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THE NON-COINTEGRATION OF QUEENSLAND REGIONAL EMPLOYMENT AND SOME CONSIDERATIONS FOR REGIONAL POLICY AND MODELLING

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ABSTRACT This paper attempts to find evidence of cointegration between regional and state employment series. The tests are conducted on Total and Manufacturing employment for Queensland and its labour force regions. A simple neoclassical model incorporating an equilibrium theory of cointegration is presented and the implications of this model are outlined. Contrary to the conclusions of the model, the tests presented here suggest that disturbances to shares are cumulative and permanent. This finding has implications for both the appropriate theoretical structure of regional models and for the efficacy of regional development policy. In particular, the results suggest that regional policy can have a permanent effect on the economic base of regional economies.

1. INTRODUCTION

Traditionally, regional modellers have used relatively simple tools such as shift-share analysis, economic base models and input–output models to estimate or forecast the impacts of regional policy or economic shocks on regional economic systems. These models, while being general equilibrium in nature, are most consistent with Keynesian models. The modelling frameworks assume perfectly elastic supply and fixed prices. All predicted changes in these models are the result of exogenous shocks to final demand. The structure of these models means that they will always predict total change in the regional economy to be proportionate to the exogenous change, with the proportion being determined by the size of the estimated multiplier.

Another feature common among these methodologies is that the analysis is often conducted at the regional level, with frequent reference made to the need for these regional models to incorporate regional data. For example, a large body of literature notes the limitation of regional input-output models that borrow national coefficients (see for example, Schaffer and Chu, 1969, Round, 1983 and Hewings and Jensen, 1986, among many others). Barth, Kraft and Weist (1975) and Schoening and Sweeney (1991) make the same observation regarding the construction of regional portfolio selection models. In addition, analysis is frequently conducted using single region models that often ignore links to the

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national economy.

On the other hand, a great deal of industrial and regional development planning is formulated using a tops-down framework. Implicitly, it is assumed that policies that are beneficial at the state level will be beneficial across all regions. This methodology appears similar to the philosophy used in strict tops-down models, in which regional impacts are derived as a function of the region's share of national employment, output etc. The assumptions of this framework are supported by a simple neoclassical model in which regional shares of employment by industry have a tendency to revert to a trend level after a shock. An implication of this model is that economic shocks cannot alter the region's relative position in the long-run. In this paper, this proposition of the neoclassical model is tested. The testing strategy used consists of tests of cointegration to see whether regional employment by industries are cointegrated with the equivalent state variable. In addition, an application of dynamic shift-share analysis is used to infer the significance of region-specific factors in determining employment growth.

These tests are conducted on industry employment data from Queensland and its labour force regions. The data used are quarterly, spanning the period 1987(Q4) through 1999(Q3). The findings of these tests will have implications for the efficacy of regional and industrial policy and the appropriateness of the strict tops-down framework for analysing regional impacts. In particular, the finding of non-cointegration will suggest that policy formulation needs to consider the differential impact of policy changes across regions. This is because non-cointegration suggests that changes in regional variables are, in part, determined independently of changes in the national variables. Non-cointegration will also suggest that regional forecasts derived from a strict tops-down strategy in which economic impacts are modelled at a national or state level and then allocated across regions using regional shares of state or national variables are also of questionable value.

The next section of this paper presents an outline of the structure of a simple neoclassical model which posits a cointegrating relationship between state and regional variables. In the third section, tests for cointegration between state and regional Total and Manufacturing employment are conducted, while the fourth section of the paper attempts to discern the significance of region specific factors in determining employment outcomes. It is suggested that the outcome of this analysis supports a disequilibrium view of regional growth and adjustment, with the implications of this finding discussed in the final section.

2. A NEOCLASSICAL MODEL OF COINTEGRATION

In some simple forms of regional neoclassical models, shocks to a regional economy cannot, in the long-run, alter a region's relative position. This result stems from two propositions incorporated in these models' structure. Firstly, the long-run relative position of a region depends on the locationally fixed inputs of the region in contrast to other regions (i.e. supply side factors). Secondly, mechanisms exist to ensure the stability of the long-run equilibrium. Demand and supply shocks may alter a region's share of output temporarily, but mechanisms exist to bring a region's share back to its long-run value. An important by-product of such a model's steady state is that the share of national output, earnings and employment generated in a region will remain constant over time.

To see the main elements of this model consider the following model of regional employment[2]. Let the production function for the jth industry in region i be given as;

$$Y_{jit} = A_t F_i L_{jit}^{\beta} \tag{1}$$

where:

Y_{jit} = output of industry j in region i at time t

A = a productivity shift factor which is independent of region;

F_i = the locationally fixed factor of production;

L_{ji} = employment of the jth industry in region i; and

β = the output elasticity of employment.

Converting the production function to logs yields:

$$y_{jit} = a_t + f_i + \beta l_{jit} \tag{2}$$

where $y_{jit} = \log(Y_{jit})$.

