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THE EFFECT OF AGRICULTURE ON COUNTRY TOWN POPULATION IN THE GRAZING AND WHEAT GROWING REGIONS OF NEW SOUTH WALES†

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An attempt was made to identify the factors which determined the rate of growth of the populations of country towns in the grazing and wheat growing regions of New South Wales between 1958 and 1971. The town population increased even though farm population declined during the period studied. In the Wheat and Sheep Zone and on the Northern Tablelands the rate of growth of country town population appeared to be determined by the rate of growth in the gross revenue from agriculture. In all other regions agricultural factors appeared to have little effect on the rate of growth of country towns.

In 1974 Phillips [7], using cross sectional data between shires, established that there was a ratio of approximately 1 to 1 between farm population and the population of towns with more than 2 000 people in the Wheat and Sheep, and High Rainfall Sheep Zones of N.S.W. He also found evidence that within individual areas of the Wheat and Sheep Zone, town population had increased, although farm population had declined during the previous 14 years. Some evidence was found to suggest that town population might be determined by the net output from agriculture rather than by the size of the farming community.

Three hypotheses can be postulated concerning the relationship between agriculture and the size of country towns. (i) It is possible, as Phillips suggested, that the size of country towns is determined by the number of people engaged in agriculture in the surrounding region. In this situation one would expect to find the ratio of farm to town population to be constant between regions and over time. (ii) On the other hand, it could be argued that rural populations can be divided into two groups, namely, a served and a servicing group. The served group would include not only farmers, but also miners, forestry workers, fishermen

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and those engaged in manufacturing and tourist industries. The servicing group would include those engaged in commerce and the service industries such as the retail and wholesale trade, educational, medical, transport and administrative services. If this is so, then the ratio between these two groups should again be constant between regions and over time, but the relationship between farm and town population would be less meaningful. (iii) It is also possible that the number of people living in country towns is determined not by the number of people engaged in primary and manufacturing industries, but by the amount of money spent by these industries in country towns. The number of people selling and maintaining the resources used in the primary and manufacturing industries in country areas are likely to depend on the gross revenue from these industries. On the other hand a large section of the work force employed by some service industries such as entertainment and part of the retail trade might be more dependent on the prosperity of primary and manufacturing industries. In these circumstances town population would depend on net revenue rather than the gross revenue from primary and manufacturing industries.

As the primary aim of the investigation was to measure the effect of agriculture on the populations of country towns, the coastal shires were excluded from the study thus reducing the distinction between hypotheses (i) and (ii). In these areas non-agricultural primary industries such as forestry and fishing are far more important than in the inland shires. In addition the towns of many of the coastal shires have been greatly affected by the tourist industry in recent years.

The regions studied correspond with the three farming zones which have been continuously surveyed by the Bureau of Agricultural Economics (B.A.E.) in N.S.W., namely the Pastoral Zone, the Wheat and Sheep Zone and the High Rainfall Zone, over the period 1957–8 to 1970–1 [1].

In order to remove the effect of other primary industries or large scale construction works on country towns' populations, an additional subregion, the Northern Tablelands, excluding Armidale and Dumaresq Shires, was defined within the High Rainfall Sheep Zone. By creating this subdivision, the effect of the Snowy Mountains Project, Liddel Power Station and Armidale University, all of which were under construction during the period covered by the investigation, are excluded. A similar adjustment was not made in the Pastoral Zone. If the mining towns of Broken Hill and Cobar and the districts they serve are removed, town population is reduced to an insignificant number of people.

The use of the B.A.E. Zones as a basis for the study ensures that there is some degree of uniformity within each farming region and has the added advantage that the B.A.E. Survey can be used as a basis for calculating the gross and net revenue from agriculture for each region. Farm and non-farm populations, the number of people living in country towns together with the number of people employed in primary, manufacturing, service and commerce industries as defined by the Australian Bureau of Census and Statistics were used as a basis for the investigation. Certain subindustrial groups were moved from the above major industrial

TABLE 1: *Changes in farm and non-farm population employees in industries and gross revenue and net revenue from agriculture between census years in different farming regions*

