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To: ELF June 5, 2012

From: Sonny Conder

Subject: Transportation Cost Post Processor in MetroScope

Thanks to Maribeth working on a transportation cost estimator for the GHG project, I had cause to revisit the similarly structured transportation cost post processor presently embedded in MetroScope. The MetroScope post processor relies on the work place – residence location auto travel distance by ezone-rzone and HIA-House Type and the American Community Survey data for 2005 – 2006 by County to make a fairly general estimate of transport costs by mode by consumption bin by rzone. Certainly updating these data with far more spatially and demographically detailed information will greatly improve its accuracy. Having said that the existing MetroScope transportation post processor provides useful *ex ante* information that can now be tested with census and more complete ACS data.

The upshot of the 7 attached graphics is that thinking ahead to GHG applications the presumption that shifts in housing type alone will result in dramatic transportation behavior change is probably misplaced. Actual location within the regional geometry (ie edge versus middle), the scale of middle to high density development in the surrounding area, the level of multi-family zoning, alternatives to driving and income levels play major roles in transportation behavior – at least according to MetroScope.

Out of curiosity I selected 9 rzones from the 220 calibration (the only 2010 calibration that I have run through the transportation and housing cost post processor). I deliberately chose these zones to reflect a wide range of densities and most importantly density scales, incomes, housing stock, location within the region and transit level of service. The areas measured at the rzone (census tract) level are as follows (my descriptions are my unmeasured general impressions):

Pearl – High density, high level of transit service, large scale high density in middle of region with all MFD and a bi-modal income distribution.

Sellwood – Moderate density, moderate transit service, large scale moderate to high density in central city, mainly SFD with middle to high income distribution.

Gateway – Moderate density, high transit service, moderate density, low high density scale, at edge of central city, ½ MFD, low to moderate income.

Sunset Transit Center – Low to moderate density, middle transit service, moderate density scale, ½ MFD, middle to high income, location at edge of high density urban area.

Gresham CBD – Moderate to middle density, surrounded by low density, moderate to middle transit, high MFD, at edge of region, low to moderate income, focus of new urban development.

Aloha – Old 50's suburb, low to middle density, moderate transit, low density surroundings, almost all SFD, moderate income.

Hillsboro CBD – Moderate to middle density, middle transit, low density surroundings, location at edge of region, mostly SFD, moderate income, focus of new urban development

Orenco – Middle income high income, ½ mfd, middle densities, scale of high densities limited to immediate area, location at edge of region, focus of new urban development

Damascus – Low density, 100% SFD, high income, very low surrounding densities, location at edge of region.