The first order condition for profit maximisation with respect to the variable factor, in this case employment, is given by:

$$w_{jit} - p_{jit} = \log\beta + y_{jit} - l_{jit} \tag{3}$$

where:

w_{jit} = the log of the wage rate; and

P_{jit} = is product j's price; and

$p_{jit} = \log(P_{jit})$.

Combining equations (2) and (3) gives the log of employment as:

$$l_{jit} = \frac{1}{1-\beta}(\log\beta - w_{jit} + p_{jit} + f_i + a_t) \tag{4}$$

Equation (4) indicates that the growth rate of employment in industry j in region i depends on the growth rate of wages, product price, fixed factors and productivity. Now, defining the ith region's share of labour in the jth industry as $S_{ji} = L_{ji}/L_{jQ}$ where the subscript Q refers to the parent region, Queensland in this paper, and using the result given by equation (4) for both regions i and Q, the log share of region i's employment relative to region Q is given as:

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[2] More complete outlines of the structure of the neoclassical model appear in Brown *et al* (1991) and Kochanowski (1992)

$$l_{jit} - l_{jQt} = \frac{1}{1-\beta}\{(w_{jQt} - w_{jit}) + (p_{jit} - p_{jQt}) + (f_i - f_Q)\} \quad (5)$$

Thus, in the short-run, region i's share of employment in industry j depends on relative wages and prices and differences in the level of the fixed input.

In this neoclassical model, although it is possible for the price of a good to differ from one region to another in the short-run, these prices should be equal in the long-run. Similarly, through labour migration or the factor price equalisation theorem, wage rates should be equalised. However, as noted by Kochanowski (1992) the conclusions are robust to several variations. For example, the inclusion of other variable factors of production such as capital or more dissaggregated types of labour, or the inclusion of cost of living differences into the equation do not alter the basic conclusion that the long-run ratio of labour in the two regions will be constant. Consequently in the long-run, equation (5) reduces to:

$$l_{jit} - l_{jQt} = \frac{1}{1-\beta}(f_i - f_Q) \quad (6)$$

thereby indicating a constant long-run share dependent entirely on locationally fixed input differences.

3. TESTING FOR COINTEGRATION

In this section, formal tests of the simple neoclassical model's prediction that regional employment shares are constant over time, reverting to a trend share after a shock, are conducted. The tests used here are tests for cointegration between the state and regional employment series. The outcome of these tests will have ramifications for both the technical structure of regional models and the assessment of regional policy.

Queensland is comprised of eight Labour Force Regions. However, for the purpose of this study, the Brisbane, South and East Moreton and North and West Moreton Labour Force Regions have been aggregated into a single region (Brisbane-Moreton). These regions were aggregated because they are closely linked, with many residents in the South and East Moreton and North and West Moreton commuting to Brisbane daily. There is some concern, therefore, that the employment data are not capturing the location of employment but rather how many are employed, either in their respective region or in the wider Brisbane-Moreton region.

The employment series tested are Total and Manufacturing employment. These series were chosen for several reasons. Firstly, Total employment data are better behaved than individual industry data because of the smaller standard deviation associated with the Total employment data. In addition, Total regional employment is a variable often targeted by State and regional government development policies. Manufacturing employment was included because Manufacturing is perhaps the industry most heavily targeted by State and regional development authorities.

In the case of the neoclassical model outlined in the previous section, regional shares of the sector are stable over time depending only on the share of a locationally fixed factor of production. Deviations from long-run equilibrium shares are caused by shocks that are corrected by factor price adjustment and factor migration to equalise prices across regions. Brown *et al* (1991) and Kiel (1997) note that this will force an interregional equilibrium where all regions grow at the same national rate in the long-run. A by-product of this type of model's steady state is that the regional share of national employment, output and earnings generated in the region will be constant over time.

This hypothesis can be modelled by starting with the identity:

$$L_{jit} = L_{jQt} S_{jit} \qquad (7)$$

where, for each time period t, L_{jit} is the jth industry's employment in region i. L_{jQt} is employment of the jth industry in Queensland and S_{jit} is the share of the ith region in Queensland employment.

Letting lower case letters represent log values, this can be expressed as:

$$l_{jit} = l_{jQt} + s_{jit} \qquad (8)$$

Under the neoclassical hypothesis, s_{jit} should be stationary. Equation (8) can be restated stochastically as:

$$l_{jit} = B_0 + B_1 l_{jQt} + \varepsilon_{jit} \qquad (9)$$

where $\varepsilon_{jit} = \rho\varepsilon_{jit-1} + \xi_{jit}$.

