Drivers of Productivity in the Australian States : A Comparative Analysis

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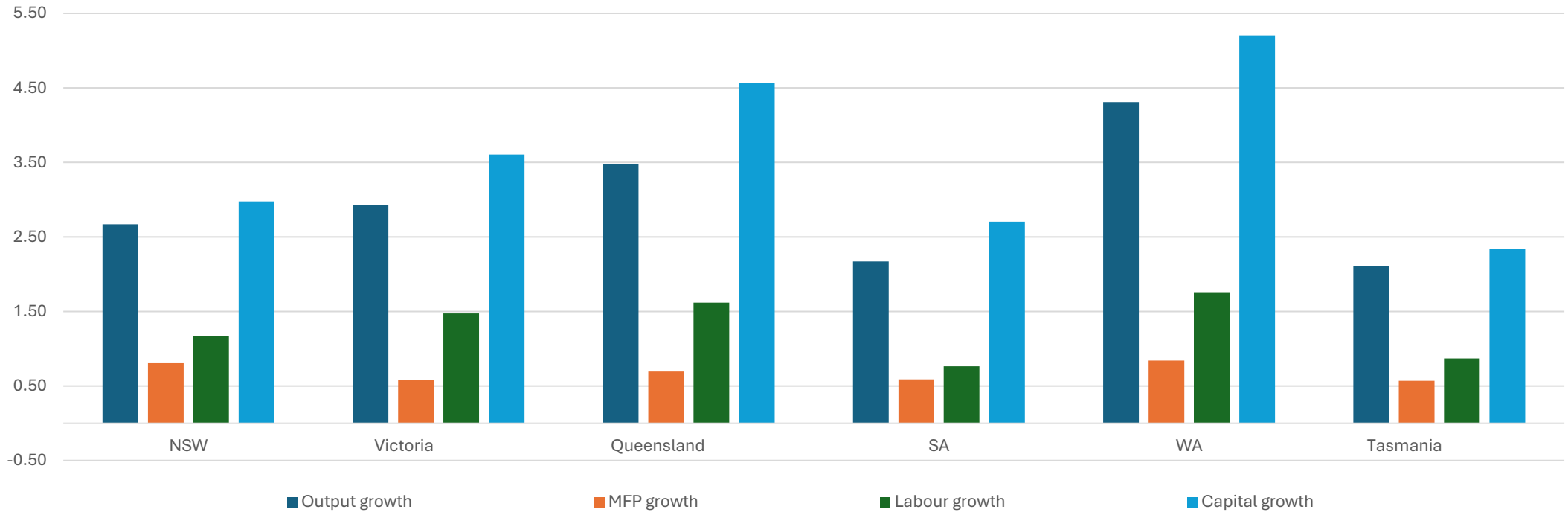
Outline

1. Motivation
2. Literature Review
3. Methodology, data and estimation
4. Results of analysis
5. Conclusion and Future Scope

Motivation

Average annual growth rates of output, multifactor productivity (MFP), labour, and capital (1996-2023) in Australian States



Source: Australian Bureau of Statistics (2022-23) Experimental Estimates of Industry Multifactor Productivity.

