Transportation **23**: 35–54, 1996

Empirical evidence on induced traffic
A review and synthesis

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Key words: generation, road-building, traffic

Abstract. Disparate evidence indicates that the provision of extra road capacity results in a greater volume of traffic. The amount of extra traffic must be heavily dependent on the context, size and location of road schemes, but an appropriate average value is given by an elasticity of traffic volume with respect to travel time of about –0.5 in the short term, and up to –1.0 in the long term. As a result, an average road improvement has induced an additional 10% of base traffic in the short term and 20% in the long term: individual schemes with induced traffic at double this level may not be very unusual, especially for peak periods. Induced traffic is particularly seen on the alternative routes that road improvements are intended to relieve.

1. Introduction

This paper first synthesises a wide range of evidence which identifies the existence and level of induced traffic, though excluding, for reasons of space, important other literature relating to the mechanisms and reasons which bring it about. This synthesis suggests some expectations about what features might be looked for in available evidence on traffic counts, albeit expecting, for the reasons outlined by Bonsall in his accompanying paper, that this comparison will be indicative rather than conclusive. The approach taken is that inferences are to be judged on the basis of "balance of probability" rather than conclusive rejection of a formal hypothesis.

The background to the investigation is that faster traffic growth on improved and less congested roads than on congested roads is a ubiquitous observation. The argument that this is connected to induced traffic, although somewhat informal in character, shows an unbroken intellectual continuity for nearly sixty years, since Bressey & Lutyens (1938) reported that the Great West Road

> . . . as soon as it opened, carried $4\frac{1}{2}$ times more vehicles than the old route was carrying; no diminution, however, occurred in the flow of traffic on the old route, and from that day to this, the number of vehicles on both

> routes has steadily increased . . . These figures serve to exemplify the remarkable manner in which new roads create new traffic.

In the post-war years the most influential study was by Glanville & Smeed (1958). Their work showed that traffic growth on roads that were already congested was much slower than traffic growth on roads which were less congested. Later evidence of this character has been cited by the Institution of Highways and Transportation (SACTRA 1994, Fig. 4.1), and by Mogridge et al. (1987) whose analysis of data for London extended Glanville and Smeed's approach. Growth in traffic at the outer London boundary cordon still approximately kept pace with the average increase in car ownership, at 2.3% per year. However, the growth rate at the inner London cordon was 0.8% a year and in central London was 0.4% a year.

Nationally, traffic growth rates have also been slowest where congestion is worst, and fastest where existing capacity is still spare, or new capacity is provided: from 1980 to 1990 measured traffic on major roads in built-up areas grew by 20%, on major roads in non-built-up areas by 58%, and on motorways by 73%.

Of itself, observation that traffic has grown more where there is spare capacity for it to do so does not prove that the provision of capacity caused the growth. However, from the late 1950s to 1990, the amount of traffic on trunk roads in the UK increased overall by a factor of eight. During this period, about 3,000 km of motorways were constructed. Present trunk road traffic patterns in time and space could not have been fitted onto the 1950 road network. In such circumstances, it is logically necessary to assume that some degree of suppression will occur. If, then, an increase in capacity is provided, it is equally logical to assume that the otherwise suppressed traffic will appear.

The field has been rich in repeated reviews of the available evidence, though without effective consensus on their results. Pells (1989) cited 78 published and unpublished studies, theoretical discussions, modelling exercises and traffic counts. There was a wide range of results, with estimated induced traffic (defined very broadly, that is, all extra traffic other than reassignment) ranging from 0% to 76% of observed increases in traffic flows. There was evidence that trip retiming could be important, and weak evidence on the relative importance of redistribution, modal change, and generated trips (each of which could represent 2% to 10% of traffic) and land-use effects. In a literature review of the effects of changing levels of congestion, Hawthorne & Paulley (1991) found reference to choice of route, departure time including flexitime, mode shifts including ridesharing and public transport, trip frequency, complex intra-household adjustments in travel and activity patterns, and changes in the willingness to own cars. One review which came to the opposite conclusion was by Howard Humphreys & Partners (1993), who suggested that reassignment is the only response for which there is evidence, and that all the observed increases in traffic on improved roads could be accounted for by drivers making very long detours to use them. (In terms of the definitions used by SACTRA (1994), such responses do count as induced traffic, though not as generated trips.)