Under the neoclassical hypothesis, $\hat{B}_1$ should be equal to 1.0. If it is, then the anti-log of $\hat{B}_0$ estimates the long-run share of the ith region's employment in industry j. In order for statistical estimates of $\hat{B}_1$ to be consistent, ε_{jit} must be stationary. Stationarity and a long-run equilibrium share will exist only if $\rho < 1$. This guarantees that the impact of any shock will become smaller with time and also means that equation (9) is a cointegrating regression. For this reason, prior to conducting tests for cointegration, additional tests to determine the level of integration of the regional employment series l_{jit} must be conducted. In order for the tests of stationarity of the ε_{jit} to be meaningful, the l_{jit} must be non-stationary. For the tests of cointegration, the l_{jit} must all be integrated of order 1, i.e. *I(1)* or more simply, when transformed to differences, the series should be stationary, or I(*0*).

Several alternative tests for stationarity exist. In this paper, two levels of testing are carried out. The employment series are quarterly. Consequently, an initial test was conducted to determine if seasonality was a significant factor in determining the behaviour of the series. This involved regressing each regional employment by industry series against four seasonal dummy variables (see

Barsky and Miron, 1989). In cases where the computed R^2 derived from these regressions is greater than 0.20, seasonality may be a significant problem and more complex seasonal unit root tests would be necessary.

As shown in Table A1 of the Appendix, the results from these tests indicate that seasonality may be a concern for three of the Total employment series (Brisbane-Moreton, North, North West and Queensland) and for two of the Manufacturing employment series (North, North West and the Far North regions). These results led to a further series of tests on these series being conducted. These tests consisted of the HEGY and Osborn tests for seasonal unit roots. The strategy adopted follows that of Osborn (1990) and McDougall (1995). A summary of the test results at the 5% and 1% level of significance is provided in Table A2 of the Appendix. The different tests provide mixed results but seem to indicate that all series tested except the Manufacturing employment for the Far North have a unit root at the seasonal frequency.

To test for cointegration between Queensland Total employment and the Total employment series of Brisbane Moreton and The North, North West regions the strategy outlined in Engle, Granger, Hylleberg and Lee (1993) was adopted. The results of these tests are presented in Table A3 of the Appendix . For the North, North West region, the hypothesis of cointegration is rejected at all frequencies. However, for Brisbane Moreton, the results indicate cointegration at the biannual and quarterly frequency. For the issues raised in this paper, cointegration at the zero frequency is the main concern with non-cointegration at this frequency precluding any long-run linear relationship between movements in the Total employment of Queensland and Brisbane Moreton. Cointegration at the biannual and quarterly frequencies suggests common seasonal patterns in the two series.

The next step involves the application of Augmented Dickey-Fuller (ADF) test on the Manufacturing employment series, effectively testing whether they are $I(0)$ or $I(1)$. This step was omitted for the remaining Total employment series because the evidence of the presence of a unit root at the seasonal frequency in the Queensland Total employment series precludes cointegration with the remaining Total employment series with the exception of Brisbane-Moreton and North, North West regions which also appear to have a seasonal unit root.

The application of the Augmented Dickey-Fuller tests on the Manufacturing employment series involves the application of an initial set of ADF tests on the log of the original employment series. ADF statistics greater than the critical value indicate that the series is stationary. Table A4 of the Appendix provides computed ADF values with up to 4 lagged difference terms. In most cases, the hypothesis that the l_{jit} series are $I(0)$ can be rejected. The only exception to this is provided by the ADF test results for the Wide Bay-Burnett region. The results for this region suggest that the l_{jit} for employment are stationary. In addition, an inspection of the autocorrelation function (ACF) of this variable for the Wide Bay-Burnett region also suggests that the series is stationary i.e. the ACF declines quickly. These tests are followed by the application of the ADF tests on the first differences of the $l_{,iit}$ series (i.e. $\Delta l_{,iit}$). The computed ADF statistics provided in Table A5 of the Appendix indicate that the hypothesis that $\Delta l_{,iit}$ is *I(0)* cannot be rejected for these series at the 5% level of significance.

The final stage of the testing involved testing for cointegration between the regional and Queensland Manufacturing employment series. The tests for cointegration used in this paper relied on the application of Engle and Granger's (1987) residual based approach, the results of these tests are presented in Table A6 of the Appendix.

Table 1 provides a summary of the results of the tests for unit roots and cointegration of Queensland and regional Total and Manufacturing employment series. This table indicates that the Queensland Total employment series appears to have a unit root at the seasonal frequency, precluding cointegration with the remaining Total employment series with the exception of those of the Brisbane-Moreton and the North, North West regions which also appear to have a unit root at the seasonal frequency. As already noted, cointegration at the zero frequency does not appear to exist between these series and the Queensland Total employment series.

For Manufacturing employment, there are four cases where the hypothesis of cointegration are rejected for all orders of augmentation of the ADF test, i.e. Brisbane-Moreton, Darling Downs and South West and Far North regions. The possibility of a unit root at the seasonal frequency in the North, North West region Manufacturing employment series precludes cointegration with the Queensland series. The results for the Wide Bay-Burnett and Mackay, Fitzroy and Central West regions suggest cointegration at the order of augmentation chosen by the model selection criteria. At higher levels of augmentation, however, the results suggest non-cointegration, with the test statistics below their critical value.

