CRUISING FOR PARKING IN DOWNTOWN MIAMI

By

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LIST OF ABBREVIATIONS

CBD	Central Business District
DDA	Downtown Development Authority
DOT	Department of Transportation
GIS	Geographical Information System
HOV	High Occupancy Vehicle
IC	Individual Cost
IDW	Inverse Distance Weighted
LRTP	Long Range Transportation Plan
MSC	Marginal System-Wide Cost
RCI	Roadway Characteristics Inventory
TTI	Texas Transportation Institute
VMT	Vehicle Miles Traveled

Abstract of Thesis Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Urban and Regional Planning

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This study is about parking and the role that parking plays within the larger context of traffic congestion. The thesis evaluated the practicality of a performance-based parking program for the downtown business district of Miami by answering the following two research questions: (1) is there evidence of cruising for parking in downtown Miami? and (2) does Shoup's theory, higher parking price differentials (off-street – on-street parking prices) generate higher vehicle miles traveled (VMT), apply to downtown Miami? This was accomplished through the development of four sets of experiments. The first experiment tested to see if average vehicle miles traveled (VMT) on metered streets were greater than unmetered streets. The second experiment was a regression analysis to see if parking price differentials, employment density, and transit stops have a significant impact on VMT. The third experiment was a production of three maps that were used to show if VMT was more associated with density or transit stops than with parking price differentials. The fourth, and final experiment, was a field trip to downtown Miami to collect primary data on on-street occupancy rates and the time it took to cruise for a parking spot. The results showed that cruising for parking is happening in downtown Miami, but

it is not severe enough to justify implementing a performance-based parking program for the downtown business district of Miami.

CHAPTER 1
INTRODUCTION

Everyone hates traffic congestion. It makes travel unreliable, reduces regional economic health, induces “road range”, and forces peak hour commuters to watch their lives pass before their eyes one lane at a time. Traffic congestion is slowing America down. In cities large and small, traffic congestion is steadily getting worse each year. In 2007 the Texas Transportation Institute (TTI) calculated that congestion caused urban Americans to travel 4.2 billion hours more and to purchase an extra 2.9 billion gallons of fuel for a congestion cost of $78 billion. This was an increase of 220 million hours, 140 million gallons and $5 billion from 2004. What is even more alarming is the disparity between driving and public transportation. The 2001 National Household Travel Survey estimated that 87 percent of all trips in the U.S. are made by personal motor vehicles and only 1.5 percent by public transit. All in all, the numbers are indicative of the fact that traffic congestion is an ever growing dilemma that needs to be attacked from many different angles.

In the transportation world, most of the focus goes towards highway projects and road building. Congestion mitigation plans hardly, if ever, factor in parking, but economists like Donald Shoup believe that cities are making a big mistake by “clandestinely” subsidizing the true cost of on-street parking. Parking is a niche topic that usually goes unnoticed in academic transportation research. Its neglect is an interesting contradiction due to the fact that cars are parked 95% of the time and only moving 5% of the time (Shoup, 2005).

Parking is an untapped research topic. It’s fertile ground for new discoveries so I decided to base my thesis on parking and the role that parking plays within the larger context of traffic congestion. The thesis sought to evaluate the practicality of a performance-based parking program for the downtown business district of Miami by answering the following two research questions: (1) is there evidence of cruising for parking in downtown Miami? and (2) does Shoup's theory, higher parking price differentials (off-street – on-street parking prices) generate higher vehicle miles traveled (VMT), apply to downtown Miami?

CHAPTER 2
LITERATURE REVIEW

The literature review is organized in a top-down fashion starting with the nature and origin of traffic congestion. Next, transportation policies are examined to gain a better understanding of what has been done, what is being done, and what will be done to mitigate traffic congestion. Then, the analysis shifts from transportation policies to parking and why parking is important from a planning perspective. Finally, I narrow the focus down to one specific parking problem, cruising for parking, and explain San Francisco's performance-based parking program.

Traffic Congestion

The best way to approach an arduous dilemma, such as traffic congestion, is to first understand the origin of the problem. According to Downs (2006), traffic congestion is a worldwide problem with four primary causes:

1. Congestion exists because societies organize economies so most people will work during the same hours each day.

2. Rising incomes intensify congestion by permitting more households to purchase vehicles and buy homes-mainly in suburban areas.

3. Population growth. When metropolitan growth is accompanied by rising prosperity, more households buy more cars, and roads become more congested.

4. Incidents and accidents. They result from high volumes of traffic generated by the first three causes.

Overall, Downs' believes that traffic congestion results from economic growth. We all want prosperity but we don't want to pay for it. This predicament can be best summarized with one of Yogi Berra's famous quotes, "Nobody goes there anymore; it's too crowded."

If we ever hope to reach a sustainable equilibrium between our desire for prosperity and our basic need to move we need to better understand how to manage traffic congestion. This leads to the next section of the literature review, transportation policies.

Highway Construction

Highway construction is the most common solution to traffic congestion. The economic rationale behind highway construction is to eliminate the inefficiency that is caused when individual cost (IC) exceeds marginal system-wide cost (MSC) (see Figure 2-1). Note that as trip volumes rise above T' the marginal cost of each additional trip exceeds the marginal benefit. As a result, total system-wide benefits will begin to fall as additional users enter the system beyond T'. The highway expansion moves the MSC curve to the right creating equilibrium between MSC and IC (Heikkila, 1994).

Traffic volumes can now increase substantially as a result of lowered costs resulting from the expanded capacity of the transportation system. On the other hand, Downs (2004) views this as a self-defeating exercise since increased system capacity only seems to stimulate more demand.

> Down's principle of triple convergence states: (1) many drivers who formerly used alternative routes during peak hours switch to the improved expressway (spatial convergence); (2) many drivers who formerly traveled just before or after the peak hours start traveling during those hours (time convergence); and (3) some commuters who used to take public transportation during peak hours now switch to driving, since it has become faster (modal convergence).

This does not mean that there are no benefits in highway construction. According to Heikkila (1994), Downs' view ignores two facts: first, travel costs are lower for all users under the expanded network and, secondly, total net benefits from use of the system have been increased. The fact that more people are using the system is a testament to its enhanced value.

The key question is whether the benefits from additional use warrant the very large construction costs required to expand the network.

Public Transit

While not all academic practitioners may agree, according to Small (1997), contributions from professional economists have led to the understanding of transit subsidies. First and foremost, public transit (like any service performed in batches) benefits from economies of scale. If demand on a particular corridor rises, the transit provider serving that corridor can respond in one of several ways. The provider can maintain the same level of service allowing average cost to decrease, or the provider can increase route density and/or frequency, which produces cost savings to passengers in the form of less walking or waiting time. In either case, total average cost (to provider and users) declines. A different way of putting the same point is that given a particular level of service, as measured by the density of routes and the frequency of vehicles on a given route, handling an additional passenger costs little extra because it does not necessitate extra vehicles or drivers. From the point of view of economic theory, this is the primary justification for transit subsidies (Small, 1997).

The problem with mass transit in America is that it is difficult to find corridors with passenger densities suitable for successful mass transit service. For example, the regional LRTP (long range transportation plan) for Los Angeles includes extensive investment in a completely new rail network for both light and heavy transit service. The purpose is to increase the modal share of transit and, in the long run, to redirect land-use patterns to a more compact, higher density urban form. Giuliano and Small (1995) say that there is little evidence to suggest that these goals can be achieved. According to Giuliano and Small, investment in rail transit has proven to be a terribly inefficient way to divert trips from automobiles. To illustrate this conclusion Giuliano and Small examined the Los Angeles Blue Line.

> The Blue Line is a single light-rail line extending 23 miles from downtown Los Angeles to the city of Long Beach. Completed in 1991 at a capital cost of $877 million, its 1992 annual operating cost was $42 million, of which just 11 percent was covered by fares. Surveys show that only about 30 percent of its passengers are former automobile users (drivers or passengers); the remainder are former bus patrons or new travelers. The public subsidy for each regular Blue Line passenger attracted from automobile comes to between $20,000 and $36,000 per year, or approximately $40 to $72 per one-way trip (pg. 203-204).

On the other hand, TTI (2007) claim that if public transportation service was discontinued and the riders traveled in private vehicles, urban areas would have suffered an additional 541 million hours of delay and consumed 340 million more gallons of fuel in 2007 (see Table 2-1). The value of the delay and fuel that would be consumed if there were no public transportation service would be an additional $10.2 billion in congestion cost, a 13 percent increase over current levels in urban areas.

