Australian Emissions Reduction Subsidy Policy under Persistent Productivity Shocks

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1. Introduction

The Australian emissions reduction systems:

- the Clean Energy Programme under the Prime Ministership of Julia Gillard in 2011 including **a carbon tax** period from 1 July 2012 to 30 July 2015 following by **an emissions trading scheme**.
- under the Prime Ministership of Kevin Rudd: the tax period would finish one year earlier, on 30 July 2014.
- under the Prime Ministership of Tony Abbott: the carbon pricing system was abolished from 1 July 2014. The government introduced emissions reduction supporting policies **the Emissions Reduction Fund** program from 13 December 2014 in which the government funds emissions reduction activities.

1. Introduction

- We study the transitions effects of an abatement subsidy policy under macroeconomic uncertainty conditions.
- To this end we use a real business cycle (RBC) model to compare the dynamic effects of such a policy when productivity shocks occur

2. Model

- Environment

$$x_t = \eta x_{t-1} + m_t + m_t^{row}$$

$$m_t = (1 - \mu_t) h(y_t)$$

$$z_t = g(\mu_t) y_t$$

- Production Sector

$$y_t = (1 - d(x_t)) a_t f(k_{t-1})$$

$$ln\, a_t = \rho \, ln\, a_{t-1} + \varepsilon_t$$

$$\pi_t = y_t - r_t k_{t-1} - z_t$$

- Consumption Sector

$$E_t \sum_{t=0}^{\infty} \beta^t u(c_t)$$

$$\pi_t + r_t k_{t-1} = c_t + i_t$$

$$k_t = (1 - \delta) k_{t-1} + i_t$$

2. Model

- Business-as-usual (BAU)

$$r_t = y_t f'(k_{t-1}) / f(k_{t-1})$$

$$m_t = h(y_t)$$

$$\pi_t + r_t k_{t-1} = c_t + i_t$$

$$\pi_t = y_t - r_t k_{t-1}$$

$$-u'(c_t) + \beta E_t u'(c_{t+1}) \left[r_{t+1} + (1-\delta) \right] = 0$$

$$x_t = \eta x_{t-1} + m_t + m_t^{row}$$

$$y_t = (1 - d(x_t)) a_t f(k_{t-1})$$

$$k_t = (1-\delta) k_{t-1} + i_t$$

$$\ln a_t = \rho \ln a_{t-1} + \varepsilon_t$$

2. Model

- Abatement subsidy

$$\pi_t + r_t k_{t-1} - s_t \mu_t = c_t + i_t$$

$$\pi_t = y_t - r_t k_{t-1} + s_t \mu_t$$

$$g'(\mu_t) y_t = s_t$$

$$r_t = y_t f'(k_{t-1}) / f(k_{t-1}) \, [1 - g(\mu_t)]$$

$$\max_{s_t, k_t, y_t, x_t} \sum_{t=0}^{\infty} \beta^t E u(c_t)$$

$$-u'(c_t)\ z'_s(s_t, y_t) + \lambda_t \{u''(c_t) z'_s(s_t, y_t)\}$$
$$+ \lambda_{t-1} \{u''(c_t)\ (-z'_s(s_t, y_t))\ (r_t + 1 - \delta)\} + \varsigma_t \{-m'_s(s_t, y_t)\} = 0$$

$$-u'(c_t) + \beta u'(c_t)\ (1-\delta) + \beta \lambda_{t+1} \{-u''(c_{t+1})\ (1-\delta)\}$$
$$+ \lambda_t \{u''(c_t) + \beta u''(c_{t+1})\ (1-\delta)\ (r_{t+1} + 1 - \delta) + \beta u'(c_{t+1})\ r'_k(y_{t+1}, k_t)\}$$
$$+ \lambda_{t-1} \{-u'(c_t)\ (r_{t+1} + 1 - \delta)\} - \beta \omega_{t+1} [1 - d(x_{t+1})]\ a_{t+1} f'(k_t) = 0$$

