Understanding Local Economic Resilience

Briefing Paper 15: Long-run Income Dynamics, Broome 1980-2013

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The views expressed and the conclusions reached in this publication are those of the author(s) and not necessarily those of persons consulted.

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Published in July 2016

Table of Contents:

1. EXECUTIVE SUMMARY:

The focus of this Briefing Paper is economic resilience. *Resilience* is defined as the ability of local economies to adjust or adapt to external disruptions or 'shocks'. Generally, *Resilience* is measured in terms of job creation (employment growth), unemployment rate dynamics, and income per capita. For each of these measures, *Resilience* can be measured in absolute terms or relative to a benchmark economy.

Using data from the Australian Department of Employment Small Area Labour Market (SALM) and the Australian Taxation Office, this briefing paper aimed to answer two questions about the evolution of the Broome economy:

- What are the long-run developmental trajectories of employment and income in Broome?

- How resilient is Broome to changes in the external social, economic, and policy environment?

Over the past thirty years:

- the average real wage in Broome was $46,067, which was lower than the Western Australian average of $47,245.

- Broome experienced an average rate of real wage inflation of approximately 1.16% per annum. This compares to an average growth rate across Western Australia of 1.9% per annum.

Based upon the econometric modelling conducted in this briefing paper the evidence is clear and distinct:

- The Broome economy has displayed *Resilience* in the face of external "shocks" that have buffed the locality in the past 35 years.

- The *Resilience* of the Broome economy suggests that the competitive forces driving the economy are dominated by longer-term growth trends rather than short-term fluctuations and "shocks".

- Benchmarked against the Western Australian economy taken as a whole, the evidence suggests that Broome responds relatively rapidly to broader forces driving the State economy.

- There is evidence that when disturbed from its long run growth path the competitiveness of the Broome economy serves to restore the local economy to its long run developmental trajectory.

Overall, these findings have the following implications for the formation of local economic policy:

- Policy initiatives which are designed to enhance local competitiveness are likely to increase the speed of responsiveness to external shocks to the Broome economy.

- Increasing the long-run developmental trajectory of the Broome will likely require capital investment in the structural competitiveness of the local economy.

This briefing report is one of series of complementary reports prepared for each of the Western Australian Regional Capital Alliance members. These Briefing Papers begin to unpack the growth experience of each WARCA member, exploring the relationship between local and structural competitiveness is the subject of ongoing research initiatives.

2. The Western Australia Regional Capitals Alliance

This is the latest in a series of reports into the developmental trajectories of localities across the Western Australian settlement system. This research is conducted as part of a strategic collaboration between the *Western Australian Regional Capitals Alliance (WARCA*) and the *Centre for Regional Development* at the *University of Western Australia*. The objectives of this ongoing collaboration are:

- To gain a clear understanding of the opportunities and barriers to regional growth and resilience across Western Australia.
- To facilitate evidence-based policy, indicating specific areas of policy-making that may require revision.

In this report, we explore the long run evolution of the Broome economy over the period 1980-2013. We address two key questions about the dynamics of growth and change for the Broome economy:

- What are the long-run developmental trajectories of income in Broome?
- How resilient is Broome to changes in the external social, economic, and policy environment?

Using the analysis of this report it is possible to target local economic policy by evaluating the potential vulnerability of local economies to forces beyond their control.

The information contained in this report is supported by the following documents:

1. UWA/Regional Capitals in the WA Settlement Hierarchy Research:

    a) Briefing Paper 2 - Employment Change and Job Creation
    b) Briefing Paper 3 – Employment Diversity and Growth
    c) Briefing Paper 4 – Endogenous Growth and Local Competitiveness
    d) Briefing Paper 5 – Identifying Regional Capitals
    e) Briefing Paper 8 – Understanding Local Competitiveness: Identifying Key and Strategic Industries, Broome 2001-2011

2. Academic Papers:

Plummer P., Tonts, M. (2015) "Path Dependence, Place Dependence, and the Evolution of a Patchwork Economy: Evidence from Western Australia, 1981-2008. *Annals of the Association of American Geographers (Forthcoming)*

Tonts, M., Plummer, P., Argent, N., (2014) "Path Dependence, Resilience, and the Evolution of New Rural Economies: Perspectives from Rural Western Australia" *Journal of Rural Studies* 1 1-14.

Plummer P., Tonts M. (2013) "Do History and Geography Matter? Regional Unemployment Dynamics in a Resource Dependent Economy: Evidence from Western Australia, 1984-2010" *Environment & Planning A 45 2919-2938*.

