Another problem arising in the research design was the small sample size and high variability within the sample as measured by standard deviations. This problem is not easily corrected since both studies include all beltways that met study criteria. However, examination of the average percentage changes in employment in Table 6 suggests that in many instances the percentages are sufficiently similar between the beltway and nonbeltway cities that a larger sample would not result in significant differences.

CONCLUSIONS

Subject to the caveats raised in the concluding paragraphs of each subject discussion, beltways appear to have no significant effects on overall central-city vitality or on overall suburbanization of people and jobs. Blayney-Dyett's case studies suggest that land use regulation, tax and mortgage policies, and other factors generally outweigh the influences of beltways. These findings based on aggregate data cannot take the place of detailed, project-level analyses that explicitly take into consideration the types of local factors that the case studies found to be important.

The findings of this research, in combination with the case studies, suggest that beltways and probably transportation facilities in general are, at most, one of many influences on the pattern of urban development and that policies to support revitalization of central cities might be better implemented by using beltways or other transportation facilities to support measures such as land use controls that bear more directly on urban development.

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Monitoring Traffic Management on Retailing Activities: Problems and Possible Solutions

A.D. MAY AND P.M. WEAVER

A method for objectively measuring the effect of traffic management on retailers' receipts is discussed. It identifies the need for information on these effects and, by considering the impact of traffic management on retailing activities in general terms, highlights the problems in obtaining such information. A checklist of criteria for studies designed to measure effects on trading performance is presented and used as a basis for developing a new method designed

to be both objective and generally applicable. The method involves collection of indexed monthly receipts for a stratified sample of individual shops and the use of national control data to project expected levels of trade. These are then used to identify changes in trading performances. The method is tested by using a traffic management scheme in York, England. Results indicate that effects, while significant, were smaller than those claimed by traders and were short lived. Outstanding methodological issues are identified.

Traffic management measures have been developed largely to help the car or bus user, pedestrian, cyclist, and resident; the business community is rarely identified as a group to be assisted. Instead, the traffic engineer all too often sees business people as inevitable opponents of traffic management, whose fears are ill-founded and who need to be pacified if possible. Not surprisingly, business people tend, therefore, to view traffic management as a threat and react against schemes that are proposed rather than suggesting ways in which schemes can be devised to help them. There has been a need for some time to reduce the delays in implementation that such differences of view cause; one obvious approach to solving this problem is to provide a clearer understanding of the ways in which traffic management can affect or assist business activity. Recently, the need to resolve these differences has become more acute since there has been a growing interest in the use of traffic management schemes as land use planning tools to help revitalize business activity. Many pedestrian streets have been introduced with this in mind (1, 2) as have the Urban Mass Transportation Administration's recent experimental automobile-restricted zones (3), and traffic cell schemes such as that in Gothenburg (4). Clearly, it is important not just to convince business interests of the merits of such schemes, but also to be sure that their beneficial effects on business are sufficient to justify the restrictions imposed.

An understanding of the mechanisms by which traffic management affects business activity and of the magnitude of the effects produced is therefore of value to transport planners and engineers and to the business community. Others who might benefit include public transport and car-park operators, customers, and clients and other professional groups such as Chartered Surveyors (5).

This paper looks briefly at the general form of such a mechanism and its application specifically to retailing activity. It discusses some of the problems of working in this field, reviews some other studies on the topic, and then describes a study conducted recently in York, England, which has been used to test some possible survey and analysis procedures.

RELATION BETWEEN TRAFFIC MANAGEMENT AND RETAILING ACTIVITY

The ways in which traffic management can affect retailing activity are best seen by considering the general relation between transport and land use (Figure 1) (6). Transport policies can affect land use in three distinct ways:

1. By consuming or releasing land,
2. By improving or reducing accessibility, and
3. By improving or worsening the environment.

Traffic management schemes rarely consume land except for minor junction improvements. However, schemes may release road space for other uses such as pedestrian streets, meeting areas, and markets. All traffic management schemes affect accessibility (in terms of journey time, distance, cost, and reliability) and most will improve or worsen the environment by adding to or reducing the traffic in individual streets.