As a result of these and other studies, by the time SACTRA invited transport professionals and others to submit evidence to its enquiry it was clear that there was a widespread discomfort with the (then) current methods of the Department of Transport. SACTRA summarised this in the words

> the assumption, that demand responses other than changes of choice of route are negligible, does not command a strong professional consensus at present. Rightly or wrongly, there is a substantial body of professional opinion believing that induced traffic can be an important consequence of certain types of highway improvement.

Partly as a result of the work summarised here, the UK Government announced in December 1994 that it accepted that "there is likely to be a significant proportion of schemes where there is a real possibility of extra traffic".

2. Evidence inferred from econometric and survey studies of travel demand

In this section evidence is reviewed that does not directly address the issue of induced traffic, but is itself well-established and which can be combined to make indirect, but powerful, inferences. Four apparently separate strands are included, namely evidence on the effects of money costs of car use, motorway capacity, travel time budgets, and the value of time.

2.1. *The cost of car use*

It is well established that out-of-pocket money costs of travel have some effect on the amount of traffic. A recent literature review by Goodwin (1992) cited 13 studies in which the effect of fuel price on fuel consumption had been calculated (with a short-term elasticity of around –0.25 to –0.3 and a long-term elasticity of –0.7 to –0.8); 11 studies in which the effect of fuel price on traffic-levels had been calculated (with results of –0.16 for a short-term effect and about –0.3 for a long-term effect, and other studies not specifying the time period showing results of about –0.5). A review of Australian evidence by Luk & Hepburn (1993) cited 28 studies, and came to the conclusion that the long term elasticity of traffic levels with respect to fuel costs was –0.1 in the short run and –0.26 in the long run. Oum et al. (1992) report seven studies of automobile usage with respect to fuel price, giving elasticities in the range –0.09 to –0.52. Halcrow Fox et al. (1993) assess a short-term price elasticity for car use in the London region of –0.16 and a long-term value of –0.31 as "likely values" from a "review of reviews". They also found a range of values for different journey purposes of –0.05 to –0.87 from a stated preference experiment. Virley (1993) gives a short-run effect of fuel prices on fuel consumption of –0.09, and a long-run effect of –0.46.

Taking these results as a whole, we can say with some confidence that, at the aggregate level, there is some effect of the money costs of car travel on the volume of traffic, with an elasticity somewhere in the range –0.1 to –0.5.

2.2. *Motorway capacity*

Williams & Lawlor (1992) analysed the relative strength of different factors behind the growth in motorway traffic over the period 1978–1988, and suggested that a 10% increase in motorway length led to about a 1% increase in motorway traffic. A more recent study by the Centre for Economics and Business Research (1994) used an elasticity-based approach, embedded in a macro-economic model relating transport and economic factors, to assess the extent of generated traffic associated with a roads expenditure 50% higher or lower than the current programme. The Executive Summary of that report summarises the conclusions as follows:

> A 50% increase over present plans . . . would increase road usage by only 0.77%. A 50% cut would reduce road use by only 1.1%.

This finding was interpreted by the report's sponsors (the British Road Federation) as indicating that induced traffic was negligible. However, a closer reading of the calculations indicates that the 50% increase in spending is estimated to be able to buy, by 2010, a 7% increase in trunk road capacity, and it is this 7% extra road capacity which generates the extra 0.77% of traffic. At average levels, this implies an elasticity of traffic with respect to capacity of 0.11. (i.e. 0.77/7), very similar to the Williams and Lawlor work.

2.3. *Travel time budgets*

Many researchers, reviewed by Gunn (1981) have found that the total amount of time spent travelling is on average rather similar for people living in different countries, or in areas of very different characteristics and travel opportunities. Downes & Emmerson (1983) concluded that faster travel speeds generally encourage more travel to be made, and when extra use of time savings in other locations is included travellers spend all of the potential time saving from higher travel speeds on further travel. Examination of the conclusions of 13 authors in the field in a special issue of the journal Transportation Research, January 1981, does not show strong support for the idea that travel time budgets are absolutely stable (which would imply that all travel time savings were ploughed back into more travel). But all the evidence was consistent with the weaker proposition that some of the time saved would be re-used in this way. Not all of this would necessarily appear on or close to the improved road itself. Stokes (1994) suggested an increase from 1952 to 1992 in the total amount of time spent travelling, from 49 minutes to 63 minutes, with an average increase of 29 minutes per person in car travel being partly offset by a reduction of 15 minutes in other modes.

2.4. *Value of time*

Empirical studies of the trade-off between money and time costs of travel constitute a very large genre of transport research. The current procedures used in the UK are based on a study carried out by The MVA Consultancy together with the transport groups at the Universities of Leeds & Oxford (1987), which also cited about a hundred other references in the field. The study found values of in-vehicle time (at mid-1985 prices) of 3.5 to 5.0 pence per minute for an average car user. At 1993 prices, this is equivalent to a representative value of time for car users of about 6 pence per minute.

