Building the Education Revolution: The Employment Effects of Fiscal Stimulus in Australia

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Introduction

- Empirical part: A generalised differences-in-differences (DiD) approach to identify the causal impact of **Building the Education Revolution (BER)** expenditure on employment
  - Cost per job-year saved estimate
- Theoretical part: A Bayesian DSGE model is estimated to relate cost per job-year saved estimates to approximate output multipliers
- Conclusions
- FYI: a long version (85 pages) has been issued as Australian National University's CAMA working paper

This paper

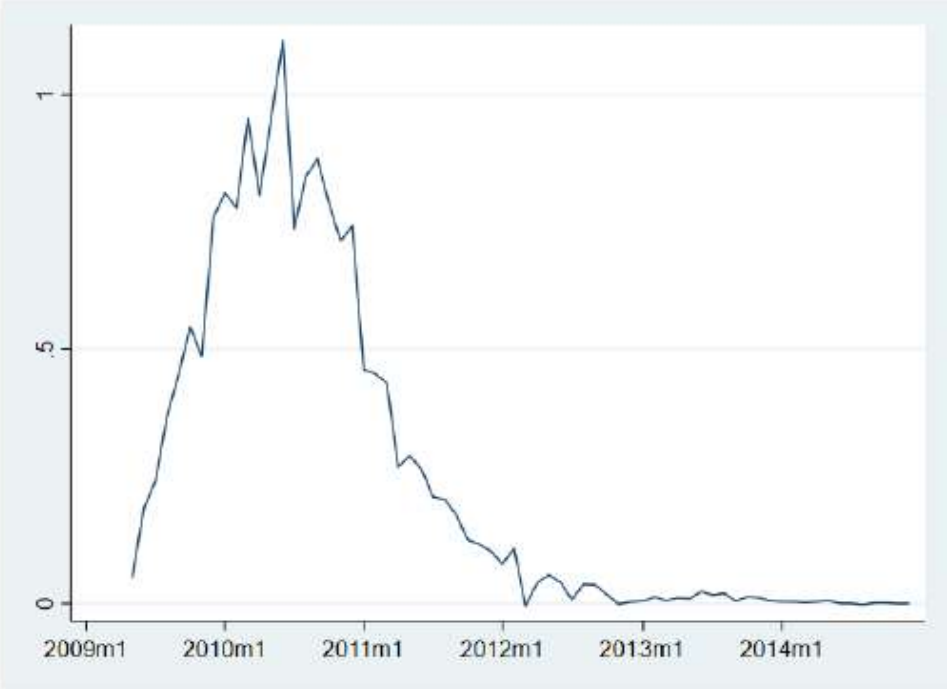
- Fiscal multipliers
- Methods for identification:
  - Wars (e.g. Barro & Redlick 2011; Ramey 2011)
  - VARs (e.g. Blanchard & Perotti 2002; Gali et al. 2007)
  - Regional shocks or "geographic cross-sectional fiscal multipliers" (e.g. Chodorow-Reich et al. 2012; Nakamura & Steinsson 2014)
- We estimate the causal impact of the Great Recession-era BER school infrastructure stimulus program
  - The empirical methodology inspired by Buchheim and Watzinger (2023, AEJ: EP)

BER program background

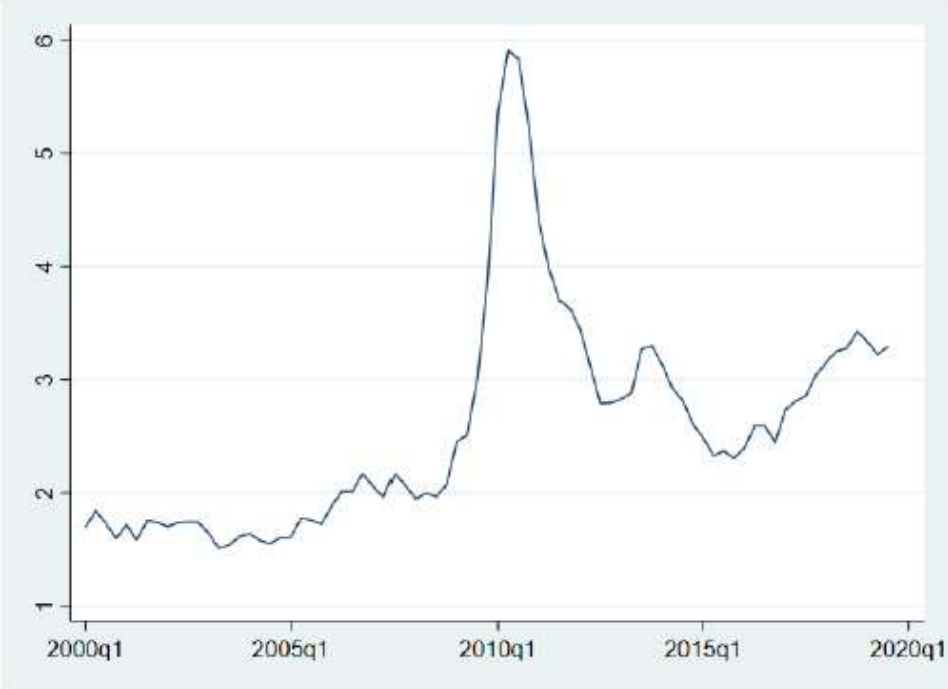
- Announced on 2 February 2009 as part of the $42.1 (€30) billion Nation Building and Jobs Plan
- The Program, initially totalling $16.2 billion, had three elements:
  - Primary Schools for the 21st Century ($14.2b): New and refurbished halls, libraries and classrooms
  - Science and Language Centres for 21st Century Secondary Schools ($821.8m)
  - National School Pride program ($1.28b): New and refurbished covered outdoor learning areas, shade structures, sporting facilities and other environmental programs
- Intended to run between 2008-09 and 2010-11 financial years, but $500m pushed into 2011-12 due to capacity constraints

BER program background

- Lewis et al. (2014): **An example of government failure**
  - A case study of how governments **should not pursue** large-scale public expenditure programs
- **Failed at the macro level:** an expansionary fiscal policy at a time when the central bank was pursuing a contractionary monetary policy
- Common criticism: **Recession was over by the time most of the spending took place**
- Media, official and academic criticism has focused on **questions of value for money in construction**
- This research is the first to comprehensively evaluate the efficacy of the entire BER Program as a fiscal stimulus measure