The ways in which these changes might affect retailing activities are depicted in Figure 2 and are briefly described below.

1. Improvements in environment and in accessibility may encourage additional custom. Conversely, a deterioration in these factors could discourage custom. In practice it is often the case that traffic management improves the environment while worsening accessibility (or vice versa) and the net effect on custom is thus uncertain.
2. It is worth noting that changes in accessibility and the quality of the environment do not have to occur for effects on custom to be felt; adverse publicity about an otherwise successful scheme may discourage customers (7).
3. Changes in consumer behavior may affect shop receipts; however, it is possible for receipts to stay constant despite changes in consumer behavior, if customers compensate by buying more on each visit (8).
4. A shop's operating costs can be affected both by changes in consumer behavior and, directly, by changes in accessibility that may add to servicing and staffing costs.
5. The combined effect on receipts and operating costs may affect the profitability of shops in the short term and may in the longer term lead to changes in the mix, intensity, and quality of activities in the shopping center.
6. Both consumer behavior in the short term and land use changes in the long term can be influenced

Figure 1. Transport-land use relation.

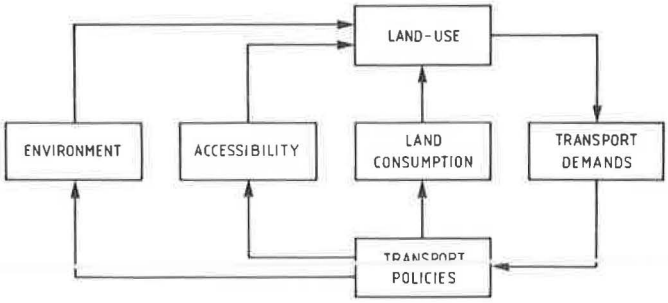


Figure 2. Traffic management-retailing relation.

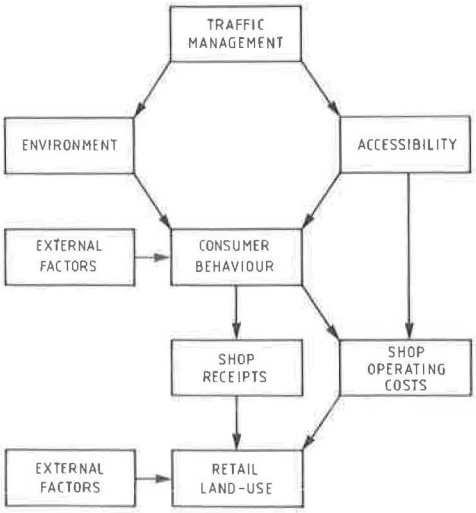
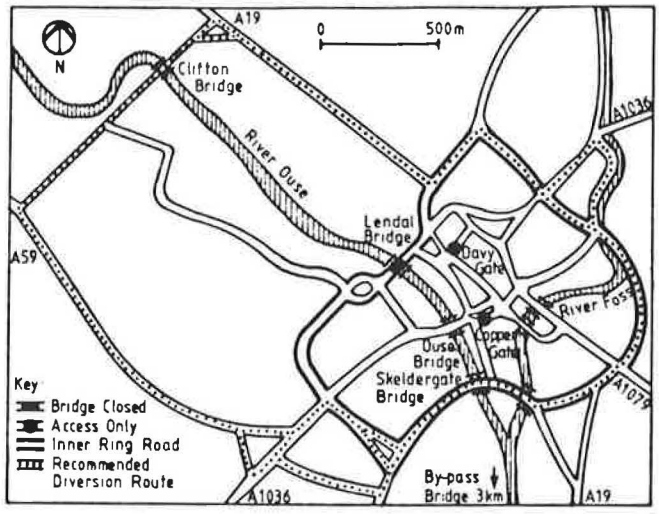


Figure 3. Temporary traffic management measures for York's road network, October 1978.



by a wide range of external factors such as seasonal factors, inflation, fiscal policy, and competition from other centers. In particular, it is worth noting that improved accessibility to one center may reduce receipts in a competing one, even if its accessibility is unchanged (7).

The work reported on in this paper limits itself to assessing the effects of traffic management on shop receipts. It excludes both the short-term effects on operating costs and the long-term ones on land use patterns.

