Queensland Government

Multifactor Productivity and R&D in Australian States*

Jimmy Louca

Principal Economist
Economic Policy Branch
Queensland Treasury

***** This paper is based on chapter 5 of the recently published volume '*Productivity and Regional Economic Performance in Australia*' (see www.oesr.qld.gov.au)

Queensland Government

Rationale

- Productivity, sustainable growth and real incomes
- Little attention to distribution of MFP gains across States
- Interstate differences in the determinants of productivity
- State governments have policy influence in this area

Queensland Government

Contents

- State multifactor productivity
  - Economic growth
  - Labour productivity
  - Real incomes
  - Convergence
- Innovation
  - Business R&D
  - Econometric results

Estimating multifactor productivity

- Törnqvist technique to calculate MFP (Appendix A)

$$y_t = a_t + \beta l_t + (1 - \beta)k_t$$

$$a_t = y_t - \beta l_t - (1 - \beta)k_t$$

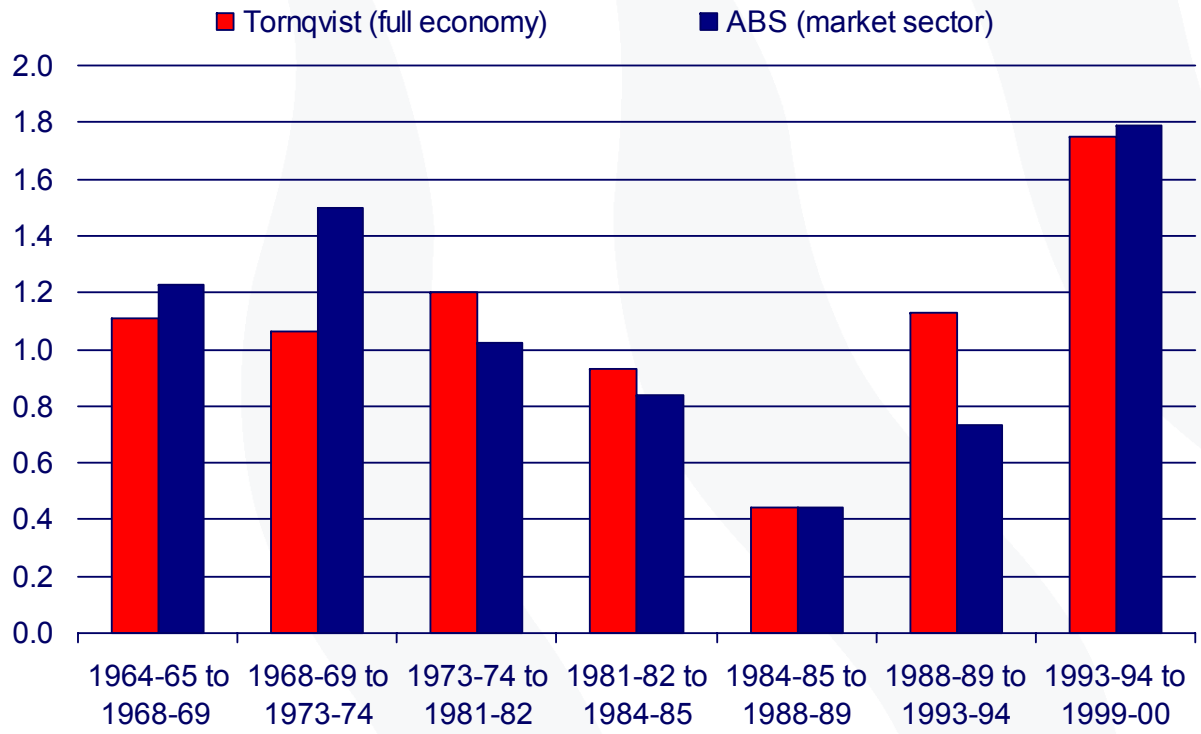
- PIM to calculate State capital stocks (Appendix B)

$$K_t = (1-\delta_t)K_{t-1} + I_t$$

Queensland Government

Comparison with ABS estimates

Figure 1: Multifactor productivity in Australia
(average annual growth)



State MFP and economic growth

Table 1: Growth decomposition in Australian States[1,2]

(average annual growth, 1985-86 to 2000-01)