Bus: Research shows that demand for transit is generally more elastic with respect to service quality than to price (Small, 1997). This suggests that the best strategy for increasing the market share of transit may be through improvements in service quality, which includes travel time, comfort, reliability, ease of access, and convenience of transfers. Three specific strategies to improve bus transit and paratransit include permitting buses, vans, and carpools to use high occupancy vehicle (HOV) facilities, tailoring commuting services to very specific markets, and using shuttle vans or jitney services. Although the market for these services is too small to reverse the overall dominance of automobiles, it is large enough to offer some limited relief to growing traffic congestion.

Land Use

By redirecting or limiting land-use development, some hope the automobile will become less attractive than public transit or other modes of travel. Policy-driven changes in land-use patterns often cluster in two alternatives-polycentric metropolitan areas and increased residential density.

Many urbanists and environmentalists believe that existing patterns of land use are the root cause of today's urban problems. They argue that dispersion fosters further dependence on the automobile, leading to congestion, environmental degradation, and a deteriorating quality of urban life. They conclude that transit-oriented development could ultimately reshape cities and reduce congestion and automobile use.

Giuliano and Small (1995) are skeptical of this conclusion. They claim that although the highway system is one explanatory factor, many other decentralizing forces are also at work. These include the growing demand for single-family housing associated with rising household incomes, the increasing scale of residential and employment development, and, in the U.S. at least, historical preference for low-density living. There is no indication that the forces of decentralization are residing. Rising incomes, information-based production, more flexible work arrangements, and increasing weight on environmental quality in individual location choices all foster continued decentralization and reliance on the automobile.

Automobile

Market Incentives: Congestion pricing can be used as a disincentive to commuting by car. Theoretically, the optimal toll amount would equal the cost a driver imposes on others by entering the freeway and slowing down traffic. In the past, congestion tolling may have been expensive to administer. Today, recent technological advances make the prospect more feasible.

According to Giuliano and Small (1995), congestion pricing does not suffer the drawback of latent demand because it uses money, instead of congestion delay, to ration scarce highway capacity. The price applying to peak times creates an incentive not to overuse that capacity, and the incentive remains even when congestion itself is drastically reduced. Rationing by money instead of time is also more efficient because time spent in congestion delay is simply wasted, whereas the tolls paid by travelers are revenue to public or private organizations.

Like any price change, congestion pricing would have significant effects on the distribution of real incomes. The complexity of the shifts in labor, housing, and land markets makes the ultimate distributional impacts far more difficult to predict than the direct impacts, which have been the focus of most analyses (Giuliano and Small, 1993). Even the true direct impacts cannot be judged without looking at how the revenues are spent.

Ridesharing (a.k.a. Carpooling and Vanpooling): Ridesharing has the potential to reduce traffic congestion by a considerable amount. One model suggests that if 30 percent of the single-car commuters switched to two-person car pools, traffic congestion would decrease by 10 percent (Downs, 2004). However, carpooling is less popular than in the 1970s. The reasons are related to the availability of the automobile, increased fuel efficiency of cars, and demographic changes. According to Ferguson (1997), data shows that older individuals and individuals with more years of education tend to be less likely to carpool. Also, the increase in the percent of single persons and persons without children is related to a decrease in car pools.

Flexible Work Places: Off-peak work hours and telecommuting are alternative strategies to decrease congestion. Employers could stagger work schedules allowing some workers to come in later in the day and leave after peak hours, or work extra hours on weekends. Fax machines, modems, internet access, and other recent innovations could allow workers to work at home.

There may even be some combination of telecommuting for part of the day and going to work during off-peak hours.

Atlanta's "Cash for Commuters" program is one example of the newer, more aggressive commute options programs. Built around a Clean Air Campaign, the program involved payment of cash incentives to driver-only commuters who switched to another mode. Participants earned up to $60 per month (for three months) by choosing and using an eligible alternative mode of transportation. During the program, participants used alternative modes an average of more than four days each week compared to less than one day per week before. A year and one-half after the program, participants still used a commute alternative an average of 2.4 days per week.

Overall, program participants decreased their single-occupant commute modes from 84 percent to 53 percent. This type of change has benefits in less vehicle travel and fewer parking spaces needed and participants have reported lower frustration levels and better on-time arrival. Decreasing each commuter's peak-period personal vehicle trips by one per week could have substantial congestion benefits, if employer and employees choose these options (TTI, 2007).

Respond More Quickly to Traffic-Blocking: Removing accidents and incidents from major roads faster by using roving service vehicles run by government-run Traffic Management Centers equipped with television and electronic surveillance of road conditions is an excellent tactic for reducing congestion delays (Downs, 2004). An incident management program can also reduce "secondary" crashes-collisions within the stop-and-go traffic caused by the initial incident. Houston's SAFEclear consists of tow trucks that respond within six minutes of notification. Quick removal of stalled vehicles and crashes, combined with the Motorist Assistance Program, has reduced collisions by more than 10 percent in the first two years of operation, saving $70 million in collision costs (TTI, 2007).

Road Use

HOV and Diamond Lanes: The theory is that if HOV and diamond lane travelers can travel faster, then other drivers will be encouraged to rideshare. According to TTI (2007), the 70 congested corridors with data on the person volume and travel time for high-occupancy vehicle lanes or high-occupancy toll lanes in 15 metropolitan regions showed an annual delay reduction of 33 million hours, with a value of $620 million per year. However, some suggest that these lanes will not necessarily reduce congestion. Unless new lanes are added, designated HOV lanes may reduce the overall road carry capacity and intensify congestion in single occupancy vehicle lanes.

Downs (2004) recommends policies that combine these lanes with financial incentives, such as widespread employer sponsored programs for carpooling. Even with potential gain, HOV lanes may be more effective in reducing congestion in comparison to building highways, because the new HOV lanes encourage ridesharing.

Metering: Entrance ramp meters are designed to create more space between entering vehicles so those vehicles do not collide or disrupt the flow of traffic. The Minnesota DOT conducted an experiment that consisted of turning off the 430 ramp meters in the Minneapolis-St. Paul region for seven weeks in 2000. The results showed that there is travel time savings from operating the ramp meters, but the most dramatic change was the 26 percent increase in crashes when the meters were de-activated. There was also a 14 percent increase in the volume handled by the freeway with the meters on (TTI, 2007)

Parking

According to Shoup (2005), twenty-first century parking problems stem from poor parking policies that aim to keep curb parking free or cheap and require lots of off-street parking. This practice has done a lot of harm for the following reasons:

Skew Travel Choices: The parking problem developed when car ownership grew rapidly during the 1910s and 1920s. In the 1930s, cities began to require off-street parking in their zoning ordinances to deal with the parking shortage. Requiring new buildings to provide lots of off-street parking solved one problem, the shortage of free curb parking, but unintentionally exacerbated many other problems. Urban planners began to assume that most people would travel everywhere by car, park at their initial destination, and then drive on to their next destination. Automobile centered planning led the automobile to be the 1st, and in most cases the only, mode of transportation.

Distort Urban Form: Efficient land use regulations are a critical factor in maximizing development potential. Local regulations requiring developers to provide ample off-street parking are inefficient and have historically led to the dispersal of new development opportunities away from central cities to suburban areas. For example, in 1961, Oakland, California, began to require parking spaces for their tenants, and within three years, the number of apartments constructed per acre in Oakland fell by thirty percent (Lewyn, 2008). Developers who construct new projects in urban areas often produce developments that are lower in density as a result of parking requirements. This practice translates into less dense development patterns with fewer residences and businesses per acre – a practice that also reduces walkability and decreases opportunities to create efficient transit systems (Lewyn, 2008).

Degrade Urban Design: No great city is known for its abundant parking supply. Most of the streets we admire for great urban design cannot be replicated with today's parking requirements. Many older areas that were built before cities required off-street parking compare more favorably to neighborhoods built since then. For example, multiple-car garages are a great change in domestic architecture in the past several centuries. Houses that used to be built with porches that jut out to wide sidewalks are now getting replaced with garages and driveways that jut out to a street or a narrow sidewalk. To meet today's parking requirements some buildings are getting built on top of parking structures. In downtown Los Angeles there's a building that has 21 floors of offices above 15 levels of parking. The building has remained empty since it was completed in 1986 partly because of its odd parking arrangement (Shoup, 2005).