STUDY REQUIREMENTS

Even with this limitation, the requirements of a study of the effects of traffic management on retail activity are complex. As indicated by Figure 2, four interrelated strands of inquiry are needed. The first must attempt to assess the impact of traffic management on the accessibility and environmental quality of the shopping center as a whole and, ideally, the specific effects of individual elements of the traffic management scheme and on individual locations within the center. The second will need to identify changes in the number and nature of shopping journeys to the center. The third must attempt to establish whether these changes in consumer behavior are caused by environmental or accessibility changes or by external factors. The fourth must identify specific changes in shop receipts and relate these to identified changes in consumer behavior. Only when all four of these strands are available will it be possible to draw tentative conclusions about the short-term influence of a traffic management scheme (and, ideally, of its individual elements) on retailing activity.

PROBLEMS FACED IN MEASURING RETAIL IMPACTS

Many difficulties will have to be overcome in order to satisfy these study requirements. First, a decision is needed on the extent of the area to be studied, since the effects of traffic management measures need not necessarily be confined to their immediate vicinity (9). Second, environmental and accessibility changes need to be measured for different locations in the center and, in the case of accessibility, for journeys from different origins and by different modes. Third, changes in numbers of customers may be difficult to assess and may need to be estimated from proxy measures such as pedestrian and parking counts. Fourth, it is often difficult to obtain adequate and valid data on receipts since firms are usually reluctant to release commercial information. Fifth, even if it is possible to measure changes in consumer behavior and in receipts, causality remains to be established. Comparative data from a panel of control shops or from shops in a control location will be needed to ensure that external factors are not influencing results. Finally, even if changes can be attributed to traffic management, the complexity of the effects will make isolation of the specific cause extremely difficult.

The study of which this report forms part has attempted to tackle all these problems. However, this paper concentrates on methodology developed to deal specifically with the problems of measuring changes in receipts and establishing suitable controls.

CRITERIA FOR MEASUREMENT OF CHANGES IN RECEIPTS

The first stage in this process was to establish a checklist of criteria for measuring changes in receipts. The method should

1. Be based on objective data, since experience suggests that assessment based on surrogate measures or on traders' subjective opinions is liable to be inaccurate;
2. Take account of past trading performances to isolate the effects of seasonal and secular trends in individual shops' performances;
3. Isolate the effects of external economic and social factors by using a control that should ideally be specific to the types of shops and center being studied;
4. Enable any statistically significant deviations in trading performance to be identified and quantified; and
5. Be able to assess whether changes in trading performance had varied with time, by shop type, or by location within the shopping center, as a basis for identifying short-lived and longer-term effects, activities particularly at risk, and specific causes of changes.

THE YORK STUDY

Based on these criteria, our own work seeks, not so much to make a case study of a particular scheme, but rather to establish and test a method for measuring effects on retail activity that might be seen to be objective and generally applicable. The traffic management scheme on which this method was tested and the other surveys of which the study of retail trade formed a part are described below.

The Scheme

The scheme under study, which has been fully described elsewhere (10), was associated with the temporary closure of Lendal Bridge for repair. The scheme operated from October 4, 1978, to April 8, 1979. During this period, Lendal Bridge remained open for buses, taxis, and cyclists, but all other traffic had to find alternative routes. Since Lendal Bridge is one of only four river crossings in the city center, providing more than 25 percent of cross-river capacity, serious congestion was feared, particularly in the narrow, medieval streets in the heart of the center. Therefore, to control through movement, two important thoroughfares, Davygate and Coppergate, were closed except for buses and for access. (See Figure 3.)

Related Surveys

This scheme was particularly well suited for a study attempting to devise and test methods of assessing the effects of such measures on retail trade. The general background to York's traffic problems was already well documented (11). The U.K. Department of Transport was measuring the direct effects on accessibility and environment and the specific changes in numbers of shopping journeys, pedestrians, and parked cars (8). Early analysis of these results indicated a significant shortfall in the number of trips to York during the first stage of the scheme. Over the midafternoon period a fall of 19 percent was recorded in the number of vehicle movements crossing the river for personal business or shopping trips. Of this shortfall, 75 percent was caused by a drop in the number of personal business or shopping trips originating from south of the river. However, while giving grounds for further enquiry, the mere spatial and temporal coincidence of these events do not, of themselves, imply causality. Moreover, as already noted, a reduction in shopping trips, however caused, need not necessarily imply a loss of trade in monetary terms.