In conclusion, the test results suggest that ten out of twelve of the series tested are clearly non-cointegrated. Two of the series appear to be cointegrated, at least at the order of augmentation suggested by the model selection criteria chosen. However, at higher levels of augmentation, this conclusion is reversed. Consequently, the hypothesis of cointegration for these series appears only to be weakly supported.

Table 1. Summary Results from Tests for Seasonality, Stationarity and Cointegration

Series	Order of Integration	Test for Cointegration
Total Employment		
Queensland	*I*(*1*,*1*)	
Brisbane-Moreton	*I*(*1*,*1*)	Cointegration at the biannual and quarterly frequency but non-cointegration at the zero frequency precluding a long-run linear relationship.
Wide Bay-Burnett	*I*(*0*,*0*)	Different order of integration to Qld total employment, precluding cointegration
Darling Downs and South West	*I*(*1*,*0*)	Different order of integration to Qld total employment, precluding cointegration
Mackay, Fitzroy and Central West	*I*(*1*,*0*)	Different order of integration to Qld total employment, precluding cointegration
North and North West	*I*(*1*,*1*)	Non-cointegration with Qld manufacturing employment
Far North	*I*(*1*,*0*)	Different order of integration to Qld total employment, precluding cointegration
Manufacturing Employment		
Queensland	*I*(*1*,*0*)	
Brisbane-Moreton	*I*(*1*,*0*)	Non-cointegration with Qld manufacturing employment
Wide Bay-Burnett	*I*(*1*,*0*)	Possible cointegration with Qld manufacturing employment
Darling Downs and South West	*I*(*1*,*0*)	Non-cointegration with Qld manufacturing employment
Mackay, Fitzroy and Central West	*I*(*1*,*0*)	Possible cointegration with Qld manufacturing employment
North and North West	*I*(*1*,*1*)	Seasonal unit root precludes cointegration with Qld manufacturing series
Far North	*I*(*1*,*0*)	Non-cointegration with Qld manufacturing employment

4. DISAGGREGATION OF THE COMPONENTS OF REGIONAL EMPLOYMENT GROWTH

The tests for cointegration presented in the previous section have two limitations. Firstly, they are probably not very powerful with only 52 observations. Secondly, it is well known that regional industry employment series have large standard errors and the tests are known to be sensitive to breaks in the data. In this section, the dynamic formulation of classical shift-share analysis is applied to Total and Manufacturing employment for Queensland. The results of the application are used in an attempt to infer the significance of region-specific factors in determining changes in regional employment. It is suggested that, if factors operating at the level of individual regional economies are playing a significant role in determining employment outcomes during the study period this will be found in the relative significance of the regional share effects of the shift share decomposition. This may also explain why the tests presented in the previous section found little evidence for cointegration in the series tested.

The classical shift-share formulation, developed by Ashby (1970), breaks down regional growth into three components, the national share effect (NS), industry mix effect (IM) and regional share effect (RS). Letting j, i and Q index the industry sector, the region and the reference area, L represent employment and e the growth rate in employment the framework can be represented as:

$$\Delta L \equiv NS_j + IM_j + RS_j \tag{10}$$

In general, the reference area refers to the national economy. However, when smaller regions are being studied, such as is the case here, the reference area can refer to the parent economy, i.e. in this case the Queensland economy. In this case, the national share (NS) component measures the regional employment change that would have occurred if regional employment had grown at the same rate as State employment.

$$NS_j \equiv L_{ji} e_Q \tag{11}$$

The industrial mix effect measures the industrial composition of the region and reflects the degree to which the local area specialises in industries that are fast or slow growing statewide. Thus a region containing a relatively large share of industries that are fast growing at a State level will have a positive proportional shift. Conversely, a region that has a relatively large share of industries that are slow growing at the State level will have a negative proportional shift.

$$IM_j \equiv L_{ji}(e_{jQ} - e_Q) \tag{12}$$

The regional share effect measures the change in a particular industry in the region of study due to the difference between the industry's regional growth rate and the industry's reference area growth rate. This component indicates growth or decline in industries due to differences in growth rates of the same industry between the region and the State as a result of the natural endowments and other comparative advantages, or disadvantages. Dinc *et al* (1999) note that, even though it may not be possible to identify these advantages or disadvantages, it is possible to determine which industries are performing well in the region by looking at the component of industrial change.

$$RS_j \equiv L_{jt}(e_{jt} - e_{jQ}) \tag{13}$$

The total shift measures the region's changing economic position relative to the reference area, which is the sum of the three components, i.e. the national share, industry mix and regional share effects.

$$TS_j \equiv L_{jt}e_Q + L_{jt}(e_{jQ} - e_Q) + L_{jt}(e_{jt} - e_{jQ}) \tag{14}$$

Shift-share analysis has often been criticised as lacking any theorectical content, this seems unfair, with both Sakashita (1973) and Casler (1988) linking the classical shift-share decomposition to a neoclassical model of regional growth. Dinc *et al* (1999) notes that the original purpose of this formulation of the shift-share framework was to emphasise the role of regional change for a region-specific industry, with the regional shift effect intended to capture this effect. A positive shift is associated with the comparative advantage of the region for that industry and vice versa. This component is seen as the most important of the model because it is unique to the region and contains employment growth effects of regional policy. The regional share effect is particularly important in this study. A relatively large regional shift would suggest that regional employment performance is in part determined by region-specific factors, thus providing evidence that state and regional employment series are not cointegrated.