Tonts, M., Argent, N., Plummer, P (2012) "Evolutionary Perspectives on Rural Geography" *Geographical Research* 50 3 291-303

3. Planning Documents:

Government of Western Australia (2014) "State Planning Strategy 2050" (http://www.planning.wa.gov.au/publications/6561.asp)

3. Long-run Development and Economic Resilience

The contemporary Western Australian economy can be characterized by a multi-speed economy, driven by a strong and consistent pattern of job creation. While this has slowed recently, the State nevertheless continues to perform well relative to other States and territories. Over the past decade, job creation across industries has not played out evenly across Western Australia. This has resulted in an increasingly 'patchwork economy', with larger and more economically diverse economies forging ahead of less resilient smaller settlements. Within this broader context, there is clear evidence that the Regional Capitals are making an increasingly significant contribution to the evolution of employment across the State. In particular, the economic performance of WARCA members relative to the other localities across Western Australia indicates that:

- Engagement in the global economy and broader socio-economic processes have been important in driving economic growth across WARCA members.

- Nonetheless, local competitiveness is critical in both allowing localities to overcome an unfavourable mix of industries or to capitalize on their industry structure.

- The relative importance of local competitiveness and the ways in which localities engage with broader socio-economic processes varies significantly across localities.

Overall, these findings have the following implications for the formation of local economic policy:

- The lived and practical experience of the WARCA members questions the efficacy of a 'one size fits all' policy stance.

- While it is true that local attributes are significant in contributing to growth, it is important not to underestimate the relevance of external demand in driving development.

- Caution needs to be exercised in focusing excessively on local competitiveness as a means of developing the economies of the regional capitals.

This briefing report is one of series of complementary reports which begin to unpack the growth experience of each WARCA member, exploring the responsiveness and resilience of these key strategic localities within the Western Australian settlement system.

4. Unpacking Local Developmental Trajectories

A recently published report by the *Western Australian Department of Regional Development* focuses on identifying the key drivers of local competitive and comparative advantage across the Western Australian economy. Similarly, the strategic blueprint reports submitted by the *Regional Development Commissions* were required to identify those economic activities in which they have a comparative advantage. In previous reports we have undertaken a preliminary investigation of the dynamics of WARCA members, imputing competitiveness and comparative advantage from the underlying industrial structure and ability of these localities to create jobs.

This briefing report builds on the evidence for the competitive and comparative advantage of WARCA members, focusing on the resilience of these localities to external "shocks" to their long-run developmental trajectories. The responsiveness and resilience of regional economies has been a key theme identified as part of the Department of Regional Development's initiative to promote Regional Centres as strategic growth 'clusters'.

In the context of this broader policy initiative this briefing paper employs concepts derived from recent advances in Evolutionary Economic Geography (EEG) to determine the:

- dynamics of economic performance of WARCA members compared with broader long run trends across Western Australia

- resilience of WARCA member regional economies to major economic shocks.

4.1 Evolutionary Thinking and the Resilience Framework

The use of evolutionary concepts is gaining increasing traction in our understanding of the dynamics of regional economies (Tonts et al, 2014). Internationally, regional economic policy is employing the key concept of resilience to understand the long-run developmental trajectories of local and regional economies (Tonts, et al, 2012, Plummer et al, 2013)). Building on previous resilience modelling in the Western Australian context evolutionary 'thinking' is currently being employed to understanding the evolution of four Regional Centres that have been identified by the Government of Western Australia as strategically important in terms of their growth potential: Albany, Broome, Busselton, and Geraldton (Plummer et al, 2016).

4.2 Evolutionary Modelling: Understanding the Concepts

Resilience is defined as the ability of local economies to adjust or adapt to external disruptions or 'shocks'. Put differently,

- the resilience of a local economy depends on its ability to 'bounce back' from "shocks' that may disrupt it from its long-term developmental trajectory.

- *Resilience* can be defined in terms of the relationship between the long-run developmental trajectories of regional economies and their short-run responses to external disruptions or "shocks".

Conventionally, Resilience is measured in terms of job creation (employment growth), unemployment rate dynamics, and income per capita. For each of these measures, Resilience can be measured in absolute terms or relative to a benchmark economy.

- *Absolute Resilience* answers the question: how resilient is the Broome economy?

