Does Compact Development Increase or Reduce Traffic Congestion?

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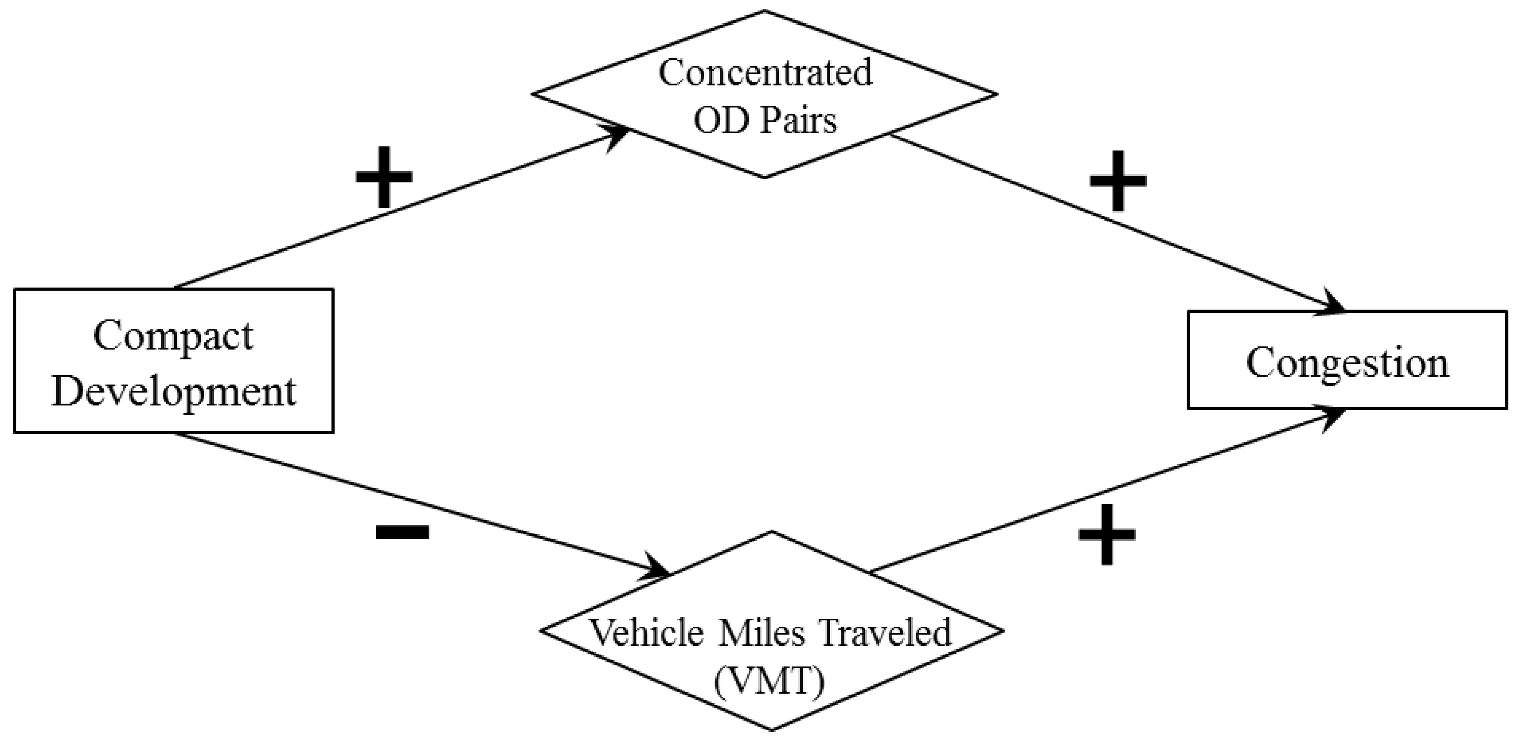
Introduction

In 1997, the Journal of the American Planning Association published a pair of point-counterpoint articles now listed by the American Planning Association as "classics" in the urban planning literature. In the first article, "Are Compact Cities Desirable?," Gordon and Richardson (Gordon and Richardson, 1997) argued in favor of urban sprawl as a benign response to consumer preferences. In the counterpoint article, "Is Los Angeles-Style Sprawl Desirable?" Ewing (1997) argued for compact cities as an alternative to sprawl. They disagreed about nearly everything: the characteristics, causes, and costs of sprawl, and the cures for any costs associated with sprawl.