3. Synthesis of the research findings

There is a logical connection among the above results, which has a direct bearing on the question of induced traffic. First, we connect price elasticities and the value of time.

If we know what effect increases in fuel price would have on traffic levels and, if we know the equivalent values to vehicle users of changes in fuel price and changes in travel time, then we can calculate what effect travel time changes would have on traffic levels. Thus:

$$D = f(G) \quad \text{and}$$

$$G = M + vT,$$

where D is demand, G is generalised cost of travel, M is money cost (fuel price), T is travel time, and v is value of time. The demand elasticities with respect to money E_m and time E_t are:

$$E_m = \partial D/\partial M.M/D,$$

$$E_t = \partial D/\partial T.T/D.$$

The elasticities are proportional to the relative importance of money and time, as follows:

$$E_m/E_t = M/Vt,$$

$$\text{so} \quad E_t = E_m.Vt/M.$$

Assume: –0.15 as the elasticity with respect to fuel price; 6 pence per minute as the value of time; average time spent travelling by car per day as 25 minutes; and spending per person per day on fuel costs as 50 pence. Then

$$E_t = -0.15 \times 6 \times 25/50$$
$$= -0.45.$$

Thus a speed change saving 10% of journey time would cause a 4.5% increase in traffic volume. In practice, we would expect the numbers to vary by journey purpose, area, mode, speed of travel, type of person and many other factors. It is important not to exaggerate the degree of precision involved in the calculations.

A particular aspect of importance in considering how sensitive the result is to the assumptions made is that the –0.15 fuel cost elasticity is usually treated as a short-term effect (that is, within the first year). As described above, there is substantial evidence that the longer-term effect is significantly greater than this. If we take the estimated longer-term elasticity to be of the order of –0.3, for example, the implied journey time elasticity would be nearly –1.0. A 10% change in speed would then lead to a longer-term change in traffic volume of nearly 10%. In congested conditions, where time is a large proportion of the generalised cost of journeys, the implied travel time elasticity will be greater, and in uncongested conditions, smaller.

With these caveats, we note that, in round terms, as an overall average, reasonably well-established research on petrol price and on values of time suggests a short-term elasticity of traffic with respect to travel time of about –0.5, and a longer-term elasticity of the order of –1.0.

These figures in turn have implications for travel time budgets, and for sensitivity to road capacity, which can be compared for consistency with the other strands of research cited above.

> The interpretation of the results for the short term suggests that about half of the time saved by speed increases would be spent on additional travel. This is consistent with the results of some of the time budget studies. The interpretation of the results for the longer term suggest that most or all of the time saved would be spent on additional travel. This is equivalent to the hypothesis of a constant time outlay on travel, and is close to the results of the TRRL research cited above.
>
> The differential pattern of short and long term effects is consistent with the differences between effects on petrol consumption, car use, car ownership, and land use if we assume that car use responses are likely to be swifter than car ownership and land use responses: these assumptions seem plausible, and themselves supported by some evidence.

Overall therefore the average elasticity of traffic with respect to travel time in the range –0.5 (short) to –1.0 (long) seems broadly consistent with just about all the disparate evidence.

If the CEBR (1994) study is representative of the relationship between road expenditure and road capacity, then the elasticities would imply a short term level of induced traffic of around 10% of base flow, and a longer term level of about 20%. In the nature of averages, this must imply that some specific schemes will be less, and others more: a prima facie expectation might be that specific schemes will have 0% to 20% induced traffic in the short run, and 0% to 40%, say, in the longer run, with the higher figures in areas of greatest prior congestion.

4. Evidence from traffic counts

We now look at the available traffic counts to see whether they are *more* consistent with the synthesis suggested above, or with the proposition that traffic volume is independent of road capacity. The "induced traffic hypothesis" suggests that we might look for increased traffic in the order of 10%–20% of flows, with a range of 0% to 40%. The "no induced traffic" hypothesis is that any extra traffic on improved roads will be balanced by an approximately equal reduction on non-improved alternatives. Both will need to pay attention to the effects of other factors, especially economic growth, either by adjustment or by suitable controls.

5. Comparisons of forecast and observed traffic growth on improved roads

Forecasts of the traffic levels expected on an improved road are routinely made as part of the planning and evaluation of each scheme. Suppose we make the complimentary assumption that the models and assumptions used for such forecasts are correct in every respect except for the omission of induced traffic. Then if induced traffic is important, there will be a systematic tendency for forecasts to underestimate actual traffic levels, the shortfall on these assumptions being a direct measure of the amount of induced traffic.

