SOME OBSERVATIONS ON THE IMPACT OF MAIN ROAD TRAFFIC NOISE IN SYDNEY

R. BRADLEY
Tutor
School of Geography
University of New South Wales

A. HOLSMAN
Senior Lecturer
School of Geography
University of New South Wales

ABSTRACT: This study investigates some of the social and economic effects of main road traffic externalities, in particular those associated with traffic noise, in Sydney. Short and long term residential property price movements on main roads and control streets and the impact of noise on property price are analysed. The social impacts of main road traffic noise are evaluated through the use of a questionnaire sent to households resident on main roads and parallel control streets. The study shows that the economic and social implications of main road traffic noise are variable across Sydney. In certain areas of Sydney, both in the short and long term there are considerable depressive effects on property prices resulting from combined main road externalities but the role of noise in determining property price is minor.

SOME OBSERVATIONS ON THE IMPACT OF MAIN ROAD TRAFFIC NOISE IN SYDNEY

INTRODUCTION

In recent decades one of the most consistent features of the concentration of population in Australia's major cities has been the increasing volume of road traffic. Although some of this increased volume has been accommodated on new or better roads, in many cases and, notably in Sydney, it has been fed into the existing road network. One outcome of this increasing concentration of traffic has been the deleterious environmental effect, represented by increased noise and air pollution, visual pollution and danger to pedestrians and other road users. This paper is concerned with one such environmental effect, traffic noise, and its economic and social effect in Sydney. More precisely the paper attempts to identify the effects of road traffic noise on property prices in nine selected residential areas of Sydney and also to ascertain the social effects (on the residential population) of exposure to main road traffic noise.

The introduction of new transport facilities has been shown to have two opposing sets of effects on property or land values (M.S.J. Keys Young 1974). Firstly, property values may experience a general increase as a result of increasing accessibility to central locations. The displacement of residential land by a transport facility may lead to increased demand pressures on the remaining land, and change in the relative supply and demand of land may lead to an increase in the value of newly accessible land. On the other hand, property prices may experience a decline, since the nuisance aspects of the transport facility may result in undesirable residential environments or because the spatial distribution of demand may result in value declines in areas left at a disadvantage. Whilst there is considerable debate in the literature about the nature and direction of such externality effects (for example see Hall et al 1977, Pearce and Nash, 1973, Gamble et al 1974) little investigative work has been completed in Australia on the relationship between property values (the indicator of economic impact used in this study) and traffic noise. Even less is concerned with Sydney.

The response of land values to airport changes in Sydney was established by Alexsandric (1974). In the long-run period the airport affected areas of Botany and Rockdale showed a faster rate of increase in land values than control areas. The airport affected areas also exhibited a short-run response to changes in airport technology or airport extensions, when house prices declined absolutely and relatively. However, the long-run evidence suggests that after these short-run periods of change, prices increased to approximately their previously established long-run trend. Using multiple regression analysis Abelson (1977) attempted to isolate the effects of aircraft and road traffic noise in Marrickville and Rockdale in Sydney in 1972-3. At Marrickville road traffic noise was found to have a 5.6 per cent depressing influence on house prices and aircraft noise of 30-40 NEF had a 6 percent depressing influence. However, at Rockdale, traffic noise had no effect on house prices, while aircraft noise of 30-40 NEF had a 10 percent depressing influence on house prices. Outside Sydney the Newcastle study of Datex (1977) revealed that increased bulk haulage traffic volumes and associated disturbance halved the annual increase in property prices of affected streets in the period from 1962-73.

A very recent study by Holsman and Paparoulas (1982) has investigated the impact of the newly completed Eastern Suburbs Railway on residential land values in the Sydney suburb of Edgecliff for the period of 1972-81 using the control area of South Paddington. The study also divided the Edgecliff study area into three sub-areas as it was felt that the impacts of the Railway would vary according to whether residents lived very close to the Railway, and were or were not affected by Railway operational noise. The study identified that there is a statistically significant difference in the long-run growth rates on property prices between the two principal areas, with Edgecliff increasing at a very fast rate since 1976 when the commitment to the Railway was given. However, in

the sub-region of Edgecliff affected by the above ground section of the Railway where considerable disturbance exists, the movement in property prices since the Railway's opening shows two years of relative decline. A questionnaire survey of residents in this sub-region also identified that noise has a statistically significant adverse impact on property values in the area. It was concluded that in the residential area affected by the operational noise of the Railway, the environmental impacts of the E.S.R. outweighed the accessibility benefits. It is also worth noting that the present study follows the same methodology as that pursued in the Holsman and Paparoulas paper.

Recent research also suggests that as traffic volume and noise increases, dissatisfaction felt by residents increases (Taylor et al. 1979, and Wyatt and Bookman, 1981). Danger from traffic, traffic noise, fumes, vibration, soot and trash were seen to be the most stressful aspects of neighbourhood environment in a study comparing three streets in San Francisco differing in traffic volume (Appleyard and Lintell, 1972). Taylor and Hall (1977) found that attitudes towards noise are relatively uniform across social status groups, but that the higher status groups reported being more disturbed by noise and were more willing to make complaints. The people who were found to be most disturbed by noise were those who had lived longest in each neighbourhood and those who spent longer periods at home. Gamble et al. (1974) noted also that the degree of annoyance from noise was not related to income, age or sex but they did report a positive relationship between annoyance and the extent to which residents felt their property values had been adversely affected by noise. In a similar study performed in London it was discovered that as dissatisfaction from traffic effects increases the probability of leaving windows open while sleeping decreases, and the need to close windows while engaging in domestic activities increases. The more dissatisfied respondents also reported more disurbance of their children's and their own sleep (Griffiths and Langdon, 1968).

These studies suggest that in areas where the environmental disturbances associated with road traffic noise are excessive, people will be adversely affected by these disturbances. Therefore, it is reasonable to propose that in areas where such disturbances are excessive that people will value such areas less highly. Hence, house values might be lower and might increase at slower rates than less affected areas.

METHODOLOGY

On the basis of the findings derived from the literature a four stage methodology was developed to investigate the economic and social effects of main road traffic noise on house prices in Sydney. These stages include:

(i) A short-run analysis of house sales prices to indicate any years during the study period (1968-1980) when property prices on main roads were significantly different from those on streets parallel to the main roads (control streets).

