POPULATION CHANGE AND RETAIL SALES PATTERNS IN LOCAL AUTHORITY AREAS OF QUEENSLAND

by

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Extension?

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POPULATION CHANGE AND RETAIL SALES PATTERNS IN LOCAL AUTHORITY AREAS OF QUEENSLAND

Regional economic theory gives small towns the role of catering to the most immediate needs of residents in the rural hinterland. This is especially important in Australia because of the immense distances between rural settlements and the extreme skewedness of the city size distribution. Of the 103 Queensland "urban centers" defined in the 1976 Census of Population, only 14 had a population above 10,000. There were 14 others with between 5,000 and 10,000 people while the remaining 75 centers had less than 5,000. Many residents of the Queensland rural hinterland must either do their shopping in very small towns, or travel long distances to larger centers.

Central place theory and threshold analysis [2,4] suggest a link between the population of a town and the role which the town plays as a provider of goods and services to residents of the town and its rural hinterland. Declining population tends to reduce the viability of some retail and service establishments in a town, while population growth may allow a town to expand its spectrum of retail and service offerings. This paper uses data from the Australian censuses of retail trade and population to document the impacts of population change on retail trade patterns in Queensland.

The 1969 and 1974 Census of Retail Trade gave the number of retail establishments and dollar value of retail sales by local authority areas. Disclosure rules prevented the release of this information for some of the smallest places, in which case several adjacent local authorities were

aggregated and the totals reported. Population estimates for 1969 and 1974 were obtained by linear interpolation from the Census of Population 1966, 1971 and 1976 counts.

One problem encountered in data collection was the instability of the local authority boundaries used in collecting Australian statistics. Local authorities in Queensland have changed boundaries many times over the years, making longitudinal studies very difficult. This paper is restricted to the period from 1969 to 1974 since only one critical boundary change occurred. Observations on the local authorities involved in this change were omitted from the data set leaving 120 complete observations.

The Relation Between Population and Per Capita Sales

Table 1 shows the relationship between per capita sales and the population of Queensland local authorities. The observations are divided into six size groups based on local authority population, and the mean per capita sales are reported for each group. The pattern is just what one would expect; higher per capita sales in larger local authorities. Residents of the smaller local authorities may purchase relatively few items locally, travelling to larger centers to shop. Residents of the larger centers have little cause to make significant retail purchases in the smaller centers.

How successful is population as a variable explaining the level of per capita sales? Table 1 shows the results of one-way analysis of variance applied to this data to determine if the groups have significantly different means.[1]

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1. Analysis of variance is especially appropriate in this case, rather than regression analysis, because AOV does not impose a linear relationship between the two variables.

Table 1: Relation between Population and Per Capita Sales; Queensland, 1974.

	Population in 1974					
	<2,000	2 to 5,000	5 to 10,000	10 to 25,000	25 to 60,000	>60,000
Number of Authorities	20	44	27	15	9	5
Mean Per Capita Sales	646.1	816.9	989.6	1,180.9	1,313.0	1,675.0
Standard Error of Mean	77.45	67.96	102.75	175.74	220.05	113.64
F-Statistics for Paired Comparisons Among all Groups						
2 to 5,000	2.29					
5 to 10,000	6.44	2.16				
10 to 25,000	9.51	5.65	1.04			
25 to 60,000	13.41	7.82	2.27	0.23		
> 60,000	40.05	17.64	8.01	2.58	1.46	
Significance Levels of F-Statistics						
2 to 5,000	>80					
5 to 10,000	>97.5	>80				
10 to 25,000	>99	>97.5	>50			
25 to 60,000	>99	>99	>80	<50		
> 60,000	>99	>99	>99	>80	>50	

Overall Significance

F = 5.792 (significant at the 99 percent level)

"R^2" = .203

For example, one can compare the smallest two groups of local authorities. Those with a 1974 population of under 2,000 people had average sales of $646.10 per person, and those local authorities with 2,000 to 5,000 people had average per capita sales of $816.90. The F-statistic which measures the significance of the difference between these group means has a value of 2.29. This is less than the 95 percent tabled F which equals 3.92. Hence these two means are not significantly different at the 95 percent levels but they do differ significantly at the 80 percent confidence level. In fact no two adjacent means are significantly different at the 95 percent level. The local authorities with a population under 2,000 did have significantly lower per capita sales than those with more than 5,000 people. Likewise local authorities with 2,000 to 5,000 people have significantly less sales than those above 10,000 population, and those with 5,000 to 10,000 sold significantly less than the local authorities having over 60,000 people.

