FORMULATING AN ECONOMIC BASE MODEL: AN APPLICATION OF TIME SERIES TECHNIQUES TO FAR NORTH QUEENSLAND EMPLOYMENT DATA[1]

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ABSTRACT Regional economic impact analysis in Australia, particularly at the sub-state level, has traditionally been conducted using the relatively simple tool of the static input-output model. Outside Australia, another methodology frequently implemented in regional impact analysis has been the economic base model. The economic base model is generally implemented within a static framework. The multipliers that are derived from such an implementation are, like those of the static input-output model, suitable for the long-run analysis of the regional response to an exogenous shock. The time path of the response of the regional economy cannot be analysed using this method of implementation. However, the economic base framework has benefited from developments within time series econometric analysis. This paper provides an outline of how these developments can be used to construct and implement a regional economic base model. This is carried out by applying these techniques to employment data for the Far North Queensland region.

1. INTRODUCTION

The economic base model is one of the oldest and simplest practical models of regional economic impact analysis. At the core of economic base theory is the proposition that the economic growth of a region ultimately depends on outside demand for its products. More precisely, whether a region grows or declines and at what rate is determined by how it performs as an exporter to the rest of the world.

The theory suggests that regional economic activity can be bifurcated into two sectors, these being the basic or export sector which trades outside the region's boundaries, producing dollar flows into the local economy, and the non-basic, or local sector which supplies local consumption of goods and services. Within economic base theory, activity in the non-basic or local sector is assumed to depend on the sales or growth of the basic sector. This external demand for a region's exportable goods and services injects income into the local economy, which in turn augments local demand for non-exportable goods and services.

The most frequent application of economic base theory is in the development of economic base multipliers. The estimation of sectoral basic and non-basic

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employment is essential for the estimation of economic base multipliers. Within the literature, a range of methods have been used to derive the basic and non-basic sectors' estimates of output, income or, most frequently, employment. These techniques are reviewed in Isserman (1980) and Nijkamp *et al.* (1986) and include the assignment method, location quotients, and the minimum requirements method.

Following Lesage and Reed (1989), a number of authors have noted that the time series properties of the basic and non-basic assignment of regional economic activity can be used to evaluate the economic base model. In particular, Brown *et al.* (1992) note that many of the methodologies frequently used to derive the basic-non-basic split of activity lack theoretical justification and none seem to be derived from the properties of the economic base multiplier itself. They note that the economic base model is a model of equilibrium and therefore, the theory postulates that basic and non-basic activity are cointegrated. That is, there is a long-run relationship between the two series. Consequently tests can be conducted to ascertain whether the basic and non-basic assignments of economic activity for the regional economy have this property.

Section 2 of this paper presents an outline of the economic base model and multiplier. In Section 3 an outline of the time series properties of the model are presented. The construction of an economic base model for Far North Queensland commences in Section 4 where the various basic – non-basic assignment methods to be evaluated during model construction are defined. In Section 5 the properties of these base assignments are evaluated using time series econometric techniques. This section commences with the application of tests for cointegration and Granger causality. The economic base multipliers are also estimated in this section. Section 5 concludes with a consideration of the dynamic properties of the model through the presentation of impulse response functions of competing models. A brief conclusion is provided in Section 6.

2. THE ECONOMIC BASE MODEL

The theory behind the economic base hypothesis is simple: it suggests that a regional economy's activity may be bifurcated into two sectors, these being the export, or basic sector and the local, or non-basic sector. The basic or export sector, which trades outside the region's boundaries, produces dollar flows into the local economy. This in turn provides impetus for consequent economic development. The non-basic or local sector, on the other hand, supplies local consumption of goods and services. Thus the theory suggests that activity in the non-basic or local sector depends on growth in the demand of the products of the basic or export sector. This change in external demand for exportable goods and services then results in an injection of income into the local economy, augmenting local demand for non-exportable goods and services.

In this regard, the economic base hypothesis can be considered to be related to the Keynesian explanation of regional economic growth and development (see, for example, McCombie, 1988 or Thirlwall, 1980). Unlike the neoclassical explanation, in which regional growth is determined by the rate of growth of indigenous factor supplies and productivity, exogenously given and independent of demand, the Keynesian explanation has regional economic growth being demand determined. In particular, demand from outside the regional economy, ie, export demand, has a significant role in determining regional growth.