(ii) A long-run analysis of house price movements to establish whether there are any differences in the movements, or rates of increase of house sales prices on main roads and on parallel streets over the study period.

(iii) Regression analysis to investigate the extent to which road traffic noise affects residential property prices.

(iv) A survey of residents at the sites under study and of associated residential characteristics to indicate whether residents exposed to traffic noise exhibit any responses or residential characteristics which are different to those of residents not exposed to traffic noise.

The study relies on a survey-control area comparison approach, that is it makes a comparison of property prices on main roads with those of adjacent parallel roads. The main advantage of incorporating the survey-control area comparison technique is that it allows an externality impact to be distinguishable from the general trends in the wider property market which are represented by the price movements on the adjacent control streets. In so doing, economic fluctuations in the study area due to inflation, migration or growth are largely controlled. Obviously, the validity of such results depends considerably on the compatibility of the study and control streets. In this study, in an effort to ensure such compatability a number of criteria were formulated which both main road and control streets had to satisfy. These criteria consisted of similar housing type, similar predominant land use, straight and level sections of road and that road traffic noise should be the major source of noise at each site. These conditions necessitated that all control streets were parallel to the main road under study. The difficulty of acquiring suitable sites was considerable and after an investigation of all main roads in Sydney only nine suitable locations were found. The location of the study sites is given in Figure 1. House sales prices for the period 1968-80 inclusive were obtained from the respective Local Government valuation books. A total of 1306 transactions were recorded, 596 on main roads and 710 on parallel streets.

A household questionnaire was distributed to households in each of the nine sites who had purchased their homes during the period of study (1968-1980). In all, 1003 mail-back questionnaires were distributed and a total of 368 returned. The survey response rate of 37% was regarded as highly satisfactory for the type of survey undertaken. The questionnaire was divided into four parts. The first part looks at the householders' decision to buy his house and his attitudes to his locality at the present time, the underlying purpose being to ascertain whether 'quiet' was an important variable in his decision to buy his house or that Main Road traffic noise was one of the variables disliked about the neighbourhood at the present time. The second part dealt specifically with main road traffic noise, its effects on the householder and his responses to that noise. Part three of the questionnaire looked at the respondent himself - age, sex, occupation and the amount of time spent at home each week. The last part of the questionnaire obtained information about the physical attributes of the house, for example its age and structure. Cross tabulations are obtained and analysed for statistical significance to establish the nature of relationships between noise attributes and other variables expressed in the data.

Measurements of road traffic noise were undertaken at all nine sites between June and August 1980 using the mobile acoustic research unit of the Graduate School of the Built Environment at the University of New South Wales. Recording sessions on both main roads and parallel streets were conducted on weekdays between 10am - 3pm. This avoided peak hour traffic and represents an attempt to record the traffic flow during the major portion of day. A traffic count was undertaken during each recording session and the number and category of vehicles was collected. Both the Leq and L_{10} noise indices were used through the study.[1]

1. Advice on all matters regarding the measurement of traffic noise and the appropriateness of various noise indices was kindly given by the staff of the Acoustic Research Unit. The Unit also undertook the noise measurements for us.

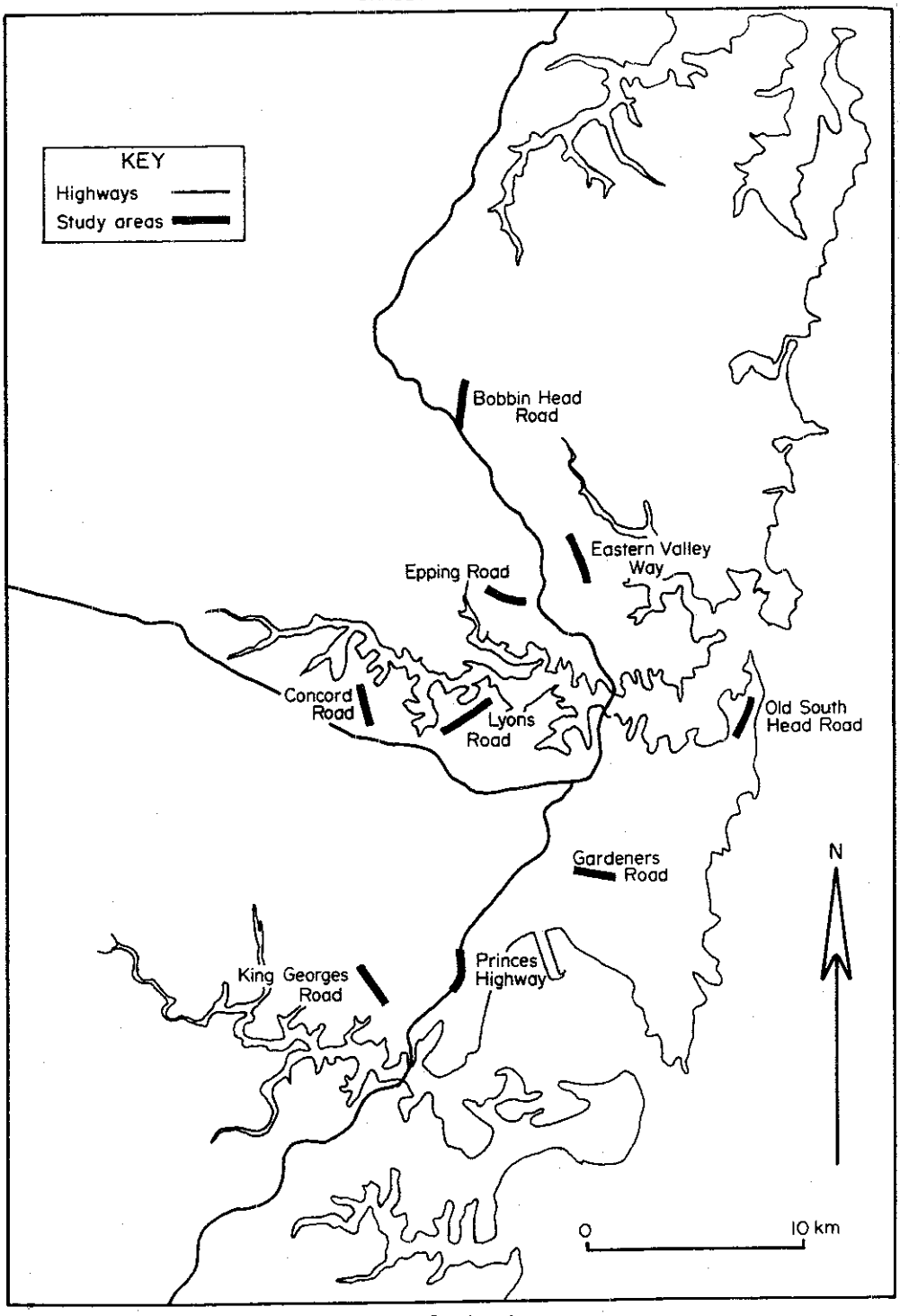
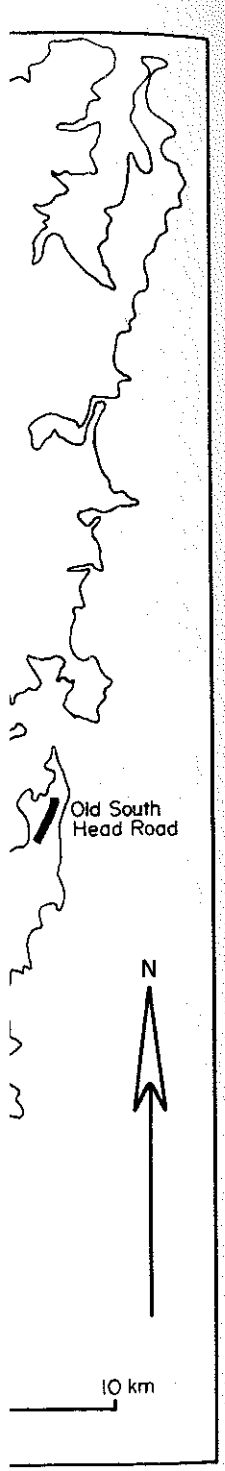