The classical shift-share technique is commonly applied using a beginning and end year to estimate change in growth over multiple periods. Using base and terminal years to compute growth rates and weight-share results over several years is known as the static approach. The weights in the shift-share equation introduce bias, with Selting and Loveridge (1998) noting that this has provoked longstanding questions about the integrity of this approach.

Shift-share results are sensitive to weights in two ways. First, the calculations do not account for changes in industrial structure over time. For example, if initial employment levels are chosen as weights, the industry mix in the first year is assumed to be constant throughout the years of analysis. As a result, the technique does not take into account the changes to a region's structure after the base year as new firms enter the region, thus altering the economic structure. Consequently, the industry mix effect can become difficult to interpret. This is particularly true for rapidly expanding regions. The second source of error in the static shift-share calculations caused by the choice of weights problem is the compounding effect (see Barff and Knight, 1988). Because the static approach does not account for continuous fluctuations in the region's employment, the allocation of growth among the three effects is skewed.

Table 2. Classical Shift Share Decomposition of Regional Total Employment Change 1987 (Q4) to 1999 (Q3)

	NS	IM	RS	TS
		'000		
Brisbane-Moreton	314.1	16.6	28.8	359.5
Wide Bay-Burnett	28.1	-1.9	-10.2	16.1
Darling Downs and South West	36.9	-1.9	-1.4	33.6
Mackay, Fitzroy and Central West	46.3	-3.3	-10.7	32.3
North, North West	34.1	-5.0	-0.1	29.0
Far North	33.4	-4.7	-6.3	22.4
Queensland	**492.9**	**-0.1**	**0.1**	**492.9**

To address these problems of traditional implementations of the shift-share methodology, Barff and Knight (1988) introduced the dynamic shift-share framework. Rather than calculating components over multiple year periods Barff and Knight suggest that annual computations be performed and summed over the years of interest. Dynamic results are theoretically more accurate because there is less change in industrial structure from year to year. In an application to the New England region of the United States, Barff and Knight conclude that the dynamic approach provides superior results by more accurately allocating growth between the components. In addition, the authors emphasise the extra information offered by dynamic shift-share, namely that a region's economic transactions can be followed on an annual basis.

The results presented in the following tables follow the application of the dynamic shift-share methodology to quarterly data for the labour force regions of Queensland. This means that the period 1987 (Q4) to 1999 (Q3) is fragmented into 52 sub-periods.

Table 2 shows the results of the dynamic shift-share decomposition for Total employment. In all regions except Brisbane-Moreton, the national share effect is greater than the total shift, indicating that these region's Total employment grew slower than that of the State. All regions except Brisbane-Moreton had both negative industry mix and regional share effects. The negative industry mix effect suggests that for all regions apart from Brisbane-Moreton, the industrial structure was concentrated in industries that were slow growing at the state level. The negative regional share effect suggests that the regional endowments possessed by the regions outside Brisbane-Moreton had a negative impact on regional growth.

Table 3 provides the dynamic shift-share decomposition of Queensland regional Manufacturing employment. The table suggests a diverse range of results for the individual regions. In Queensland, Manufacturing employment increased by 46,800 jobs. In Brisbane-Moreton, Manufacturing employment increased by 36,400 jobs over the study period. However, the national share effect indicates that this region's growth would have been 40,300 jobs if it had increased by the amount suggested by its national share component. It failed to do so because of a negative industry mix effect, again indicating a specialisation

Table 3. Classical Shift Share Decomposition of Regional Manufacturing Employment Change 1987 (Q4) to 1999 (Q3)

	NS	IM	RS	TS
		'000		
Brisbane-Moreton	40.32	-7.10	3.19	36.4
Wide Bay-Burnett	3.36	-1.01	-0.55	1.8
Darling Downs and South West	3.93	-1.29	0.36	3.0
Mackay, Fitzroy and Central West	5.02	-1.34	4.42	8.1
North, North West	3.02	-0.17	-5.96	-3.1
Far North	2.56	-0.51	-1.45	0.6
Queensland	**58.2**	**-11.4**	**0.0**	**46.8**

Table 4. Correlation Matrix of Shift-Share Components of Total Employment

	NS-TS	(*t* stat)	IM-TS	(*t* stat)	RS-TS	(*t* stat)
Brisbane-Moreton	1.00	86.91	0.92	15.64	0.75	7.59
Wide Bay-Burnett	0.70	6.56	-0.52	-4.06	0.45	3.34
Darling Downs and South West	0.78	8.43	-0.55	-4.38	0.61	5.19
Mackay, Fitzroy and Central West	0.67	6.14	-0.52	-4.04	0.63	5.38
North, North West	0.25	1.72	-0.03	-0.23	0.58	4.72
Far North	0.66	5.95	-0.60	-5.06	0.84	10.48
***t* (critical) at 5% = 1.645**						

in industries that were slow growing at the State level.