Analysis using the economic base framework commences with some regional aggregate such as output, income or, most frequently, employment being divided into two components, that portion which is exogenously generated by export demand, and that which is endogenously generated by local demand. In the case of the current implementation, employment is the variable that will be used to estimate the basic and non-basic sectors. Letting E represent regional employment, we can write:

$$E = B + L \tag{1}$$

where B is regional employment generated by basic or export demand and L is non-basic or locally generated employment. Brown *et al.* (1992) note that a behavioural equation analogous to the Keynesian consumption function can be added to this definitional equation, ie:

$$C = a + bY \tag{2}$$

where Y is total regional income and C is final demand for local goods and services. In this equation, b is the marginal propensity to consume locally and a, which is often assumed equal to zero in multiplier studies, represents autonomous local demand. Letting θ be labour's share of output divided by average wages or the inverse of the productivity of the two sectors[2] and multiplying through equation (2) by this parameter yields:

$$L = a\theta + bE \tag{3}$$

since $E = \theta Y$ and $L = \theta C$ by definition. Appropriately rearranging and substituting yields the reduced form equation:

$$E = \frac{a\theta}{(1-b)} + \frac{1}{(1-b)}B \tag{4}$$

where θ is the marginal base multiplier, which gives the increase in total regional employment given a unit increase in B, and is the parameter of interest in this analysis. To estimate equation (4) a number of authors have obtained a time series of basic and non-basic employment and then reformulated the equation as:

$$E = \alpha + \beta B + \nu \tag{5}$$

where ν is a stochastic error term.

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[2] It is possible for θ to change over time as productivity grows leading to a misspecification of the estimating equation. For this reason output data is preferred to employment data. However, regional output data is at best scarce and in the case of time series modelling, impossible to obtain. Consequently, in time series applications of the economic base model employment data has been used in model construction.

However, in many early applications, economic base models were constructed from just one data point (for a description, see Nijkamp *et al.*, 1986 or Isserman, 1980). In this form of analysis the model was constructed by first allocating employment to the basic or non-basic sector and then forming the ratio:

$$\text{Base multiplier} = B/E \tag{6}$$

Other early studies such as Moody and Puffer (1970) and Sasaki (1963) have used time series versions of the economic base model such as that specified in equation (5) to estimate economic base multipliers. To produce such a model, employment must be allocated to the basic and non-basic sectors on a monthly or quarterly basis rather than at a point in time.

Armstrong and Taylor (1993) note that the simple economic base model has several limitations, these include the fact that employment in the domestic sector of a regional economy is likely to be determined by several factors, one of which will be the level of exports. In addition, the export sector is likely to consist of a number of very different industries with the effect of a change in the exports of these industries having quite different consequences for regional growth and development. In particular, different industries are likely to be associated with different multiplier effects. A third problem with the economic base multiplier is that it fails to take into account the possibility that a given increase in output in the export sector can be achieved in different ways, each one giving rise to different multiplier effects on output, income and employment. Finally, there have always been problems associated with determining the division between the basic and non-basic sectors.

These problems have seen the export base multiplier replaced by the Keynesian multiplier (see, for example, Armstrong and Taylor, 1993; p 9) or, in many applications in Australia, the input-output approach. Despite these limitations, the economic base model does provide some insights into the workings of the regional economy. In particular it stresses the critical role of the regions export sector in determining output, income and employment levels. In addition, the tractability of the technique has meant that it has remained a useful tool in regional economic analysis in cases where data, time or financial constraints have meant that more sophisticated models are not feasible.

3. TIME SERIES PROPERTIES OF THE ECONOMIC BASE MODEL

A number of techniques have been developed to assign employment to the basic or non-basic sectors. However, early evaluations of these methodologies frequently failed to consider the time series properties of the economic base model (see, for example, Isserman, 1980). Lesage (1990) and Brown *et al.* (1992) were among the first authors to notice this oversight. These authors noted that the economic base model presumes a long-run relationship between basic and non-basic employment. This allows the time series properties of the error term in equation (5) to be used to assist in the evaluation of the various base assignments. In particular, the economic base hypothesis implicitly assumes that the basic and non-basic sectors move together in a stable long-run relationship, that is they are cointegrated. Consequently cointegrating tests can be used to test whether the assignments of these sectors have this property. This allows the construction of a basic – non-basic assignment that is consistent with the economic base hypothesis, overcoming to some degree the problem of determining the allocation of output, income or employment to the basic and non-basic sectors.

The concept of cointegration provides the link between relationships involving the levels of nonstationary variables and the concept of equilibrium. If basic and non-basic employment are nonstationary, but the first difference of these variables is stationary they are said to be integrated of order 1 ie, I(1). In this case it is possible that a constant parameter vector $\alpha = (\alpha_0, \alpha_1)$ exists such that $z_t = L_t - \alpha_t - \alpha_1 B_t$ [3] is I(0). If this is the case, basic and non-basic employment are cointegrated, with $\alpha = (\alpha_0, \alpha_1)$ being the cointegrating vector. The finding of a cointegrating vector (z_t) suggests that there exists a long-run equilibrium relationship between these variables with an equilibrium error correction represented by z_t. It should be noted that, in this context, equilibrium need not be used to imply anything about precise economic relationships but might simply describe the tendency of an economic system to move towards a particular point over time.

