Testing Newman and Kenworthy’s Theory of Density and Automobile Dependence

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Presented by:

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Google scholar search:
- “automobile dependence newman OR kenworthy”;
- 33,400 results
The Newman and Kenworthy work is well known in practice (Figure 4).

Some authors, controversially, posit a different viewpoint and contend that continued dispersal will lead to a natural "locational fix" of activities and reduced travel (Gordon and Richardson, 1989 and 1992). Such views tend to be based on the US suburban context. There are also issues raised around the acceptability of various policy stances, particularly the public acceptability of compact cities (Banister, 1998b and 1998c). It is argued here that suburbanisation has been stimulated by lifestyle choice and that attempts towards urban compactness are running against the aspirations of the majority of the public. However, the need to test compact cities for feasibility, feasibility, and acceptability (Handy, 1998c) also points to one of the empirical difficulties—in essence, e.g., whether the impact of density on travel patterns is due to density itself or of other variables associated with density (such as good transit or a central location).

Within the British context, there is a strong link between settlement size and transport. There are also some difficulties in applying the theory in terms of individual development decisions. It may take several decades before a policy of higher densities has a material effect on overall densities. The debate has also moved on somewhat from the compact versus dispersed argument, towards the question of balance, including polycentricity and "deconcentration" (see important principles—which growth concentrated at multiple locations (Henderson, 1997; Deffley and Johnson, 1997 – Figure 5). Hall and West (1998) describe their "sustainable social cities of tomorrow", developing the early garden city ideals of "development clusters along [re-opened] railway lines in the UK (Figure 6) – the case of Anglia). We will see that these ideas have been influential in places such as Sheffield and Northampton.

**Critiques**

- Ignoring other variables that affect fuel use (population size and income, for example) (Dujardin et al., 2012; Gordon and Richardson, 1989; Perumal and Timmons, 2015);
- Bivariate rather than multivariate (Dujardin et al., 2012);
- Incomparability of the different countries studied (Perumal and Timmons, 2015).

**Defending**

“In response to the question of whether increased density alone is enough, we say that public transit improvements are also needed—but the two go together, they are totally intertwined.” (Newman and Kenworthy, 2015, p. 174)
Literature on travel

- Built environment and VMT;
- Highway capacity and VMT;
- Fuel prices and VMT;
- Transit service and VMT;
Hypotheses

✓ (1) That GPD (density in persons per square mile) bears a simple, smooth inverse relationship to per capita VMT for urbanized areas in the United States.

✓ (2) When confounding variables are controlled, the relationship between GPD and per capita VMT continues to be strong and negative.

✓ (3) That a more complete measure of urban compactness/sprawl than GPD bears a similar inverse relationship to per capita VMT.
(4) That the relationship between density and per capita VMT is the same for urban form studies using aggregate data, such as Newman and Kenworthy’s, and the more numerous travel behavior studies using disaggregate (household level data).
Methodology

- Ordinary least squares (OLS) regression;
- 158 large urbanized areas in United States;
- Variables:
  - per capita VMT
  - population density, density factor, compactness index,
    population size, per capita income, fuel price, freeway lane miles, other lane miles, transit route density, transit service frequency
Results

**Hypothesis (1)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td></td>
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<tr>
<td>constant</td>
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<td>$R^2$</td>
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Figure 7. Daily Per Capita VMT versus Population Density of 158 U.S. Urbanized Areas (variables not logged)

Figure 8. Daily Per Capita VMT versus Population Density of 158 U.S. Urbanized Areas (logged variables)
Hypothesis (2)

When confounding variables are controlled, the relationship between density and per capita VMT remains significant and negative, but the significance level drops.
Measuring Sprawl and Its Impacts

- Low Density
- Segregation of Uses
- Lack of Strong Centers
- Sparse Street Network

Released October 2002
Suburbia USA: Fat of the Land?

Report Links Sprawl, Weight Gain

By Bob Stein
Washington Post Staff Writer

Suburban sprawl appears to be contributing to the nation's obesity epidemic, making people less likely to walk and more likely to be overweight, researchers reported yesterday.

In the first comprehensive examination of whether suburbia spreading across the U.S. landscape are affecting Americans' health, the researchers studied more than 200,000 people in 448 counties, producing the first conclusive evidence supporting suspicions that sprawl is aggravating the nation's growing weight crisis.

People who live in the most sprawling areas spend fewer minutes each month walking and weigh about six pounds more on average than those who live in the most densely populated places. Probably as a result, they are almost as prone to high blood pressure as cigarette smokers, the researchers found.

"There are lots of other reasons why we should work to contain sprawl," said Rod Hoving of the University of Maryland's National Center for Smart Growth, who led the study.

The study also found that the effect of sprawl was most pronounced in the 25 densest counties.

People living in the most spread-out areas were found to weigh about six pounds more on average than those in the most densely populated places. For example, people in the least sprawling counties were 33 percent more likely to have high blood pressure than those in the most sprawling counties.