$$u'(c_t)\ (1 - z'_y(s_t, y_t)) + \lambda_t \{-u''(c_t) z'_y(s_t, y_t)\} + \omega_t$$
$$+ \lambda_{t-1} \{u''(c_t)\ (1 - z'_y(s_t, y_t))\ (r_t + 1 - \delta) + u'(c_t)\ r'_y(y_t, k_{t-1})\} + \varsigma_t \{-m'_y(s_t, y_t)\} = 0$$

$$\varsigma_t - \beta \varsigma_{t+1} \eta + \omega_t a_t f(k_{t-1}) d'(x_t) = 0$$

3. Calibration

$$u(c_t) = \frac{c^{1-\zeta}}{1-\zeta}$$

$$g(\mu_t) = \theta_1 \mu_t^{\theta_2}$$

$$h(y_t) = y_t^{1-\gamma}$$

$$d(x_t) = d_0 + d_1 x_t + d_2 x_t^2$$

$$f(k) = k^{\alpha}$$

3. Calibration

Parameter	Value	Description	Source
α	0.33	Output elasticity of capital	Rees (2013), Gomez-Gonzalez and Rees (2013)
ζ	1.66	Risk aversion coefficient	Hodge *et al.* (2008)
β	0.99	Discount factor	Jaaskela and Nimark (2011), Gomez-Gonzalez and Rees (2013), Rees (2013)
δ	0.02	Capital depreciation rate	Rees (2013)
ρ	0.98	Autocorrelation parameter of the productivity shock	Rees (2013)
σ	0.007	Standard deviation of ε_t	Rees (2013)
η	0.9979	Autocorrelation parameter of the pollution equation	Heutel (2012)
d_0	-0.0011	Intercept of damage function	Estimated by the authors for Australia from the Nordhaus (2010) model
d_1	$-5.6629e^{-10}$	Linear coefficient of damage function	Estimated by the authors for Australia from the Nordhaus (2010) model
d_2	$1.2261e^{-8}$	Quadratic coefficient of the damage function	Estimated by the authors for Australia from the Nordhaus (2010) model
θ_1	0.07	Abatement cost function coefficient	Nordhaus (2010)
θ_2	2.8	Abatement cost function exponential coefficient	Nordhaus (2010)
$1-\gamma$	0.0975	Emissions elasticity of output	Estimated by the authors from the Australian emissions and GDP data over the period Q2, 2001- Q4, 2013

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3. Simulation Result

Variable	BAU	Emissions Reduction Subsidy (% change from BAU)
Emissions (m)	1.1075	1.0361 (-6.45%)
Abatement (μ)	0	0.0625
Output (y)	2.8335	2.7904 (-1.52%)
Capital (k)	32.0936	30.5901 (-4.68%)
Consumption (c)	2.1917	2.1785 (-0.60%)
Welfare Cost	0	0.60%