Given the existence of this cointegrating parameter vector, the relationship $z_t = L_t - \alpha_t - \alpha_1 B_t$ is interpreted as a long-run or equilibrium relationship, in this case suggested by economic base theory. The variable z_t measures the extent to which the systematic relationship between basic and non-basic employment is out of equilibrium and is often called the 'equilibrium error'. The finding of cointegration between basic and non-basic employment implies that the error term of equation (5) can be viewed as a measure of the disequilibrium between these variables at any given time. In addition, the Granger representation theorem (Engle and Granger, 1987) demonstrates that the existence of an equilibrium relationship between these two variables means that there exists a generating mechanism which moves the two variables back into equilibrium following a disturbance to the relationship between the two variables. More specifically, if basic and non-basic employment are cointegrated then it can be shown that there exists an error correcting mechanism (ECM) or adjustment representation which links the short-run behaviour of these two variables to the long-run steady state relationship.

Following the Granger representation theorem which proves that if B_t and L_t are I(1) and cointegrated, there always exists a generating mechanism for these variables, which is the error correction mechanism. This mechanism is shown in equations (7) and (8) below:

$$\Delta B_t = D_1 + \gamma_1 Z_{t-1} \sum_{j=1}^{m} \beta_j \Delta B_{t-j} + \sum_{j=1}^{m} \alpha_j \Delta L_{t-j} + \varepsilon_t' \qquad (7)$$

[3] As in Section 2, B denotes the basic sector employment and L the local or non-basic sector employment.

$$\Delta L_t = D_2 + \gamma_2 Z_{t-1} \sum_{j=1}^{m} \lambda_j \Delta B_{t-j} + \sum_{j=1}^{m} \Phi_j \Delta L_{t-j} + \varepsilon_t^{''} \tag{8}$$

where γ_1, γ_2, β_j, α_j, λ_j and Φ_j are the parameters to be estimated, $\gamma_1, \gamma_2 \neq 0$, and $\varepsilon_t^{'}$ and $\varepsilon_t^{''}$ are finite order moving averages. Harris *et al.* (1999) note that this provides an alternative test of the existence of equilibrium imposed by the economic base hypothesis.

Lesage (1990), Brown *et al.* (1992), Mur and Trivez (1996) and Harris *et al.* (1999) use the property of cointegration between the basic and non-basic sectors within the economic base model to test the adequacy of their definition of basic and non-basic sector employment. The same authors note that a further time series property of economic base theory can be used to check the adequacy of the basic and non-basic sector definition. Specifically, the economic base hypothesis assumes that causality flows from the basic sector to the non-basic sector, ie, economic base theory postulates that the basic or export sector, which trades outside its boundaries, produces dollar flows into the local economy. This in turn provides impetus for consequent economic development. Thus, implicitly, the theory postulates that changes to export demand lead to injections of income into the regional economy, flowing on to higher demand for local products, and in turn, increased employment in the non-basic sector. This proposition of the model can be established using Granger causality tests.

Lesage and Reed (1989) note that the idea of Granger causality is intuitively appealing in the context of economic base theory. Within the economic base hypothesis, the Granger notion of causality can be defined in the following way. If, after taking into account variation in the non-basic sector explained by its own past values, it is found that past variation of the basic sector contributes significantly in explaining future variation in non-basic employment, while the converse is not true, the basic sector can be said to Granger-cause the non-basic sector ie, basic sector variation causes future variation in non-basic employment. By the converse the economic base hypothesis implies that, after taking into account past variation in the basic sector, past variation in the non-basic sector does not help explain future values of basic employment. Thus, the economic base hypothesis can be stated in terms of this combined set of Granger causality relationships.

An additional time series approach that has been used to test the adequacy of the basic – non-basic assignment of regional employment is the use of impulse response functions generated by a vector autoregression (VAR) model of basic and non-basic employment (see, for example, Lesage and Reed, 1989). Impulse response functions can be used to provide a graphic representation of the dynamics of the basic and non-basic employment relations determined by the VAR model. In addition, these impulse response functions can be used to provide another test into the adequacy of the assignment procedure adopted to construct a time series version of the economic base model. For example, letting *t* denote the time period (a given quarter in our example), the impulse response functions will allow the determination of whether past values in basic employment give rise to significant future variation in non-basic employment. It would be concluded that the economic base theory is not consistent with the data if it is found that shocks which create a positive deviation from basic employment do not lead to future positive deviations from local employment. In addition, because causality is presumed to flow from the basic to non-basic sectors, shocks which raise non-basic employment above trend should not result in significant future deviations from trend basic employment.

Lesage and Reed (1989) note that the Granger causality tests are based on the variance-covariance structure of the distributions of the estimated parameters while the impulse response functions are based on the point estimates of the parameters, providing an independent test of the economic base hypothesis. Lesage and Reed (1989) consider that this provides an important alternate test since the precision of VAR model estimates is generally thought to be degraded by collinear relationships that may exist between the large number of explanatory variables in such models. The same authors note that, since the economic base hypothesis purports to describe a dynamic event involving growth and change in the regional economy, these modelling techniques seem far more appropriate than the traditional static approaches.

