Promoting Transit Utilization

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Summary

People make transportation choices based on a number of considerations. This paper offers an economic analysis of transportation choice and suggests ways to increase use of alternate modes of transportation.

Introduction

According to the National Capital Region Transportation Planning Board (TPB), the TPB and virtually all US metropolitan areas use a four-step process to forecast regional travel behavior. Step three, known as mode choice, assumes three possible transportation modes: mass transit, driving alone, and carpooling. Factors affecting mode selection include accessibility of mass transit, automobile ownership, proximity to carpool lanes, costs to use each mode, and time to use each mode.

While most of the factors used in the forecast—for instance automobile ownership—are relatively stable, the time to use transit is affected every day by the performance of the Washington Metropolitan Transit Authority (WMATA). While riders may consider the amount of time scheduled for a trip from point A to point B, riders develop an awareness of the reliability of the system and factor their knowledge of the system's reliability into their choice of transportation modes. WMATA tracks and publishes a Scorecard of Metro's Key Performance Indicators (KPI), including Rail On-Time Performance by Line and Bus On-Time Performance. WMATA considers that during peak periods, trains are on-time if they arrive within two minutes of the scheduled headway, while during off-peak periods, trains are on-time if they arrive no later than scheduled plus 50% of the scheduled headway. Buses are considered on-time if they arrive no more than two minutes ahead and no more than seven minutes behind schedule.

Given the importance of transit costs and time, we have developed a Transit Accessibility Index (TAI) that measures the accessibility of individual locations by public transit versus private automobile. We have developed an economic model that examines the impact of transit accessibility at different opportunity cost and different fare levels. In addition, we conducted a survey of the arrival of buses over a four day period at Tysons Corner Shopping center and evaluated the arrival time against scheduled arrival times.

We believe there are a number of steps to be taken to promote increased transit utilization, some based on behavioral economics and some based on the concept of utility maximization that is fundamental to neoclassical economic theory. Behavioral economists have made the convincing case that human behavior is not always utility maximizing—sometimes behavior is affected by social, emotional, and other factors and might therefore be labeled as irrational. Individual choice of transportation mode is part rational and part irrational, with the balance between the rational and irrational varying among individuals, and varying at different times and according to the circumstances of each individual. Both

behavioral and utility maximizing factors must be addressed in order to increase the use of public transit and other "alternate" (with respect to single occupancy vehicles) forms of transportation. We will touch just briefly on behavioral factors and then look more fully at utility maximizing factors.

Behavioral Economics

Some people consider behavioral economics to be new, yet Adam Smith, who is considered by many to be the father of modern economics, recognized that individuals were motivated by a desire for respect and admiration. "Conspicuous conservation" is an example of behavior motivated by a desire for respect and admiration rather than by a desire for utility maximization. Conspicuous conservation has been reported, for example, in studies of the demand for Priuses, which found a higher demand for Priuses relative to other hybrid vehicles in parts of the country where environmental concerns were high, compared to the demand for Priuses in parts of the country where environmental concerns were low. Conspicuous conservation has also been found in studies of the demand for green products when shopping in public versus shopping in private.

The recent introduction of Capital Bikeshare in the Washington, DC area reflects the fact that there is local interest in the various attributes associated with bicycling, such as health, physical fitness, and the environment. This interest offers an opportunity to generate demand for alternate forms of transportation besides Bikeshare, including public transit and walking. Marketing efforts, such as a "Walk" campaign utilizing concepts and materials shown in the figure below, can make alternate transportation a more attractive choice to individuals who might not choose alternate transportation based on utility maximization principles alone.

Figure 1 Campaign Collateral

Utility Maximizing and the Transit Accessibility Index (TAI)

As discussed above, travel time and cost are significant factors that affect rational utility maximizing transit decisions. Utility maximizing transportation consumers will take into consideration travel time, out of pocket cost, and their own opportunity cost, as part of their process of making transportation mode choices.

When considering whether to drive or use public transit, we believe that the relationship between the amount of time required by driving versus public transit is one of the most important considerations. We have developed a Transit Accessibility Index (TAI) which offers an objective measure of the ratio of travel time on public transit versus travel time in private vehicles. We measure time door-to-door, including time walking to the destination or from the point of origin. We also consider desired arrival and departure times, so that the time of a public transit trip that requires a traveler to arrive fifteen minutes ahead of the desired arrival time will include such necessary, but undesired, additional fifteen minutes.