State	Output	Contribution to growth		
		Labour	Capital	MFP
NSW	**3.3**	1.1	1.0	**1.2**
Vic	**3.0**	1.0	1.0	**1.0**
Qld	**4.5**	1.9	0.9	**1.6**
SA	**2.4**	0.6	0.7	**1.1**
WA	**4.4**	1.7	1.3	**1.3**
Tas	**1.5**	0.4	0.8	**0.3**
Australia	**3.5**	1.3	1.0	**1.2**

[1] As with all MFP estimates, the numbers should be taken as indicative of trends rather than precise estimates of productivity growth, due to the measurement problems involved (Industry Commission, 1997, p. 29), particularly in relation to State capital stocks (see Appendix A and B of this study).

[2] State MFP estimates are based on ABS data for consistency of measurement., Queensland Treasury also produces preferred MFP estimates for Queensland based on Queensland State Accounts data.

MFP and labour productivity

Table 3: MFP, capital deepening & labour productivity

(average annual contribution to growth, 1985-86 to 2000-01)

State	Labour Productivity	Contribution	
		K/L	MFP
NSW	**1.5**	0.4	**1.2**
Vic	**1.4**	0.4	**1.0**
Qld	**1.5**	-0.1	**1.6**
SA	**1.4**	0.3	**1.1**
WA	**1.8**	0.4	**1.3**
Tas	**0.8**	0.5	**0.3**
Australia	**1.5**	0.3	**1.2**

- Regional insight into Dowrick (1990) study on LP growth slowdown in 80s (argued that real wage restraint had slowed rate of capital deepening)

State MFP and real incomes

Table 2: Drivers of real incomes across States[1,2]

(average annual contribution to growth, 1985-86 to 2000-01)

Components		NSW	Vic	Qld	SA	WA	Tas	Aust
Real incomes per capita		**2.2**	**1.9**	**1.9**	**1.7**	**2.8**	**1.0**	**2.2**
Terms of trade		0.0	-0.2	-0.4	-0.2	0.4	0.0	0.0
Productivity	K/L	0.4	0.4	-0.1	0.3	0.4	0.5	0.3
	MFP	**1.2**	**1.0**	**1.6**	**1.1**	**1.3**	**0.3**	**1.2**
Participation	Unemployment rate	0.2	0.1	0.1	0.1	0.2	0.1	0.1
	Participation rate	0.2	0.4	0.5	0.1	0.4	0.1	0.3
	Working age share	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Average hours	-0.1	-0.1	-0.2	-0.1	-0.2	-0.2	-0.1