Fig 1 Study sites



The Short-Run Analysis Procedure - To investigate the hypothesis that the mean sales price of houses located on a Main Road is significantly different to that of houses located on parallel control streets, an appropriate 't' test was used. The form of the 't' test used was:

$$t = \frac{y_1 - y_2}{s.e.\ (y_1 - y_2)}$$

where $y_1 - y_2$ = difference between the mean property sales prices for a main road and its control street for a particular year

and $s.e.\ (y_1 - y_2)$ = standard error of the difference.

This 't' statistic was used for each year for each site. In an attempt to synthesise any common trends which may appear in the analysis of data for the nine sites a further set of tests was performed on the mean sales prices of houses in all main roads and in all parallel streets.

Long-Run Analysis Procedure - The determination of the long-run general trends of the property markets on the main roads and on the control streets was achieved by a series of regression analyses, all using property values as the dependent variable, and time as the independent variable. Three different forms of the model were used as it was discovered that no single form of the model was universally successful in describing the movement of house prices in all study sites. All three models used the above variables, or transformations of those variables. The first model (1) is linear, and the second (2) is a quadratic function :

$$P = a + bt \qquad (1)$$

$$P = a + bt + ct^2 \qquad (2)$$

where P = house sales price

t = time, being 1 for 1968 and 13 for 1980

b = linear time trend coefficient

c = quadratic time trend coefficient

a = constant

The third form of the model suggests that the growth rate of prices may be constant :

$$P = a(1 + g)^t e \qquad (3)$$

where g = growth rate

e = error term

Equation (3) can be linearised using logarithmic transformation. Thus

$$L_N P = L_N a + (L_N\ (1+g))\ t + L_N e \qquad (4)$$

To determine whether the rate of growth of house prices was significantly different in noise affected streets and parallel streets, an appropriate 'F' test was used.

Multiple Regression Model - This final section of the analysis is not concerned with actual differences in house sale prices, but with establishing the effect which main road traffic noise has had on property prices on the main roads and on parallel streets both absolutely, and in comparison with other independent variables which are considered to be property price determining factors. It needs to be stressed that the aim of this section is not to account totally for the movement of property prices, but to identify the role of noise. A stepwise regression procedure was used to test the following model:

$$P = C + X_1T + X_2A + X_3R + X_4N$$

where P = house sale prices on main road or parallel street

T = Year of the sale

A = Age of the house

R = no. of rooms in the house

N = measure of traffic noise

C = constant

$X_1 - X_4$ = Regression coefficients

The model uses similar variables to those discovered to be of general significance in related studies. In total, four models were run, two for main roads and two for parallel streets, in the first instance using the Leq measurement for noise, and secondly, the L_{10} value. The sample sizes used in the regression analyses are 153 in the case of the main roads data set, and 215 for the parallel streets.

RESULTS

For space reasons it is impossible to give all the results of the numerous analyses undertaken as part of this study. Emphasis is therefore given to the more important and representative findings. More details of the study's findings can be obtained from the authors.

1. Short-Run Movements

The following results were recorded for each of the nine sites:

(1) Bobbin Head Road - the mean sales price of houses in Bobbin Head Road was significantly below that of the parallel streets in 1974, 1976 and 1978. However, in some years the mean price on main roads was higher than that on parallel streets.

(2) Eastern Valley Way - apart from 1976 all years reveal a mean sales price for property on Eastern Valley Way which is less than that for the parallel streets. However, only in 1971 is the difference statistically significant.

(3) Epping Road - mean price differences were significant in 1973, 1979 and 1980 (main roads less than parallel streets) but there were also years when mean prices were higher than those on parallel streets.

(4) Concord Road - mean sales prices of houses in Concord Road were not shown to be significantly different to those on parallel streets for any of the years under consideration.

(5) Lyons Road - the mean sales prices was significantly greater than that for the parallel streets in 1969, 1970 and 1972 and significantly less in 1971.

(6) Old South Head Road - mean prices were significantly lower on the main road in 1972 and 1978.

(7) Gardeners Road - the mean sales price was significantly greater than that for the parallel streets in 1976 and 1979 but significantly less in 1980.

(8) Princes Highway - the prices on the main road were significantly less than those in the parallel streets in 1976 and 1979.

(9) King Georges Road - the data for this site are the most supportive of any of the sites for the basic hypothesis of this study, namely that house prices on main roads are lower than those on parallel streets. The mean sales price of houses in King Georges Road was less than those in the parallel streets in every year of the study period. Also there were six years when those differences were statistically significant (1974-1976 and 1978-1980).

