NONWORK TRAVEL TIMES AND CITY SIZE:

TESTING VARIANCES AS WELL AS MEANS

ABSTRACT

Relatively little attention has been paid to the relationship between travel time variances and city size. We utilize 2009 Nationwide Highway Travel Survey data and test the relationship between metropolitan area *nonwork* (home-based shopping and social/recreational) trip time means as well as variances with metropolitan area size. We include tests for metropolitan areas as a whole and for residents from included Urban, Suburban, Second City, and Town and County sub-areas. OLS regression analysis shows some estimated slopes are not statistically significant, and none is much greater than zero. Nonwork travel time means and variances are highly correlated. These relationships are also invariant with respect to the sub-area place of residence.

Whereas urban economists have emphasized the co-location of linked firms as part of their interest in agglomeration economies (see, for example Quigley, 1998, in particular his Table 1), we cite and build on literature that provides evidence for the co-location of workers and jobs hypothesis. Average trip times do not rise appreciably as metropolitan population increases, regardless of trip type. We conclude that our results here are additional, although indirect, evidence that the co-location hypothesis extends to nonwork travel and location behaviors.

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INTRODUCTION

Suburbanization is practically universal, and has been observed as a matter of empirical fact for almost as long as records describing the phenomenon have been kept (Bruegmann, 2005). See Table 1. Despite the near ubiquity of this trend, many of the discussions about cities and their growth reflect concerns over the cities' outward expansion and decentralization.

Some of the worries are predicated on the possibility of increased commuting costs. The Real Estate Research Corporation's *Costs of Sprawl* (1974) study was a widely cited simulation exercise that fed this fear. It suggested that miles traveled by residents of high-density central areas would be less than half the distances traversed by residents of low-density areas. But Altshuler (1981) reported that the report's authors had made a "simple error of calculation" (p. 387) in reaching their conclusions. Nevertheless, the intuition that cities' decided tendency to spread must mean longer travel distances has proved durable. Among urban economists there was a similar line of thought from a model derivation of "wasteful commuting" (Hamilton, 1982). Against the simplest ideal of perfectly informed trip cost minimization in a monocentric city, it seemed that many metropolitan area residents travel too far and too long.

Both of these approaches are strongly linked to the idea of a monocentric city where most employment is at the urban core and outward growth inevitably involves ever longer trips to the center – in terms of both longer distances as well as more congestion on radial routes oriented to serve travel to the core.

These views are uninformed by real world events highlighted by the suburbanization of jobs and residences. Many employers and employees co-locate and co-relocate because it is in the interests of each to avoid overly costly access. This behavior is predicated on the co-location hypothesis: Urban land markets operate sufficiently well to allow many employers and residents to obtain locations proximate to each other.

The empirical evidence is compelling. Anas (2012) found that

> "The data on the largest U.S. MSAs show that commute times increase only slightly with city size: the elasticity of the average

commute time with respect to the number of workers was about 0.1 in 1990 and 2000" (p.146).

Various studies identify evidence of spatial self-organization, e.g., remarkably efficient commuting patterns even in the second-best world of unpriced congestion externalities. Commute times increase only slightly with city size. Lee (2007) also documented this result and showed that those working in areas of "dispersed" job locations had the shortest commutes.

Co-location requires travel flexibility that is difficult to deliver with public transit services. Private automobiles offer greater flexibility than any other mode, and the utility of co-location strategies should covary with the frequency with which residents drive to work. Most recently, Cox (2013) relies on data from the American Community Survey to report that more than three fourths of US employment access was by driving alone, and that this has increased slightly between 2007 and 2012, despite the economic upheaval that began in 2008. Further, Cox reports that "driving along accounted for 94 percent of the employment access increase." Transit use hovers at 5 percent of commute trips (Shah 2013). Carpooling has greatly diminished, dropping to under 10 percent in 2012 from 20 percent in 1980. Working at home, the ultimate co-location strategy, was the work mode that showed the greatest relative increase in share, doubling from 2 percent in 1980 to 4 percent in 2012.

In our recent paper on work trips (An, et al., 2013), we utilized data from the 2009 Nationwide Highway Travel Survey (NHTS) for the 47 largest U.S. metropolitan areas to show that the various metropolitan subdivisions involved very similar relationships between *mean* commute times and area population. The NHTS (http://nhts.ornl.gove/) specifies interviewees place of residence along an urban continuum from "most central" to most "suburban-exurban." We adopted their categories, Urban, Suburban, Second City, and Town and Country; and examined the data for these four categories as well as for each metropolitan area as a whole.

We previously found that when commute time *variances* are estimated, they also respond only very moderately to increases in the number of people residing in the metropolitan area, in spite of the fact that variance estimates are more sensitive to outlier observations. We asserted that our findings corroborate the idea that employers and employees are involved in significant co-location. The main findings of this previous paper are shown in the Appendix.