Sprawl and Obesity

New research links suburban sprawl to obesity. You are more likely to be overweight live in an area with low population density and a more expansive street grid.
Connections to Outcomes

**Physical activity, obesity** (Ewing et al, 2003; Kelly-Schwartz et al, 2004; Sturms and Cohen, 2004; Doyle et al, 2006; Fan and Song, 2009; Plantinga and Bernell, 2007; Lee et al, 2009)

**Traffic fatalities** (Ewing et al, 2003)

**Air quality** (Kahn, 2006; Stone et al, 2010; Schweitzer and Zhou, 2010)

**Residential energy use** (Ewing and Rong, 2008)

**Emergency response times** (Trowbridge et al, 2009)

**Teenage driving** (Trowbridge and McDonald, 2008; McDonald and Trowbridge, 2009)

**Social capital** (Kim et al, 2006; Nguyen, 2010)

**Private-vehicle commute distances and times** (Ewing et al, 2003; Zolnik, 2011; Holcombe and Williams, 2012)
Update and Refinement

- National Institutes of Health
- Ford Foundation
- Smart Growth America

MEASURING URBAN SPRAWL AND VALIDATING SPRAWL MEASURES

Reid Ewing and Shima Hamidi

Prepared for:
National Cancer Institute, National Institutes of Health
Ford Foundation
Smart Growth America
Principal Component Analysis

DENSITY

MIX USE

CENTERING

STREET

popden
empden
lt1500
gt12500
urbden
jobpop
jobmix
wlkscore
popcen
empcen
varpop
varemp
smlblk
avgblk
intden
pct4wy

Department of City & Metropolitan Planning, University of Utah
Hypothesis (3)

<table>
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<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
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<tr>
<td></td>
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<tr>
<td>tfreq</td>
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<td>.033</td>
<td>-1.021</td>
</tr>
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</table>

R² 0.458

The compactness index is slightly more significant than gross density, but the difference is not material. It is the same for R².
This result can be taken as confirmation of Newman and Kenworthy’s basic theory, that density, properly measured, is strongly related to vehicle use, at least at the large scale of urbanized areas.
## New Results

Table 1.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Density</td>
<td>Household/population density</td>
<td>-0.04</td>
<td>-0.22</td>
<td>-0.22</td>
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<tr>
<td></td>
<td>Job density</td>
<td>0.00</td>
<td>-0.07</td>
<td>-0.07</td>
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<tr>
<td>Diversity</td>
<td>Land use mix (entropy index)</td>
<td>-0.09</td>
<td>-0.07</td>
<td>+0.03</td>
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<td></td>
<td>Jobs–housing balance</td>
<td>-0.02</td>
<td>NA</td>
<td>0.00</td>
</tr>
<tr>
<td>Design</td>
<td>Intersection/street density</td>
<td>-0.12</td>
<td>NA</td>
<td>-0.14</td>
</tr>
<tr>
<td></td>
<td>% 4-way intersections</td>
<td>-0.12</td>
<td>NA</td>
<td>-0.06</td>
</tr>
<tr>
<td>Destination accessibility</td>
<td>Job accessibility by auto</td>
<td>-0.20</td>
<td>NA</td>
<td>-0.20</td>
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<tr>
<td></td>
<td>Job accessibility by transit</td>
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<td>0.00</td>
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<tr>
<td></td>
<td>Distance to downtown</td>
<td>-0.22</td>
<td>-0.29</td>
<td>-0.63</td>
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<td></td>
<td>Distance to nearest transit stop</td>
<td>-0.05</td>
<td>NA</td>
<td>-0.05</td>
</tr>
</tbody>
</table>

Note:

a. Values supplied by Mark Stevens but not included in his article.
**Hypothesis (4)**

The alternate hypothesis is confirmed, which is the relationship between density and per capita VMT is different for urban form studies using aggregate data (regional) and the more numerous travel behavior studies using disaggregate (household).

- In the meta-analysis of Ewing and Cervero (2010), the elasticity of VMT per capita with respect to population density is only -0.04.
- In the aggregate analysis here, the elasticity of VMT per capita with respect of density factor is -0.599.
Discussion and Conclusion

• The contribution of Newman and Kenworthy to the planning field is undeniable.

• While density is correlated with per capita VMT, it accounts for relatively little of the variance in per capita VMT across U.S. urbanized areas.

• Other variables such as personal income and freeway capacity are more significant and have greater elasticities.
We suspect the reason is that the density factor includes information beyond simple population density. \text{Lt1500} (\% pop living at low suburban densities) and \text{gt12500} (\% pop living at medium to high urban densities) are more about the \textbf{distribution of population} than about simple density. Thus, the distribution of population and employment might be more important than overall density at the regional level.
This suggests an apples and oranges problem in the dataset. Houston and Hong Kong differ in many ways other than density alone, or even density and transit service availability. They differ in terms of per capita income, fuel price, highway capacity per capita, and myriad other factors, including culture. This may be most serious limitation of Newman and Kenworthy’s analysis.
Thank you!