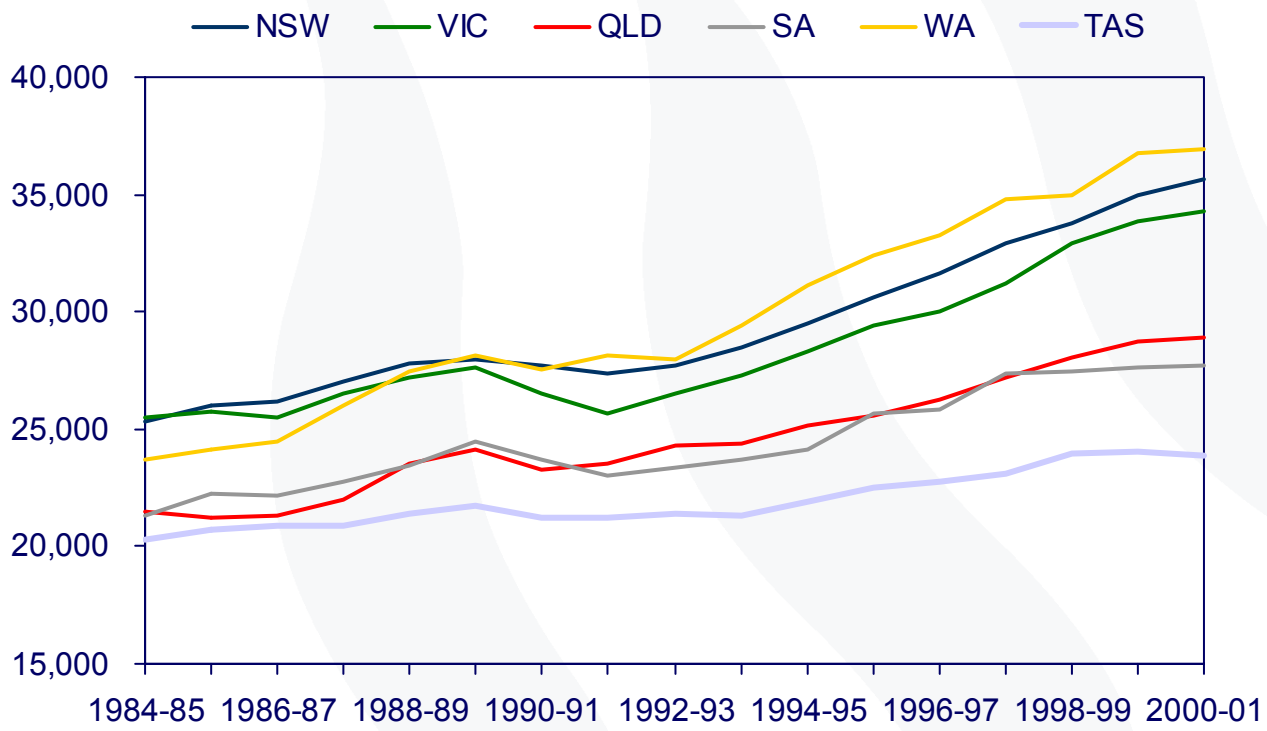
[1] This study follows the ABS (1993, p. 113) method of revaluing exports with the price deflator for imports to provide a measure of the purchasing power of exports over imports and substituting this value for the actual constant price value of exports in deriving real gross domestic product.

[2] The terms of trade adjustment for the States has been conducted on relative prices of traded goods, since services data is not available over the period. Another limitation in interpreting the terms of trade result is that some States import many of their overseas goods via the larger States, such as NSW and Victoria.

State MFP and convergence

Figure 2: Real incomes across States

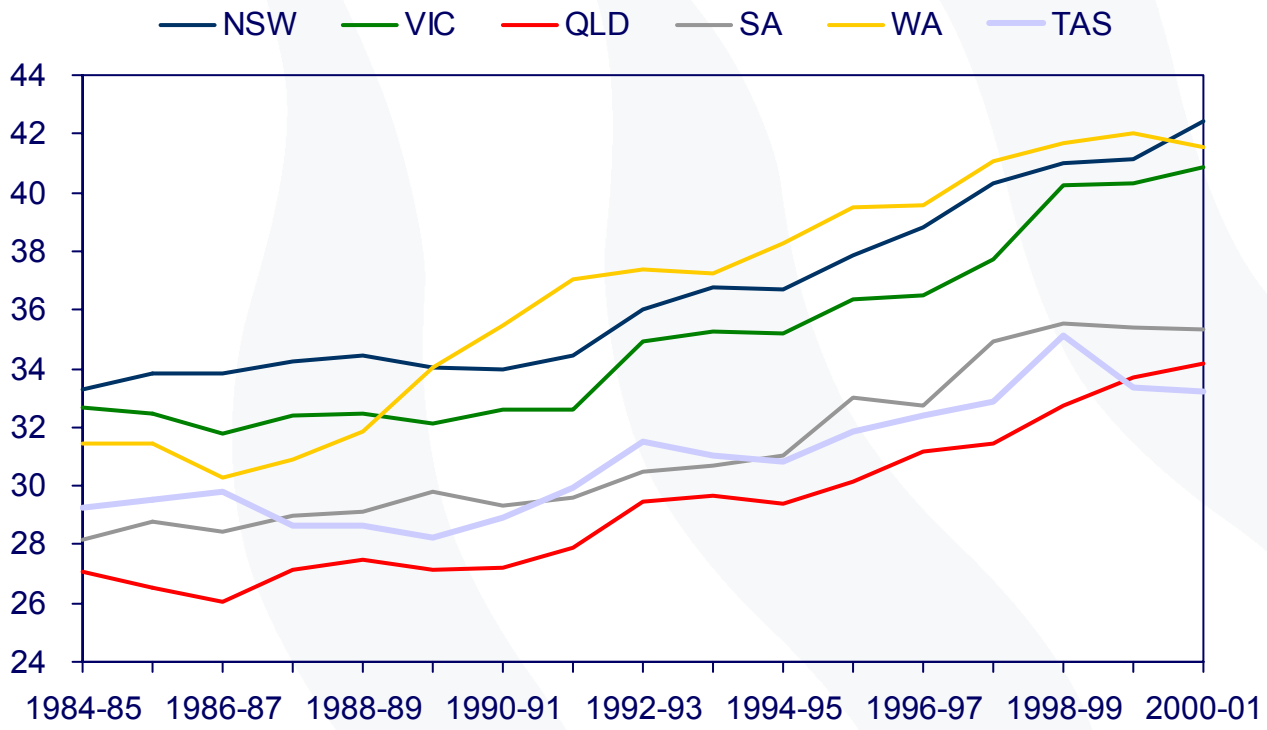
(per capita terms ($), 1984-85 to 2000-01)



