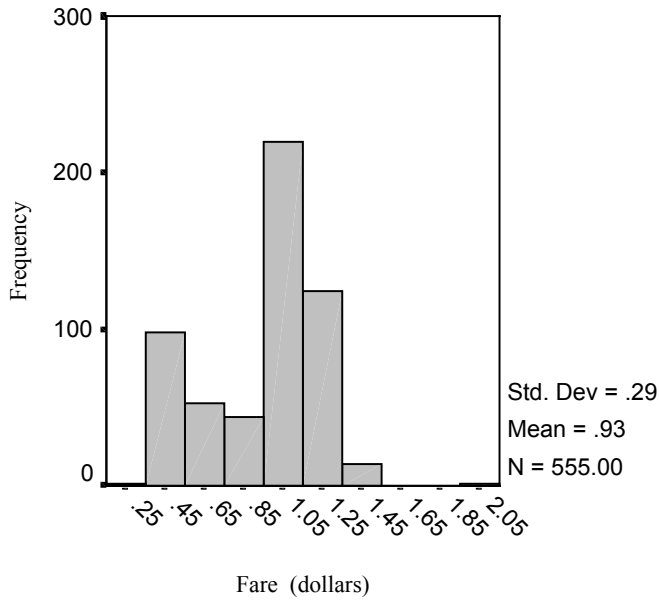
Fare (dollars)

Figure 5.5. Van fare, dollars.

Std. Dev = .16
Mean = 1.21
N = 326.00
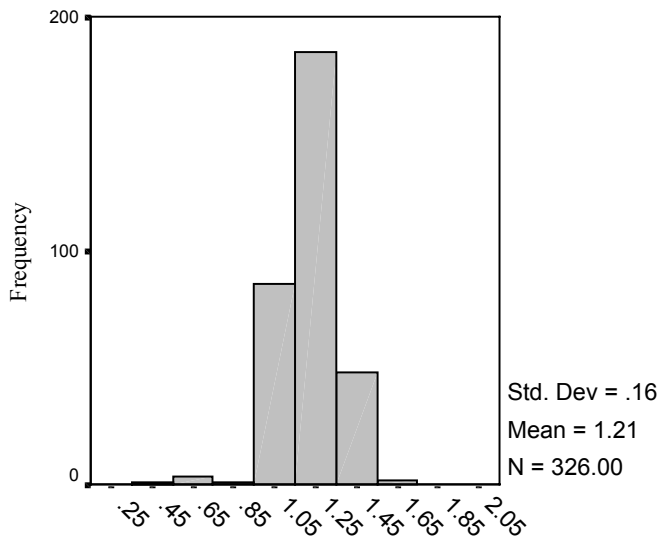
A direct comparison of fares can be made through a scatter diagram (Figure 5.6) comparing fares for bus and van for each trip (the same destination). In some cases, the van is less expensive, but in most cases, the van is more expensive. Note that train fares are set to 40 cents.

Figure 5.6 Comparison of Van and Bus fares.
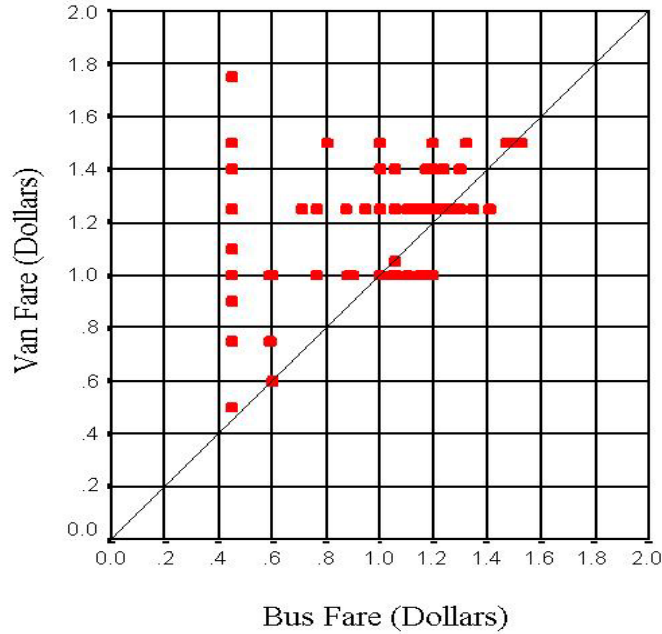
Income in Brazil is commonly expressed in terms of a multiple of "minimum salaries" someone earns. One minimum salary equals 75 U.S. dollars per month, or about 4 dollars per day. Income distribution is unbounded on the higher end, but very few responded making more than 10 minimum salaries. The income and age categories are shown in Table 5.5. For much of the presentation of the results, income classes 4, 5, and 6 are combined because of the small number of respondents in those groups, though all calculations are made keeping them separately.

Table 5.5. Definition of the income and age categories.

Group	1	2	3	4	5	6
Monthy Salary (U.S. $)	<150	150-300	300-450	450-600	600-750	>750
Age (years)	<20	20-30	30-40	40-50	>50	n.a.

The nature of workers' employment varies between income groups and this can affect whether they receive VT tickets. Table 5.6 presents the share of each income group receiving VT tickets.

Table 5.6. Proportion receiving VT, by income group.

Income Group:	1	2	3	4-6
Receive VT	0.49	0.39	0.47	.62

The respondents' income and age distribution by category are shown in Figures 5.7 and

5.8. The mode choice by income group in the surveys is shown in Table 5.7.

Table 5.7 Mode Choice by income in the final data set[*].

Income Group	1	2	3	4-6	Overall
Train Share (%)	23.2	25.0	21.2	27.0	24.0
Bus Share (%)	43.5	28.1	27.3	21.6	32.3
Van Share (%)	33.3	46.9	51.5	51.4	43.7

*This differs slightly from table 5.2 because these are only the 433 data pieces used in the final model calibration.

Figure 5.7. Distribution of income of respondents.

Std. Dev = 1.02
Mean = 2
N = 578.00

Income Category
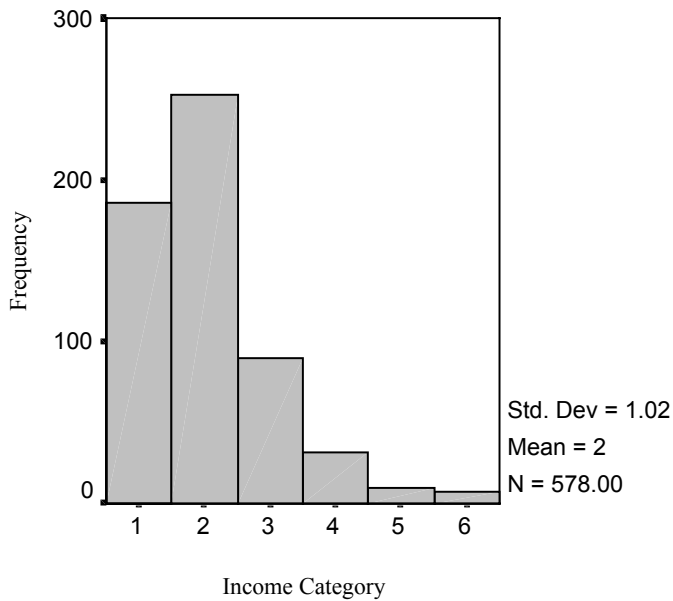
Figure 5.8. Distribution of age of respondents, number of respondents by age class.
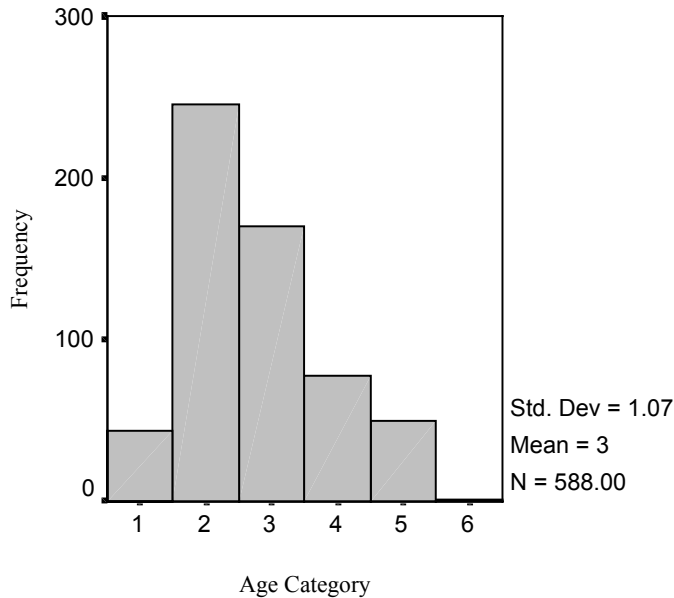
Of the respondents, 52.8% were male, and 47.2% female, 53% received "Vale-Transporte" government transit coupons. The destinations of the respondents spanned the entirety of the Baixada Fluminense.

The train schedule was used to determine in-vehicle travel times for train. Accurate in-vehicle times for the buses and vans could not be found through any official source. Travel times for buses were tabulated by regulators, but they were of questionable reliability and available for only a limited set of routes [DETRO]. Estimates for travel times during the peak and off peak hour to all of the destinations were made by combining the DETRO data with field estimates of vehicle speeds and distances, and interviews with bus and van drivers. Several trips were made to parts of the Baixada to observe traffic conditions and speeds to assist in making these estimates.

In-vehicle travel times varied significantly by mode. The times to closest destinations were about 20 minutes for all modes, and to the farthest destinations, roughly 90 minutes by van, 100 by train, and over 100 by bus. To more distant destinations, van was typically the fastest, with train roughly 10% slower, and bus slightly slower than train. To some destinations, train was the fastest mode. The afternoon peak period begins at around 5:30 and ends at around 7:30, and is

defined more by passenger demand and queuing at terminals than actual vehicle traffic congestion on roadways. There was very little freeway congestion, and the most congestion was observed on local roads, and at local intersections and transit terminals. Passenger queuing in the Central Station is markedly worse during the peak hours for all modes, but because of small headways, waiting times are not bad. Travel times by van and train are compared to bus in Figure 5.9 below for the same trip destination. It can be seen that bus travel times are always longer than van times, but train times are sometimes short and other times longer.

Figure 5.9. Travel times for van and train compared to bus.
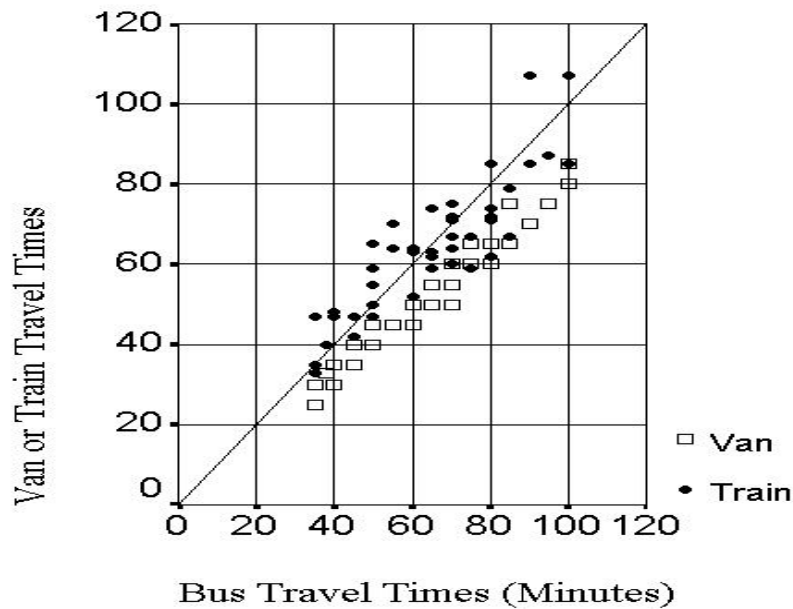
The distribution of travel times, by mode, shown in Figures 5.10, 5.11, and 5.12, illustrates how long a commute much of the population endures. The figures also show how long the bus travel times are compared to the train and van.

Figure 5.10. Distribution of train travel time, number of respondents by time group.

Std. Dev = 15.59
Mean = 62
N = 281.00

Travel Time (minutes)
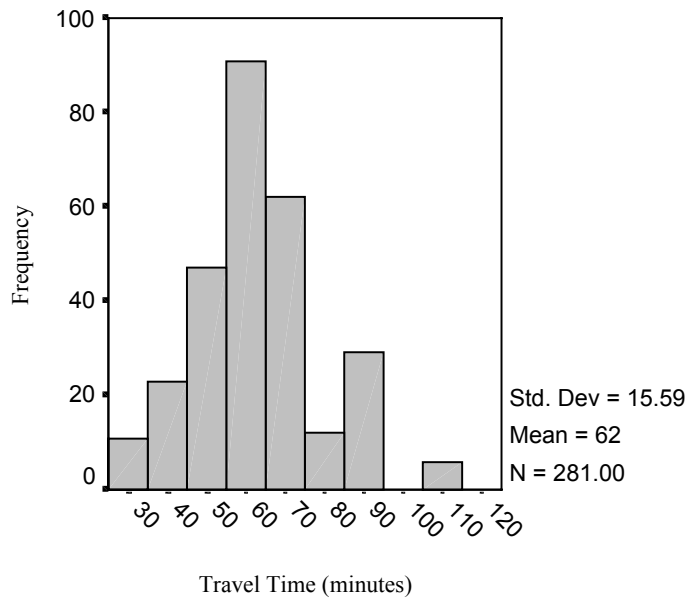
Figure 5.11. Distribution of bus travel time, number of respondents by time group.

Std. Dev = 18.45
Mean = 67
N = 520.00
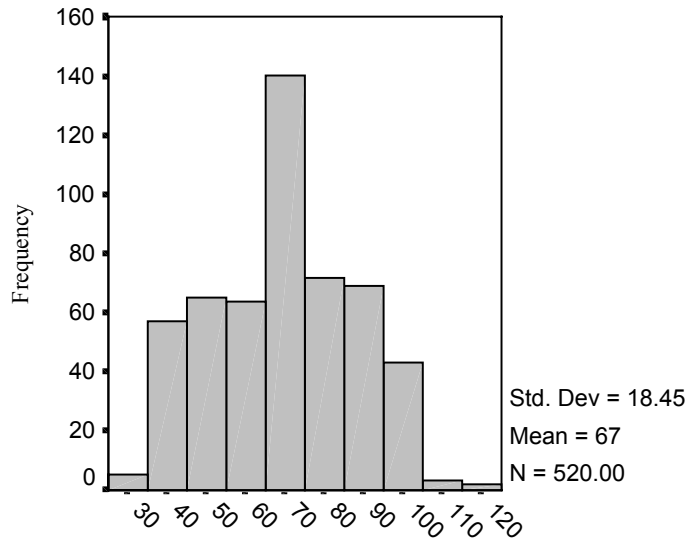
Figure 5.12. Distribution of van travel time, number of respondents by time group.

Travel Time (minutes)

Std. Dev = 12.71
Mean = 58
N = 326.00
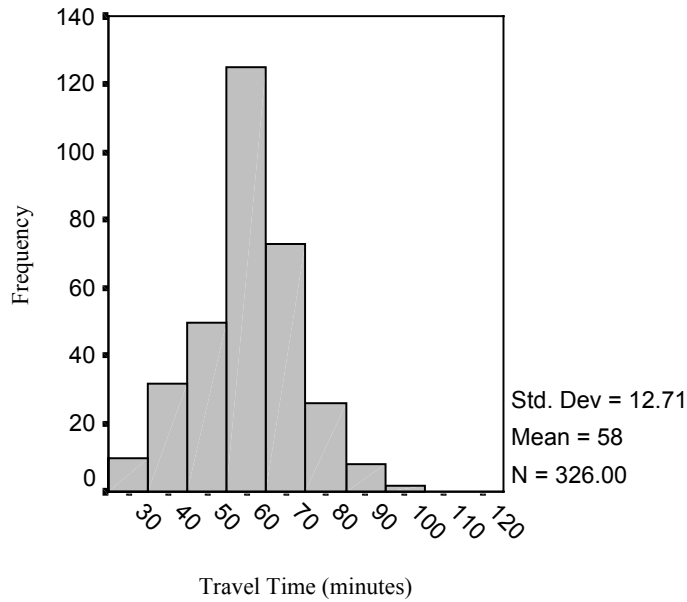
Distance to train for those who had train available was measured in terms of time. Though our survey asked for respondents to chose a distance, many responded that it was more easily expressed in terms of time. It was decided to ask verbally for either time or distance. Figure 5.13 shows the distance distribution for the respondents.