(a) BER, source: DEEWR



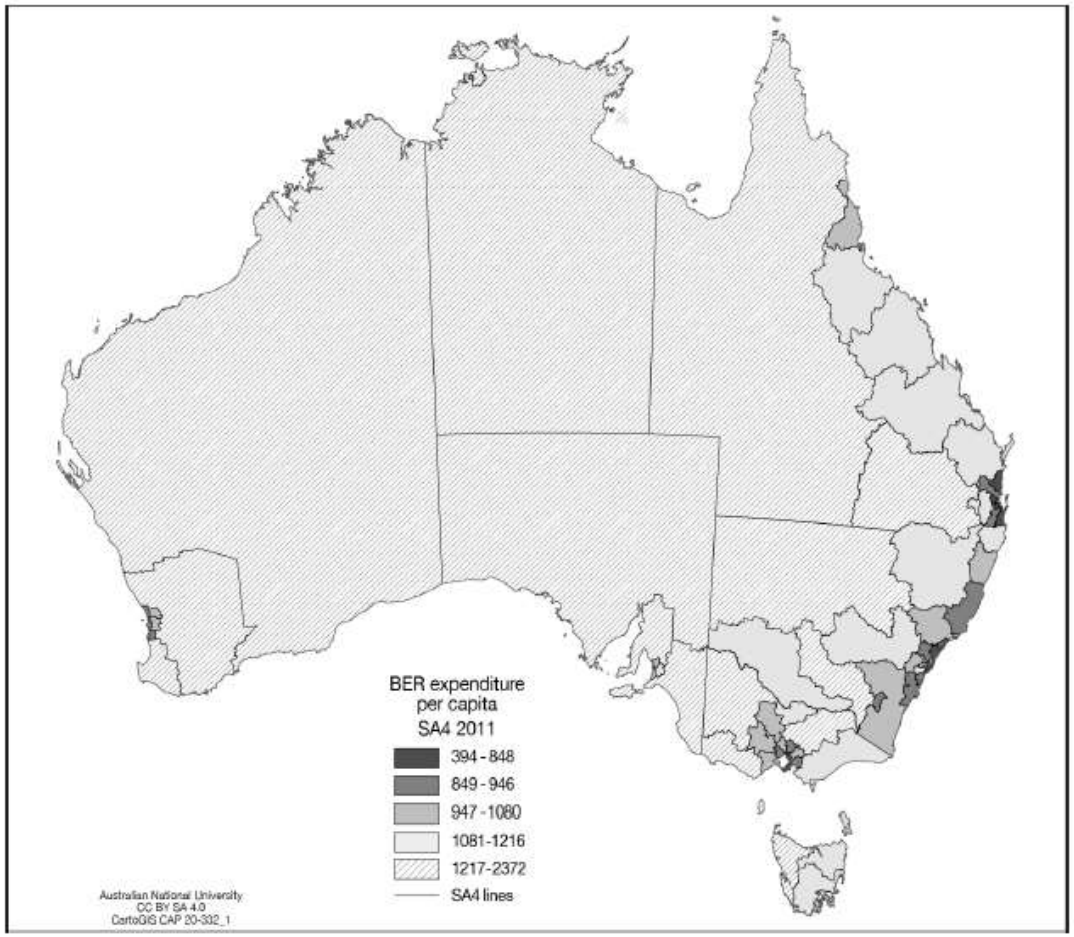
(b) Real public sector, source: ABS

Figure 2: Construction Expenditure, $A billion

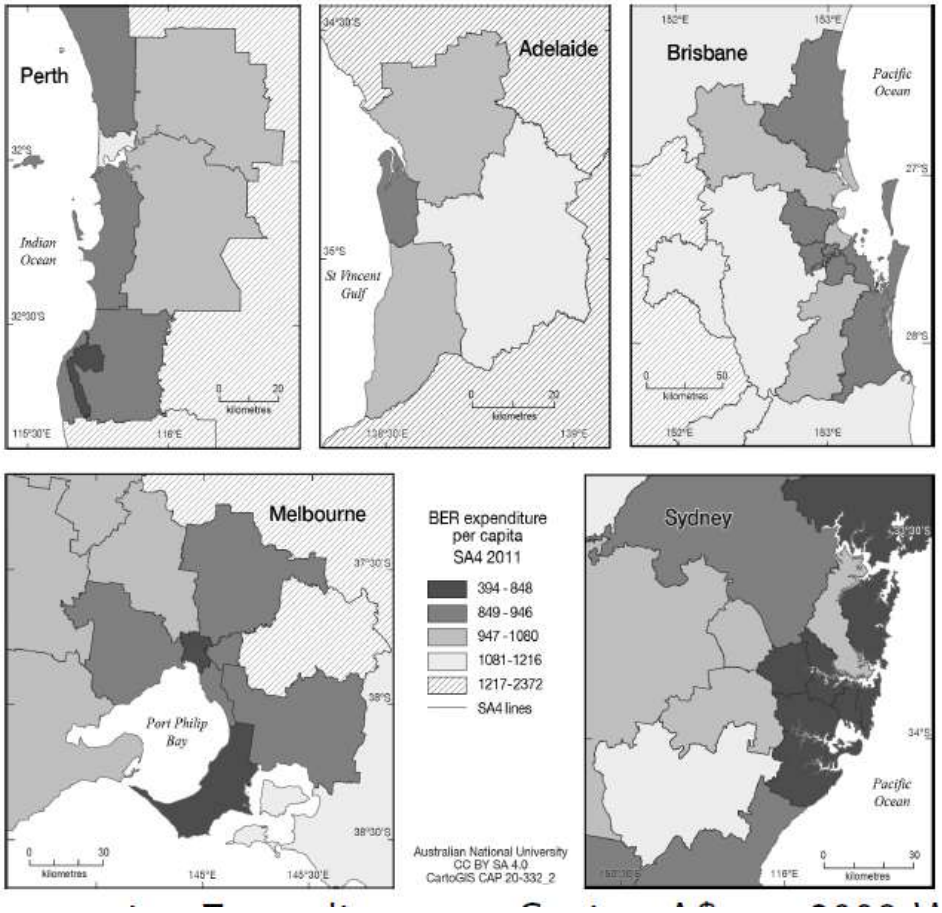
Statistical area level 4 (SA4)

- “There are 107 SA4 regions covering the whole of Australia without gaps or overlaps.”
- “A minimum of 100,000 persons was set for the SA4s, although there are some exceptions to this.”
- “In regional areas, SA4s tend to have populations closer to the minimum (100,000 - 300,000). In metropolitan areas, the SA4s tend to have larger populations (300,000 - 500,000).”