The practice of using parking generation rates as the basis for parking requirements has been particularly inappropriate at land uses with short, sharp peaks in parking demand. For example, shopping malls are slammed on the weekends and during the holidays but during the week they're not that busy. Using the peak demand to set a minimum parking requirement leaves many parking spaces empty almost all of the time. The full cost of the parking lot is incurred to serve a few hours each week, so the cost per hour the parking spaces area occupied can be enormous.

Raise Housing Costs: Parking requirements raise the cost of housing, but most people probably don't realize that because parking spaces are bundled into the cost of housing. Increased parking requirements increase housing development costs, which reduce the supply of lower priced housing and raise the cost to the consumer. A study by Jia and Wachs (1998) found that in San Francisco single-family houses without off-street parking sold for an average of $348,000 while otherwise similar houses with an off-street space sold for $395,000. A parking space increased the price of a house by $47,000. The study also estimated how the required parking increased the income necessary to buy a house. The annual family income necessary to get a mortgage was $67,000 for a house without parking, and $76,000 for one with parking. As a result, 24 percent more San Francisco households could afford to buy houses if they did not include the required on-site parking space.

Damage to the Urban Economy: The central business district (CBD) of any city is a prime example of how off-street parking requirements harm the urban economy. High density is a prime advantage of the CBD because it offers proximity to many activities, but high density also implies a high cost of constructing new parking spaces. According to Shoup (2005), off-street parking requirements increase the cost of all development, reduce density by preventing land from other uses, and increase traffic both within the CBD and on the routes to it. All in all, off-street parking requirements reduce the essential features that make a CBD attractive – high density and accessibility.

Cruising for Parking

One of the problems of our existing system of having low on-street parking prices is that it creates cruising for curb parking. Cruising for parking happens as drivers circle an area or parking lot looking for a parking space. As motorists, we've all been faced with the common dilemma of needing to park for one hour, and curb parking is $.50 an hour and off-street parking is $2 an hour. We usually ask ourselves, how long would I be willing to cruise for curb parking rather than pay the higher price for off-street parking? The few researchers that have attempted to estimate the volume of cruising and the time it took to find a curb space found that between 8 and 74 percent of traffic was cruising for parking, and the average time to find a curb space ranged between 3.5 and 14 min (Shoup, 2006). The wide range in the estimates can be attributed to the reality of cruising for parking. On most streets most of the time, none of the traffic is cruising, but on some streets some of the time, most of the traffic may be cruising (2006).

The following excerpt from Transport Policy shows the snowball effect that cruising for parking has on the transportation network.

> Even a small search time per car can create a surprising amount of traffic. Consider, for example, a congested downtown where it

> takes three minutes to find a curb space and the parking turnover is 10 cars per space per day. Each curb space generates 30 min of cruising time per day. If the average cruising speed is 10 miles an hour, each curb space generates five vehicle miles traveled (VMT) per day. Over a year, this cruising amounts to 1825 VMT, greater than halfway across the United States, for each curb space. Because this cruising adds to traffic that is already congested, it makes a bad situation even worse (Shoup, 2006, pg. 480).

Cruising is individually rational when on-street parking is cheaper than off-street parking. Collectively, however, it congests traffic, causes accidents, wastes fuel, pollutes the air, and degrades the pedestrian environment.

Some cities are beginning to realize the problems that are caused when they underprice curb parking, and they are trying to solve the parking problem by getting the price of parking right and implementing the following three reforms:

1. Charge the right price for curb parking. The lowest price that will leave one or two vacant spaces on each block (85% occupancy rate)-performance-based pricing.

2. Return the meter revenue to the neighborhoods that generate it. Revenue return will make performance-based prices for curb parking politically popular.

3. Reduce or remove off-street parking requirements. Do not require additional parking when a building's use changes. Freedom from parking requirements will allow higher density and new uses for old buildings (Shoup, 2005).

San Francisco is a model city when it comes to parking reform. The San Francisco Municipal Transportation Agency (SFMTA) is one of the few transportation entities in the country that controls both transit and parking. Under the city code, developments in the downtown area do not require parking, and only seven percent of the gross floor area of any building may be dedicated to parking facilities. Furthermore, the proposed parking scheme must provide a proper mix of parking types (long-term, short-term, and carpool) (TRB, 2004c). As a demand management strategy and disincentive to automobile commuting, there is a 25% parking tax imposed on all garages and lots in the City. Finally, in 2011, San Francisco introduced

SFpark. The SFpark demonstration, backed with nearly $20 million in federal funding, sets parking rates at curbside spaces and in public garages based on demand. SFpark is a federally funded two-year pilot project that will adjust parking prices each month block-by-block and hour-by-hour. If spots are always full at a certain place, prices will go up. If many spots are empty, prices will go down. San Francisco’s goal is to set prices so that there is one open space on each block. The idea is that most spots should be utilized, yet anyone looking for a spot should be able to find one quickly – reducing the cars search for parking (SFpark.org, 2011).

As San Francisco launches and tests SFpark, I wanted to see if other cities would benefit from performance-based parking prices. The next chapter outlines the methodology that I used to answer the research questions introduced in the previous chapter.

Table 2-1. Delay increase if public transportation service were eliminated

Population Group and Number of Areas	Average Annual Passenger-Miles of Travel (Million)	Delay Reduction Due to Public Transportation		
		Hours of Delay (Million)	Percent of Base Delay	Dollars Saved ($ Million)
Very Large (14)	37,691	430	17	8091
Large (25)	5459	64	7	1193
Medium (30)	1665	15	4	270
Small (16)	287	1	3	26
Other (352)	6324	31	5	574
National Urban Total	51,426	541	13	10,154

Source: 2007 Texas Transportation Institute

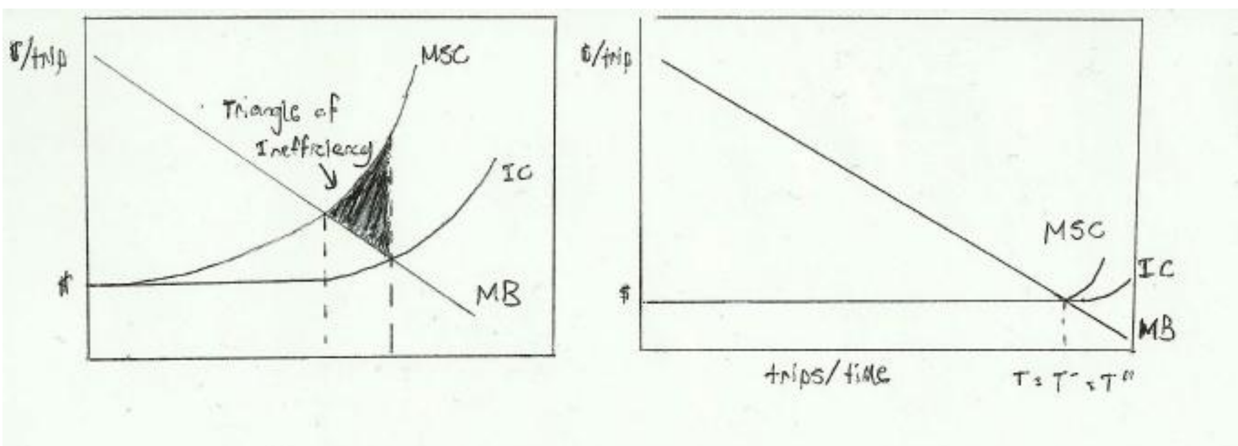

Figure 2-1. Highway construction equilibrium curve (Heikkila, 1994).

CHAPTER 3
METHODOLOGY

The study used data on Florida’s roads and on-street and off-street parking rates to test if cruising for parking was occurring in downtown Miami. Road data was provided by Florida Department of Transportation (FDOT) Statistics Office from the Roadway Characteristics Inventory (RCI) extracts for the year 2008. The Roadway Characteristics Inventory is the largest database about traffic in Florida and contains information related to roads that are maintained by or are of special interest to FDOT (FDOT, 2009). In particular the study used the following fields from the RCI dataset:

> RDWYID. RCI identifies the different roadway segments with a unique Roadway ID, with segments containing information on roadway features, characteristics and other data elements (FDOT, 2009, pg.2-4).
>
> BEGPT. This is a seven-byte field that represents the beginning mile point location of the Roadway ID (FDOT, 2009, pg.3-15).
>
> ENDPT. This is a seven-byte field that the ending mile point of the Roadway ID (FDOT, 2009, pg.3-15).
>
> FUNCLASS. The functional classification of a road refers to the FHWA approved designations that are divided into a hierarchy of road types that range from arterials to Locals (FDOT, 2009, pg.2-1)
>
> NOLANES. Number of through roadway lanes.
>
> SECTADT. The total volume of traffic on a highway segment for one year, divided by the number of days in the year (FDOT, 2009, pg.12-9).