Figure 5.13. Distribution of walking time to train, number of respondents by time group.

Std. Dev = 7.22
Mean = 19
N = 505.00
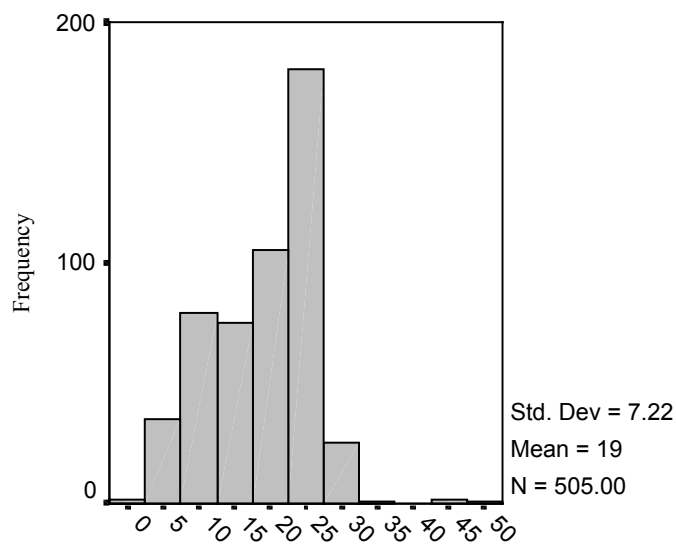
Trip motives were categorized as leisure, work, shopping, education, and health. The distribution of surveyed passengers' trip purposes is shown in Table 5.8.

Table 5.8. The distribution of trip purposes among respondents

Purpose	Frequency	Percent
Leisure	11	1.9
Work	534	90.8
Shopping	8	1.4
Education	15	2.6
Health	20	3.4
Total	*588*	*100.0*

An opinion about safety was given by respondents for the modes the respondent felt familiar with, using rating between one and five, with one being the lowest and five being the highest. The distributions of ratings for each mode are shown in Figures 5.14, 5.15, and 5.16.

Figure 5.14. Distribution of rating of safety for respondents familiar with train.

Std. Dev = 1.23
Mean = 2
N = 418.00
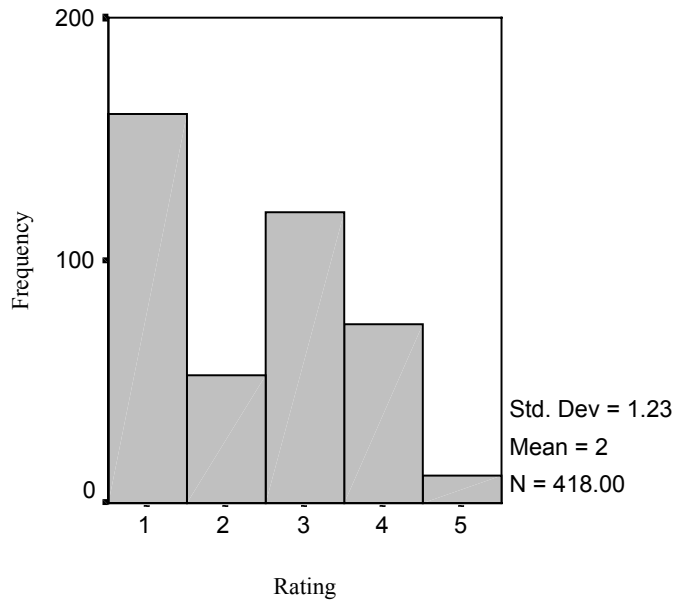
Figure 5.15. Distribution of rating of safety for respondents familiar with bus.

Std. Dev = 1.13
Mean = 2
N = 573.00
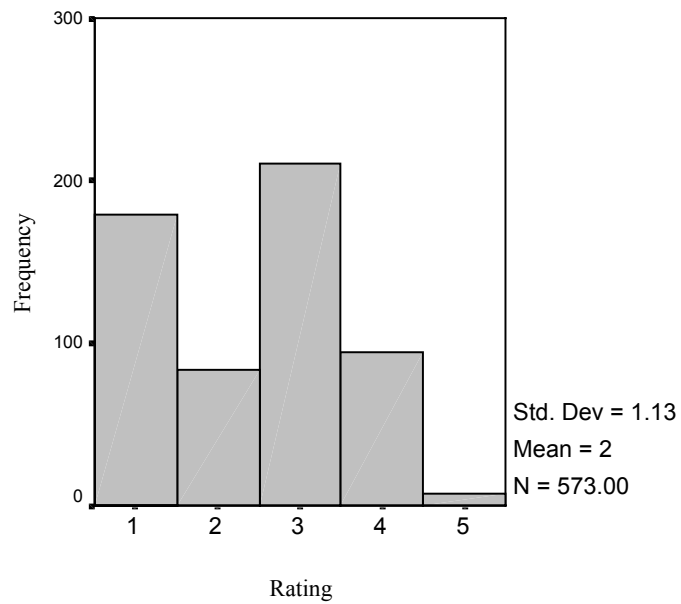
Rating

Figure 5.16. Distribution of rating of safety for respondents familiar with van.

Std. Dev = 1.23
Mean = 3
N = 426.00
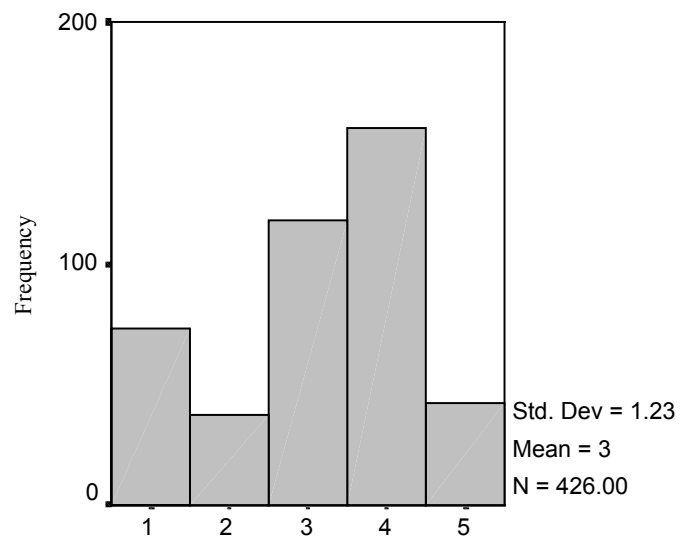
An opinion regarding comfort was given by respondents for the modes the respondent felt familiar with, using the same 1-5 rating. The distributions of ratings for each mode are shown in Figures 5.17, 5.18, and 5.19,

Figure 5.17. Distribution of rating of comfort for respondents familiar with train.

Std. Dev = 1.17
Mean = 2
N = 419.00
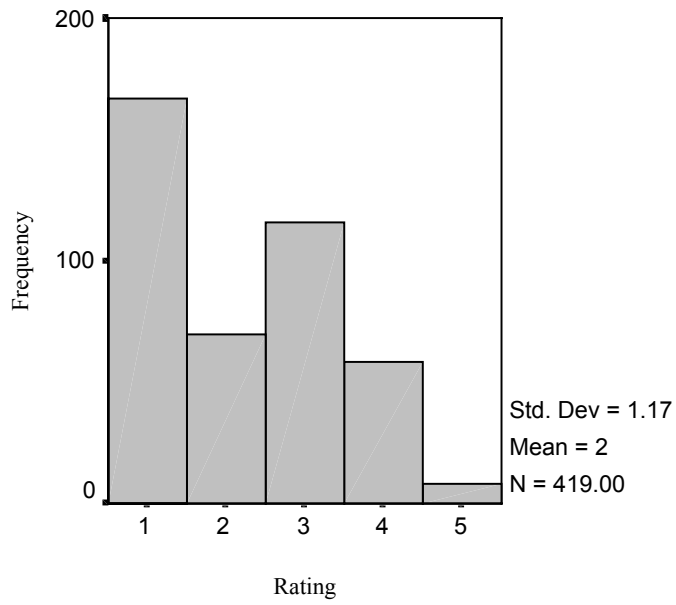
Rating

Figure 5.18. Distribution of rating of comfort for respondents familiar with bus.

Std. Dev = 1.14
Mean = 3
N = 573.00
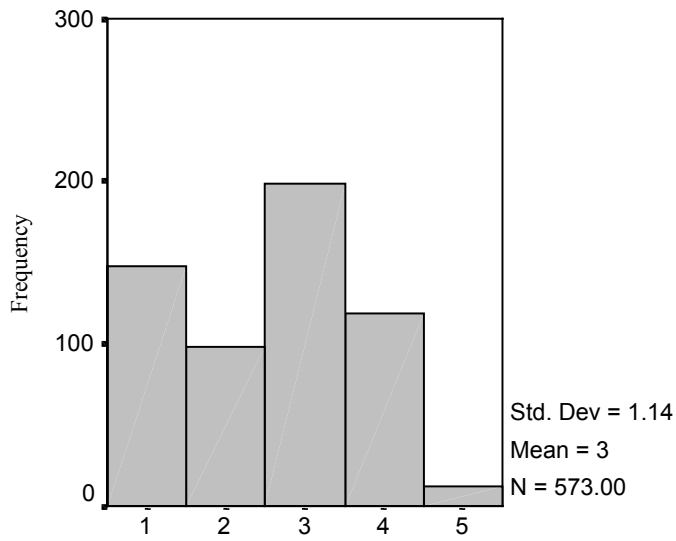
Figure 5.19. Distribution of rating of comfort for respondents familiar with van.

Std. Dev = 1.16
Mean = 4
N = 426.00
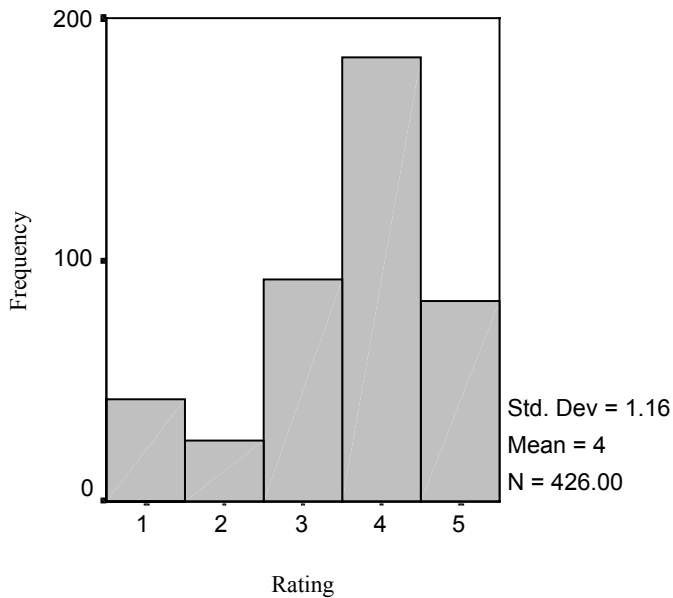
Other statistics from the data are, 37% of the trips were taken during peak hour, 91.2% were taken in good whether and 15.8 % were to neighborhoods with no train access within a 30-minute walk.

5.3 Model of Mode Choice

Standard maximum likelihood techniques was used to estimate the logit discrete choice models, as described in Chapter 3. The ALOGIT statistical package was used to make the estimates. Table 5.9 lists the data available for each trip. These variables are candidates for inclusion in the utility functions. For dummy variables and other variables remaining constant across modes, bus was used as the reference mode.

Table 5.9. Data available for use in utility functions.

Variable	Measure	Units
Peak	1 if trip is during peak hour (between 5:30 and 7:30)	Dummy variable (0/1)
Weather	1 if good weather (not raining)	Dummy variable (0/1)
Gender	1 if female, 0 if male	Dummy variable (0/1)
Choice	1 if train, 2 if bus, 3 if van	Categorical Variable (1,2,3)
Fare1	Cost of train, adjusted for use of Vale-Transporte	US Dollars
Fare2	Cost of bus, adjusted for use of Vale-Transporte	US Dollars
Fare3	Cost of van, adjusted for use of Vale-Transporte	US Dollars
IVT1	In-vehicle travel time by train	Minutes
IVT2	In-vehicle travel time by bus	Minutes
IVT3	In-vehicle travel time by van	Minutes
VT	1 if rider receive government transit ticket, Vale-Transporte	Dummy variable (0/1)
Motive	1 (leisure), 2 (work), 3 (shopping), 4(education), 5(health)	Categorical Variable (1,2,3,4,5)
Distance	Walking time to train station from home	Minutes
Saf1	"Rating" of safety for train, on a scale of 1 to 5	Ordinal Variable (1 to 5)
Saf2	"Rating" of safety for bus, on a scale of 1 to 5	Ordinal Variable (1 to 5)
Saf3	"Rating" of safety for van, on a scale of 1 to 5	Ordinal Variable (1 to 5)
Com1	"Rating" of comfort for train, on a scale of 1 to 5	Ordinal Variable (1 to 5)
Com2	"Rating" of comfort for bus, on a scale of 1 to 5	Ordinal Variable (1 to 5)
Com3	"Rating" of comfort for van, on a scale of 1 to 5	Ordinal Variable (1 to 5)
Age	1 (0-20 years), 2 (20-30), 3 (30-40), 4 (40-50), 5 (>50)	Ordinal Variable (1 to 5)
Income	1 (<150$/month), 2 (150-300$), 3 (300-450$), 4 (450-600$), 5 (600-750$), 6 (>750$) converted to dollars per day for use in choice model	Ordinal Variable (1 to 6)
Av1	1 if train is available	Dummy variable (0/1)
Av2	1 if bus is available	Dummy variable (0/1)
Av3	1 if van is available	Dummy variable (0/1)
Work Trip	1 if work trip (if Motive = work (2))	Dummy variable (0/1)
H1	Headway between departures, train	Minutes
H2	Headway between departures, bus	Minutes
H3	Headway between departures, van	Minutes
Notrain	1 if rider lived in a neighborhood with no train service	Dummy variable (0/1)
OVT-train	Notrain*5 + Distance (assumed a transfer takes 5 minutes)	Minutes
Special Age	If rider is less than 20, or greater than 50 (Age = 1,5)	Dummy variable (0/1)

From the complete survey data of 588 trips, records were eliminated with missing or bad entries and 433 pieces remained in the final data set. The following paragraphs will describe some of the problems confronted while attempting to make this estimation, including the correlation of the subjective ratings with choice and the unexpected cost coefficient predicted by a first model.

Subjective Ratings

One of the most important differences between the three modes in the study is their subjective levels of quality, comfort, and safety. It was hoped that the data gathered concerning riders' perceptions of safety and comfort would allow for these differences to be captured in the model. Given the length of time available for each interview, it was hoped that one or two simple questions could yield the relevant attitudinal measures needed for the choice model. Based on the literature, however, the likelihood of these data being useful to the final model was low. Respondents were asked to rate, in front of the interviewer, their perceptions of comfort and safety along a five point uni-dimensional scale [Golob, et al. 1977].

The subjective ratings were found to be highly correlated with choice, a finding consistent with psychology's "cognitive dissonance theory" [Golob, 1975], which explains how this reduces the usefulness of such simple metrics in choice modeling. Cognitive dissonance theory says that people will alter responses to questions associated with a choice they have made or expect to make, in order not to conflict with that choice. On the other hand, for people without a choice, such as "captive" bus riders, they will more accurately depict their subjective rating in a survey, because they are not trying to affirm a choice. For example, among the surveyed riders, those choosing van are very likely to rate van as the most comfortable, and the other modes as less comfortable. Train riders, who face crowded conditions and few available seats (on the order of 1 for every 10 during the peak hour) for a ride which can often exceed one hour, will also rate the train as the most comfortable compared with the other modes, including the van, which has guaranteed seats. If they didn't reaffirm their choice through their ratings, they'd experience "cognitive dissonance", which, according to the theory, creates an internal discomfort in most people. That is, if they were to respond that their choice was not the most comfortable or the most safe, they would be saying that they make poor choices or that these factors are not important to their choice. Figure 5.20 shows the effects of this bias resulting from cognitive dissonance on the safety and comfort ratings. Average comfort and safety ratings for the three modes, are presented

according to respondents' choice. It becomes clear in this figure how choice biases ratings of all the modes as the chosen mode is always rated highest.