This was the implied logic behind the pivotal role played by construction of an orbital motorway around London, the M25, in generating renewed public interest in the question of induced traffic, because it rapidly became clear that the amount of traffic using the road on almost every section was much greater than had been predicted. By 1992 the total volume of traffic on the M25 was 55% higher than the design year forecasts would have implied.

However, it seems unwarranted to attribute all of this 55% to induced traffic, since some may be due to other errors in the forecasts. These errors could not justify an adjustment greater than the actual traffic growth observed in the outer London area. The various sections opened between 1980 and 1986, so that there had been six years of full operation, and up to 12 years for some sections. Observed traffic growth in comparable areas would not justify an adjustment of more than between 1% and 3% a year, which still leaves 30% to 45% of the traffic unexplained. Given the suggestion above that some schemes might be found in which induced traffic was at this order of magnitude – and the observation that large, urban, congested conditions would be where one might expect the greatest effects – the M25 may be treated as reasonably strong supporting evidence.

Comparison of forecast and outcome traffic levels can be applied to a large number of other schemes, of all types, because since 1981 the Department of Transport has operated a monitoring system to compare observed traffic flows on recently-opened schemes with the forecasts (Department of Transport 1993). The counts are generally taken about one year after opening. SACTRA (1994) gives detailed figures for 151 schemes which had been studied in this way. Table 1 summarises the overall results for each category of scheme. Table 2 gives comparable information for the alternative routes, sometimes called "relieved routes" for 85 of these: this information was kindly made available by the Department of Transport after the SACTRA report was drafted. There are two particularly important features.

First, it is notable that the underestimates are greater for the alternative routes than for the improved roads themselves. Observed traffic levels on 39 rural roads which had been relieved by trunk road schemes were nearly 20%

Table 1. Comparison of forecast and observed traffic flows on 151 improved roads.

Class of Scheme	Forecast traffic flow (veh/day)	Observed traffic flow (veh/day)	Extra traffic over forecast	Number of schemes
Urban	244,603	258,520	+5.7%	9
Rural	714,215	809,154	+13.3%	61
On-line and junction improvements	731,120	864,966	+18.3%	27
Motorway	356,222	380,050	+6.7%	11
Bypasses	586,910	593,239	+1.1%	43
Total	2,633,070	2,905,929	+10.4%	151

Table 2. Comparison of forecast and observed traffic flows on 85 "relieved routes".

Class of scheme	Forecast traffic flow (veh/day)	Observed traffic flow (veh/day)	Extra traffic over forecast	Number of schemes
Urban	145,668	146,712	+0.7%	5
Rural	130,956	156,661	+19.6%	39
On-line and junction improvements	na	na	na	na
Motorway	155,367	177,298	+14.1%	7
Bypasses	251,620	315,027	+25.2%	34
Total	683,611	795,698	+16.4%	85

higher than forecast. The roads which bypasses had been intended to relieve showed traffic levels 25% higher than forecast, even though the forecasts for the bypasses themselves were (on average) reasonably good.[1] As a whole, the discrepancy for the improved roads was a little over 10%, but for the relieved roads over 16%.

Secondly, the results bear an interesting relationship to the work by the Centre for Economics and Business Research (1994) referred to above, which indicated that there was an elasticity of traffic levels with respect to road capacity of 0.11, interpreted mainly as a first year effect. If then all other aspects of a forecast were correct except for omission of induced traffic, and if all induced traffic appeared on the improved road, then we would expect for an average scheme the traffic levels to be 11% higher than forecast.

Table 1 shows that the unpredicted traffic in the first year, over and above the forecast, was 10.4%. On the face of it, this could be interpreted as a level of induced traffic entirely in accordance with expectations. Taking only those schemes for which we have counts on both the improved and the relieved roads, the additional unforecast traffic was about 16%, which gives a greater figure than the CEBR results, because extra traffic is appearing over more of the network. But in both cases, the expectation of 10%–20% induced traffic appears supported by the counts.