The region with the worst result for Manufacturing employment growth was the North, North West region. This region lost 3,100 manufacturing jobs over the period of the study. A large contributor to this was a negative regional share component indicating unfavourable regional endowments.

Tables 4 and 5 provide correlation coefficients (and their estimated *t*-statistics) between the various components of the shift-share decomposition for each region. In Table 4 the correlation matrix for Total employment is provided. The results seem to suggest that the national share effect is the most closely correlated with movements in regional employment for Brisbane-Moreton, Wide Bay-Burnett, Darling Downs and South West and the Mackay, Fitzroy and Central West Labour Force Regions. In contrast, for the North, North West and Far North Labour Force Regions the correlation coefficient between the regional share and total shift effect is the largest, suggesting that regional share is an important determinant of changes to total employment over the period of study. In all cases, the t-statistic of the correlation coefficient between the regional share and total share effect is significant, suggesting that regional share is a significant component of regional growth.

Table 5. Correlation Matrix of Shift-Share Components of Manufacturing Employment

	NS-TS	(t stat)	IM-TS	(t stat)	RS-TS	(t stat)
Brisbane-Moreton	0.86	11.47	-0.09	-0.63	0.31	2.18
Wide Bay-Burnett	0.17	1.13	0.21	1.47	0.86	11.56
Darling Downs and South West	0.44	3.27	0.16	1.12	0.94	19.14
Mackay, Fitzroy and Central West	0.69	6.34	-0.14	-0.93	0.89	13.45
North, North West	-0.34	-2.44	0.18	1.23	0.92	16.10
Far North	0.27	1.89	0.29	2.07	0.95	20.01
***t* (critical) at 5% = 1.645**						

Table 5 provides correlation coefficients (and their t-statistics), for the components of the shift-share decomposition of Manufacturing employment in Queenslands Labour Force regions. In the case of Manufacturing employment, for all regions except Brisbane-Moreton, the regional share component of the shift-share decomposition seems to be the most closely correlated with movements in the growth of Manufacturing employment. The exception of Brisbane-Moreton is probably due to the fact that this region accounts for more than 60 percent of Queensland employment in this industry for every quarter of the study period. Despite the fact that the national share effect appears to be the most strongly correlated with the Manufacturing employment change in Brisbane-Moreton, the t-statistic suggests that the regional share effect is significantly correlated with Total employment being above the critical value of 1.65. The significance of the regional share effect, which is significantly different from zero in all shift share decompositions for both Total and Manufacturing employment, suggests that factors operating at the level of the regional economy play an important part in determining regional success, in this case measured by employment growth.

To ensure that individual regional share series were not picking up some common effects operating across regions, correlation coefficients between the individual regional share effects were estimated and their significance tested. These results are presented in Table 6. The correlation coefficients in *italics* are significant at the 5 percent level. An interesting feature evident from Table 6 is that in all but two cases the significant correlation between the regional share effects is negative. In general, therefore, the results in Table 6 suggest that the regional share effects are not only significant as shown in Tables 4 and 5, but also are capturing effects specific to the regional economy with the correlation between regional share effects across regions being either negative or insignificant in all but two cases.

Table 6. Correlation Matrix of Regional Share Effects

Total Employment	**BM**	**WBB**	**DDSW**	**MFCW**	**NNW**	**FN**
Brisbane-Moreton	1					
Wide Bay-Burnett	*-0.33*	1				
Darling Downs and South West	-0.16	*-0.40*	1			
Mackay, Fitzroy and Central West	-0.21	-0.03	*-0.44*	1		
North, North West	*-0.51*	0.06	*-0.32*	*0.52*	1	
Far North	-0.03	0.05	*0.32*	*-0.81*	*-0.62*	1
Manufacturing Employment	**BM**	**WBB**	**DDSW**	**MFCW**	**NNW**	**FN**
Brisbane-Moreton	1					
Wide Bay-Burnett	*-0.24*	1				
Darling Downs and South West	*-0.66*	-0.12	1			
Mackay, Fitzroy and Central West	*-0.25*	-0.19	0.08	1		
North, North West	*-0.46*	0.14	-0.07	-0.22	1	
Far North	*-0.62*	-0.09	*0.46*	-0.08	0.10	1

This finding tends to suggest that, in most cases, the idea that the regional share effects are being driven by common factors, or are operating uniformly across regions cannot be accepted. This again supports the idea that forces operating at the individual regional level are playing a significant role in determining employment growth.