Using one way analysis of variance results in an overall F-statistic of 5.792 for testing the joint equality of all six group means. This is greater than the 95 percent tabled F which equals 2.29. One can reject the hypothesis that there are no differences among the six means. There is a significant pattern of higher per capita sales in higher population local authorities, in spite of adjacent group means not being significantly different at an acceptable significance level. The proportion of variation in per capita sales explained by population (analogous to R^2 in a regression model) is just over 20 percent.

The low explanatory power of the AOV model suggests that factors other than the population of a local authority are also important determin-

ants of per capita sales. The proximity of a local authority to larger centers should be one such important variable. Small local authorities near large centers are likely to capture only a very low level of local retail sales. A similarly sized local authority distant from large centers may cater to most of the retail needs of its residents. The populations of all local authorities adjacent to each given local authority are summed to give a proximity variable. This new variable is used in a linear regression. The observations were sorted to exclude those local authorities with greater than a 20 percent population growth since they were considered to be "boom" areas that might not yet have adjusted retail services to population. Also excluded were those local authorities with above 25,000 population, since our primary interest is with the smaller places. The regression, with 91 observations is:

Retail sales per capita 73-74	= 873.13 (10.40)	+	.0689 (6.59)	Population 1974	- .0096 (5.16)	Adjacent Population 1974

The numbers in parentheses are t-ratios, all of which exceed the 99 percent confidence level. The regression R^2 was .436 and the F was 34.06. The results strongly support the hypothesis about the effects of population and proximity on per capita retail sales.[2]

The Effect of Population Change on Retail Sales

If population is positively related to a local authority's ability to capture the retail sales expenditures of its residents--then what is

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2. The regression results would certainly have been better were it not for variations in the way local authority boundaries are drawn. Some urban local authorities comprise only the built up city area, while others encompass large tracts of surrounding hinterland. Some cities are surrounded by a single shire, while others may abutt half a dozen or more local authorities. These ambiguities reduce the effectiveness of both the population and the adjacent population variables.

the likely impact of population change? If the relation in the above regression is a stable one, then local authorities should be able to move along the function as their population rises or falls. Population increases should result in an even greater retail sales jump due to the combined effect of more people and more local purchases made by each. Population decline should cause the reverse result; retail sales falling by more than the decline in number of residents.

The effect of population change is tested directly in Table 2. The mean percent change in retail sales between 1968-69 and 1973-74 is shown for six groups of local authorities. The groups of local authorities are based on percent change in population between 1969 and 1974. The means and the F-statistics verify the existence of a highly significant positive relation between changes in local authority population and changes in retail sales.

Interpretation of Table 2 is complicated by the multiplicative effects of population change and inflation. A growing place will have more people making retail purchases, and each is likely to spend more due to rising prices. The cost of living index for Queensland increased by about 38% during the period from 1968-69 to 1973-74. One can conclude from Table 2 that retail sales in local authorities which lost population failed to keep up with inflation. Those places with population growth showed gains in the real value of retail sales.

The Effect of Population Change on Per Capita Retail Sales

The situation is seen more clearly in Table 3 which relates the percent change in per capita sales between 1968-69 and 1973-74 to the percent change in population. The group means certainly suggest the tendency of

Table 2: Relation between % Change in Population and % Change in Retail Sales; Queensland, 1969-74.

