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

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Keywords

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JEL Classification

E24, E62, E65

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

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Abstract

This paper estimates the causal impact of the Great Recession-era Building the Education Revolution (BER) school infrastructure stimulus program on labour market outcomes in Australia. The evidence suggests that the program provided value for money, with costs per job-year saved most likely below $8,500 ($US 8,000) on average between 2009 and 2012. In 2009, the main year of program impact, roughly one third of employment benefits related to lowering unemployment, and two-thirds reduced labour force exit. Unemployment reductions were concentrated amongst men, while program effects on employment appear more equally distributed by gender than would be anticipated based on the gender composition of the construction industry. Employment benefits were highly concentrated amongst 25 to 34 year olds, were not greater in regions experiencing higher unemployment at the outset of the program, and geographic demand spillovers may have grown as the program progressed.

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1 Introduction

The $16.9 billion Building the Education (BER) program was a major school infrastructure building program that was the largest individual component of the Australian Government's second major Global Financial Crisis (GFC) stimulus package, the $42 billion *Nation Building and Jobs Plan* announced in February 2009 (Charlton, 2019). The implementation challenge was significant, with projects to be delivered in practically every school in the country, in about a third of the time usually taken to develop school infrastructure projects (ANAO, 2010). The Program saw the construction of 24,000 infrastructure projects in 9,500 schools up until May 2012 (Lewis et al., 2014). From a macroeconomic policy perspective, popular criticisms of the BER have suggested that it was an ineffective stimulus program because the majority of spending took place after the worst of the GFC had passed (see Stutchbury, 2010). The 'School Halls Program' as it was popularly known also became almost synonymous with government waste and mismanagement in public opinion owing largely to persistent media criticism alleging poor value for money in construction (Lewis et al., 2014). However, no previous academic studies have sought to formally evaluate how cost-effective the BER was in achieving its primary objective, which was to help save jobs in the face of the then largest global economic downturn since the Great Depression.

The BER was expected to support approximately 120,000 jobs over its full duration, which based on it's intended spend of $16.2 billion equated to a cost per job saved of roughly $135,000 (Australian Government, 2010b). When formulating its stimulus program, the Australian Government relied on Treasury Department assessments regarding the size of output multipliers, which were 0.85 for infrastructure spending, or 1 assuming no import leakage. In its first report, the BER Implementation Taskforce reported updated multiplier estimates for the BER Program, with Treasury predicting an impact multiplier of 1.14 in 2009, with the creation of 31,600 jobs in that year (Australian Government, 2010b). As can be seen in Figure 1, and similarly to other advanced economies at the same time (see Blanchard and Leigh, 2013), suspicions quickly emerged that the Government may have significantly underestimated output and employment multipliers.

Utilising a never before used administrative dataset recording construction expenditure under the BER program, this paper seeks to address the question of whether the BER was