5. IMPLICATIONS AND CONCLUSIONS

The tests presented in this paper have found little evidence of a stable long-run relationship between State and regional employment series. The residual-based tests of cointegration presented in Section 3 find little support for the existence of cointegration between State and regional employment. It is well known that these tests are sensitive to breaks in data series and additionally require large data sets[3]. Regional employment series are known to have large

[3] It may be suggested that the 12 year sample period used to conduct the tests may be too short a period to find evidence of a return to a long-run relationship, particularly given the many shocks that have affected Queensland's regional economies over this period. However, given that such shocks are likely to continue to affect the regional economies at the same frequency in future periods, one must question the policy relevance of the simple neoclassical model outlined in section 2.

standard errors as well as breaks in the series following the incorporation of census data when the series are rebased. For this reason, additional tests based around the components derived from dynamic shift-share analysis have been used in an attempt to determine the significance of region-specific factors in determining employment outcomes. This methodology found evidence supporting the idea that region-specific factors have played an important role in determining employment performance, thus supporting the results derived from the formal tests of cointegration. These findings have important implications for regional modelling and the development of appropriate regional policy.

For regional modelling, there is at least one clear implication. At the sub-state level, little support for models predicting an equilibrium structure can be found. The model outlined in section 2 presumes that factor price adjustment and factor migration will act to equalise prices across regions and force an interregional equilibrium wherein all regions grow at the same national rate in the long-run. Such an outcome is not supported by the results of the tests conducted in this paper.

In addition, the results may have implications for tops-down modelling strategies. In their simplest form, these types of models forecast the results of economic variables at the level of the parent economy, that is, the nation or state. These macro-level forecasts are then allocated across regions using regional shares of certain variables to derive a spatial measure of the overall impact. Frequently, tops-down modelling strategies are seen as possible tools for modelling the regional impact of national or state-based policies. The results presented in this paper challenge the efficacy of this methodology. If regional variables are not cointegrated with the same variable at the state level and, as indicated by the shift-share analysis, region specific factors are important to regional growth outcomes, a tops-down model, explaining regional impacts as some share of national or state impacts is not an appropriate modelling strategy. Other studies, i.e. Kiel (1997), suggest that a methodology assuming a stable long-run relationship between state and regional variables would produce biased results.

The applicability of these conclusions for tops-down modelling will depend very much on the extent to which region specific policies have affected employment outcomes over the period of study. It is possible that non-cointegration may be due to the operation of region specific policies. If this is the case tops-down modelling of nation or statewide policies may still be appropriate. This suggests avenues for future research aimed at disentangling the effects of National, State and regional policies. One such approach could follow the work of Carlino and DeFina (1999) who for the United States produced evidence that national monetary policy has had a differential impact across regional economies.

The finding of non-cointegration, or the absence of any stable long-run equilibrium, also has implications for regional policy makers and the efficacy of regional development policy. As noted in Kiel (1997), whatever the source of shocks, the effects of these shocks seem to be permanent. This conclusion has implications because it may dramatically affect the cost benefit analysis of local industry policy. The findings in this paper suggest that a program aimed at attracting new industry will yield employment and income over the long-run if it yields them in the short-run. This occurs because any increase in the share of output in a sector can be viewed as being permanent with little evidence of a tendency to revert to a trend share being found in the series tested. Similarly, the analysis suggests that the actions of competitor states or regions may permanently reduce industrial shares in another region so that interventionist policies become important. This finding is in accordance with the game theoretic approach to local policy analysis and suggests that region specific policies may possibly have spillover effects on surrounding regional economies with these effects perhaps being negative. This points to the need for a greater understanding of the behaviour of regional economies and the state or nation wide impacts of such policies.

Finally, future research in this area should also consider the possibility and implications of cointegration across regions and not only between the individual regions and the state. Such research will need to employ spatial econometric techniques such as outlined in Fingleton (1999). Regional cointegration in employment and income may suggest regional economies share similar long-run growth paths and have implications for regional industrial and growth policy.

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Appendix 1 Statistical Results

Table A1 Miron Tests for Seasonality

	Total	Manufacturing
Brisbane - Moreton	0.27	0.12
Wide Bay - Burnett	0.15	0.01
Darling Downs and South West	0.05	0.05
Mackay, Fitzroy and Central West	0.19	0.11
North and North West	0.30	0.25
Far North	0.05	0.29
Queensland	0.46	0.05