However, this inference is disputed, essentially because it is not valid to assume that the forecasts are, except for induced traffic, perfect. The Department of Transport (as reported by SACTRA 1994 and Harris 1993) argued that forecasts for all the schemes were made using the 1980 or 1984 National Road Traffic Forecasts, which failed to anticipate the high economic growth rates of the mid-1980s and therefore underestimated the growth in national traffic levels, by an average factor of 16%. Subtracting this removes the underprediction. SACTRA criticised this correction, suggesting that there was an element of circularity in the reasoning, since subtracting the "NRTF error" presupposed that no significant part of this error was due to ignoring induced traffic. In addition, it was suggested that the counts were too early after the scheme had been completed, the geographical coverage of the network too narrow, and the analysis obscured the different reasons that would underlie overestimates and underestimates. The Department of Transport accepted some but not all of these criticisms.

However, the question arises, how to interpret the errors due to demonstrably wrong assumptions about income growth? One possible answer is as follows. The volume of traffic induced by the trunk road programme must be a small proportion of the *total* volume of traffic on trunk roads – on the figures used here, between 0.5% and 2% at the outside. This is because little extra capacity has actually been added to the network: the CEBR report suggested about 5% between 1982 and 1992, albeit with a rather crude measure of capacity. Therefore the Department of Transport may well be right in attributing the largest errors in the national forecasts to income assumptions. However, it does not follow that it is correct to attribute the same percentage error to all road classes: as demonstrated above congested roads (where naturally many of the schemes were located) would be expected to show lower growth in the absence of improvement. In addition the income elasticities may themselves be biassed by the assumption that there is no induced traffic. A new correction will then need to be designed, probably with a significant induced traffic effect, a slightly lower income elasticity, allowance for delays in response, and differential growth rates on different classes of road. This will be certainly be more consistent with the observed pattern of errors (since it uses more degrees of freedom), but more important it will be more behaviourally plausible and consistent with the research evidence, than the correction suggested by the Department of Transport. Until there is a forecasting procedure that can allow for induced traffic (and makes whatever changes to the income elasticities that follow from that) it is difficult to assess the amount of correction that should be carried out.

Thus the discrepancies between forecasts and observations, though consistent with the calculations of induced traffic derived from indirect research evidence, can also be interpreted as a measure of other imperfections in the forecasting procedures used.

6. Measurement of traffic growth for specific schemes

The analysis above relies on comparing actual outcomes with forecasts. Even if no forecasts are made, or they are ignored, it is still possible to look at the growth of traffic on improved roads, provided that the counts include both the improved road and other roads in the same corridor. The induced traffic hypothesis suggests

- that the overall traffic growth in the corridor will be higher than some appropriate control corridor or than average growth rates,
- that the discrepancy will increase over time, and
- that the reduction in traffic on the relieved roads, if any, will be less than increased traffic on the improved roads.

Records of several studies were available, over a time scale ranging from a few months to two decades, to test these expectations. The main method used in these analyses was to carry out screenline counts of traffic using, as far as possible, the entire corridor of the improved road, before and after the improvement and during the following several years. In some cases the studies chose an unimproved control corridor for comparison, and in other cases the studies suggested induced traffic by subtracting an average growth rate due to other reasons. Sources are Beardwood & Elliot (1986), Castle & Lawrence (1987), Cleary & Thomas (1973), Pells (1989), Pizzigallo & Mayoh (1989), Purnell (1985), SACTRA (1994), Younes (1990). A short summary of the results[2] is shown in Table 3.

If we take the results at their face value – accepting the validity of the controls where given, and the original authors' suggested interpretations, and assigning an arbitrary growth of 2% per year to "other factors" where there is no control – then we can compare them with the three expectations as follows.

- The growth rates in the corridors observed were in every case substantially greater than the controls, and than other growth rates – an unweighted average "unexplained" growth of 25% from the 20 results cited in the table, albeit a range from 7% to 66%.
- This unexplained element systematically increases over time. The unweighted averages are: less than a year 9.5%; one year 22%; 2–5 years 26%; greater than 5 years 33%.

Table 3. Summary of studies of specific schemes.

Scheme	Interval	Result
Barnstaple Bypass	3 years	Corridor flows +48%. After "NRTF correction", extra traffic +39% on some specific links, about 20% overall.
M62	5 years	Flow +19% after correction by index for rural roads.
York Northern Bypass	Ambiguous timescale	Redistribution, modal diversion and new trips 20% of interviewed drivers.
Severn Bridge	1 year	Authors suggest 44% induced traffic.
London Schemes:		
Westway	4 months	Corridor +14%, Control +2%
	10 years	Authors suggest 40%–50% induced traffic
M11	9 years	Corridor +38% (peak 56%), Control + 29% (peak 33%)
A316	12 years	Corridor +84% (peak 107%), Control + 66% (peak 41%)
Blackwall	1 year	Screenline +15%
	20 years	Screenline +19% (peak 50%), Control +64% (peak 8%)
M25/Lea	4 months	Corridor +9%
Rochester Way	2 years	Corridor West + 26%, East +24%, Transverse +30%
Leigh Bypass	1 year	Screenline +20%
Manchester Ring	1 year	East-West + 23%, North-South +15%

