REVIEW - *THE IMPACT OF TRANSPORTATION ON AFFORDABILITY: AN ANALYSIS OF AUTO COST WHITE PAPER*

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1.0 Introduction and Methodology

This paper was prepared in 2012 for the Manhattan Strategy Group in an effort to measure the costs of auto ownership and usage. The authors used the Consumer Expenditure Survey (CEX) to: (1) estimate the components of auto cost by income and auto ownership and (2) examine the pattern of depreciation of auto value. Both exercises are closely related because an accurate measure of depreciation could be used to determine the flow cost of auto ownership. In this review, we examine:

- The usefulness of the CEX for measuring auto costs;
- Omitted auto costs including parking and tolls;
- Auto cost estimates based on the CEX; and
- Statistical models for measuring depreciation.

2.0 CEX and Auto Costs

The CEX has several attributes that make it potentially useful for measuring auto costs. In particular, it is a very large sample with over 7,000 consumer units per month and it provides detailed information on auto-related expenditures. These detailed data have been usefully aggregated into four categories of auto costs:

- Purchase costs;
- Ownership costs;
- Drivability costs; and
- Fuel costs.

Because of the large size of the CEX, it is possible to present these cost categories disaggregated into income groupings. The researchers have reasonably chosen five groupings, with greater disaggregation at the lower end of the income scale since these are the groupings where the affordability concern is the greatest.

Purchase costs, which include the upfront expenditure required to purchase a car, finance charges, and lease payments present the biggest issue for estimating auto costs. For many, purchase costs are “lumpy;” for example, a household that purchases a car in a given year will have a large auto purchase cost in that year but little or no purchase cost in subsequent years. When they trade in or sell the vehicle, they will then recoup part of their purchase costs. Thus for any given household, purchase costs as reflected in the CEX may not reflect the annual cost of auto ownership. Averaging over large samples, however, should provide reasonable estimates of purchase costs. Note that the purchase costs could fluctuate across years based on the level of car sales. Averaging over the business cycle should largely address this issue.

Ownership costs (which households endure whether they drive the costs or not) include insurance, registration etc., and are essentially fixed each year.

Drivability costs are basically maintenance costs and are assumed to vary by vehicle miles traveled (VMT).

Similarly, fuel costs vary with VMT. Because the primary interest of the Location Affordability Index (LAI) is how costs vary geographically and because VMT is spatially dependent, a measure of variable auto cost per VMT is needed. While not discussed in this paper, the LAI uses regional average fuel prices, average fuel economy and estimated location specific VMT to compute fuel costs per mile traveled. Unfortunately, no corresponding measure of "drivability" per mile can be calculated. The LAI addresses the issue by assuming that the ratio of drivability costs to fuel costs is constant for each income group. [1] Thus the paper displays the ratio of drivability costs to fuel costs in Tables 3 and 4.

The assumption of a constant ratio of drivability costs to fuel costs is problematic. Specifically, I would expect maintenance costs to increase with age and mileage of vehicle, both because of wear and tear on the vehicle and the expiration of manufacturer warranties. Thus, drivability costs are likely to be underestimated for those who own fewer cars (less miles traveled per car) and those who keep their cars longer (or purchase previously owned cars) to save on purchase costs. Lower income households are likely to have fewer vehicles and older vehicles and therefore drivability costs may be underestimated for these groups.

2.1 Other Costs

One set of costs that are omitted from the main auto cost analysis are tolls, but these costs are addressed separately in the appendix. The authors point out that tolls are highly regional in nature, and less than 12 percent of households have any toll expenses at all. While it may be appropriate to exclude tolls from the analysis, there are locations for which tolls may seriously affect commuting costs. Bridge crossings into Manhattan, for example, can be as high as $13.00 which is a significant travel cost.

Another cost that can be significant for some locations is parking. While parking in many areas is free at both one's residence and employment location, this is not the case in many urban areas. Some dense urban communities have residential parking costs of $200 per month, and major urban employment destinations often have very high parking costs. Many low and moderate income people work in central business districts where parking costs are very high. While these workers don't have to work in the CBD, it is one of the primary locations of employment opportunity. Ignoring the parking costs in these cases significantly understates the auto cost associated with residential locations that are the primary commute shed for the CBD.

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[1] Based on documents from MSG, the calculation of auto cost is:

$$Cost = A * (Vp + Vf) + \left(\frac{VMT}{MPG}\right) * G * (1 + R)$$

Where:
A = Modeled autos per Household
Vp = Per vehicle purchase cost for the appropriate income group
Vf = Per vehicle (fixed) ownership cost from for the appropriate income group
VMT = the modeled annual household VMT
MPG = the national average fuel efficiency (20.7 mpg for 2008)
G = the cost of gas per gallon (average annual regional cost for 2008 - EPA)
R = the Average Ratio drivability to fuel cost for the appropriate income group

Note that since there is no measure in the CEX of total vehicle miles traveled there is no way to calculate the total spending on drivability (maintenance and repairs) as related to driving. However, from the CEX there is data on the ratio of fuel cost to drivability cots, thus $\left(\frac{VMT}{MPG}\right) * G * (1 + R)$ represents the total amount of spending attributed to VMT.