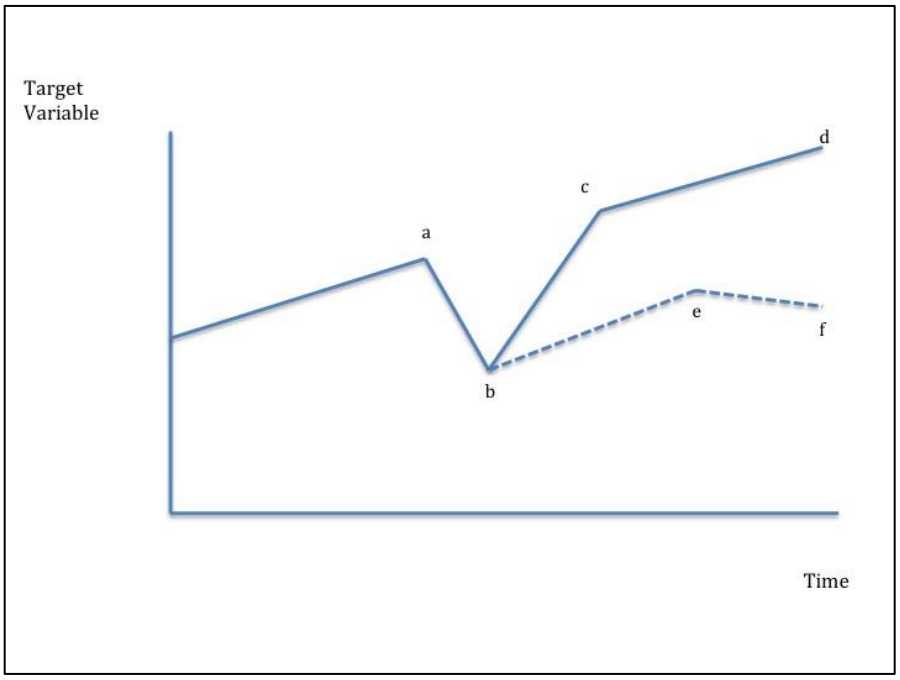
- *Relative Resilience* answers the question: how resilient is the Broome relative to what might be expected based upon the resilience of the Western Australian economy.

Benchmarking against comparator economies provides a means to address 'what if?" questions: what would have happened to the development trajectory of Broome had evolved in a similar way to the Western Australian economy as a whole?

Figure 1 shows a stylized representation of the 'anatomy' of *resilience* for a hypothetical regional economy, depicting four stages of its long-run developmental trajectory.

- *Vulnerability*: Prior to an external "shock" at (a), for example, the recent global financial crisis, the region's growth follows a long-run equilibrium trajectory. This growth trajectory could be measured in terms of key target policy variables such as job creation, unemployment, income or population.
- *Resistance*: The initial impact of the external "shock", which will depend on the nature, scale, and duration of the "shock", and the ability of a region to resist the "shock", resulting in the difference (a) – (b) .
- *Robustness*: The nature of the adjustment and adaptation to the external "shock", in particular whether the region returns to a long-run equilibrium (b) – (c) or displays persistent out-of-equilibrium dynamics or path dependence.
- *Recoverability*: This is defined in terms of the nature of the path to which the economy recovers. If an economy displays resilience, then it will return to its pre-shock long run developmental trajectory (c) – (d). Otherwise, the region can experience a shift in its long-run developmental trajectory, for example (b)- (e) – (f)

Figure 1: The 'Anatomy' of Regional Resilience



The resilience of rural economies is interpreted in two ways: i) *engineering resilience*, which means that external shocks only have transient effects, with adjustment and adaptation driving the system back towards the long-run equilibrium developmental trajectory that existed prior to the external shock; ii) *ecological resilience* means that an external "shock" can have permanent effects, shifting the long-run developmental trajectory of a locality. Figure 1 shows scenarios in which a locality displays engineering resilience in the sense that it revert to a long-run equilibrium developmental path following an external shock and ecological resilience in the sense that the external "shock" has a permanent effect, moving to either a higher long-run developmental trajectory or to a lower long-run developmental trajectory.

The anatomy of regional economic resilience for localities can be explored using a general dynamic econometric model that is capable of discriminating between the competing notions of resilience with respect to long-run developmental trajectories (Plummer et al, 2015) (see technical appendix).

5. Data Description:

5.1 Regionalization

The data used in this briefing paper employs the Statistical Area 2 (SA2) geographical boundaries derived from the latest geography provided by the Australian Bureau of Statistics (ABS). Currently SA2s are the smallest area produced by the ABS for primary output of non-census and intercensal statistics. The advantage of the SA2 geography is that it provides a more consistent population size than Statistical Local Areas (SLAs), with an average population of 10,000. The Australian Bureau of Statistics (ABS) has phased out use of SLAs as geographical boundaries. As of 2012 these data are no longer available at this geographical scale, with SA2 introduced as their replacement. Accordingly, much of the data was converted to SA2 from either postal areas or SLAs using conversions provided by ABS correspondence files. Once converted into SA2s these geographical areas were further aggregated into regions that define the WARCA members. Specifically the WARCA regions are defined by the following SA2s:

ALBANY: Albany Region, McKail-Willyung, Bayonet Head-Lower King, Little Grove - Elleker, Albany.

BROOME: Broome, Roebuck.