Much of the work on subjective measurement has shown that a series of questions are needed to eliminate the biases due to cognitive dissonance and establish groups of riders with homogeneous choice availabilities [Recker, Golob, 1976]. Longer surveys would have been needed to add some of these details to the data. This would have made completing the surveys even more time consuming and expensive, eroded participation rates, and might have added even new dimensions to our problems dealing with the terminal officials and other similar issues.

Figure 5.20. Average ratings of safety and comfort for the three modes, grouped by users' mode choice. For example, the solid square symbol are the ratings of safety for the three modes made by Van riders, while the open square symbol are the ratings of comfort made by Van riders.
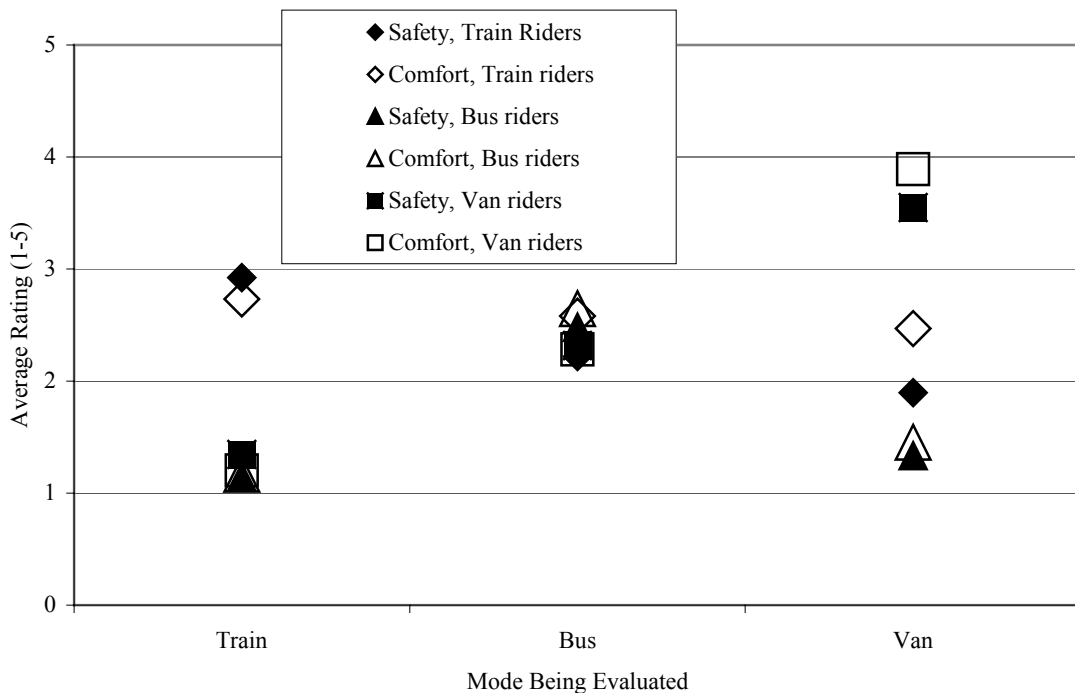
This correlation resulting between choice and subjective ratings makes the uni-dimensional rating data difficult to use in the choice model. Two instrumental variables were constructed, equally for both safety and comfort, in an attempt to remove the bias in the ratings for the chosen mode. The first variable corrected the rating for the chosen mode for each data

record by dividing it by the average ratio chosen modes' ratings were biased above the other ratings. This average bias equaled 1.46 for safety and 1.69 for comfort. The second variable corrected the rating for the chosen mode for each data record by subtracting out the average difference between the chosen mode's rating and the average of the two remaining ratings. This average difference equaled 0.23 for safety and 0.55 for comfort. These instrumental variables, however, still exhibited wrong signs or were statistically insignificant.

The data illustrate that there are interesting differences between people's rating of the modes. For van users (square symbols in Figure 5.20), ratings of comfort and safety for vans were much higher than for buses and trains, with a slightly higher rating for buses and trains. For train riders (diamond symbols in Figure 5.20), the story was similar, but there was less difference between the ratings. Train riders rated trains highest in comfort and safety, but buses and vans weren't too much lower, and buses were rated slightly higher than vans. Train riders exhibited the highest cognitive dissonance as they had the greatest bias between their own ratings for the train and the ratings for trains given by choosers of other modes. Riders of buses and vans rated trains very low. Similarly, bus riders (triangle symbols in Figure 5.20) rated bus the highest in comfort and safety, but interestingly, this rating was roughly equal to those received by users of other modes. For some reason bus ratings did not exhibit any bias based on users' mode choice. This could result from the fact that many are solely dependent on the bus, and therefore don't exhibit the bias of cognitive dissonance, as there is no "choice" to reaffirm. Bus riders still rated bus much higher than the other two modes.

Initial Model

A major factor in the choice between bus, van and train is comfort. Seat availability, ride quality, noise, vehicle motion and acceleration differ greatly between the three modes. Safety concerns differ as well, but are less clear. Some commuters interviewed feared the vans because of their reputation for reckless driving and occasional robbery. The general reputation of the train

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was that robbery and violence were common. Leaving these important factors out of the model impaired its predictive power. The initial model exhibited other problems, and whether or not they were linked to the lack of subjective variables is a question that remains unanswered. The marginal utility of money was estimated to be positive, which is highly unlikely. This meant that, all things being equal, a more expensive mode would be chosen over a less expensive one. The results of the full, unconstrained, model are shown below in Table 5.10.

Table 5.10. Estimated utility functions from logit model. Variable definitions are stated in Table 5.9 above. Numbers in parenthesis are asymptotic t-statistics.

	Constant	Peak[a]	Income	OVT	Special Age[a]	Transf[a]	IVT	Cost
Train	0.6525 (0.8)	-3.177 (-7.0)	0.2344 (1.7)	-0.0421 (-2.6)	0.3603 (1.0)	-0.7473 (-1.2)	-0.1319 (-5.2)	2.528 (5.0)
Bus	-0-	-0-	-0-	-0-	-0-	-0-	-0.1437 (-7.3)	2.528 (5.0)
Van	-3.841 (-3.6)	-0.8405 (-1.6)	0.06429 (0.3)	-0-	-0.4898 (-0.7)	0.2096 (0.3)	-0.1495 (-5.3)	2.528 (5.0)

a. Dummy variables.

The performance of the initial model is captured by the following statistical measures:

Table 5.11. Statistics of unconstrained model.

Number of observations	433
Initial Log-Likelihood	-359.7142
Log-Likelihood with Zero Coefficients	-351.0918
Log-Likelihood with Constants only	-312.9763
Final value of Log-Likelihood	-234.8330
Likelihood Ratio (w.r.t. zero)	232.52 ($\chi 2$ (df=17, α=0.01) = 33.41)
ρ^2 (w.r.t. zero)	0.3311

The model shows a good level of statistical fit with the data, explaining roughly 33 percent of the variation in the data. This low level of fit is typical in multinomial choice modeling because of the highly non-linear behavior of the model. Several of the model's coefficients, such as the train transfer dummy variable for the van choice, are probably not statistically significant, and thus will be removed as the model is refined. This process of trial and error, culling away

insignificant coefficients, and attempting to correct for the deficiencies in the data described earlier led to the final model to be used in the welfare calculations.

Final Model

In order to remedy the problems in the data, a model was constructed of the choice between the rubber-tired modes, bus and van. Because differences in fares and comfort levels are less drastic, the tradeoffs between fare and other attributes would be less affected by the absence of the subjective variables and result in more realistic marginal utilities of money. Interviews with Professor of Economics, Kenneth Train, an expert on discrete choice modeling, confirmed the validity of this approach [Karlstrom, 2002; Train, 2002]. Additionally, the value of time, equal to the ratio of the coefficient of travel time to the coefficient of money, was constrained to equal half of the rider's wage rate. This ratio is cited in the literature as a fraction of the wage rate, ranging from as little as one-fifth, to seven times the hourly wage. [Black, et al., 1992; Jara-Díaz, 1990; Jara-Díaz, 1996; Waters, 1994]. An earlier study performed in the Central Station using stated preference methods with commuters revealed a value of time equal to roughly 42% of the hourly wage [Arruda, 1998]. Also, the explanatory power of the model was not significantly sensitive to the ratio used, so one-half was chosen.

The resulting marginal utilities of income (MUI) and marginal utility of time are:

$$\beta_{money} = \frac{-6.923}{Income}, \qquad \beta_{time} = -0.0058,$$

where income is expressed in dollars per day. Table 5.12 presents the resulting MUI for the 6 income groups.

Table 5.12. MUI for the 6 income groups.

Income Group	#1 <150 $/mo ave = 112.5	#2 150 to 300 ave = 225	#3 300 to 450 ave = 375	#4 450 to 600 ave = 525	#5 600 to 750 ave = 675	#6 >750 ave = 800
MUI (utils/$)	-1.23	-0.62	-0.37	-0.26	-0.21	-0.17
N	183	252	90	32	10	9

A choice model containing all three modes and all of the data was then estimated while constraining the marginal utilities of money and time to these values. The estimated model is shown in Table 5.13.

Table 5.13. Estimated utility functions from logit model. Variable definitions are stated in Table 5.9 above. Numbers in parenthesis are asymptotic t-statistics.

	Constant	Peak[a]	Income	OVT	Special Age[a]	Transf[a]	IVT[b]	Cost[b]
Train	-0.2702 (-0.7)	-1.265 (-4.7)	0.440 (3.7)	-0.0517 (-2.6)	-0-	-0.1685 (-0.4)	-0.0058	$\frac{-6.923}{Income}$
Bus	-0-	-0-	-0-	-0-	-0-	-0-	-0.0058	$\frac{-6.923}{Income}$
Van	-1.573 (-3.0)	-0.694 (-1.4)	0.137 (0.7)	-0-	-0.4456 (-0.6)	-0-	-0.0058	$\frac{-6.923}{Income}$

a. Dummy variables.
b. Fare and time coefficients are constrained to the values determined by the sub-model, presented above.

The performance of the final model is captured by the following statistical measures:

Table 5.14. Statistics of final model.

Number of observations	433
Initial Log-Likelihood	-359.7142
Log-Likelihood with Zero Coefficients	-351.0918
Log-Likelihood with Constants only	-312.9763
Final value of Log-Likelihood	-293.1856
Likelihood Ratio (w.r.t. zero)	115.81 ($\chi2$ (df=9, α=0.01) = 21.66)
ρ^2 (w.r.t. zero)	0.1649

Travel time, and fare are specified as generic variables because of the need to constrain the value of time as discussed earlier. Out of vehicle travel time (OVT) was important for the

train mode. The OVT for the bus and van were very similar since they both can drop off and pick up at various locations as they enter destination neighborhoods. Since they were so similar, the train's OVT was changed to measure the additional OVT train riders endure over bus or van riders. The peak-hour dummy is showing that the bus mode share during the peak is even higher than for the rest of the day. Using a dummy variable for peak hour was a way to model the greater preference for buses without needing to know the exact headways for the three modes. Income was specified in order to try to capture the differences in "tastes" between the income groups, or possibly account for different residential locations. The wealthy tend to live in the denser, traditional neighborhoods built up along the train lines, causing them to prefer the train mode. Income also positively influenced choice of van, which might reflect its higher status and price with the respect to the other modes. Vans did not honor free entry for youth or elderly, and this clearly reduced the utility of choice for those riders via the special age constant. Finally, the transf dummy was included to see whether riders were willing to connect to trains from outlying neighborhoods. It was shown that the need to transfer diminished the utility of the train choice, which would be expected.

Overall statistics of the performance of the model were not as good as those for the unconstrained model, which is to be expected. Some of the coefficients of variables were not significantly different from zero, but their values were retained in the model because they represented important variables for later policy testing. Given the small number of data pieces (433), low asymptotic t-values and poor overall fit were not surprising, and it was decided to keep the most important coefficients, even if they proved to be of low significance. The constant for the train choice, the transfer coefficient for train choice, the special age discount coefficient for van choice, and the peak-hour coefficient for van choice were not significantly different from zero. The final values of the log-likelihoods, however, shows that the model is giving some improved fit to the data over merely assuming the choice is split evenly between the three modes (coefficients are equal to zero) or just using the model constants. Since the cost and in-vehicle

travel times were taken as given from another model, they were not variables with coefficients to be estimated. These constraints lowers the overall fit of the model, as well as the significances of the other variables in the model.

5.4 Conclusions

The final choice model is not as predictive as would be preferred. It was assumed a priori that subjective ratings, or the importance people place on the subjective characteristics of the modes would be significant components of a model predicting choice between the informal and formal modes. Unfortunately, using intercept surveys with necessary short time durations it is difficult to gather more in-depth subjective data. Focus groups would have allowed a great exploration of the choice process, including some of the subjective differences between modes. Perhaps stated preference surveys could have been combined with the survey data to yield a better mechanism for including subjective differences between the choices. The final choice model makes behavioral sense and should be powerful enough to show the impacts of policies with reasonable confidence.

Appendix 5.1: Passenger Survey Instrument

Below is the survey instrument used in the station survey work. English translations can be found under each question.

Estudo de Escolha Modal no Rio de Janeiro **Universidade de California, Berkeley**
Apoio (Sponsors): PET/COPPE/Universidade Federal do Rio de Janeiro

Data: **6** (6ª) **9** (2ª) **10** (3ª) **11** (4ª)   Hora: Tempo: Bom Ruim

1. **O destino: bairro_____cidade_____ Sexo: M F**
   Destination: Neighborhood, City, Sex

2. **Qual o modo de transporte que vai utilizar para seu destino?**
   What mode of transportation will you use for your trip?
   trem [ ]   ônibus [ ] van [ ]   linha:_____preço:_____

3. **Tem outros modos de transporte para seu destino?**
   Are there other modes available to you for this trip?
   trem [ ]   ônibus [ ]   van [ ]   linha:_____preço:_____
   trem [ ]   ônibus [ ]   van [ ]   linha:_____preço:_____

4. **Recebe Vale-Transporte no trabalho?   sim [ ] não [ ]**
   At work, do you receive a transportation coupon?

5. **Qual é motivo da sua viagem para à cidade?**
   What is the purpose of your trip? Pleasure Work Shopping Education Health
   Lazer [ ]   Trabalho [ ]   Compras [ ]   Educação [ ]   Saúde [ ]

6. **Qual é a distância da sua casa ate a estação de trem mais próxima?**
   How far is the nearest rail station from your home?
   <100 metros [ ]   100-500 m [ ]   500m-1km [ ]   >1km [ ]   não tem/não sabe [ ]

7. **Como você avalia a segurança dos modos: (escolha um por cada modo)**
   How would you rate the safety of the transportation modes: (Chose 1 for each mode)

	Péssimo *(very bad)*	**Ruim** *(bad)*	**Regular** *(ok)*	**Bom** *(good)*	**Ótimo** *(very good)*
Ônibus	(1)	(2)	(3)	(4)	(5)
Trem	(1)	(2)	(3)	(4)	(5)
Van	(1)	(2)	(3)	(4)	(5)

8. **Como você avalia o comforto dos modos: (escolha um por cada modo)**
   How would you rate the safety of the transportation modes: (Chose 1 for each mode)

	Péssimo *(very bad)*	**Ruim** *(bad)*	**Regular** *(ok)*	**Bom** *(good)*	**Ótimo** *(very good)*
Ônibus	(1)	(2)	(3)	(4)	(5)
Trem	(1)	(2)	(3)	(4)	(5)
Van	(1)	(2)	(3)	(4)	(5)

9. **Qual é sua faixa de idade?**
   What is your age group?
   <20 anos [ ]   20-30 anos [ ]   30-40 anos [ ]   40-50 anos [ ]   >50 anos [ ]

10. **Qual é sua faixa de renda?**
    What is your income group?