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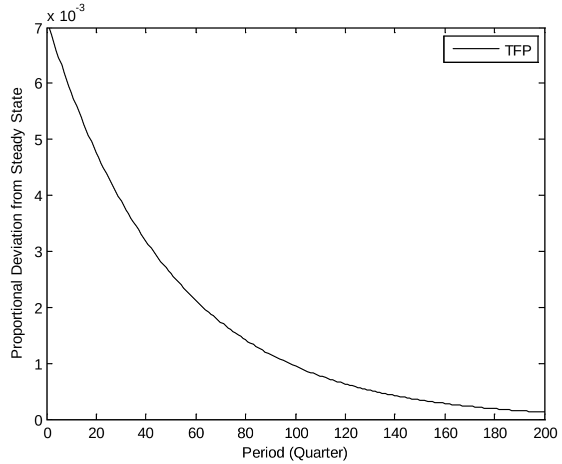
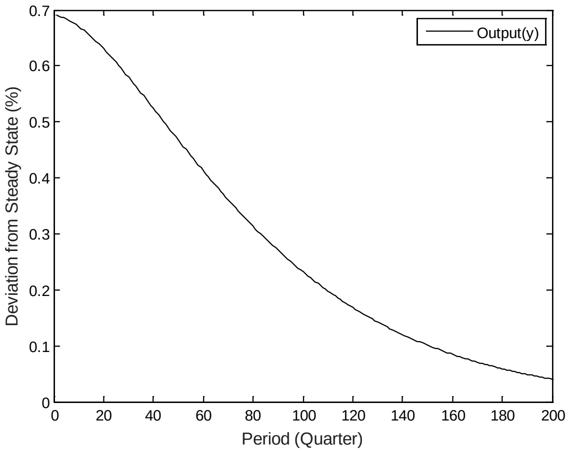
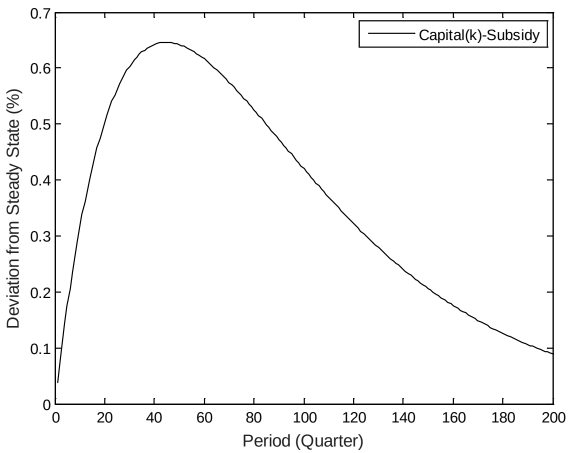
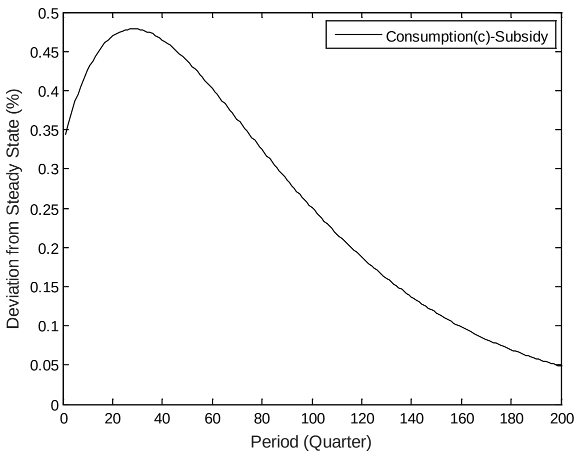
3. Simulation Result