It can be seen from the above list that the short run measurements at the nine sites appear to fluctuate quite markedly. However, in an attempt to discover any common short-run trends in mean sales prices the data for all main roads and all parallel streets were combined. Such a process obviously biases the results towards the trends of the larger sample groups and this point must be taken into account when interpreting Table 1. where the results are given. Nevertheless, when the data are combined the results support the basic hypothesis of the study, for eight of the thirteen years under consideration differences in mean sales prices were found to be significantly different. There appears to be three distinct periods during which the prices were significantly different, 1968-69, 1973-74 and 1977-80 (excluding 1979). 1971 does not seem to belong to any group.

A consideration of the percentage changes in prices on the two sets of streets suggests a differential response of the property prices on main roads and parallel streets to movements in the property market. It is accepted that the residential land market goes through periods of boom (or major surges in prices) and stabilisation. In times of high demand prices move upwards more rapidly for those properties in more desirable localities (on parallel streets as opposed to main roads). As the boom wanes such properties cannot sustain their price superiority and main road properties catch up. For the thirteen year period under review the average yearly difference in mean house prices of property located on all main roads and those of all the parallel streets is 16%.

2. Long Run Movements

As stated earlier three forms of a time series regression model were used to investigate the long-run movements of property prices each using sales price as the dependent variable and time of sale as the independent variable. Summarised results of the analyses are given in Table 2. The table states which form of the model best fits the movement of house prices at each site. The most appropriate model is identified by the R^2 value, or coefficient of determination; which indicates the proportion of variation in the dependent variable (price) which is explained (in the statistical sense) by the independent variable (time). The table also indicates a listing of 'F' statistics which indicate whether the best fit equations for main road and parallel road long-run prices movements are significantly different from one another.

TABLE 1

SHORT RUN ANALYSIS: ALL MAIN ROADS, ALL PARALLEL STREETS

Year	All Main Roads Mean Price $	All Parallel Streets Mean Price $	t-statistic	All Main Roads % change in prices	All Parallel Streets % change in prices	difference in mean values
1968	18472.2	24935.4	1.6046*			34.5%
1969	19769.5	22848.0	1.6134*	7.02	- 8.37	15.7%
1970	22605.9	22752.1	0.0479	14.35	- 0.42	0.04%
1971	21538.2	26665.2	2.8413***	-4.72	17.20	24.2%
1972	27704.2	28956.4	0.4979	28.63	8.59	4.3%
1973	33146.2	37566.6	1.8628**	19.64	29.73	13.6%
1974	36077.8	46665.0	2.6861***	8.84	24.22	29.1%
1975	39051.6	44293.2	1.2691	8.24	- 5.08	13.3%
1976	40353.1	43990.7	1.2642	3.33	- 0.68	9.0%
1977	42896.9	48263.8	1.6094*	6.30	9.71	12.6%
1978	48281.1	61316.4	2.6664***	12.55	27.04	27.2%
1979	61674.2	68471.5	1.2637	27.74	11.67	11.0%
1980	76514.5	92440.4	1.7901*	24.06	36.47	22.1%

* significant at .10 probability level.
** significant at .05 probability level.
*** significant at .01 probability level.

TABLE 2

SUMMARY OF RESULTS : REGRESSION MODELS OF LONG-RUN TRENDS OF PRICES[2]

	SITE	MAIN ROAD OR PARALLEL ST	BEST FIT MODEL	R^2	F - RATIO
1.	BOBBIN HEAD RD	MAIN ROAD	LN PRICE	.61	12.99 **
		PARALLEL	LN PRICE	.59	
2.	EASTERN VALLEY W.	MAIN ROAD	LN PRICE	.87	9.06 **
		PARALLEL	LN PRICE	.73	
3.	EPPING ROAD	MAIN ROAD	QUADRATIC	.73	7.76 **
		PARALLEL	QUADRATIC	.75	
4.	CONCORD ROAD	MAIN ROAD	LN PRICE	.57	0.50
		PARALLEL	LN PRICE	.68	
5.	LYONS ROAD	MAIN ROAD	QUADRATIC	.84	2.14
		PARALLEL	QUADRATIC	.62	
6.	OLD SOUTH HEAD RD	MAIN ROAD	QUADRATIC	.34	0.98
		PARALLEL	QUADRATIC	.32	
7.	GARDENERS RD	MAIN ROAD	QUADRATIC	.55	1.72
		PARALLEL	QUADRATIC	.22	
8.	PRINCES H.	MAIN ROAD	LN PRICE	.47	3.57
		PARALLEL	LN PRICE	.76	
9.	KING GEORGES RD	MAIN ROAD	LN PRICE	.57	18.22 **
		PARALLEL	LN PRICE	.34	
10.	ALL MAIN ROADS	MAIN ROAD	LN PRICE	.52	35.94 **
		PARALLEL	LN PRICE	.45	

* Significantly different at 0.01 probability level

* Significantly different at 0.05 probability level

[2]: Refer to page 5 for details of the models.