Farming Zone	Pastoral Zone			Wheat and Sheep Zone			High Rainfall Zone		
	1961	1966	1971	1961	1966	1971	1961	1966	1971
Farm population, '000	22.8	22.6	19.1	120.7	119.3	120.7	54.6	52.2	47.5
Non-farm population, '000	70.7	68.3	70.7	289.3	309.8	315.6	189.0	198.3	213.1
Employees in primary and manufacturing industries, '000	21.1	19.2	17.1	68.3	71.0	61.6	32.5	36.5	33.5
Employees in commerce and service industries, '000	14.9	17.3	17.1	82.0	99.4	104.8	45.6	62.1	66.9
Gross revenue from agriculture, $ million*	174	222	147	555	723	694	174	233	215
Net revenue from agriculture, $ million*	62	100	47	183	314	233	63	92	75

* Average of the three years preceeding the census year expressed in 1970–1 money terms.

divisions to another in the 1971 census. Any bias which might have arisen because of this was corrected by placing all the industrial subgroups in the 1961 and 1966 census in the same major industrial division as they were included in the 1971 census. A summary of the data used is shown in Table 1 and details of its sources are included in Appendix I. Because regional gross revenues were highly correlated with net revenues (R^2 ranging from 0.86 to 0.96) it was decided to exclude one of these variables from the investigation. As gross revenue was found to be a better determinant of town population than net revenue the latter was excluded. Because town populations were only available in three census years during the period studied it was necessary to assume that non-farm population approximated town population. A check of this hypothesis suggested that it was substantially correct (Appendix I).

THE RATIOS OF NON-FARM POPULATION TO FARM POPULATION IN DIFFERENT FARMING REGIONS AND BETWEEN INDUSTRIAL GROUPS

In all regions farm population declined and country town populations increased over the period studied as is shown in Table 1. The ratio between the population living off farms and that living on farms in each of the major regions surveyed by the B.A.E. in the three census years are shown in Table 2.

TABLE 2: *Ratio of non-farm to farm population and of employees in commerce and service industries to employees in primary and manufacturing industries in farming regions.**

Farming Zone	Non-farm to farm			Employees, commerce and service industries to primary and manufacturing industries		
	1961	1966	1971	1961	1966	1971
Pastoral	3.1	3.0 (− 2.6)	3.7 (2.8)	0.7	0.9 (21.9)	1.0 (15.7)
Wheat and Sheep	2.4	2.6 (8.3)	2.9 (10.0)	1.2	1.4 (16.4)	1.7 (20.4)
High Rainfall Sheep	3.5	3.8 (9.8)	4.5 (17.8)	1.4	1.7 (19.9)	2.0 (20.1)
Northern Tablelands (adjusted)	2.4	2.5 (4.2)	2.9 (16.0)	n.a.	n.a.	n.a.

* Percentage changes between census years are shown in brackets.
n.a. = not available.

The ratio between the number of people employed in service and commerce industries and those employed in primary and manufacturing regions are included in the same table. Both ratios vary between regions and over time. In any one census year the ratio of non-farm to farm population is only the same in the Wheat and Sheep Zone and the adjusted Northern Tablelands region.

With the exception of the ratio of non-farm to farm population in the Pastoral Zone between 1966 and 1971 all of the ratios increased over time and at a faster rate between 1966 and 1971 than between 1961 and 1966. Thus there is not a constant relationship between country town and farm population. Nor is the number of people employed in commerce and service industries a constant proportion of the number employed in primary and manufacturing industries. Hence the results do not agree with Phillips' conclusion that there was a ratio of 1 to 1 between farm and country town populations. However, by combining regional and time-series data this discrepancy can be explained.

THE RELATIONSHIP BETWEEN AGRICULTURE AND COUNTRY TOWN POPULATION BETWEEN REGIONS

Because changes in the number of people employed in various industries are only recorded in census years it is only possible to examine the relationship between numbers of people employed in different industries in these years. The B.A.E. Surveys from which agricultural gross revenue is calculated are limited to the period covered by the three census years of 1961, 1966 and 1971 and the surveys themselves are limited to three regions. Thus only nine observations are available for analysis even when cross-sectional and time-series data are combined.

The use of combined cross-sectional and time-series data can give an erroneous result if there are large differences in the magnitude of the variables between regions. This is illustrated in Figure 1. The best fitting line for all observations, using linear regression would be *A-B*, indicating that there is a strong positive relationship between the two variables studied. However, within each of the three regions the lines of best fit would be *C-D*, *E-F* and *G-H*, indicating that there is a negative relationship between the variables within each region.