Vehicle Miles Traveled (VMT), the number of miles driven by residential vehicles, is a calculation that is commonly used in traffic studies. VMT was calculated for every record in the RCI dataset by multiplying average daily traffic by lane miles and dividing that by number of through roadway lanes. Table 3-1 is an example of a record from the RCI dataset. In this example VMT was calculated by multiplying 11,263 (SECTADT) by 0.302 (LANEMILES) and dividing that by 2 (NOLANES_R + NOLANES_L). Lane mile was calculated by multiplying road section (ENDPT - BEGPT) by number of through roadway lanes. Although the dataset is comprehensive it doesn't include every single road in the study area. In total, there were 93 records in the study area.

The central business district (CBD) of Miami was chosen because it has the following two conditions that encourage cruising for parking: low on-street parking prices (compared to other large metropolitan areas) and an abundant supply of off-street parking. Figure 3-1 is a map of the study area. The CBD boundary is not a political boundary. The boundary was originally developed by the Miami Downtown Development Authority (Miami DDA), and then further expanded by a research team at the University of Florida (UF). The research team from UF analyzed the extent to which parking management strategies can positively or negatively influence the economic and social vitality of a CBD. The original CBD developed by the Miami DDA included the following boundaries: NE 5th Street to the north, the Miami River to the south, Biscayne Boulevard and Bayfront Park to the east and SE First Avenue to the west (Miami DDA, 2009). The UF research team expanded the northern boundary from NE 5th Street to NE 9th Street based off of recommendations from Miami DDA's 2009 Downtown Master Plan.

In Figure 3-1 the violet color polygons represent off-street parking and the blue bold lines represent on-street parking. The rates for on-street parking range from $1.25 to $1.50 per hour and the rates for off-street parking range from $1 to $15 per hour. All private off-street parking, garages and surface lots that are not open to the public, were removed from the off-street parking dataset. The rationale behind that was that motorists who rent or own a parking spot/lot are not inclined to cruise for parking since they already have a reserved spot. In total, there were 49 off-street parking records (including both garages and surface lots) in the study area.

Experiments

The first experiment tested to see if average vehicle miles traveled (VMT) on metered streets were greater than unmetered streets for 2008. In downtown Miami the majority of off-street parking is located adjacent to metered parking. If cruising is occurring you would expect average VMT to be higher on metered streets than on unmetered streets.

The second experiment was a regression analysis to see if higher parking price differentials (off-street parking – on-street parking) generated higher VMT. According to Shoup (2005), motorists are most likely to cruise if curb parking is cheap and off-street parking is expensive. In addition to parking price differentials, other variables, employment density and transit stops, were also included in the regression analysis to control for other factors that can influence VMT. The dependent variable was VMT and the independent variables were parking price differentials, employment density, and transit stops. Null hypothesis, there is no difference in the prediction of VMT given parking price differentials, employment density, and transit stops.

Employment density was determined by using census block extracts from Longitudinal Employer-Household Dynamics (LEHD). Longitudinal Employer-Household Dynamics (LEHD) is a program within the U.S. Census Bureau. The program is tasked with the mission of administering and maintaining data on employers and employees. The data was accessed by using LEHD’s graphical user interface called OnTheMap. OnTheMap allows the user to access data at the census block level, so to obtain the data that was relevant to downtown Miami I used the following census blocks: 34, 36.01, 37.01, 37.02, 67.01, and 67.02. OnTheMap also allows the user to export shapefiles that contain raster files called thermals. A thermal is a digital image that displays a variety of different colors, and each color represents a different range of jobs per square mile. Transit stops were determined by using the following shapefiles from miamidade.gov: Metro Rail stations, Metro Mover stations, Metro Mover routes, and bus stops. Each parking garage was used as a focal point for determining VMT, parking price differentials, employment density, and the number of transit stops that pertain to that particular garage. Every garage in the off-street parking data set is marked with a unique ID. Figure 3-3 is an example of how I determined the variables for the garages with the ID 1, 2, and 3. VMT = 6545 + 4819.5 = 11,364.5, parking price differential = 2 – 1.5 = $0.5, transit stops = 9, and employment density isn't featured but the garages are located in an area that has an average employment density of 25,044 jobs per square mile.

The third experiment was a production of three maps that were used to show if VMT was more associated with density or transit stops than with parking differentials. In total, the following three maps were developed: VMT vs. Parking Differentials, VMT vs. Employment Density, and VMT vs. Transit Stops. The employment density and transit stops maps were developed using ArcGIS 10 and data from Experiment 2, and the map for parking differentials was developed by using a spatial analyst tool in ArcGIS called Inverse Distance Weighted (IDW). IDW is a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. I used IDW to generate two surfaces; one surface is a surface based off of the hourly off-street parking rate and the other surface is a surface based off of the hourly on-street parking rate. The differential was achieved by subtracting the two surfaces, and the areas with the highest parking price differential were labeled as cruising "hot" spots.

The fourth experiment was a field trip to downtown Miami to test on-street occupancy rates and the time it took to cruise for a parking spot. The tests were conducted around the areas that were identified as cruising "hot" spots in Experiment 3. The tests were conducted during a normal work week between the hours of 12pm and 5pm. To test on-street occupancy I selected the blocks that are listed in Table 3-2 and counted the number of parking spots that are on the block vs. the number of cars parked in those parking spots. I also collected data on the adjacent off-street parking garage, the hourly and daily rate, date and time.

To test for cruising I selected a popular destination within the "hot" spot area (see Table 3-3) and timed (using a stop watch) how long it took me to find an on-street parking spot next to the popular destination. The stop watch started the moment I spotted the popular destination and stopped when I found a parking spot. I also timed how long it took me to walk from the parking spot to the destination. Additional data such as the off-street parking garage, the hourly and daily rate, the intersection where the on-street parking spot was found, the total trip (in minutes) and the distance walked (in miles) was collected as well.

Table 3-1. Record from the Roadway Characteristics Inventory (RCI) dataset

RDWYID	BEGPT	ENDPT	FUNCLASS	LANEMILES	SECTADT	DVMT
87067510	0.543	0.694	16	0.302	11263	1700.713

Source: 2009 Florida Department of Transportation Statistics RCI Office Handbook

Table 3-2. Blocks used to test on-street occupancy rates

Hot Spot ID	On-Street Parking
1	NE 3 St between NE 2 AVE & NE 1 Ave
2	NW 1st Ave between NW 3 ST & NW 2 ST
3	Flagler St between SW 1 Ave & Miami Ave
4	NE 1st between NE 3 Av & NE 1 Ave
5, 6	Flagler between SW 2 Av & SW 1 Ave
7	NE 2nd St between NE 1st Ave & NE 2nd Ave
8	SE 1st ST between Biscayne Blvd & SE 2nd Ave

Table 3-3. Popular destinations

Hot Spot ID	Popular Destination
1	Wolfson Campus
2	United States Courthouse
3	Miami-Dade County Courthouse
4	Dade-Common Wealth Building
5, 6	Cultural Center
7	GESU Catholic Church
8	SunTrust Bank