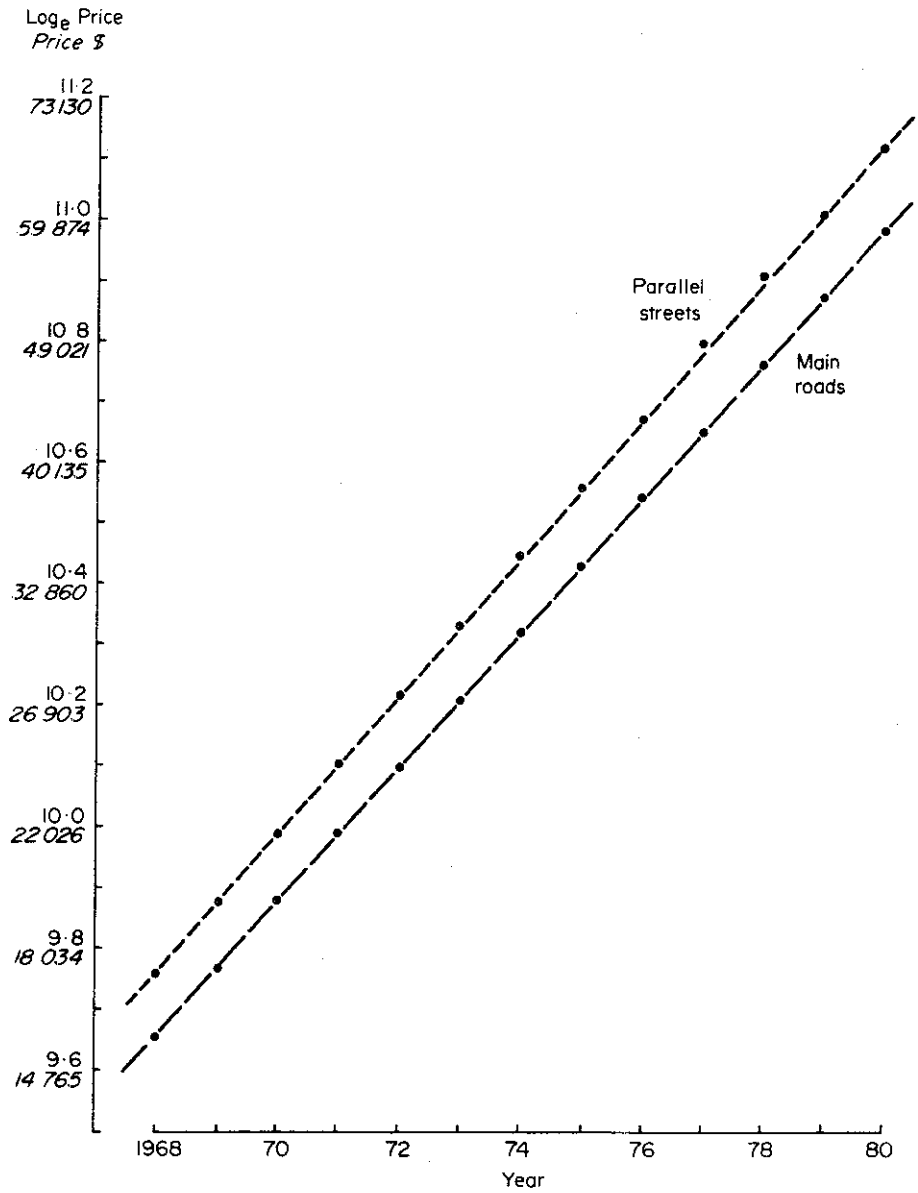


Fig 2 Long run trend of house prices

An exa
sites provided

(1) No one fo
all nine
explains
Only in t
Highway d
(R^2 <.50)
main and
none of t
sentation
certain 1
which hav
trends re

(2) If only t
ered, the
Road, and
observed
parallel
main road
obviously

(3) At the re
ter signi
those on
of house
similar c

In an
data, the data
all parallel s
taken. The re
form of the mo
main roads and
representatio
Figure 2. Gi
or four sites
main roads and
that the long-
significantly

3. Regressi

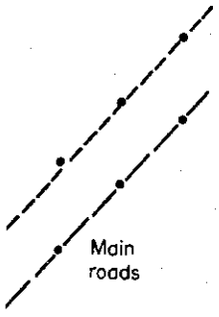
The t
particular ye
property pric
housing stock
streets such
of traffic ex
in property p
a small numbe
in studies el
1977). The r

An examination of the results of the regression analyses for the nine sites provided some interesting findings:

(1) No one form of the three regression models is universally applicable to all nine sites. However, in six of the study sites one of the models explains the long-run movement of house prices to a satisfactory degree. Only in three cases, Old South Head Road, Gardeners Road and the Princes Highway do the R^2 values for the main roads not exceed 50 percent (R^2 <.50). The low R^2 values at some sites, and in two cases for both main and parallel roads, indicates two possibilities. The first is that none of the time series models used in this study is an adequate representation of the movement of house prices in these areas. Secondly, in certain localities particularly local influences may have been at work which have encouraged prices to move substantially above or below the trends represented by the various functions.

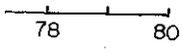
(2) If only the results of the most successful model at each site is considered, then at four sites, Bobbin Head Road, Eastern Valley Way, Epping Road, and King Georges Road, a statistically significant difference is observed in the long-run movement of house prices on main roads and parallel streets. At these four sites the movement of house prices on main roads and parallel streets have been diverging, with the latter obviously moving ahead at a faster rate.

(3) At the remaining five sites the best fit form of the model did not register significant differences between long-run main road price movements and those on parallel streets. This suggests that at these site the movement of house prices on main roads and parallel streets has been somewhat similar despite the increase in road traffic during the study period.



In an effort to draw together any common trends that may exist in the data, the data were again combined into the two data sets of all main roads and all parallel streets and the three time series regression analyses were undertaken. The results of these analyses are also summarised in Table 2. The best form of the model accounted for 52% of the variation in price movements on all main roads and 45% of the variation in all parallel streets. Diagrammatic representation of the regression equations for the two samples is given in Figure 2. Given the unsatisfactory levels of explanation of the models at three or four sites, the overall level of explanation of the best fit model for all main roads and parallel streets is not surprising. The 'F' statistic identifies that the long-run trend in house prices on main roads and parallel streets is significantly different.

3. Regression Analyses of Effect of Main Road Traffic Noise on House Prices



The two previous sections have identified that for selected sites and in particular years there is a statistically significant difference in main road property prices and those on parallel streets. Because of the similarity of housing stock and other property price determining factors on the two sets of streets such significant differences were considered to be largely the result of traffic externality effects. This section attempts to account for variations in property prices on both main roads and parallel streets by relating price to a small number of independent variables, including noise, which have been shown in studies elsewhere to be significant price determining factors (see Hall, et al, 1977). The results of the exercise are given in Table 3.

BRADLEY & HOLSMAN

TABLE 3

RESULTS OF STEPWISE REGRESSION ANALYSIS[3] -
ALL MAIN ROADS

In order of entry into equation	Equation 1 (using L_{10} as noise measurement)		Equation 2 (using L_{eq} as noise measurement)	
Variables	Coefficient	Cumulative R^2	Coefficient	Cumulative R^2
Year	5460**	0.14	5483.5**	0.14
L_{10} or L_{eq}	-1727.9*	0.17	-1381.4*	0.17
Constant	121693.2*		101520.8*	

3: Refer to page 6 for details of the model.