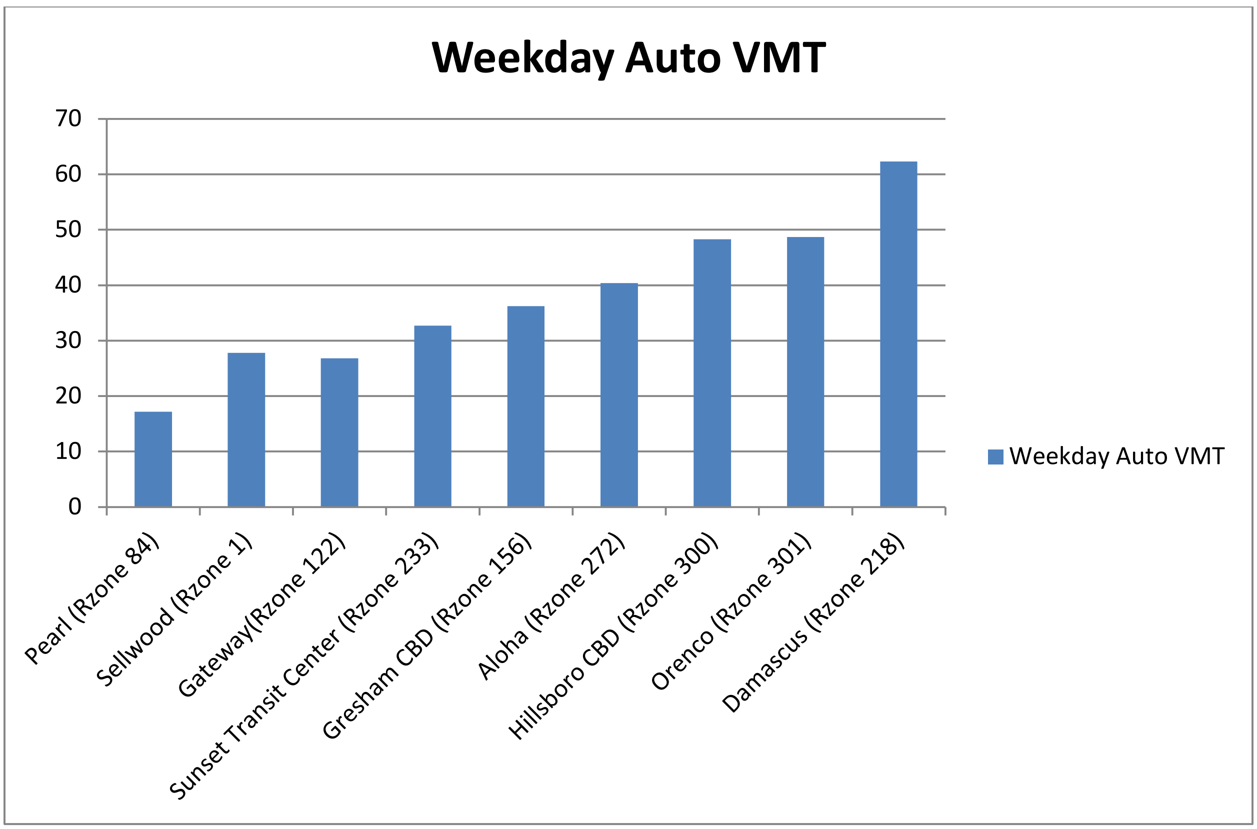


**Figure 1: The MetroScope Postprocessor calculates that weekday VMT varies by a factor of 3 for the census tracts selected.**

Figure 1 above indicates that the travel behavior of the census tracts selected according to MetroScope varies over a wide range. Part of this difference owes to differences in housing type by size and tenure, part owes to income, household size, age and demographic makeup and part owes to the level of transportation services and location within the region's geometry. The Pearl District is dominated by middle to high rise multi-family and mixed use development in the middle of the region with a bi-modal distribution of incomes dominated by low income in affordable units and middle to high income in new condo developments. Street connectivity, walking, biking and transit infrastructure are plentiful. Vehicle costs measured in average speed and parking charges are high. Damascus represents almost the polar opposite. The area is low density, SFD dominated with no street connectivity, walking, biking or transit infrastructure to speak of. High income, larger households dominate the demographics. Travel speeds are relatively high and free parking is plentiful.

We have deliberately chosen census tracts representing the Gresham and Hillsboro CBD's as well as Orenco where concerted local government efforts have lead to substantial "new urban" type public investments with accompanying zoning and investment support for moderate to high densities. The remaining census tracts comprise a range of development types and eras representative of what may be found in the region that falls within Metro jurisdiction.

Immediately noticeable is that at least at the census tract scale that with the notable exception of the Pearl new urban areas do not demonstrate a marked reduction in VMT. Indeed census tracts more centrally located in areas dominated by pre WWII development and infrastructure patterns materially outperform them without benefit of focused investment. This suggests that building an island of new urban design in a sea of 50's – 70's suburbia has a very limited benefit as regards travel behavior.