< 2 salários mínimos	**2-4**	**4-6**	**6-8**	**8-10**	**>10**
(< 300 Reais/mês)	**(300-600)**	**(600-900)**	**(900-1200)**	**(1200-1500)**	**(>1500)**
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

Chapter 6. Analysis of Policy Scenarios

6.1 Introduction

This chapter presents the results of the benefit calculations for each of eleven policy scenarios. The results include each policy's net benefits, and the distribution of those benefits among groups within the population. Estimates of the public sector costs and a comparison of the costs and benefits contribute to an analysis of the efficiency of each scenario. In the first section, the policy scenarios will be presented, including how they are modeled for purposes of the welfare calculation and how their costs are estimated. Results of the welfare calculations and cost-benefit comparisons are presented next. A discussion comparing the policies' relative merits will close the chapter.

6.2 Presentation of Policy Scenarios

The State of Rio de Janeiro's Department of Road Transport (DETRO) is responsible for regulating all road-based inter-municipal transportation including private and public transit, and freight transportation. The Baixada-Fluminense to Central corridor crosses from the City of Rio de Janeiro into the municipalities of the Baixada Fluminense and is under DETRO's jurisdiction. DETRO would be the agency responsible for making decisions regarding the regulation of vans. A review of both academic and popular media and interviews with policy makers, academics and industry insiders helped to construct the following eleven policy "scenarios." These scenarios address the corridor's transportation system directly and do not seek to manage demand or other exogenous factors such as fuel prices or employment or residential location. Each scenario

prescribes different levels and types of treatments of the train, van, and bus systems in the Baixada-Central corridor.

The magnitude of policies' effects on modal characteristics depends strongly on the behavior of the transportation system, the response of transportation suppliers to policy and price changes, and the response of users to changes in the characteristics of the transportation system. The users' response is found via the choice model developed in this work. The response of the system and suppliers to policies could only be estimated. The system was observed and best estimates were made to determine how levels of service would change due to policy effects. The response of suppliers was estimated through study of their operations, costs, positioning in the market and typical responses to changes in market characteristics. The point in time of the estimated effects is 6 months after the implementation of policies. That is, this evaluation is comparing the state of the market and demand, etc., 6 months after policies are assumed to take effect.

Several sessions were held with graduate students and academics during the summer, 2001 trip to Rio de Janeiro, in order to get opinions about the supply-side response to policy. Meetings were held with Ronaldo Balassiano and Romulo Dante Orrico Filho of the Transportation Engineering Program at the Federal University of Rio de Janeiro (UFRJ), along with graduate students [Amaral et al., 2001]. A seminar was given in the department to facilitate a more open discussion of what the group thought supplier response would be to the policy scenarios being proposed for study. In this session, the 10 policies were defined along with some of the important responses operators would make to their enactment. Meetings were also held with Abdul Haikal, president of the Federation of Alternative Transportation Cooperatives of the State of Rio de Janeiro (FECOTRAL), the umbrella federation of all the Van Cooperatives in the Baixada Fluminense [Haikal, A., 2001], and Jose Guerra of the City of Rio de Janeiro Secretary of Urban Transportation, which regulates public transportation within the city [Guerra, 2001]. In February of 2003, a final trip was made to UFRJ to meet with Professor Balassiano and Eric

Ferreria and Ayres Araújo [Ferreira et al., 2003]. The results of the scenario analysis were presented and the group helped make final adjustments to the modeling assumptions, analysis, and interpretations.

Finally, the response of user demand to changes in unseen factors such as legal status or an improvement in appearance or general reputation was estimated. These unseen factors absent from the mode choice model are effectively lumped together as each mode's constant in its utility function. For policies involving changes to these unseen factors, an elasticity of demand was estimated. These estimates were developed with the input of Abdul Haikal, Jose Guerra and the faculty and students at UFRJ using their experiences in the sector, recent trends, and for the lack of better terms, intuition and engineering guesswork [Ferreira et al., 2001; Haikal, A., 2001; Guerra, J., 2001].

In the models, policies can affect the modal characteristics only via the terms in the modes' utility functions. The evaluation of each policy requires an estimate of its effects on the modal characteristics 6 months after the start of the policy. This effect is a multiplier equaling the change to the characteristic compared with the status quo (do nothing) scenario. For instance, bus fares are assumed to rise 2.5% during the 6 months, and a policy which forces bus fares to remain unchanged would be modeled as multiplying bus fares by 0.9756 (or 1/1.025). Changes to a mode's demand because of less tangible variables such as an improvement in "reputation," are made by changing the constant in the mode's utility function according to the estimated elasticity.

Delays due to congestion are approximated by a linear function of the total van activity (total van demand). At current van demand levels, it is assumed that vans and buses experience an average of 4 minutes of delay per trip. This was estimated by observing queues and congestion in the Central Station exits and several terminal areas in destination neighborhoods in the Baixada Fluminense. Increases and decreases in van demand are translated into changes in van and bus

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travel time using this linear relationship. For example, a 10% decrease in van demand equals a 0.4 minute decrease in bus and van travel times.

Safety costs are an important issue for several of the policy scenarios studied here. Estimating the safety costs of continued operation of the informal van services and how they would be reduced by regulation is very difficult. Very little was found regarding the accident or fatality rates of the van services. In fact, among even the most aggressively anti-van articles and publications, safety was merely mentioned in passing, with no formal data or studies cited [NTU, 1997; ANTP, 2000]. This indicated that either very little is known about these rates, or that they do not differ significantly from the population as a whole, or both. It seemed that safety was mentioned to evoke fear in the public and policy makers, and not to engage in a discussion of the real costs of informal operations. Consequently, these issues will only be treated superficially where they apply. It is hoped that policy makers with a deeper concern about the safety costs and benefits would go deeper into the issue and attempt to compile this data in a meaningful way.

The eleven scenarios are listed below, grouped by their overall approach, along with their nicknames, which will be used from now on to refer to them.

Status Quo (Do nothing)

Restricting the Vans

   1. Weak (Some ticketing), "Restrict 1"

   2. Medium (Heavy ticketing, policing at bus stops), "Restrict 2"

   3. Strong (Removing all vans from circulation via police action), "Restrict 3"

Ignoring the Vans

   4. Change specific terms of Bus Concessions to lower operating costs, "Change Bus Concession"

   5. Restrict Vale-Transporte transit coupon use to buses and trains, "Change VT"

   6. Bus System Improvement, "Improve Bus"

   7. Train System Improvement, "Improve Train"

Recognize the Vans

   8. Legalize the Vans, "Legalize"

Regulating the Vans

   9. Regulation, following Decree 25.955, "Regulate"

   10. Regulation and public investment, "Regulate +Invest"

   11. Competitive Case, "Prices = Long Run Marginal Costs"

The following paragraphs introduce each policy scenario in detail, discussing their key regulations or actions, their effects on the modes' utilities, and their costs.

Status Quo

Description   The status quo is the "base" against which all of the eleven policy scenarios are compared. In effect, it's the "do-nothing" scenario and is presented graphically in figure 3.1 in Chapter 3 (page 38). The status quo is presumed to be the state of the do-nothing case at the time policy effects are being analyzed, which is 6 months after "time zero". That is, for the do-nothing scenario, changes in fares or demand are assumed to go according to the way they were going during the time this study was being performed. Given the current supply of buses, the relative prices and remaining available niches for the vans, it is difficult to foresee a major rise in van demand. It is assumed that demand for vans would remain steady during the 6-month period. Bus

fares rise periodically through petition by the bus firms to the state regulators and van fares are set according to the bus fares, and are generally set about 5 to 10% higher.

Modeling Van and bus fares were modeled to rise by 2.5%.

Costs The main costs of the status quo are the safety costs of continued unregulated passenger transportation activity. These costs are very difficult to estimate and will be discussed at the end of this section.

Restrict Vans

1. Weak (Some ticketing) - "Restrict 1"

Description The restriction of the vans is a fairly simple scenario and does not require any new rulemaking or analysis on the part of any agency. The vans are illegally providing transit services without a permit, and the means are already in place to enforce those rules. Though, in the past, attempting to enforce these laws provoked a harsh reaction by van drivers, it is conceivable that the state becomes motivated to try to limit van activity. A weak restriction of the vans could be carried out with the placement of a small group of traffic police or military police in areas around the outlets or inlets to the Central Station terminals. Stopping and ticketing vans would result in a slight decline in Van use, because of the threat of delays and possible violence between drivers and officers. Common knowledge that vans are being targeted for ticketing would probably reduce demand for the vans and travel times might be affected because of more conservative driving behavior. It was assumed that the act of ticketing the vans would not interfere with the bus operation or cause any additional delay.

Modeling This policy was modeled as a decline in van demand by 10% (by lowering the constant in the van's utility function), and a rise in travel time by van of 5%. Bus travel time was estimated to decline by 0.4 minutes according to the linear congestion relationship.

Costs The costs of dedicating police resources to this job are difficult to estimate. It is doubtful that additional resources would be acquired for this particular job, meaning costs are purely the

opportunities lost for the use of those resources in other ways. The direct cost was estimated to be 100 man-hours per day (equal to perhaps 20 men ticketing vehicles during the evening peak hour as the vans leave the city), times 20 days per month and 0.8 dollars per hour, which totals 1600 dollars per month. The yearly cost would be roughly $20,000. We will assume that about half of these resources would have been used for similar activities anyway, so the net cost of the policy equals $10,000 per year.

2. Medium (Heavy ticketing, policing at bus stops) - "Restrict 2"

Description   Heavier enforcement of restrictions would send the van operations even more underground. This would probably result in a closing of the terminals closest to the Central Station. More circuitous routes, and more cautious driving behavior, combined with the greater likelihood of being stopped would increase travel times, and lower the general attractiveness of the mode. It was estimated that van use would decline by 70% and average travel time would increase by 10%. It was assumed that about 30% of the van ridership had the strongest and most inelastic demand and would remain with the vans in spite of the higher risks of being stopped. Bus firms, in reaction to the increased police action, and in keeping with their rhetoric about the detrimental effects of the vans on their operations, would probably lower the rate of fare increase. This would mean a 2.43% decrease in bus fare, offsetting the status quo assumption that fares would rise by 2.5%. Van fares would probably remain the same as the status quo. Bus travel times would decline because of a shrinking interference from van activity around the bus terminals and adjacent intersections.

Modeling This policy was modeled as a decline in van demand by 70% (by lowering the constant in the van's utility function), and a rise in travel time by van of 10%. Bus fares are reduced by 2.43% and travel times reduced by 2.8 minutes.

Costs The costs of dedicating police resources to this job are similarly difficult to estimate. It is likely that additional resources would be acquired for this particular job (i.e. overtime), meaning

costs are a combination of the opportunities lost for the use of existing resources and the costs of any additional resources. The direct cost was estimated to be 500 man-hours per day, times 20 days per month and 0.8 dollars per hour, for a total of $8000 per month. The yearly cost would be roughly $100,000. We will assume that $10,000 was to be spent anyway for similar services (the same amount assumed in policy 1), so the net cost of the policy would be $90,000 per year.

3. Strong (Removing all vans from circulation via police action) - "Restrict 3"

<u>Description</u> Complete restriction of van operation would require extensive police action, over a period of two months. The political ramifications of this action and the potential for violent responses by the van operators and allies are grave, but it is assumed for our purposes that the police action is implemented and achieves its goals. This was modeled as if the van mode was completely removed from the available choice set. Bus travel times, again, from less interference from vans at destination bus stops and other bottlenecks, were also assumed to decrease by 4 minutes. Bus firms, in reaction to the police action, and in keeping with their rhetoric about the detrimental effects of the vans on their operations, would probably not apply for any rate increases within the time frame considered in this analysis, and the same fare reduction used in Scenario 2 was used.

<u>Modeling</u> This policy was modeled as if the van mode choice disappeared from the choice set (achieved by decreasing the constant in the van's utility function). Bus fares are reduced by 2.43% and bus travel time is reduced by 4 minutes.

<u>Costs</u> The costs of dedicating police resources to this job are going to be high, but for a shorter duration. It is likely that additional resources would be acquired for this particular job (i.e. overtime or personnel from other agencies), meaning costs are a combination of the opportunities lost for the use of existing resources and the costs of any additional resources. The direct cost was estimated to be 1000 man-hours per day, times 20 days per month and 0.8 dollars per hour, which

comes to $16,000 per month. The total cost would be $32,000, which when amortized over 20 years equals $3,500 per year.

Ignore Vans

4. Change specific terms of Bus Concessions to lower operating costs - "Change Bus Concessions"

Description   DETRO is charged with issuing operating concessions to firms, defining fares, inspecting and licensing vehicles and drivers and managing all intermunicipal transportation, including the travel between the Central Station and the municipalities of the Baixada. These operating concessions are long term, on the order of 20 years. Changing their terms would not be easy, but it is conceivable considering the urgency of the situation in the corridor. Changing their terms to lower bus operating costs would be very controversial, but it is often cited in the literature as an important option for discussion [NTU, 1997; ANTP, 2000]. Lowering labor restrictions, safety and fitness specifications for vehicles, among other things, would help lower production costs. Ignoring the political ramifications (which in Rio would definitely involve some kind of strike or demonstration by organized labor), we would assume these savings would result in a lowering of bus fares, and concomitantly, van fares. This might take some vans out of the system, because of the now lower profit margin of the activity, which could lower bus travel times slightly due to less congestion at bus stops and traffic bottlenecks.

Modeling   In all, this was modeled as a 10% decrease in bus and 5% decrease in van fares. Because of a slight decline in van demand (~1%), bus and van travel time decreases by 0.03 minutes.

Costs   There are substantial new costs due to the compromise of safety and reliability by the more relaxed rules. These are very difficult to measure, but are real and should be studied and accounted for in the decision making process. Bus accident rates would probably increase with relaxed fitness standards, vehicle maximum ages and maintenance requirements. The translation

of this increased risk into an expected monetary cost is beyond the scope of this work, but it should be noted that the cost would not be trivial and might possibly rival the benefits of this policy in magnitude. On the other hand, the public expenditures to change the concessions are basically zero, figuring that the funds used to make this policy decision are already being spent by the agency to make policy decisions in general. The lost opportunity resulting from the use of the agency's resources is small, but very difficult to estimate.

5. Restrict Vale-Transporte to buses and trains - "Change VT"

<u>Description</u> The workings of the Vale-Transporte (VT) ticket are described in Chapter 4. The VT ticket is currently just a small piece of paper with graphics similar to any currency and a computer printed number and barcode stating its value. It is redeemable through a variety of means, and anyone can sell or trade the ticket for nearly its face value in cash at numerous street markets. The vans accept VT tickets at slightly less than their face value, or equivalently, they accept the VT at full value, but charge a slightly higher fare. In either case, the paid fare was modeled in this analysis as the original fare minus 80% of the value of the VT ticket the employee received. Technologically changing the VT ticket to make it impossible to redeem illegally would be a way to decrease van use by forcing ticket receivers to use the formal modes, or forfeit the money. This would probably reduce van fares slightly as operators respond to this loss in patronage. Reducing van use could lower bus travel times slightly due to less congestion at bus stops and traffic bottlenecks.

<u>Modeling</u> This policy was modeled by removing entirely the discount on van fare for riders who receive Vale-Transporte tickets. Van fares were assumed to decline by 10%, and bus and van travel times declined by 0.25 minutes.

<u>Costs</u> Changing the Vale-Transporte ticketing system would require a major capital investment, preceded by an extensive study and trial period. An estimate of the costs for a fully automated ticketing system is around $40 million for the initial pilot project and other capital costs, and

about $10 million per year after that for maintenance. A 20-year project life brings that figure to roughly $13 million per year. Since we're only considering automating this particular coupon and not a more complex account with balances and other data, we should assume costs would be considerably less, at around $5 million per year.