As initial plotting suggests that a straight line relationship existed between the variables, simple least square regression was used to examine the relationship using the equations:

$$NFP = a + bFP$$
$$NFP = a + bGR$$
$$SC = a + bPM$$
$$SC = a + bGR$$

where for each of the three regions:

NFP = the number of people not living on farms in each of the three census years, 1961, 1966, and 1971.

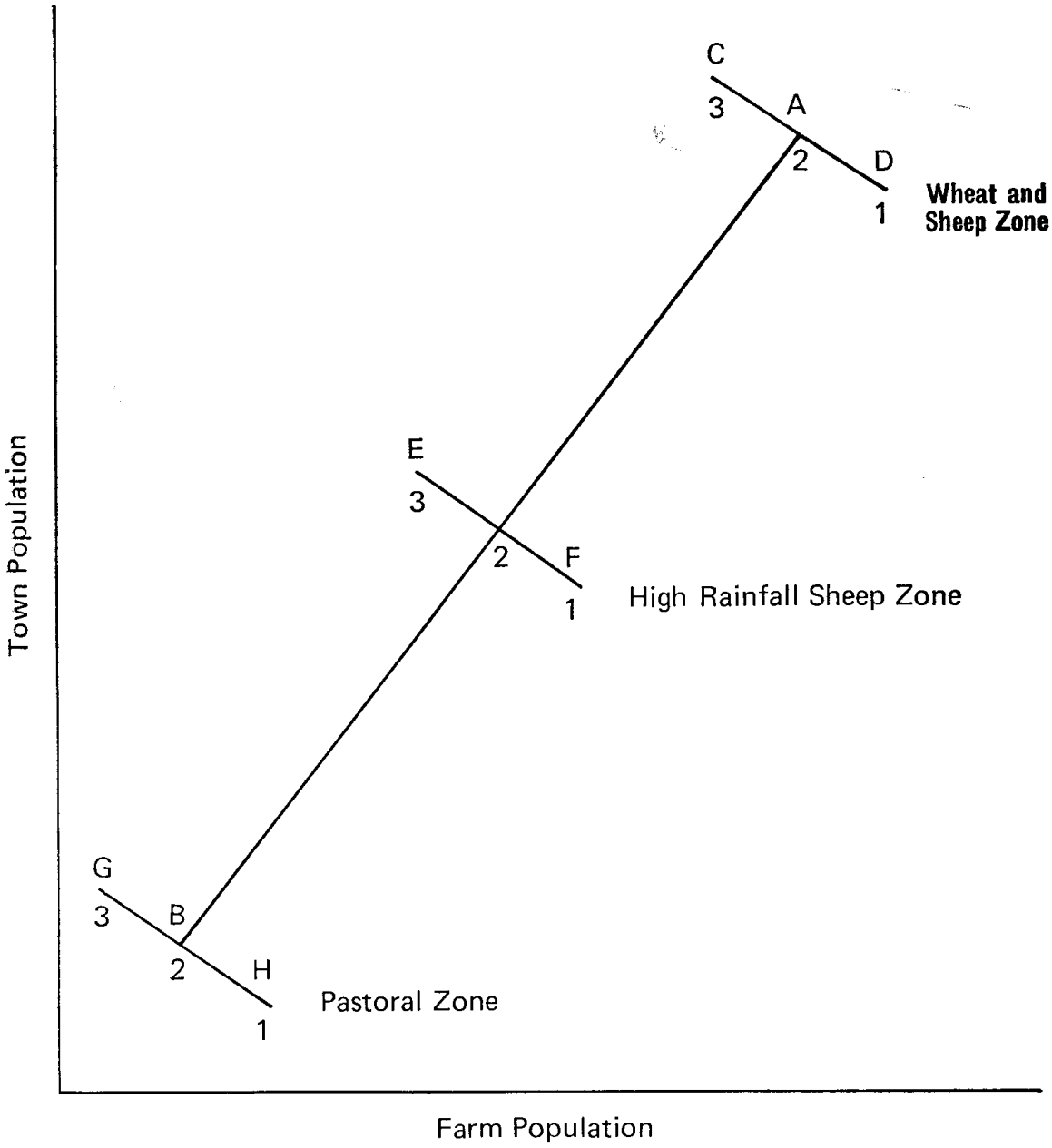

FIGURE 1: *The relationship between farm and country town population between and within regions*

(The numbers 1, 2 and 3 indicate the magnitude of the variables for successive census years in each zone.)