A TAI of less than one indicates that it is faster to get from point A to point B by public transit. This is rarely the case, though it may happen, for instance, during rush hour when private vehicles experience congestion that transit vehicles (trains and buses in special lanes) can avoid. There are many instances when public transit may take three or more times as long as private transport, giving us a TAI of 3.0 or higher. There are also times when public transit isn't available, such as late at night, and locations that are not served by public transit, in which case the TAI is infinite. WMATA considers any location situated one mile or more from a transit stop is not served by public transit.

The chart below provides an example of the TAI during weekday rush hour for the existing Virginia WMATA Orange line metro stations and the four metro stations being constructed in Tysons Corner. The most transit accessible location is at the Rosslyn Metro station, shown here with a silver flag, with a TAI of less than 1.0. The least accessible of these locations, with TAI scores of over 3.0, are the four Tysons Corner stations currently under construction (their scores will of course change when the new stations open).

Figure 2: TAI: WMATA Rush Hour (Example)

The total cost of private transportation includes the cost of the vehicle, fuel maintenance, insurance, fees, etc., while the cost public transit includes the cost of the fare. Both public and private transportation also incur opportunity costs. We have conducted sensitivity analyses on the total cost of transportation, at different opportunity costs, different TAI scores, and different transit fares. What we have found is that as opportunity costs rise, total cost is highly sensitive to the TAI score.

The chart below is an example of our findings. In this example, with an opportunity cost of $25 / hour and a TAI of 1.0 (labeled "15 Minute Public Trip"), public transit is less expensive than private transit until transit fares hit $6.00. With a TAI of 2.0 (shown here as a "30 Minute Public Trip"), there is no fare—not even a fare of $0.00—at which the total cost of public transit is less than the total cost of private transportation. The range within which public transit is the rational economic choice with a $25 / hour opportunity cost is bounded at one point by a transit fare of close to $6.00 and a TAI of 1.0, and at another point with a TAI of close to 2.0 and a transit fare of $0.00.

Though the specifics faced by any traveler may differ, these are not unrealistic assumptions. The $25 opportunity cost approximates a $50,000 annual salary. The TAI for Ballston Metro station during rush hour is 1.2, and the rush hour fare for the 10.4 mile trip on Metro from Vienna Metro to Ballston Metro is $3.85. (More detail is available in our report, "'Green Your Meeting,' An Economic Approach to Reduced Oil Demand, Greenhouse Gas (GHG) Emissions, and Improved Security")