	% Change Population 1969-74				
	<-10	-10 to 0	0 to 20	20 to 50	>50
Number of Authorities	23	35	42	13	7
Mean % Change Sales	8.9	28.5	48.5	99.9	137.6
Standard Error of Mean	5.23	4.84	4.73	18.45	32.49
F-Statistics for Paired Comparisons Among all Groups					
-10 to 0	7.24				
0 to 20	28.54	8.82			
20 to 50	35.92	28.05	15.43		
> 50	44.28	39.44	27.59	1.26	
Significance Levels of F-Statistics					
-10 to 0	> 99				
0 to 20	> 99	> 99			
20 to 50	> 99	> 99	> 99		
> 50	> 99	> 99	> 99	> 50	

Overall Signficance

F = 22.52 (significant at the 99 percent level)

"R^2" = .439

Table 3: Relation between % Change in Population and % Change in Per Capita Retail Sales; Queensland, 1969-74.

	% Change Population 1969-74				
	<-10	-10 to 0	0 to 20	20 to 50	>50
Number of Authorities	23	35	42	13	7
Mean % Change Per Capita Sales	25.9	35.0	38.5	55.8	31.4
Standard Error of Mean	5.82	4.72	3.86	15.82	19.61
F-Statistics for Paired Comparisons Among all Groups					
-10 to 0	1.21				
0 to 20	3.53	0.55			
20 to 50	4.64	3.23	2.49		
> 50	0.14	0.04	0.35	0.94	
Significance Levels of F-Statistics					
-10 to 0	>50				
0 to 20	>90	<50			
20 to 50	>95	>90	>80		
> 50	<50	<50	<50	>50	

Overall Significance

F = 1.850 (significant at the 80 percent level)

"R^2" = .060

moderately growing centers to attract increasing per capita retail expenditures, however the F-statistics in Table 3 underline the weakness of this relation. Only the 20 to 50 percent population increase group can be said to differ at the 95 percent level from the group which is losing population faster than 10 percent. Two other mean comparisons achieve a 90 percent level of significance; the rapid loss group compared to the slow gain group and the slow loss group compared to the slow gain group and the slow loss group compared to the moderate gain group. The overall F-statistic of 1.850 is not significant at the 95 percent level, barely meeting the criterion for 80 percent significance.

Part of the problem lies with the fastest growing local authorities. It appears that in boom situations population can outstrip the local availability of retail services resulting even in declines of per capita retail sales. Also, the starting position of a local authority seems to be important. Local authorities with very low levels of per capita retail sales tend to be unable to capture more sales. Many of these local authorities are the ones adjacent to cities where most spending is done in the nearby city rather than locally. Population growth in such a situation can result only in more people going to the city to shop, and very little local sales gain. Local authorities with very high levels of per capita retail sales tend to be the service centers for a surrounding hinterland that extends beyond the immediate local authority boundary. The changes in retailing over many years have tended to favour such centers when compared to the smaller retail establishments of the hinterland.

Regression analysis was used to try to clarify these results. To eliminate the problem of boom growth, the data set was restricted to local

Table 6: Relation between % Change in Population and % Change in Sales per Firm; Queensland, 1969-74.

	% Change Population 1969-74				
	<-10	-10 to 0	0 to 20	20 to 50	>50
Number of Authorities	23	35	42	13	7
Mean Sales Per Firm	29.1	42.4	56.1	58.7	89.4
Standard Error Mean	6.10	4.21	4.24	9.48	7.65
F-Statistics for Paired Comparisons Among all Groups					
-10 to 0	3.49				
0 to 20	13.95	5.27			
20 to 50	7.77	3.40	0.08		
> 50	26.59	22.51	9.56	4.94	
Significance Levels of F-Statistics					
-10 to 0	>90	>97.5			
0 to 20	>99	>90	<50		
20 to 50	>99	>99	>99	>95	
> 50	>99				

Overall Significance

F = 8.376 (significant at the 99 percent level)

"R^2" = .226

authorities with population growth rates under 20 percent. The regression results were:

% Change in Retail Sales per capita 68-69 to 73-74	= 25.44 (4.36)	+ .9002 (3.27)	% Change population 69-74	+ .0148 (2.03)	Retail Sales per capita in 68-69

The regression has an overall F-statistic of 7.55 indicating significance at above the 99 percent level. The coefficient of population change differs from zero with more than 99 percent confidence, while the coefficient for per capita retail sales at the start of the period is significant at the 95 percent level. While these results are promising, it must also be noted that the R^2 was only .134; only 13.4 percent of the variation in per capita sales changes is explained by the model. While the results indicate the existence of other explanatory factors not recognized in this study, there is also the clear indication that both population change and the initial level of per capita sales are important explanatory variables.