BER construction expenditure per capita 2009-2012, $ per 2008 working age population



BER construction expenditure per capita 2009-2012, $ per 2008 working age population



Generalised Difference-in-Difference model, follows Buchheim and Watzinger (2023)

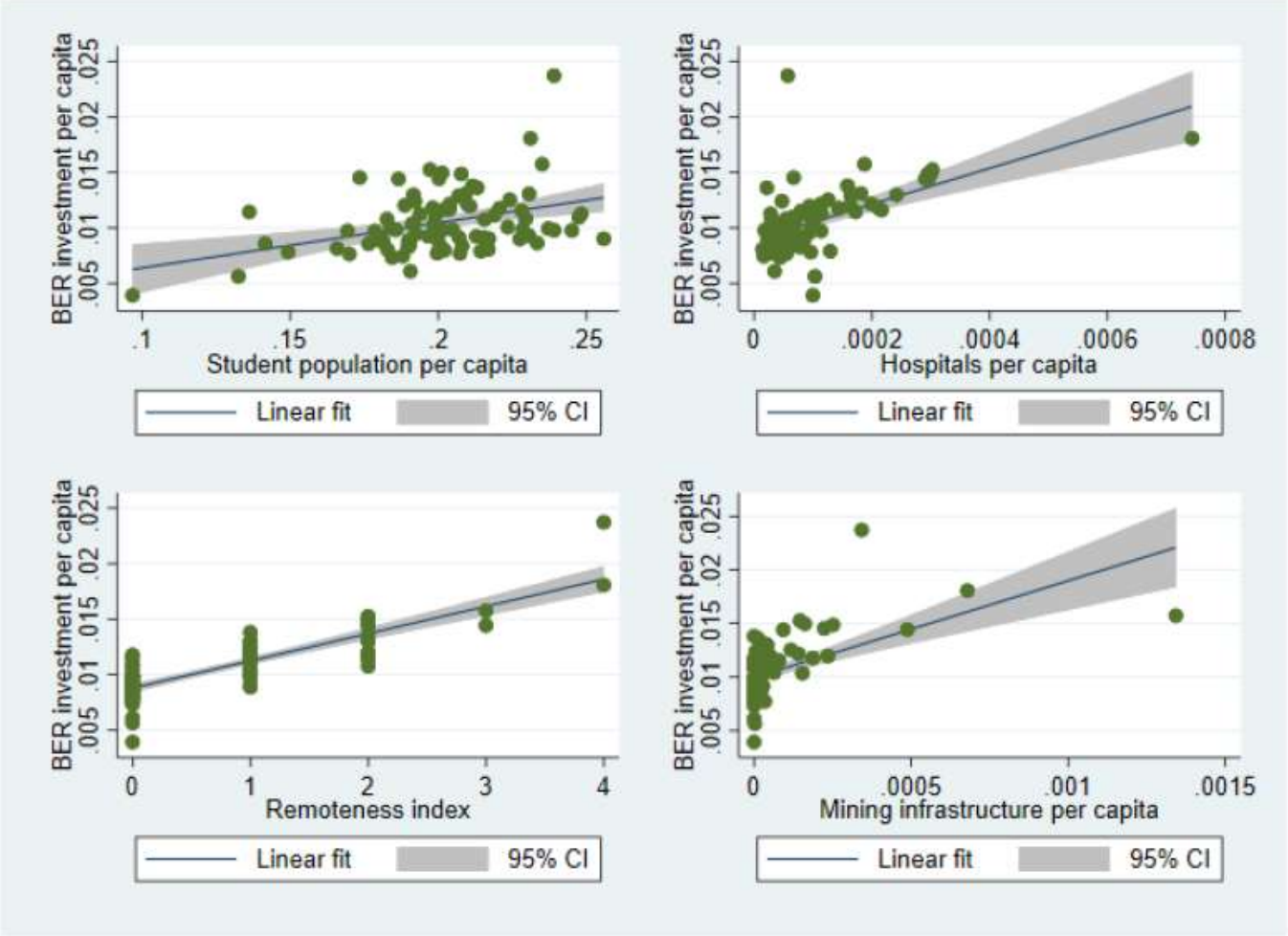
$$
\begin{aligned}
E_{i,t} = {} & \alpha_i + \lambda_t + \lambda_t \times \text{State}_j + \alpha_i \times t \\
& + \beta_{pre} \text{BER p.c}_i \times I(t \in [2007Q1, 2008Q3]) \\
& + \sum_{Y=2009}^{2012} \beta_Y \text{BER p.c}_i \times I(t \in [YQ1, YQ4]) \\
& + \beta_{post} \text{BER p.c}_i \times I(t \in [2013Q1, 2014Q4]) \\
& + \sum_{t: t \neq 2008Q4} \lambda_t \times \mathbf{X_i'} \mathbf{\Gamma_t} + \delta Pop_{i,t} + \epsilon_{i,t}
\end{aligned} \tag{1}
$$

- $E_{i,t}$ is a labour market outcome variable
- α_i and λ_t are SA4 and time specific fixed effects
- $\lambda_t \times \text{State}_j$ are date-by-state fixed effects, and $\alpha_i \times t$ are SA4 specific time trends
- BER p.c$_i$ is BER construction expenditure between 2009 and 2012
- $\mathbf{X_i'}$ include SA4 specific characteristics as controls
- $Pop_{i,t}$ is the growth in the working age population relative to 2008

SA4 specific controls

- SA4 specific controls are interacted with date dummies to control for trends in employment that may be related to particular SA4 characteristics
  - ABS remoteness index (ASGS 2011)
  - Number of mines, minerals processing and port facilities (end 2008)
  - Number of hospitals (2009-10 financial year)
  - School age population at the beginning of the 2009 school year
- With the exception of the ABS remoteness index and deterministic variables, all controls expressed as a ratio of the 2008 working age population

SA4 specific controls



Instrumenting BER spending

- Primary eligibility criteria for uncapped SLC21 funding was 'demonstrated need or disadvantage' of the school or school community
  - Measures of educational disadvantage are highly correlated with BER construction expenditure and labour market conditions in SA4s
- BER funding rules created a strong presumption that *all* schools would accept projects
  - Roughly 24,000 infrastructure projects in 9,500 schools
- Only the number of schools by type in each SA4 are used as instruments for BER expenditure
  - This addresses concerns that stimulus expenditure was likely endogenous to local economic conditions

How many jobs the BER created per $100,000?