BUNBURY: Bunbury, College Grove- Carey Park, Davenport, Eaton-Pelican Point, Koombana.

GERALDTON: Geraldton, Geraldton North, Geradlton East, Geraldton South, Mullewa-Greenough (20% of Northampton-Mullewa-Greenough).

KALGOORLIE: Boulder, Kalgoorlie, Kalgoorlie-North.

KARRATHA: Karratha, Roebourne.

PORT HEDLAND: Port Hedland, South Hedland.

Within the limits of data availability in the Australian context, this report uses real income per capita as the measure of local economic performance. We have chosen to focus on ATO income per capita as a measure of local economic performance because it is the more consistent and reliable than area based ABS estimates of local employment and unemployment rates. Employment data can sourced from the Department of Employment Small Area Labour Market (SALM) database. Employment data is available for the period from 1984 to 2013 for SLAs and was corresponded to SA2 for this period, while date for 2014 and 2015 was published at SA2 level. As defined by the Department of Employment (https://employment.gov.au/small-area-labour-markets-publication-explanatory-notes).

Income and Tax data is sourced from the ATO Annual Taxation Statistics, available from ato.gov.au and data.gov.au. The data has undergone a series of conversions from postal area to the final output at the SA2 level (via SLA for 1982 to 2011 data). Non-taxable individuals are

defined as those individuals who have submitted a tax return and not paid any income tax at the end of the period (ie. earnings below tax free threshold). Taxable individuals are those individuals who have submitted a tax return and paid income tax (ie. earnings above tax-free threshold). Aggregate taxable income is income that is eligible to be taxed. Income per taxpayer data is calculated as the total taxable income dived by number of taxable individuals. 'Real' income/tax figures are calculated for the baseline CPI for the period 2007-08.

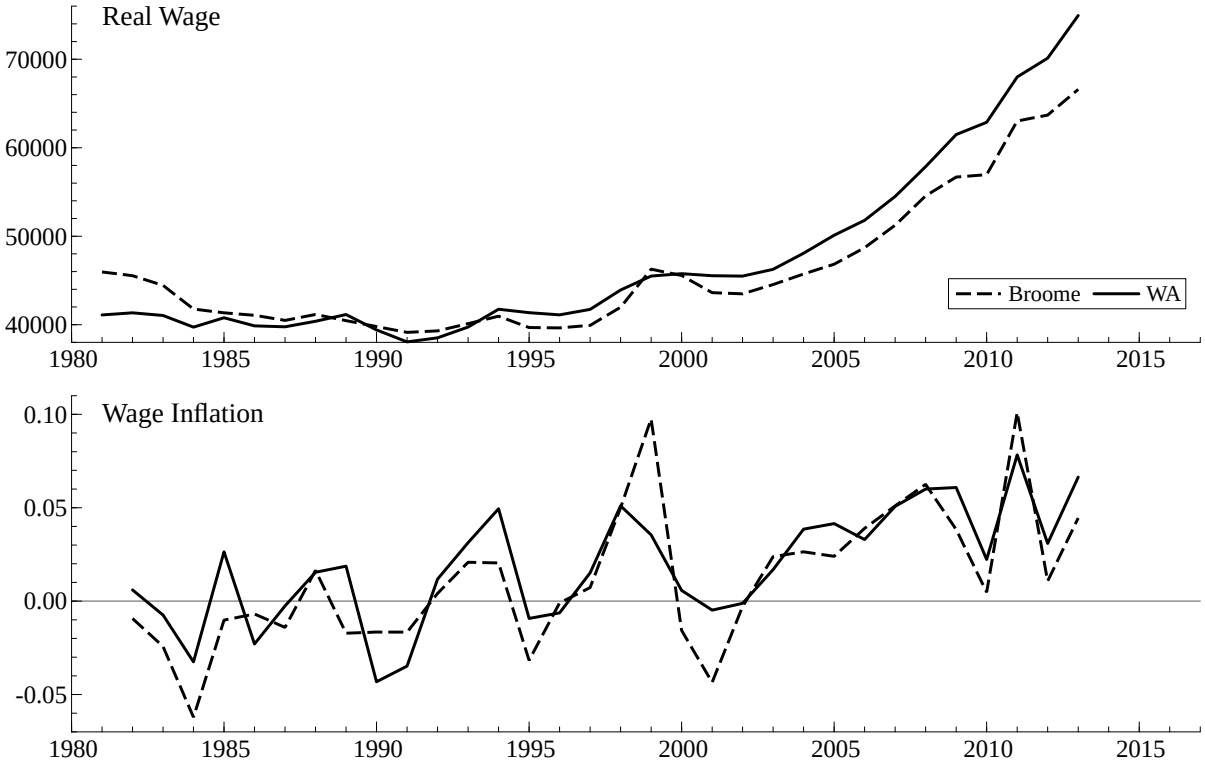
We have chosen to focus on ATO income per capita as a measure of local economic performance because it is the more consistent and reliable than area based ABS estimates of local employment and unemployment rates. Employment data can sourced from the Department of Employment Small Area Labour Market (SALM) database. Employment data is available for the period from 1984 to 2013 for SLAs and was corresponded to SA2 for this period, while date for 2014 and 2015 was published at SA2 level. As defined by the Department of Employment (https://employment.gov.au/small-area-labour-markets-publication-explanatory-notes).