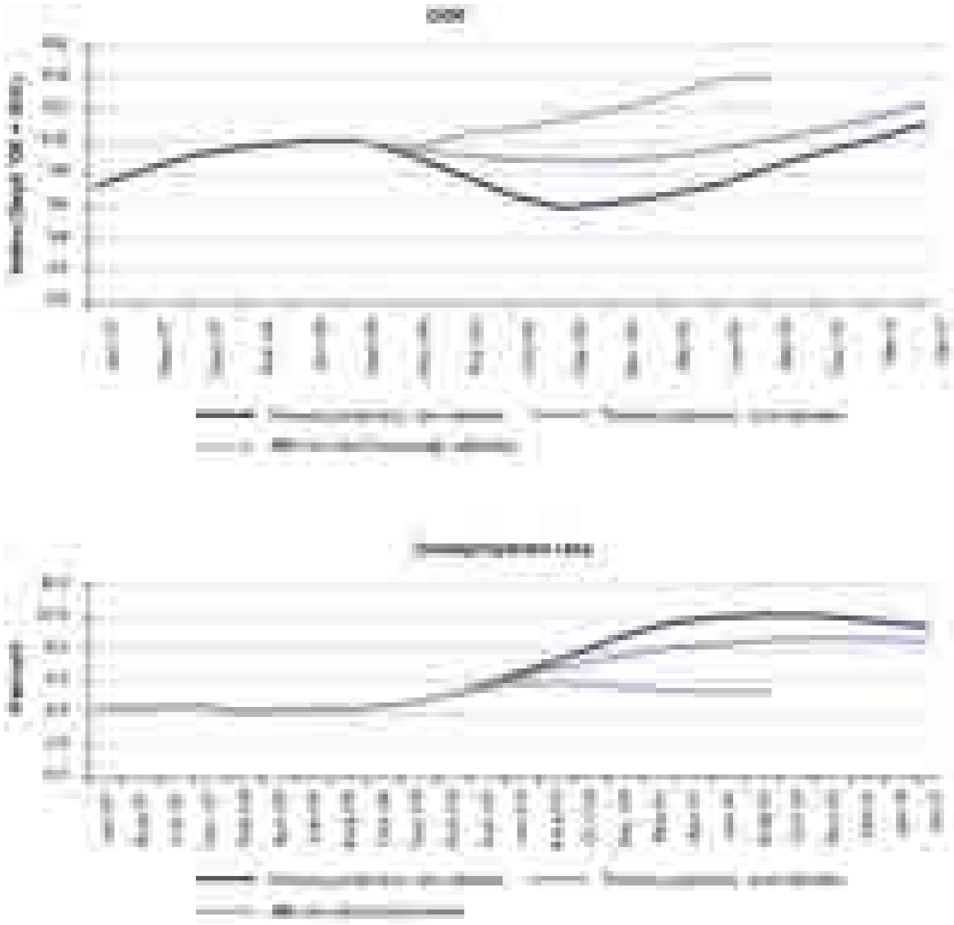

Figure 1: Budget 2009-10 Projections for Output and Unemployment vs. Actual, Source: Australian Government (2010b)

a cost-effective stimulus program, particularly with respect to employment creation. The paper is situated within the emerging literature on geographic cross-sectional fiscal multipliers (Chodorow-Reich, 2019), and follows in the footsteps of Buchheim and Watzinger (2017) who study a similar school infrastructure stimulus program in Germany following the GFC. Specifically, this paper uses a dynamic generalised differences-in-differences (DiD) approach to identify the impact of BER construction expenditure on employment in Australian Statistical Level 4 (SA4) regions.[1] Schools per capita are used as instruments for BER construction expenditure per capita to address concerns that stimulus expenditure was likely endogenous to local economic conditions. A medium-scale dynamic stochastic general

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[1] SA4 regions are the largest sub-state regions in the Australian Statistical Geography Standard (ASGS) maintained by the Australian Bureau of Statistics (ABS). From a labour economics perspective they are intended to represent distinct regional labour markets.

equilibrium (DSGE) model is also estimated to relate cost per job-year saved estimates to approximate 'closed economy, no monetary policy response' output multipliers in the spirit of Chodorow-Reich (2019).

Focusing on the average SA4 level, this paper finds that the program created roughly 8.58 jobs per $100,000 of program construction expenditure in the 2009 year, implying a cost per job-year saved of $11,661 ($US 9,212) in this year alone. Of the employment benefits in 2009, roughly one third relate to reductions in unemployment, and two thirds relate to reduced labour force exit. Beyond 2009, cumulative employment effects over the remainder of the program period are statistically insignificant, although potentially large, given that economically and statistically significant employment effects are observed for 25 to 34 year olds in particular. Controlling for mining activity is important to help identify program employment effects, especially considering that BER construction expenditure per capita was higher in remote labour markets where the mining industry is a significant employer. These results alone suggest that the BER program is amongst the most cost effective fiscal stimulus measures implemented in recent history.

Despite the highly gender segregated nature of the Australian construction industry, employment benefits for women in 2009 were about two thirds as large, and statistically indistinguishable from those of men. Over the program as a whole, differences in employment benefits between men and women are statistically indistinguishable. The program reduced unemployment amongst men by a statistically significant 2.64 job-years per $100,000 in program expenditure in 2009, and a statistically insignificant 0.47 job-years for women. However, it is estimated that there were 3.48 more women in the labour force in 2009 per $100,000 in program expenditure compared to only 2 more men, although the results are again statistically indistinguishable. Employment benefits under the program were also highly concentrated amongst 25-34 year olds, with a cost per job-year saved in the average SA4 between 2009 and 2012 of only $5,000 ($US 4,725) for 25-34 year olds alone. Aggregate as well as gender and age disaggregated program effects with respect to unemployment and Not in the Labour Force (NILF) status sum quite closely to aggregate employment effects, demonstrating the empirical consistency of all results.

Controlling for geographic spillovers has statistically insignificant effects on employment estimates, although there is weak evidence that positive demand spillovers may have increased as the program progressed. While it is possible that employment multipliers displayed some time variation based on aggregate business cycle conditions, there is no evidence that SA4 regions with higher unemployment rate immediately before the program commenced experienced higher employment multipliers.