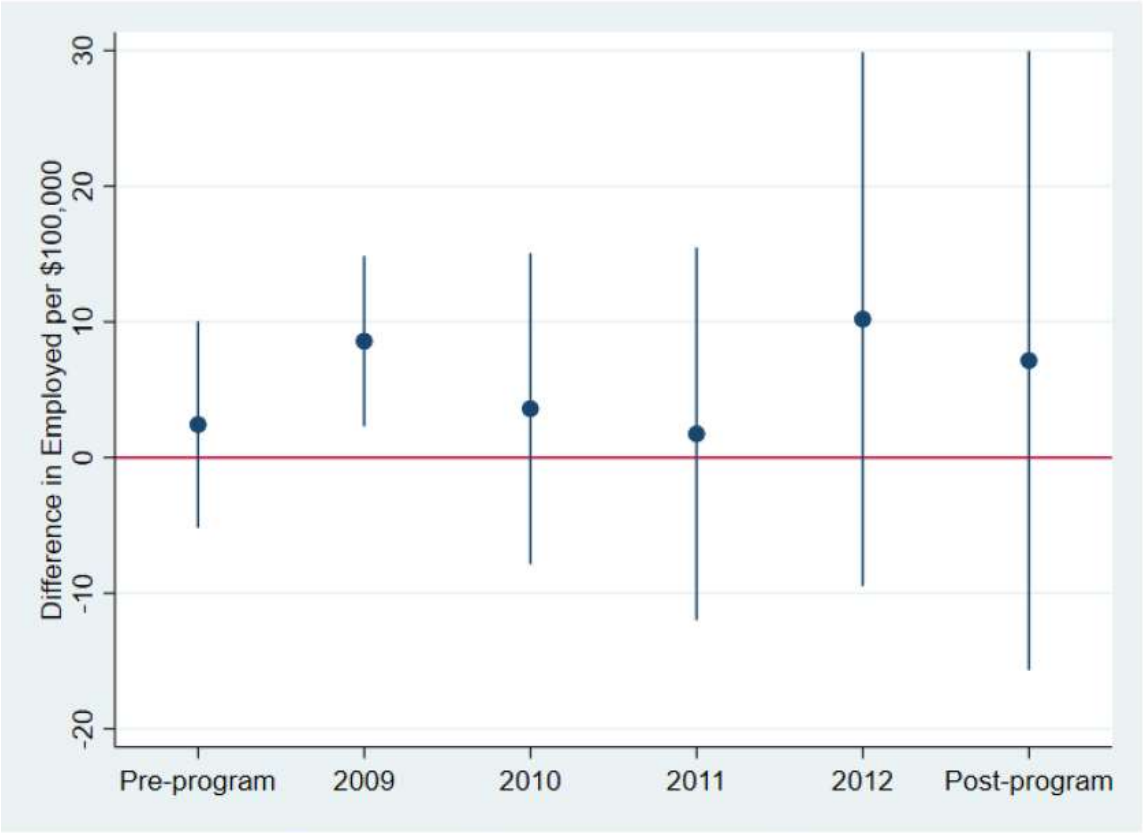


Figure: BER Employment Effects

Table: BER Average SA4 Employment Effects

BER spending p.c	IV			OLS		
× 2007-2008Q3	2.43	1.30	-5.42	0.86	0.68	-3.44
	(3.88)	(4.16)	(2.62)	(3.01)	(3.28)	(2.52)
× 2009	8.58	8.41	4.65	2.41	2.46	1.93
	(3.21)	(3.16)	(2.04)	(2.35)	(2.36)	(2.00)
× 2010	3.60	2.87	2.36	-1.08	-0.98	-0.17
	(5.85)	(5.73)	(3.84)	(4.70)	(4.79)	(3.69)
× 2011	1.74	1.67	2.27	-3.85	-3.47	-1.63
	(7.00)	(7.02)	(3.84)	(4.94)	(5.00)	(4.12)
× 2012	10.20	10.31	8.77	-3.53	-3.04	0.13
	(10.04)	(10.01)	(6.03)	(6.04)	(6.16)	(5.18)
× 2013-2014	7.15	7.35	7.32	-6.66	-6.23	-1.91
	(11.64)	(11.67)	(7.72)	(6.84)	(6.89)	(5.98)
Hospitals p.c.	Yes	Yes	Yes	Yes	Yes	Yes
Remoteness index	Yes	Yes	No	Yes	Yes	No
Mining inf. p.c.	Yes	No	No	Yes	No	No
Cost per 2009 job-year	11661	10081	21464	41501	40619	51748
SE cost per job-year 2009	4359	4475	9378	40542	38985	53493
2009 job-years saved	1432811	1404945	778445	402606	411349	322884
SE job-years saved	535607	528693	340125	393296	394801	333774
Cost per 2009-2012 job-year	4147	4299	5535	-16536	-19892	390867
SE cost per job-year	4222	4510	4724	393296	65921	21200000
2009-2012 job-years saved	4029000	3886838	3018727	-16536	-839974	42748
SE job-years saved	4101761	4077783	2576461	44615	2783659	2316598

Cost per job-year saved

- **The BER program created roughly 8.58 jobs per $100,000 of program expenditure in 2009**
- This implies **a cost per job-year saved of $11,661 ($US 9,212) in 2009**
- **Roughly one third relate to reductions in unemployment, and two thirds relate to reduced labour force exit**
- Comparison:
- American Recovery and Reinvestment Act, ARRA (Chodorow-Reich, 2019): costs per job year ranging from $US 26,316 to $US 131,579
- The German public investment program (Buchheim and Watzinger, 2023): $US 32,800
  - The employment effect is short-lived

Table: SA4 Average Employment Equation Robustness Analysis

Model variant	β_{2009}	SE	Cost per 2009 job-year	SE
(0) Baseline	8.58	3.21	11661	4359
Estimation approach				
(1) LIML	8.65	3.23	11566	4323
(2) Probability weighted by working age population	5.42	3.73	18456	12713
Instruments				
(3) Combining school types	7.62	3.55	13124	6113
(4) Excluding secondary schools	7.33	3.15	13641	5866
Controls				
(5) Quadratic SA4-specific time trend	10.07	3.73	9935	3683
(6) No SA4-specific time trends	7.81	2.66	12807	4357
(7) No $Date_t \times State_j$	6.85	2.13	14587	4523
(8) No SA4-specific time trends or $Date_t \times State_j$	7.47	1.92	13393	3449
(9) Mines p.c.	8.68	3.19	11522	4240
(10) Mines and processing facilities p.c.	8.55	3.21	11701	4392
(11) Universities p.c.	8.60	3.17	11634	4285
(12) Gender controls	8.46	3.25	11824	4544
(13) Demographic controls	9.07	2.89	11020	3509
(14) Full gender and demographic controls	8.78	2.91	11406	3787

Program effects by gender

- Australian Government budgets and policy responses have been criticised for focusing disproportionately on male dominated sectors of the economy, including construction (Woods et al. 2020).
- The Australian construction industry is highly male dominated, with women comprising 12-14% of the industry
- **We can’t reject hypothesis that employment benefits were evenly distributed between men and women**

