

Planning, Density, Fuel Use and Emissions: a Survey (or ‘Lies, Damned Lies, and Statistics’)

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(With apologies to Benjamin Disraeli to whom the above quotation is attributed by Mark Twain)

Introduction

In 1989 two Australians, Newman and Kenworthy, the one a geographer, the other an engineer, published a book which they called Cities and Automobile Dependence: an International Sourcebook. Two figures in that book appear to show a very strong negative relationship between population density and fuel use. The implication of these figures is that increases in urban density will result in lower fuel use and lower emissions, and they has been used since its publication to justify this view. In particular one was reproduced and used as a justification for higher densities in English cities in both the Rogers Report in 1999 and the Planning Policy Guidance on housing (PPG3) which was issued in early 2000 by the Department of the Environment, Transport and the Regions. Following that guidance the density of new housing in English cities increased substantially with the proportion of new housing built as apartments rising from 17 per cent in 1999 to 40% percent in 2009, and the proportion built as detached houses falling from 48 per cent in 1999 to 16 per cent in 2009. (I should note that the guidance did not apply in Scotland so the density of new housing development did not change in the same way there – see Evans and Unsworth, 2012).

Thus the book has been successful in promoting an increase in density, in England at least. And the authors would regard this as a success, since as one reviewer pointed out when it was first published, the second half of the book may be a source book and but the first half is more a piece of propaganda, being set out to support the authors’ belief that higher densities are desirable (Gomez-Ibanez, 1991). In the rest of this paper I shall provide evidence to justify this view. I shall show firstly that the evidence presented by Newman and Kenworthy is faulty, largely because of their antipathy to economic rather than physical data, and, secondly, that other factors have to be taken into account in planning cities to actually reduce fuel emissions.

Newman and Kenworthy

One of the figures published in their book purports to show ‘gasoline use per capita versus urban density adjusted to US income, vehicle efficiencies and gasoline prices’. In this form their figure was reproduced in Kate Barker’s Review of Planning (2006). There it was noted that these adjustments are stated to have been made so that, in this form, Newman and Kenworthy’s evidence is proof against claims that the differences in fuel use between cities arise from differences in prices and incomes so that any differences remaining result from differences in their physical characteristics, in particular density..

As stated earlier Newman and Kenworthy publish two figures showing a negative relationship between density and fuel use, one showing the relationship before any adjustments made to take account of economic differences, the other showing the relationship after the adjustments outlined above had been made. I have to say that when comparing the two figures closely for the first time I found it odd that the adjusted figure for gasoline use in London seemed to be only some twenty or thirty per cent higher than it was before any adjustment was made. After all one would have thought that differences in incomes alone would account for such a small difference, never mind differences in prices. And this is implicitly the Newman and Kenworthy argument – ‘it’s density that’s important not economic variables’.

In fact prices and incomes in the various cities are given in their Table 4.1. There the average per capita income for London is given as about \$5,000 (in 1980), whilst the average income for US cities was at that time just under \$8,000. The fuel price in London is given as 70cents per litre whilst the average fuel price in US cities is given as 23.6cents per litre. The implication of these figures is that if London incomes increased by 60% and fuel prices fell by 65% then the average per capita consumption of fuel would increase by about 30%! In my view, and I would have thought, in the view of almost anybody, this is clearly absurd. How do they justify this conclusion?

After a fairly diligent study of the book, though I did not find a justification, I did at least find an explanation. Their Table 4.2 shows the gasoline use per capita for cities in various regional groupings – U.S., Canadian, European, Australian, and Asian. It then gives two figures for the adjusted fuel use for each of these two groups, one using short term elasticities, the other using long term elasticities. In a footnote to the table these elasticities are given. Unsurprisingly the short term elasticities are smaller in absolute terms than the long term elasticities. The short term price elasticity is given as -0.2 and the long term price elasticity as -1.0. The long term elasticity of income is given as +0.6, the short run elasticity as +0.11. Using the short term elasticities the average gasoline usage in European cities rises from 13,280 Million Joules to 17,082, using the long term elasticities usage rises to 31,080.