State MFP and convergence *cont.*

Figure 3: Labour productivity across States

(output ($) per hour worked, 1984-85 to 2000-01)



State MFP and convergence *cont.*

Figure 4: Convergence in labour productiviy?

(1984-85 to 2000-01)

State MFP and convergence *cont.*

Figure 5: Convergence in MFP?

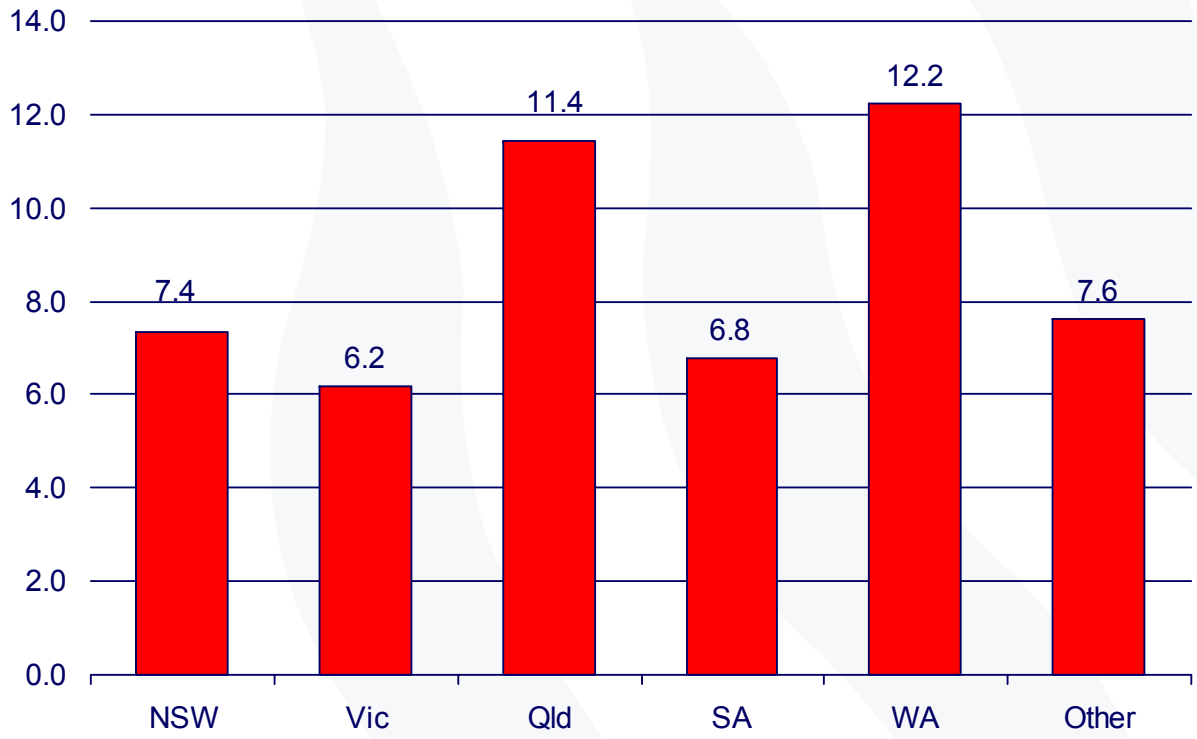
(1984-85 to 2000-01)