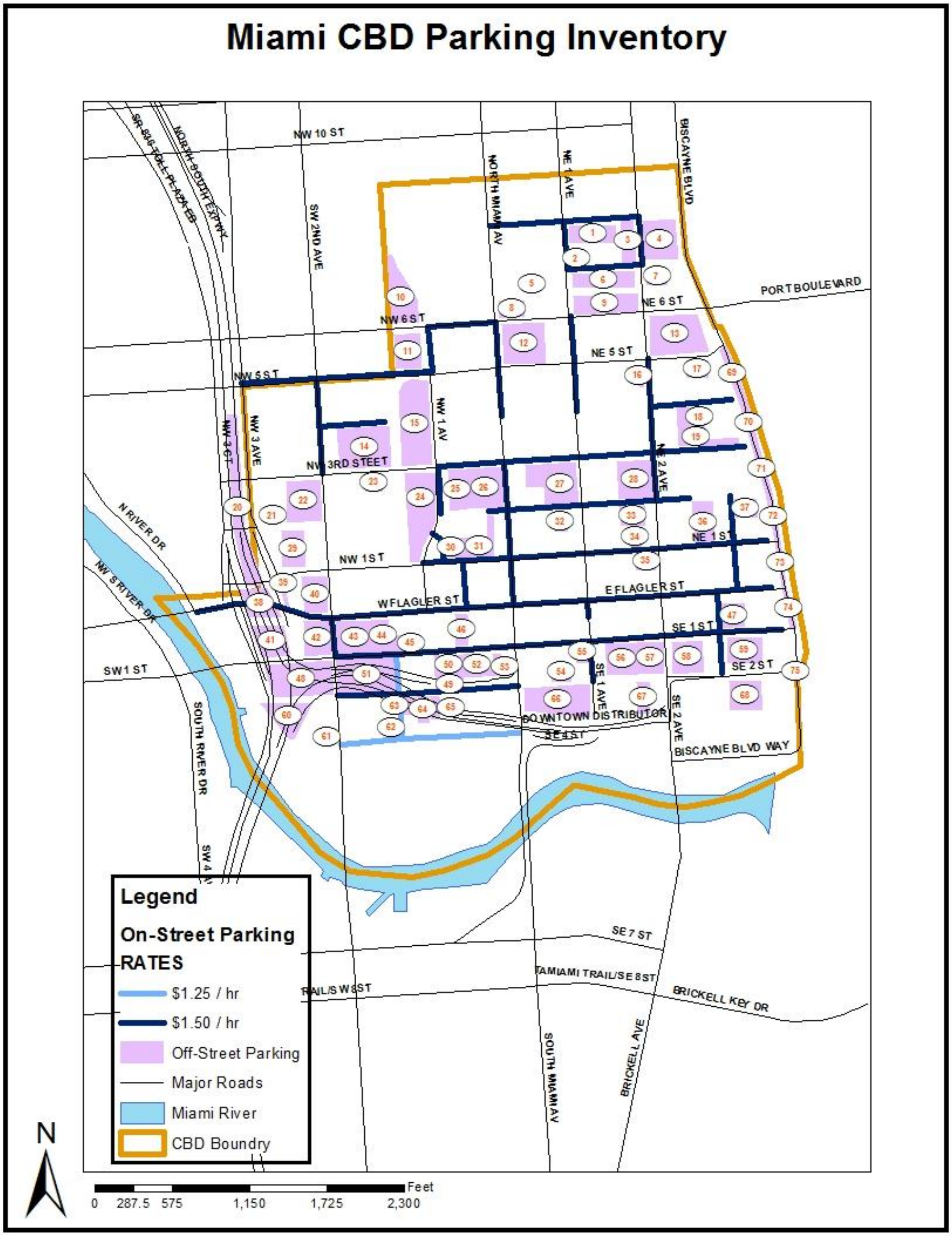

Figure 3-1. Miami central business district (CBD) study area

Figure 3-2. Metered vs. unmetered streets

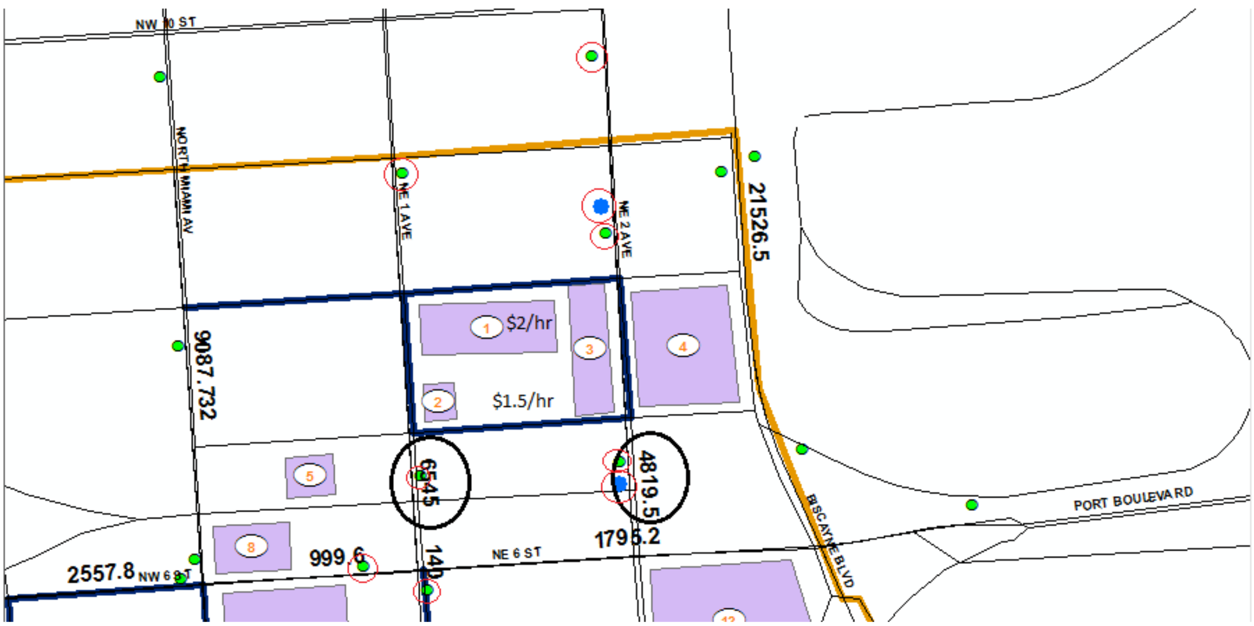

Figure 3-3. Calculating dependent and independent variables

CHAPTER 4
RESULTS

The results from the four experiments are provided in this chapter. The results from Experiment 1, Metered vs. Unmetered Streets, are displayed in a table format. Average VMT for metered streets are on the left-hand column, and average VMT for unmetered streets are on the right-hand column. The results from Experiment 2, Regression Analysis, are displayed using a correlation matrix and a regression summary output table. The tables were obtained by using the data analysis feature of Microsoft Excel. Experiment 3 is a bit different. The results from Experiment 3, Maps, are displayed on maps, and the maps are meant to show if VMT is more associated with density or transit stops than with parking differentials. The final experiment, Field Work, displays on-street occupancy rates and cruising for parking times for downtown Miami in a table format.

Metered vs. Unmetered Streets

The study area has substantially more VMT on unmetered streets than on metered streets. The sum of VMT on unmetered streets was three times greater than the sum of VMT on metered streets (see Table 4-1). The average, which carries more significance due to the disproportionate nature of the study area, found that VMT on metered streets was lower than unmetered streets by about 200 VMT. The results indicate that cruising for parking did not occur in the study area. If cruising for parking did occur than one would expect average VMT to be higher on metered streets than on unmetered streets.

Regression Analysis

The results from the correlation matrix found that the three independent variables, parking price differentials, jobs per square mile, and transit stops, have an inverse relationship with VMT (see Table 4-2). Parking price differentials and transit stops have a weak relationship with VMT, and jobs per square mile have absolutely no relationship with VMT.

The results from the regression analysis found that there's no statistical significance (0.499 > 0.05) between the independent variables and the dependent variable (see Table 4-3). Also, the independent variables only explain 1% of the variation in VMT. Prior to running the experiments I assumed that parking price differentials and VMT would have a positive relationship, but the results show otherwise. The negative correlation from the correlation matrix and the negative coefficient from the regression summary output mean that as parking price differentials decrease VMT increases. This contradicts the assumption that higher parking price differentials generate higher VMT. Transit stops was the only variable where the results match the expected behavior. One would expect that as transit stops increase VMT would decrease. Overall, no association can be made between the independent variables and VMT.