Looking again at Figure 2, with this knowledge it is evident that the adjustment which has been made to the raw data has used only the short term elasticities, not the long term! I can find no justification in the book for this choice, a choice which is not discussed at all. Frankly to any economist the statement that the figures have been adjusted to take account of differences in prices and incomes implies the use of the long term not the short term elasticities. After all, when it is stated that the figures take income and price differences into account the impression is given that if US prices and incomes existed permanently in, say, London, this would be the change, not that the adjustment which has been made assumes that US prices and incomes have existed for only for a few years so that full adjustment has yet to be made. The most favourable interpretation of what Newman and Kenworthy did is that it results from their disdain for economic variables, not that it was a deliberate choice because it made the relationship between fuel use and density look better than it clearly is. Though some people, more suspicious than I am, might think otherwise.

Because the authors don't give the adjusted figures for any European cities anywhere in the Sourcebook the only figure we have is the average for these cities. If the long term elasticities are used then expected fuel use in these cities more than doubles, going from 13,280MJ to 31,080MJ, rather than a thirty per cent increase from 13,280MJ to 17,082MJ if short term elasticities are used.

There remain further problems with the figure. There are clearly errors in their calculations though this can be proved only in a single case. That is because they only consider one Canadian City, Toronto, so that full information is given about this city – it is not simply treated as one of a group of cities.

Their data shows that average income per capita in Toronto in 1980 was (in US dollars) \$7,521 against an average for US cities of \$8,089. The price of fuel was virtually the same at 23.5 cents per litre against a US average of 23.6 cents per litre. Fuel efficiency was lower, however, at 16.3 litres per 100km against the US average of 15.35. Thus any adjustment of Toronto fuel consumption to US incomes, prices and fuel use would involve a rise in incomes of 7%, no change in prices, and an increase in efficiency of 6%.

From these data their calculations somehow show that the adjustment would lead to fuel consumption falling by 14% in the short run, from 34,818MJ to 29,995MJ and, in the long run, a fall to 26,090MJ, i.e. a fall in the long run of 25%! These results are clearly wrong. But this is the only city for which one can actually check the calculations. Which means that we cannot rely on the rest of Newman and Kenworthy's calculations, those which we cannot check. How do we know that there is not a similar downward bias with respect to these other calculations?

Even accepting their figures as correct there is an important omission in their analysis, an omission consistent with their disdain for economic factors rather than physical form. Nowhere in their analysis is the cost of travel by public transport mentioned. This contrasts with the fact that there are extensive discussions of the physical characteristics of the public transport systems in the various cities. This omission is particularly important with respect to any contrast between US and European cities since the latter tend to subsidise public transport. As it happens Newman & Kenworthy's base year is 1980 and in that year a new Labour administration was elected in Greater London on the basis of a promise to subsidise and reduce fares. The fares were reduced and car journeys to work in central London fell in consequence. Since 1982 fares have continued to be subsidised and this has clearly affected usage. Free transport was also introduced in the eighties for old age pensioners. Most if not all European cities similarly subsidise public transport which leads to less fuel use. US cities do not. Once this is taken into account, and the differences in fuel prices and incomes properly taken into account physical density becomes relatively unimportant except with respect to the cities of the western United States with their exceptional, in world terms, urban sprawl.

The position of Newman & Kenworthy regarding economic factors is summarised in two paragraphs on page 75. "The econometric models suggest that there is little that can be

done other than taxing gasoline and vehicles or legislating for better vehicle fuel efficiency. This study does not examine those policies but results so far suggest that increases in urban density and centralisation, together with the provision of a good transit option and restraint in the provision of automobile infrastructure, have important potential for saving fuel.”

But there is a clear problem here. Urban land use and infrastructure variables can only be altered in the long run and at considerable cost. It has been calculated (Hall,2001) that doubling the density of a city would reduce fuel use only by some fifteen per cent, a change which could be achieved far more quickly and at no cost in terms of resource use by increases in the price of fuel. For a significant change in the density of a large city in a short period of time is impossible. And as we know with respect to, say, the construction of Crossrail currently underway in London, changes in transport infrastructure are years in the planning and years in the construction.

A further problem is that Newman & Kenworthy are inconsistent. They talk in terms of very long run changes in density, but then use, as we have shown that they have, the short run elasticities of fuel price and income in order to demonstrate that the effects of changes in the price of fuel are unimportant compared to changes in density. Their inconsistency, however, does fit in with the view that we reported earlier – that the book was written to demonstrate the importance of urban density, virtually as a piece of propaganda.