4. DERIVATION OF THE ECONOMIC BASE

The application of economic base modelling commences in this case with the division of aggregate regional employment into the basic and non-basic sectors. The data available to construct a time series model of Far North Queensland consist of the first division Australian and New Zealand Standard Industrial Classification (ANZSIC) employment data, which divides aggregate regional employment into 17 industrial categories and is available for the period 1987Q4 through to 2001Q1.

At the end point of this sample the Far North Queensland region had a labour force of 112,400, or 6.7% of Queensland. It had experienced rapid growth, growing by 63.1% over the sample period, compared to growth of 45.9% for Queensland. The region, like Queensland has a relatively large proportion of its employment accounted for by the ANZSIC industry, Retail trade (14% compared to 15% for Queensland). Agriculture is also an important contributor to the regional economy, accounting for around 9% of employment compared to 6% in Queensland. Other significant differences include the high share of total employment accounted for by the Personal and recreational services industry which accounted for around 13% of total employment in Far North Queensland and only 4% in the State. Mining employment is relatively insignificant, accounting for less than 0.2% of employment in Far North Queensland compared to about 1% of total employment in Queensland.

It is also a relatively isolated region, being distant from the core region of South East Queensland. In this way the Far North Queensland region is perhaps a more appropriate region in which to implement an economic base model than are many other regions. Harris *et al.* (1999), suggests that the basic – non-basic assignment is more meaningful for small isolated economies than it is for large more complex economies.

The methodology to select the economic base follows Lesage (1990), Brown *et al.* (1992) Mur and Trivez (1996) and Harris *et al.* (1999). The idea is to find an assignment procedure that produces basic and non-basic employment series that are cointegrated and so have a long-run linear relationship. In addition, the adequacy of the competing base definitions can be gauged by evaluating the estimated long-run economic base multipliers derived from the competing definitions: the Granger causality tests and impulse response functions also provide a means of evaluating the assignment procedures. With this in mind, four assignment procedures were used to provide an allocation of regional employment to the basic and non-basic sectors. These assignment procedures consist of:

Base 1: Assign only manufacturing employment to the economic base. While this appears a crude assignment procedure, Brown *et al.* (1992) note that it has frequently been used within regional economics literature and there are many regional econometric models that specify the manufacturing sector as exogenous to the regional economy.

Base 2: Basic and non-basic employment are assigned by allocating the excess of the location quotient to the economic base. This is estimated by first specifying theoretical local employment as:

$$TLE_r^i = E_r \left[\frac{E_n^i}{E_n} \right] \tag{9}$$

where i refers to the ith sector, r the region, and n the nation. Non-basic sector employment (L_r^i) and basic sector employment (B_r^i) are then defined as follows:

$$\left.\begin{matrix} L_r^i = E_r^i \\ B_r^i = 0 \end{matrix}\right\} \Rightarrow if \ : TLE_r^i \ \left.\begin{matrix} L_r^i = TLE_r^i \\ B_r^i = E_r^i - TLE_r^i \end{matrix}\right\} \Rightarrow if \quad TLE_r^i < E_r^i \tag{10}$$

All sectors are potentially mixed and, consequently, the regional base is obtained by adding the various sectoral bases. In this allocation procedure the sectors employment is allocated to the basic sector if the location quotient is greater than 1. For an industry sector with a location quotient between 0 and 1, the value of the location quotient becomes the proportion that is allocated to the basic sector with the residual allocated to non-basic employment.

Base 3: A sector is classified as basic if the sample average of its location quotient for the region in question is greater than one, considering that, under the hypothesis of stationarity, this sample average is a consistent estimate of the unconditional expectation of the coefficient. The regional base is obtained by adding the sum of the employment in the basic sectors so defined.

Base 4: This is a hybrid solution adopted by Brown *et al.* (1992), using the criteria underlying Base 3 for the manufacturing industry and that of Base 2 for all other sectors.

5. EVALUATING THE ECONOMIC BASE MODEL

In section 3, it was noted that relatively recent developments in time series analysis could be used to evaluate the economic base model. Specifically, following Brown *et al.* (1992), a necessary condition for an appropriate assignment of regional employment to the basic and non-basic sectors is that basic activity must be cointegrated with non-basic activity. Section 3 also noted that the economic base can be couched in terms of the cointegrating VAR framework because the theory presumes a long-run cointegrating relationship between the basic and non-basic sectors. Additionally, the theory explicitly specifies a direction of causality running from the basic sector to the non-basic sector. This allows the use of several time series techniques through which it is possible to evaluate the basic – non-basic assignment of employment and the time series properties of the economic base model.

The first step is to determine if there is a cointegrating relationship between the definitions of basic and non-basic employment. Prior to testing for cointegration between the basic and non-basic employment series, it is necessary to establish the order of integration of each series. In particular, cointegration requires that both series are I(1). Tests for the order of integration of the series commence with a preliminary test for seasonality[4]. This test consists of regressing four seasonal dummy variables against the first difference of both the basic and non-basic sectors. In cases where the R^2 is greater than 0.2, seasonality may be a problem and a more sophisticated test may be required. Fortunately this was not the case with the basic and non-basic sectors specified for the Far North Queensland labour force region.