6. The Resilience of Local Economies: Broome, 1980-2013

6.1.1 Descriptive Statistics

Figure 2 shows the trajectory of real wages (income per taxpayer) for Broome for the period 1980-2013 relative to the benchmark of Western Australia's real wage level over the corresponding period. Preliminary inspection of this graph would suggest that over this period Broome experienced two distinct regimes of wage dynamics. Prior to the recent resource boom commencing in 2000, real wages were relatively stagnant, whereas post 2000 Broome experienced a rapid increase in real wages. Within the context of these trends, the dynamics of real of wage inflation are complex and varied in terms of the levels of volatility for Broome.

Figure 2: Real Wage Dynamics



Setting aside the time series properties of real wage dynamics:

- Over the past thirty years the average real wage in Broome was $46,067, which was lower than the Western Australian average of $47,245.

- Broome experienced an average rate of real wage inflation of approximately 1.16% per annum. This compares to an average growth rate across Western Australia of 1.9% per annum.

- Adjusting for differences in the average real wage, the volatility of real wages was lower in Broome (0.165 coefficient of variation) than in Western Australia as a whole (0.212 coefficient of variation).

- The evidence suggests that there is a common trend underpinning the relationship between real wages in Broome and Western Australia. That is, there are high positive correlation between the real wages in Broome and Western Australia (0.98 Pearson's correlation coefficient).

- Furthermore, once this common trend is removed, there remains a strong positive relationship between wage inflation in Broome and Western Australia (0.81 Pearson's correlation coefficient).

6.1.2 Modelling Absolute Resilience

- Table 1 and Figure 3 show the estimates *Absolute Resilience* (see appendix, equations 1-4) and should be read together when interpreting the degree of absolute resilience exhibited by real wages in Broome. For both the 'general' and 'final' model:

- Other things being equal, Broome displays a significant long-run deterministic growth trend, which is greater than that of Western Australia taken as a whole (α_1).

- Accordingly, Broome returns rapidly to its long-run equilibrium growth path following an external "shock".

- Furthermore, there is evidence of path dependent out-of-equilibrium employment dynamics (β_1). This suggests the possibility that small disturbance are likely to have long-run effect on the trajectory of real wages.

- Importantly, formal empirical testing contradicts our casual interpretation of Figure 2 in the sense that there is no evidence of a structural break, or step change, in wage dynamics corresponding to the resource boom around 2000.

Figure 3: Testing for Real Wage Resilience: Observed versus Fitted (log Scale)