Other Research

Given the problems with the Newman and Kenworthy ‘research’ it is unsurprising that others who have used the data which N and K put together have come up with rather different conclusions. Thus Ian Gordon (1997) carried out regression analysis using the N&K data. His findings were that, using logs, and regressing Fuel Use on Density alone, the relationship was:

$$FU = 5.8 - 0.70 d,$$

and the R squared was 0.78, with t=9.5. On the other hand, if prices and incomes were included then the relationship changed to:

$$FU = 6.7 - 0.23d - 0.75p + 0.25 y.$$

The R squared improved significantly to 0.95 and fuel price, p, was far more significant than density with a t value of 6.0 against 3.7 for density. Once both density and price were included incomes became non-significant and ‘explained’ little. Thus the conclusion from the use of statistical analysis was that it was gasoline prices rather than density which was the most important determinant of fuel use, a finding which carries the added benefit for policy purposes that prices can be changed quickly and easily whereas density can be changed only slowly and at considerable cost. Thus the increases in taxes on petrol carried out by British governments over the past ten years or so will have done far more to hold back fuel consumption than any changes in planning policy.

Later research carried out by Mindali, Raveh and Salomon (2004) also casts doubt on the N&K conclusion that there is a simple relationship between density and fuel use. Mindali et al do not use price or income data, however, but analyse solely the data collected on the physical characteristics of cities collected by Newman & Kenworthy using a relatively sophisticated statistical analysis called Co-Plot. They conclude that their 'research asserts that one cannot refer to the negative correlation between urban density and energy consumption as a given'. The distribution of the population within the urban area matters. They conclude that 'outer area population density has no statistical correlation with energy consumption' in either the group of European cities or the group of American and Australian cities. This appears to be because increases in outer city population may increase overall urban density but these new outer city residents will not necessarily work in the inner or central city, commuting by public transport, but will often find jobs elsewhere in the outer city making 'circumferential trips' to work by car.

UK Planning Policies and Fuel Use

What has been established then, contrary to the 'evidence' provided by Newman and Kenworthy, is that economic policies will be more efficient in reducing fuel use and CO₂ emissions than planning policies. But I think we can go further than that and show that the evidence suggests that UK planning policies are actually counterproductive.

In an earlier paper, published in 1998, thus prior to the Rogers Report published in 1999, I put forward the argument that the UK's planners seemed to have reacted to the idea that CO₂ emissions should be curbed in a manner which I likened to that of Dr Pangloss, Candide's tutor who believed that everything is for the best in the best of all possible worlds. Thus the view seemed to be at that time that UK planning policies of constraining land use through restrictions on the development of 'greenfield' sites, designation of green belts, etc, policies which were already in existence, were all that was needed to reduce CO₂ emissions and needed only to be strengthened.

This seems still to be the position whereas, as I shall attempt to show, the converse is true – if we are serious about reducing fuel use and CO₂ emissions in the long run then these planning policies need to be rethought. This applies particularly to 'greenbelt' policies of constraining the boundaries of existing towns but allowing development at a distance from these towns. Since the jobs and employment remain in the towns and cities then commuting to these jobs remains but for distances which are longer than they would have been without the policies of constraint. In the rest of this section I shall spell out the evidence supporting this view.

First there is evidence from research carried out at Oxford Brookes University which was carried out some years ago and referred to in my earlier paper.

Secondly there is now considerable evidence that development is taking place away from major centres, in rural areas, and resulting in more and longer journeys, with consequent increases in fuel usage. It is here that the requirement that the development of 'brown field' sites for housing is to be encouraged, wherever they may be, becomes

counterproductive in so far as fuel use is a matter for concern. As a specific example, some six miles to the west of Reading, near the village of Bradfield in Berkshire, a small cottage hospital set in open countryside closed down some ten or twelve years ago. Though some distance from the nearest major centre it was redeveloped for housing at a relatively high density. The nearest bus stop is some six or seven hundred yards away and the buses stop there six times a day. If you miss the eight a.m. bus to go to work then the next is an hour and a half later! Clearly anyone living there will go to work by car and most households would need two cars. But as far as planning policy is concerned the right boxes have been ticked. – (1) a brown field site has been redeveloped, (2) at a high density, and (3) there is a local bus service. The development is therefore clearly in line with current planning policies aimed at protecting green field sites and encouraging the use of public transport rather than cars. Only a nitpicking economist would complain that the policies have been followed but in a way that achieves the result that planners claim their policies are intended to prevent i.e. the development results in greater fuel use and emissions than might have occurred if it had been better located.