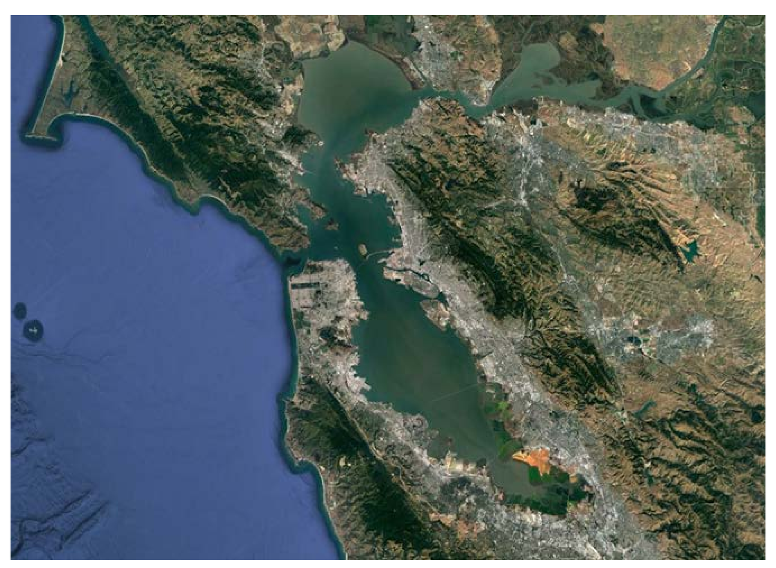
Gordon and Richardson said at the time and since that suburban sprawl acts as a "traffic safety valve, more of a solution than a problem." They go on to say: "Suburbanization has been the dominant and successful mechanism for reducing congestion. It has shifted road and highway demand to less congested routes and away from core areas. All of the available recent data from national surveys on self-reported trip lengths and/or durations corroborate this view." They note that most people live and work in the suburbs, and that most commuting is from suburb to suburb. A concept central to their claim is that as activities are spread across a greater area, and more roads are built to accommodate them, the resulting trips will also spread out, in turn, reducing congestion. Ewing took the opposite tack, arguing that sprawl, by definition, means spread out development where every trip is by automobile and many trips are long. He cited increases in average commute times from census to census. Neither article looked directly at congestion levels.



From the theoretical perspective, it is not obvious whose position is strongest. From years of research, we know that compact development that is dense, diverse, well-designed, etc. produces fewer vehicle miles traveled (VMT) than sprawling development. But compact development also concentrates origins and destinations, as shown in Figure 1. Since VMT is positively related to congestion, a reduction in VMT with compact development would tend to reduce congestion. And since concentrated OD pairs are positively related to congestion, an increase in concentration with compact development would then to increase congestion. No one has yet determined, using credible urban form metrics and credible congestion data, the net effect of these countervailing forces on area-wide congestion.

In the literature, there is a lack of consensus on the impacts of sprawl on congestion, as well as a clear need for more empirical analysis. It also suggests that how we measure sprawl may affect the resulting relationship between sprawl and congestion. Finally, it suggests that the use of proxies for congestion, such as commute times, may lead to different conclusions than the use of congestion measures themselves.

(a) San Francisco-Oakland urbanized area



(b) Atlanta urbanized area

Analysis

In this study, a cross-sectional study design is used with structural equation modelling (SEM) to estimate the long-run relationships between transportation and land use at a point in time. It is hypothesized that long-run relationships are explained by these models as each urbanized area has had decades to arrive at quasi-equilibrium among land-use patterns, road capacity, transit service, VMT, and traffic congestion.