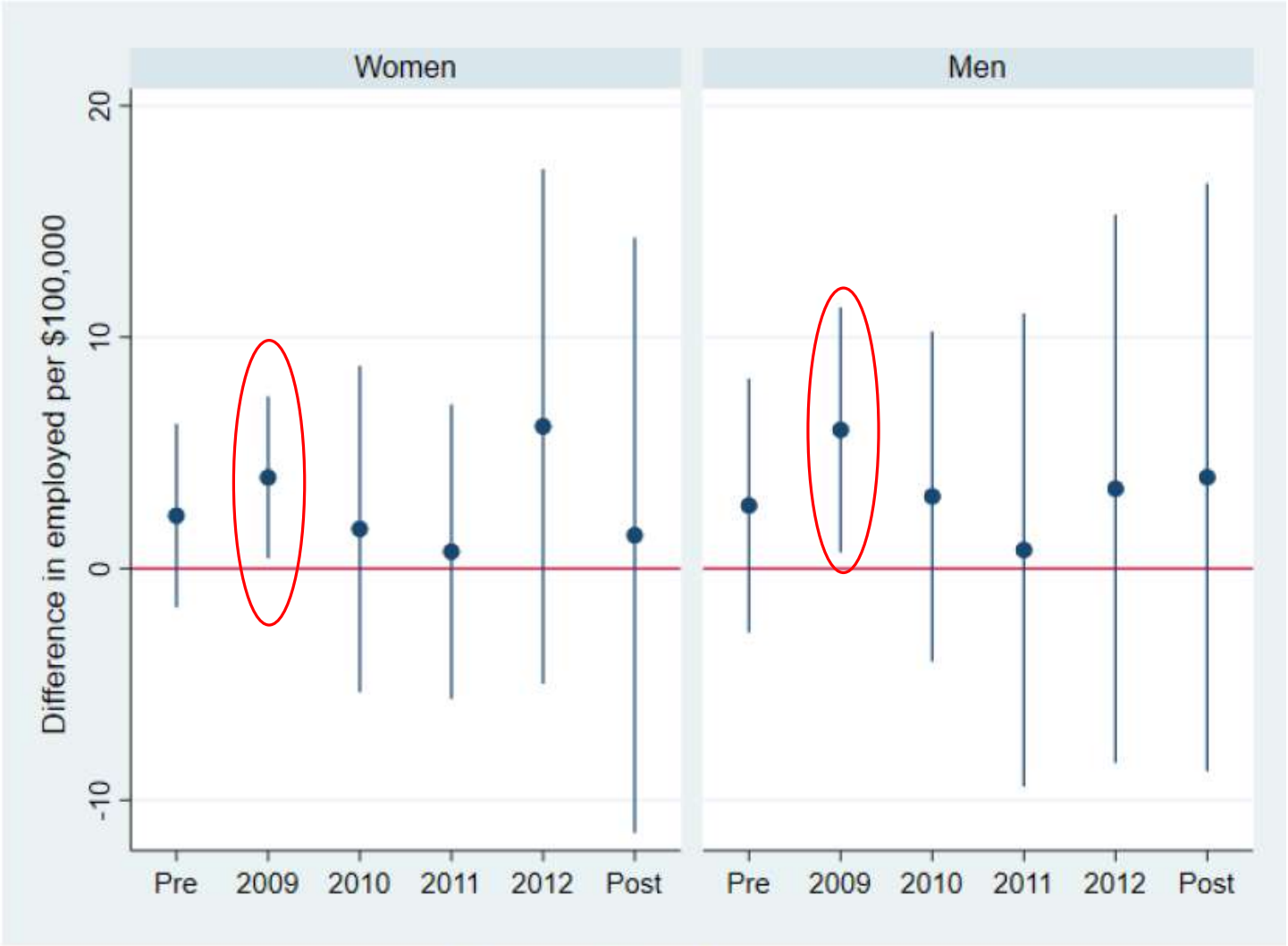


Figure: Employment

Figure: Unemployment

Figure: Not in the Labour Force (NILF)