Maps

The maps were produced to complement the results from the regression analysis. Figure 4-1 shows VMT vs. Parking Price Differentials. The differentials are displayed using a red to blue color scheme that ranges from $13.5 an hour to zero respectively. The white numbers represent the Hot Spot ID. The Hot Stop ID uniquely identifies cruising "hot" spots, and the Hot Spot ID is associated with the ID field in Table 3-2, 3-3, 4-4, and 4-5. The map shows that the cruising "hot" spots tend to cluster towards the center of the study area. It appears that the higher parking price differentials are associated with lower VMT. For example, the max differential (Hot Spot ID 3) has an estimated VMT of 10,445. On the other hand, the min differential (bottom left garage) has an estimated VMT of 51,620. VMT vs. Employment Density (see Figure 4-2) shows that employment is concentrated in the center of the study area. The results do not support the expected behavior that as employment density increases VMT increases. Lower

VMT was observed in areas where employment density ranged from 61,638 and 96,306. Higher VMT was observed in areas where employment density ranged from 3858 to 15,413 jobs per square mile. The final map (see Figure 4-3) VMT vs. Transit Stops, shows that lower VMT can be found around areas with a higher volume of transit stops. In summary, the maps reveal that VMT was more associated with transit stops than with parking price differentials or employment density.

Field Work

Unlike Experiment 1, the data from the field work shows that cruising for parking is actually happening in the study area. The test for on-street occupancy rates found that four out of the eight cruising "hot" spots had an on-street occupancy rate of one-hundred percent (see Table 4-4). Fairly high occupancy rates were also observed for the other four cruising "hot" spots. There was only one instance, at Hot Spot ID 5, 6, where half of the metered spots were open. The cruising for parking test found that the average cruising time in the study area was 5:17 minutes, average walking time from the parking spot to the destination was 5:08 minutes, and the sum of the two makes the total trip 10:25 minutes (see Table 4-5). The highest cruising time was observed at the GESU Catholic Church, Dade-Common Wealth Building, and SunTrust Bank. The lowest cruising time was found at the Cultural Center, which makes sense since that was also the area where the lowest on-street occupancy rates were observed.

Table 4-1. Metered vs. unmetered streets

	VMT (ADT * lane miles)	
	Metered	Unmetered
SUM	59,717.48	201,313.44
AVG	3,732.43	3,947.32

Table 4-2. Correlation matrix

	VMT	Parking Price Differential	Jobs Per Square Mile
Parking Price Differential	-0.154		
Jobs Per Square Mile	-0.025	0.390	
Transit Stops	-0.159	0.014	-0.037

Table 4-3. Regression summary output table

Regression Statistics	
Multiple R	0.23
R Square	0.05
Adjusted R Square	-0.01
Standard Error	5735.35
Observations	49.00

ANOVA

	df	SS	MS	F	Significance F
Regression	3.00	79280491.10	26426830.37	0.80	0.50
Residual	45.00	1480239053.37	32894201.19		
Total	48.00	1559519544.47			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	17435.80	3497.73	4.98	0.00	10391.02	24480.59
Parking Price Differential	-386.40	354.81	-1.09	0.28	-1101.01	328.22
Jobs Per Square Mile	0.00	0.04	0.11	0.91	-0.08	0.09
Transit Stops	-315.59	307.62	-1.03	0.31	-935.17	303.99

Table 4-4. On-street vehicle occupancy rates

Hot Spot ID	On-Street Parking	Off-Street Parking	Rate	Date	Time	On-Street Occupancy	Occupancy Rate
1	NE 3 St between NE 2 AVE & NE 1 Ave	190 NE 3rd Street College Station Garage	1/2 hr - Free 1/2 hr - 1 - $4 1 hr - 2 hr - $8 Each add hr - $4 Max - $16	8-Mar	1pm	15 out of 16	93.75%
2	NW 1st Ave between NW 3 ST & NW 2 ST	LOT A-3301 LOT B-3302	$4 & $6 Each hr	8-Mar	1:10pm	22 out of 22	100.00%
3	Flagler St between SW 1 Ave & Miami Ave		$4 per hr	 7-Mar 8-Mar	3pm 3:30pm 12:20pm	17 out of 17 17 out of 17 16 out of 17	100.00% 100.00% 94.11%
4	NE 1st between NE 3 Av & NE 1 Ave	Alfred Du Pont Garage	1/2 hr - $3 each add 1/2 hr - $3 All Day - $15	7-Mar 8-Mar	4pm 12:15pm	20 out of 21 21 out of 21	95.25% 100.00%
5,6	Flagler between SW 2 Av & SW 1 Av	Metro Dade Center Garage Cultural Center Parking	$2 for 1/2 hr $17 daily	7-Mar 8-Mar	5pm 12:35pm	6 out of 11 9 out of 11	54.54% 81.81%
7	NE 2nd St between NE 1st Ave & NE 2nd Ave	190 NE 3rd Street College Station Garage	Up to 1 hr - $3 Each add hr - $2 Max per day - $10 Flat rate - $5	 7-Mar 8-Mar	1pm 1:30pm 12pm	15 out of 15 15 out of 15 15 out of 15	100.00% 100.00% 100.00%
8	SE 1st ST between Biscayne Blvd & SE 2nd Ave	Suntrust Garage	1/2 hr - $4 Each add 1/2 hr - $4 All Day - $28	 7-Mar 8-Mar	2pm 2:30pm 12pm	18 out of 19 17 out of 19 19 out of 19	94.74% 89.47% 100.00%

Note: Monday average is 91.75% and Tuesday average is 95.67%

Table 4-5. Cruising for parking

Hot Spot ID	Destination	Off-Street Parking	Rate	Found On-Street Parking At	Average search time (minutes) 11 a.m. - 3:30 p.m. Cruising	Walking	Total Trip (minutes)	Distance Walked (miles)
1	Wolfson Campus	190 NE 3rd Street College Station Garage	1/2 hr - Free 1/2 hr - 1 - $4 1 hr - 2 hr - $8 Each add hr - $4 Max - $16		5.20	5.80	11.00	0.5
2	United States Courthouse	LOT A-3301 LOT B-3302	$4 & $6 Each hr	NW 5 St & NW 2 Av	5.20	3.00	8.20	0.3
3	Miami-Dade County Courthouse		$4 per hr	Flagler & Miami Ave	2.50	0.50	3.00	0.1
4	Dade-Common Wealth Building	Alfred Du Pont Garage	1/2 hr - $3 Each add 1/2 hr - $3 All Day - $15	Flagler & SW 2 Av	6.00	11.50	17.50	0.5
5,6	Cultural Center	Metro Dade Center Garage	$2 for 1/2 hr $17 Daily	Flagler & SW 2 Av	0.00	0.50	0.50	0.05
7	GESU Catholic Church	190 NE 3rd Street College Station Garage	Up to 1 hr - $3 Each add hr - $2 Max per day - $10 Flat Rate - $5	NE 1 Ave & NE 5 St	8.50	4.50	13.00	0.2
8	SunTrust Bank	Suntrust Garage	1/2 hr - $4 Each add 1/2 hr - $4 All Day - $28	SW 2 St & SW 2 Av	6.00	9.75	15.75	0.6
				Average	4.77	5.08	9.85	0.32