- Parallels finding in Dowrick & Nguyen (1989) OECD study (while LP had diverged since 1970s, cross country differences in capital deepening had masked convergence process in MFP)

Innovation and R&D

Figure 6: Nominal Business R&D

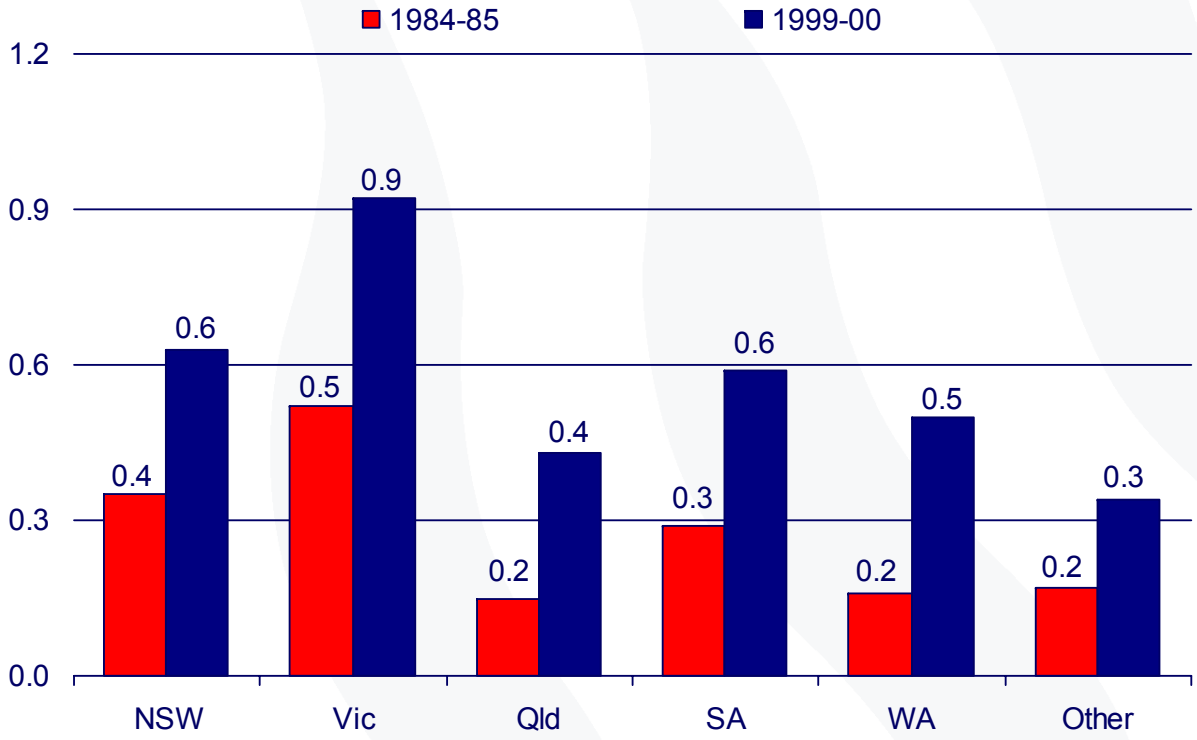
(average annual growth, 1985-86 to 1999-2000)



Innovation and R&D *cont.*

Figure 7: Business R&D intensity

(Ratio of business R&D to GDP)



Econometric results

$$log\text{MFP}_{it} = \alpha_i + \beta_1 log\text{R}^{D}_{it} + \beta_2 log\text{R}^{IS}_{it} + (\beta_3 \cdot m_{it}) \cdot log\text{R}^{F}_{it} + \beta_{xyz} \cdot XYZ_{it} + \varepsilon_{it}$$

MFP = multifactor productivity

R^D = business R&D stock in the State

R^{IS} = business R&D stock in the rest of Australia

R^F = import weighted business R&D stock in G7 countries

m = imports as a share of GDP

XYZ = retention rates (human capital)

= rates of industrial disputation (labour market)

= import tariffs

= capacity utilisation

Econometric results *cont.*

Table 3: Multifactor Productivity (*log*MFP) [1,2]

(1984-85 to 1999-2000)