The next stage of testing involved the application of the Augmented Dickey Fuller test to the alternate basic and non-basic assignments to determine the order of integration of each series. Tables 1a and 1b show the results of this test for applications to the levels and first differences of the series respectively. The results in these tables clearly suggest that all the series require first differencing to induce stationarity, suggesting that they are I(1).

As it has been determined that the series are I(1), it is now appropriate to test for cointegration between the various specifications of the basic and non-basic sectors. Cointegration is required if there is a long-run linear relationship between the series. In this application, tests for cointegration were conducted using the procedure developed by Johansen (1988).

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[4] These tests, and all subsequent modelling, are is conducted using the original series. Transformation to logarithms was not appropriate in this case because equation (5) specifies the economic base multiplier. If basic and nonbasic employment were transformed to logarithms the coefficient of β in (5) would become an estimate of the elasticity of total employment with respect to changes in basic sector employment rather than the economic base multiplier.

Table 1a. ADF Values for Levels of Basic and Non-basic Employment

Industry	Lag(-1)	Lag(-2)	Lag(-3)	Lag(-4)
Basic employment 1	-3.28	-2.27	-2.37	-2.43
Non-basic employment 1	-1.89	-1.59	-1.73	-1.26
Basic employment 2	-2.92	-2.92	-2.19	-1.61
Non-basic employment 2	-2.00	-1.52	-1.92	-1.36
Basic employment 3	-3.12	-3.21	-2.47	-2.00
Non-basic employment 3	-1.79	-1.51	-1.67	-1.17
Basic employment 4	-2.63	-2.35	-1.85	-1.63
Non-basic employment 4	-1.62	-1.30	-1.42	-1.23
Critical value at 5% level of significance = -3.50				

Table 1b. ADF Values for First Differences of Basic and Non-basic Employment

Basic employment 1	-7.66	-5.00	-4.06	-3.61
Non-basic employment 1	-5.63	-6.00	-5.87	-4.31
Basic employment 2	-6.08	-4.12	-4.69	-3.65
Non-basic employment 2	-6.79	-3.76	-4.58	-3.54
Basic employment 3	-5.96	-6.06	-5.58	-5.03
Non-basic employment 3	-6.09	-4.10	-4.73	-3.51
Basic employment 4	-6.04	-5.71	-4.89	-4.19
Non-basic employment 4	-7.32	-3.95	-4.34	-3.79
Critical value at 5% level of significance = -2.92				

The Johansen (1988) tests for cointegration are conducted within a vector autoregression (VAR) framework. Prior to conducting the tests, it is important to select the correct order of the VAR. The method used to select the appropriate lag length in this case was done using the model selection criteria, especially the Akaike information criterion (AIC) and the Schwarz Bayesian criterion (SBC). Table 2 presents the output from the model selection procedure for bases 1 through 4. The results presented in this table suggest that the appropriate order of the VAR for all assignment procedures includes only one lagged term. Initially, a VAR with only one lagged term was estimated, however, before carrying out tests for cointegration an inspection of the single equation estimation results and the residuals was conducted to ensure that the residuals were well behaved. This appeared to be the case for all the base assignments.

The series being tested for cointegration may have non-zero means and deterministic trends, as well as stochastic trends. Similarly, the cointegrating equation may have intercepts and stochastic trends. Johansen's (1988) framework for testing for the presence of cointegration considers five possible combinations of these ingredients. The tests carried out to determine if

Table 2. Selection Criteria for Lag Length of Vector Autoregressions

Lags	Base 1 Assignment		Base 2 Assignment		Base 3 Assignment		Base 4 Assignment	
	AIC	**SBC**	**AIC**	**SBC**	**AIC**	**SBC**	**AIC**	**SBC**
4	-252.28	-269.49	-265.82	-283.03	-287.04	-304.24	-273.51	-290.72
3	-251.41	-264.79	-263.52	-276.90	-286.77	-300.15	-269.89	-283.28
2	-250.60	-260.16	-261.16	-270.72	-286.52	-296.08	-268.14	-277.70
1	-249.10*	-254.84*	-257.82*	-263.55*	-284.33*	-290.07*	-266.35*	-272.09*
0	-290.28	-292.20	-303.32	-305.23	-331.62	-333.53	-311.41	-313.32

Note: Asterisk indicates lag length selected by criteria.