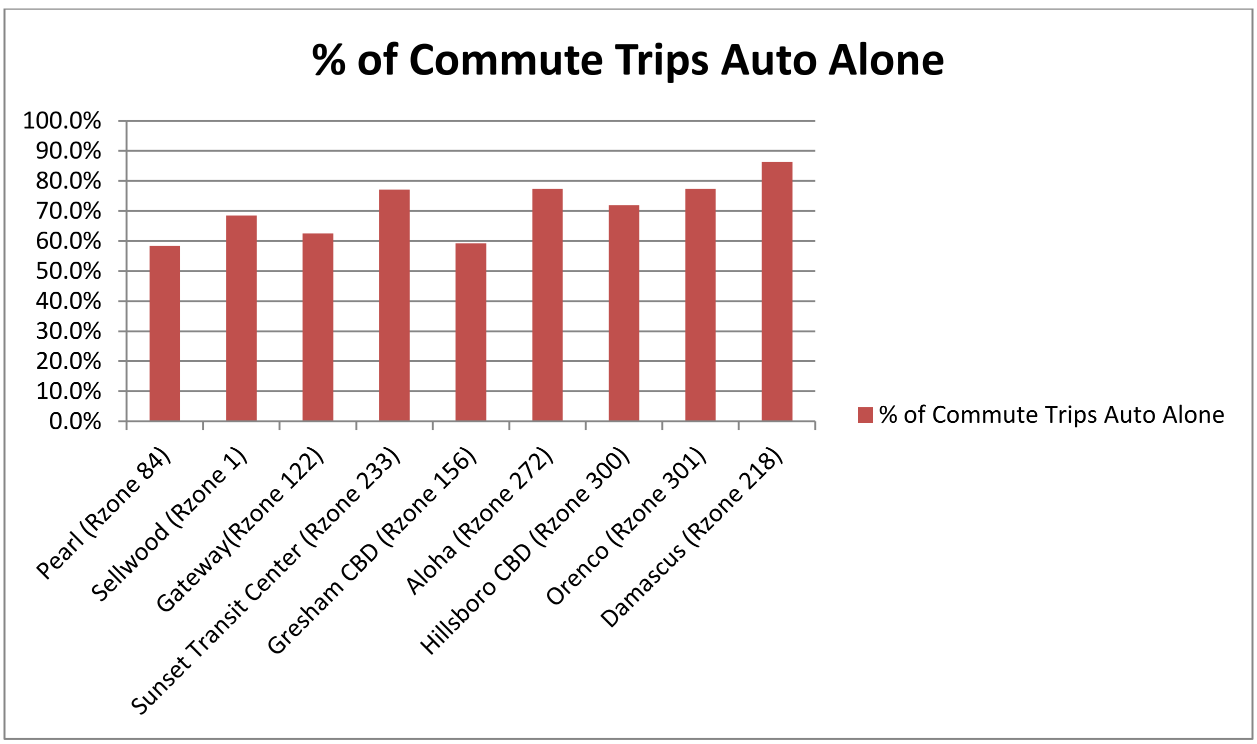


**Figure 2: According to MetroScope the Pearl, Gateway, and Gresham CBD have relatively low vehicle alone commute percentages.**

In Figure 2 we discern that the VMT pattern is not completely replicated in terms of mode commute choice. Areas with high transit connectivity and lower incomes experience more non vehicle alone choices that do high income areas particularly those with relatively low transit connectivity.  At this juncture I should emphasize that these are MetroScope estimates based on fairly crude county wide ACS 2005 – 2006 data.  More detailed LEHD (longitudinal employment household dynamics) survey data while underscoring the Figure 2 pattern indicate more robust responses to non vehicle mode connectivity.