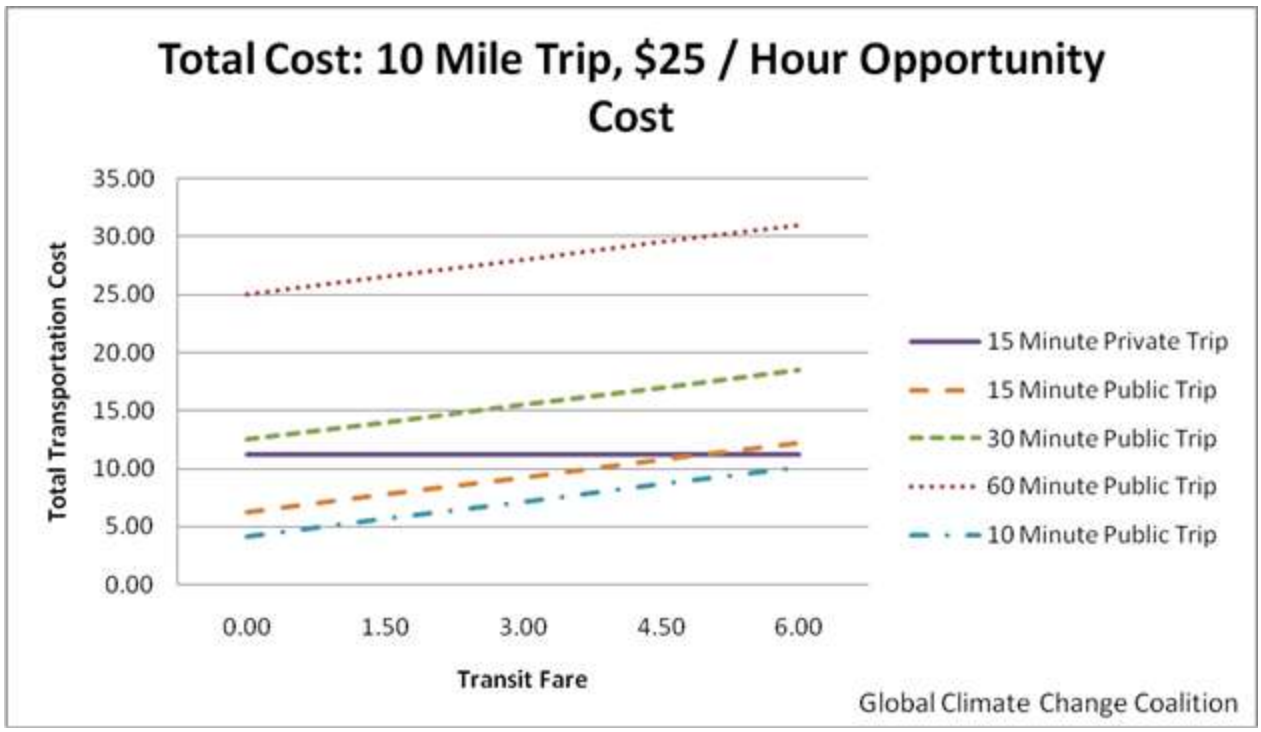

Figure 3: Total Cost: 10 Mile Trip, $25 / Hour Opportunity Cost

Given the impact that travel time has on rational transit choice, public transit utilization may be increased through actions that serve to reduce public transit travel time. Some of these actions must be made by the transit authorities themselves, but some of the actions may be undertaken by individuals and groups outside of transit authorities but with transit authority support.

Transit Authority Actions

One of the most important steps transit agencies can take is to ensure on-time performance. WMATA's route planner builds-in a minimum of five minutes between scheduled arrival on one transit leg and scheduled departure on a next transit leg. Given the fact that there may be thirty minutes or more between scheduled buses, the impact of missing a connection because one leg was late may be significant.

We recently sampled bus arrival times at the Tysons Corner Shopping Center during evening rush hour on four weekdays over a seven day period. We compared the actual arrival times against scheduled arrival times to determine whether a particular bus was on-time or if it wasn't on-time, how many minutes off schedule it was. We call this measure the Average Arrival Time Difference (AATD).

The on-time performance varies depending on the length of the arrival allowance—the number of minutes a bus could arrive before a scheduled time and still be measured against such scheduled time. We conducted a sensitivity analysis of arrival allowances from zero minutes to four minutes. When we set the arrival allowance at zero minutes, the AATD is ten minutes, and the median is seven minutes. When we set the arrival allowance to four minutes, the average and the median fall to five and four

minutes, respectively. Given that the WMATA trip planner allows five minutes between arrival on one leg and departure on the next leg, we believe that setting an allowance at three or four minutes is too long. Consider passengers on bus A who wish to connect with bus B that is scheduled to arrive at a stop five minutes after bus A. If bus A arrives three or four minutes late and bus B arrives three or four minutes early, passengers on bus A will miss their scheduled connection.

Therefore, we set the arrival allowance at two minutes, so buses that arrive one or two minutes ahead of a scheduled arrival are considered to be early for the next scheduled time, and buses that arrive more than two minutes early are considered to be late for the previously scheduled time. Using this two minute arrival allowance, the average difference between actual and scheduled arrival is seven minutes, and the median difference is five minutes. We note that WMATA considers buses that arrive no more than two minutes early or seven minutes late to be on time. Given the impact that such a wide allowance has on travel time, we believe that this difference needs to be significantly reduced.

AVERAGE ARRIVAL TIME DIFFERENCE (AATD) While we used the actual bus schedules, we did not match specific buses against particular arrival times. Rather, if a bus was scheduled to arrive at 5 PM and a bus actually arrives at 5 PM, we consider that that particular bus was on-time, even though that particular bus might have actually been scheduled to arrive much earlier (or even later). If a bus is scheduled to arrive at 5 PM and a bus actually arrives at 5:05 PM, we consider that that bus arrived five minutes late though it could in fact be far later.

We understand that traffic, construction delays, traffic signals, the number of boarding passengers, vehicle breakdowns, and other factors beyond the driver's control affect actual bus performance. Sometimes buses may arrive shortly before a scheduled arrival time. Such occurrences may arise when a bus is significantly behind schedule, though sometimes such occurrences may arise because traffic and other factors are less than anticipated and buses arrive ahead of their scheduled time. Though it might seem that early arrival is desirable, it is in fact problematic because buses that arrive early—and depart early—may leave before passengers arrive on connecting buses or via other transport modes.

For purposes of our analysis, we believe it is appropriate to "allow" buses that arrive a few minutes ahead of schedule to be considered on-time, but don't believe it is appropriate to allow buses that arrive a lot ahead of schedule to be considered on-time. In our analysis, we associate buses that arrive early but within this "allowance period" to have arrived ahead of the next scheduled arrival time, and buses that arrive earlier than the allowed amount of time to have arrived late for the previously scheduled arrival time. Determination of this allowance period is discussed below. When analyzing the difference between the actual and the scheduled arrivals, we took the absolute value of this difference.

