

Increasing Use of Public Transportation Through Direct Fees

Stuart M. Whitaker, November 15, 2010

Introduction

The Environmental Protection Agency (EPA) reports that the US average annual per capita CO₂ emissions from transportation are 5.7 metric tons, which represents 30% of the average annual per capita CO₂ emissions from all sources (19.3 metric tons), and 61% of the average annual per capita CO₂ emissions in two-person households (9.4 metric tons). CO₂ emissions are a major cause of climate change, and a transition from private (automobile) transport to transport modes that produce lower emissions per mile presents a significant opportunity to reduce harmful emissions.

In many communities, including the local DC / MD / VA metropolitan area, we have observed many professionals who use public transit to commute back and forth to work but use private transport for personal, evening, and weekend transportation. Consumer transportation choices are based on a number of factors, including the direct cost of each alternative—such as vehicle expenses, parking fees, and transit fares—and the amount of time required by each alternative. Opportunity costs, which represent benefits that are lost while engaged in another activity or the perceived value of one's time, may be combined with direct transportation costs to determine the total cost of a particular alternative. Individual opportunity costs vary widely—from zero for people enjoying a leisurely day off, to hundreds and even thousands of dollars per hour for high-priced professionals and affluent individuals.

Using the local metropolitan area, we have developed a simple economic model that uses the total cost of alternative forms of transportation to explain the transportation choices that individuals make and to estimate the impact that parking fees would have on transit choices. Key inputs include individual opportunity costs, transportation costs, and travel times.

Opportunity Cost

The table below shows the income distribution in Fairfax County, Virginia, which had a population of 1,051,990 and 384,420 households in 2009. Applying the fact that there were 1.5 persons employed per household, we develop an estimate for the average income per employee per year, and the average income per employee per hour, for the income groups reported. For example, 15% of the households have an income between \$50,000 and \$74,999. We estimate that the average income per year for these households is \$62,499, that the average income rate per employee per year for these households is \$42,026, and that the average income rate per employee per hour for these households is \$21.01. Approximately 34.2% of the households have an average income per employee per hour of \$21.01 or below. (Minimum wage is used as an estimate for the average income per employee per hour for the lowest income households; we do not estimate the average income per employee per hour for households reporting over \$150,000 per year in income.)

We use these average income per employee per hour estimates as a measure of individual opportunity costs. We assume that opportunity costs apply equally to all persons in a household, such that a non-working partner or child of an employee will share the opportunity cost of the employee. Thus, we find that the opportunity costs range from \$7.25 to \$42.03 per hour.

Income / Year:	Average Income / Year	% Households:	% Households, Cumulative:	Income Rate / Employee / Year	Income Rate / Employee / Hour
25,000		7.6	7.6		7.25
49,999	37,500	11.6	19.2	25,216	12.61
74,999	62,499	15.0	34.2	42,026	21.01
99,999	87,499	14.1	48.3	58,837	29.42
149,999	124,999	21.3	69.6	84,054	42.03
150,000		30.4	100.0		

<http://www.fairfaxcounty.gov/demogrph/gendemo.htm#inc>

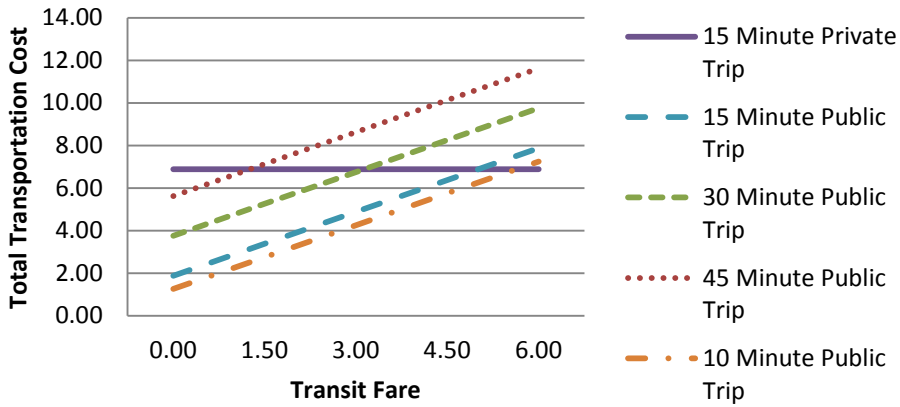
Transportation Costs

Total private transportation costs include the cost of an automobile, estimated at \$.50 per mile, the appropriate opportunity cost, and any other direct transportation costs. Total public transportation costs include the fare and the opportunity cost. Both private and public transportation costs are affected by the time required for travel.

The charts below display the total cost for a ten mile trip at different transit fares for individuals with opportunity costs of \$7.50, \$15.00, and \$30.00. For example, the chart which displays the total transportation cost at a \$15.00 per hour opportunity cost shows that the cost of a fifteen minute trip by private transport is \$8.75, which consists of the \$5.00 vehicle cost (\$.50 per mile times 10 miles) plus the \$3.75 opportunity cost (\$15.00 per hour times .25 hours). Private vehicle travel is unaffected by the transit fare. A public transit trip over this same distance that takes fifteen minutes has a total cost of \$3.75 (less than the cost by private vehicle) if the transit fare is \$0.00 and a total cost of \$8.75 if the transit fare is \$5.00.