- In some cases, a reduction in traffic on the alternative routes was observed but on average only of about half as great as the increase in traffic observed in the improved route, ie the relief was less than would be hoped. Expressing reductions on the alternative routes as a percentage of the observed increase in traffic on the improved road, the results were: Westway 63%; M11 29%; Lea 57%; Rochester Way West 66%, East 44%; Leigh 60%; M66 East-West 51%. In the other cases an *increase* in traffic was observed on the alternative routes studied. (This is consistent with the greater discrepancies in the forecasts for relieved routes noted above.)

The results are closely in line with the pattern that would be expected from the reviews and calculations in the first part of this paper, and it is difficult to justify further adjustments of a size that would be necessary to explain them away.

Nevertheless, it must be recorded that in every case there has been scope for alternative interpretations or caveats. A more detailed description is now given of two of the schemes, chosen because they have in the past acquired a high profile in the "roads generate traffic" argument. They are both London schemes – Westway, cited to prove induced traffic, and the Rochester Way Relief Road, cited to disprove it – and demonstrate the need for great care in interpretation, remembering also that urban areas in general (and London in particular) may not be relevant to interurban schemes.

7. Westway (M40)

Table 4 shows the 1970 24-hour counted flows on Westway, compared with the Finchley Road corridor chosen as a control.

The authors point out that the total traffic on Westway was greater than the reductions in traffic on all the alternative roads, and that in five months, traffic in the Westway corridor as a whole increased by 14%, whereas in the Finchley Road corridor traffic only increased by 2%. If this figure is subtracted, then the remaining 12% would represent an upper bound on very short term induced traffic, though it is noted that the screenline may not be perfect, and that there may be some more distantly reassigned trips from north of Harrow Road.

Looking at inbound peak period trips only, the authors note that the discrepancy between increases in traffic on the new road compared with smaller reductions in traffic on the alternative roads is much greater, amounting to 47.5% of the Westway flow.

Figure 1 shows the results of a similar exercise continued over the subsequent 14 years, compared with both the Finchley Road corridor and the Old Brompton Road corridor.

It may be seen that traffic growth on the Westway corridor continued steeply for some five years after opening, by comparison with the much more stable traffic levels on the other corridors. In a submission to SACTRA, Elliott suggested that (on admittedly somewhat arbitrary assumptions about the level

Table 4. Westway (M40) traffic flows, 1970, veh/day.

	Before (May)	After (Sept)	Change
Westway	–	46,900	+46,900
Other roads*	123,500	94,100	–29,400
Total Westway corridor	123,500	141,000	+17,500
Total Finchley Road corridor	127,200	129,200	+2,000

* Notting Hill Gate, Moscow Road, Dawson Place, Westbourne Grove, Talbot Road, St Stephens Gardens, Harrow Road.

Source: Purnell (1985)

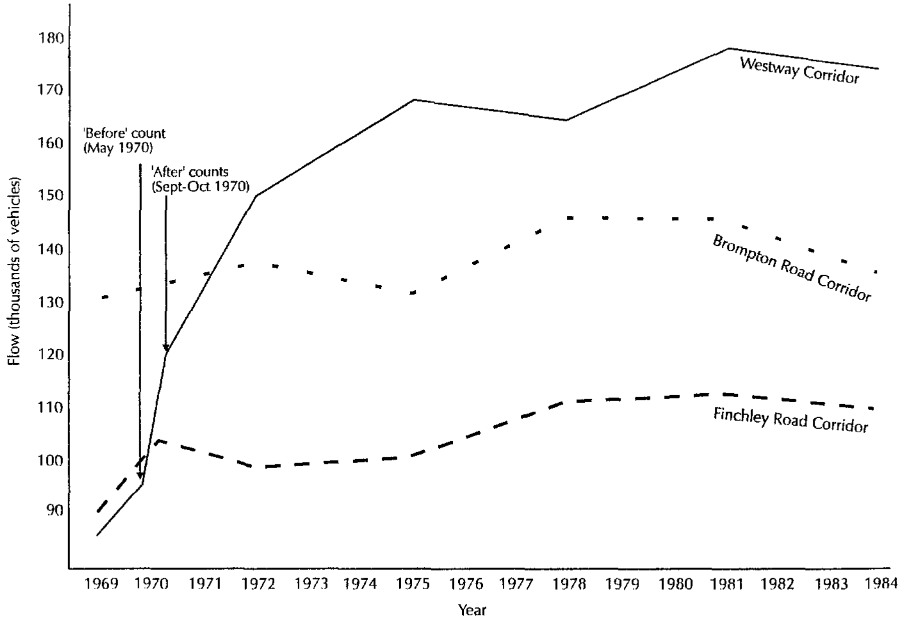

Fig. 1. Traffic growth in the Westway, Finchley Road and Old Brompton Road Corridors.