Table 3. Tests for Cointegration Between Basic and Non-basic Employment

Part A: Cointegration Test Based on Maximal Eigenvalue of the Stochastic Matrix

Null	Alternative	Assignment 1	Assignment 2	Assignment 3	Assignment 4
r = 0	r = 1	19.88*	19.49*	13.25**	21.51*
r <= 1	r = 2	5.23	4.93	3.05	3.29

Part B: Cointegration Test Based on the Trace of the Stochastic Matrix

Null	Alternative	Assignment 1	Assignment 2	Assignment 3	Assignment 4
r = 0	r = 1	25.10*	24.41*	16.31**	24.80*
r <= 1	r = 2	5.23	4.93	3.25	3.29

Note: Asterisk denotes significant results at 95% level of significance and ** denotes significant at the 90% level of significance.

cointegration exists between the four base definitions assumed that there were intercepts but no trends in the cointegrating vector. Thus it was assumed that the long-run equilibrium relationship between the basic and non-basic sectors did not have a trend.

The results presented in Table 3 suggest that in all cases the maximum and trace eigenvalue statistics reject the null hypothesis that there is no cointegration between basic and non-basic employment although the evidence for the Base 3 assignment procedure is weaker, being rejected at the 90% level of significance.

Cointegration between the basic and non-basic sectors is a necessary condition for the identification of the economic base, and also permits the economic base multiplier to be estimated consistently. Consequently, the test

Table 4. Estimated Economic Base Multipliers for Far North Queensland

Base Definition	Intercept	Coefficient	R^2	$F(1,52)$
Base 1	57.35	4.32	0.34	26.18
Standard Errors	(5.88)	(0.84)		
Base 2	40.85	3.1	0.54	61.23
Standard Errors	(5.19)	(0.40)		
Base 3	22.27	1.28	0.43	39.90
Standard Errors	(6.39)	(0.20)		
Base 4	28.64	1.45	0.05	2.52
Standard Errors	(24.20)	(0.92)		

Table 5. Tests for Granger Causality Between Basic and Non-basic Employment

	Test Statistic	Level of Significance
Base Assignment Method 1		
Base 1	0.54	(0.46)
Non-base 1	4.15	(0.04)
Base Assignment Method 2		
Base 2	9.22	(0.00)
Non-base 2	3.40	(0.07)
Base Assignment Method 3		
Base 3	10.11	(0.00)
Non-base 3	0.37	(0.54)
Base Assignment Method 4		
Base 4	0.42	(0.52)
Non-base 4	5.80	(0.02)

Chi- squared critical value with 1 df at 5% significance level is 3.84.

results presented in Table 3 suggest that an equation such as equation (5) will yield consistent results, and Table 4 reports the estimates of this equation for all four base assignment procedures. In this estimation, the non-basic sector has been the regressand rather than total employment that has been used in many other studies. Harris *et al.* (1999) consider this is a more appropriate approach because basic employment is a component of total employment and a regression of one variable on part of itself may blur any statistical distinction of the estimated parameter. With this specification of the model, the base multiplier is equal to one plus the estimated coefficient of basic employment from the regression equation. Table 4 shows that the estimated base multipliers range from 5.32 for assignment procedure 1 to 2.28 for assignment procedure 3. The results of the estimation of the multiplier from the Base 4 definition reveal some problems in that the estimated coefficients are insignificant and the equation has an extremely low explanatory power.

Following Lesage and Reed (1989) and Lesage (1990), the next stage of model evaluation involves the use of Granger causality to test the assumption of economic base theory that the export or basic sector activities initiate local economic growth. If it is found that local employment Granger-causes export employment, we reject the null hypothesis of economic base theory. Table 5 provides the results of the two Granger causality tests for all base assignment methods.

The results in this table suggest that the hypothesis of non-causality of the basic sector to the non-basic sector cannot be rejected at the 95% level of significance, while the converse is not true, for both the Base 2 and Base 3 assignment procedures for Far North Queensland. For these assignment procedures, the hypothesis of the non-causality of the basic sector to the non-basic sector is rejected. The results for procedures 2 and 3 suggest then, that causality flows from the export sector to the basic sector, ie, shocks to the regional export producing sector flow back into the local sector. This is in accordance with the export base hypothesis. In contrast, the non-causality of the local sector in both the Base 2 and Base 3 assignments suggests, as one would expect, that shocks to the local sector do not have an effect on the export producing sector. Because assignment procedures 1 and 4 do not produce results consistent with the economic base hypothesis they are no longer considered in the remainder of the analysis.

The final stage of the evaluation of the base assignment procedures for the competing base definitions for the Far North Queensland economic base model is comprised of an evaluation of the dynamic properties of the economic base model for both the Base 2 and Base 3 assignments. This step in model evaluation consists of two parts. Firstly, the error correction parameters of the Base 2 and Base 3 models are presented, and finally, the impulse response functions of basic and non-basic employment for the Base 2 and Base 3 definitions are presented.

Table 6 provides estimates of the cointegrating vectors (z_t) and error correction parameters of both the basic and non-basic sectors for the Base 2 and Base 3 assignments. The estimated cointegrating vectors suggest that the equilibrium relationship for the Base 2 assignment is equal to $z_t = 1*Base2-0.23*Nonbase2$ while for Base 3 the cointegrating relationship is estimated to be $z_t = 1*Base3-0.80*Nonbase3$.