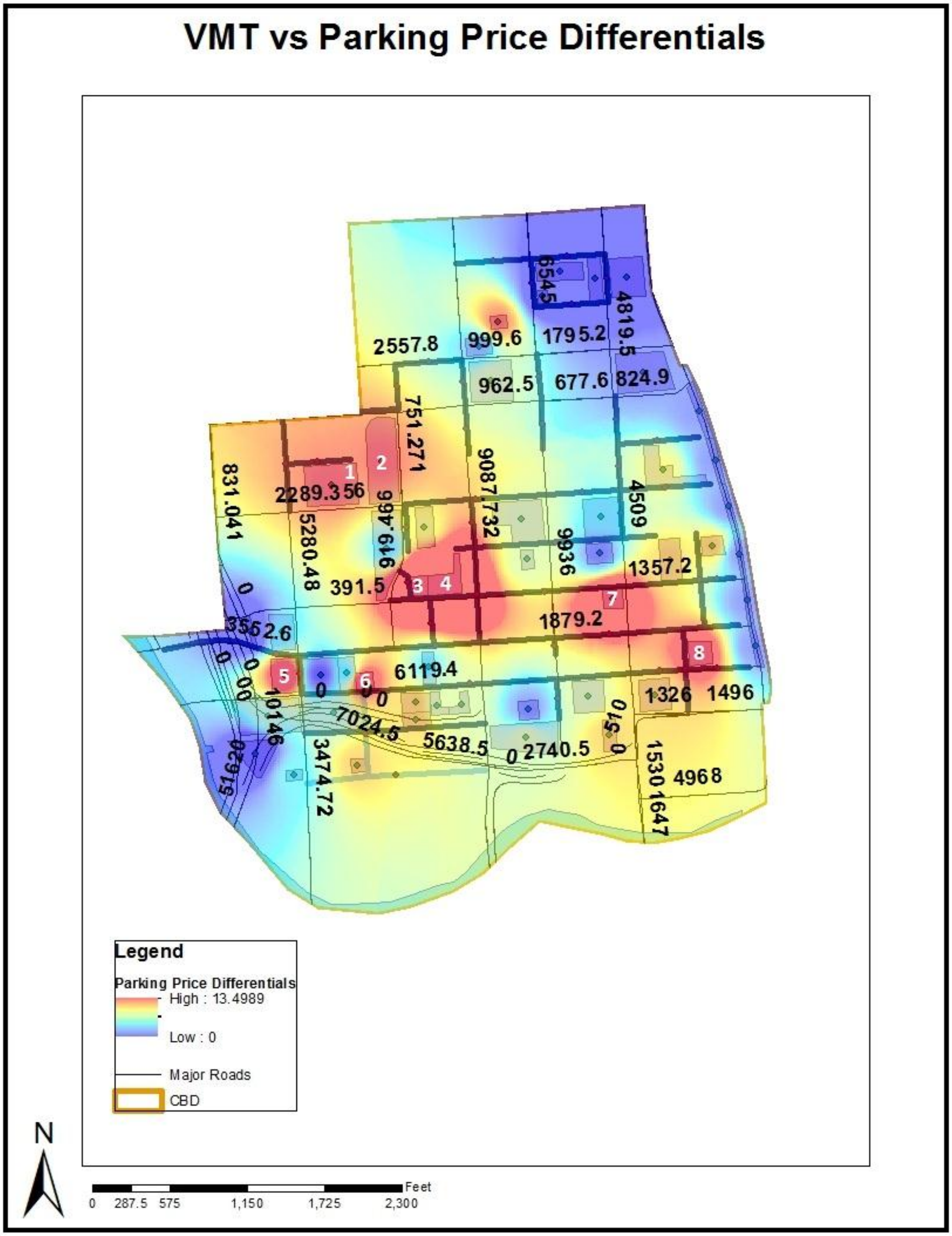

Figure 4-1. VMT vs. parking price differentials

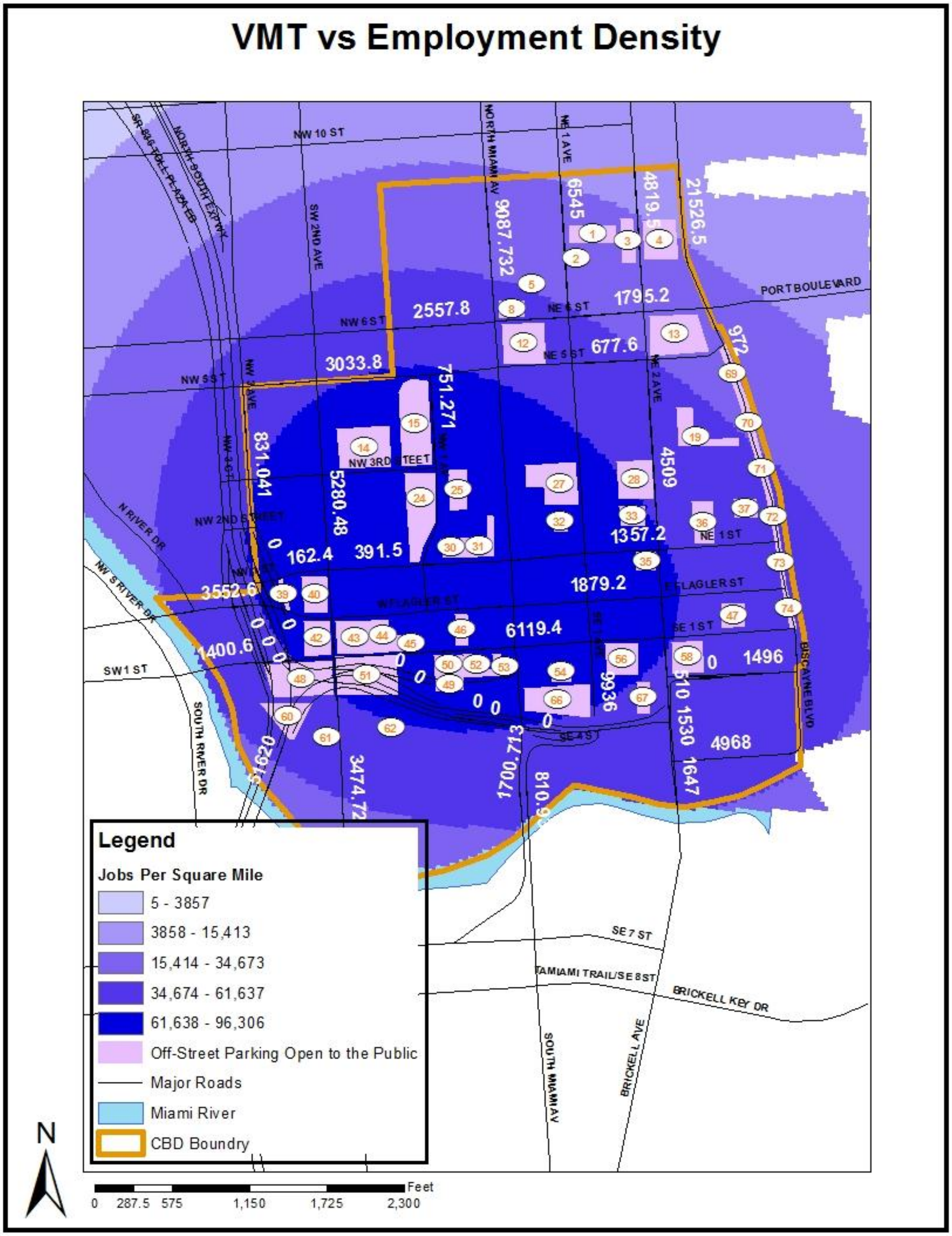

Figure 4-2. VMT vs. employment density

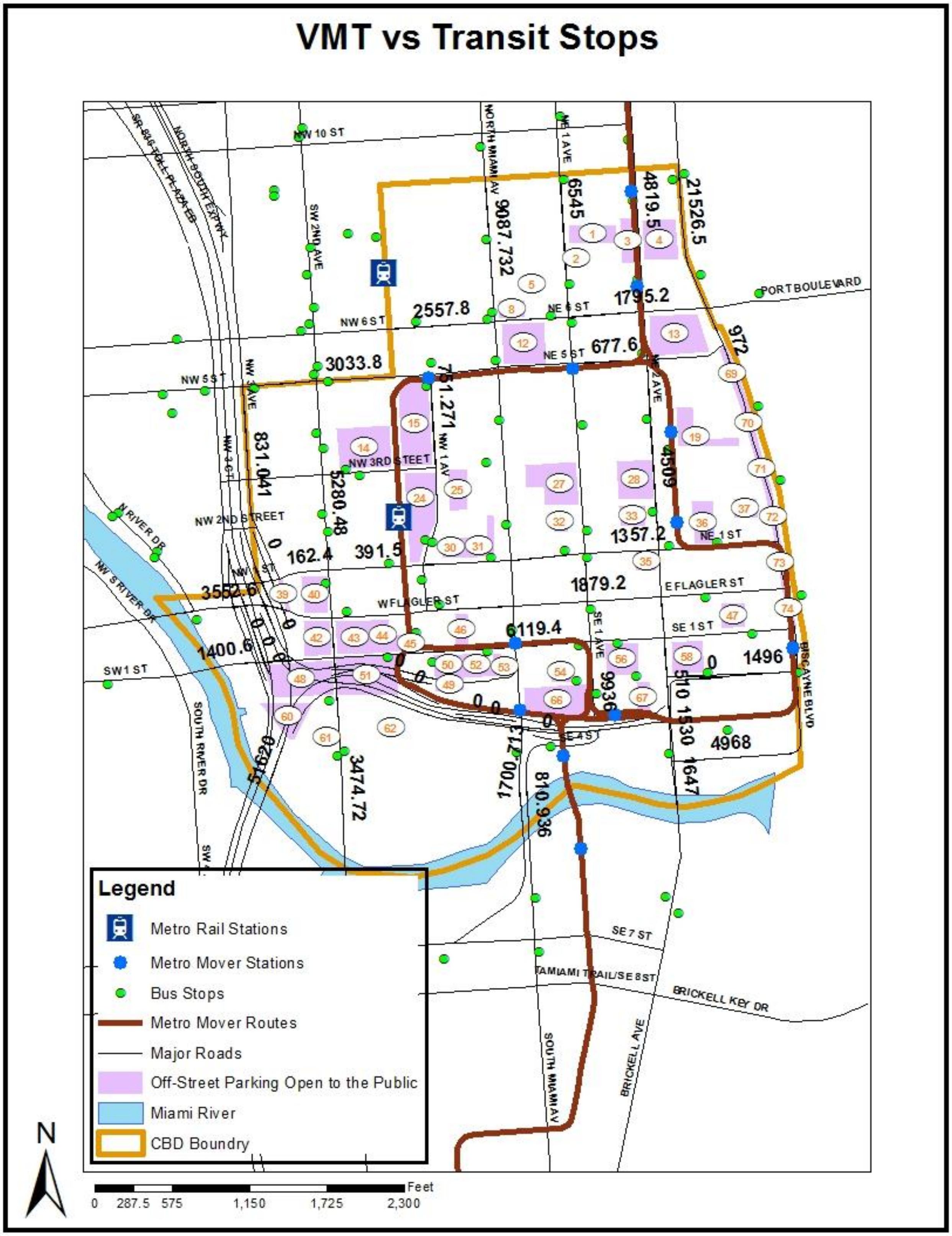

Figure 4-3. VMT vs. transit stops

CHAPTER 5
DISCUSSION

The previous chapter detailed the quantitative findings of this research. This chapter is going to contextualize those findings in an attempt to give a greater understanding of the research question. The underlying purpose behind the thesis was to evaluate the practicality of implementing a performance-based parking program in downtown Miami. This was accomplished by asking the following two research questions: (1) is there evidence of cruising for parking in downtown Miami? and (2) does Shoup's theory, higher parking price differentials (off-street – on-street parking prices) generate higher VMT, apply to downtown Miami?

The two main conclusions that can be drawn from my results are that cruising for parking is happening in downtown Miami, and Shoup's theory does not apply to the study area. Although Experiment 1 and Experiment 4 found contradictory results, the findings from Experiment 4 hold greater weight than the findings from Experiment 1. Experiment 1 found that average VMT was lower on metered streets than unmetered streets. This can mean a number of different things. It can mean that cruising for parking did not occur in downtown Miami during the time of the experiment. If cruising did occur than one would expect average VMT to be higher on metered streets than on unmetered streets. It can also mean that curve parking is located on streets with less traffic. This alludes to the fact that VMT may not be the best or the only dependent variable for measuring cruising for parking. First of all, VMT was derived from traffic counts and traffic counts are not available for every road in the study area. Also, VMT doesn't factor in time of day, weather, special events, income, or other factors that might influence a driver's decision to park in a garage or search for on-street parking.

The limitations of Experiment 1 were addressed by Experiment 4. Experiment 4 collected primary data on on-street occupancy and the time it took to cruise for a parking spot. The test for on-street occupancy rates found that the average occupancy rate during a normal business day was 93.71%. That translates into one or two spots being available on any given block within the cruising "hot" spot areas. The cruising for parking test found that the average trip, cruising for parking + walking to the destination, took about ten and a half minutes.

The average search time in Miami is not as bad as other large metropolitan areas. Table 5-1 summaries the results of 16 studies of cruising in 11 cities. Between 8 and 74 percent of traffic was searching for parking, and it took between 3.5 and 13.9 minutes to find a curb space. The studies that date back to 1927 are not relevant and probably not very accurate, but the recent studies (after 1985) show that cities like Cambridge, Cape Town, New York, San Francisco, and Sydney have an average search time that is about five minutes higher than Miami. New York tops the chart with an average search time of 13.9 minutes and San Francisco and Sydney tie for last with an average search time of 6.5 minutes.

Experiment 2 found that the three independent variables, parking price differentials, jobs per square mile, and transit stops, have an inverse relationship with VMT, and that there's no statistical significance between the independent variables and the dependent variable. This contradicts the hypothesis that higher parking price differentials generate higher VMT, and proves that Shoup's theory does not apply to downtown Miami. Although no conclusive evidence was found on what is driving VMT, nobody can deny that downtown Miami does not have traffic. The maps from Experiment 3 show that downtown Miami has an abundant supply of cruising "hot" stops, employment centers, and transit stops. Empirical evidence has shown that these three factors either promote or demote driving, but unfortunately that was not captured by my results.