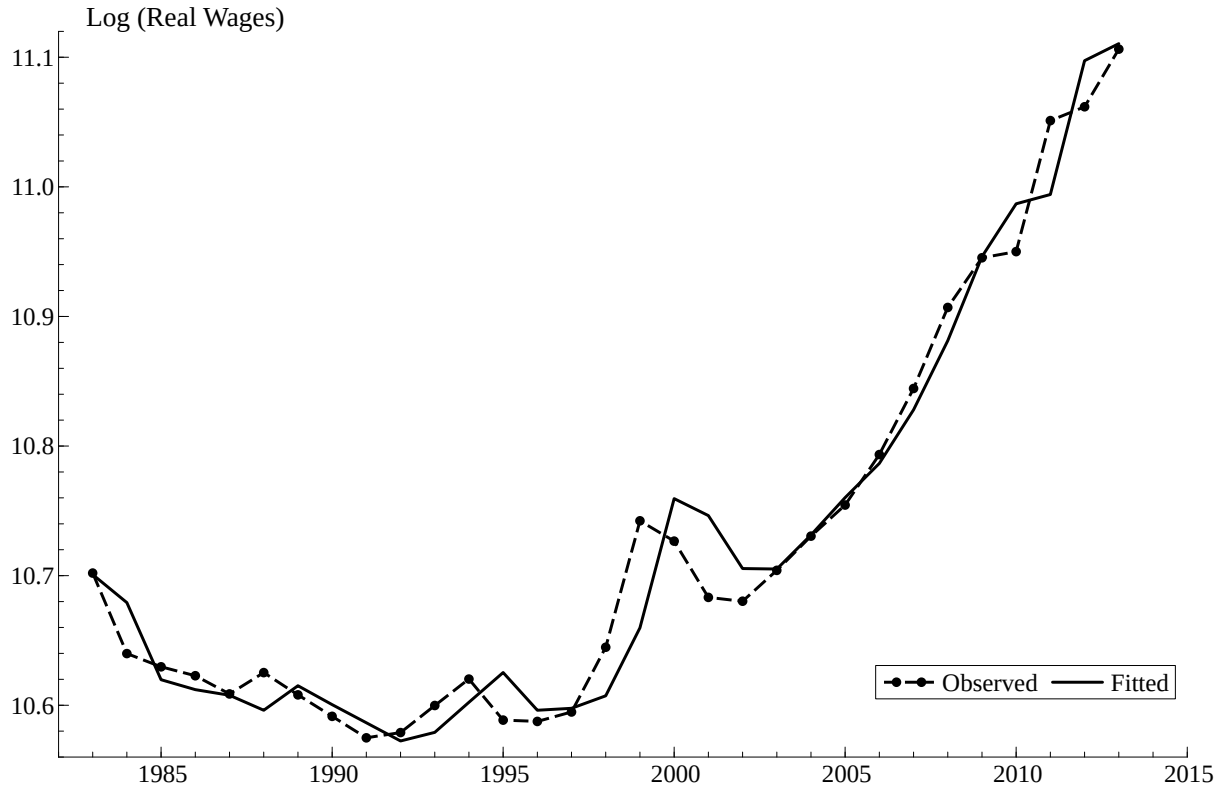


Table 1: Testing for Absolute Resilience: Real Wage Dynamics

Broome	α_{ot}	α_1	β_1	**SIS**	**SPEC**	**ADF Test****
General	0.75	0.003**	0.97**	-	-	-1.300
Final	-	0.00250**	0.997**	-	-	-
WA						
General	0.13	0.002**	1.15**	-	-	-0.150
Final	-	0.002**	1.00**	-		-

SIS = Step Indicator Saturation (equation 4)
SPEC = mis-specification issues related to ε_{it} random errors ("shocks") . Tests for normality (NORM), Heteroscedasticity (HETERO), and functional form (RESET)
ADF Test: test for path dependence (null of path dependence)
** significant at 5% level
* significant at 1% level

6.1.3 Modelling Relative Resilience

Table 2 show the estimates of *Relative Resilience* (see appendix, equations 1-4) for the real wage dynamics exhibited by Broome.

For the general model specification, the key features are:

- The relationship between Broome and the rest of Western Australia is characterized by path dependent real wage dynamics, with no tendency to return to a simultaneous developmental trajectory following external "shocks" (β_1, β_3).

- Nonetheless, there is evidence of short run, concurrent responsiveness of Broome to changes in WA employment (β_2).

For the final model specification, the key features are:

- There is evidence of a long run co-evolving relationship between the real wage dynamics for Broome and Western Australia (β_2).

- However, there is evidence that this long run developmental trajectory "shifted" five times (or in other words, five step changes): in 1983, 1990, 1993, 1998, and 2000.

Table 2: Testing for Relative Resilience: Real Wage Dynamics

Broome	α_{ot}	α_1	β_1	β_2	β_3	**SIS**	**SPEC**	**Unit Root****
General	0.167	-0.002	0.48**	0.948**	-0.439**	-	-	-3.243
Final	-	-0.007		1.01**		1983, 1990, 1993, 1998, 2000	-	-

Figure 4 shows the long-run trajectory of Relative Resilience for Broome using Western Australia as the benchmark economy. A long-run equilibrium exists between the wages rate in Broome and the wage rate of Western Australia if the equilibrium correction mechanism (ECM) fluctuates around the zero line. If the ECM is above the zero line then the out-of-equilibrium adjustments in Broome wages is greater than the long-run equilibrium response to changes in Western Australian

wages. In contrast, if the ECM is below the zero line then the out-of-equilibrium adjustments are less that would have been expected given the change in Western Australia's wage rate.

Table 3 shows the results of fitting the equilibrium correction model (ECM) for Broome. This model specification disaggregates wage rate dynamics into (a) relationship between wage inflation in Broome and Western Australia, (b) a short-run disequilibrium adjustment in wage levels, and (c) the long-run equilibrium relationship between wages in Broome and Western Australia.