York traders did, in fact, claim that receipts had fallen by as much as 25 percent as a direct result of the scheme but, as noted earlier, such estimates are not necessarily reliable. Investigation, both into the causes of changes in consumer behavior and into actual changes in trading performance, were still required, but the Department of Transport was unsuccessful in seeking the agreement of the York Chamber of Trade and Commerce to such surveys. The Chamber was, however, prepared to accept the involvement of the Institute for Transport Studies, acting as an impartial and objective third party. The techniques used by the Institute to identify causes of changes in consumer behavior and the findings of that inquiry are documented elsewhere (12). The following sections describe the techniques adopted to measure trading effects and outline the results obtained.

TRADERS' SURVEY

The survey and analysis method was designed to meet the criteria set out above by

1. Collecting objective data in the form of traders' receipts;
2. Obtaining information for a sufficient period to identify seasonal and secular trends for individual shops;
3. Using national data to provide a control and, with data from number 2 above, to project expected levels of trade for individual shops over the period of the traffic management scheme;
4. Analyzing statistically the differences between projected and achieved receipts for individual shops; and
5. Aggregating these differences to permit comparisons by time period, type of shop, and location.

Methods Used to Collect Trading Data

A questionnaire was drafted that sought information from individual stores on the shop's characteristics (e.g., type of business, number of employees, and whether a chain store) and trading trends since January 1976. The decision to ask for trends in receipts from 1976 was a compromise between the desire to have information going back as far as possible for analytical reasons and the risk of low response if shopkeepers were asked for too much information. Turnover trend information was obtained by asking retailers to plot receipts graphically for successive months. A monthly time interval was chosen to maintain compatibility with national data (13) and to enable short-lived and longer-term effects to be isolated. Traders were asked to choose their own scale for the axis indicating receipts. The only constraint was that they should choose an equal interval scale starting from a zero origin. Having constructed the graphs, traders wishing to preserve confidentiality were invited to cut the receipts scale away. This left only a pattern of points that, by depicting the relative magnitude of successive trade figures, could be converted into a numerical time series based on index linking.

Before distributing the questionnaire, the University, in cooperation with the York Chamber of Trade and Commerce, convened a meeting of local traders. This gave the opportunity to publicize the survey, explain the approach adopted, and assess trading opinion. By the close of the meeting a show of hands indicated almost complete support for the survey. It was on this basis that, for the pilot survey, it was decided that further personal contact would not be necessary. However, a postal survey proved very disappointing with response rates of below 20 percent. Discussion with shopkeepers later showed that, in almost all cases, failure to respond was due, not to a reluctance to supply information, but rather to the time and effort involved in completing the questionnaire. Evidently, for the full survey, the survey procedure had to be revised.

First, a new questionnaire was designed. Many of the background questions asking about the store and its business and most of the more complicated explanations were omitted. It was decided that the revised questionnaire should be distributed and collected personally. The intention was to give most of the explanations and instructions for completing the forms verbally, while also building some degree of rapport with individual traders to boost response rates. Throughout the distribution phase, an official from the York Chamber of Trade and Commerce was at hand both to demonstrate the authenticity of the survey and to encourage traders to complete their forms.

Questionnaires were distributed to all department stores and to a 20 percent stratified random sample of all other shops in the city center. Stratification was both by store type and location within the city center. Four categories of store were recognized: foodshops, clothing and footwear stores, household durables (furniture, carpeting, and decorating) shops, and specialty hard-goods stores (e.g., jewellers and electrical goods). In addition the city center was divided into an inner and an outer zone (Figure 4) to test whether the core of the center, which included the main traffic restrictions, was more seriously affected. Of the 92 questionnaires distributed, 58 usable returns were obtained. This represented a 100 percent return from the department stores (7 questionnaires) and a 60 percent return from the other shops (51 questionnaires). This meant that a usable return was obtained from approximately one in every eight shops in York's city center.