SC = the number of people employed in service industries and commerce during the three census years 1961, 1966, and 1971.

FP = the average number of people living on farms in the three or five years preceeding the census year.

PM = the number of people employed in primary and manufacturing industries in each of the three census years, 1961, 1966, and 1971.

GR = the average gross revenue from agriculture for the three or five years preceeding each census year.

To allow for the time which would elapse before a change in any of the independent variables affected town population, the average gross revenue for the three and five years preceeding the census year were used. The same procedure could not be used for the number of people employed in primary and manufacturing industries as these are only recorded in each census year and this value had to be incorporated without a time lag.

As was suggested in Figure 1, a highly significant positive relationship between all the dependent and independent variables was found for all equations, a result similar to that obtained by Phillips (R^2 ranged from 0.90 to 0.71).

An attempt was made to overcome the bias from aggregation by pooling time-series and cross-sectional data and fitting this data to a model containing regional dummy variables.

The general equation took the form:

$$y = a + b_1x_1 + b_2x_2 + b_3x_3$$

where y = non-farm population *or* the number of people employed in service and commerce industries in each census year.

x_1 = farm population, *or* the average of the gross revenue from agriculture in the three or five years preceeding the census year, *or* the number of people employed in primary and manufacturing industries in the census year.

x_2 and x_3 are regional dummy variables. For region 1, both take the value zero; for region 2, x_2 is equal to 1 and x_3 is equal to zero; for region 3, x_2 is equal to zero and x_3 is equal to 1.

The results are shown in Table 3.

These indicate that there is a negative relationship within each region between farm population and both non-farm population and the number of people working in service and commerce industries (Equations 1 to 4). This indicates that both non-farm population and the number of people employed in commerce and service industries increased over time, even though farm population decreased. Thus confirming the trends found in the population ratios shown in Table 1.

TABLE 3: *The relationship between farm and non-farm population, industrial employment groups and gross revenue from agriculture in N.S.W. wheat growing and grazing zones**

Equation No.	Dependent**	Independent**	a	x_1 b_1	x_2 b_2	x_3 b_3	F	$\overline{R^2}$	DW
1	NFP	FP_3	775.9^{xx} (6.33)	-3.93^{xx} (− 3.85)	-366.40^{xx} (− 5.37)	-661.5^{xx} (− 6.2)	809.3	0.99^{xx}	1.88
2	NFP	FP_5	856.4^{xx} (6.27)	-4.59^{xx} (− 4.04)	-409.40^{xx} (− 5.4)	-682.2^{xx} (− 6.15)	872.5^{x}	0.99^{xx}	2.02
3	SC	FP_3	536.9^{xx} (6.03)	-3.68^{xx} (− 4.96)	-282.38^{xx} (− 5.70)	-436.51^{xx} (− 6.05)	179.8	0.99^{xx}	2.0
4	SC	FP_5	606.0^{xx} (5.88)	− 4.25 (− 4.95)	-319.27^{xx} (− 5.59)	-493.0^{xx} (− 5.89)	179.4	0.99^{xx}	2.14
5	NFP	GR_3	69.1 (1.43)	0.37 (4.07)	10.80 (0.21)	− 23.7 (− 0.47)	5.5	0.63^{x}	0.85
6	NFP	GR_5	68.1 (1.44)	0.38^{xx} (4.17)	9.2 (0.18)	− 16.9 (− 0.34)	5.8	0.64	0.85
7	SC	GR_3	26.8 (0.92)	0.10^{x} (2.73)	9.9 (0.48)	− 56.70 (− 1.17)	63.5	0.96	1.68
8	SC	GR_5	10.8 (0.34)	0.13^{x} (2.7)	20.77 (0.94)	− 13.84 (− 0.50)	73.55	0.96	1.75
9	SC	PM	128.4 (1.47)	− 0.50 (− 0.38)	− 53.18 (− 1.23)	− 102.56 (− 1.63)	2.99	0.92	1.8

* The numbers in parentheses are values for Student's t Statistic. The number of observations was 11 for 3-year averages and 9 for 5-year averages of gross revenue.