Table A2 : Tests for Seasonal Unit Roots

a. Osborn Test

	Variable	$\beta1=0$	$\beta2=0$	5%	1%
Manufacturing	NNW	-1.06	-2.91	I(1,1)	I(1,1)
	FN	-0.67	-4.16	I(1,0)	I(1,1)
Total	BM	-0.23	-3.25	I(1,1)	I(1,1)
	NNW	-1.80	-3.76	I(1,0)	I(1,1)
	QLD	-0.53	-3.84	I(1,0)	I(1,1)
Critical	5%	-2.11	-3.75		
Values	1%	-2.82	-4.35		

b. HEGY 2 Test

	Variable	$\pi1=0$	$\pi2=0$	$\pi3=\pi4=0$	5%	1%
Manufacturing	NNW	-2.15	-1.65	6.12	I(1,1)	I(1,1)
	FN	-2.38	-3.10	5.00	n.s.	I(1,1)
Total	BM	-2.03	-1.46	4.14	I(1,1)	I(1,1)
	NNW	-3.85	2.00	4.33	I(0,1)	I(0,1)
	QLD	-3.23	-2.46	3.74	I(0,1)	I(1,1)
Critical	5%	-3.08	-3.04	6.60		
Values	1%	-3.77	-3.75	9.22		

c. HEGY 1 Test

	Variable	$\pi1=0$	$\pi2=0$	$\pi3=\pi4=0$	5%	1%
Manufacturing	NNW	-2.46	-1.85	8.12	n.s.	I(0,1)
	FN	-1.78	-3.45	7.67	I(1,0)	I(0,1)
Total	BM	-1.05	-1.41	4.87	I(0,1)	I(0,1)
	NNW	-2.39	-1.50	5.59	I(0,1)	I(0,1)
	QLD	-2.36	-1.99	7.36	n.s.	I(0,1)
Critical	5%	-3.71	-3.08	6.55		
Values	1%	-4.46	-3.80	9.27		

Table A 3. Tests for Seasonal Cointegration of Brisbane Moreton and North North West Total Employment

1 Test at Zero Frequency					
	0	1	2	3	4
Brisbane-Moreton	-1.72	***-2.57***	-2.34	-2.87	-1.93
North and North West	-0.67	**-1.71**	*-1.89*	-1.86	-1.08
Critical value (95%) =- 3.5009					
2 Test at Biannual Frequency					
	0	1	2	3	4
Brisbane-Moreton	-9.03	***-4.51***	-3.38	-2.78	-4.00
North and North West	-8.01	***-2.94***	-1.94	-2.45	-2.69
Critical Value (95%) =- 3.50	Italic = Akaike information criterion		Bold = Schwarz Bayesian Criterion		

3 Test at Quarterly Frequency						
	Cointegrating Regression			*t*	*t*	*F*
	Y3	*Y3(-1)*	R^2	$\pi 3$	$\pi 4$	$\pi 3=\pi 4=0$
Brisbane-Moreton	0.85 (4.96)	0.19 (1.21)	0.84	(14.98)	(1.01)	112.43
North and North West	1.14 (1.35)	-0.60 (-0.75)	0.03	(0.00)	(0.00)	3.48E_16

Table A4. Tests for Stationarity of Log(Employment) Series

Manufacturing Employment	**0**	**1**	**2**	**3**	**4**
Brisbane - Moreton	-2.98	-2.93	-3.38	-2.83	-3.41
Wide Bay - Burnett	-3.72	-3.60	-4.13	*-2.73*	-2.79
Darling Downs and South West	-2.70	-2.45	-1.18	-1.19	-0.96
Mackay, Fitzroy and Central West	-3.48	-3.48	-3.31	-2.90	-2.24
North and North West	-2.88	-2.29	-1.79	-1.67	-2.66
Far North	-3.11	-3.24	-2.49	-2.19	-2.24
Queensland	-2.35	-2.28	-3.01	-2.44	-2.59
Critical Value (95%) -3.52					

Table A5: Tests for Stationarity of Difference of Log (Employment) Series

Manufacturing Employment	**0**	**1**	**2**	**3**	**4**
Brisbane - Moreton	-7.32	-4.79	-5.39	-4.08	-3.91
Wide Bay - Burnett	-7.37	-5.03	-6.07	-4.32	-2.28
Darling Downs and South West	-7.32	-7.62	-4.85	-4.33	-4.41
Mackay, Fitzroy and Central West	-6.85	-5.51	-5.16	-5.25	-3.56
North and North West	-8.44	-6.35	-4.61	-2.71	-2.88
Far North	-6.83	-6.37	-5.22	-4.01	-3.54
Queensland	-6.96	-4.02	-4.69	-3.87	-3.11
Critical value (95%) -2.9320					

Table A6. Tests for Cointegration of Regional Employment Series

Manufacturing Employment	**0**	**1**	**2**	**3**	**4**
Brisbane - Moreton	-3.06	-2.55	***-1.58***	-1.04	-1.15
Wide Bay - Burnett	-3.67	**-3.63**	-4.15	*-2.47*	-2.52
Darling Downs and South West	-3.05	***-2.92***	-1.89	-1.85	-1.87
Mackay, Fitzroy and Central West	-3.98	***-4.10***	-3.54	-3.16	-2.12
North and North West	-2.82	**-2.15**	-1.73	-1.50	*-2.36*
Far North	-3.66	***-4.02***	-3.00	-2.71	-2.75
Critical Value (95%) -3.4812	Italic = Akaike Information criterion			Bold = Schwarz Bayesian Criterion	