of "natural" growth) nearly two-thirds of the traffic on Westway might be counted as induced. If that were valid, it would suggest induced traffic after about ten years of about 40% to 50% of base flows, which is high but not inconsistent with the hypothesis that this would represent the upper bound of results for specific schemes, and within the range of other schemes for which longer term data were available.

Three caveats in particular should be made. First, it is extremely difficult to be sure that any cordon or screenline observations are absolutely complete (because of rat-runs) and that a sufficiently large area is covered. Secondly, control corridors and screenlines should be very similar to the improved road in every respect, except that no improvement is made. In practice, this is almost impossible to achieve. Thirdly, over a very short period, the problem of general traffic growth can be discounted, but a full range of behavioural response could not yet have been completed. With a longer time period, there will be a fuller response, but many other things will also have changed in the meantime, and it will not be possible, with certainty, to distinguish "growth due to inducement" from "growth due to other factors".

8. Rochester Way Relief Road

A study of the Rochester Way Relief Road (RWRR) was carried out by Younes and Crow of Imperial College London, supported by the British Road Federation and the Rees Jeffreys Road Fund. The report of this study was submitted to SACTRA by several different agencies, drawing special attention to the conclusions of the authors that:

> there is no evidence at all to show that the road has induced or generated a great deal more traffic within the corridor . . . the increase in traffic has been no more than might have been expected had the road not been built (about two per cent per annum).

Tables 5, 6 and 7 show traffic counts on three screenlines, representing the western and eastern boundaries of the Rochester Way Relief Road corridor, and transverse (that is, north-south) movements across the corridor, respectively.

In both the above tables, it is clear that there has been a significant reduction in the traffic on other roads covered by the screenlines, though only amounting to about half the measured increase on the Relief Road itself.

Table 5. Traffic counts, Western Screenline, Rochester Way Relief Road (A2), 18-hour two-way flow, pcu/day.

	1978	1990	Change (1978 to 1990)
RWRR (West)	–	68,400	+68,400
Other roads*	87,200	41,739	–45,461
Total	87,200	110,139	+22,939

* Shooters Hill Road, Corelli Road, Woolacombe Road, Rochester Way, Dover Patrol Slip Road, Kidbrooke Park Road.
Source: Younes (1990), Table 3.1.

Table 6. Traffic counts, Eastern Screenline, Rochester Way Relief Road (A2) 18-hour two-way flow, pcu/day.

	1978	1990	Change
RWRR (East)	–	60,400	+60,400
Other roads*	144,300	118,000	–26,300
Total	144,300	178,400	+34,100

* Shooters Hill Road, Rochester Way, Bexley Road, Footscray Road, Sidcup Road.
Source: Younes (1990), Table 3.2.

Table 7. Traffic counts in roads crossing the Rochester Way Relief Road (A2), 18-hour two-way flow, veh/day.

	1978	1990	Change
Transverse roads*	77,700	100,700	+23,000

* Kidbrooke Park Road, Westhorne Avenue, Well Hall Road, Westmount Road, Glenesk Road (the only one to show a reduction), Reifield Road.
Source: Younes (1990), Table 3.3.

(This is similar to the results of Purnell, Beardwood and Elliott referred to above, although the authors do not draw the same conclusions). Table 7 records the north-south traffic crossing the Relief Road. The increase of 30% of movements is substantial.

An important influence on interpretation of this study was the policy context in which the scheme was conceived and built. The authors made a very important caveat, namely that:

> The forces suppressing growth in radial movements, such as inner London congestion and parking controls, have remained unchanged and unaffected by the new road.

The specific circumstances of this road scheme were that new radial capacity was produced which could not be used for much increased traffic, due to downstream constraints. As a matter of local policy, grade-separation and the retiming of traffic signals therefore allocated additional effective capacity to transverse movements. When investigating whether there has been induced traffic, therefore, it is necessary to look at both the radial and the transverse movements. The evidence seemed to be that there was indeed an increase in transverse movements.