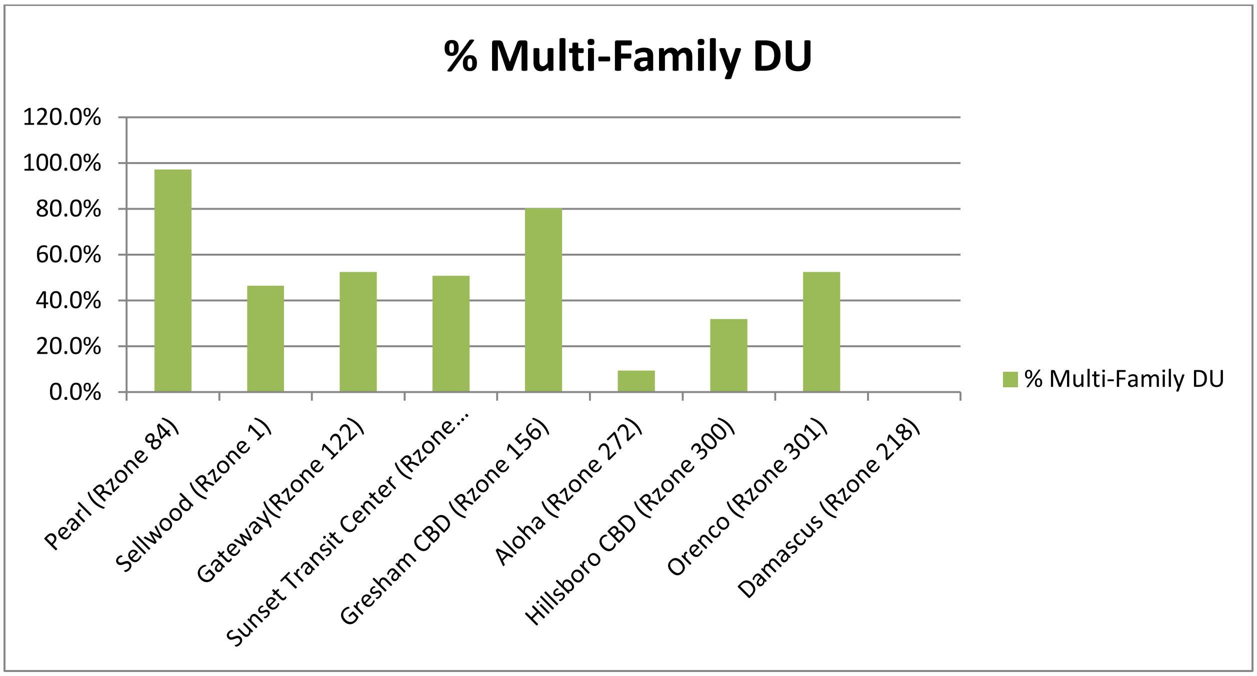


**Figure 3: The percentage of multi-family dwelling units in each census tract varies from almost 100% to 0% within the region.**

Figure 3 provides at least 4 levels of information relevant to household travel behavior.  First, a high level of multi-family development in the census tract (Pearl 97%) indicates high densities, a high level of connectivity and a large number of destination opportunities located nearby.   Second, high levels of multi-family development signal a self-selection process whereby households locate themselves in areas where the attributes of high density are common. Third, areas of high density are consciously targeted by various service planners to provide high levels of transit and alternative mode transportation. Fourth, such areas are likely to have a very heterogeneous income mix favoring small households without school age children.

By way of contrast we note that the Damascus area census tract with 0% multi-family has low densities, spotty transit service, limited non auto connectivity and large households with high incomes and substantial investment in private vehicles.  Likewise Aloha has a very low percentage of multi-family but has substantially lower VMT than Damascus due to lower incomes, more central location and higher surrounding densities. Gresham CBD despite a peripheral location has lower VMT than the Orenco census tract due to substantially higher percentage multi-family and lower incomes.[1]