That this is not some exceptional example is demonstrated by evidence presented in a recent paper in the journal Land Use Policy. This showed that, in the period , more homes had been provided through the infilling of spaces within villages than had been provided in English city centres. Once again planning policies were being followed but the benefits in terms of reduced fuel use or reduced emissions were, to say the least, highly questionable. The benefit seems to be that urban expansion is restrained, and this could be seen as to the benefit of the preservation of the English countryside.

The third piece of evidence does not relate to development in England but to development in the United States. The advantage of US data is that different policies can be operating in different States and indeed in different metropolitan areas, whereas the centralisation of government in the UK reduces the possibility of this variation to differences between, say, England and Scotland. The evidence is contained in a paper in Urban Studies by Rodriguez, Targa, and Aytur (2006). In a study of the largest twenty five U.S cities they found that ‘the presence of containment policies at the local level is related to higher development densities and to higher miles travelled at the metropolitan level’. (p.1892). In brief, their explanation is that containment at a local level raises densities and costs, and the increase in costs causes people to travel from elsewhere in the urban region where costs are lower.

What Rodriguez et al describe can be seen to be occurring in UK urban regions, most obviously London. The green belt constrains development so house and land prices are high. People therefore live on the other side of the green belt and commute across it in the morning and evening. Newman and Kenworthy themselves recognised this problem in remarking (p.19) that the data for London was unsatisfactory in that it was available only for the county of Greater London. Though this includes most of the contiguous urban area it does not include all of it, and it certainly does not include what any economic geographer would recognise as the Functional Urban Region (F.U.R.), the area from which a high proportion of the population commute into London.

Consideration of the FUR nevertheless suggests that higher density in the FUR could be achieved by a greater expansion of the urban area. The current extent of the urban area is the result of a policy decision – to maintain a green belt – which results in higher fuel usage and CO2 emissions (and lower overall density) in just the way that Newman and Kenworthy criticised when discussing the US cities of the west and far west. We too have sprawl, but contained sprawl – to pretend otherwise is to put the telescope to one's blind eye.

Conclusions

I have attempted to show in this paper that policies which are claimed to reduce fuel use and CO2 emissions appear to be based on opinions but that these opinions are not grounded in hard evidence. Indeed the evidence which exists seems to have been manipulated, whether intentionally or not, to fit in with preconceived opinions. Since it seems to me that there is some urgency in the need to reduce CO2 emissions to claim that policies are intended to do this when, as operated, they actually result in greater emissions, seems to me to be at best misguided, and at worst dishonest.

References

Bibby, Peter (2009) Land Use Change in Britain, *Land Use Policy*, Vol. 265, S2-S13.

Evans, Alan W. (1998) Dr Pangloss Finds His Profession: Sustainability, Transport and Land Use Planning in Britain, Journal of Planning Education and Research, December , Vol 18, pp.137-144.

Evans, Alan W., and Rachael Unsworth (2012) Density and Consumer Choice. Urban Studies, Vol. 49, May

Gomez-Ibanez, J.A. (1991) Review of Newman & Kenworthy. Journal of the American Planning Association, Vol 57 No 3, pp376-9.

Gordon, Ian (1997) Densities, Urban Form, and Travel Behaviour. Town & Country Planning, Vol 66, No 9, pp 239-241.

Hall, Peter (2001) Planning for a Sustainable Future. Sustainable Cities or Town Cramming, eds. A. Layard and S. Davoudi (London)

Headicar, P. & C.Curtis (1994) Residential Development and Car Based Travel: Does Location Make a Difference? Paper presented to a PTRC Forum. School of Planning, Oxford Brookes University (Unpublished)

Mindali, O., A.Raveh, & I. Salomon (2004) Urban Density and Energy Consumption: a New Look at Old Statistics. Transportation Research A, Vol 38, pp143-162.

Newman, P.W.G., and Kenworthy, J. R., (1989) Cities and Automobile Dependence: An International Sourcebook. (Aldershot: Gower)

Rodriguez, Daniel A., F. Targa, & S.A. Aytur (2006) Transport Implications of Urban Containment Policies: A Study of the Largest Twenty-five US Metropolitan Areas, Urban Studies, Vol 43, No 10, September 2006.