Australian SA4 regions are relatively heterogeneous in size, and analysis at the average SA4 level might provide a misleading perspective of average national employment effects, as well as raise some concerns with respect to imprecise measurement given the labour force data used is derived from small surveys. In order to address these issues, the full employment model was estimated with analytic weights based on SA4 working age population, and controlling for geographic spillovers which could in practice result in the under or overestimation of aggregate multipliers. Employment effects are roughly half as large and much less precisely estimated for aggregate employment when these adjustments are made, although still large in economic magnitude. The results imply over 800,000 jobs saved in 2009 alone, and up to 3 million jobs saved between 2009-2012, albeit imprecisely estimated based on standard confidence levels. Nonetheless, estimation with employment data for 25-34 year olds alone yields estimates of aggregate job-years saved of over 500,000 and 800,000 in 2009 and 2012 respectively, both statistically significant at the 5 per cent level. This translates into an aggregate cost per job-year saved between 2009-2012 of \$8,557 (\$US 8,086), or almost 2 million jobs saved amongst 25-34 year olds alone which is significant at the 10 per cent level. These results provide confidence that the program had a significant impact on national level employment, noting the caveat that the influence of factors such as monetary policy and the exchange rate are all held constant in the empirical framework utilised.

Finally, simulations based on our simulated DSGE model provide a reasonably close match to empirical approximations based on the method of Chodorow-Reich (2019), especially over the first three years of the program period, the period before the Australian economy suffered another cyclical downturn related to the end of the mining boom. Model simulations reinforce the fact that output and employment multipliers related to public infrastructure spending can be relatively large, and also crowd-in private sector investment, making them a useful complement to transfer-like stimulus measures that tend to increase private consumption, but crowd-out private investment (see Watson et al., 2022).

Overall, the evidence suggests that a stimulus program comprising many small infrastructure projects can be a cost-effective form of fiscal stimulus in recessionary conditions. Some of the factors that contributed to the program's success most likely include targetting a highly cyclically sensitive industry; the requirements that projects had to be new, and in addition to schools existing capital works plans; geographically dispersing projects broadly across the country in the face of a widespread demand slow down; the crowding-in of private sector investment; the speed to peak construction during the most intensive stage of the crisis; complementarity and phasing with other fiscal supports; the capacity to generate demand spillovers both geographically and between industries; the diverse range of projects involved which opened participation to contractors with a wide range of skill levels and capabilities; and the focus on promoting skill development and human capital formation amongst younger Australians in particular.

2 BER Program Overview

2.1 BER Program Design

The objective of the BER was to provide practically every school in Australia with a new building on the proviso that construction could be completed within 18 months. The initially proposed \$14.7 billion in construction expenditure constituted the largest element of the \$34.9 billion in medium-term GFC-era stimulus that was allocated to infrastructure investments that could be undertaken quickly, and distributed broadly geographically (Charlton, 2019). The initially proposed \$14.7 billion represented only 90 per cent of estimated construction costs under the Program, and was later revised up to \$16.2 billion. In the end a total of \$16.9 billion was actually spent by the Commonwealth Government under the Program.

The three main elements of the BER, the *Primary Schools for the 21st Century* (P21); *Science and Language Centres for the 21st Century* (SLC21); and the *National School Pride* (NSP) programs are set out in detail below. Initially, \$12.4 billion was allocated to P21, \$1 billion to SLC21 and \$1.3 billion to NSP (Australian Government, 2009). With the increase in funding from \$14.7 to \$16.2 billion this changed to \$14.1 billion to P21, \$0.8 billion to SLC21, and \$1.3 billion to NSP. Under the BER program the Commonwealth Government provided funds directly to state and territory Education Departments to fund eligible projects in state and territory public schools, while Block Grant Authorities (BGAs) were used to provide funding to non-Government schools.

2.1.1 Primary Schools for the 21st Century (P21)

Under P21 the Commonwealth Government funded capital expenditure on (in order of priority) libraries, multi-purpose halls, and classrooms, including refurbishing existing facilities, in all primary and special schools. Schools were permitted to apply for funding for early childhood centres under the program; however, the building or refurbishment of religious facilities was not permitted. P21 was subject to three separate funding rounds based on expected commencement and completion deadlines. Round 1 projects were expected to start by May-June 2009, and be completed by December 2010; Round 2 projects were expected to start in June/July 2009 and be completed by January 2011; and Round 3 projects were expected to start in September/October 2009 and be completed by March 2011. Projects that could not indicate a capacity to be completed within the specified time periods were ineligible for funding (Australian Government, 2009). Despite this, due to capacity constraints in the construction industry, \$500 million in Commonwealth funding was eventually re-phased into the 2011/12 financial year (Australian Government, 2010a).