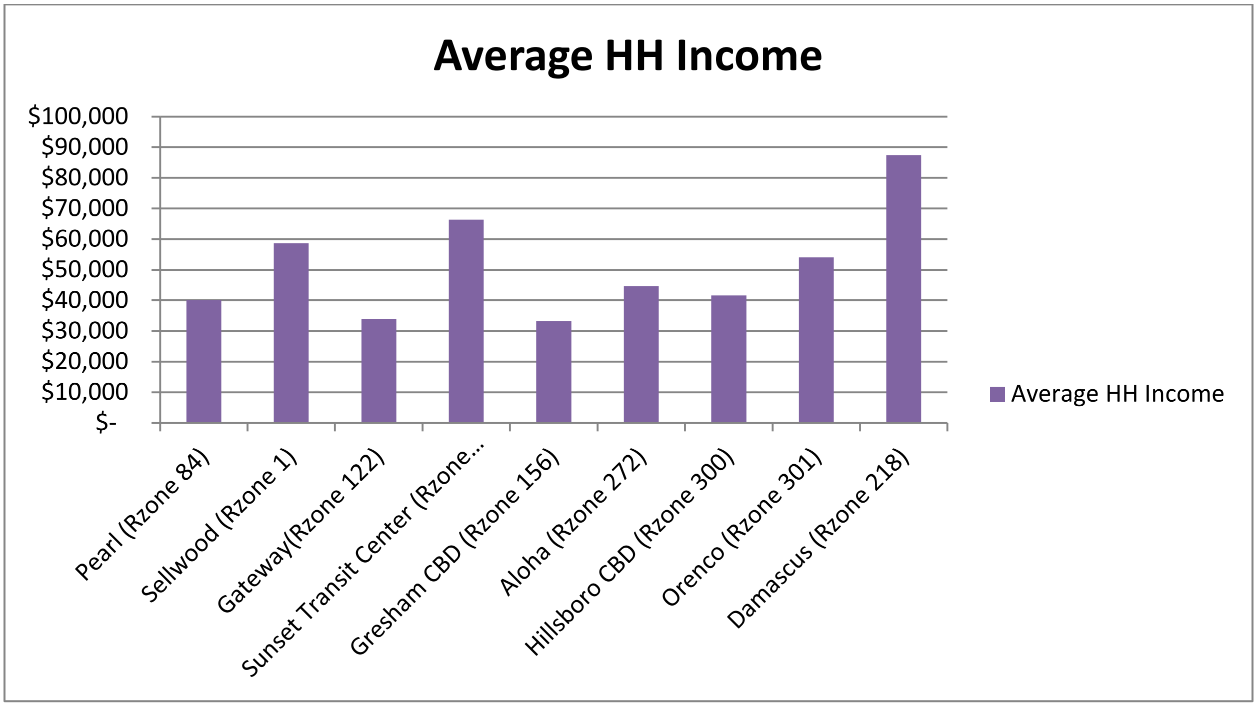


**Figure 4: Average household income varies widely in the region depending on housing mix, location and density.**

In Figure 4 we note as before that income has a mixed effect on VMT depending on surrounding densities, housing mix and location within the region. Notable is the Gresham CBD that despite low surrounding densities and location at the region's edge has middling VMT and relatively high non vehicle alone usage. Interesting is that the Sunset Transit Center's VMT remains fairly low despite higher incomes and high reliance on auto alone for commuting. Location close to the center of region by itself has a strong influence on the level of VMT for any given household.

So do Figures 1 through 4 tell us much about reducing VMT? First off, since resources are very limited we should be putting a high priority on finding and investing in areas more like the Pearl and avoiding areas like Damascus. That seems obvious except we have very few areas like the Pearl and an abundance of areas like Damascus simply as an artifact of geometry. It is the areas in between the Pearl and Damascus that remain critical to land use achieving much in the way of VMT reduction. I should point out that all evidence of appropriate scale (more on this later) points to new urban design reducing VMT below what it would be otherwise. It is just that some locational settings are more effective than others. The Gresham, Hillsboro CBD's and Orenco do not perform like the Pearl, Sellwood or Gateway

[1] In fairness we need point out that the Orenco census tract of 326.05 in 2000 has split into 4 tracts in 2010 – 326.07-326.10. The new tracts that specifically contain the new urban development display higher levels of transit, shorter average commutes, higher multi-family and VMT lower than the surrounding densities and peripheral regional location would imply.

because they are far more remote from the regional center and do not enjoy access to large tracts of middle to high density development. Given limited resources the problem reduces to choosing investments that yield the best returns on your objectives.

Up to this point the "data" we have been viewing comprise the outputs of our urban simulation model MetroScope. All of it is synthesized. One of the primary uses of integrated urban models is to be able to run "experiments" and make observations that one can never or very seldom actually measure. While an attractive feature, one is still left with a legitimate doubt as to validity. Does this exist or will it exist in reality or is it simply an artifact of the many intricacies of an admittedly complex model attempting to simulate a complex urban system?