Note:

- We eliminated from considerations buses that appeared to be mismarked.
- Not all vehicles may be accounted for.

Individual and Group Activity.

A recent report from the National Research Council found that increasing residential and employment density could mean reductions in vehicle travel, fuel use, and CO2 emissions (National Research Council. *Driving and the Built Environment: The Effects of Compact Development on Motorized Travel, Energy Use, and CO2 Emissions -- Special Report 298.* Washington, DC: The National Academies Press, 2009). While this report illustrates the important of considering transportation in future planning and development, our Transit Accessibility Index is a tool that helps illustrate how transportation can be taken into consideration given today's as-built environment.

While individuals and groups don't control the transit service, they can respond in a simple but meaningful way to the service that is being provided in this as-built environment. Using our Transit Accessibility Index, individuals and groups can choose to meet in transit accessible locations. Through initiatives such as Green Your Meeting, individuals and groups may do just that: take transit accessibility into consideration when planning meetings. Individuals and groups benefit from increased transportation choices and lower transportation costs when meetings are held in transit accessible locations. Transit systems attract additional riders and revenue. Transit accessible venues gain additional business. Local, state, and federal transportation dollars are more efficiently invested.

A look at the four Panera Bread locations near Tysons Corner illustrates how different locations of even the same retail business may vary in their accessibility. The chart below shows that two Panera locations, marked with red triangles, are very inaccessible—with 8 AM Weekday TAI scores of over 3.0. One of the locations, marked with a red tear drop, has an 8 AM Weekday TAI of 2.8. The most accessible location is in the Tysons Corner Shopping Center, with a score of 1.9.

We believe many groups will incorporate the TAI into their activities, including not only environmental groups, but corporations, government organizations, and other civic groups that are interested in reducing transit costs, increasing accessibility to their programs, and reducing emissions.

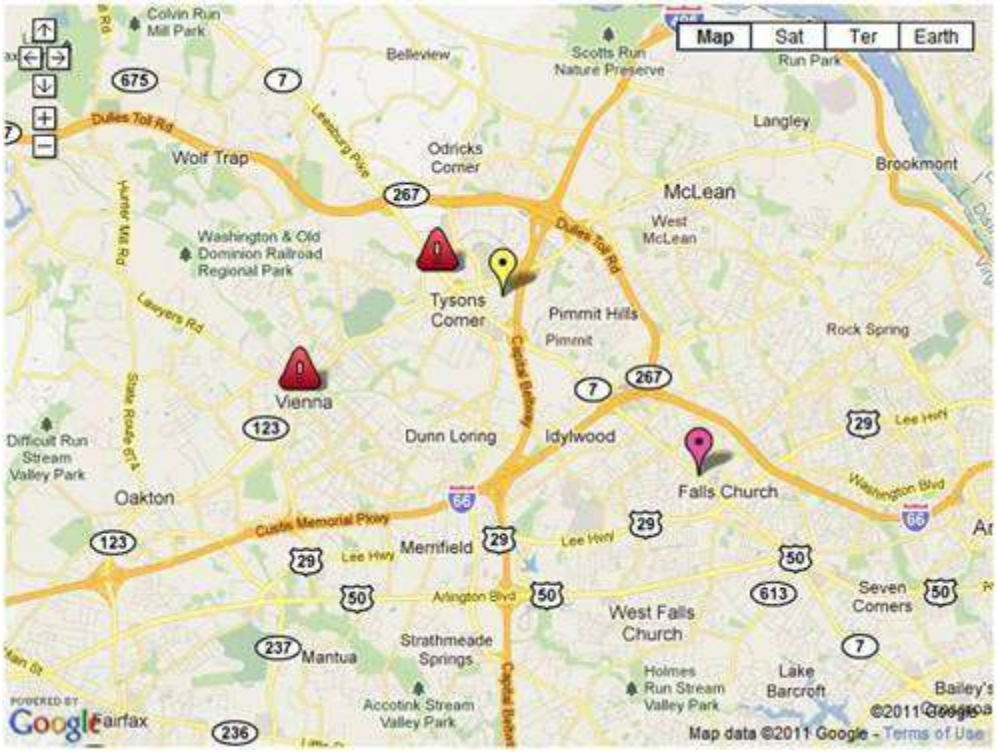

Figure 4: TAI: Panera Bread, Weekday Morning