TABLE 4

RESULTS OF STEPWISE REGRESSION ANALYSIS -
PARALLEL STREETS

In order of entry into equation	Equation 1 (using L_{10} as noise measurement)		Equation 2 (using L_{eq} as noise measurement)	
Variables	Coefficient	Cumulative R^2	Coefficient	Cumulative R^2
Year	5062**	0.25	5057.1**	0.25
No. of Rooms	3364.7**	0.34	3318.0**	0.34
House Age	-262.1**	0.37	-249.8**	0.37
L_{10} or L_{eq}	-499.9*	0.38	-652.3*	0.38
Constant	17444.8		26069.3	

** statistically significant at 0.05 probability level.

* statistically significant at .10 probability level.

SOME OBSERV
In t
house prices
levels of ex
This is not
level of exp
the relation
variation in
two are show
of the prope
the year of
14 per cent
equation, th
noise exerts
in describin
coefficients
on main road
per decibel

The
property pri
little diffe
38 per cent
However, in
are shown to
least signif
level of exp
very minor
and is much
size or age.
traffic nois
decibel of
measurement
less than t

Alt
variations
presented h
they do all
on house pr
was shown t
difference
power of th
unexpected.
factor in a
is a depres
be a greate
just 3 per
trade off n
that actual
residential

4. Analys

A t
residents w
on one of t
on the stat
from males,
under-repre
6 per cent
roads or pa

4. See Law
IAC Mee

In the case of the main roads data only 17 per cent of the variation in house prices is accounted for by the regression model outlined earlier. The levels of explanation using either L_{10} or Leq as the measure of noise are identical. This is not surprising as the L_{10} and Leq values are highly correlated.[4] The poor level of explanation (17 per cent) indicates that the four variables used to explore the relationship with property price are not successful indicators of the variation in property prices. Indeed, of the four independent variables only two are shown to be statistically significant. These two variables are the year of the property sale and the L_{10} or Leq noise measurement. Of these two variables the year of property sale is entered into the equation first and accounts for 14 per cent of the variation. When the noise variable is added into the equation, the level of explanation rises just three per cent. Therefore, although noise exerts a statistically significant effect on house prices, its impact in describing variations in house prices is quite minor. The regression coefficients in Table 3 indicate that noise (L_{10}) decreases the price of property on main roads by $1727 per decibel. This figure is greater than the dollar value per decibel quoted by Hall et al ($700 per/decidel) in their Canadian study (1977).

The regression model was more successful in accounting for variations in property prices on parallel streets than on main roads (Table 4). Again it made little difference whether the L_{10} or Leq measure of noise was used as only 38 per cent of the variation in house prices was discovered in both cases. However, in the analysis of property prices on parallel streets all four variables are shown to be statistically significant. However, the noise variable is the least significant of the four variables and adds just one per cent to the overall level of explanation of the model. In other words, noise can be regarded as a very minor determinant of house prices in the parallel streets under investigation and is much less important than the characteristics of the property such as its size or age. Despite its lesser significance in this analysis, the impact of traffic noise is still shown to be important in monetary terms. Each additional decibel of noise depresses the price of property by $500 using L_{10} as the noise measurement and $652 using the Leq measure. These values are obviously considerably less than the equivalent values obtained in the main roads analysis.

Although neither regression model is very successful in accounting for variations in property prices on main roads and parallel streets, the results presented here do serve the purpose for which the models were designed, that is, they do allow an appreciation of the effect which main road traffic noise has on house prices. Given the results of the earlier analytical sections where it was shown that for numerous streets, there is no significant short or long term difference in house price movements, the somewhat minor level of explanatory power of the noise variable in the two regression models may not be totally unexpected. Also it would not be expected that traffic noise would be a major factor in accounting for house prices on parallel streets (though certainly it is a depressing factor). However, it was anticipated that traffic noise would be a greater determinant of price on main roads. That it is not (accounting for just 3 per cent of property price variation) suggests that many residents may trade off noise for increased accessibility, or whatever. It may also suggest that actual noise levels are very different from perceived noise levels of the residential property purchaser.

4. Analysis of Survey Questionnaire

A total of 368 questionnaires were returned, 153 of these being from residents who live on one of the main roads and 215 from residents who live on one of the parallel streets. Again to save space discussion here is focussed on the statistically significant relationships in the data. More responses came from males, and of all the adult age groups only the over 65 year olds were under-represented. The length of the residence of respondents varies up to 6 per cent within each category between the two groups of respondents (main roads or parallel streets). For example, a greater percentage of residents on

4. See Lawrence, A (1974) "Stop-Start Traffic Noise". Paper presented to 8th IAC Meeting, London.

parallel streets have lived in their residence for between 4-10 years (51 percent against 42 percent), and a lesser percentage on parallel streets have lived in their house for more than 10 years (11 percent against 19 percent). For the sample interviewed there is little evidence of a high turnover of property on main roads (induced possibly by traffic noise). Indeed, a greater percentage of that resident group stay in their houses for more lengthy periods of time.

4.1 Decision to Purchase Home. The cost and quality of the house appear consistently as the major factors influencing people's decision to purchase their homes within both groups. Within the main road group neither a quiet neighbourhood nor distance from main roads was a major contributing factor to that decision. A quiet neighbourhood is more important within the parallel streets, with 36% of respondents recording its importance compared with 18% of respondents from the main roads. Investigation of the factors which were ranked first in the householders' decision to purchase their house failed to reveal any significant differences between the main roads and parallel streets.

4.2 Factors Disliked about the Neighbourhood. Within the main road group the short distance from main roads was perceived as the major factor or aspect disliked by residents (24 percent response). The negative externality effects of main road traffic obviously extend beyond noise (7 percent response) and incorporates safety and visual factors. Air quality, which is also largely a traffic externality characteristic was ranked first by 9 percent of the group. When total responses are included the factor which recorded the greatest general negative response (31 percent) was neighbourhood noise (animals, domestic appliances, neighbours, etc.). This high response indicates that some respondents probably included traffic noise as part of their interpretation of neighbourhood noise even though they were asked to consider main road traffic noise as a separate element. This viewpoint is supported by a comparison of neighbourhood noise responses of the two groups. Neighbourhood noise is basically similar in most areas yet only 11.6 percent mentioned it as a negative neighbourhood factor on parallel streets. On the parallel streets only two negative factors registered more than 10 percent response, these being distance from work and neighbourhood noise. It is not surprising then that the responses of the residents in the two localities with regard to those factors that they dislike about their neighbourhood are discovered to be significantly different (chi-square significant at .01). Distance from main roads, air quality and neighbourhood noises are the three variables representing the major difference in response rates.