Figure 4: Real Wages Equilibrium Correction Mechanism

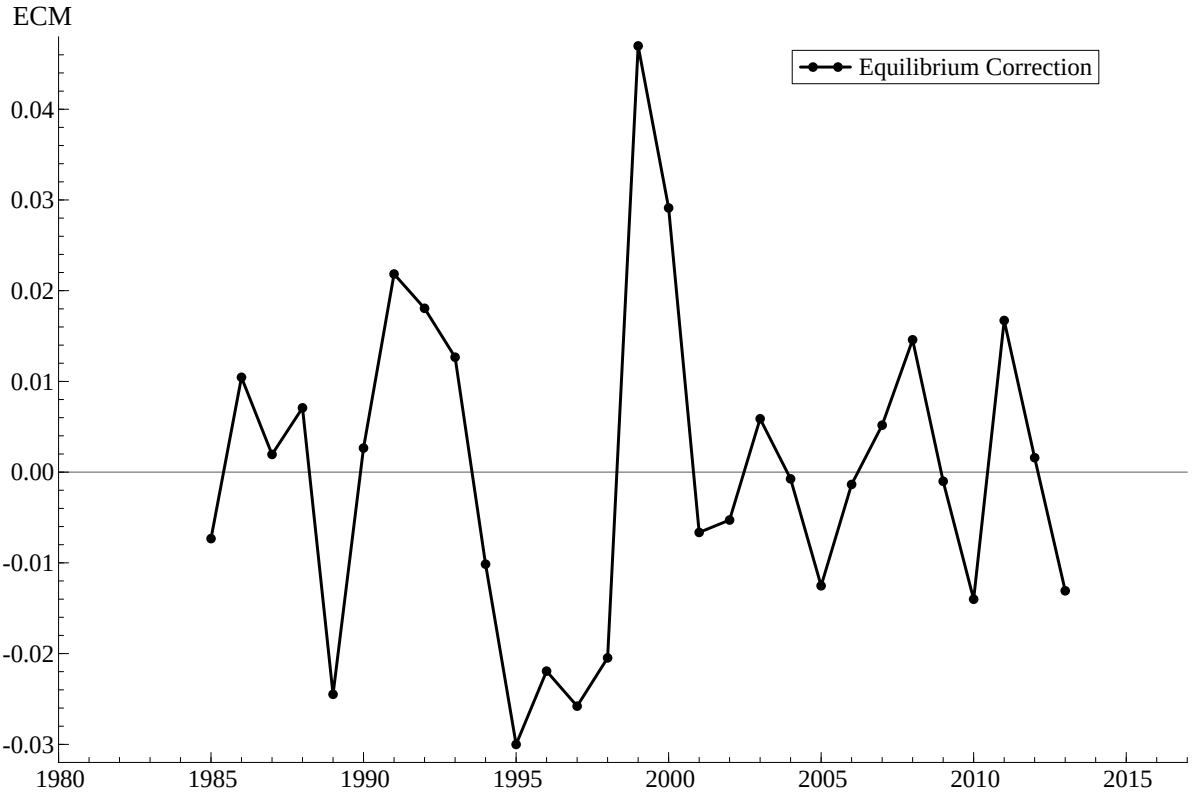


Table 3: Fitted Model of Wage Dynamics as an ECM

$$\Delta y_{it} = b_{i2}\Delta z_{it} + \left(b_{i1} - 1\right)\left(ECM_{it-1}\right) + e_{it}$$

$$\Delta y_{it} = 0.88\Delta z_{it} - 0.711\left(ECM_{it-1}\right)$$

- There is evidence of a long-run equilibrium relationship between real wage rate in Broome and Western Australia.

- Accordingly, benchmarked against Western Australia, Broome displays *Relative Resilience* in its Real Wage Dynamics.

- There is evidence of a significant positive relationship between wage inflation in Western Australia and Broome. Higher rates of real wage inflation in Broome are associated with higher rates of wage inflation in Western Australia.

- There is evidence that, when moved off its long-run developmental trajectory, there are competitive mechanism that serve to restore the local economy to its long run equilibrium wage dynamics relative to Western Australia.

7. Implications of Resilience for Local Economic Policy

This briefing paper aimed to answer two questions about the evolution of the Broome Economy:

- What are the long-run developmental trajectories of employment and income in Broome?
- How resilient is Broome to changes in the external social, economic, and policy environment?

Based upon the econometric modelling conducted in this briefing paper the evidence is clear and distinct:

- The Broome economy has displayed *Resilience* in the face of external "shocks" that have buffed the locality in the past 35 years.
- The *Resilience* of the Broome economy suggests that the competitive forces driving the economy are dominated by longer-term growth trends rather than short-term fluctuations and "shocks".
- Benchmarked against the Western Australian economy taken as a whole, the evidence suggests that Broome responds relatively rapidly to broader forces driving the State economy.
- There is evidence that when disturbed from its long run growth path the competitiveness of the Broome economy serves to restore the local economy to its long run developmental trajectory.