No statistically significant differences were found between the composition of the achieved sample (classified both by store type and location) and the population distribution. However, it should be noted that while this revised procedure achieved a much more satisfactory response rate, the effort involved in distributing and collecting the questionnaires was considerable at up to 2 h/shop.

Projecting Expected Levels of Trade

In order to counter the effect of external economic

factors, the time series data for each shop was compared with the national pattern of sales for shops of a similar type. The comparison was made by dividing successive monthly trade figures for each shop in York by the corresponding national index. This left a series of trading ratios for each store that described the trading performance of that store over time relative to national levels. An example is given in Table 1.

A time series analysis was then performed on the trading ratios for each shop. The secular trend was obtained in each case by a least-squares, line-fitting procedure and the seasonal component was isolated by using a conventional additive model.

Thus calibrated, the time series models could be projected forward under the assumption of stable, but not static, conditions to predict trading ratios for each shop in the absence of the traffic scheme. Expected levels of trade were then set for each shop by multiplying the projected ratios by the corresponding national index for each month that the traffic management scheme was in operation. An example is given in Table 2.

Comparing Achieved with Projected Levels of Trade

This put the projected figures, calculated to take account both of past trading performances and national trends, into a form enabling direct comparison with the achieved figures for individual shops reported by traders. The percentage difference between actual and expected trading levels was then calculated for each shop on a monthly basis. Table 2 illustrates how these comparisons were made. By weighting these monthly figures according to the relative importance of each month's receipts, comparisons were then made for the entire six-month closure period of Lendal Bridge. Only at this stage was aggregation across groups of shops by type or location possible, because the measure of trading performance used--the percentage deviation of achieved from expected trading levels--was common to all shops and was independent of the type of scale used by individual shopkeepers to supply the initial trading data.

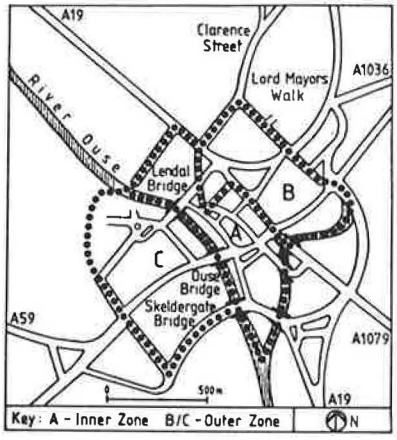


Figure 4. Division of city center into an inner and an outer zone.

Limitations of the Method

Obviously even such a complex procedure has its limitations. It relies on shopkeepers to provide valid information and to have constructed their graphs correctly. While the latter point was checked when collecting the information, it was not considered possible to include questions to check on the validity of the information. Ideally, the information should have covered a before period of more than 2.5 years to identify seasonal trends with greater accuracy; however, as noted above, it was felt that requests for further data would have reduced the response rate. The use of a national control is subject to criticism on the grounds that it contains shops from a variety of urban, suburban, and rural locations that may not be suitable for identifying the external influences occurring in towns similar to York. This problem was imposed on the study by the aggregate form in which national data were then available (13); the only alternative would have been to identify a suitable control center. Finally, the analysis gives equal weight to all shops, irrespective of their importance to the center's economic health or overall trade. This limitation is imposed on the analysis by the reluctance of traders to release absolute receipt data. It is worth noting in this respect that only 5 percent of the respondents elected not to remove their receipt sales.

Results of Trading Analysis

In the analysis, department stores were considered separately from other shops. As has been mentioned, information was obtained from all seven of York's department stores and, in consequence, analysis of the data was not concerned with the estimation, but rather with the derivation, of population parameters.

Over the full period of closure of Lendal Bridge, the mean percentage deviation of achieved from ex-

Table 1. Hypothetical example to show derivation of trading ratios.

Ratio	Trading Factor	Jan. 1976	Feb. 1976	March 1976	April 1976	May 1976	June 1976[a]	Sept. 1978
a	Trading index (York shop)	100	120	160	180	220	230	300
b	Trading index (national)	100	132	164	180	200	200	250
a/b	Trading ratio	1.00	0.91	0.97	1.00	1.10	1.15	1.20

[a]This analysis was continued for 33 months.