Impulse Responses of Economic Variables to a TFP Shock









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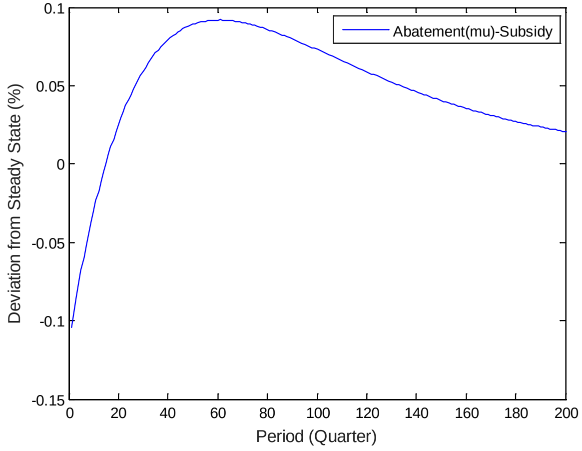
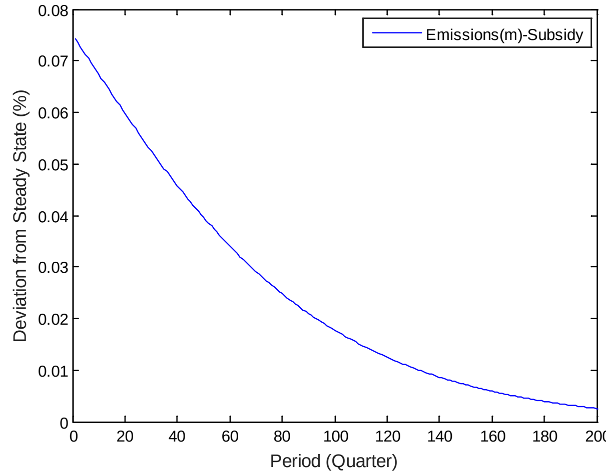
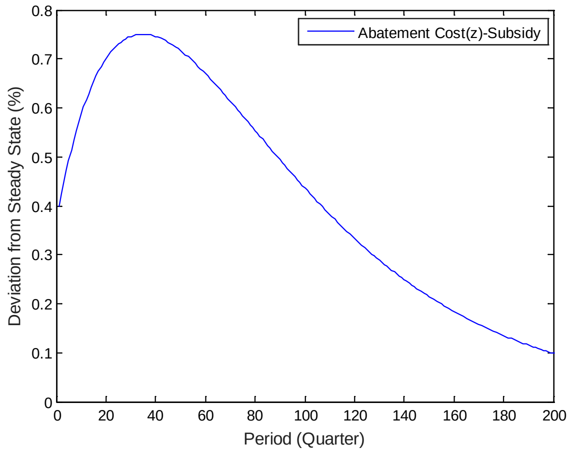
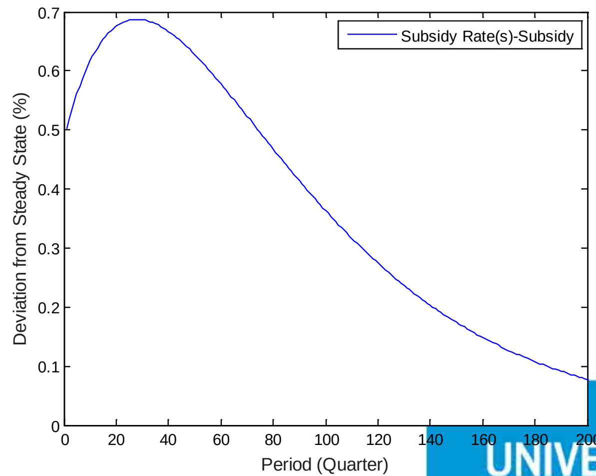
3. Simulation Result

Impulse Responses of Environmental Variables to a TFP Shock









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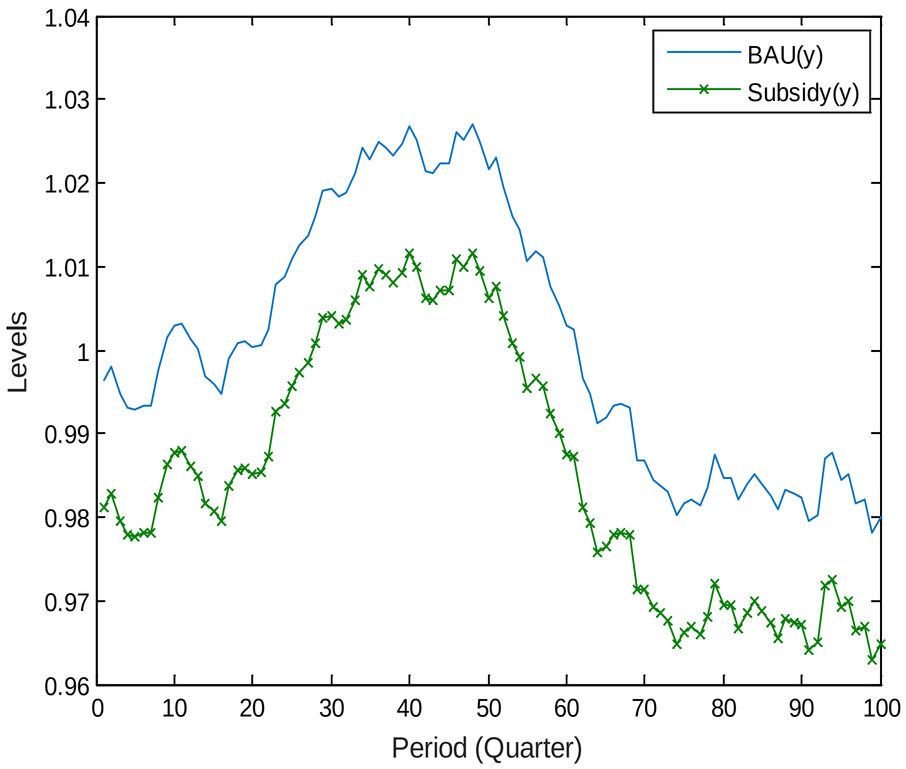
3. Simulation Result