Table 6 also provides the parameters of the error correction equations for both the Base 2 and Base 3 assignment procedures. The coefficient of the error correction term for basic employment in the Base 2 assignment (-0.27) is the correct sign, suggesting that any shock to the equilibrium relationship is reduced gradually over time, taking about four quarters to return to within 10% of its level prior to being shocked. The diagnostics of this equation also seem to be reasonable. However, for the Base 3 assignment the diagnostics (low R^2 and

Table 6. Error Correction Representation and Cointegrating Vector

Error Correction Representation					
Base 2 Assignment					
Cointegrating Vector	z_t = 1*Base2-0.23*Non-base2				
	Intercept	Coefficient	R^2	F (1,51)	DW
Basic	-1.38	-0.27	0.10	6.17	1.89
Standard Errors	(0.67)	(0.10)			
non-basic	8.53	1.37	0.21	13.56	2.12
Standard Errors	(2.28)	(0.37)			
Base 3 Assignment					
Cointegrating Vector	z_t = 1*Base3-0.80*Non-base3				
	Intercept	Coefficient	R^2	F (1,51)	DW
Basic	-0.53	-1.33	0.04	2.40	1.81
Standard Errors	(0.65)	(0.09)			
Non-basic	3.00	0.40	0.14	7.95	2.02
Standard Errors	(1.09)	(0.14)			

insignificant F statistic) along with the magnitude and insignificance of the coefficient on basic employment (-1.33) suggest some problems with the estimates of basic and non-basic employment derived using this assignment procedure. This may be related to the findings in Table 3, which reject the hypothesis of non-cointegration at the 90% level of significance for this assignment procedure, suggesting that the evidence for cointegration is less tenable for the Base 3 definition than for the remainder of the base definitions.

The final stage of evaluating the various base assignment procedures involved an examination of the impulse response functions. The use of impulse response functions allows the timing as well as the magnitude of local employment responses to be analysed. Lesage and Reed (1989) note that the impulse response function technique takes an empirical approach to the exploration of the dynamic relations between basic and non-basic employment. The technique involves perturbing the estimated system on an equation by equation basis with a shock equal to one standard deviation of the estimated error term. Shocks of this size can be viewed as representative of the magnitudes that would shock the system. The responses over time of the dependent variables to these standardised shocks is then monitored. In this way it is possible to obtain an understanding of the dynamic workings of the system of equations.

An issue that arises with this technique is the order in which to perform the decomposition of the error matrix. This can be an issue since changes in the

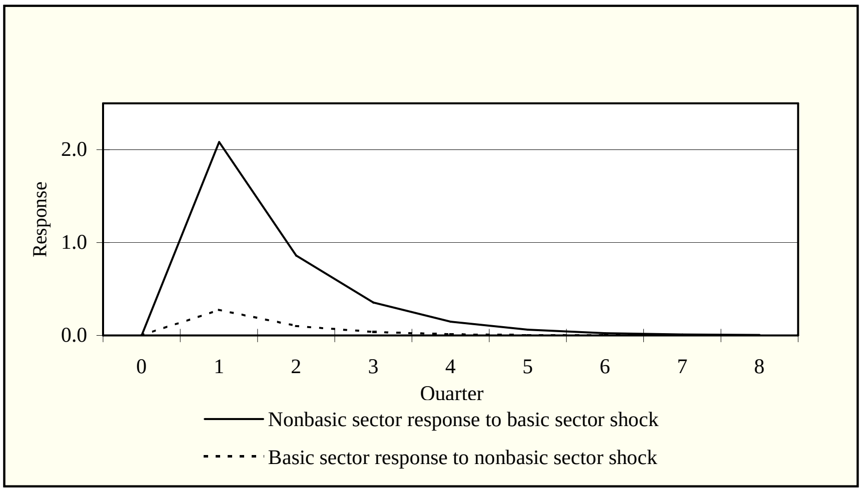

Figure1. Impulse Response Functions of Base 2 Assignment

ordering of the equations may result in different impulse responses. In the present example this is not considered a significant issue on two counts. Firstly, economic base theory suggests a causal relationship from the basic or export sector to the non-basic or local sector. Secondly, this direction of causality is supported by the results presented in Table 5 using Granger causality testing techniques for the Base 2 and 3 assignments.

Figures 1 and 2 provide a graphic representation of the impulse response functions of the Far North Queensland economic base model under both the Base 2 and Base 3 assignment. Lesage and Reed (1989) note that the shocks to basic employment may result in a positive or negative response by non-basic employment. A negative response might indicate that when the export sector expands due to a positive shock, workers move from the non-basic or local sector to the basic sector.