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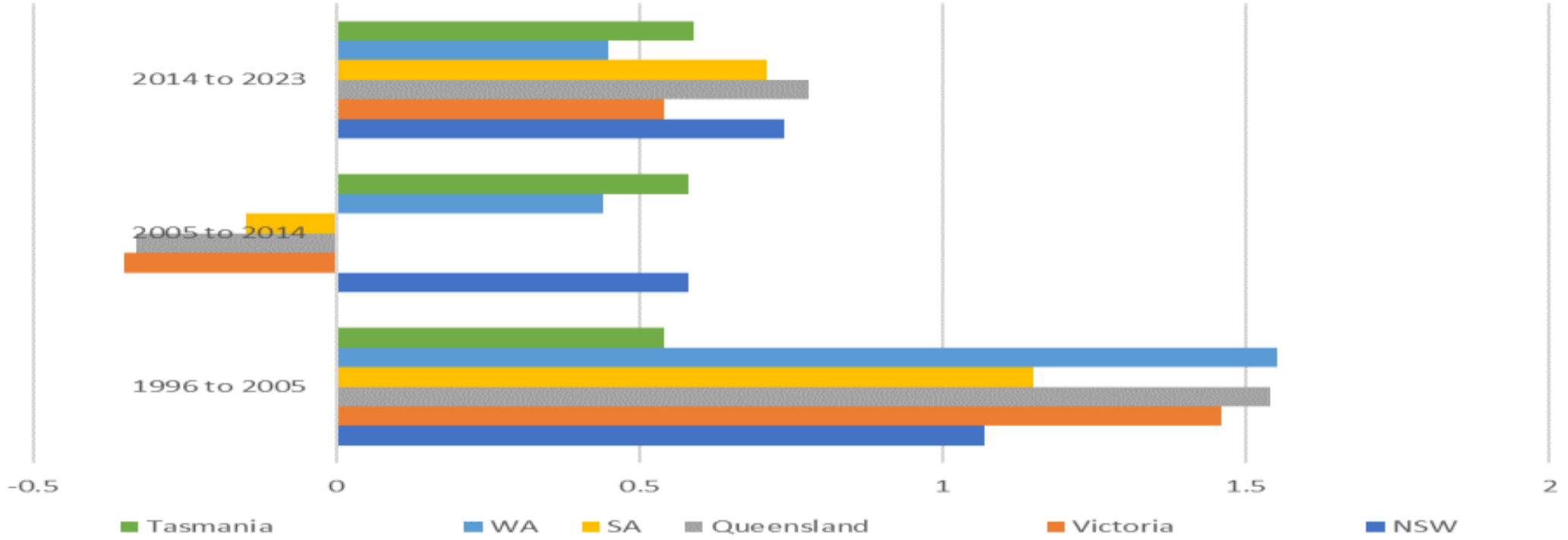
Motivation

MFP growth and decadal averages (%) in Australian States



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What others have done?

- DEA ~ Fare et al. (1994), Angeriz et al. (2006), Jerzmanowski (2007), Dakpo et al. (2019).
- SFA ~ Jung & Pyo (2009), Keng & Li (2010), Pires & Garcia (2012), Abudureheman et al. (2023).
- Only a limited number of studies have attempted to decompose MFP into its components for the Australian economy as a whole.
- Australia ~ Wadud & Paul (2006), O'Donnell (2010), Sheng et al. (2017), O'Donnell (2022), Fox (2022).
- To date, no published studies have decomposed MFP into its distinct components—technological progress and efficiency change—at the level of Australian states and territories.

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Objective

- This study aims to enhance the understanding of productivity dynamics across Australian states by decomposing MFP growth into its core components using SFA model.
- Identify region-specific drivers and barriers to MFP growth.
- Provide useful guidance for targeted policy design to address MFP gaps.

Model Specification

- The general stochastic production frontier model is described by the equation below,

$$y_{it} = f(t, x_{it}, \beta).\exp(v_{it}).\exp(-u_{it}), u_{it} \geq 0 \qquad (1)$$

- This paper utilizes the Bayesian approach of O'Donnell (2018) to estimate the stochastic frontier. In a simplified form, the Bayesian stochastic frontier model can be expressed as:

$$y_{it} = x_{it}^{'}\beta + v_{it} - u_{it} \qquad (2)$$

- This paper employs SFA techniques to estimate the parameters of six distinct stochastic production frontier models. Each model follows the basic structure below:

log(state output) = constant + trend_1995-2004 + trend_2005-2014 + trend_2015-2022 + log(capital) + log(labour) + log(intermediate inputs) + statistical noise - technical inefficiency *(3)*

- Bayesian methods were employed to enforce nonnegativity constraints on the coefficients associated with both the trend components and the logarithmic input variables.

MFP Decomposition

The MFP change is decomposed into three components listed below, plus a fourth factor that measures Changes in Statistical Noise (CSN):

$$\boldsymbol{MFPC = TP \times TEC \times SMEC \times CSN} \qquad (4)$$

- The technological change (TP) that represents the shift in the stochastic frontier over time. It can be computed directly from the estimated parameters.
- Technical efficiency (TE) represents the downward deviation of the stochastic frontier. TE is the ratio of observed output to maximum feasible output.

$$TE = \frac{y_{it}}{\exp(x_{it,}\beta)} \qquad (5)$$

- Scale and mix efficiency change (SMEC) refers to improvements in productivity that result from changes in economies of scale and substitution (changing the input mix and/or the output mix).

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Variables and Data

- Gross output indexes, labour input indexes, capital services indexes, and intermediate inputs indexes are used as quantity series of state output, labour, capital and intermediate inputs.
- Yearly data from 1995 to 2022 for the market sectors of Australian states.
- Labour input indexes and capital services indexes are collected from the *Experimental Estimates of State Multifactor Productivity* tables published by the Australian Bureau of Statistics (ABS).
- We calculate an index for gross output and intermediate inputs with assistance from the ABS using data on gross value-added output and total intermediate use.