Table 1. Compactness/Sprawl Scores for 10 Most Compact and 10 Most Sprawling UZAs in 2010

Rank		compactness index	density factor	mix factor	centering factor	street factor
Ten Most Compact urbanized areas						
1	San Francisco-Oakland, CA	175.50	190.14	88.90	169.16	148.36
2	Reading, PA	162.19	120.74	128.44	126.47	138.92
3	Eugene, OR	155.08	118.34	128.22	123.68	127.25
4	Madison, WI	154.73	118.70	88.50	186.95	111.97
5	Salem, OR	153.88	123.04	135.33	112.19	123.12
6	Lexington-Fayette, KY	152.04	134.48	123.02	124.22	112.03
7	Huntington, WV-KY-OH	146.87	83.29	129.11	148.69	126.96
8	New York-Newark, NY-NJ-CT	146.62	186.88	75.10	185.54	124.87
9	York, PA	146.17	98.46	138.95	126.74	113.29
10	Allentown, PA-NJ	145.91	108.68	134.48	105.34	149.70
Ten Most Sprawling urbanized areas						
148	Nashville-Davidson, TN	66.05	94.10	64.31	97.93	79.97
149	Cleveland, OH	64.29	99.21	88.55	95.75	64.26
150	Lancaster-Palmdale, CA	63.88	98.34	97.30	54.81	61.05
151	Winston-Salem, NC	63.27	70.82	89.69	89.15	61.51
152	Fayetteville, NC	62.90	80.58	89.21	67.29	69.36
153	Chattanooga, TN-GA	61.63	70.13	67.38	100.48	71.59
154	Atlanta, GA	58.34	87.47	113.62	104.91	49.05
155	Baton Rouge, LA	57.67	74.57	107.36	71.05	57.73
156	Jackson, MS	55.90	63.24	94.84	104.76	36.48
157	Shreveport, LA	45.80	66.36	71.04	68.36	66.43

- Our outcome variable, annual delay per capita.
- Exogenous explanatory variables. The exogenous variables, population and per capita income, are determined by regional competitiveness. The real fuel price is determined by federal and state tax policies and regional location relative to ports of entry and refining capacity.
- Endogenous explanatory variables. The endogenous variables are a function of exogenous variables and are, in addition, related to one another. They depend on real estate market forces and regional and policy decisions: whether to increase highway and local street capacity, whether to increase transit revenue service, whether to zone for higher densities, and whether to aim to reduce VMT. The compactness index is an endogenous variable which affects annual delay per capita both directly and indirectly.

Variable	*Definition*	*Source*	*Mean*	*Sta. Dev.*
Outcome variable				
delay	Natural log of annual delay per capita	TTI congestion data	3.25	0.38
Exogenous variable				
pop	Natural log of population (in thousands)	US Census	6.40	0.96
inc	Natural log of income per capita (in thousands)	American Community Survey	3.27	0.19
fuel	Natural log of average metropolitan fuel price	Oil Price Information Service	1.02	0.06
Endogenous variable				
flm	Natural log of freeway lane miles per 1000 population	FHWA Highway Statistics	-0.49	0.42
olm	Natural log of other lane miles per 1000 population	FHWA Highway Statistics NAVTEQ	0.85	0.28
rtden	Natural log of transit route density per square mile	National Transit Database	0.60	0.75
tfreq	Natural log of transit service frequency	National Transit Database	8.68	.55
tpm	Natural log of annual transit passenger miles per capita	National Transit Database	4.00	1.15
compact	Natural log of the compactness index	Many sources – see reference (Ewing and Hamidi, 2014)	4.57	0.25

The SEM was estimated with the software package Amos and maximum likelihood procedures. Causal pathways are represented by uni-directional straight arrows. Correlations are represented by curved bi-directional arrows (to simplify the already complex causal diagrams, some correlations are omitted). By convention, circles represent error terms in the model, of which there is one for each endogenous (response) variable. The final model has a chi-square of 12.1 with 12 model degrees of freedom, a p-value of 0.44, a Comparative Fit Index (CFI) of 1.0, and a root mean square error of approximation (RMSEA) of 0.008.