Fortunately in this case Maribeth has mined the LEHD survey to produce a set of indicators for every 2010 census tract in the larger CMSA region. I have matched her data on average commute length and vehicle alone mode choice with the census tracts (year 2000 tract) I have used in Figures 1 through 4.

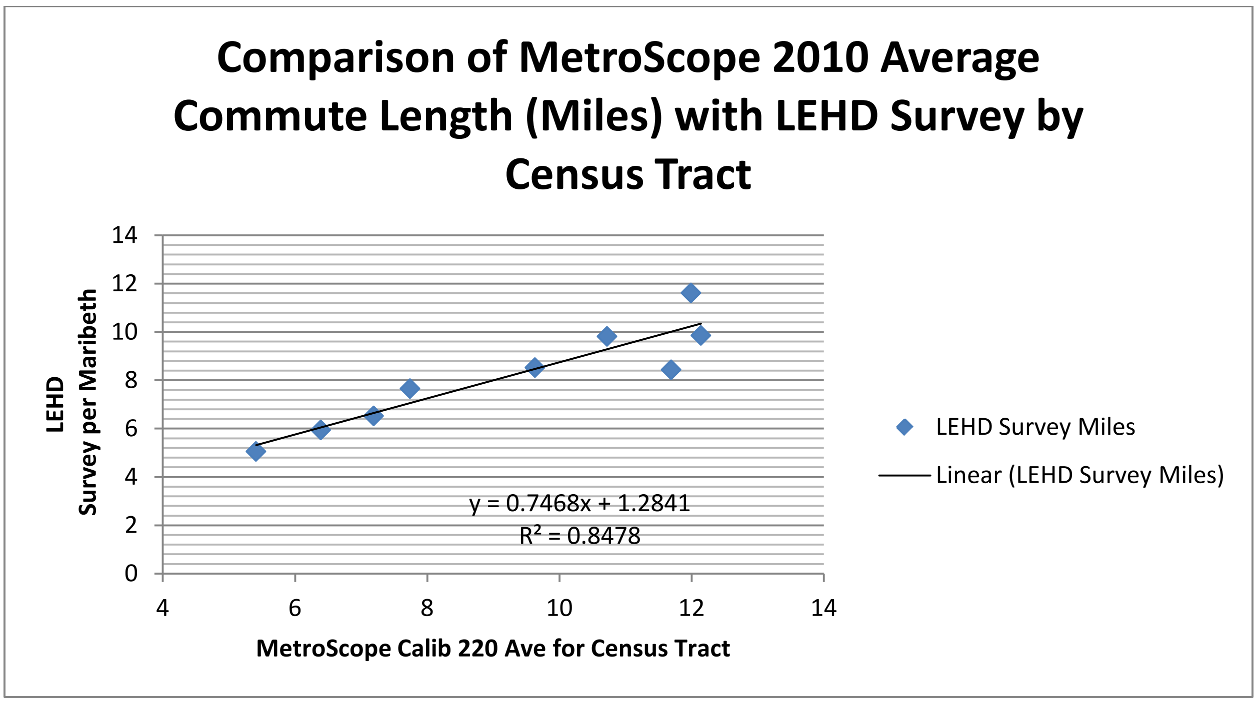


**Figure 5: Average commute length generated from the MetroScope residential location model matches consistently with actual measured average commute lengths taken from the LEHD survey.**

The comparisons suggest a good match of actual to MetroScope derived output. We emphasize that the comparison is *ex ante* and independent. It is *ex ante* in that the MetroScope numbers were calculated long before the actuals were tabulated. More cogent, no LEHD data or anything resembling LEHD data were available to MetroScope; so the results above do not reflect a trivial "fitting the curve to the data exercise". The distribution of commute lengths calculated for MetroScope reflect the operation of the residential location choice model where each household given its place of employment finds a residential housing type/tenure and location that satisfies its requirements for neighborhood, travel time and house size/type at a satisfactory price.