Variable	Coefficient	Standard error	t-statistic
State R&D stock	0.056***	0.014	3.912
Rest of Australia R&D stock	0.039**	0.018	2.159
Import tariff	-0.555*	0.098	-1.767
Rate of industrial disputation	-0.009*	0.313	-1.857
Capacity utilisation	0.691***	0.005	7.059
Diagnostics:			
R^2	0.963	-	-
Levin & Lin (1992)	-5.441***	-	-
Error correction term	-5.817***	-	-

*[1] The terms *, ** and *** denote significance at the 90%, 95% and 99% confidence levels respectively.*

[2] The equation was estimated in levels (rather than in rate of change form) in order to determine the significance of any long-run elasticity and thus the rate of return on R&D. However, various diagnostic tests indicate that the equation forms a cointegrating relation. For instance, results from applying the Levin and Lin (1992) panel unit root tests indicate that the null of nonstationary residuals can be rejected at the 99% level of confidence, while the coefficient on these residuals lagged once as an error correction term in a short-run differenced equation was also significant at the 99% confidence level.

Econometric results *cont.*

$$log\text{MFP}_{it} = \alpha_i + \beta_1 log\text{R}^{D}_{it} + \beta_2 log\text{R}^{IS}_{it} + (\beta_3 \cdot m_{it}) \cdot log\text{R}^{F}_{it} + \beta_{xyz} \cdot XYZ_{it} + \varepsilon_{it}$$

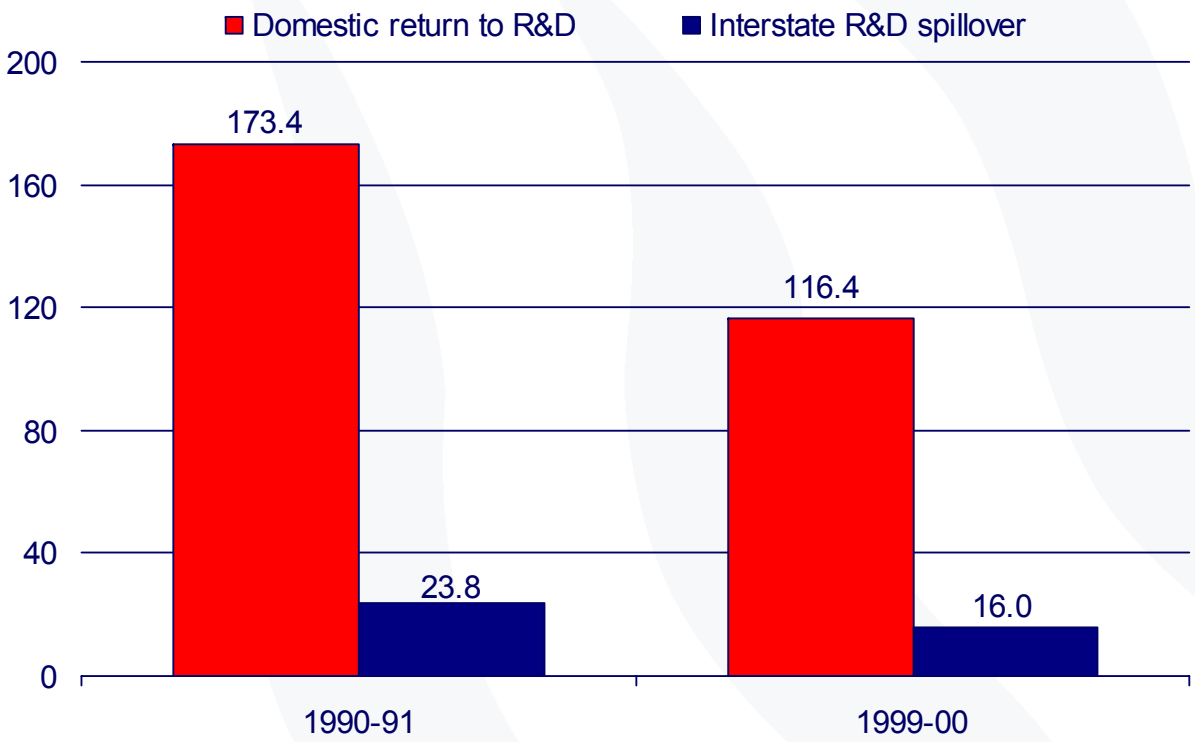
- Converting elasticities into rates of return:

$$\beta = \frac{\delta Y/Y}{\delta R/R} = \frac{\delta Y}{\delta R} \cdot \frac{R}{Y}$$

$$\beta \cdot \frac{Y}{R} = \frac{\delta Y}{\delta R}$$

Econometric results *cont.*

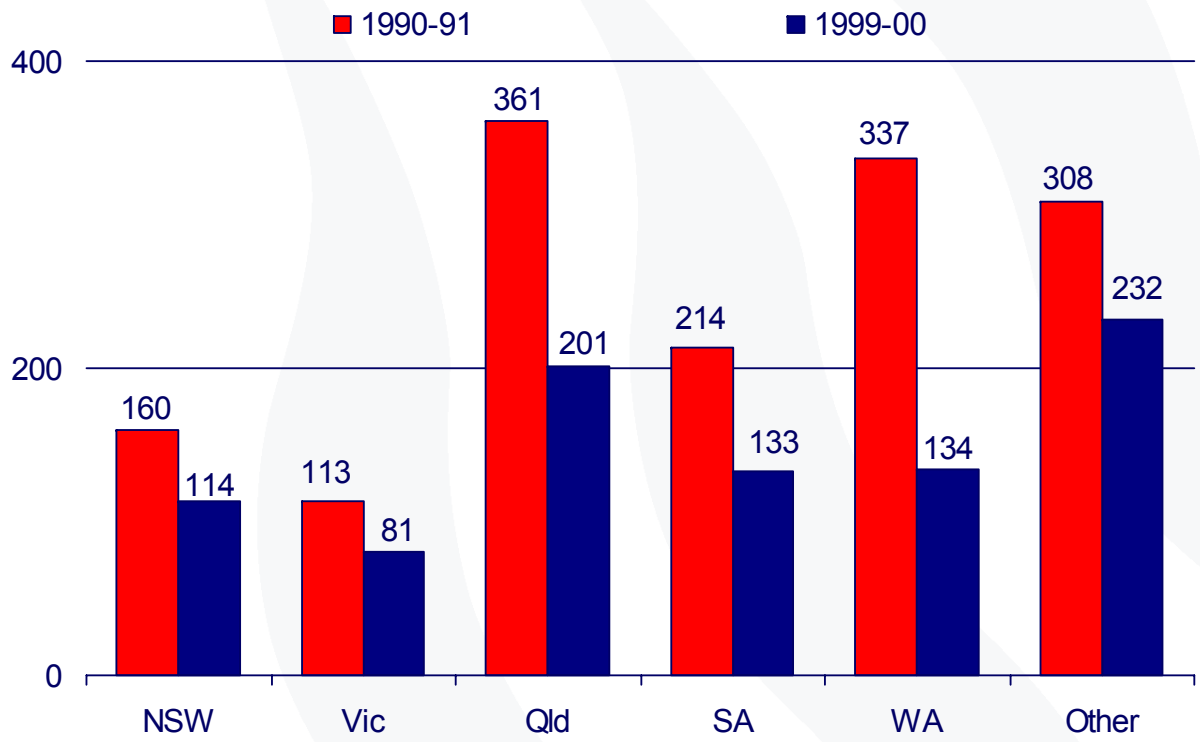
Figure 8: Returns to R&D in Australia



- Coe & Helpman (1993) – 196%
- Dowrick (1994) – 166%
- Industry Commission (1995) – 147%

Econometric results *cont.*

Figure 9: Returns to domestic R&D across States



Queensland Government

Summary

- States with highest economic growth had highest MFP growth
- No convergence in labour productivity or per capita incomes
- Differences in the rate of capital deepening have masked an underlying process of convergence in MFP
- Interstate R&D spillovers & convergence in returns to domestic R&D
- States initially facing the highest returns from R&D invested most heavily in R&D, coinciding with faster MFP growth

Future research

- Collect improved State level data on MFP and its determinants (ie. capital stocks, R&D in other sectors, human capital etc)
- Update study for 1984-85 to 2003-04
- Sensitivity analysis on estimation of MFP (ie. production function) and econometrics (ie. functional form, principal components)
- Better understand R&D and its determinants across States