The implication of this seems to be that, if other factors, whether policy or physical constraints, are preventing the growth of traffic, then there may be little induced traffic and intended speed increases can be achieved, in the improved section if not elsewhere. This is an important point, not only for forecasting but also for the policy assumptions on which the forecasting is based. If induced traffic is foreseen, but is prevented by deliberate policy measures or capacity restraint elsewhere in the network, then the geographical area over which the forecast must be made has to be considerably wider than the scheme itself. As one of the authors also commented, current plans for a further upgrading of the Blackwall crossing (one of the capacity constraints) "could well release an element of suppressed traffic" which had not previously been apparent.

Overall, the pattern of changes shown in this study is similar to those shown in the GLC studies. This study has been widely cited as one of the more persuasive pieces of evidence against the existence of important induced traffic effects. Tables 5 to 7 above do not seem to support this interpretation.

Conclusions

Induced traffic must be heavily dependent on the context, size and location of the scheme, but theoretical calculations based on literature reviews give an average value for the elasticity of traffic volume with respect to travel time of about –0.5 in the short term, and up to –1.0 in the long term. This is consistent with an expectation that an average road improvement for which the traffic growth due to all other factors is forecast correctly, will see an additional 10% of base traffic in the short term and 20% in the long term.

Examination of the size of errors in traffic forecasts for improved roads, and also observations of traffic growth on those roads, both subject to caveats, nevertheless give results which are of similar order of magnitude.Those are average figures, and in the nature of averages must be subject to variation in individual values – a range from zero to double the average is not inconsistent with any of the indirect or direct results.

There seem to be four recurrent elements in the studies:

Unexpected short-term growth. For 151 Department of Transport schemes traffic flows were on average 10.4% higher than forecast a year after opening, and for 85 of these observed flows on the alternative routes were on average 16.4% higher than forecast. Taking the seven studies where there was only a short time interval between the before and after counts (Westway, Blackwall Tunnels, M25 (A10–A121), York, Severn, Leigh, M66), the net measured increase in traffic in the corridor as a whole ranged from 9% to 44% of the total before flow in the corridor, with an unweighted mean of 20%. (It is likely that the schemes which were subject to such close study were selected and cited because there was a greater than average concern about induced traffic).

Greater longer-term overall growth. Increases in traffic in the corridors as a whole have been greater than both traffic growth generally, and growth in the corridors selected as controls. For six sets of results for which longer periods of counts were given (Barnstaple, M62, Rochester Way, Westway, M11, A316) the growth ranged from 20% to 178%, with an unweighted mean of 77%. This sort of growth is not easy to explain away by general income related trends.

Greater Peak Period Growth. Peak period growth rates in the improved sections have been notably high, which is not characteristic of traffic growth generally. This suggests that, when extra capacity is provided, there is a reversal of peak-spreading, consistent with both a suppression effect due to congestion and an induced traffic consequence when that is released.

Limited Relief to Alternative Routes. Increases in traffic counted on improved roads have, in general, not been offset by equivalent reductions in traffic counted on the unimproved alternative routes either in the short or long run.

Overall, it is difficult to conclude otherwise than that the provision of extra road capacity results in a greater volume of traffic, though studies for a longer period of time, over a wider geographical area, and with more probing methodologies, will be necessary to explain how and why.

Acknowledgements

This paper is largely a recasting and summary of two chapters from SACTRA (1994), with the addition of some important references which became available after the report was submitted to the Secretary of State for Transport in May 1994. Acknowledgement is due to the other members of the committee, and those submitting evidence to it, who contributed with substantial comments and evidence. Except where direct quotation is made, the judgements and interpretations in this paper are the responsibility of the author alone. Additional work was supported by the research programme of TSU as the designated transport research centre of the UK Economic and Social Research Council.

Notes

1. Actually the *range* of error was worse in the case of bypasses than most other schemes, with a ratio of forecast/observed from 0.552 to 2.038, but these errors were roughly symmetrical: the forecasts were poor, but not evidently biassed.
2. One additional scheme was included in the SACTRA report, the opening of the Zeeburger Tunnel in Amsterdam, which is not reported here as more details are given in the accompanying paper by Kroes et al. On a comparable basis, their traffic counts indicate an induced 24-hour corridor traffic due to the tunnel of about 3% of total flows, equivalent to about 15% of the Tunnel flows, which is in line with the UK results, but the result seems very sensitive to assumptions about seasonal effects and is not reflected in their adjusted interview data.

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