Under the Program Guidelines preference was also given to projects where planning and relevant approval processes were well advanced to expedite construction and spending (Australian Government, 2009). Another measure to expedite the construction process was mandating the use of standard design templates, unless it could be demonstrated that using a non-standard design was reasonable in the circumstances, and building could still be undertaken within the specified BER program timelines (Australian Government, 2009). Indicative P21 funding caps per school were set on the basis of school size (Table 1). States, territories and BGAs had discretion to go above or below these funding caps for individual schools provided that the funding caps were adhered to on average in aggregate. Where an application was for an amount ten per cent less than the indicative funding cap, the state or territory education authority or BGA only required the signed approval of the school principal to redirect funding within the relevant school system.

Table 1: P21 Funding Allocations

School size (full-time equivalent students)	Indicative funding cap
1 to 50	$250,000
51 to 150	$850,000
151 to 300	$2,000,000
301 to 400	$2,500,000
401+	$3,000,000

Source: Australian Government (2009)

2.1.2 Secondary Schools for the 21st Century (SL21)

This element of the BER program was focused on building or refurbishing science laboratories and language learning centres in secondary schools. The states, territories and BGAs were responsible for conducting competitive expression of interest (EOI) processes to undertake the projects, that were in turn sent to the Commonwealth for funding approval. Projects were supposed to start in August-September 2009, and be completed by the end of June 2010. $821.8 billion was made available under SL21, which was intended to build or refurbish up to 500 buildings. Unlike the P21 and NSP elements there were no school-size based funding caps under this program. Rather, the states, territories and BGAs were tasked with identifying a priority list of projects within their systems which were then to be approved by the Commonwealth. Eligibility was decided on the basis of: School or broader school community need or disadvantage based on recognised measures of disadvantage such as the DEEWR socio-economic status (SES) score, the Socio-economic Indexes for Area (SEIFA), or the Index of Relative Socio-economic Disadvantage (IRSED); 'demonstrated need for the specified building'; and 'readiness and capacity to begin and complete construction of the building within the 2009-10 financial year.'

2.1.3 National School Pride (NSP)

The NSP element of the BER provided funding to all primary and secondary schools, government or non-government, to undertake small infrastructure or refurbishment projects. Funding could be used to refurbish buildings, construct or upgrade 'fixed shade structures, covered outdoor learning areas (COLAs), sporting grounds and facilities', green infrastructure including rain water tanks and insulation, and 'special infrastructure support for students with disabilities or special needs'. Like the P21 program, funding could not be used for the building or refurbishment of buildings that were had a primary purpose of facilitating religious worship.

Funding was provided to states, territories and BGAs by the Commonwealth on the basis that 60 per cent of schools would be provided funding in the 2008-09 financial year (Round 1), and 40 per cent in the 2009-10 financial year (Round 2). Round 1 projects were expected to commence in April-May 2009, and be completed in December 2009. Round 2 projects were expected to commence in July 2009 and be completed by February 2010. Funding was based on two milestone payments, with 50 per cent available upon project commencement, and the remaining 50 per cent available on project completion. Like the P21 program funding allocations to states, territories and BGAs were calculated based on full-time equivalent student numbers at the February 2009 census (Table 2).

Table 2: NSP Funding Allocations

School size (full-time equivalent students)	Indicative funding cap
1 to 50	$50,000
51 to 150	$75,000
151 to 300	$125,000
301 to 400	$150,000
401+	$200,000

Source: Australian Government (2009)