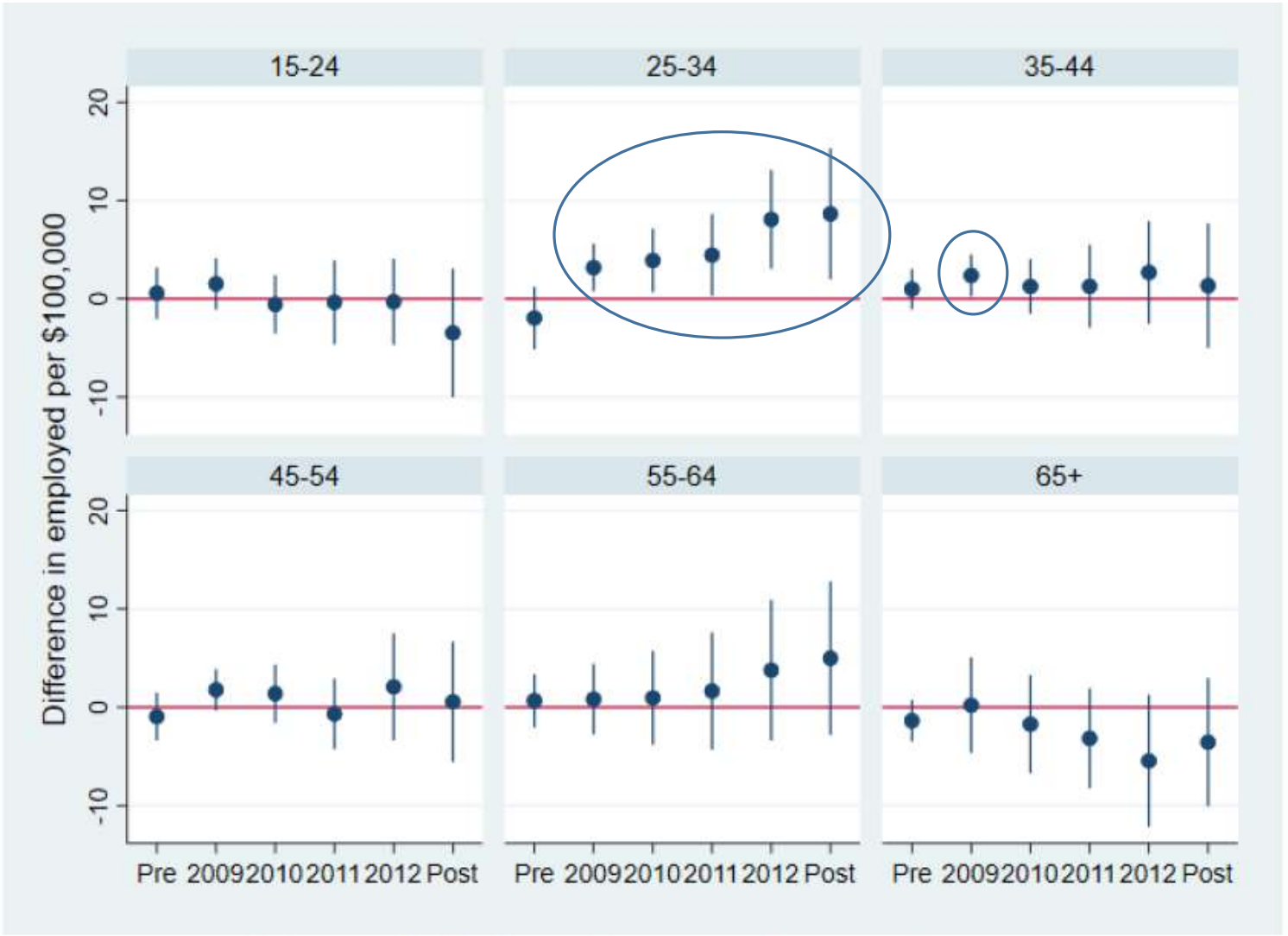


Figure: BER Employment Effects by Age

Geographic spillovers

- A potential concern in utilising a panel of sub-national level data is that employment effects may be under or over-estimated as a result of geographic spillovers between regions
- The preferred models indicate that controlling for regional spillovers has no statistically significant impact on the employment estimates
- This is consistent with Buchheim and Watzinger (2023)

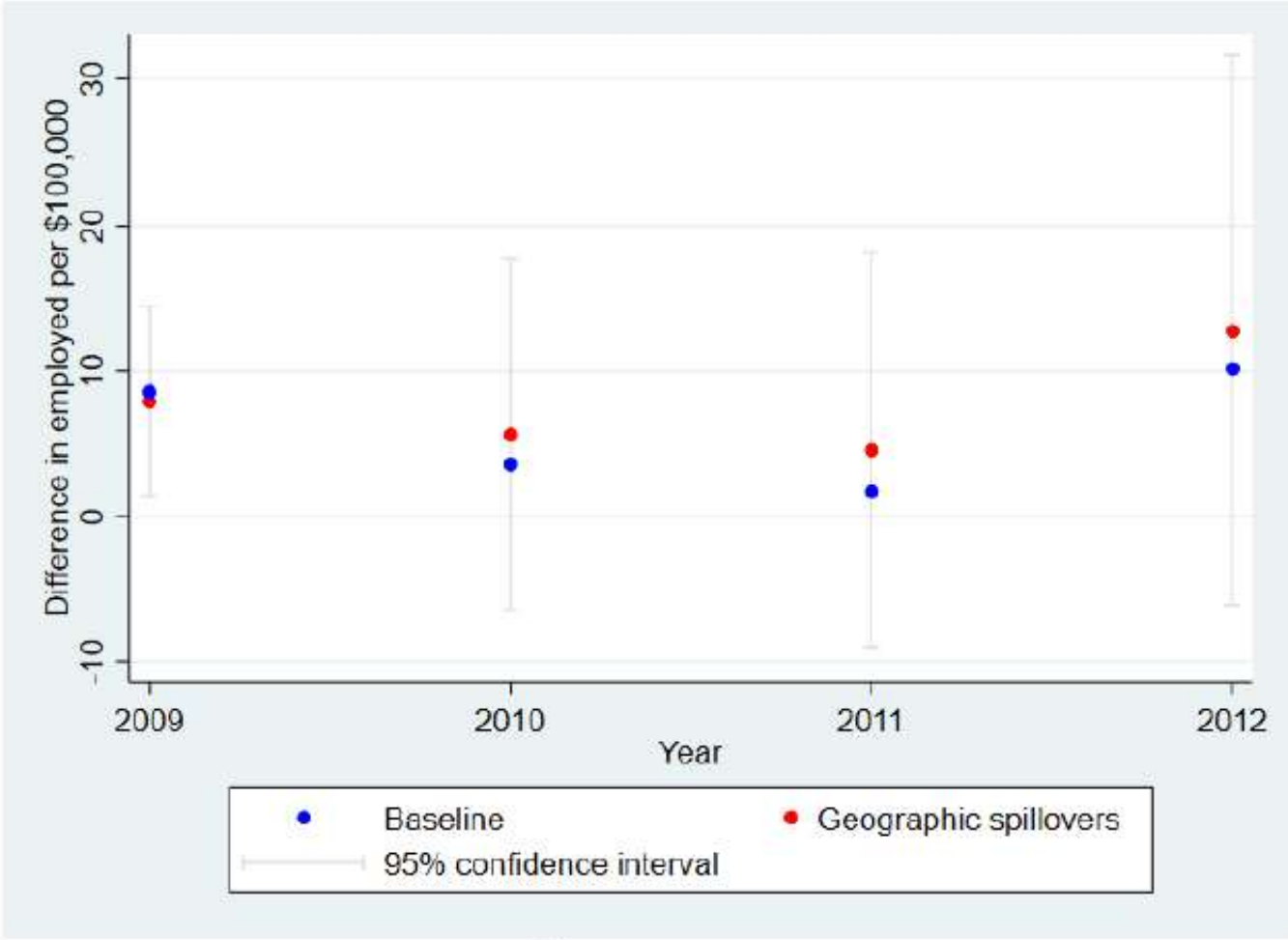


Figure: Difference in Employed per $100,000 With and Without Geographic Spillovers