Overall, these findings have the following implications for the formation of local economic policy:

- Policy initiatives which are designed to enhance local competitiveness are likely to increase the speed of responsiveness to external shocks to the Broome economy.
- Increasing the long-run developmental trajectory of the Broome will likely require capital investment in the structural competitiveness of the local economy.

This briefing report is one of series of complementary reports which begin to unpack the growth experience of each WARCA member, exploring the relationship between local and structural competitiveness is the subject of ongoing research initiatives.

8. TECHNICAL APPENDIX:

Let $y_{it} = \ln Y_{it}$ define the relevant target variable for regional policy in region i (e.g. Broome) at time t and $z_t = \ln Z_t$ define the average value of the target variable for a benchmark economy (e.g. Western Australia). In the context of this briefing report, the target policy variable is income per capita. For simplicity, it is possible to test for *Relative Resilience* using a first order autoregressive distributed lag (ADL) representation of the relationship between the target variable for the locality and the benchmark economy.

$$y_{it} = \beta_{i0t} + \beta_{i1} y_{it-1} + \beta_{i2} Z_t + \beta_{i3} Z_{t-1} + \varepsilon_{it} \quad (1)$$

$$\beta_{0t} = \alpha_{0t} + \alpha_1 T \quad (2)$$

$$\varepsilon_{it} \sim N\left(0, \sigma^2\right) \quad (3)$$

$$\alpha_{0t} = \alpha_0 + \sum_{t=1}^{T} \phi_t 1_{(t \le T)} \quad (4)$$

Where, $\left(\beta_{0i}, \beta_1, \beta_2, \beta_3\right)$ defines the set of "pull factors" determining the response of both the local and benchmark economy to exogenous "shocks", $\left(\alpha_{0i}, \alpha_1\right)$ the deterministic components, and ε_{it} the set of "push factors" moving the system away from long-run equilibrium: assumed to be normally distributed with zero mean $E\left(\varepsilon_{it}\right) = 0$ and constant variance $E\left(\varepsilon_{it}^2\right) = \sigma^2$ and serial independence $E\left(\varepsilon_{it}\varepsilon_{jt}\right) = 0$. The possibility of structural break (regime shifts) is captured with the step function ϕ_i, which takes on a value of 1 from time i onwards, zero otherwise. A long-run equilibrium growth path is defined as follows:

$$E\left(y_{it}\right) = \frac{\beta_{i0t}}{1-\beta_{i1}} + \frac{\beta_{i2} + \beta_{i3}}{1-\beta_{i1}} Z_t \quad (5)$$

In the absence of shifts (equation (4)) then *Engineering Resilience* can be tested by imposing the linear restriction $\left(1-\beta_1\right) = 0$. If the restriction holds, then exogenous "shocks' accumulate and the target variable displays persistent out-of-equilibrium dynamics, with no tendency to return to its long-run equilibrium growth path. If the restriction does not hold, then the system displays *Resilience*, returning to a unique long-run equilibrium growth path following an exogenous shock.

Equation (1) can be re-written as an equilibrium correction representation (ECM) linking wage inflation dynamics to the out-of-equilibrium adjustments of wage levels in response to exogenous "shocks":

$$\Delta y_{it} = \beta_{i2}\Delta z_{it} + \left(\beta_{i1} - 1\right)\left(y_{it-1} - \frac{\beta_{i01}}{\left(1 - \beta_{i1}\right)} - \frac{\beta_{i2} + \beta_{i3}}{\left(1 - \beta_{i1}\right)} z_{it-1} \right) + \varepsilon_{it} \quad (6a)$$

or equivalently,

$$\Delta y_{it} = \beta_{i2}\Delta z_{it} + \left(\beta_{i1} - 1\right)\left(ECM_{it-1}\right) + \varepsilon_{it} \quad (6b)$$

where $\Delta y_{it} = y_{it} - y_{it-1}$, $\Delta z_{it} = z_{it} - z_{it-1}$, and $ECM_{it-1} = y_{it-1} - \frac{\beta_{i01}}{\left(1 - \beta_{i1}\right)} - \frac{\beta_{i2} + \beta_{i3}}{\left(1 - \beta_{i1}\right)} z_{it-1}$.

The *Ecological Resilience* of a locality depends on how the dynamic system depends on the ways in which that system responds to structural breaks. Equation (4) tests recursively for the existence of structural breaks $\left(\beta_{0t}\right)$ in the location of the target variable. The absence of structural breaks provides evidence of *Ecological Resilience* whilst the existence of non-constant parameters indicated that the effects of exogenous "shocks" shift the long run development growth path of localities.

If *Absolute Resilience* is the appropriate measure of economic resilience, then the restriction $\beta_2 = \beta_3 = 0$ can be imposed on the *Relative Resilience* model and empirically tested within this modeling framework.