PRELIMINARY RESULTS FOR NONWORK TRAVEL

We examine data for home-based shopping and social/recreational trips and report evidence that the co-location hypothesis extends to residents and retailers' location behaviors. As in the previous paper, we restrict the analysis to solo operated private vehicles and tabulate minutes instead of miles because we expect that what matters in individuals' decisions are time expenditures. We focus on the single-driver auto mode because we are interested in spatial separation; the use of travel time would distort the comparisons if mode variations between cities are introduced.

The data summarized in Table 2 indicate that trip time means and variances do not vary significantly across the three non-exurban area types for any of the three trip types studied. Town and Country commuters have the longest trips, but there are small differences among descriptors of trips taken by Urban, Suburban and Second City commuters. In contrast, when it comes to shopping, Second City and Suburban shoppers have the best access. The same is true for social/recreational trips. The variances for both of these trip types follow the same pattern.

Table 3 shows shopping trip comparisons for the same sub-areas, comparing the U.S. (actually all NHTS metropolitan areas) to the largest metropolitan areas. Three findings interest us. First, with the exception of Boston, all of the mean trip times in all of the MSAs are shorter than for the U.S. totals. This occurs in spite of the fact that these are the largest and densest U.S areas. Second, travel time differences among the MSAs are remarkably consistent. Third, within each of the MSAs (perhaps excepting Boston), mean travel times differ only slightly between sub-areas.

Table 4 shows results of OLS regression estimations against metropolitan population for the shopping trip times and the social/recreational trip times. The Appendix Table shows the corresponding results for commuting trips, from our previous paper. As in the previous paper, we show results for bivariate regressions as well as for specifications that add Census Divisions as controls. Once again, inclusion of the controls does little to differentiate the impact of population on either means or variances.

The close association between average nonwork travel times and variances and the increases in both nonwork travel times and variances with population suggests a possible decrease in travel time reliability in the largest cities. Higher travel time reliability means less uncertainty and fewer scheduling trade-offs. The plausible network performance losses associated with a decrease in travel time reliability are also mitigated by co-location strategies. Thus the data suggest a further incentive for co-location, and support for the co-location hypothesis: High travel time means come with higher travel time variances, and more schedule uncertainty, which co-location strategies diminish.

Most important for our interest, all the estimated elasticities are small. Many of them are not even statistically significant. This holds for models that predict mean travel times as well as those that predict variances. The results for the two classes of nonwork trips corroborate the co-location of retail and workers hypothesis even more strongly than the results from our commuting study. People living in outlying areas are well served by commercial opportunities no matter how large the metropolitan area. Most retailers have been adept at following their market, and households are likely astute at locating to provide access to consumption options. To the extent that many social/recreational destinations also involve private vendors often sited near retail outlets, this conclusion plausibly applies to more than just the retail shopping trips.

DISCUSSION

Mean travel times for work trips as well as for non-work trips do *not* rise appreciably with metro area population or location, but neither do the variances of travel times. This is counter intuitive, because these variance estimates are much more sensitive to outlier values in the data. These results are interesting for at least two reasons. First, household location choice with respect to journey-to-work optimization had long been thought by urban economists to be the fundamental organizing principle to explain urban structure. But it appears that households execute a more complex set of decisions that take into account their non-work travel. We would say that there is good evidence for strategic co-location of origins and destinations. Second, "Sprawl," at least as measured by travel costs, appears to be less of a market failure, amplifying efficiency losses in larger cities, than it is a co-location mechanism for mitigating road and highway network externalities.

The "smart growth" label identifies many planners' favorite prescriptions for how cities should develop. If more people were to live in compact and walkable neighborhoods, there would be less traffic congestion, cleaner air, more interaction between neighbors, fitter citizens, more voting, etc. It is far more likely that

Americans will continue to do most of their travel via automobile; albeit in lower emission, higher intelligence vehicles traveling across dynamically priced roads; and that most of them will continue to choose suburban living options.

There is no rationale for public authorities to pursue costly life-style reorientations. The data show that, no matter how large the metropolitan area and no matter how suburban the residence, auto users face fairly consistent and relatively benign opportunities for nonwork travel and the benefits it provides. So long as city residents value their time, major lifestyle changes to support the smart growth model are costly propositions. Policy prescriptions in this direction range from ineffective to economically wasteful.