From a more critical perspective we note that MetroScope fairly consistently overestimates commute lengths by about 10 – 15%. For our selection of census tracts we note that the commute length for the Orenco census tract is overestimated 11.69 versus 8.44 miles. This significant difference strongly suggests that the Orenco area has shorter trips than would be expected from larger scale trends based on the surrounding area. In short, the Orenco area VMT is probably somewhat less than the MetroScope numbers suggest.

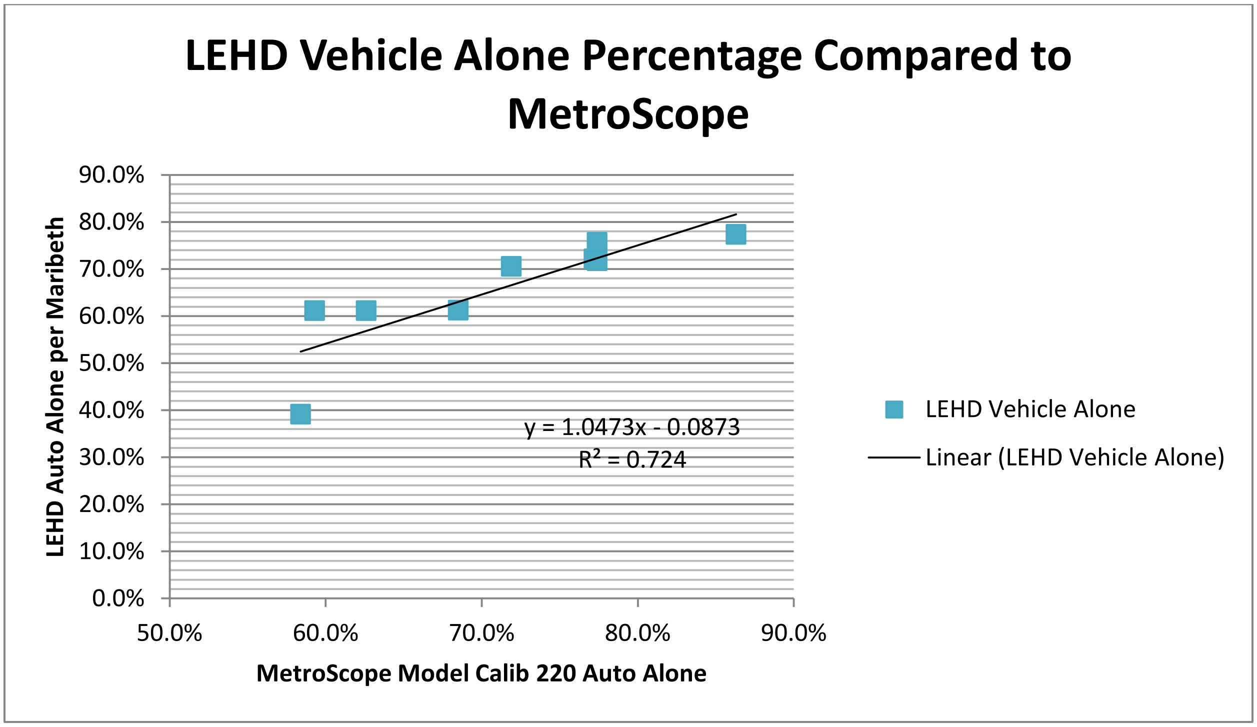


**Figure 6: MetroScope using 2005 – 2006 ACS county level data does a fair job of estimating actual auto alone percentages by census tract for 2010.**

The above comparison looks at the same 9 census tracts and compares the MetroScope vehicle alone share to the actual survey results taken from the LEHD survey. In this instance MetroScope overestimates vehicle alone by about 10% with a major outlier for the Pearl where MetroScope estimates slightly over 58% vehicle alone versus the actual measurement of 39%. While reasonably accurate, in the future we shall be using LEHD and census PUMS data to provide more spatial and demographic resolution to the MetroScope post processor.