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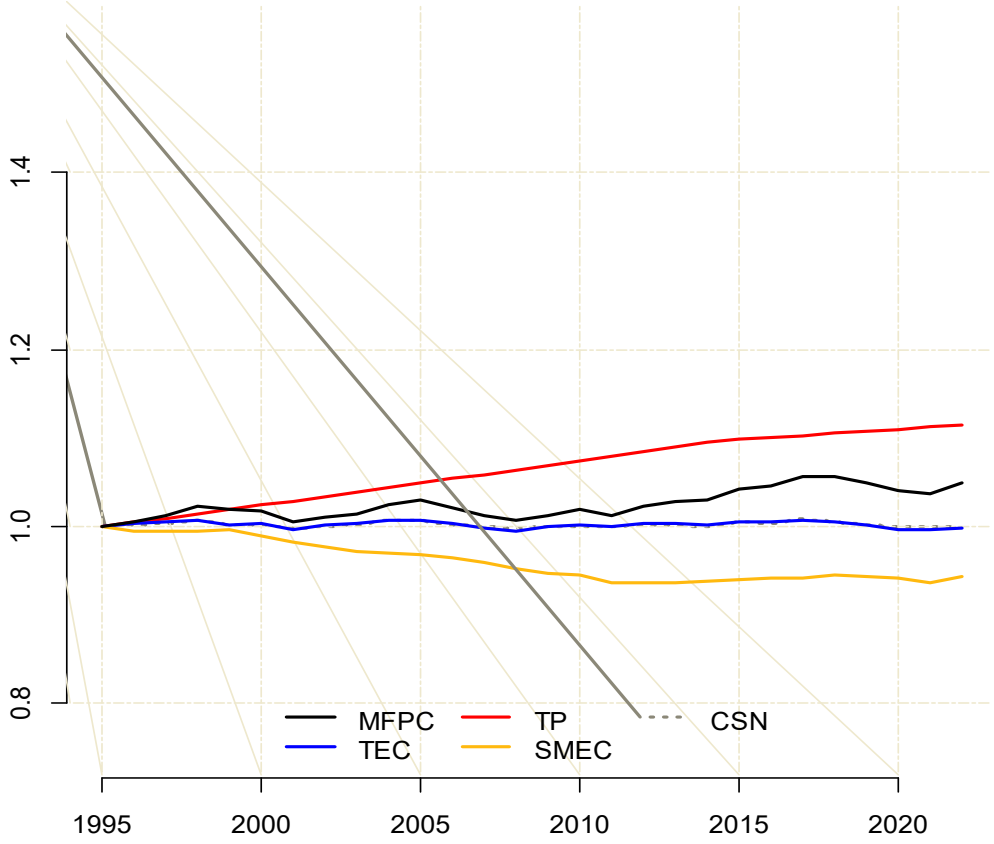
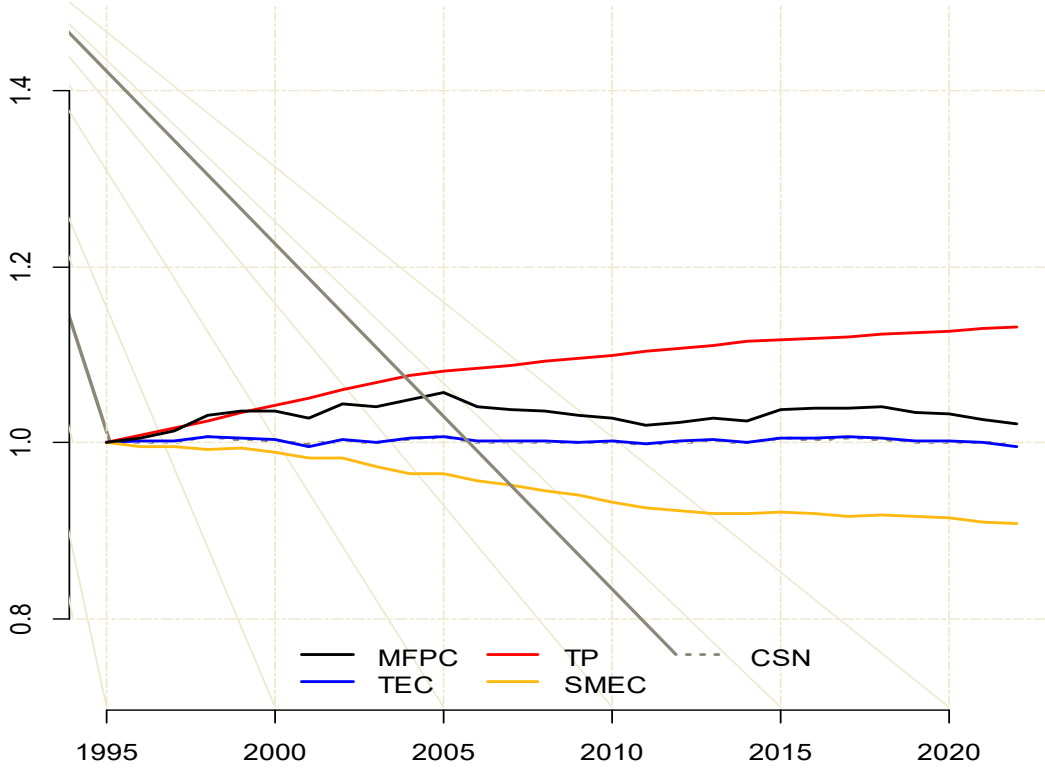
MFP Decomposition across States (average annual growth)