TABLE 1: Core and Suburban Growth in Major Metropolitan Areas

Nation	**Since**	**Areas**	**Share of Change in Historical Core Municipalities**	**Share of Change in Suburbs**	**Classification**
United States	1950	52	8.4%	91.6%	Metropolitan regions over 1,000,000
Canada	1951	4	5.3%	94.7%	Metropolitan areas over 1,000,000
Western Europe	1965	42	-13.0%	113.0%	Metropolitan areas over 1,000,000
Japan	1965	8	7.6%	92.4%	Metropolitan areas over 1,000,000
Australia & New Zealand	1965	6	7.2%	92.8%	Metropolitan areas over 1,000,000
Hong Kong	1965	1	55.5%	44.5%	Metropolitan area
Israel	1965	1	-1.6%	101.6%	Metropolitan areas over 1,000,000
Total		114	5.6%	94.4%	

Source: http://demographia.com/db-highmetro.htm

TABLE 2: Travel Time Means and Variances by Trip Type for Metropolitan Sub Areas, 2009

Commuting Times (Minutes, Solo Drivers, One-Way)

Area	Means	Variances
Metro	25.2	338.7
Urban	22.8	214.7
Suburban	24.5	292.4
Second City	23.6	308.5
Town and	28.4	457.0

Home-Based Shopping Trips (Minutes, Solo Drivers, One-Way)

Area	Means	Variances
Metro	12.5	95.4
Urban	12.1	93.3
Suburban	11.9	80.9
Second City	11.3	78.4
Town and	17.6	221.4

Home-Based Social/Recreational Trips (Minutes, Solo Drivers, One-Way)

Area	Means	Variances
Metro	16.9	188.6
Urban	17.3	177.7
Suburban	16.4	173.7
Second City	16.3	183.9
Town and	17.2	208.2

Source: Calculated from 2009 NHTS data

TABLE 3: Home-based shopping trips (average minutes, solo auto drivers, one-way), U.S. and Largest Metropolitan Areas and their Sub-Areas

Area	U.S.[1]	New York	Los Angeles	Chicago	Washing-ton, DC	San Francisco	Philadel-phia	Dallas	Boston	Detroit	Atlanta	Houston	Miami	Seattle	Phoenix
Metro	**12.5**	**12.6**	**12.0**	**13.0**	**13.9**	**12.1**	**12.4**	**12.3**	**13.9**	**13.1**	**13.6**	**12.8**	**13.0**	**12.7**	**11.9**
Urban	12.1	13.5	11.8	13.4*	13.4	11.9	13.0*	10.9	--	--	--	12.2	13.0	--	10.9
Suburban	11.9	11.8	11.8	12.4	11.9	12.6	12.5	12.0	13.8	13.1	12.5	12.0	13.1	12.8*	11.7
Second City	11.3	11.6	11.1	12.3	12.1	10.7	10.6*	11.3	15.7*	--	10.0*	11.3	12.6	--	10.5

Source: 2009 NHTS (entries with n>100 shown; entries with n>50 but <100 denoted by*)
Sub-areas defined here: http://nhts.ornl.gov/2009/pub/UsersGuideClaritas.pdf

Urban
• Urban areas have highest population density scores based on density centiles
• 94% of block groups designated Urban have a density centile score between 75 and 99
• Downtown areas of major cities and surrounding neighborhoods are usually classified as urban

Suburban
• Suburban areas are not population centers of their surrounding communities
• 99% of block groups designated Suburban have a density centile score between 40 and 90
• Areas surrounding urban areas are usually classified as suburban

Second City
• Second Cities are population centers of their surrounding communities
• 96% of block groups designated Second City have a density centile score between 40 and 90

• Satellite cities surrounding major metropolitan areas are frequently classified as Second Cities

[1] All MSAs in 2009 NHTS

TABLE 4a. Estimated Elasticities: Coefficients from Log Population vs. Log Home-Based Shopping Trips

	Dependent Variable			
Area	**Means**	**Variances**	**Means with Census Division Controls**	**Variances with Census Division Controls**
Metro	0.04656*	0.1521*	0.05761*	0.1834*
Urban	0.11276*	0.3365*	0.11803*	0.3367*
Suburban	0.06664*	0.2388*	0.06753*	0.2772*
Second City	0.05618	0.2157*	0.07346*	0.2352*
Town and	0.01151	-0.0080	0.03570	0.04349

*Indicates significantly different from zero at the five percent level

TABLE 4b. Estimated Elasticities: Coefficients from Log Population vs. Log Social/Recreational Trips

	Dependent Variable			
Area	**Means**	**Variances**	**Means with Census Division Controls**	**Variances with Census Division Controls**
Metro	0.05585*	0.2225*	0.05659*	0.1979*
Urban	0.01036	0.05465	0.05967	0.2107
Suburban	0.06849*	0.3148*	0.05790	0.2536*
Second City	0.07267	0.3473*	0.08503	0.3449*
Town and	0.01090	0.02958	0.04906	0.01197

*Indicates significantly different from zero at the five percent level

APPENDIX

TABLE A. Estimated Elasticities: Coefficients from Log Population vs. Log Commute Trips

		Dependent Variable		
Area	**Means**	**Variances**	**Means with Census Division Controls**	**Variances with Census Division Controls**
Metro	0.1165*	0.3794*	0.1407*	0.4149*
Urban	0.1457*	0.4198*	0.1355*	0.3616*
Suburban	0.1425*	0.5329*	0.1518*	0.5210*
Second City	0.1533*	0.5384*	0.1927*	0.5833*
Town and	0.1122*	0.3978*	0.1271*	0.4159*

*Indicates significantly different from zero at the five percent level

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