4.3 Noises in the Neighbourhood. When noise is explicitly stated in the question the recognition of main road traffic noise is immediately apparent (see Table 5). Nearly 63 percent of respondents from the main road sample found that main road traffic noise was the most noticeable neighbourhood noise compared with about 18 percent from the parallel streets. The most noticeable noise in the parallel streets was domestic noise (29 percent) followed by local traffic noise. It is interesting to note that within the main road sample 27 percent stated that local traffic noise was the most noticeable noise. This suggests that many of the respondents either do not consider themselves to be resident on a main road or that they do not differentiate between main and local traffic noise. The other interesting response from the table is the large number of people who mentioned aircraft noise as being one of the three most noticeable noises. A comparison of noises ranked most noticeable by residents in the two locality groups revealed a significant difference between responses for main roads and parallel streets.

Similarly, the chi-square statistic revealed a significant difference between attitude to main road traffic noise by the two groups of residents. Of those residents on main roads 84 percent find main road traffic noise disagreeable to some degree, compared with 44 percent for residents of parallel streets (see Table 6). The latter percentage, which is somewhat higher

TABLE 5

NOISE RANKINGS BY RESIDENTS (%)

Main Road

	1st ranking	2nd ranking	3rd ranking	total mentioning noise
Domestic noise	5.4	20.2	26.4	52.0
Local traffic noise	27.0	30.6	12.1	69.7
Aircraft noise	1.4	16.9	23.1	41.4
Garden noise	1.4	11.3	22.0	34.7
Main road traffic noise	62.8	16.9	7.7	87.4
Other	2.0	4.0	8.8	14.8

Parallel Streets

	1st ranking	2nd ranking	3rd ranking	total mentioning noise
Domestic noise	29.4	14.8	13.5	57.7
Local traffic noise	25.8	31.8	12.0	69.6
Aircraft Noise	13.4	17.0	23.3	53.7
Garden noises	7.2	14.8	24.1	46.1
Main road traffic noise	18.0	15.3	15.5	48.8
Other	6.2	6.3	12.0	24.5

TABLE 6

ATTITUDE TO MAIN ROAD TRAFFIC NOISE BY LOCALITY

	Main Road	%	Parallel Streets	%
Extremely agreeable	1	0.66	30	14.6
Moderately agreeable	6	4.0	24	11.6
Slightly agreeable	0	0.0	3	1.4
Neutral	18	12.0	57	27.6
Slightly disagreeable	33	21.8	55	26.7
Moderately disagreeable	62	41.0	27	13.1
Extremely disagreeable	32	21.2	8	3.9

chi square = 88.0879 6 degrees of freedom significant at .0005 probability level.

than anticipated may possibly reflect experience of main road traffic noise obtained when travelling rather than attitudes based on residential experiences.

4.4 Activity Interference. The number of activity interferences caused by main road traffic to residents of main roads is approximately double that experienced by residents on parallel streets. However, for both groups the nature and order of interference is somewhat similar - sleeping is affected most, then talking outside, and then T.V. watching! Disturbance of sleep is registered by a half of main road residents and by 15 percent of residents of parallel streets. Again, in the latter case, some confusion in the minds of parallel streets' residents may exist between main road traffic noise and local traffic noise.

Table 7 identifies that for the sample response many more residents of main roads suffer medical complaints resulting from main road noise but that the distribution of nature of complaints was not significantly different to the responses from residents on parallel streets. As a follow up all those residents who had noted some health effect of main road traffic noise were asked if they had sought medical treatment. Thirteen people or 8 percent of households responding on main roads had sought medical assistance. Although this percentage is small, it is regarded as a significant percentage and it must be remembered that a much larger number are suffering some discomfort though not to the level of seeking medical help.

4.5 Actions Resulting from Annoyance by Main Road Traffic Noise. A resident may undertake three sets of actions to decrease the impact of main road traffic noise: short term actions such as closing windows or turning up the TV, long term action such as installing air conditioning or insulation, or finally by making a complaint to councils or other bodies. Only in respect of short term actions are the responses of the two groups significantly different. Households on main roads are more likely to respond to traffic noise by staying indoors, wearing earplugs, turning up the television or radio or by living more in the back of the house. For approximately 60 percent of those residing on main roads associated traffic noise has been sufficiently irksome for some long term action to be undertaken. Most commonly this involves the planting of hedges or trees. A relatively small percentage of residents have attempted to have their residential environment improved in some way by making a complaint about their problem to some public body. It can be suggested that the cost of long term solutions and the unlikelihood of achieving any positive response from complaint activity, appears to lead most residents into making short term responses to cope with main road traffic noise.

4.6 Attitudes to Main Road Traffic Noise. The final investigation of the survey data represents an attempt to discover whether people who found main road traffic noise to be disagreeable exhibited any particular personal characteristics. In respect of the sex variable no significant differences were noted for the attitude to main road traffic noise between males and females for either main road or parallel street residents. Similarly, no significant differences in attitudes to main road traffic noise were discovered among the four age categories (18-25, 26-40, 41-65, 65+) residing on main roads. However, the age group that finds main road traffic noise most disagreeable is the 41-65 year group.

The analysis of the household questionnaire revealed that main road traffic noise was not one of the major factors which people dislike about their neighbourhood. However, when questioned further, main road residents did acknowledge main road traffic noise (and local traffic noise) as the noise which was most noticeable in their neighbourhood. Further analysis of the questionnaire reflects two points: first, main road residents revealed that they undertook more actions aimed at reducing the impact of main road traffic noise than did residents in the parallel streets, and secondly, they noted a greater

TABLE 7

MEDICAL COMPLAINTS BY LOCALITY RESULTING FROM TRAFFIC NOISE

COMPLAINT	MAIN ROAD	% Response	PARALLEL STREET	% Response
Headache	17	11.1	5	7.5
Nervousness	15	9.9	10	14.9
Hearing Difficulties	9	5.9	1	1.5
Irritability	28	18.3	13	19.4
Interrupted Sleep	78	51.0	38	56.7
Total	147		67	

Note: Multiple responses are permissible

number of domestic activities with which main road traffic noise interfered.