States	MFPC	TEC	TP	SMEC	CSN
New South Wales	1.025	1.002	1.064	0.957	1.002
Victoria	1.031	1.002	1.086	0.943	1.002
Tasmania	1.016	0.999	1.045	0.972	1.000
South Australia	1.018	1.003	1.061	0.952	1.002
Queensland	1.025	0.996	1.027	1.003	1.000
Western Australia	1.072	0.965	1.094	1.023	0.991

Decomposition of MFP into components (NSW and VIC)



(a) New South Wales



(b) Victoria

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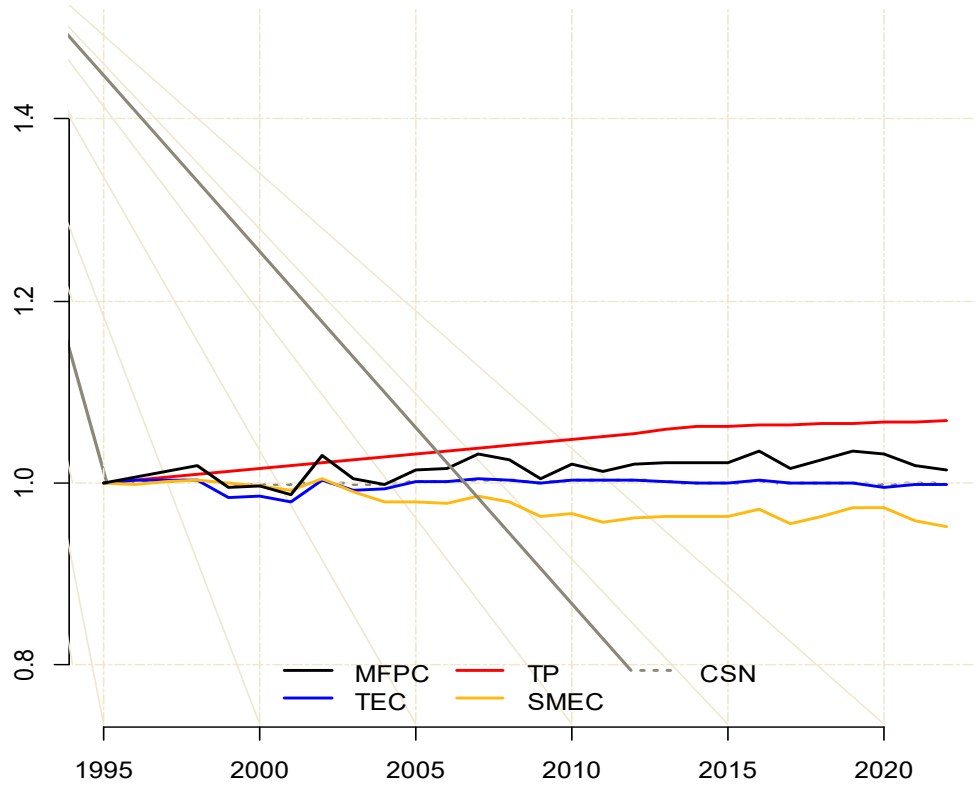
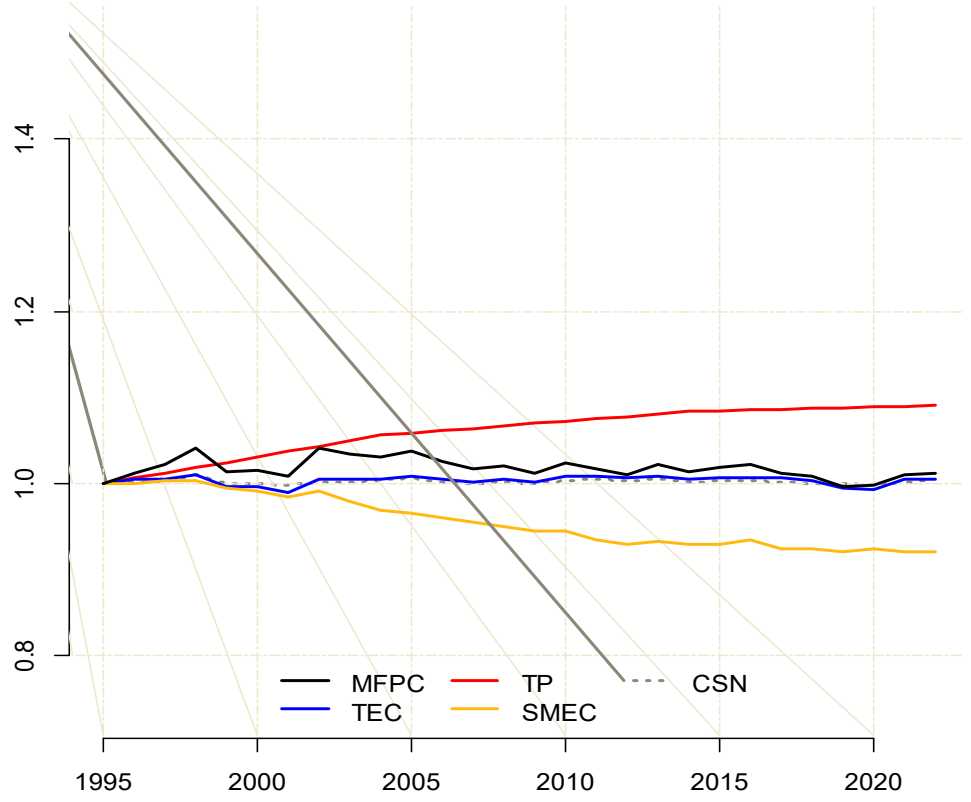
Decomposition of MFP into components (TAS and SA)