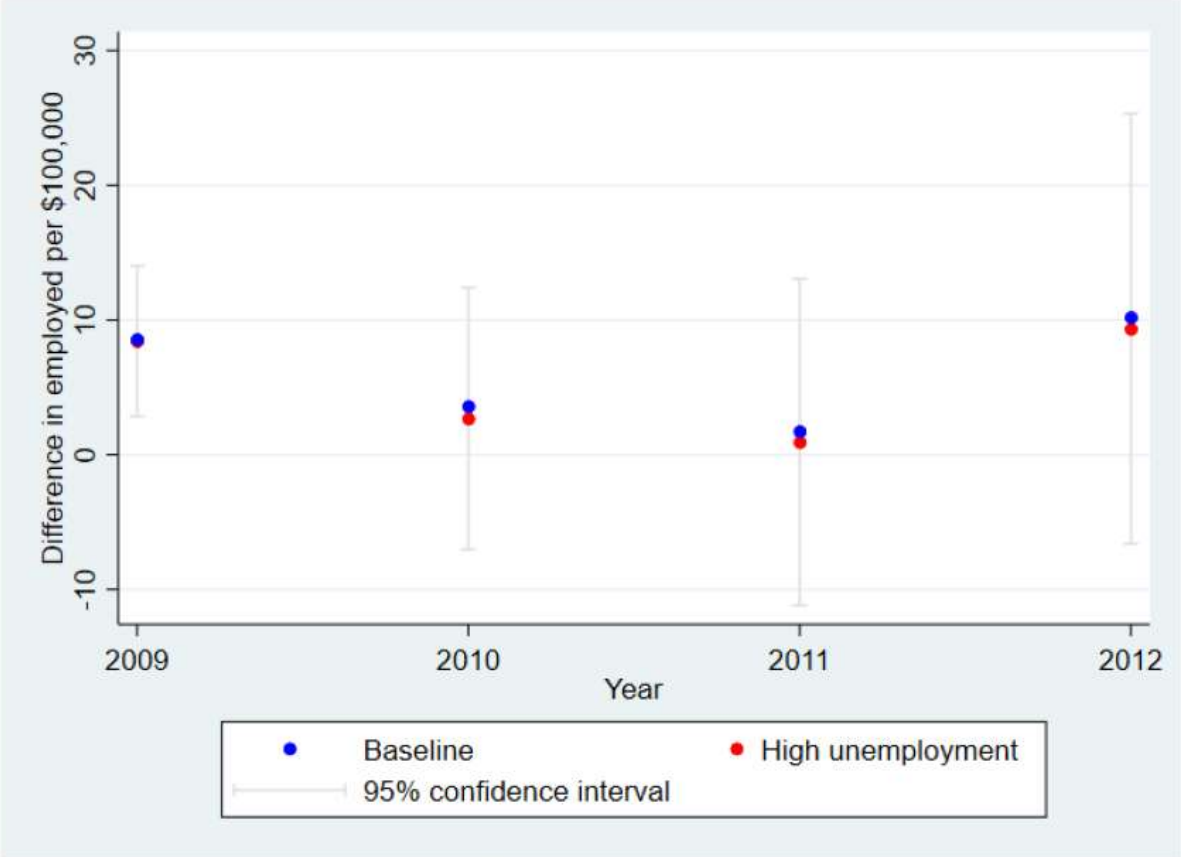


Figure: Difference in Employed per $100,000, Baseline vs. Unemployment Rate Greater than SA4 Median in 2008Q4

Employment benefits were not greater in regions experiencing higher unemployment at the outset of the program

Relevance to aggregate multipliers

- The geographic point of reference has been the average SA4 region
- **Average SA4 employment effects vs. national average employment effects**
  - SA4s are relatively heterogeneous
  - **Weighted estimation:** Estimation using working age population probability weights can provide multiplier estimates more closely relatable to aggregate multipliers
- **At the national level, employment effects are insignificant at conventional significance levels**
- **We repeat the analysis only with reference to the 25-34 year old cohort, where statistically significant results were revealed at the SA4 level**
  - **BER program created roughly 11.69 jobs per $100,000**
  - **A cost per job-year saved of $8,557**
- **Output multipliers:** Chodorow-Reich (2019) derives the mapping between costs per job estimates and output multipliers (`closed economy, no monetary policy response' output multipliers)
  - We use this method

Relevance of results for national employment

Table: Implications for National Employment and Output, 25-34 Year Olds Only

	2009	2010	2011	2012	Cumulative
Aggregate job-years per $100,000	3.13	1.00	2.52	5.04	11.69
SE job-years	(1.39)	(1.54)	(2.17)	(2.42)	(6.64)
Aggregate cost per job-year	31981	100092	39668	19842	8557
SE cost per job-year	14247	154722	34224	9523	4865
Aggregate job-years saved	522457	100092	39668	842086	1952682
SE job-years saved	(232747)	(258043)	(34224)	(404146)	(1110101)
Output multiplier	2.58	0.83	2.12	4.33	9.87
min(Shea Partial R^2)	0.31	0.33	0.32	0.32	-
Sanderson-Windmeijer χ^2	290.68	603.45	415.13	679.76	-
Sanderson-Windmeijer F	9.14	18.97	13.05	21.37	-

Theoretical results: Motivating large multipliers

- Leduc and Wilson (2013) and Nakamura and Steinsson (2014): DSGE models with use generate Greenwood, Hercowitz, and Huffman (GHH, 1988) preferences generate large geographic cross-sectional output multipliers
- Auclert et al. (2020): these models make the fiscal multiplier proportional to the elasticity of substitution of intermediate goods
  - This is implausible
- We develop **a Bayesian DSGE model that can motivate large fiscal multipliers utilising learning-by-doing in the production technology (productivity hysteresis or endogenous business cycles)**
  - Following Enger and Tervala (2018, JEDC)

DSGE model

- A DSGE model with some twists
  - We extend the model of Tervala and Watson (2022, JIMF)
- Fraction of households are assumed to be liquidity constrained (non-Ricardian)
- Learning-by-doing in the production technology
- Private and public capital
- Detailed fiscal structure:
  - Deficit financed government spending
  - Distortionary income and consumption taxes
  - Fiscal rule uses income taxes to stabilise government debt
  - Spending instruments: Consumption, investment, and transfers

The production function

$$Y_t(z) = K_t(z)^{\alpha}(N_t(z)X_t)^{1-\alpha}K_{G,t}^{\phi_{kg}}, \tag{14}$$

$Y_t(z)$ representing the output of firm z, $K_{G,t}$ is public capital, ϕ_{kg} is the output elasticity of public capital, and X_t represents the skill level of the average worker. Productivity increases in the skill level of the average worker as in Chang et al. (2002) and Engler and Tervala (2018). X_t is assumed to depend on the hours a worker has worked in the past reflecting learning-by-doing with a law of motion given by

$$X_t = X_{t-1}^{\rho_x}N_{t-1}^{\mu_l}(z), \tag{15}$$

where ρ_x captures the persistence of the past stock of human capital, and μ_l the elasticity of human capital to hours of employment in the previous period.