6. Bus System Improvement - "Improve Bus"

Description This would be a major public works undertaking on the order of $250 million with the goal of increasing bus travel speeds, comfort, and adding new niches like express or executive class services. The project might include the construction of exclusive bus lanes and flyovers to access the downtown terminal, special feeder concessions, new route and service configurations, or a new management approach to the system. These specific options are left open, however, as the main effect of the policy is the improvement and diversification of the services. While coming at a heavy public expense, upgrading the bus system could have a substantial effect on demand and welfare. Because of the "many-to-one" nature of the morning inbound commute to the central business district, major bottlenecks occur as traffic enters the city. The afternoon peak in the outbound direction is much less congested after traffic gets out onto the network of highways in the Baixada Fluminense. Exclusive bus lanes could greatly reduce travel time in the morning, but only marginally in the afternoon.

Modeling This was modeled as an average reduction in bus travel time by 15%, keeping in mind that most of these travel time savings will be experienced in the morning inbound commute. Bus demand was also assumed to increase by 5% above what the time change would predict. All fares were assumed to remain the same. Improvements in bus travel will cause a mode shift to bus, causing less van congestion, and am improvement in van travel times by 0.86 minutes.

Costs Assuming a total project cost of $250 million, amortized over 20 years, yields about $30 million per year.

7. Train system improvement - "Improve Train"

Description Similar to Policy 6, and at heavy public expense, upgrading the train system could also have substantial effect on demand and welfare. A new control system, purchasing more cars and engines, adding express limited stop trains, and purchasing faster vehicles could all lower travel times and increase the system's competitiveness with the bus, especially during the peak hour, when bus seems to have a significant advantage. An improvement in image, cleanliness and its reputation for safety and comfort might improve ridership beyond what the time savings might predict. Again, the specific modifications made are not to be prescribed here, only that service effects include improvement in travel times, safety, comfort, and overall attractiveness, along with the introduction of new service niches. The train system suffers from an especially bad reputation, and has lost about 75% of its peak ridership of the early 1980s [Neto, 1998]. An improvement in the system could drastically shift demand back to train, and it was assumed therefore that a demand increase of 20% could be expected, compared to only a 10% increase for the buses in Policy 6.

Modeling This change is made by increasing the utility constant to increase ridership by 20%. Travel time was assumed to decrease by 15%. Bus and Vans, because of lowered demand, experience travel times decrease by 0.21 minutes.

Costs Assuming a total project cost of $250 million, amortized over 20 years, yields 30 million dollars per year.

The seven policies described thus far have dealt with the vans externally, changing their operating environments, while leaving their operations unaffected. The last 3 policies affect the operating costs of the van firms. Before proceeding, these costs should be discussed in order to clarify how formalization and legalization affect these costs. According to Araújo and Ballasiano [Ferreira, et al., 2003], van operator's revenues just cover short run marginal costs, with little discernable revenues for long term returns to sustain the business. The reasons for this can only be speculated, but are most likely the van operators' desire to match bus fares. Van operating

costs per boarding are likely much higher than for bus, and though bus fares are inflated, they still leave the vans operating on the margins of operation.

Among the largest impacts regulation would have are the costs faced by van operators and owners. Legalizing and regulating van activity means that participating operators are subject to the same requirements for business taxes, licensing, social security fees, insurance, etc. that other formal transit operators are. These costs are estimated from data gathered by Araújo [2001] and sample data in the bus fare cost tables [Ministerio dos Transportes do Brasil, 1996]. Table 6.1 lists some of these new fees, along with the fees needed to operate informally.

Table 6.1 Incremental costs associated with formalization of van operations, estimated by author.

Item	Cost ($/veh-month)
General Business Tax[1]	100
Benefits, Insurance, Social Security[2]	210
Driver Training, licensing	small
Additional safety and fitness expenses[3]	100
Reduced Police Bribes	-50
Total	**360**
Cost per boarding	0.18

1. Tax towards local utilities, and rider insurance.
2. Social tax going towards health care, education, vacation, worker protection, unemployment insurance, maternity leave, marriage leave, etc. and equals about 70% of labor costs.
3. Estimated incremental costs for a more durable vehicle, additional tire replacement, more strict fitness and appearance requirements, etc.

An 18 cent increase in costs would drastically affect the small profit margins experienced by the informal operations. How the operators might respond will be discussed in more detail in the descriptions of the policies to follow.

Recognize Vans

8. "Legalize"

<u>Description</u> Recognizing the vans and lifting their illegal status could bring additional riders to the system who previously avoided the mode for reasons of legality. This was assumed because of the heavy campaigning and marketing the van operators perform over the issue of legalization. Private investments in the system, expansion and upgrading of its terminals, additional ability to secure loans, etc. could all add to the attractiveness and acceptance of the system. The effects on van fares are probably small. The share of their total monthly fines of $150 due solely to their illegal status was estimated to be about $50. This $50 savings spread over 2000 boardings translates into a saving of 2.5 cents per boarding. It is doubtful the operators would pass these small savings along to consumers.

<u>Modeling</u> We would assume that the fares and travel times remain unchanged by this policy, and model this as an increase in the constant representing immeasurable attractiveness so as to increase ridership by 5%. This small additional van demand would increase bus travel times by 0.2 minutes, according to the linear model of travel time and van demand.

<u>Cost</u> Additional unregulated van use would add to the existing safety costs of the system, which are difficult to estimate as the current accident rates are unknown. Congestion costs are accounted for by the bus's increased travel times. There are no other perceivable costs.

Regulate Vans

9. Regulation (Following Decreto 25.955) - "Regulate"

<u>Description</u> A proposal in the state assembly to regulate the vans, called Decree 25.955, is the best model available for the regulatory scenario [O Governador do Estado do Rio de Janeiro, 2000]. Some of the specifics of the regulation are presented in Appendix 6.1 at the end of this chapter. This policy response would restrict van entry, enforce a set of rules concerning vehicle type, age, fitness, licensing for drivers and vehicles, insurance, acceptance of Vale-Transporte

coupons and honoring free entry for the school aged and elderly. The policy would involve creating a new office for the administration of the program. The issuing of licenses and inspections of vehicles would insure the safety of the public and improve the reputation of the van service. The regulations would probably not affect the actual operational characteristics of the services, which would leave travel times and headways unchanged. An improvement in image, cleanliness and their reputation for safety and comfort was estimated to increase van demand by 10%.

Modeling Van demand was assumed to rise by 10%, modeled by increasing the utility constant representing immeasurable attractiveness. Additionally, van fares were increased by 5%, and bus travel times increased by 0.4 minutes due to the rise in van activity.

Costs Most of the additional operating costs on the part of van operators were assumed to be passed along to the consumer through a slight rise in fares. At a less significant level, the public expenditures to design the concessions are basically zero, figuring that the funds used to make this policy decision are already being spent by the agency to make policy decisions in general. The lost opportunity resulting from the use of the agency's resources is small, but very difficult to estimate. The costs needed to implement the concession, fund and staff the regulatory body and implement the monitoring capabilities are not trivial. This cost was estimated to include renting and supplying an office at a cost of $20,000 per year, and 40 full time workers, each at an average of 5,000 dollars per year. The total estimate is $220,000 per year.

10. Regulation and additional Support - "Regulate + Invest"

Description This policy extends Number 9 to include additional public investments to improve the van service. New terminals, better route integration and planning, and more attention to the vans as a part of the larger system could add even more capacity and ridership. This might include commitments from the Baixada municipalities to improve van terminals, signage and coordinated routes and timetables to improve integration into the larger system.

Modeling   This was modeled as a 5% increase in van fares, and a 0.6 minute increase in bus travel times due to increased van activity. Van demand was assumed to rise by 15%, modeled by increasing the utility constant representing immeasurable attractiveness.

Costs   All of the costs discussed in Policy 9 apply here. The costs of the additional public investments to be included in this scenario are difficult to estimate, as they depend on the projects pursued. Given the size of the van system, and the kinds of facilities that might be included in a development plan for the vans, a rough estimate of total project costs would be $100 million, or $11.5 million per year over 20 years. Adding the $0.22 million in administration costs from scenario 9 equals $11.72 million per year.

11. Competitive Case

Description   In this scenario, a regime of competitive tendering for concessions, by route, is implemented. Barriers to entry are lowered, and information about potential costs, risks, etc are good enough to make the bus and van sectors very contestable. This scenario is theoretical in the sense that there are a variety of ways of fostering this competitive environment. The essential effect here is that the resulting fares are at the estimated long-run marginal costs. These costs include operating costs plus vehicle depreciation and an allowance for other fixed costs, such as driver training, insurance, etc. Currently, bus fares are theoretically set equal to the long run marginal costs plus an allowance for profit, though because of problems discussed earlier, the costs are misrepresented. According to the literature concerning the inflation of bus fares mentioned earlier, actual long-run marginal costs for the buses are equal to about 60% of current fares. For vans, the work of Araújo [2001] was used to estimate long-run marginal costs, which turn out to be very close to current fares. Long-run marginal costs for formal operators would be, therefore, about 18 cents higher per boarding as estimated in Table 6.1.

Modeling This was modeled as if van fares and bus fares were at their long-run marginal costs, which are current levels plus 18 cents, and 60% of current levels, respectively. With lower van demand, there would be travel time savings by van and bus users, calculated to be 0.51 minutes.

Costs All of the costs discussed in Policy 9 apply here, which were $0.22 million dollars per year.

Table 6.2 summarizes how each policy scenario affects the main variables of the utility functions for the three modes. These changes are made with respect to the status quo scenario.

Table 6.2. Summary of Policy Effects.

Scenario	Travel Times	Fares	Demand
Status Quo		Van, Bus, +2.5%	Van, +2.5%
1. Restrict 1	Van, +5%, Bus, -0.4 min		Van, -10%
2. Restrict 2	Van, +10%, Bus, -2.8 min	Bus, -2.43%	Van, -70%
3. Restrict 3	Van, +∞ %, Bus, -4 min	Bus, -2.43%	Van, -100%
4. Change Bus Concession	Bus, Van, -0.03 min	Bus, -10%, Van, -5%	
5. Change VT	Bus, Van, -0.25 min	Van, -10% while also not adjusted for Vale-Transporte	
6. Improve Bus	Bus, -15%, Van, - 0.86 min		Bus, +10%
7. Improve Train	Train, -15%, Bus, Van, - 0.21 min		Train, +20%
8. Legalize	Bus, +0.2 min		Van, +5%
9. Regulate	Bus, +0.4 min	Van = max[bus*1.15, van + 0.15]	Van, +10%
10. Regulate + Invest	Bus, +0.6 min	"	Van, +15%
11. Prices = LRMC	Bus, Van, -0.51 min	Van = present + 0.18, Bus = present*0.60	

6.3 Results

Table 6.3 summarizes the net benefits for the population of commuters during one year. This is presented in terms of benefits "per boarding," and a total summed benefit over an entire year of commuting for the entire commuter population. The costs are just those mentioned in the scenario summaries in the last section.

Table 6.3. Net benefits and costs for the policy scenarios.

Policy	Benefit ($/boarding)	Benefit (M$/year)	Cost (M$/year)[a]	Net Benefit (M$/year)
1. Restrict 1	-0.02	-5	0.01	-5
2. Restrict 2	-0.11	-33	0.1	-33
3. Restrict 3	-0.16	-47	0.003	-47
4. Change Bus Concession	0.05	14	Safety!	14 – Safety!
5. Change VT	-0.01	-2	5	-7
6. Improve Bus	0.38	115	30 (total = 250M$)	85
7. Improve Train	0.24	72	30 (total = 250M$)	42
8. Legalize	0.01	3	Safety	2 – Safety
9. Regulate	0.02	6 + Safety	0.22	6 + Safety
10. Regulate + Invest	0.03	8 + Safety	12 (total = 100M$)	-4 + Safety
11. Prices = LRMC	0.18	54 + Safety	0.22	54 + Safety

a. Costs for infrastructure projects are annualized over 20 years.

Net benefits are the measure of economic efficiency of a policy – the more benefits surpass costs, the more "efficient" a policy is in creating welfare. The best choice from a set of mutually exclusive policies with no budget constraint is the one that creates the most positive net benefits [Stokey, E. et al., 1978]. Net benefits were seen to be greatest from policies addressing the mass transit modes, and the competitive pricing of the modes. "Improve Bus" and "Improve Train" create such benefits because a large share of the population uses these modes or has them as available and realistic choices. The competitive case brings fares down substantially for the bus system, increasing welfare drastically because of the high ridership and magnitude of potential fare savings. Changing bus concessions has some benefits, but increases safety costs,

which are hard to estimate. Legalizing and regulating the vans also have some benefits, though their magnitude is small because of the small share of the population riding vans. Finally, restricting van use and the use of the government issued transit tickets negatively affect the population. Further discussion and comparisons of the policies follow.

Distributional issues

Net benefits don't give any information about the differences in benefits between different portions of the commuting population. Here, the calculations were done for 6 income groups of the population. The distribution of benefits varies from group to group because the marginal value of money, time, and the income-based proxy for choice varies among income groups. Distributional analysis is important because most policy makers seek to explicitly promote certain benefit distributions, especially ones benefiting the poor more than the rich.

Before presenting the benefit distributions for each of the ten policies, it should be noted that the marginal utility of income plays an important role in determining the relative size of benefits of different population groups. Reviewing the calculation of the E[CV] in Equation 1 below shows how the MUI (λ) of the income groups will drastically affect the values of the benefits for each group.

(1) $$E[CV_n] = \frac{1}{\lambda_n} \left\{ \ln \sum_{i=1}^{I_1} \exp(V_{ni}^1) - \ln \sum_{i=1}^{I_0} \exp(V_{ni}^0) \right\}$$

The λs and incomes of the different income classes referred to in the rest of this chapter are summarized in Table 6.4. Note that benefit values for classes 4, 5 and 6 are combined (with N = 51) in the presentation of the distributions because of their low counts.

Table 6.4. Marginal Utility of Incomes (λ) for the 6 Income Classes.

Income Group	#1 <150 $/mo ave^a = 112.5	#2 150 to 300 ave = 225	#3 300 to 450 ave = 375	#4 450 to 600 ave = 525	#5 600 to 750 ave = 675	#6 >750 ave = 800
λ (utils/$)	-1.23	-0.62	-0.37	-0.26	-0.21	-0.17
N	183	252	90	32	10	9

a. average income is the assumed income (equal to the midpoint for category) for all people choosing these income categories.

In this discussion, the values of the utility changes from the policies, equal to the value of the terms inside the brackets, will be compared, without converting the values to dollars (by not dividing by the λ). This value of benefit, with units of "utils", is important as it is the value which affects changes in choice, and represents an overall "accessibility" or utility from a choice set. In order to come to a total net benefit (in dollars) value, the E[CV] for each group are calculated as in Equation 1, and summed. We will proceed to discuss the distributions in terms of utils here, because we are not adding the values from different groups, but are only comparing them.
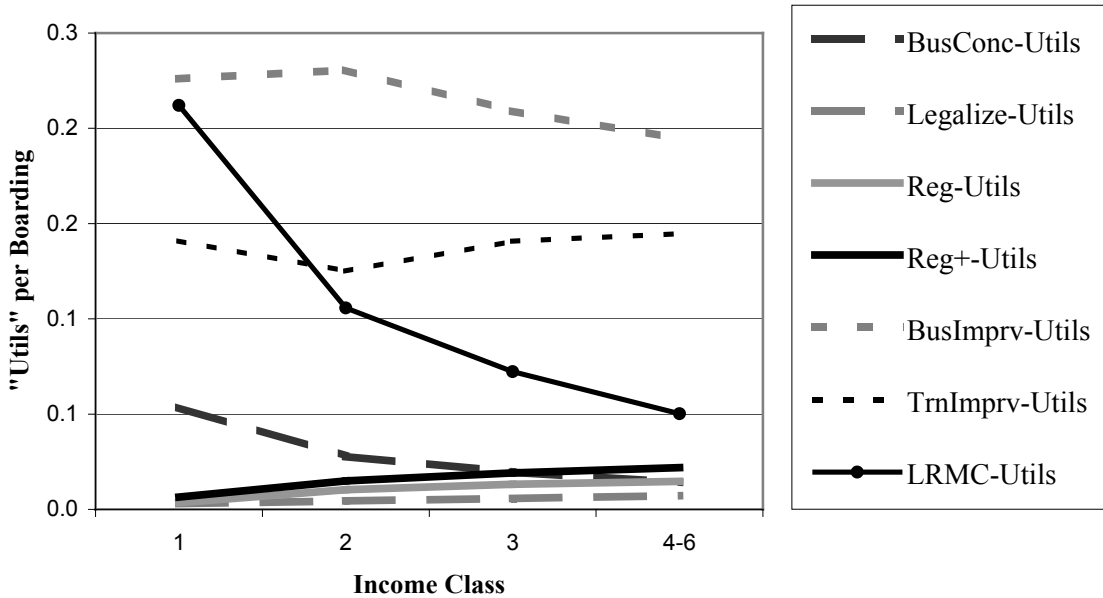
The first three policies, Restrict 1, Restrict 2 and Restrict 3, and the fifth policy, "Change VT", have negative net benefits. Figure 6.1 shows their benefit distributions in units of utils.