In summary, downtown Miami has a slew of other parking problems, but this study only focused on one specific parking problem, cruising for parking. One of the major limitations of the study was that I wasn’t able to find conclusive evidence on what is the driving factor behind VMT in the study area. I support Shoup’s theory on parking differentials, but the data shows that the theory does not apply to downtown Miami. That does not negate the fact that cruising for parking is happening in downtown Miami, as shown in Experiment 4. Cruising for parking is an issue that ought to be addressed by the Miami-Dade Transit Authority, but the issue is not severe enough to justify implementing a performance-based parking program.

Table 5-1. Twentieth-century cruising

Year	City	Share of traffic cruising (percent)	Average search time (minutes)
1927	Detroit (1)	19%	
1927	Detroit (2)	34%	
1933	Washington		8.0
1960	New Haven	17%	
1965	London (1)		6.1
1965	London (2)		3.5
1965	London (3)		3.6
1977	Freiburg	74%	6.0
1984	Jerusalem		9.0
1985	Cambridge	30%	11.5
1993	Cape Town		12.2
1993	New York (1)	8%	7.9
1993	New York (2)		10.2
1993	New York (3)		13.9
1997	San Francisco		6.5
2001	Sydney		6.5
Average		30%	8.1

Source: 2005 Shoup

CHAPTER 6
CONCLUSION

SFPark is still an on-going demonstration, so it is premature to make conclusions about the effectiveness of demand-responsive pricing for parking. Before evaluating its effectiveness, people need time to become aware of rate differences between blocks, time of day, and/or between on- and off-street alternatives. These changes do not happen overnight. A thorough evaluation will be conducted in the near future, and if SFPark is found to be a success than other cities will probably implement similar projects in their respective downtowns.

To other cities, I hope that this thesis laid the foundation for how to think about cruising for parking, how to measure cruising for parking, and how to statistically measure the relationship between independent variables and VMT. The study was not without limitations. First and foremost, the results from the regression analysis found that there's no statistical significance between the independent variables and the dependent variable. The fact that downtown Miami is an employment center and the results showed that the independent variables only explain 1% of the variation in VMT means that there either has to be something wrong with the data or the way that I set up the regression analysis. As previously mentioned, VMT was derived from traffic counts and traffic counts are not available for every road in the study area. Also, the map scale for jobs per square mile needs to be adjusted to a finer granularity. The scale that was used in Figure 4-2 is a default scale that was provided by the U.S. Census Bureau. As for the regression analysis, other focal points, such as popular destinations, could have been used, and the parameter for summing the adjacent VMTs and transit stops could have been expanded to one or two blocks.

Shoup (2006), in a publication featured in Transport Policy, said that, "Getting the price of curb parking right will benefit everyone, and every city can do it" (pg. 486). Every city can do it, but not every city should do it. City officials could use the methodology that was developed in this study to see if performance-based parking pricing is the right choice for their city.

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BIOGRAPHICAL SKETCH

Max Shmaltsuyev was born in Bobruysk, Belarus in 1984. He immigrated with his family to the United States in 1990. He grew up in the north suburbs of Chicago and attended high school at Niles North High School in Skokie, IL. After high school Max attended Loyola University of Chicago and studied finance and received a graduate certificate in data warehousing.

Since graduating from Loyola, Max has worked at two separate data warehouse consulting firms before deciding to pursue a master's degree in Urban and Regional Planning at the University of Florida. At the University of Florida, Max worked as a research assistant and interned for the City of Gainesville. Upon finishing up his coursework, Max moved back to Chicago to pursue a career in transportation planning, but instead found a great opportunity with a business intelligence start-up called Clarity Solution Group.