** For the definitions of symbols see pages 151 and 153.

NFP, *FP*, *PM* and *SC* in thousands of people. *GR* in $ million.

^{x} Significant at the 5% level.

^{xx} Significant at the 1% level.

No significant relationship was found between the gross revenue from agriculture and either non-farm population or the number of people employed in service and commerce industries (Equations 5 to 8). Similarly the relationship between the number of people employed in primary and manufacturing industries and the number of people employed in service and commerce industries was not significant (Equation 9). However, the sign of the regression coefficients in the equations do suggest that there might be a positive relationship between both non-farm population and the number of people employed in service and commerce industries and the gross revenue from agriculture.

The joint effect of the independent variables or non-farm population could not be examined as these were highly correlated with each other (R^2 ranging from 0.98 to 0.94). The results explain Phillips' analysis in that a highly significant positive relationship exists between non-farm population and each of the independent variables including farm population when pooled cross-sectional and time-series data is used. However, as was suggested in Figure 1, this relationship appears to be spurious and merely due to large differences in the magnitude of the data between regions. Once the examination is limited to individual regions by means of regional dummy variables a negative relationship was found between town and farm population and there is a suggestion that the size of town population might depend on the gross revenue from agriculture. A correct measure of the effect of agriculture on country town population can only be obtained by limiting the investigations to individual regions using time-series data alone.

AGRICULTURAL FACTORS AFFECTING THE TOTAL POPULATION LIVING IN COUNTRY TOWNS WITHIN DIFFERENT REGIONS

The influence of agriculture on country town populations within regions can be analysed using time-series data for farm population and gross revenue from agriculture which are available on an annual basis over the thirteen year period from 1957–8 to 1970–1 (Appendix I).

In limiting the study to the effect of these two variables on country town population the second hypothesis namely that country town population is determined by the number of people employed in primary and manufacturing industries is excluded from the analysis.

As there appears to be little relationship between the two independent variables within each region (R^2 values ranging from 0.18 to 0.07), their combined effect on town population can be examined. It was decided to examine the effect on town population of each independent variable lagged by one year, and of the three-year moving average of each independent variable lagged by one year. In addition the relationship between first differences in the above variables was also investigated.

TABLE 4: *The effect of changes of farm population and gross revenue from agriculture on the total non-farm population in different farming zones in New South Wales**

Equation**	Zone	a	b_1	bd	$\overline{R^2}$	F	DW
$NFP_t = a + b + FP_{t-1}$	1. Pastoral Zone ..	72.45^{xx} (14.27)	1.24 (− 0.55)	..	− 0.067	0.31	1.20
	2. Wheat & Sheep Zone	1 098.54^{xx} (5.78)	− 6.68^{xx} (− 4.2)	..	0.602^{xx}	17.63	0.94
	3. High Rainfall Sheep Zone.	409.77^{xx} (22.08)	− 3.99^{xx} (− 11.36)	..	0.921^{xx}	129.0	1.07
	4. Northern Tablelands (adjusted).	36.67^{xx} (12.59)	− 0.71^{x} (− 2.78)	..	0.380^{x}	7.75	0.45
$NFP_t = a + bFP_t(3M)$	5. Pastoral Zone ..	73.20^{xx} (12.54)	− 0.16 (− 0.61)	..	− 0.068	0.57	0.90
	6. Wheat & Sheep Zone	760.66^{xx} (18.21)	− 3.844^{xx} (− 4.94)	..	0.701^{xx}	24.44	0.83
	7. High Rainfall Zone	420.70^{xx} (27.83)	− 4.203^{xx} (− 14.60)	..	0.895^{xx}	213.08	0.95
	8. Northern Tablelands (adjusted).	40.64^{x} (13.26)	− 1.06 (− 3.93)	..	0.590^{xx}	15.47	0.53

TABLE 4—*continued*

Equation**	Zone	a	b_1	bd	$\overline{R^2}$	F	DW
$NFP_t = a + bGR_t(3M)$	9. Pastoral Zone ..	71.69^{xx} (58.09)	− 0.012 (− 1.66)	..	0.15	2.77	1.02
	10. Wheat & Sheep Zone	234.97^{xx} (16.75)	0.102^{xx} (4.87)	..	0.69^{xx}	23.49	2.15
	11. High Rainfall Zone	168.57^{xx} (5.71)	0.149 (1.02)	..	0.02	1.15	0.15
	12. Northern Tablelands (adjusted).	26.307^{xx} (29.07)	0.040^{x} (2.55)	..	0.356^{x}	6.52	0.66
$NFP_t = a + bGR_t(3M) + b_2d$	13. Northern Tablelands (adjusted).	25.832^{xx} (52.31)	0.050^{xx} (5.891)	− 0.092^{xx} (− 4.842)	0.816^{xx}	23.116	1.66

* The numbers in parentheses are values for Student's t Statistic. The number of observations was 13. For definitions of symbols see pages 151 and 153.