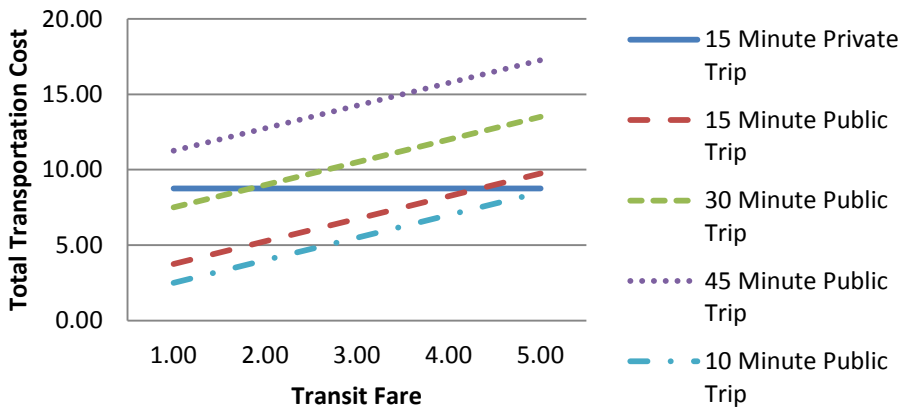
We see from these charts that a public trip that takes three times as long as a private trip costs less than the private trip if the opportunity cost is \$7.50 as long as the fare is low. The total transportation cost for people with an opportunity cost of \$30.00 is very sensitive to travel time. In this illustration, private transportation is a less expensive choice for people with opportunity costs of \$30.00 or higher for any trip that takes longer on public transit. Because approximately 50% of the population of Fairfax County has an opportunity cost of \$30.00 or higher, 50% of the population will find private transportation to be the better economic choice whenever a private trip takes less time than a public trip.

Total Cost: 10 Mile Trip, \$7.50 / Hour Opportunity Cost



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Total Cost: 10 Mile Trip, \$15.00 / Hour Opportunity Cost



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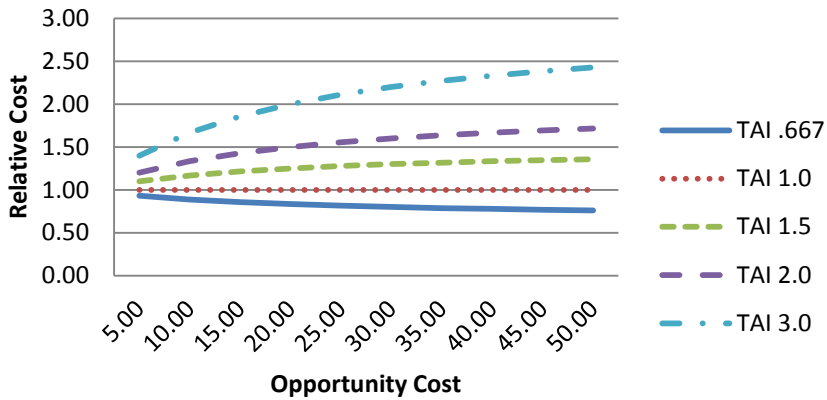


Transit Accessibility Index

The Transit Accessibility Index (TAI)TM is the ratio of the amount of time that it takes to travel from point A to point B by public versus private transportation. Transit accessibility, direct costs, and opportunity cost have significant impacts on the relative cost, or the cost competitiveness, of public versus private transportation. In the chart below, we see that when the transit fare is set to the vehicle cost per trip (\$5.00), public travel is competitive with private travel across all opportunity costs as long as public travel time is equal to or less than private travel time, which is to say as long as the TAI equals 1.0 or less.

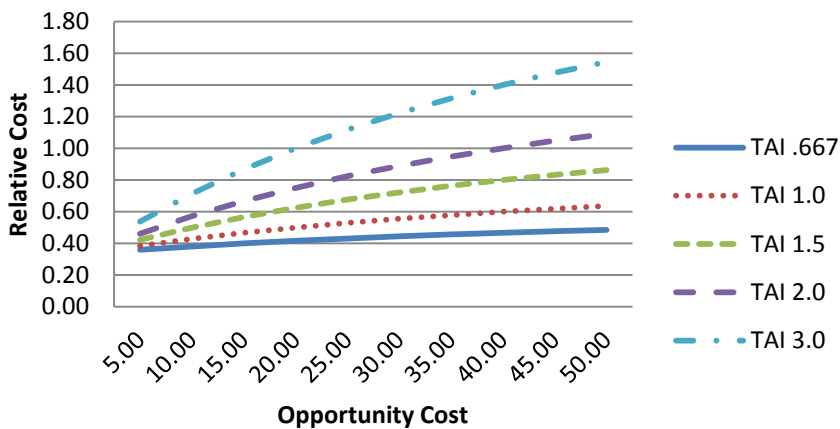
We have found very few instances in which the TAI is less than 1.0. In fact, it is often 2.0 or higher. One way to make public transit more competitive with private transit is through parking fees. As shown below, a \$10.00 parking fee renders private transport less expensive than public transport, i.e., the rational economic choice, to locations with a TAI of 2.0 and above for individuals with opportunity costs of \$40.00 and above. This \$10.00 parking fee renders private transport less expensive than public transport to locations with a 3.0 TAI and above for individuals with opportunity costs of \$20.00 and above.

Impact of Opportunity Cost on Relative Cost at Different TAI (Fare = \$5.00, Parking = \$0)



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Impact of Opportunity Cost on Relative Cost at Different TAI (Fare = \$5.00, Parking = \$10.00)



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Summary

Numerous factors influence individual transportation decisions, some of which are economic and may be described as "rational," and some of which are not. This model explains rational economic transportation decisions and describes how to use pricing to alter behavior.