(f) Tasmania



(d) South Australia

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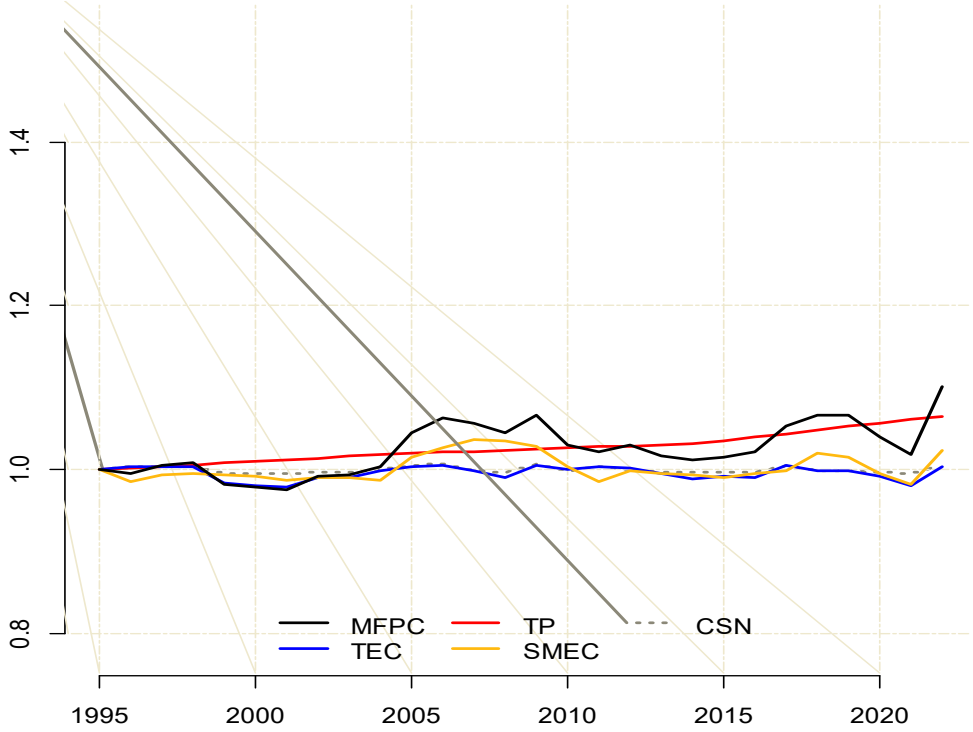
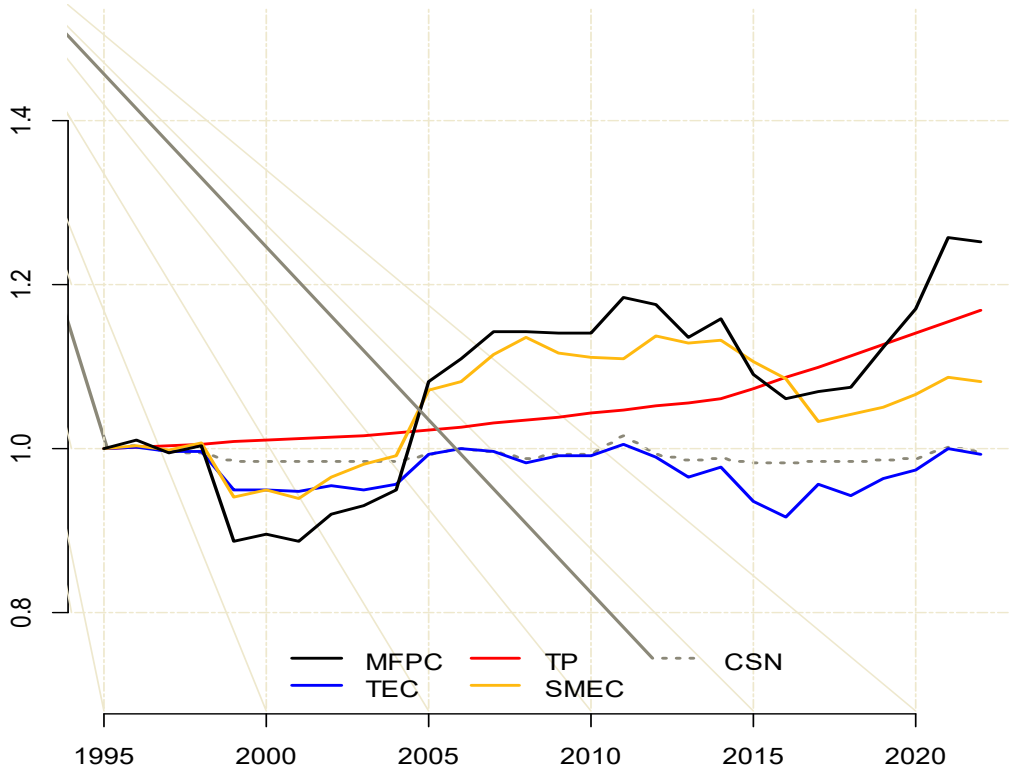
Decomposition of MFP into components (QLD and WA)



(c) Queensland



(e) Western Australia

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Decomposition of MFP into components

- ***NSW, VIC, TAS, SA ~*** MFP growth was driven by technological progress but dampened by losses in scale and mix efficiency, with little change in technical efficiency.

- ***QLD and WA ~*** Strong technology-led growth, with scale and mix efficiency providing additional support.

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Conclusion and Future Scope

- MFP growth has been uneven, and the drivers of productivity varies across Australian states.
- Technological innovation and adoption are critical for productivity growth; they are not sufficient on their own.
- SMEC has huge contributions as a drivers of productivity.
- Building on these insights, further avenues of research are necessary to deepen our understanding of productivity dynamics

➢ Further investigate Changes in Statistical Noise (CSN).

➢ Conduct this analysis in Industry level for State.

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Thank You for your attention!

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Appendix 1

Output-Oriented MFP Decompositions (O'Donnell (2018)):

$$MFPI\left(x_{ks},y_{ks},x_{it},y_{it}\right) = \left[\frac{\exp(\lambda t)}{\exp(\lambda s)}\right] \times MFPI\left(x_{ks},y_{ks},x_{it},y_{it}\right) \prod_{m=1}^{M} \left(\frac{x_{mit}}{x_{mks}}\right)^{\beta^m} \frac{Q(y_{ks})}{Q(y_{it})} \times \left[\frac{\exp(-uit)}{\exp(-uks)}\right] \times \left[\frac{\exp(vit)}{\exp(vks)}\right]$$

Appendix 2