** NFP in thousands of people. $GR(3M)$ in $ million.

^{x} Significant at the 5% level.

^{xx} Significant at the 1% level.

The relationships examined are described by the following equations:

$$NFP_t = a + bFP_{t-1}$$
$$NFP_t = a + bFP_{t-1}(3M)$$
$$NFP_t - NFP_{t-1} = a + b(FP_{t-1} - FP_{t-2})$$
$$NFP_t = a + bGR_{t-1}$$
$$NFP_t = a + bGR_{t-1}(3M)$$
$$NFP_t - NFP_{t-1} = a + b(GR_{t-1} - GR_{t-2})$$
$$NFP_t = a + b_1FP_{t-1} + b_2GR_{t-1}$$
$$NFP_t = a + b_1NFP_{t-1}(3M) + bGR_{t-1}(3M)$$

where NFP_t = non-farm population.
FP_t = farm population.
$NFP_t(3M)$ = the three-year moving average of non-farm population.
GR_t = the gross revenue from agriculture.
$GR_t(3M)$ = the three-year moving average of gross revenue.

The values of the equations giving significant results are shown in Table 4.

A highly significant negative relationship exists between non-farm population and farm population in all regions except the Pastoral Zone and possibly in the Northern Tablelands where the Durbin-Watson statistic suggests that there is a high degree of serial correlation (Equations 1 to 8).

In the High Rainfall and Wheat and Sheep Zones it appears that non-farm population was increasing at a rate of 4 to 6 persons for every 1 person leaving farms during the period studied. This suggests that some factor other than non-farm population determines the size of urban population within each region.

No significant relationship exists between non-farm population and gross revenue lagged one year in any region. However, a highly significant positive relationship was found between non-farm population and the three-year moving average of gross revenue lagged one year in the Wheat and Sheep Zone (Equation 10). This variable explains approximately 70 per cent of the variation in urban population and indicated that an increase of $9,800 in the gross revenue from agriculture is required to increase non-farm population by one person.

The only other region in which the three-year moving average of gross revenue lagged one year gives a significant result is in the adjusted Northern Tablelands region (Equation 12). However, it only explains 36 per cent of the variation in non-farm population and the Durbin-Watson statistic suggests there is a high degree of serial correlation. An examination of the data for the Northern Tablelands revealed that town population was much higher and farm population was much lower in 1965 and 1966 than in either the previous or the succeeding years. It is difficult to explain the deviation from the normal population trends in these two years. It may have been caused by the 1965–6 drought, which

was particularly severe in this region. The effect of the unexplained movement in these two years can be overcome by inserting a dummy variable for both years using the equation:

$y = a + b_1x + b_2d$

where y = non-farm population.

x = the three-year moving average of gross revenue from agriculture.

d = the dummy variable.

The results are shown in Equation 13 (Table 4).

The equation is significant at the 1 per cent level and indicates that over 80 per cent of the variation in population in the adjusted Northern Tablelands region can be explained in terms of the three-year moving average of gross revenue from agriculture. The regression coefficient indicates that town population would increase by 1 person for each additional $19,800 of gross revenue from agriculture.

The combination of farm population and the three-year moving average of gross revenue from agriculture appear to explain a high proportion of the variation in population in all regions (R^2 0.95 to 0.98) except the Pastoral Zone. However, the regression coefficient for non-farm population was negative and the regression coefficient for gross revenue was not significant.

DISCUSSION

The negative relationship within regions between country town population and farm population which has existed during the last decade could be due to a number of factors.

During this period agriculture has become more commercialized and there has been an increase in the number of resources such as fertilizer, insecticides, herbicides, fuel and machinery consumed on farms. The increase in the supply of these requisites would lead to an increase in the town labour force needed to distribute them.