Table 2. Hypothetical example to show derivation of expected trading levels and comparison with achieved figures.

Ratio	Trading Factor	Oct. 1978	Nov. 1978	Dec. 1978	Jan. 1979	Feb. 1979	March 1979
a′/b	Projected trading ratio	1.1	1.0	0.9	0.8	0.9	1.2
b	Trading index (national)	150	160	200	125	130	140
a′	Expected trading index (York shop)	165	160	180	100	117	168
a	Achieved trading index (York shop)	160	152	171	105	117	170
a-a′/a′	Deviation from expected (%)	-3.0	-5.0	-5.0	+5.0	0.0	+1.2

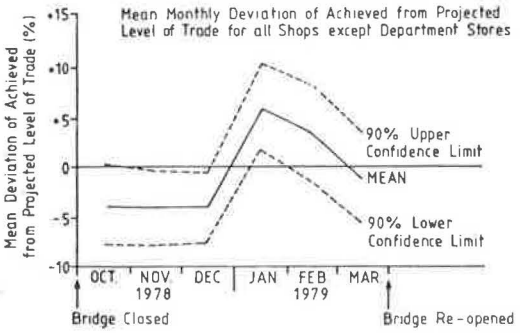
Table 3. Mean percentage deviation of achieved sales from expected sales by shop type.

Type	Mean	Standard Error	n	95 Percent Confidence Bands
Foodstores	-6.0	2.0	8	±5.6
Clothing, footwear stores	+1.4	2.3	14	±5.1
Household durables	+3.2	2.3	8	±5.4
Specialty hard-goods stores	-5.6	2.6	21	±5.4

Table 4. Mean percentage deviation of achieved sales from expected sales by zone.

Zone	Mean	Standard Error	n	95 Percent Confidence Bands
Inner	-4.2	1.9	31	±3.9
Outer	+0.3	1.8	20	±4.4

Figure 5. Mean monthly deviation of achieved from projected level of trade for all shops except department stores.



pected sales was -2.4 percent (±2.9 percent) for all shops except department stores. The mean deviation for department stores was +1.1 percent.

Table 3 gives the mean deviation of achieved from expected sales for different types of shops. It can be seen that two categories of shops, foodstores and specialty hard-goods stores, experienced levels of sales that were significantly better than those of foodstores and specialty hard-goods stores (at least at the 90 percent level and, in most cases, at the 95 percent level).

Trading performances were also found to differ according to location within the shopping center. Table 4 shows that the performance of shops in the middle of the center was significantly below that expected (at the 95 percent level) and was significantly worse than the performance of shops in the outer fringes (at the 90 percent level). The extent of the shortfall in the case of shops in the inner zone was 4.2 percent (±3.9 percent).

Finally, trading performances varied throughout the six-month period during which Lendal Bridge was closed. Figure 5 shows how the mean trading performance of all stores except department stores varied by month. Over the first three months, the mean trading performance was below expected levels. The shortfall was significant at the 90 percent level. Trade was significantly above that expected in January 1979; it then returned to projected levels in February and March.

These results suggest that York's shopkeepers, and particularly those selling food and hard goods and those in the inner part of the center, did experience a pattern of trade different from the pattern that they might have expected during the period that Lendal Bridge was closed. This effect was most marked in the initial period of closure.

These results, as indicated earlier, provide one input to an assessment of the effects of the closure of Lendal Bridge on retailing activity. It is not possible from these results alone to identify the closure of the bridge as the specific cause of the changes in trading performance, since other factors peculiar to York may have been responsible. Indeed, York experienced a serious flood in late December that had some effect on trade. The results of the study of consumer behavior (12) are being used to isolate specific causes.

Preliminary results indicate that closure of the bridge was the most important cause of any changes in behavior and, hence, receipts, although its significance varied with origin and mode of the shopping journey. They also suggest that problems of route finding and parking as a result of the closure were the major factors causing changes in shopping patterns. This may explain the greater impact in the inner zone. It appears likely that differences between retail sectors in the number and location of alternative shopping opportunities account for the variation in trading performance by type of shop.