It is worthwhile probing further into the implications of the above regression equation. If one fixes initial per capita retail sales at $800, a figure that would have represented the small rural retail centers in 1968-69, then the equation describes the relationship shown in Figure 1. If such a local authority had experienced a 10 percent population loss, then per capita sales would be expected to increase by 28 percent, which is substantially below the inflation rate. However if population had increased by 10 percent, per capita sales would increase by 46 percent, which is well above the inflation rate.

Figure 2 shows the relationship between change in per capita sales and the initial level of per capita retail sales at the start of the period. A local authority starting with $500 per capita sales and a stable population, could expect per capita retail sales to increase by 33 percent,

Figure 1: Impact of Population Change on Per Capita Retail Sales Change, Initial Sales Fixed at $800.

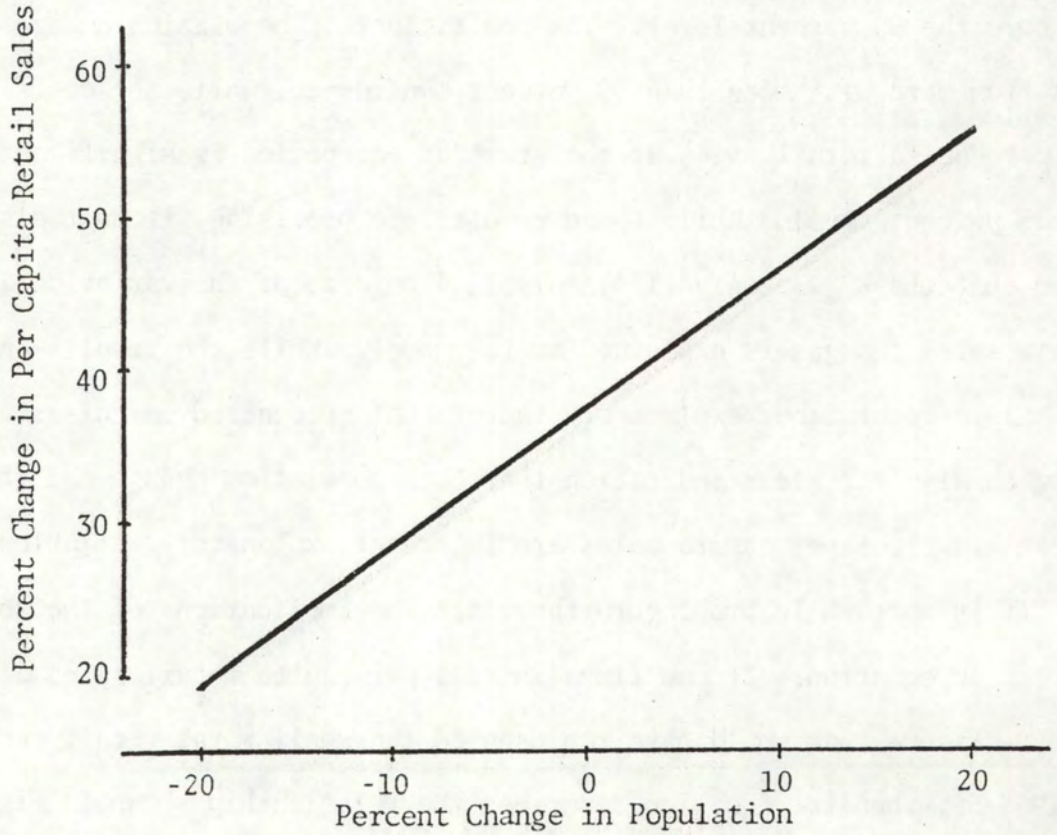
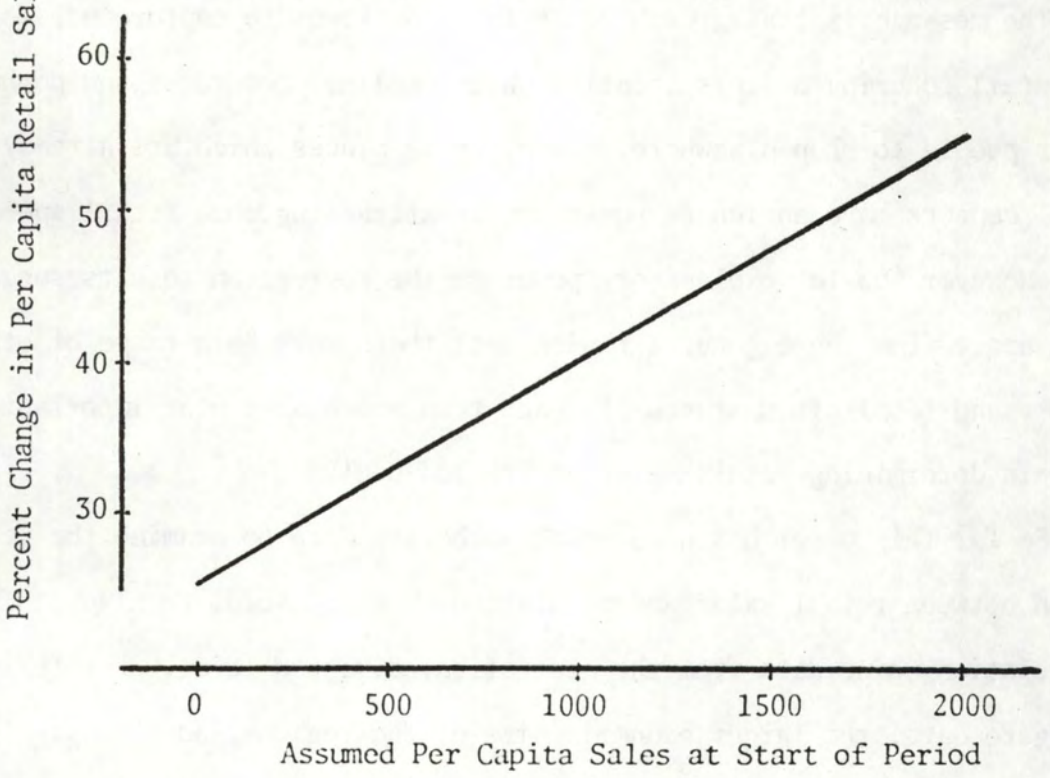


Figure 2: Impact of Initial Retail Sales Level on Per Capita Retail Sales Change, Population Change Fixed at 0.



well below the rate of inflation. A city serving as a regional retail center with per capita sales of $1500 at the start of the period, and also with stable population, could expect per capita sales to climb by 48 percent, substantially above the inflation rate.

The message is that growth seems to allow towns to capture more of the retail spending dollars locally, while decline encourages and perhaps forces people to shop elsewhere. Also, those places which are already retail centers have an innate advantage in attracting more retail spending. However the low explanatory power of the regression results suggests that, apart from these general tendencies, there must be a range of other forces, and local circumstances in each town which also play important roles in determining retail sales growth and decline.

So far this paper has used local authority data to examine the relation between retail sales and population. It is useful to also study the relation using data from the statistical division level. For the more aggregate data, the larger economic size of the regions, and the greater physical areas covered (internalizing some factors that might be external to a given local authority) would be expected to damp down some of the variation seen in the disaggregate data. Data from the statistical divisions of both Queensland and New South Wales provided 21 observations usable for measuring the impact of population change on per capita retail sales.

A linear regression was fitted, giving:

$$\begin{matrix}\text{\% Change in Retail Sales} \\ \text{Per Capita 68-69 to 73-74}\end{matrix} = \underset{(23.25)}{42.77} + \underset{(6.41)}{1.37}\ \begin{matrix}\text{\% Population} \\ \text{Change 69 to 74}\end{matrix}$$

with an R^2 of .685 and an F of 41.34. The good fit of the regression

and the significant positive coefficient when statistical division data is used should be interpreted as supporting evidence for the relationship at the local authority level.

The Impact of Population Change on Number of Retail Firms

Perhaps more important to both local businessmen and local consumers than the sales impacts of population change are the impacts on number of firms. Here we are dealing directly with the birth and death of retail establishments, and hence directly with the diversity of goods and services locally available to residents of the community. Technological change in retailing, away from small shops toward supermarkets and department stores has meant a general downward trend in number of retail firms in most areas. Only 30 of the 120 local authorities showed an increase in numbers of firms between 1968-69 and 1973-74. Eight others showed no change in numbers, while the remaining 82, or 68 percent, registered declines. Clearly consumers in many areas of Queensland have a reduced diversity of local retail establishments from which to choose.

Table 4 uses local authority data to look at the relation between percent change in population and percent change in number of firms. The positive impact of population change on number of firms shows up very clearly. As predicted by the literature on threshold analysis, places losing popualtion are losing retail firms at an even faster rate than places with stable to slowly growing population. In Queensland the rapidly growing places show increases in firm numbers and presumably increases in the diversity of retail establishments available to residents. The F-statistics attest to the strength of this relation. However the increase in diversity is tempered by the general trend toward larger and fewer

Table 4: Relation between % Change in Population and % Change in Number of Firms; Queensland, 1969-74.

	% Change Population 1969-74				
	<-10	-10 to 0	0 to 20	20 to 50	>50
Number of Authorities	23	35	42	13	7
Mean % Change # Firms	-14.5	-9.7	-4.9	25.1	21.8
Standard Error of Mean	2.05	2.38	1.54	7.25	10.00
F-Statistics for Paired Comparisons Among all Groups					
-10 to 0	2.07				
0 to 20	14.04	3.04			
20 to 50	44.15	36.09	39.32		
> 50	32.43	21.69	24.83	0.75	
Significance Levels of F-Statistics					
-10 to 0	>80				
0 to 20	>99	>90			
20 to 50	>99	99	99		
> 50	>99	99	99	>50	

Overall Significance

$_2F$ = 21.910 (significant at the 99 percent level)
"R^2" = .432

retail establishments. For only 23 local authorities was the change in number of firms more positive than the change in population.

Still obvious is the "boom area" phenomenon. The fastest growing local authorities seem both to lag in terms of entry of new firms, and also to be extremely variable in their response. That there should be lags in adjusting firm numbers to population is reasonable, given the necessary response time for setting up a new firm. Presumably, these boom areas will catch up at some future time. It is likely that this distributed lag response of firm numbers and sales volume to population changes contributes to the often weak statistical fits of the models used in this paper.

Table 5 relates local authority population to retail sales per firm in 1973-74. Again the relationship is as one would expect, small places having small firms. In fact there are four small local authorities with retail firms averaging less than $30,000 gross sales. Surely such firms return only a marginal living for their owners. Presumably as one goes to larger local authorities, the supermarkets and department stores contribute to the much higher average sales; well above $100,000 for places with more than 25,000 people. The F-statistics confirm that mean sales for most of the groups differ at high levels of significance.

Table 6 looks at changes in sales per firm as population changes. Here there are two important factors at work. It may be that a given firm in a growing place can sell more. It is also probably true that growing places attract more large firms, raising average sales per firm. From this data it is impossible to distinguish between the two forces. The increasing group means suggest that one factor or the other, or more

Table 5: Relation between Population and Sales per Firm; Queensland, 1974.