Many of the tasks performed on farms which were previously performed by employed or family labour are now carried out by contractors who live in country towns. An increase in the use of off-farm resources and services is normally associated with an increase in farm gross revenue which enables the farmer to increase his purchases of these requisites. This appears to be the situation in the Wheat and Sheep Zone and in the adjusted Northern Tablelands region, where gross revenue from agriculture explains 70 and 80 per cent respectively of the increase in town population.

The increase in the purchase of resources by farmers might also explain why an additional $9,800 of gross revenue from agriculture increases town population by one person in the Wheat and Sheep Zone while an increase in gross revenue of approximately double this amount, $19,800,

is needed to increase town population by one person on the Northern Tablelands. It is possible that highly mechanized wheat farming requires a larger locally based supply of contracting services, fuel, fertilizer and seed suppliers and machinery repair services per unit of gross revenue than do purely grazing enterprises, such as are found in the Northern Tablelands.

On the other hand, as gross and net revenue from agriculture are highly correlated, it is possible that the increase in town population per unit of gross revenue is larger in the Wheat and Sheep Zone than on the Northern Tablelands because profits from wheat growing were larger than from grazing during most of the period studied.

In the Pastoral and High Rainfall Zones there appears to be little relationship between country town population and either farm population or gross revenue from agriculture. This might be due to a number of factors.

In the High Rainfall Zone there may have been an increase in the number of farmers who live in country towns and travel to the farm each day. On the other hand some people recorded as living on farms are merely using the farm as a dwelling place and travel to work in the country town. The above two factors would tend to cancel each other but the relative importance of each is unknown. It is also possible that more farmers retire into country towns than in the past, rather than remaining as part of the farm family or living in the city.

The most likely explanation of the lack of any relationship between either the population living on farms or the gross revenue from agriculture in the Pastoral and High Rainfall Sheep Zones is that non-agricultural factors determine the size of country towns. The large scale State construction works, such as the Snowy Mountains Scheme, Liddel Power Station and Armidale University in the High Rainfall Zone and mining activity in the Pastoral Zone may have overshadowed any effect that changes in farm population or gross revenue from agriculture may have had on country town population.

Once these effects are removed by treating the Northern Tablelands (excluding the city of Armidale and Dumaresq Shire) as a separate region, a high degree of correlation is found between country town population and gross revenue from agriculture. The lower ratio between town population and farm population in the Wheat and Sheep Zone and the Northern Tablelands than in the Pastoral or High Rainfall Sheep Zones, also suggests that farming would have a greater influence on town population in the former regions than in the latter.

The results obtained also indicate that far more complex models than the regression techniques used in this study are required to examine the effect of agriculture on country town population. This is particularly so in the regions where industries other than agriculture are important. The models failed to explain the effect of agriculture on town population in both the Pastoral Zone and the High Rainfall Sheep Zone. In the

former zone mining is an important activity and in the latter, forestry, power generation and the provision of educational services employ large numbers of people.

In addition the models give no indication of which industries or group of employees within country towns are being affected by a given change in the population or the gross or net revenue from agriculture. Nor do they give any indication of the degree to which changes in agriculture affect the profits of individual industries and the wages of people employed in them. It is possible that input-output models, such as that used by Mandeville and Powell [5], [6] in their examination of the rural and urban linkages in the Central Western Statistical Division of N.S.W. would be a more satisfactory basis of measuring the effect of agriculture on country town population than regression techniques.

CONCLUSION

The use of cross-sectional data in which there are large regional differences in the magnitude of the data gave the impression that there was a strong positive relationship between country town population and farm population in N.S.W. grazing and wheat growing regions during the last decade. Investigations within regions based on time-series data alone clearly indicates that there is a strong negative relationship between town and farm population.

Between 1961 and 1971 farm population decreased by between 16 and 9 per cent in the three zones, while town population remained static in the Pastoral Zone and increased by approximately 25 per cent in the Wheat and Sheep and High Rainfall Sheep Zones. Obviously, country town population is not dependent on farm population, at least in the 1 to 1 sense postulated by Phillips [7].

In the Wheat and Sheep Zone and the Northern Tablelands regions, town population is positively correlated with the gross revenue from agriculture which appears to explain over 70 per cent of the increase in town population in these regions.