However, the most important point to note is that the aggregate effects were not only small, but also short lived, and significantly less pronounced than traders or changes in shopping journeys had suggested.

CONCLUSIONS

Although it has been possible to draw some conclusions specific to York above, this paper has been concerned mainly with the problems of measuring the effects of traffic management measures on retailing. The following conclusions can be drawn on this issue.

1. A measure of trading performance based on receipts does not necessarily lead to the same conclusions as an assessment based on traders' opinions or the interpretation of surrogate variables. Although it is not possible to say that any of these methods provides wholly reliable answers, the method based on receipts is certainly the most objective.
2. It is possible to obtain details on receipts from shopkeepers. However, it is a time-consuming task and may well need to be done by an independent and impartial agency.
3. From the work in York and work in the Netherlands, reviewed elsewhere (14), it seems possible to achieve a response rate of at least 50 percent; however, it would be worth trying to find ways of increasing this rate.
4. Given the kinds of changes in economic conditions that were experienced over the course of this study, a control to separate external influences on receipts is essential. Asking shopkeepers to specify the cause of any change in receipts is probably not a sufficiently reliable approach.
5. Obtaining such a control is difficult. In the United Kingdom, national data can be used (although their format has recently been changed), but this does not necessarily represent expected patterns of trade in a particular town. The use of a control town is an alternative approach, and it may be worth devoting more effort to identifying suitable control towns.
6. However, it appears that effects of traffic management schemes on receipts, even for the most

severely affected groups of shops, may well be relatively small. It will be important, therefore, to devote as much effort as possible to studying the more-direct costs imposed on retailers' operations.

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Nonlocal Traffic in a Residential Neighborhood: The Problem and Its Management as Seen by Residents

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This study examines the problem of nonlocal traffic in a relatively lightly traveled residential neighborhood adjacent to the Pennsylvania State University campus at State College, Pennsylvania. The purpose of this research is, first, to assess what constitutes a traffic problem for the area residents and, second, to evaluate their preferences among alternative traffic control measures. The data were collected through field observation and a home-interview survey on a sample of streets in the neighborhood. An analysis of variance shows significant overall differences between medium- and light-traveled streets in the residents' perception of the problem and willingness to accept traffic restraint measures; however, the residents' location relative to a particular control device and how it affects their mobility, as well as other socioeconomic factors, account for a great deal of the difference. Controlling speeding in the neighborhood is the residents' most important concern and four-way stop signs are the preferred solution to that problem. The research findings point out some of the inadequacies of traffic engineering practices, such as traffic counts, accident records, and solicitation of citizen complaints when viewed in isolation to be used as a basis for traffic management decisions.

Management of nonlocal traffic in residential neighborhoods has been a complex and controversial issue among transportation planners and the public. According to standard planning principles, streets in residential areas that are designed for local traffic should not be used by nonresidents to minimize travel times, to avoid traffic signals, or for parking (1). Environmental research has shown that high traffic volume and speed directly increase traffic accidents, as well as noise and air pollution; they have also been associated with decline in neighborhood quality and property values (2). Although traffic management strategies have been shown to alleviate some of the above problems, they have met with opposition from area residents and outsiders because they inhibit mobility and are an inconvenience, especially to those who do not benefit directly from the reduction of traffic (3).

IMPACT OF THROUGH TRAFFIC ON RESIDENTIAL ENVIRONMENTS

Studies of the quality of residential environments, as perceived by residents, have identified noise; accessibility; social compatibility with neighbors; maintenance of lawns, buildings, and streets; and safety of both self and property as important dimensions of neighborhood satisfaction (4,5). Through traffic in a residential neighborhood disturbs many of these qualities and threatens that environment. Traffic noise causes the greatest disturbance (2). Noise is related to volume of traffic and the speed and type of vehicle. Perception of noise correlates strongly with objective noise levels (6). However, personality, past experience, and situational variables such as time of sound are important in determining how a sound is perceived (7,8).

The volume and speed of traffic threaten the safety of residents. Families with young children and the elderly are especially fearful. For instance, in one study 74 percent of child and automo-