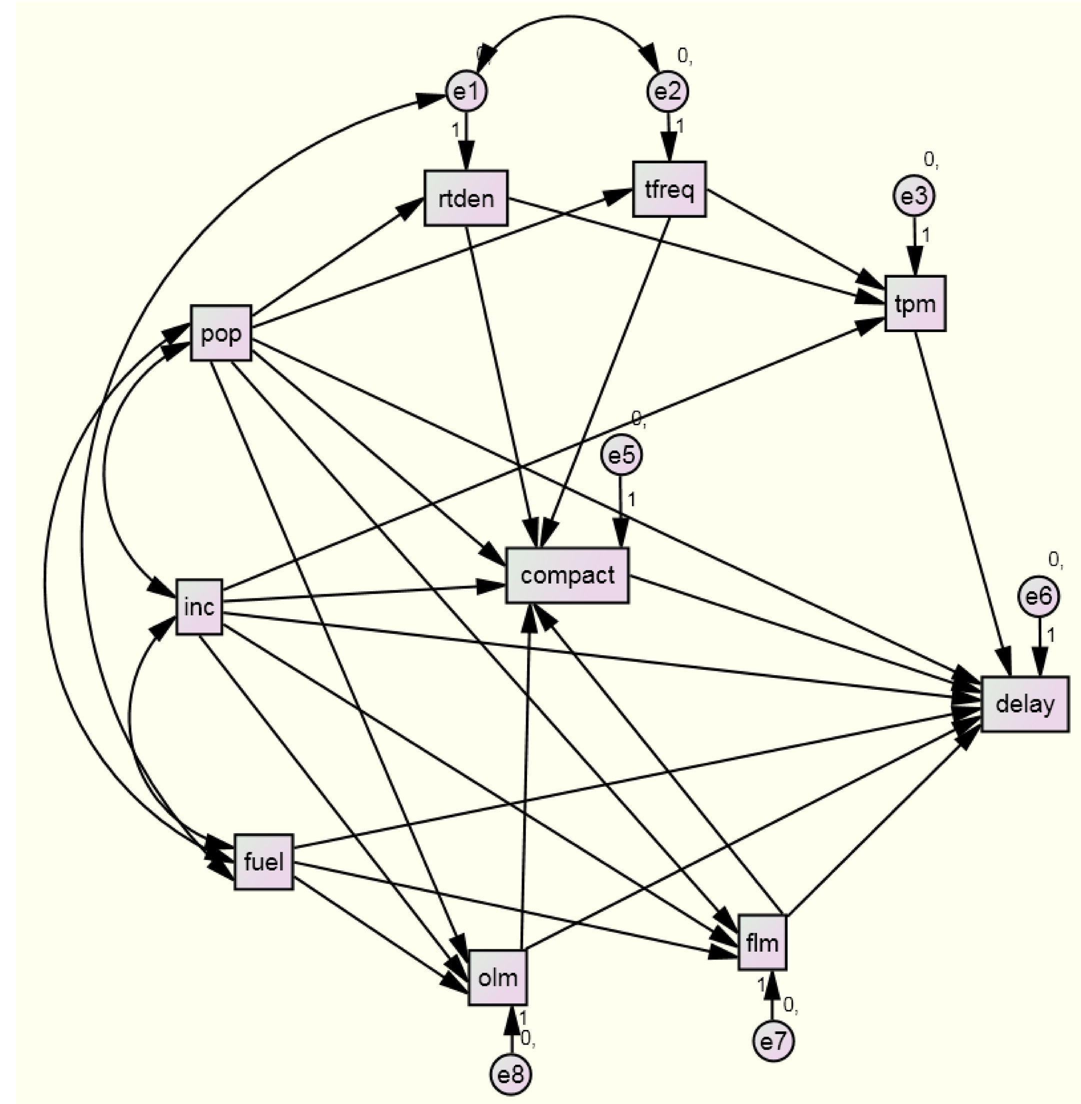


Table 2. Direct, Indirect, and Total Effects of Variables on Delay Per Capita in the Model

	Direct Effect	Indirect Effect	Total Effect
pop	0.181	0.039	0.22
fuel	-2.165	0.287	-1.878
inc	0.474	-0.022	0.452
flm	0.081*	0.004	0.085
olm	-0.24	0.032	-0.209
tfreq	0	0.01	0.01
rtden	0	0.006	0.006
tpm	0.022*	0	0.022
compact	-0.119*	0	-0.119

* Indicates effects that include a non-significant direct link.

Conclusion

The most widely used compactness/sprawl index has, when both direct and indirect effects are considered, essentially no relationship to a widely accepted and cited measure of congestion.

❖Developing in a more compact manner may help at the margin.

❖But the greatest reduction in congestion appears to be achievable through expansion of surface streets and higher highway user fees.