It appears that an increase of approximately $10,000 in gross revenue from agriculture in 1970–1 money terms was needed to increase country town population by one person in the Wheat and Sheep Zone. On the Northern Tablelands approximately double this amount ($20,000) is required to achieve this effect. No relationship was found between the gross revenue from agriculture and town population in the Pastoral or High Rainfall Sheep Zone. It is probable that in these regions other factors, such as mining or State activity in the form of large scale construction works or the provision of community services, are more important than agriculture in determining the size of country towns. More sophisticated techniques than regression analysis would be required to measure the effect of agriculture on country towns in these circumstances.

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APPENDIX: THE DATA

Population and Number of People Employed in Industrial Groups

The number of people employed in each type of industry and the number of people living in each country town with a population of more than 500 people is published by the Australian Bureau of Statistics for each five-year census on a shire and municipality basis.

In non-census years an estimate of town population can be made for any region by subtracting the number of people living on farms from the total population of the region. This estimate assumes that all people not living on farms live in country towns. The accuracy of the estimate can be checked by comparing it with the actual number of people living in country towns in the census year. The ratio of population living in country towns to non-farm population in each of the regions covered by the B.A.E. Sheep Industry Survey is shown in Table A for the census years 1966 and 1971. Non-farm population comes close to town population and the ratios change little between census years. The comparison cannot be made in 1961 as town boundaries were defined on different bases in the 1961 census.

TABLE A: *Ratios of people living in towns with a population of more than 500 people to total non-farm population in farming regions*

Farming Zone	1966	1971
Pastoral Zone	0.83	0.83
Wheat and Sheep Zone	0.87	0.82
High Rainfall Sheep Zone	0.97	0.98

The Calculation of Gross and Net Revenue from Agriculture

(1) Using Australian Bureau of Census Data:

The Australian Bureau of Census and Statistics calculates the gross and net revenue from agriculture for each state on an annual basis. This data could only be used to calculate the gross and net revenue from agriculture for a region by assuming that crops and animals in each region have the same gross or net revenue per unit area or per animal as the average for the whole state. Such an assumption ignores differences in regional prices and productivity. It also fails to account for the large effect of the movements of fodder and livestock not sold for slaughter between regions. In addition changes in the value of live and deadstock held on farms are excluded from the estimate.

(2) Using Bureau of Agricultural Economics Surveys:

In the early 1960's almost all of Australia's major agricultural industries were surveyed by the B.A.E. and it was possible to calculate the gross revenue per acre of each crop and per animal for each type of livestock, in each region surveyed by the B.A.E. The average gross revenue per acre of each crop and per head of each type of livestock in the survey was multiplied by the total area of each crop and by the total number of each type of livestock in the region, to obtain the gross revenue from each type of crop and livestock for the region. These were then summed to obtain the total gross revenue from agriculture for each region.

The accuracy of the method was checked by adding the gross revenue for all regions and comparing these with the local value of agricultural output as calculated by the then Bureau of Census and Statistics. For Australia as a whole the gross revenue from agriculture estimated from the B.A.E. surveys was within one per cent of the Bureau of Census and Statistics' calculation of the local value of agricultural production and for N.S.W. t was within three per cent of the Bureau of Census and Statistics' estimate [4].

The value of net revenue from agriculture for any region can be calculated from the same data by assuming that total net revenue of a region is the same proportion of gross revenue of the region, as net farm income forms part of the gross revenue of the average farm in the same region.

The above method was used to calculate the value of gross revenue and net revenue for the Pastoral, Wheat and Sheep and High Rainfall Zones of N.S.W. as defined by the B.A.E. for each of the years 1957–8 to 1970–1 [1, 2, 3]. The values of gross revenue and net output were then converted to constant (1970–1) money terms using the Consumer Price Index.

As the present investigation is concerned with the effect of changes in gross and net revenue of agriculture on town population, between years or census years, it is doubtful if minor differences between the estimated and true gross revenue and net output of agriculture would greatly affect the results obtained as the error is likely to be fairly constant in all years.

As the regions surveyed by the B.A.E. are made up of groups of shires which are also the basis on which population statistics are collected by the Australian Bureau of Statistics, it is possible to assemble the total population, the number of people employed in various industries, farm and non-farm population and the gross and net revenue from agriculture for the three regions continuously surveyed by the B.A.E. in the Australian Sheep Industry Survey on the same basis.