- Business Cycle Simulation of Output



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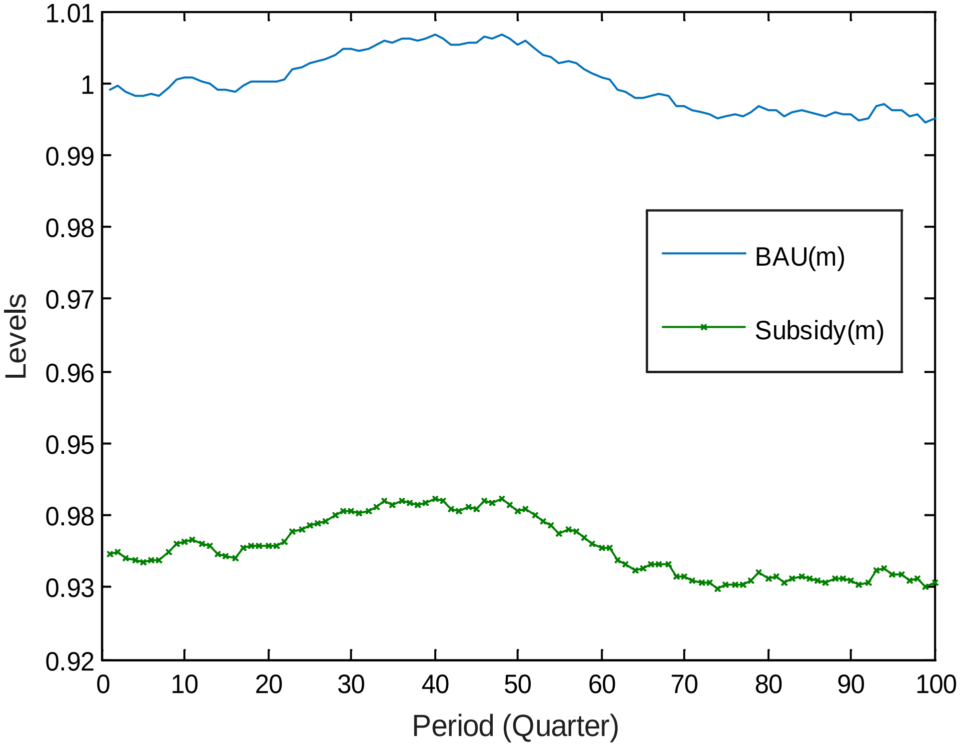
3. Simulation Result

- Business Cycle Simulation of Emissions



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4. Conclusion

- The results showed that such a policy results in an emissions reduction but at an output decrease and welfare cost compared with a BAU scenario. In a stochastic situation and in the presence of a TFP shock an emissions subsidy can encourage polluters to move to cleaner technologies such as renewable energies when a positive TFP shock occurs.

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4. Conclusion

- the regulator should set the subsidy to be pro-cyclical to business cycles: they increase during expansion and decrease during recessions.
- the abatement subsidy findings are for the scenario specified here in which the firm receives a subsidy for its abatement effort in each period and the policy is run for a long period, which may be different from the Emissions Reduction Fund program which is planned to continue only for 5 years.

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Thank you

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