A Bayesian DSGE model

Table: Calibrated Parameters

Parameter		Source	Value
β	Discount rate	Watson and Tervala (2021)	0.995
φ	Frisch elasticity	Freestone (2020); Keane and Rogerson (2012)	2
α	Capital's share	Galí (2015); Chodorow-Reich (2019)	0.33
θ	Substitution elasticity (intermediate goods)	Galí (2015)	6
λ	Non-Ricardian share	ABS Household Income and Wealth (2019)	0.27
τ^c	Consumption tax rate	OECD (2021)	0.10
τ_0^y	Av. income tax rate program period	OECD (2021)	0.27
GC	Av. Government consumption (% GDP) 1993-2014	ABS (2022)	0.18
IG	Av. Government investment (% GDP) 1993-2014	ABS (2022)	0.03
B	Av. General government debt (% GDP) 1993-2014	IMF (2022)	0.20

- The remaining parameters are estimated using Bayesian techniques
- Data are expressed in log-deviations from their Hodrick-Prescott trends (Lambda=1600), and estimation is undertaken using data for the 1993Q1 to 2014Q4 period

Table: Model Results

Parameter	Prior Distribution			Posterior Distribution			
	Shape	Mean	Std. Dev.	Mode	Mean	5 per cent	95 per cent
ρ_x	Beta	0.93	0.05	0.93	0.89	0.78	0.99
μ_l	Normal	0.2	0.025	0.17	0.18	0.13	0.22
ϕ	Normal	4	1	6.50	6.58	5.19	7.98
δ	Beta	0.0175	0.005	0.0124	0.0139	0.0059	0.0226
ϕ_{kg}	Normal	0.083	0.025	0.084	0.084	0.035	0.133
δ_g	Beta	0.0125	0.005	0.0107	0.0125	0.0040	0.0224
γ	Beta	0.75	0.01	0.71	0.71	0.69	0.74
Φ_{ty}	Normal	0.075	0.025	0.088	0.083	0.037	0.129
μ_1	Beta	0.75	0.05	0.56	0.55	0.48	0.62
μ_2	Normal	1.5	0.1	1.72	1.73	1.55	1.92
μ_3	Normal	0.125	0.025	0.28	0.28	0.19	0.37
ρ_{tp}	Beta	0.8	0.1	0.71	0.71	0.65	0.77
ρ_{cp}	Beta	0.8	0.1	0.56	0.57	0.39	0.76
ρ_{is}	Beta	0.8	0.1	0.81	0.81	0.70	0.91
ρ_{gc}	Beta	0.9	0.025	0.86	0.86	0.81	0.91
ρ_{gi}	Beta	0.9	0.025	0.86	0.85	0.78	0.92
ρ_{gt}	Beta	0.9	0.025	0.90	0.89	0.84	0.94
σ_{tp}	Gamma	0.5	0.4	0.11	0.11	0.09	0.14
σ_{cp}	Gamma	0.5	0.4	0.02	0.02	0.01	0.02
σ_{is}	Gamma	0.5	0.4	0.04	0.04	0.03	0.04
σ_{gc}	Gamma	0.5	0.4	0.13	0.13	0.11	0.15
σ_{gi}	Gamma	0.5	0.4	0.13	0.13	0.11	0.15
σ_{gt}	Gamma	0.5	0.4	0.00	0.01	0.00	0.03
σ_{ms}	Gamma	0.5	0.4	0.04	0.04	0.03	0.04

- Prior means for learning-by-doing parameters are set based on the estimates by Tervala and Watson (2021)
- Support for the learning-by-doing process (hysteresis) is found in the data
- **Fluctuations in employment have a strong and persistent effect on productivity (human capital)**

Simulated output multipliers

- In simulations, parameters are set to the calibrated and estimated values above
- Shock: a 1% of GDP increase in public investment
- A positive effect on output, productivity (human capital), employment and private investment
- Higher levels of employment and productivity and public and private capital → a high output multiplier
- Simulated output multiplier for the BER over the entire program period is 10.17
  - Empirical approximation: geographic cross-sectional output multiplier: 9.87

Table: Simulated Output Multipliers

	2009	2010	2011	2012	Cumulative
Average SA4					
Empirical Approximation (aggregate)	4.14	2.00	2.71	6.12	14.96
Empirical Approximation (25-34 only)	2.58	0.83	2.12	4.33	9.87
Baseline Simulation	3.88	2.84	2.19	1.25	10.17
$\lambda = 0.2$ (0.27)	3.63	2.65	1.93	0.90	9.11
$\lambda = 0.3$ (0.27)	3.98	2.95	2.33	1.44	10.70
$\rho_x = 0.8$ (0.89)	5.48	3.16	2.29	1.57	12.50
$\rho_x = 0.99$ (0.89)	2.04	2.08	1.64	0.70	6.45
$\mu_l = 0.1$ (0.18)	4.29	2.48	1.92	1.33	10.01
$\mu_l = 0.3$ (0.18)	3.77	3.37	2.57	1.18	10.89
$\alpha = 0.47$ (0.33)	3.69	3.36	3.25	2.45	12.76
$\phi = 2.5$ (6.58)	3.78	2.80	2.15	1.22	9.94
$\phi = 10$ (6.58)	3.91	2.86	2.21	1.26	10.23
$\beta = 0.99$ (0.995)	4.04	2.92	2.25	1.27	10.48
$\beta = 0.9995$ (0.995)	3.73	2.78	2.14	1.23	9.87
$\theta = 9$ (6)	3.88	2.84	2.18	1.23	10.14
$\gamma = 0.85$ (0.71)	4.56	2.94	2.20	1.19	10.89
$\varphi = 1$ (2)	3.40	2.44	1.91	1.17	8.91
$\varphi = 3$ (2)	4.42	3.41	2.81	1.99	12.62
$\Phi_{ty} = 0.05$ (0.083)	3.09	2.68	2.18	1.21	9.15
$\Phi_{ty} = 0.1$ (0.083)	4.11	2.86	2.16	1.27	10.40

Conclusions

- High value for money: **Costs per job-year saved was only $8,600 ($US 8,000)**
  - The BER was likely **more cost effective than other GFC stimulus programs**, ARRA (Chodorow-Reich 2019) and the German public investment program (Buchheim and Watzinger 2023)
  - The BER was likely to be **much more cost effective than the JobKeeper Payment**, the Australian fiscal stimulus package during the Covid-19 recession (Sainsbury, Tervala and Watson 2022)
    - A cost per job-year saved of around $112,819 ($US80,959)
- **A fiscal stimulus program comprising many small infrastructure projects can be a very cost effective form of stimulus in recessions**
- Support for learning-by-doing (endogenous business cycles) is found in the data: Fluctuations in employment have a strong and persistent effect on productivity and output
- Learning-by-doing can motivate large output multipliers

Conclusions

- The paper identifies several factors that contributed to the success of the BER program, including
  - targeting of a highly cyclical industry
  - geographical dispersion of projects across the country
  - crowding-in of private investment
  - rapid construction during the crisis's most intensive stage
  - and emphasis on skill development and human capital formation among younger Australians.
- When evaluating the sensibility of a **stimulus** measure, it is important to assess **its impact on the aggregate supply (productivity (including human capital), private investment, public capital and labor supply)**