The economic base hypothesis suggests that we should see a more pronounced response of non-basic employment to temporary shocks in basic employment and a less pronounced response of basic employment to a similar shock to non-basic employment. This hypothesis seems to be confirmed by the impulse response functions presented in both Figures 1 and 2. The lines in these figures represent the impulse responses to single period shocks, with the unbroken line representing the response of the non-basic sector to a shock in the basic sector, and the broken line representing the response of the basic sector to shocks in the non-basic sector. In both cases the response of the non-basic sector to a shock in the basic sector is much more pronounced. It can be seen that these shocks create a short-term impact that decays back to zero within 7 or 8 quarters in the case of non-basic employment. This is indicative of a stable system of relations.

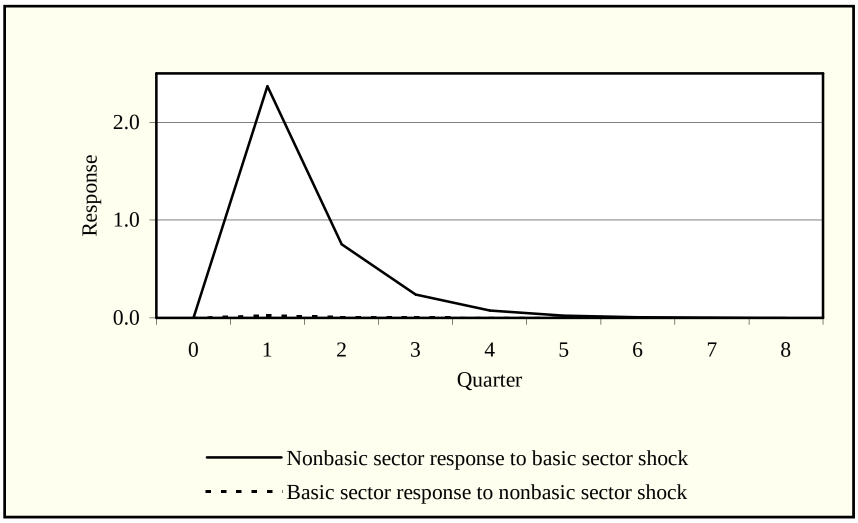

Figure2: Impulse response functions of Base 3 Assignment

Another point worth noting is the lack of response of the Base 3 definition of the basic sector to shocks to non-basic employment with almost no change being registered by this series. As suggested by economic base theory, the results confirm for these base assignments that the non-basic sector is much more responsive to shocks to the basic sector than vice versa. This result is consistent with the findings of the Granger causality testing presented in Table 4 and is in line with the prediction of export base theory and the Keynesian explanation of regional growth. In addition, it seems implausible to expect shocks to the local or basic sector to have significant impacts on the export or non-basic sector.

6. CONCLUSION

This paper has presented an outline of how regional employment data may be used to construct a time series version of the economic base model. Relatively recent developments in time series econometrics can be used to help in the construction and evaluation of these models. In particular, economic base theory postulates a long-run relationship between the regional basic and the non-basic sectors.

In traditional applications, assignment techniques were typically applied to one or two points of data to derive an economic base. This procedure does not allow an evaluation of the validity of the methodology used to derive the basic-non-basic assignment. A time series application, however, overcomes this problem allowing tests for cointegration between the basic and non-basic sectors, so enabling an evaluation of the estimated basic and non-basic sectors. Additionally, because the economic base hypothesis specifies a flow of causality from the basic to the non-basic sector, the time series data allow the implementation of Granger causality tests, allowing a further verification of the assignment procedure. Impulse response functions can also be used as an independent test of the direction of this flow of causality.

This study has shown that a model constructed using time series techniques can be used to derive the traditional base multiplier from which it is possible to estimate the long-run implications of the development of the export or basic sector of the regional economy being modelled. The time series implementation of this model provides additional information in the form of the dynamics of the regional economy in response to an expansion of basic sector employment.

In this study of Far North Queensland, the results seem to indicate that only the Base 2 and Base 3 assignment procedures, defined in Section 4, have characteristics consistent with the economic base hypothesis. Overall the procedures adopted in the evaluation of these competing base assignments find little difference in model performance but tend to favour the Base 2 model. This is because the error correction equation for the model derived from the Base 3 assignment procedure is not statistically significant. In addition, the tests for cointegration between basic and non-basic employment for the Base 3 assignment are not as conclusive as those of the Base 2 assignment. However, a result in favour of the Base 3 assignment procedure is that the economic base multiplier (2.28) seems more reasonable than that for Base 2 (4.1).

In addition, this paper has shown that it is possible to implement this modelling technique with readily available Australian regional data. The framework provides an additional tool for the analysis of regional economies and should perhaps be seen as a compliment to the traditional tools of regional analysis, particularly the static input-output model. Whereas the regional input-output model can provide a detailed sectoral breakdown of the regional response through its representation of inter-industry linkages, the economic base model, implemented in a time series framework allows the dynamics of the regional response to exogenous shocks to be analysed. Furthermore, the economic base model implemented using time series data is capable of being extended in a number of directions. The framework has been used as a forecasting tool (see, for example, Lesage, 1990), and can extended to a multiregional setting, allowing the estimation of interregional spillovers (see, for example, Mur and Trivez, 1996).

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