Figure 6.1. Distribution of Benefits (1)
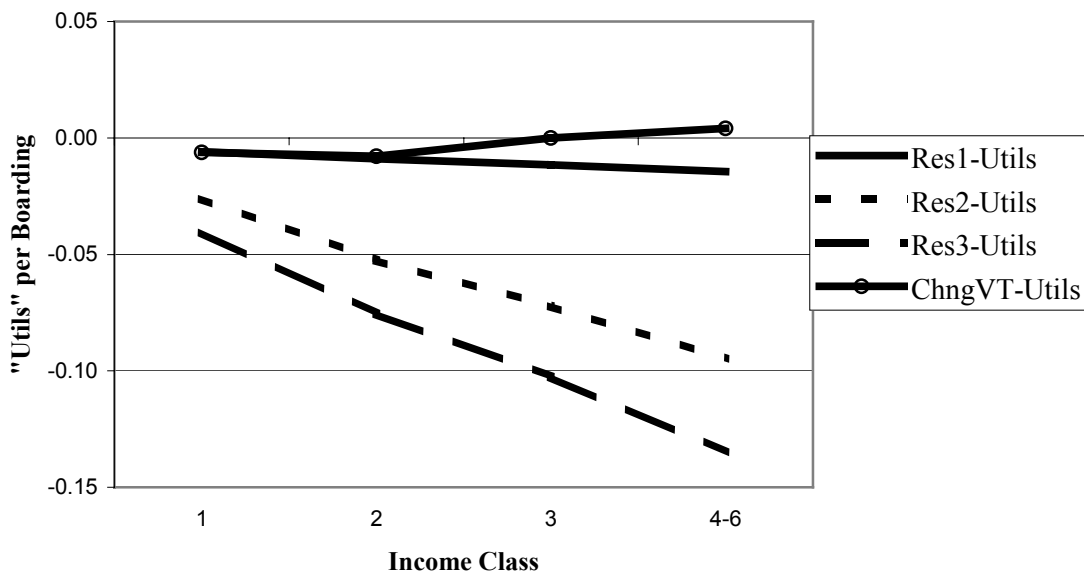
The other seven scenarios result in positive net benefits and their benefit distributions are shown below in Figure 6.2.

Figure 6.2. Distribution of Benefits (2)

6.4 Discussion

The first three policies, "Restrict 1, 2 and 3" reduce the utility of the van mode and will be discussed only briefly. For these scenarios, the slight savings in bus travel times from reduced van congestion doesn't add enough utility for the overall benefits to be positive. The distribution of benefits (Figure 6.1) illustrates the amplification resulting from the conversion of utils to dollars, which is most notable for the higher income groups. The distribution of benefits in utils for "Restrict 1" is fairly flat, showing that everyone is harmed fairly evenly by the policy. It should be noted that a small fraction, around 5%, of each income class takes vans, so policies reducing its utility harm each group fairly evenly. "Restrict 2" and "Restrict 3" force bus fares down slightly which exaggerates the differences in losses between the richer and poorer groups. Lowering fares helps the poor more than the rich because of the poor's higher marginal utility of money, so the poor end up suffering less than the rich. Effectively, the poor lose less by these policies than the rich.

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The fifth policy, "Change VT", also shown in Figure 6.1 hurts the poor more than the rich because it effectively raises van fares. The bus travel time savings resulting from slightly lowered van use does not offset the loss for the poor because their value of time is too low. For higher income groups with higher values of time, this trade off of higher fares for time savings results in a slight benefit.

The sixth and seventh policies, "Improve Bus" and "Improve Train", shown in Figure 6.2, result in huge net benefits resulting mainly from the fact that they improve the truly "mass transit" modes used by large shares of the population. Even small changes made to the mass modes can have large economic benefits compared with changes made to the more marginal van mode. This can be seen in the net benefit results, which are an order of magnitude higher than the benefits resulting from regulating the vans. The rich benefit slightly more for the improvement in train, as they are more likely to take the train, while the poor benefit slight more by improvements to the bus, because they have higher bus ridership.

The fourth policy, "Change Bus Concession" (BusConc), shown in Figure 6.2, results in a positive net benefit, and effectively lowers fares in exchange for lowered safety and vehicle fitness regulations. The poor are more fare sensitive and appear to benefit the most from the fare reduction in units of utils. The rich do not gain as much utility from the fare reduction.

The eighth policy, Legalize, also shown in Figure 6.2, creates benefits purely from removing the stigma of the illegal status and adding additional demand for the service. While no operational variables were changed, the "immeasureable" attractiveness was increased, bringing benefits to all income groups fairly equitably.

The ninth and tenth policies, "Regulate" and "Regulate + Invest", also shown in Figure 6.2, create benefits even though van prices are assumed to rise slightly in response to the additional costs of formalized operation. The increases in the "immeasurable" attractiveness outbalanced the fare increases, though just barely for the poorest group. For the rich, increases in levels of service, which are included in the "immeasurable attractiveness" captured by the

constant, are highly valuable. This means that the richer groups receive slightly high benefits. It is evident that investing in van services is not efficient, as benefits don't exceed costs (scenario "Regulate + Invest").

Finally, the theoretically competitive "Prices = LRMC" scenario, where prices of buses are lower, while those of vans are higher, results in benefits highly skewed in favor of the poor. The poor have the highest marginal utility of money, and greatly win with reductions in fares, combined with the fact that the fare reductions are on the bus mode, the mode most used by the poor. On the other hand, the rise in van fares hurts disproportionately the rich who choose the van disproportionately. The rich do gain slightly as there are some time savings as mode share shifts slightly from the vans to the buses and trains which the rich value highly. This scenario illustrates how sensitive the poor are to reductions in fare.

It should be restated that the benefit model is only as accurate as its inputs. The sensitivity of the benefit estimate to the overall accuracy of the estimated inputs, like an estimated change in travel time, is large. Obviously, it is hoped that these estimates were the best that can be made given the resources and time available.

Understanding these uncertainties leads us to recognize that only several conclusions can be made with high confidence. The first is that heavy restriction of the vans (Restrict 2, Restrict 3) leads to losses in consumer benefits. A second conclusion is that both of the investments in the mass transit modes, "Improve Bus" and "Improve Train", and the competitive scenario "Price = LRMC" create economic benefits greatly surpassing those of any of the other policies. Third, regulating vans shows a greater net benefit than either legalizing (Legalize) or regulating and investing ("Regulate + Invest") do. Finally, "Change VT", "Restrict 1" and "Legalize" show net benefits that are probably not significantly different from zero, so any rank ordering of them is likely to be meaningless.

The net benefits from restricting van use, even with the effects of reduced congestion, are negative. Restricting Vale-Transport use probably results in negative benefits as well. In terms of

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users' welfare, these policies are detrimental and would be fought by a policy maker or politician attempting to maximize benefits for users.

Investing heavily in the train or bus modes is the most beneficial to users. Policy makers most interested in benefiting the widest range of users and maximizing benefits from public investment should strongly pursue investment in the mass-transit modes in the Baixada-Central corridor. Additionally, the benefit distribution is fairly flat, and has few equity implications.

Achieving a competitive environment for the concession of bus and van services, as related through the "Price = LRMC" would also achieve substantial welfare gains. The drop in bus fares, with no improvement in service or other investments, creates a huge gain for the poorer groups, nearly rivaling the benefits from the scenarios of investment in mass transit. The net benefit also rivals the two investment scenarios, illustrating the magnitude of welfare loss the population is currently experiencing under the bus cartel. The distribution of benefits is highly skewed in favor of the poor. Given the social and political nature of the region, a political actor seeking to be a champion for the lower income groups in the region could use a policy like this towards this specific goal, while also being fiscal responsible and creating massive net welfare benefits for the population as a whole. The difficulty in achieving this scenario will be discussed in the next chapter.

The four other policies bringing positive benefits are not nearly as effective. Changing the bus concessions brings benefits, but at the expense of lowered level of safety and service, and possibly, labor. The poor, who are extremely price-sensitive, show the greatest benefit from this approach in units of utils. In this case, however, the reliability of the model lacking the variables for safety and comfort must come into question. In the long term, lowering service quality to achieve lower fares would not be an advisable solution. Even though fares are inflated and travel times and schedules could be greatly improved, cartelization has brought orderly, uniform, safe and professional services. Reducing safety in exchange for lower fares, without necessarily addressing the core of the problems with the bus system might lead to a worse conclusion. While

the models show that the poor would trade lower fares for worse service, this is not always true, and there might be tradeoffs, like for safety or security, which they are willing to pay for. Indeed, the trains were at one time heavily patronized, but after a decade of declining service, patronage has fallen drastically to one-third of its 1980 level. This policy effectively capitalizes on the captivity of the users of public transit modes by assuming they will remain with the system even with poorer qualities, and could add to a general feeling of discontent among the population. The ramifications of this discontent could be serious, causing harm to bus operators' property and the bus drivers themselves. And, it could lead ironically to a growth in informal activity and support for alternative modes.

Regulating vans appears to be the most effective treatment and brings net benefits to the population. The distribution of these benefits is extremely regressive, like the bus and train investments, but given that few public funds would be spent on these policies, there are only slight distributional problems. Both the rich and poor would receive benefits without consuming a significant amount of public resources. Legalization brings with it additional van demand with no safety regulations, exposing even more of the population to the risks of the informal mode. Investment in vans brings no net benefit according to the results of the calculations.

6.5 Conclusions

This chapter presented the welfare analysis of several policy scenarios in response to the van situation. Some policies showed clear benefits and will be the subject of further discussion in the next chapter. The methods used address those effects on users of the system, and did not attempt to account for supply side costs and implications on earnings, investment, etc. An estimate of public costs was made to estimate a total "public" net benefit, but private costs and benefits were not included. This approach was taken to fill in some of the gaps in the existing discussion about van regulations, which focuses on the viability of the private bus firms. In analyzing the feasibility of these policies, however, the behavior of private firms can become

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important. The success of these policies involves not only a theoretical prediction but also a realistic appreciation for stakeholder buy-in, which are addressed in the next chapter.

Nothing precludes policy makers from pursuing more than one policy. In the interest of user benefits, it seems that a combination of policies 6,7 and 9 ("Improve Bus", "Improve Train" and "Regulate") would be the best strategy. The scale of the "Improve Bus" and "Improve Train" that would maximize benefits is also uncertain, and might be more or less than the level suggested here. The next chapter considers the combination of these three approaches in more detail.

Appendix 6.1. Decree 25.955

A proposal was placed before the state legislature in January of 2000 to recognize and regulate

the van passenger transportation system [O Governador do Estado do Rio de Janeiro, 2000].

Decree 25.955 proposed the creation of a regulatory body, "Servico de Transporte Alternativo

Rodoviario Intermunicipal de Passageiros" (SETAIP - Alternative Intermunicipal Road Passenger

Transport Service) to oversee the organization, licensing and concessions for the new service.

The proposal contained a fairly detailed group of rules and terms, some of which are summarized

in the following list:

1. All vans are driven and owned by one owner/operator, with an auxiliary driver hired if need be.
2. All owners/operators are to be members of a Van cooperative.
3. Specifics of locations of pick up and drop off points are defined by SETAIP.
4. Vehicles types, are to be defined by SETAIP but will be 9-16 passenger vans with air conditioner.
5. Service coverage cannot exceed 75 kms beyond metropolitan area limits.
6. Concessions are for 5 year periods.
7. Vans in operation can be up to 7 years old, and only up to 5 years old when first registered.
8. Fares will be determined by SETAIP by the standard cost reporting methods used for buses, and will be at least 15% greater than bus fares for the equivalent trip.
9. Concessions on a particular line will be limited so that only 20% of all passenger trips are made by van.
10. Total system concessions will limit the number of vans to 55% of all public transit vehicles.
11. All operating parameters, including routes, terminal locations, stop locations, fares, schedules, headways, hours of operation, etc., will be defined by SETAIP.
12. Drivers must have appropriate public transit licenses, be registered to vote, be a resident of the state for at least 2 years, not have any other employment, and receive first aid and consumer relations training.
13. Qualifying cooperatives have adequate vehicle storage facilities, and offer members liability insurance according to levels specified by SETAIP.
14. Must honor student and elderly discounts (unspecified) and offer a special seat for elderly people.

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Chapter 7. Policy Implications

7.1 Introduction

The results of the scenario analysis presented in the last chapter have important implications for real policy recommendations for the sector. Situational realities also shape expectations for the potential success of these policies. This chapter discusses the meeting of these two currents – the policy prescription resulting from a technical analysis, and the realities of implementation. It will conclude with some recommendations and likely outcomes.

7.2 Policy Recommendations

The welfare analysis presented in Chapter 6 showed that consumer-side benefits produced by the informal sector vans were small compared to those possible from improvements to the formal modes in the study corridor. Regulating the informal vans brought modest benefits, most likely dominated by improvements in safety. It also showed that the potential benefits of competitive pricing in both the formal and informal sector are substantial and rival those gains resulting from investments in infrastructure. Optimal policy recommendations will likely involve some element of all three of these strategies, namely: regulating the informal van modes, investing in the formal modes (train and bus), and seeking a competitive environment for entry to both van and bus operations.

The first consideration taken here is for the regulation of the informal modes. Regulation of van services will include certain minimal entry requirements, periodic inspections, and various labor rules and licensing requirements. These entry requirements will insure that vehicle safety and durability are satisfied, while leaving the market open to any operator who can satisfy these

requirements. This would most likely force prices up in order to cover the demands of the new requirements and actual operating costs and investments. As prices arrived at long-run marginal costs, the vans, with per-seat costs much higher than for buses, would charge significantly higher fares than buses and be forced to serve the niche markets where value of time, or value of service, is higher. This will naturally reduce van use and cutthroat competition in the road, as now the fares differ significantly enough that the two services are not close substitutions.

The second consideration concerning infrastructure and investment in the formal modes is straightforward. Various investments in the system are able to produce the improvements in service and attractiveness that were assumed in this scenario. These could include dedicated busways, new flyovers, preferential intersection timing, and possibly new vehicle technologies, like bus guideways or light rail.

The last of these considerations, creating a competitive market, is the most contentious. As mentioned previously, the right mix of entry requirements for vans can create a very competitive and contestable situation. For the buses, the situation is much more complex. The concentration of operators in the sector and the resulting monopoly pricing can only be confronted through a wide-reaching reform of the tendering process for the service concessions, or a complete upheaval of the fare calculation process.

7.3 Implementation

Regulating Vans

Beyond the actual design of the regulatory regime for the vans, the enforcement of the regulations will be most important to the success of the program. Two forces pose significant challenges to any regulatory program for vans – the dispersed nature of the operators and the potential strength of the route associations. Route associations can play an important part in solving some problems, while they may create some in the process.

Van operators are autonomous, and the only real structure comes from the route associations in which they participate. The primary difficulty in regulating the vans will be the required regular inspections and licensing in the field. Currently, there are roughly 5000 private van firms in operation in the Baixada, each of which will need regular evaluation, licensing and monitoring, complicating management and regulation efforts and perhaps compromising the success of the regulations.