DISCUSSION

At this stage it is appropriate to make some comment on the methodology adopted in this study to indicate some future research initiatives and the policy implications of the research. A number of points can be made about the methodology adopted in this study. The first is that it must be emphasised that the study has attempted to say something about the impact of main road traffic noise rather than the composite externality effects, both positive and negative, of main roads. The latter effects represent a much broader issue which can only be investigated through the inclusion of data on air quality, traffic flow and mix, access problems, safety or accident measurements, public transport availability and various distance measurements to key local facilities. Similarly, although it has been possible to demonstrate that property prices on main roads do vary significantly, both in the short and long term, from those on parallel streets, such variations are not only accounted for by traffic noise but by the range of main road characteristics mentioned above. The role of noise has been shown to be significant but minor. In this respect the household survey proved an invaluable exercise in identifying the relative significance of noise to the household as both a determining factor in buying their property, or as a factor disliked about the neighbourhood. If the survey procedure had a weakness, it was that the differentiation of main road traffic noise, local noise and local traffic noise was not sufficiently clear and some households were obviously confused. A final point about the methodology is that the study was confined to a small number of sites. This resulted not from any desire to limit the study task, but from the observation that there are very few ideal study sites across Sydney that meet the requirements of such a study.

The nature of the current work could be extended in a number of areas. In the first instance, a much broader investigation of transport externality effects could be achieved within the economic analysis by the inclusion of numerous other indicators of main roads. Secondly, a more comprehensive understanding of the attitudes of households to main road traffic noise could be obtained by an extensive survey of residents living on main roads in a greater number of areas than considered here. A larger sample of residents would allow an investigation of variations of attitudes and impacts by socio-economic area, by traffic volume and mix, and by road characteristics (grades, number of lanes, extent of signalling etc)

In a policy and planning sense, this study afforded many useful findings. In the first instance, it has established the nature and extent of the economic and social disadvantages of living on main roads in large urban areas such as Sydney. The results of this work can be used to widen the debate within the community of any policy measures that can be introduced at the Local or State government level to alleviate such problems for both existing households and those who will be affected by main road developments in the future. Such policy measures that may warrant debate is assistance for those who incur financial loss in attempting to provide long term solutions to their noise problems or health damage related directly to main road traffic noise. The results of this study also have implications for more effective planning guidelines on property development close to or alongside main roads and for the design standards of main roads.

However, based on the findings of this study, the extent of direct recommendations that can be made to government is inevitably limited by the variable impact of main road traffic impacts (of which noise is just one indicator) across Sydney. Only in four areas of Sydney since 1968 have such externality impacts appeared to have increased the disparity of property prices between

main roads and parallel streets. The responses from these four areas might be indicative of the responses of the middle to upper status areas to main road effects. In such areas it would appear that peace and quiet and the absence of main road disamenities has become more valued in recent years. The residents of such localities may also be in a better financial position to purchase separation from such effects. Elsewhere long-run variations in property price trends have not occurred. This does not mean that residents in such areas suffer traffic noise, or whatever gladly, but that in the long term in such areas main road externalities have not been gaining in significance.

This study has shown that the economic and social implications of main road traffic noise are variable across Sydney. It has been established that in certain parts of Sydney, both in the short and long term, there are considerable depressive effects resulting from combined main road externalities. On average across Sydney such economic impact is estimated at 16 percent difference in property price, but substantial variations around that value do occur. The precise contribution of main road traffic noise to this difference cannot be established at this stage, but in accounting for variations in the sales prices of property, noise appears to play a minor role. This study has initiated a research exercise into the socio-economic impacts of main road externalities. The authors are very aware that they have only scratched the surface of a broad area of environmental research but are hopeful that the present work will be seen as a useful contribution to this increasingly recognised important area of investigation.

ACKNOWLEDGEMENTS

This study was conducted with the financial support of a research grant from the N.S.W. State Pollution Control Commission. We gratefully acknowledge the assistance of the Commission. We are also grateful for the help of Professor Anita Lawrence, Marion Burgess and the technical staff of the Graduate School of Built Environment at the University of New South Wales in recording and processing traffic noise measurements.

REFERENCES

Abelson, P. (1977) The Impact of Environmental Factors on Relative House Prices. A Report Prepared for the Bureau of Transport Economics, Australian Government Publishing Service, Canberra.

Aleksandric, V. (1974) The Effect of Externalities on the Residential Land Market in the Vicinity of an Airport: a Case Study of Sydney (B.Sc. Thesis, School of Geography, UNSW (unpublished.)

Appleyard, D. and Lintell, M. (1972) "The Environmental Quality of City Streets: The Residents 'Viewpoint", American Institute of Planners Journal, Vol. 38, pp 84-101.

Datex Cooperative Limited (1977) Trucks in Suburbs - The Social and Economic Impacts of Bulk Road Haulage on Urban Communities. McCalden. G. and Jarvis, W. (Eds)

Gamble, H.B., Sauerlander, O.H. and Langley, G.J. (1974) Social, Economic, Behavioural and Urban Growth Considerations in Planning Transportation Research Record Vol. 508 pp. 37-47

Griffiths, I.D. and Langdon, F.J. (1968) Subjective Response to Road Traffic Noise. Journal of Sound and Vibration Vol. 8, pp 16-32

Hall, F.L. Breston B.E. and Taylor, S.M. (1977) The Effects of Highway Noise on Residential Property Values, Faculty of Engineering, McMaster University, Canada.

Holsman, A.J. and Paparoulas A. (1982) The Impact of the Eastern Suburbs Railway on Property Prices in Edgecliff (NSW). The Valuer Vol. 27,3 p255-261

M.S.J. Keys Young Planners (1974) Social Impact Analysis Australian Commonwealth Bureau of Roads.

Pearce, D and Nash, C. (1973) The Evaluation of Urban Motorway Schemes: A Case Study - Southhampton. Urban Studies Vol. pp.129-143

Taylor, S.M. and Hall F.L. (1977) Predicting Community Response to Road Traffic Noise Journal of Sound and Vibration, Vol 53, pp 387-399

Wyatt, R.G. and Bookman, R.C. (1981) Operational Techniques for Socially Sensitive Road Placement - A Melbourne Contribution Department of Town and Regional Planning, University of Melbourne.

William Y
Lecturer
Monash Ur

ABSTRACT: