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Population Change and Retail Sales Patterns in Local Authority Areas of Queensland

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Census data from Queensland were used to test whether or not the relationships between population and retail trade patterns derived from central place theory were applicable at the local authority level. Larger local authorities achieve higher per capita retail sales than less populous places. Proximity to larger centres reduces per capita sales. Population growth allows a local authority to capture a higher proportion of spending locally, while decline encourages and even forces people to shop elsewhere. There is a general tendency toward fewer retail firms, presumably due to technological changes in retailing, but the rate of loss is related to population change. Only places with moderate population growth show increases in firm numbers. Changes in retail sales per firm are also directly related to population change.

1. Introduction

The role of small towns in catering to the most immediate needs of rural residents is especially important in Australia because of the large distances between settlements and because of the extreme skewedness of the city size distribution. Of the 103 Queensland urban centres defined in the 1976 Census of Population, only 14 had a population above 10 000. There were 14 others with between 4 000 and 10 000 people while the remaining 75 centres had less than 5 000. The relative dependence on agriculture as an economic base, and lack of alternatives such as manufacturing, education, and recreation except along the coastal fringe, coupled with the extensive nature of most Queensland agriculture contributes to the large number of small centres. (While mining is a very significant economic base for the Queensland rural economy, it tends to promote employment and population growth in isolated enclaves.) Consequently many residents of the rural hinterland must either do their shopping in very small towns, or travel long distances to larger centres.

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Population shifts of recent decades have affected the commercial roles of these smaller Queensland towns. The patterns of rural depopulation of the interior have been documented by Widdows, Christiansen and Ellis (1974). Changes in agricultural technology and depressed prices of primary products have contributed to the decline of many small centres (Montague 1977, p. 164). At the same time the coastal fringe has attracted population due to developing extractive industries and recreation, and its urban centres have shown relative vitality.

This paper uses data from the Australian censuses of retail trade and population to explore the linkage between population change and retail trade patterns, emphasizing the implications for Queensland's smaller urban centres.

2. The Theoretical Basis for a Population-Retail Sales Link

Much of the regional economics literature deals with why and how places grow and decline (for example see: Smith 1976; Richardson 1979; Isard 1974). The approach of these authors is varied, as some focus on population change as the primary indicator of community growth or decline, while others use various measures of commercial activity to indicate the changing fortunes of a town or region.

It is central place theory (Hoover 1948; Christaller 1966; Beckman 1968; Smith 1976; Berry and Pred 1965) which establishes the link between population and the role which a town plays as a provider of goods and services to residents of the town and its adjacent rural hinterland. Central place theory is based on two fundamental concepts:

(1) The amount of business a retail firm will get from distant consumers depends on the "range" of the particular goods being offered. Range is defined as the circular area beyond which purchasers would be unwilling to travel for the goods, given elasticity of demand, price, transportation cost, and frequency of use.

(2) The volume of sales a supplier needs to stay in business is his economic "threshold". This threshold is based on the circular area having enough people and sufficient per capita demand to allow the supplier enough volume and profits to stay in business.

Using these two concepts, range and threshold, central place theory describes the relation between the pattern of population settlement and the system of central places. High order goods (those items which people are willing to travel some distance to buy, and those items with a high sales volume threshold) tend to be offered only in the high level centres. Low level centres tend to offer only items which people are not willing to drive long distances for, and items that can feasibly be sold in low volume retail establishments. High level centres tend to be more populous and dispersed, and low level centres, with smaller populations, tend to nest in the trade areas of the high level centres.

Christaller claimed that central place theory was useful not only for explaining the development of existing patterns of settlement and trade, but also for describing the dynamics of decline:

> "Reverse development causes a widening of the lower limit of the range of central goods—perhaps in consequence of an increase in the intensive use of production capital, and perhaps because of the impoverishment of the population. A larger region is then necessary . . .. Some central places will not be able to keep up with this development; they are not able to extend their ranges because the regions of neighboring central places have already formed. These central places will fade away and the number of central places will be decreased." (Christaller 1966, p. 117.)

The consequences of both growth and decline depend very much on the nature of the goods being provided and the firms providing them:

> "Growth of population will lead to the following effects on local retail business:
>
> 1. Businesses with monopolies over a given product or service will tend to benefit from local growth;
> 2. Those businesses without such a monopoly position will tend to experience increased competition for the increased total area sales volume;
> 3. Businesses with unique services and merchandise . . . will tend not to be eroded by increased competition, particularly from regional shopping centres;
> 4. Additional population growth leads to additional retailing activity, but the form of that activity changes from home owned businesses or "strip" shopping streets to absentee-owned chainstore businesses in large-scale shopping centres." (Applebaum, Bigelow, Kramer, Molotch and Relis 1976, p. 54.)

There are some conceptual problems with using central place theory to develop hypotheses about the relation of population to retail sales which are empirically testable using local authority data. One problem relates to the appropriate unit of analysis. Central place theory asserts that the population settlement pattern across a wide area determines the system of central places that can be supported. A population change at one point can have repercussions for the whole hierarchy of central places that include that point within their range. The nesting of trade areas for different levels of goods means that a central place supplying one good may be part of the hinterland for a higher level good. Yet the population and retail sales census data are based on political units—local authority areas with only weak correspondence to trade areas and with no recognition of the hierarchical ordering of goods.

Another problem for empirical analysis concerns which population groups to include. Towns serve not only the needs of their adjacent rural hinterlands, but also the needs of town residents. Many of these town residents have jobs in the local retail and service establishments. Thus total area population is both a result of and a cause of retail trade status. It is this circularity which underlies the multiplier concept found in economic base analysis (see Richardson 1969, pp. 247–254) and growth pole theory (see Kurklinski and Petrella 1972).

Looking at town population only, as did Walzer and Schmidt (1977) and Hamilton, Peterson and Reid (1976), excludes part of the population relevant to the relationship:

> ". . . it is quite possible that the economic functions of a central place are more closely related to the population of its trade area than to the population of the place itself" (Hart, Salisbury and Smith 1968, p. 344).

But again the data base intrudes—the population data are reported for local authority areas, and it would be difficult to separate hinterland population engaged in basic activities from central place residents employed in retailing and service roles. Indeed, local authorities in Queensland include both shires, which for high level goods are probably hinterland, and cities, which presumably function as high level central places, but exclude the adjacent hinterland.

In spite of these conceptual and data problems, it would be useful to be able to specify the relation between population and retail sales at the local authority level. This is true not only because that is the way the data are available, but also because local development problems are perceived in terms of local government units. Such a local authority based relation between population and retail sales is obviously a hybrid relation that aggregates across a range of more fundamental structural linkages specific to the goods or services bought and sold in each local authority. Moreover, there will be a pronounced boundary effect, where many of the forces which determine local authority retail sales originate elsewhere. These aggregations and boundary effects can be expected to limit the explanatory power of any empirical models.

3. Problem Statement

The empirical section of this paper will address several questions about the relationship between population and retail sales at the local authority level for Queensland:

1. Do local authorities with larger populations actually serve as (or in many cases actually contain) higher level central places? That is, is high population associated with high levels of per capita sales?
2. Is there a depressing effect on local retail sales caused by the proximity of larger centres outside the local authority boundary?
3. Is there an identifiable dynamic relationship between population change and central place status for these smaller local authorities? Do population gains result in an increase in total local sales, in greater per capita local sales, in an increased number of local retail firms, and in increased average sales per firm as more money is spent locally and more customers are attracted from outside?

4. The Population and Retail Sales Data

The 1969 and 1974 Censuses of Retail Trade give the number of retail establishments and dollar value of retail sales by local authority areas for 1968–69 and 1973–74. Disclosure rules prevented the publication of this information for some of the smallest places. In these cases 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.

This study is restricted to the 1969–1974 period because of data compatability problems with earlier censuses. One of the problems was the instability of the local authority boundaries used for reporting census statistics. Local authorities in Queensland have changed boundaries many times over the years, making longitudinal studies very difficult. Between 1969 and 1974 only one critical boundary change occurred in Queensland. The local authorities involved in the change were omitted from the data set leaving 120 complete observations.

It should be noted that in the period selected for study rural Queensland was "just emerging from the economic slough of the drought and depression of wool prices of the sixties" (Montague 1977, p. 164). As a consequence, large population shifts were still occurring in the study period, but this should only make the linkage to retail sales more evident and easier to study. Some problems could emerge because rural recessions can be spatially variable in their impact. Larger rural centres may be better insulated from the effects of recession than small places that are totally dependent on the prosperity of primary production. Also the response lags, whereby shifts in retail trade lag behind changes in population could damage the explanatory power of the analysis.

The data set was further restricted by omitting five local authorities with over 50 000 people in 1974, ten with population increases above 30 per cent between 1969 and 1974 and three that met both criteria. The larger local authorities were omitted to focus interest on the small to medium sized places. The statistical results for the larger places would have been questionable anyway because of the small number of such places and the possibility that the relation between population and retail trade is non-linear. Omitting the rapidly growing "boom" areas was done to minimize the problems caused by lags between changes in population and changes in retail sales. Because it takes time for retail outlets to adjust to higher population, one would expect boom areas to be outliers in the analysis. Of course this limits the implications of this study to the impacts of moderate population change, and the results are not directly applicable to the boomtown phenomenon. There were 102 observations with under 50 000 population and less than 30 per cent population increase.

5. Empirical Results

A. The Relation Between Population and Per Capita Sales

The first relationship tested was whether the larger population authorities are actually associated with higher level central place functions as measured by higher per capita retail sales. Such a relation would presumably mean that the larger places were both retaining more of the retail spending of local residents and capturing more spending by non-residents who travel there to shop. Table 1 shows the mean 1973–74 per capita retail sales for five size groupings of the 102 local authorities in the data set. There is a smooth increase in mean per capita retail sales from the places with under 2 000 people, up to places with 25–50 000 people. While the results may depend somewhat on the size group boundaries used, the mean sales figures conform to expectations from central place theory.

Table 1: *Average Per Capita Retail Sales by Population Size Class*

Population of local authority in 1974	Number of places	Per capita retail sales in 1973–74
Less than 2 000	20	646.10
2 to 5 000	43	832.67
5 to 10 000	23	1 069.96
10 to 25 000	11	1 361.64
25 to 50 000	5	1 481.80

The means in Table 1, however, show nothing of the variability of per capita retail sales within each size grouping. Linear regression on the 102 observation data set was used to address this issue. The regression of per capita sales on population produced the following results:

$$\text{(1)}\quad \begin{matrix}\text{Per capita}\\ \text{retail sales}\\ \text{in 1973–74}\end{matrix} = \underset{(11.18)}{726.21} + \underset{(4.87)}{.0338}\ \begin{matrix}\text{Population}\\ 1974\end{matrix}$$

The *t*-ratios in parentheses indicate that the regression coefficient and intercept are significant at the 99 per cent confidence level. These results clearly show the positive relation between per capita retail sales and size of place that would derive from central place theory. Considering the cross section of Queensland local authorities, a 1 000 person increase in population was associated with a $33.80 increase in retail sales per capita. However, the R^2 of .192 from the regression means that less than 20 per cent of the variation in per capita sales was explained by the population variable.

B. The Effect of Nearby Larger Centres

The proximity of larger centres outside local authority boundaries could be one factor limiting the explanatory power of the regression. Small local authorities near large centres are likely to capture only a low level of retail sales. A similarly sized local authority distant from large centres may cater to most of the retail needs of its residents. To measure this effect, a proximity variable consisting of the sum of the populations of adjacent local authorities (including those in adjacent states when appropriate) was constructed for use in the regression analysis. While the variation in size and shape of Queensland local authorities may make this new variable a less than perfect measure of proximity, each of the alternative proximity measures would have different but equally vexing problems. The regression, with 102 observations, was:

$$\text{(2)}\quad \begin{matrix}\text{Per capita}\\ \text{retail sales}\\ \text{1973–74}\end{matrix} = \underset{(12.24)}{1029.7} + \underset{(5.96)}{.0362}\ \begin{matrix}\text{Population}\\ 1974\end{matrix} - \underset{(5.71)}{.0106}\ \begin{matrix}\text{Adjacent}\\ \text{population}\\ 1974\end{matrix}$$

The coefficients and intercept are significant at the 99 per cent confidence level. The regression R^2 was .392 and the *F*-statistic was 31.88. The population coefficient is nearly equal to the estimate in equation (1). The coefficient of adjacent population implies that a 1 000 person increase in the population of adjacent local authorities was linked to a $10.60 decrease in per capita retail sales. Clearly nearby larger centres have the sales depressing effects that central place theory leads us to expect.

C. The Effect of Population Change on Total Retail Sales

Regressions (1) and (2) have addressed cross sectional differences in local authority population and retail sales, but have not directly addressed the dynamics of changes in population and sales. If these cross sectional relationships are at all stable, one would expect total retail sales in particular local authority areas to change in line with the estimated functions as their populations change. Population increases should result in an even greater jump in total retail sales due to the combined effect of more people and more local purchases made by both old and new residents and by customers attracted from outside the local authority. Population decline should cause the reverse result—total retail sales falling by more than the decline in number of residents.

The relationship between per cent population change and the per cent change in retail sales in real terms is shown in Table 2. The mean per cent change in real retail sales between 1968–69 and 1973–74 is shown for four groups of local authorities. The groups of local authorities are based on per cent change in population between 1969 and 1974. The change in real retail sales removes the effect of inflationary price increases by using the consumer price index reported for Brisbane in the Queensland Statistical Yearbook. While the cost of living may be quite different in the various parts of Queensland, the 38 per cent price level increase experienced by Brisbane should be roughly representative of the price increases experienced by other parts of the state. The means shown in Table 2 suggest the existence of a strong positive relation between changes in local authority population and changes in real retail sales.

Table 2: Average Per Cent Change of Real Retail Sales by Population Change Class

Per cent population change 1969–74	Number of places	Per cent change real retail sales 1968–69 to 1973–74
Over 10 per cent loss	23	−21.02
0 to 10 per cent loss	35	−6.87
0 to 10 per cent gain	29	−0.99
10 to 30 per cent gain	15	37.93

The regression of per cent change in real total retail sales on per cent change of population is used to further explore the relation.

$$\text{(3)}\quad \begin{matrix}\text{Per cent change in}\\ \text{real total retail sales}\\ \text{1968–69 to 1973–74}\end{matrix} = \underset{(0.27)}{-.614} + \underset{(8.33)}{1.757} \begin{matrix}\text{Per cent change}\\ \text{of population}\\ \text{1969–74}\end{matrix}$$

The R^2 of .409, F of 69.32, and highly significant t-ratio on the population change coefficient indicate that the relationship is a strong one. In the cross section of Queensland local authorities, each one per cent increase in the rate of population growth was associated with a 1.757 per cent increase in the rate of real total retail sales growth.

D. The Effect of Population Change on per Capita Retail Sales

Both the means shown in Table 2 and the results for regression equation (3) indicate that the per cent change in total retail sales tends to exceed the per cent change in local authority population. A regression coefficient of one and a zero intercept would imply equality between these rates of change. The 1.757 coefficient (which exceeds unity at the 95 per cent confidence level) and the intercept not significantly different from zero suggest that the per cent loss or gain in real retail sales will exceed the corresponding per cent loss or gain in population. Not only is there a change in the number of residents making local purchases, there is also a change in the attracting power of the local retail sector as predicted by central place theory.

Table 3: *Average Per Cent Change of Real Per Capita Retail Sales by Population Change Class*

Per cent population change 1969–74	Number of places	Per cent change real retail sales per capita 1968–69 to 1973–74
Over 10 per cent loss	23	−8.72
0 to 10 per cent loss	35	−2.58
0 to 10 per cent gain	29	−5.36
10 to 30 per cent gain	15	16.16

This relation is demonstrated directly in Table 3, which shows per cent change in real per capita retail sales for the four groupings of local authorities based on growth rate. While the relation shown in Table 3 is not smooth, the results are generally what was expected. The regression for this data:

$$\text{(4)}\quad \begin{matrix}\text{Per cent change in}\\ \text{real per capita sales}\\ \text{1968–69 to 1973–74}\end{matrix} = \begin{matrix}-1.477\\ (0.69)\end{matrix} + \begin{matrix}.716\\ (3.58)\end{matrix} \begin{matrix}\text{Per cent change}\\ \text{of population}\\ \text{1969 to 1974}\end{matrix}$$

has a coefficient significant at the 99 per cent level and a non-significant intercept. The R^2 is .113 and F is 17.29. These results reinforce what was shown in equation (3). The .716 coefficient in equation (4) is roughly equivalent to the amount by which the population change coefficient in equation (3) exceeds one. While the low R^2 of equation (4) suggests that many other factors affect the change in real per capita sales, the highly significant coefficient supports the predictions from central place theory that increases (decreases) in population increase (decrease) the attracting power of the local retail sector.

E. The Impact of Population Change on Number of Retail Firms

Perhaps of more interest both to 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 establishment and survival 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 19 of the 102 local authorities showed an increase in numbers of firms between 1968–69 and 1973–74. Seven others showed no change in numbers, while the remaining 76, or 75 per cent, registered declines. Clearly consumers in many areas of Queensland have a reduced diversity of local retail establishments from which to choose.

Table 4: *Average Per Cent Change in Number of Retail Firms by Population Change Class*

Per cent population change 1969–74	Number of places	Per cent change number of retail firms 1968–69 to 1973–74
Over 10 per cent loss	23	−15.23
0 to 10 per cent loss	35	−9.66
0 to 10 per cent gain	29	7.91
10 to 30 per cent gain	15	18.21

Table 4 uses local authority data to look at the relation between per cent change in population and per cent change in number of firms. The positive impact of population change on number of firms shows up very clearly. The regression for the data was:

$$(5)\quad \begin{matrix}\text{Per cent change in}\\ \text{number of retail firms}\\ \text{1968–69 to 1973–74}\end{matrix} = \begin{matrix}-5.640\\ (3.94)\end{matrix} + \begin{matrix}1.002\\ (7.52)\end{matrix} \begin{matrix}\text{Per cent change}\\ \text{of population}\\ \text{1969 to 1974}\end{matrix}$$

with an R^2 of .361 and both intercept and coefficient significant at the 99 per cent level. As predicted by the literature on central place theory and threshold analysis, places losing population 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. However regression (5) with its significant negative intercept, suggests that a local authority would have had to increase population by 5.6 per cent (5.640/1.002) to retain a stable number of retail firms.

It is important to note that while population shifts and technology changes may result in fewer retail stores, the number of functions present in a centre might not decline at all because establishments tend to perform multiple functions. Also, the loss of one of several functionally similar establishments does not mean the loss of that functional type from the centre. However, such a change results in a loss of retailing jobs in the community, reduces the range of options open to a customer, diminishes the competitiveness of the retail sector, and reduces the attractiveness of the town as a shopping destination.

F. The Impact of Population Change on Sales per Retail Firm

There is a clear relationship between size of local authority and the volume of retail sales per firm. Those local authorities with under 2 000 people had average retail sales per firm of under $50,000 in 1973–74. In fact there were four small places 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, which is well above $100,000 for places with more than 25 000 people.

Table 5: Average Per Cent Change of Real Retail Sales per Firm by Population Change Class

Per cent population change 1969–74	Number of places	Per cent change real sales per firm 1968–69 to 1973–74
Over 10 per cent loss	23	−6.41
0 to 10 per cent loss	35	3.21
0 to 10 per cent gain	29	7.10
10 to 30 per cent gain	15	17.43

Table 5 contains changes in real sales per firm classed by population change. 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 probably both, were active between 1968–69 and 1973–74. Note that all but the rapid decline group had average sales increases exceeding the 38 per cent inflation experienced in that period. The regression on this data was:

$$\text{(6)}\quad \begin{matrix}\text{Per cent change in}\\ \text{real sales per firm}\\ \text{1968–69 to 1973–74}\end{matrix} = \begin{matrix}4.711\\ (2.60)\end{matrix} + \begin{matrix}.701\\ (4.16)\end{matrix} \begin{matrix}\text{Per cent change}\\ \text{of population}\\ \text{1969 to 1974}\end{matrix}$$

The R^2 of .147 indicated that a range of other factors must also be at work, but the significant coefficient and intercept add support to the hypothesis that population changes have a direct impact on changes in real sales per firm.

6. Summary and Implications

This paper demonstrates that the relationship of retail sales patterns to population predicted from central place theory can be empirically observed using Queensland local authority data. More populous Queensland local authorities achieve a higher level of per capita retail sales than do those with fewer people. However, close proximity to larger centres exerts 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. There is a general tendency towards loss of retail firms from local authorities, presumably due to technological change in retailing, away from small shops toward supermarkets and department stores. Places losing population are losing retail firms at an even faster rate than places with stable to slowly growing population. The

moderately growing places show increases in the number and presumably the diversity of retail establishments available to residents. 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. All but the firms in rapidly declining local authorities had average sales increases exceeding the 38 per cent inflation experienced in the period.

The successful demonstration of these relationships for Queensland local authorities adds to our knowledge of the economic mechanisms of growth and decline of country areas. This has implications for those who formulate policy regarding the provision of basic services to these communities. If agricultural technological change continues to be labour saving, the resulting population shifts will continue the downward pressure on the retail sectors of small rural towns. Perhaps this provides impetus for policies to promote a desirable population distribution, such as promoting industrial decentralization or nurturing growth centres. Programmes to stabilize the agricultural economy and programmes such as irrigation development that would result in a more intensive agriculture might have similar effects.

Another implication of the results from this analysis concerns the proper procedures to be used in project planning and 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. Moreover, by increasing the attraction of the local retail sector, more spending may be attracted from outside. Because input-output results are very sensitive to this "induction effect" of local household spending, proper treatment and quantitative estimates of these spending pattern shifts are potentially quite important.

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