Route associations, as discussed in Chapter 2, can offer an organizing force to assist with the enforcement and implementation of almost any regulatory approach. They can play an important role in helping to organize the field inspections. Both the neighborhood and downtown terminals for the route associations can be used as locations for inspections and the dissemination of information to the operators. It will be important to involve the route associations in the formal arrangements of inspection and driver licensing [Kirby, 1987]. Buenos Aires and Quito, Ecuador benefit from the organizing role of its route associations [ECLAC, 1992].

Route associations, on the other hand, could pose a barrier to creating a truly contestable market for van operators. The significance of this barrier is difficult to predict. It is very likely that as regulation takes place and demand for vans declines with the rise in fares, competition among existing firms will grow and route associations will begin to prevent free entry by controlling services on established routes. That is, though official entry is contingent only on meeting fitness standards required for safety, etc, route associations might place artificial limits on market entry to protect the shrinking market. In Chile, cartelization through route associations contributed (but were not the sole factor) to rising fares after deregulation [Darbéra, 1993] and in Mexico City, route associations have risen to an apex of power within the urban transportation arena [Wirth, 1987].

Currently, the use of violence by route associations is common in protecting routes. The free formation of new routes is very difficult, and must meet "approval" of existing cooperatives. In cases where independent operators are seen as intruding on an existing route or area,

associations can become violent in defending that turf [De França Baboza et al., 2002]. Though all vans will probably be inspected by officials without issue, the regulating agency will not have any control over entry into associations, which means that control by associations will be left unchallenged, unless individual drivers denied entry take up a legal fight against the association, could be highly dangerous and unlikely. This parallels the fact that market will also shrink and the number of firms allowed to operate (at a profit) will shrink accordingly. The result is a protected market that can, in theory, charge fares above marginal costs. The van service, however, will probably have a high elasticity of fare, now that their prices are well above those of buses. This means that the associations will lose even more ridership if fares are inflated.

The outcome of these contradicting benefits and risks of route associations is difficult to predict. It is likely that some of the routes will be protected and subject to some fare hiking, and others remain more open with fares closer to the long run marginal costs. Where routes overlap might be places of competition and reduced fares. Where markets are more isolated, the effects of route associations might be detrimental. Much of the variation may depend on neighborhood characteristics, such as the degree to which neighborhoods are dominated by drug smugglers or groups of bandits, as well as the particular history of the neighborhoods' route cooperatives.

The entry of larger multi-vehicle firms is also likely, though their advantages in the market are not clear. Economies of scale in bus and paratransit operations are not well established [Evans et al., 1987]. Cross subsidization from another service, such as intercity buses, might let an operator under-price others out of the market. The original regulatory proposal [Appendix 6.1, page 118] specifically prohibited multi-vehicle firms from participating. This is an issue that should be addressed in designing the program.

In all, the enforcement of competitive operation in the van market will test the capabilities of the city agencies and prove to be a key variable to the success of this approach. In places where enforcement is all but absent, the system will continually return to fierce in-market competition and lowered service standards for patrons even after honest attempts at regulatory

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reform. In Kingston, Jamaica, several honest attempts to regulate their informal sector, in 1982, and again in 1990, have failed. In this case, the regulations as designed were not at fault, but the lack of capacity for enforcement and oversight [Cervero, 2000] were the inroads for new informal operators. The Secretary of Transportation for the State of Rio de Janeiro should pay particular attention to the way enforcement is handled in order to prevent "leaks" in the system, bribes, and other mechanisms for overcoming the barriers to entry and operation. Poor enforcement and a failed implementation of concessions could prove politically harmful as new or expanded regulatory regimes and concessions might be seen in a poor light in other cities that are trying similar approaches.

Investments in Mass-Transit Modes

Investments of the magnitudes proposed in "Improve Bus" and "Improve Train" ($250 Million) for any city are difficult, and for Rio de Janeiro, one of Brazil's poorest cities, even more so. The last transportation capacity added in the Baixada area was roughly 80 Kms of two and three-lane expressway in 1991. Indeed, the train system has since been privatized to lower public expenditures in the sector. A general sketch plan, however for a network of busways in Rio has been on the books for several years now [Ribeiro, 2001]. Engineers at COPPE, a public-private research center at the Federal University of Rio de Janeiro, in conjunction with the state science research agency FAPERJ have developed a proposal for dedicated bus lanes in some corridors, and are quietly seeking monies from national and multilateral agencies to proceed with planning and engineering. As illustrated by the renowned bus systems of Porto Alegre and Curitiba, Brazil is an innovator in developing cheap and effective mass transit solutions with buses and dedicated facilities, and proposals in this area are likely to be successful in achieving the necessary service improvements.

The likelihood that the project will include the Baixada Fluminense and will receive substantial support is not great, however. Implementing a plan across the Baixada, consisting of

nearly a dozen municipalities would be very complex and could break down into political or municipal infighting. Additional political differences between the mayor of Rio de Janeiro and the governor of the state of Rio de Janeiro, and their alignments with national level development banks and transportation ministries add additional difficulties to the likelihood of funding for such a project.

Politically, it could prove difficult to justify expenditures of this level on transportation given the other grave problems facing the Baixada Fluminense, such as lack of sewage, water, electricity, schools, and pavement, etc. While the welfare calculations show large gains for the population, a comparison with costs and benefits of policies in other sectors has not been made. Additionally, considering the stance of the new Brazilian federal administration with respect to receiving new monies from multilateral loan agencies, finding the funds needed for construction will prove difficult.

Concessions for Bus Services

The suggestions in this work of competitive contracting are not new. Concessions in the urban bus sector in Brazil have already been the subject of great debate for over five years [Orrico Filho, 1999; Brasiliero, 1999; Aragão, 1998]. Competitive tendering for bus service concessions is mandated by the 1995 Brazilian Law on Procurement Procedures and Concession Contracts [Aragão, et al., 2003]. In public transportation, contracts for service are to be awarded to the lowest bidder meeting all of the minimal service requirements (equipment, safety, etc) for each route as designated by the regulatory agency. The planning of services remains with public bodies, but competition for the market is fostered by the competitive bidding. The new bidding process would be transparent and subject to comment by anyone, whether they are participants or not [Aragão et al., 2003]. Fare policy could be based on bids for the lowest fare, or, if the agency wanted to set fares, then the concession would be rewarded to the lowest subsidy or highest monetary offer to the agency [Aragão et al., 2003]. It would be difficult for fares, in this case, to

remain significantly higher than long-run marginal costs, unless there was collusion among bidders, which will be discussed later.

Is this scenario of competitive concessions for the bus services and semi-regulated van operations really feasible? The bus transportation market in the Central Station-Baixada Fluminense corridor is tightly regulated. The industry, however, has used the regulations as a means to attain super-profits and will be reluctant to change this arrangement. As discussed in Chapter 4, regulations dictate fare, acceptance of discounted tickets, vehicle types, various work and labor rules, service hours, routes, and timetables, along with other mandatory checks of fitness and cost reporting. Changes can be made to any of these items only by way of a lengthy petition process. Concessions periods are now typically 20 years, and the renewal process is rarely competitive. Many non-economic and subjective criteria are included in the concession requirements, allowing powerful firms to gain advantages in the bidding process. Firms also take on concessions through mergers and annexes and can renew concessions indefinitely via various clauses in exiting concession laws, and without any conditions of merit or performance [Aragão, 1998]. As well, new route concessions are commonly given to firms "geographically close" to the new lines, contributing the firm concentration and size [Orrico Filho, 1999]. The market is "uncontestable" by any measure [Orrico Filho, 1999], and even after the removal of minimum fleet size requirements, levels of firm concentration rose [Dos Santos, 1999]. The expected abuses resulting from such an oligopoly position abound, and the effects on fares was discussed in Chapter 4. In few cities are bus fares calculated with highly accurate data, and in some cities, fares are just adopted from neighboring cities.

Challenges to this structure will be met with great resistance from a very wealthy and well-connected stakeholder. Exiting firms stand to lose greatly from increased competitiveness in the sector. The long terms of concessions currently allow great stability and low risk for large firms. This will no longer be the case under a competitive regime. As well, less efficient firms keep system average costs higher, and allow more efficient firms to gain through higher fares.

This will no longer be the case, as for the firm time, in theory, efficiency will be rewarded and required of winning bidders. The competitive concessions have already met with strong resistance from incumbent bus firms. The following list, adapted from Aragão [2003] summarizes the current challenged facing the implementation of the full bidding procedure:

1. Many operators inherit routes from decades of operation, and are not subject to the prescribed renewal process. In effect, only new operators are subject to the competitive bidding process.

2. Many times, new routes are conferred to the nearest supplier, being considered as such an extension of existing service areas. No external bidding takes place for these concessions and these decisions are made internally.

3. In many cities, concessions are renewed without new bidding or any substantial evaluation process.

4. As was discussed several times earlier, fares are calculated based on unreliable information on costs and ridership supplied by the private firms themselves, without any independent review. Compliance with the rules for reporting operating costs has been shown to be low.

5. Firms have come together to challenge the new procedures in the legislature, proposing a set of relaxations of the laws that apply only to the public transit sector. Included in these proposed changes are especially long contract periods (15 years, with renewable 15 year terms), unnecessary, non-economic and highly subjective entry requirements, and fare calculations that give generous room for recovery and future investment. These fare calculations effectively guarantee returns on investment and return to the "cost-plus" fare calculation methods criticized for not inducing efficiency and increased productivity in the sector. In essence, this would negate any effects the bidding would have on the competitiveness of the sector.

6. Because of average-cost fare policies and no rewards for efficiency, more modern firms profit from the higher costs of less advanced firms. These less advanced firms in effect raise the fares allowed for all firms and the modern firms have much to loose if productivity and efficiency of all participating firms were to improve under a competitive regime of concessions.

Even in the event that the competitive tendering is put in operation, there remains a real likelihood that corruption or mismanagement prevents the realization of a truly competitive market. Corruption in the administering agency could affect bidding or foster collusion among bidders, or bidding firms could collude to define minimum fares or maximum payments to the agencies.

Placing problems involving corruption aside, the question remains of whether the market itself could really be contestable. The minimal investments and sunk costs are not small, though the market for used buses is lucrative and finding facilities for bus storage isn't too large a problem in the ad-hoc development patterns of the northern area of Rio. Demand for bus trips in the corridor is high, over 500,000 trips per day, and considering the fare inflation, this demand could be even higher for a competitively priced service. Indeed, one of the great fears of the incumbents is that bids will come from firms all around the country and perhaps even internationally to participate in such a lively market. If the market didn't show this attractiveness and potential contestability, the incumbents might not fight so hard to protect it. Also, various levels of service and other niches can probably be exploited to gain a foothold in the market that has never been explored before. This contestability is shown clearly in the great demand for van services. It is obvious that this market has unmet demand, and could thrive under a competitive entry regime.

In the long term, bus firms have everything to gain for this restructuring of the regulatory regime. New forms of competition, from the private automobile and informal operator reveal a significant pent-up demand for better services. Operators not willing to respond are merely stalling this inevitable demand for better and more diverse services at competitive prices. Many users are already choosing alternative modes like car, vans, and even their own feet. The firms should realize that the culture of service provision is changing, and that privatization and outsourcing require a push towards competitive firms and industries. Urban bus companies are behind in this movement towards modernization and are politically isolated and backwards,

preferring to hide behind heavy handed decade-old legislation [Aragão, 2003]. Other sectors in Brazil have undergone great changes, and indeed, the urban public transport sector in other cities are being modernized as well [Aragão, 2003]. São Paulo is currently undergoing a complete redesign of its bus system and procurement process, inducing much of the same competitiveness being called for in Rio de Janeiro.

7.4 Conclusion

Two related problems motivate the policy scenarios examined here: monopoly in the bus sector and informality. Based on this analysis, three policy approaches appear to help with these problems. First, competitive bidding in both buses and vans will prevent the growth of monopoly in both while keeping fares "fair." Second, investments in the mass modes can provide improved service for the masses. Third, regulating the vans can address some of the labor, tax and vehicle safety issues. The regulatory regime for vans as well as the concession process for buses will be important to achieve a contestable environment.

Some infrastructure approaches can present an additional barrier to informality and protect the bus system from the return of in-market competition from future informal operators. Infrastructure is an important element of regulation, especially in developing countries where the "threat" of encroachment by informal operators is high. Infrastructure such as busways allow for easier segregation of services – it physically separates the van and bus markets, turning former similar goods into markedly different ones. The faster, protected rights-of-way and the modern feeling of the busways, can give buses in exclusive lanes a great advantage in the marketplace. The Transmilenio bus system in Bogotá, Colombia and some of the lines in Curitiba, Brazil employ left-side-entry articulated buses matched to platforms one meter off the ground. Unless the informal operator has access to such a vehicle, passengers would be forced to unload into the middle of the busway. In Santiago, Chile, prime road space is bid for, leaving informal operators in congested side lanes and streets and with less advantage in the market. Exclusive bus lanes,

flyovers, special terminals and stops, etc. facilitate enforcement against illegal entry at their designated entry and exit points. Bus firms could form a strong proponent for the use of infrastructure to deter informality. The system in Curitiba is famous for its bus-exclusive connections and flyovers, great inter-neighborhood and circumferential service, and is also one of the few cities in Brazil with no significant numbers of informal operators. The infrastructure becomes a handicap to informality. With the threat of competition from the informal sector more securely removed, however, prevention of monopoly in the bus sector becomes even more precarious and important.

Regulating the vans into a higher fare is what the Brazilians call "benchmarking" [Ferreira et al., 2003]. By raising the entry standard for the operator, the fares are pushed higher, forcing the market into a higher priced niche. Demand is restrained and this eases competition in the marketplace. In effect, the regulation solves the problem of ruinous competition, while also tackling safety and labor issues. The potential response of cooperatives is extremely touchy, and hard to understand or predict without further research.

Competition in the urban bus industry will lead to a "house cleaning" of inefficient firms, a new group of winning firms, new techniques for management of quality and production, and force informal operators into new niches, along the lines discussed in this work [Aragão, 2000]. In this way, competition in the formal bus sector is really part of the processing of forcing small operators into niches. As well, small operators might find niches within the new formal sector as subcontracting and sub-franchising become important parts of urban bus industry practice.

All of these plans take substantial political will, money and know-how. The technical capabilities of regulators in Brazil are excellent, and there is no lack of know-how or experience concerning regulatory or concession design in other sectors. The first two items pose a serious threat to the implementation of these plans and to the long-term sustainability of the programs. There is a lack of political will because of the complex and delicate nature of informality in Brazil. Regulating informality is seen by many as repressive and "anti-poor." The informal sector

has gained substantial political standing in the past five years and can sometimes bully candidates in ways that now rival the firmly entrenched bus sector. Besides the political issues, the there is a lack of will because there is a poor understanding of the problem, or even recognition that there is a problem. Without giving this issue priority, the difficult stands will never been taken.

Policies are a social choice, and the various groups involved need to have a vision of where they want to go with the corridor and with the Baixada Fluminense in general. Based on the research here, this choice should prioritize the mass modes over the informal operators in this corridor, while attempting to instill competition and regulation in both the informal vans and formal bus sector. Monopoly operations are clearly as costly and detrimental as informality, and working on these problems together yields a more sustainable and robust solution.

Chapter 8. Conclusions

8.1 Summary of Findings

In many policy-making processes, decisions are made without considering the effects on all of the stakeholders. By intent or mistake, some stakeholders are just not included in the decision-making analysis and process. This dissertation investigated the effects of several policies proposed in the debate to control the growth of informal jitney in cities in Brazil. The main goals of restricting illegal van activity are to prevent the decline of the formal bus system, minimize the disorganization and stigma of informality, and maximize the efficiency of the transportation network and terminals. The full impacts on users' welfare of proposed policy responses are rarely considered in these discussions. Of course, externalities like safety and congestion are mentioned, and are related to user welfare, but they are normally held up as benefits of regulation, or disbenefits of non-regulation, and not as the main goals of regulation. The reasons for this disregard are complex, but related to the typical marginalization of poorer populations and of informal activities in general characteristic of the planning and development process in urbanized areas of developing countries [Vasconcellos, 1997]. The only impacts from policies normally discussed are the current or potential losses or gains to the private sector.