	Population in 1979 ('000)					
	<2,000	2 to 5,000	5 to 10,000	10 to 25,000	25 to 60,000	>60,000
Number of Authorities	20	44	27	15	9	5
Mean Sales Per Firm	48,300	61,900	79,800	89,300	120,800	144,400
Standard Error Mean	4,690	3,000	4,520	11,780	8,230	10,680
F-Statistics for Paired Comparisons Among all Groups						
2 to 5,000	6.27					
5 to 10,000	23.17	12.09				
10 to 25,000	13.09	10.62	0.82			
25 to 60,000	69.02	61.65	20.62	3.76		
> 60,000	83.30	76.05	32.77	6.87	3.25	
Significance Levels of F-Statistics						
2 to 5,000	>97.5					
5 to 10,000	>99	>99				
10 to 25,000	>99	>99	>50			
25 to 60,000	>99	>99	>99	>90		
> 60,000	>99	>99	>99	>99	>90	

Overall Significance

F = 20.55 (significant at the 99 percent level)

"R^2" = .474

probably both, were active between 1968-69 and 1973-74. While the dispersion around the group means is quite wide because of the number of other forces at work, the F-statistics indicate a fairly high level of significance between most of the groups. Note that all but the rapid decline group had average sales increases exceeding the 38 percent inflation experienced between 1968-69 and 1973-74.

Again it is useful to use the statistical division data to support relationships found using the local authority data. The data for Queensland and New South Wales statistical divisions was used to estimate the regression:

$$\begin{array}{l}\text{Percent Change in Number} \\ \text{of Firms 68-69 to 73-74}\end{array} = \underset{(6.34)}{-7.08} + \underset{(5.05)}{.655}\ \begin{array}{l}\text{Percent Population} \\ \text{Change 69 to 74}\end{array}$$

with an R^2 of .573 and an F of 25.50. The slope of the regression line is interesting, being somewhat flatter than the diagonal. The result is that the regression line is further below a diagonal for rapidly growing places than for slow growing or declining places. This suggests that declining or slow growing places are quite tenacious in holding on to their small number of vital retail outlets, while the faster growing places are embroiled in the shift that is replacing small shops with fewer large retail outlets.

Summary and Implications

This paper empirically documents the retail sales patterns predicted by regional economic theory and threshold analysis. The larger Queensland local authorities achieve a higher level of per capita retail sales than do the less populous local authorities. However, close proximity to larger centers has a significant negative influence on per capita sales.

Changes in population tend to be reflected in greater than proportional changes in retail sales. Growth allows towns to capture a higher proportion of retail spending dollars locally, while decline encourages and even forces people to shop elsewhere. Those places which are already retail centers have an innate advantage in attracting more retail spending. The results suggest that declining or slowly growing places are more tenacious in holding on to what retail outlets they have, while the faster growing places are engaged in replacing small shops with large establishments. Growing local authorities tend to have increased average sales per firm, but how much of this is increased sales by existing firms and how much is due to the entry of large new firms is impossible to discern from the data. Sales per firm in places with rapid population decline failed to keep up with inflation, and places experiencing slower population decline just barely managed to increase sales per firm by more than inflation.

Besides the obvious implications for small towns contained in the above conclusions, there are several methodological implications worth noting. The first deals with the reversibility of the growth/decline process. This paper has treated growth and decline not as two fundamentally different processes as suggested by Jensen [3], but as extremes on a continuum. The functional relationships used in this paper show no obvious discontinuity between the behavior of growing and declining places. While this is perhaps weak evidence, it still remains to be shown that small town decline is anything but "negative growth".

The other methodological implication of the results in this paper concern the proper procedures for use in economic impact analysis. Many impact analyses, especially the input-output variety, assume that income

from a new project will be spent within the study area in about the same pattern as was true of area spending prior to the new project. However, the results in this paper suggest that a moderate sized project may not only increase local income, but may also increase the portion of local income spent locally. Because input-output results are very sensitive to this "induction effect" of local household spending, proper treatment of spending pattern shifts is potentially quite important.

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