Finally in Figure 7 below we show the census tract level for average one way commute distance for all comparable year 2000 and 2010 census tracts. Keep in mind that the MetroScope estimates are derived from the residential location model and do not use any origin and destination information but rather behavioral assumptions about how households trade off travel time to work versus housing price, housing type and neighborhood livability. The comparisons are *ex ante and independent.* These validity criteria are far more demanding than fitting parameters to observed or surveyed data. Evaluated at the mean travel distance MetroScope overestimates the travel commute length about 15% with the larger errors owing to including travel from external counties to the Metro region without correcting for travel in those counties to nearby employment centers (such as Salem) not represented in MetroScope. Also using centroid distance in the very large rural census tracts (ie Corbett) exaggerates the travel distance somewhat. MetroScope fit the observed survey measurements with an Rsq of .87; certainly more than adequate considering the nature of the validity test.

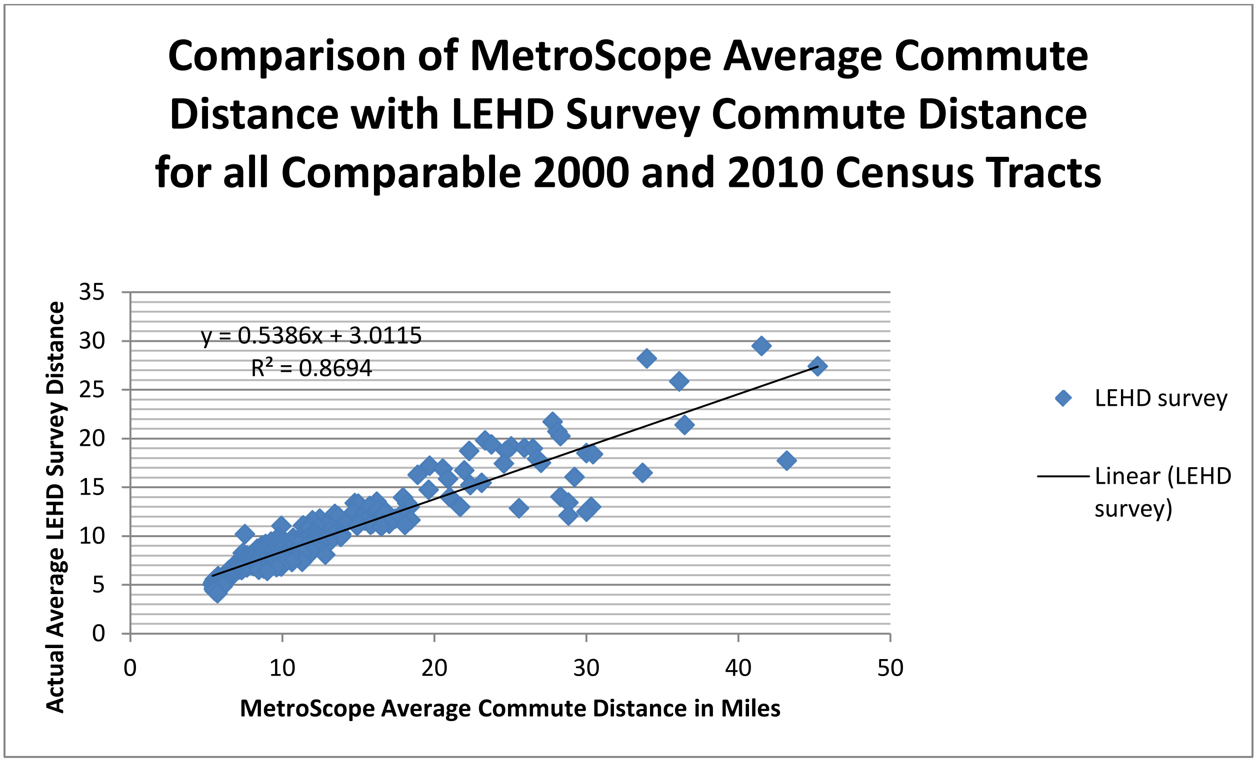


**Figure 7: The above graphic provides a comparison of MetroScope independently derived estimates of average commute distance by census tract with LEHD survey actual measurements. Considering that MetroScope estimates are *ex ante* and independent derivations not fits to data; the comparison is impressive.**