3.0 Auto Cost Estimates Based on the CEX

The four components of auto cost by income group that are developed in this analysis are summarized in Tables 2, 3, and 4 from CNT's report. Careful examination of these tables raises a number of questions about the nature of the data, methods of calculation, and suitability of the approach for measuring auto costs at the local level.

Four empirical regularities are evident in these tables:

- Auto purchases increase with income;
- All categories of auto costs per vehicle rise with income;
- The ratio of drivability costs to fuel costs rises with income;[2] and
- Auto purchase costs *per vehicle* increase with income.

The finding that auto purchases increase with income is exactly what one would expect. Higher income households will buy more and better cars if autos (and auto quality) are normal goods. One point needs to be made about this unsurprising finding. The fact that expenditures on auto rise with income indicates that when one is purchasing a car, one is purchasing more than just transportation. Rather, they are buying a set of amenities that can make driving more or less pleasurable. This notion is clearly illustrated by the increasing *per vehicle* purchase costs shown in Table 3. These findings suggest that the correct metric for auto costs would be "quality adjusted." However, that is clearly beyond the scope of this analysis.

The remaining findings raise a number of questions as to the nature of the underlying costs being measured. While the finding that vehicle purchases and *per vehicle* purchase costs increase with income is not surprising, it is less clear why one would expect *per vehicle* drivability and fuel costs to increase with income. Consider drivability costs. One might expect that lower income households would have older cars that are out of warranty and therefore have higher maintenance costs, but this is evidently not the case.[4] Similarly, one might expect that higher income households could afford more fuel efficient vehicles which would lower fuel costs per vehicle. Again this is not the case.

The lower per vehicle fuel cost for lower income households raises a particularly vexing question for the purpose of the LAI. One of the reasons why fuel costs for low income households may be low is that 1) they make fewer discretionary trips and 2) they choose residential and work locations that minimize their fuel costs. (And higher income households, with high amenity cars choose distant locations—with consequent high fuel costs—in part because driving is more pleasurable.) The endogeneity of the estimated fuel cost to household location choices is problematic because it is an input for the drivability to fuel cost ratio, which is the basis for the *location specific* auto cost estimates in the LAI.

[2] This does not strictly hold true when the sample is disaggregated by number of cars owned.

[4] One possible explanation for higher maintenance costs for higher income households is that the average repair bill for lower income household cars less, but that for these households the repair bill is more likely to be above the scrap value of the car. This would lead to a truncation of the distribution of repair costs and therefore a higher measured average repair cost for higher income households, despite a lower average repair bill for their cars. Another possibility is higher income households simply by more expensive cars which are more expensive to fix. In this case maintenance costs as a percent of value may be lower due to better reliability, but overall maintenance costs would be higher.

As discussed above, and in the previous section, the ratio of the drivability to fuel costs is conceptually problematic. Its measurement is also somewhat problematic. The researchers have chosen to present the average of the household ratios of drivability to fuel costs. These figures are roughly 50% larger than the ratio of the averages of drivability to fuel costs. The authors should make it clear why one estimate is preferred to the other.

While most of the findings that are disaggregated by auto ownership rates and income presented in Table 4 are as one would expect, the finding with respect to per vehicle purchase cost are perplexing. *Per Vehicle* purchase costs are more than three times as high, on average for households owning three or more vehicles than those owning one vehicle. What is the source of this dramatic increase in purchase costs? There is no obvious explanation of why purchase costs should increase so dramatically with the number of cars owned.

4.0 Statistical Models for Measuring Depreciation

As an alternative to purchasing costs based on the relatively lumpy expenditures and receipts associated with car purchases and sales, one could measure the decline in the value of a car over time to capture the flow cost of auto ownership. The approach taken in this paper uses a regression framework with dummy variable for age to observe the change in value of specific auto models as they age. The method is similar to that used in house price indexes. The implementation is appropriate and the findings appear to be reasonably robust to specification.

Interestingly, the models imply that autos lose over a third of their value in three (3) years, 75 percent of value in eight (8) years, and 90 percent of value in twelve (12) years. The authors interpret these residuals as scrap value. The fact that depreciation is most rapid in early years means that purchase costs should be considerably lower for households purchasing second-hand cars. Presumably, this lowers purchase costs for lower income households. However, one would expect that the value of cars decline rapidly, in part because the costs of drivability increase. This effect, however, is not evident in the data on drivability costs. It would be useful to have a better understanding of drivability costs, age of vehicle, and income of household.

5.0 Conclusion

From a conceptual point of view, the task of measuring auto costs is challenging, in part because the purchase of a car is not simply the purchase of transportation. From the LAI's perspective, one would ideally like to measure the cost of auto transportation from a location, not the cost of amenities of a car. That suggests the need for a quality adjusted measure of auto costs which would be a major challenge.

Overall, the CEX is very useful in estimating the components of auto costs. There are three specific areas of concern:

- The endogeneity of fuel costs to household location;
- The relationship between drivability costs and fuel cost seems likely to change with vehicle age; and
- The increasing purchase costs with number of vehicles owned is unexplained.

Finally, it would be useful to explore the relationship between drivability costs and age of car. This would provide more insight into the extent to which purchasing an older car is a viable alternative for lower income households, or whether maintenance costs increase to offset the lower purchase costs. With respect to this issue, it is also important to note that older cars may have other unobserved costs for lower income households related to poor reliability. Unreliable transportation could have large costs on households.