It was the goal of this study to look at the effects of the regulatory options on users. A demand-side approach was taken, combining original survey work with consumer surplus calculations adapted to the users' discrete choice processes. A case corridor in Rio de Janeiro was chosen for study combining characteristics typical of places with growing transit informality and a well-defined locus of origins and destinations. A discrete choice model was estimated using the results of the interviews to calculate a demand function for the modes. Eleven policy

interventions were converted into impacts on the market and demand, and the consumer surpluses resulting from these eleven scenarios were calculated.

Several policies appeared to benefit users more than others, while several were clearly harmful to them. Benefits can be substantial, on the order of tens or even hundreds of millions of dollars per year for the commuters studied, almost one hundred dollars per year per commuter. This amounts to a significant share of their total yearly income of roughly one billion dollars, or about two thousand dollars per commuter. Legalizing vans was found to possibly benefit users, while adding some degree of regulation would add to those benefits significantly, on the order of 10 million dollars per year or twenty dollars per commuter. The analysis showed that further investment to develop the vans and improve their infrastructure was probably not an efficient use of resources. Users were seen to benefit most from improvements in the mass modes of train and buses, on the order of 50 to 100 million dollars per year, or about 100 to 200 dollars per commuter. Finally, creating a competitive environment for the delivery of both van and formal bus services would benefit users, on the order of 50 million dollars per year, or about 100 dollars per commuter.

From a users' viewpoint, regulation of informality, eradication of monopoly in the formal sector, along with improvements in the service levels of the mass modes hold potential to the bring substantial gains. The difficult questions are how to achieve these scenarios in practice. Competitive bidding for services can prevent the growth of monopoly in both the van and bus sectors and help to attain fair pricing in the sectors. The bidding can be combined with the entry regulations for van services, addressing some of the labor, tax and safety issues. Improvements in service levels can involve extensive use of infrastructure, which serves additionally an important form of regulation. This is especially important in Brazil where the "threat" of encroachment by informal operators is high. Infrastructure, such as busways, physically segregate services and give buses a great advantage in the marketplace.

Together, these three approaches: concessions, regulation of vans, and investments in the formal modes synergistically reinforce each other. Regulation of vans insures that marginal costs are higher, which prevents the further uncontrolled growth of the sector based on fare competition in the street, while formalization lowers perceived risks and can induce better investments on the part of operators. Investments in infrastructure for formal modes lower costs and risks to formal operators. These two processes: higher van fares, and physical segregation, increase confidence in the markets and could contribute to the push towards contestable markets for bus operations. Merely the regulation and "benchmarking" of van operations, with concomitant higher fares, might boost confidence enough to open discussions of competitive concessions for bus operations. Further protection from competition in the market would give more security to bus operators, removing risk from the operations sphere and placing it in the new sphere of competitive tendering. Considering the effects uncontrolled entry of informal operators has had on the market, the bus operators might be persuaded to give up some rent opportunity in exchange for this new form of security.

8.2 Limitations of Model

The limitations of this work result from its particular scope, in space, time and perspective; its use of modeling and utility theory; and limitations from the particular model specifications used. Each of these will be explored in the following paragraphs.

The study involved only one corridor affected by informal activity, while there exist countless in Brazil and other countries, and at least dozens in the Baixada Fluminense. There are some limitations in using results from this corridor for policy making in other places in Brazil, or even in other countries. The well-defined, one-to-many, line-haul configuration of the Central Station to Baixada corridor is not the most common configuration for informal activity. Some of this work's results might be due to the high levels of demand and the line-haul configuration, where informal activities using small sized vehicles have a natural transportation disadvantage.

The corridor was chosen because from the Central Station depart many different lines for many different destinations, and in this way, data could easily be taken at one point for a diverse set of trips with a diverse set of characteristics (prices, travel times, etc).

The time frame of the study of 6 months is also a limitation. It was chosen so that longer term changes in overall demand, supply, residential or work patterns would not affect the corridor, and the firms would only really be making changes in response to the immediate appearance of competition. The longer term effects of the policy scenarios studied could also be significant as users shift residential or work locations, or firms relocate, to cope with new system offerings, costs, bottlenecks, etc. Also, producers over a longer period of time could change their practices and become more efficient, possibly changing costs or fares.

A final limitation in scope involves perspectives. User welfare and public costs were presented in the final analysis of the policy scenarios while costs to producers or externalities were specifically left out. Total social costs or benefits were not calculated. Public costs were only loosely estimated and interviews with regulatory agencies and law enforcement would be needed to get a more detailed estimate of these costs. Safety costs are probably the least understood but most significant cost element not included in this study. The safety costs of informal operation are generally poorly understood and are subject to the political leanings of those studying and reporting the information. Accident data including vehicle type or use could be used to estimate the accident rates for vans, but this data was difficult to find. The data would enable an estimation of the safety costs of informal van operation and how regulation could affect those costs, adding much detail to the calculations of total costs of regulation and add confidence to the net benefit measures.

The values of some of these externalities could rival benefits or costs included in the analysis. The safety of other road users was not considered. Congestion from increased van activities were only captured in bus and van travel times, not those of other road users. Environmental costs such as noise or emissions from changes in the corridor were not tabulated.

Other impacts exist as well, such as changes in interest rates to firms due to changing operating environments (i.e. interest rates for van operators might fall with the passing of regulation).

Other limitations resulted from the traffic modeling used in the estimations. More detailed models of the transportation network, including the behavior of key bottlenecks in the destination neighborhoods and the downtown terminals would be helpful in estimating more precisely the response of the transportation system to regulation. The estimates of changes in travel time due to changing congestion could be made with more confidence using a traffic model calibrated for the Baixada Fluminense traffic network.

The calculations made in this work use microeconomic methods based on utility theory, and it is important to mention that these methods are not without critics [Little, 1957; Boland, 1992]. In the literature, two overarching critiques are posed: are consumers really utility maximizers? and, can utility really be maximized [Boland, 1992]? If utility theory is not an accurate description of the consumers' choice process, then it would follow that consumer surplus is not completely representative of changes in welfare due to policy changes. These estimates, even when done competently and with precision, should be recognized for their potential weakness in predicting the desired quantity. Carlos Daganzo [1997] raises a related critique on the conversion of measures of utility to monetary equivalents. He points out that as different groups' marginal utilities of money vary, the "weight" of different groups' utilities will vary. Monetary equivalents of utility, which are equal to utilities divided by marginal utility of money, "over-weights" wealthier groups' utilities, who have smaller marginal utilities of money. If utilities were converted to "time equivalents," then the opposite might occur, as poorer groups tend to have smaller marginal utilities of time. He points out therefore, that the ranking of policies is difficult, because if they were ranked by time measures, the ranking would come out differently. After all, he questions, if one policy were empirically better than another, shouldn't it be so under any system of ranking? According to Daganzo, this discrepancy hurts the poor, whose marginal utilities of money are high, and therefore value changes to utilities from policies

less and contribute less to total net benefits. Net economic benefits can mask the different weights given to different groups and therefore should be used with reservation.

Finally, beyond questioning the techniques used, there are still limitations in the models as specified. The lack of understanding of the tradeoffs and values users place on the subjective characteristics weakened the predictive ability of the choice model used in this work. More detailed surveys or focus groups could add this valuable detail to the modeling and additional confidence to the policy analysis by making the model a more powerful predictor. Adding marginal utilities of subjective characteristics from other studies of mode choice would be a way to add this needed detail to the model. This would allow policies to be modeled not only in terms of their more operational effects such as fare, travel time and overall demand, but by their effects on comfort and safety. Future work could fill in these gaps in the choice model and add additional scenarios that involved changes in the subjective characteristics more directly.

While this list of model limitations is large, the level of detail in many places is probably sufficient to make the broad statements about the policy scenarios needed for this study. There is actually great confidence in the relative orders of magnitude in the results, and as a sketch planning exercise, the methods used here economized on expensive surveywork and used the relatively scarce existing data as best it could. Removing uncertainty from some parts of the estimations would still be overshadowed by uncertainties in other parts of the estimation. Given the poor state of knowledge about the informal sector in general, limitations in the data are a problem throughout the model. What is important, however, is that the results of models like this are not relied on exclusively, and that these calculations make up one of many important sources of information and guidance.

8.3 Future Prospects

A joint publication of this work is being planned with faculty at the Federal University of Rio de Janeiro. It is hoped that stakeholders in the current debate on van regulation find the new

information useful. The policies recommended here fit within a larger process of urban development and history. At this time, Brazil is just beginning to grapple with the prospects of competitive bidding for concessions and privatization, while it has extensive experience in infrastructure development. The policies recommended here build on those strengths while seeking to push the sector into uncharted territory.

Great difficulty exists in implementing competitive bidding in a sector in which concentration and monopoly was the main policy objective for the past 30 years. An entrenched group of firms now controls the policy formation process. Making a transition to a system which would eradicate all of the various protections, legal and otherwise, these companies enjoy requires extreme political will. In similar cases, it has taken a strong political actor such as a mayor to embrace a vision of change and the concomitant challenges and pressures. No particularly strong force has come forward thus far and the bus firms have had an easy time preventing legislation that would foster competitive bidding for concessions. The prospect of this changing in the near future seems small, and other cities are also facing difficulties. Indeed, São Paulo, is undergoing a complete reorganization of its bus network, concessions, and treatment of informal operators. Many of these proposals are being met with resistance from private bus operators, formal and informal, and the spring of 2003 was punctuated with several crippling bus system strikes. This does not bode well for Rio de Janeiro considering that São Paulo has already been making inroads to competitive concessions for bus transportation over the past decade. Rio, the formal capital of the country, holds a legacy of the former burgeoning state and is relatively unused to small contracts and flexible terms of entry and competition. Now, the informal sector offers a real threat to these decades of protection and stewardship, bringing the global marketplace for cheap vehicles and the self-inflicted policies of market liberalization into the bus terminals.

In infrastructure, Rio could benefit from iterations on developments made in Brazil thirty years ago, which are being advanced throughout the world with great success. Indeed, even Los

Angeles is trying to learn from Brazil as they develop busways and enhanced bus treatments on some of their important bus corridors. But these advances have a different significance for the developing world: protection from informality. The infrastructure becomes a physical handicap to informality. With the threat of competition from the informal sector more securely removed, however, prevention of monopoly in the bus sector becomes even more important. The prospects for Rio in this regard are mixed. Support for investments will come from a very powerful and entrenched sector, including the private bus firms, while the costs remain prohibitive. The results here show that riders gain tremendously, and that considerable investments bring equally considerable net benefits.

Relegating the vans to a higher standard for safety and service, at a higher fare, forces, or "benchmarks" the market into a niche and out of direct fare competition with buses. This has been done in Porto Alegre, in the south of Brazil, a city more used to political participation and regulation, and less subject to corruption or cronyism. The potential response of van cooperatives is extremely touchy, and hard to understand or predict without further field research.

One recommendation appearing among most of the current debates concerning the vans is to confine them to being feeders to the larger mass transit systems [Balassiano et al., 1998; Torres, 1998]. The model was unable to test this scenario, as it did not incorporate directly the mode choice for accessing the line-haul system in the outlying neighborhoods. This feeder approach might solve several key problems at once. It can preserve the informal sector and avoid the political fallout of any restriction on the activity. Some of the increased service levels sought through the policies attempting to bolster the train and bus modes could be found without public investment by using vans as feeders and making more efficient use of the bus and train system as truly line haul systems. Pilot programs in Sao Paulo using vans to feed some of the subway stations are meeting with some success, though they are not having a significant effect on reducing regional van activity. Service levels on the line haul system must increase enough, however, to compensate for the losses predicted for removing the vans from the Baixada-Central

corridor. It still remains uncertain if this would solve the problem of informal activity in the line-haul corridor.

Much has changed since the fieldwork for this study was completed. The same macroscopic forces that gave rise to informal transportation in the first place, specifically, the high exchange rates of the early nineties (the Brazilian Real was once worth 1.09 dollars), might in the end, spell its demise. Since 1999, the Brazilian Real has fallen in value, first to $0.50 and then down to about $0.27. This means that importing minivans for use in the informal sector is much more expensive than it was ten years ago, while bus operators continue to rely on domestically produced equipment. Brazil is one of the largest producers of buses in the world. Van maintenance and other repairs might also suffer because of reliance on foreign parts. On the other hand, the past 3 years have seen a flurry of activity by foreign vehicle manufacturers, most notably Renault, to market their minivans to the informal sector. As well, the manufacturing and use of minibus is beginning to skyrocket. Bus firms are attempting to reduce costs and improve productivity by using a more diverse vehicle fleet, and to compete with vans by offering similar products. In this vein, it is difficult to say what should be the status quo for this study. Of course, it was difficult to predict what was to be the situation as these calculations were being performed.

The larger political framework within which stakeholders act is important to the struggle for accessibility to urban functions. The disorganized city and state regulators and their subordination to the business interests of the private bus operators create a power struggle leaving transit users in a weak position. The losses from monopoly pricing result from a political situation faced by the public and its representatives in the state and city agencies. This situation can be confronted within the policy making arena, by attempting to implement competitive tendering, adding more oversight into firms' cost reporting, or removing the distortions in the cost estimation in the concession's fare calculations. Or it can be confronted in the political sphere by attempting to balance the power of the bus firms with a movement in the users' interest. This would mean organizing stakeholders (bus riders) who currently suffer by the firms' practices and

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the regulatory agencies' complacency, effectively forming a bus riders' union. With 5 to 6 million potential members in the metropolitan region (car-less adults), and about 1.5 million in the Baixada Fluminense corridor, this union could, in short time, force the bus firms to concede some of their power. Considering the kind of gains available to the study population, the effort to create such a group would be well spent. There is relatively little precedent, however, for this kind of organizing in other larger cities in the developing world.

It is significant to note that the policy scenarios tested in this study only roughly approximate the realities of large cities in developing countries. It is probable that a black market for transit coupons would grow, even after automating them, and, more importantly, that van use would continue even after trying to eradicate them. None of these policies address the strong and underlying forces contributing to the growth of the informal sector. Macroeconomic issues such as poverty, unemployment, and a widespread reliance on informal means of income are left unaddressed by the eleven policies discussed in this work. This work tried to understand the effects on the users of the systems, and the population was defined as those particular commuters. Those looking for "solutions" to informal activities in general should look to their strong connections to larger and more difficult issues in the economy and society. Scholarly work in urban development and sociology, both specific to Brazil and in the developing world in general, address the issue of urban informality and informal economies [Portes, et al., 1989; Rakowski, 1994]. Some of the key debates in the literature involve the long-term development impacts of the informal sector. Questions which remain important but unanswered include: what are the implications of the semi-employed, or, such as in the case of van drivers, jobs paying less than minimum wage, on long term labor organization and militancy? Informality relieves the tension between capital and labor, perhaps easing the situation in the short term, but long-term conflicts over development remain unaddressed. Are truly democratic institutions being developed, or is the informal sector autocratic, corrupt and violent. Can it be changed as it is granted new powers and concessions and integrated into the formal system? Are small enterprises being fostered, or

will multi-vehicle firms move in through the cooperatives and take control? On the other hand, the benefits of the sector are well documented. It is providing jobs to the jobless, and indeed, is adding competition to a long time stagnant industry. The complete picture is complex, emotional, and most of all, extremely ideological. Hopefully some of the results here paint a clearer picture of the tradeoffs within the transportation sector.

Whether by political struggle or regulation, user interests should be addressed out of a concern for the social and urban development implications of informality in transportation. It was shown that transit policies have a significant impact on the economic welfare of the population, which can benefit from cheaper, better and more diverse transportation options. Based on the research presented here, policy directions should prioritize the mass modes over the informal operators in this corridor, while attempting to instill competition and regulation in both the informal vans and formal bus sector. Monopoly operations are more costly and detrimental than informality, and working on these problems together could yield a more sustainable solution. In this way, informality has opened up the question of users' welfare and though it might not remain as a long-term transportation issue, it has at least brought other important issues like the losses from monopoly to light. Clearly, it is important that any policy strategy balance operational concerns with an understanding of their effects on users, as these effects can be profound.

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