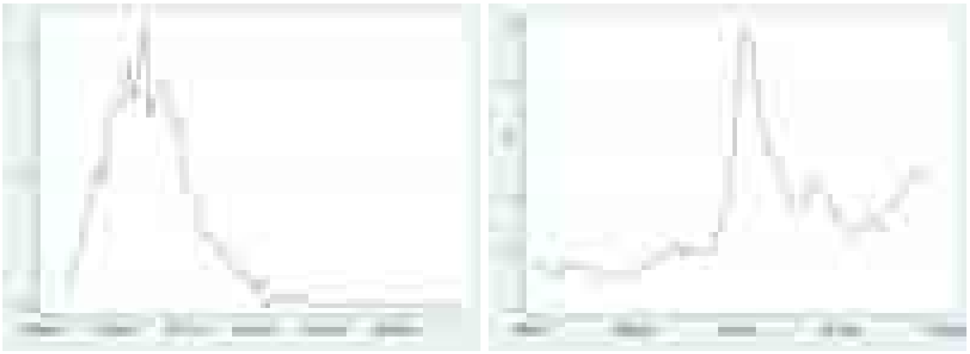
2.1.4 General funding criteria

All projects funded under the BER program were subject to monthly reporting requirements. Monthly reports detailed the value of construction activity undertaken in the preceding month, which constitutes the primary source of data regarding BER program expenditure used in this paper. There were also common rules across the three elements of the program concerning planned school closures, amalgamations, new schools and schools with multiple campuses. Funding could not be provided to schools that were planned to close. Where schools were planning to amalgamate within the next three years, then school funding was permitted to be merged and combined. Where a school was newly built or completed and the school community and principal had agreed that no further buildings were required, funding could be reallocated to another government school or school system of which the non-government school was a member. Schools with multiple campuses were treated as a single school, and non-government schools needed to demonstrate their financial viability in order to receive funding.

Under the funding criteria, the states, territories and BGAs were required to maintain their current and planned levels of investment over the following four years. Any BER funding received was then to be allocated for *additional* investment over that which was already planned. Evidence was required to be provided to the Commonwealth regarding capital expenditures over the preceding four years, and forecast expenditures for the next four years. Common design templates were created for each element of the BER program, and were expected to be used by schools unless they had a reasonable case to use alternative plans. This was designed to fast-track project planning and building approval processes. Further the states, territories and BGAS were expected to 'use their best endeavours to give priority in tendering and contracting' to businesses that agreed to provide at least 10 per cent of total contract hours to apprentices and trainees. BER funded projects needed to demonstrate 'value for money' (from August 2009); compliance with relevant local government planning requirements; and capacity to be delivered within required program timelines.

2.2 BER Program Implementation

Figure 2 presents construction expenditure under the BER program from the Department of Education, Employment and Workplace Relations (DEEWR) administrative dataset for the BER (panel a) alongside real public sector construction activity (panel b). The BER program data records the value of construction activity undertaken under the BER in the preceding month, and is the primary data used to identify BER employment effects in this paper. BER-related construction activity commenced in April 2009, and peaked during 2010, before gradually declining to negligible levels towards the end of 2014. This coincides with the dramatic spike in public sector construction activity that occurred between the June quarter of 2009 and the September quarter of 2012 as part of broader GFC stimulus efforts (panel b).



(a) BER, source: DEEWR (b) Real public sector, source: ABS

Figure 2: Construction Expenditure, $A billion

Figure 3 provides a spatial representation of BER construction expenditure per capita between 2009-2012, with 'per capita' referring to the 2008 working age population. BER construction expenditure per capita is the main independent variable used in estimation below. BER construction expenditure per capita was generally greater in smaller and more remote SA4 regions. This was driven by the fact that these SA4s have a higher number of schools as a percentage of the population, as well as comparatively high construction costs associated with undertaking projects in more remote regions (see ANAO, 2010 p. 96).

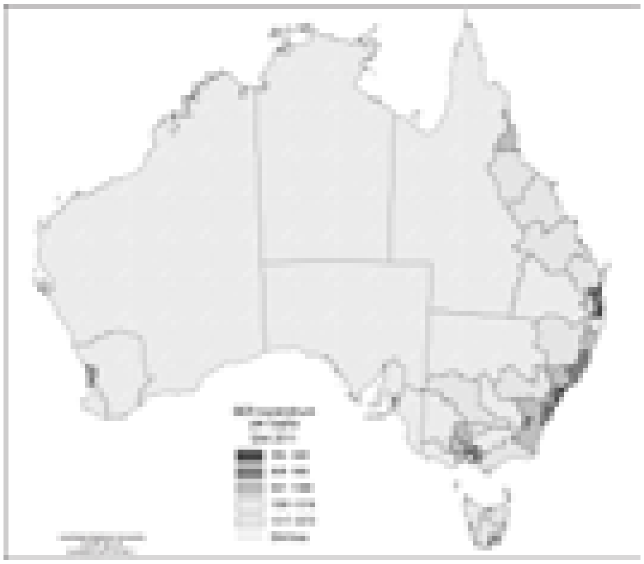


Figure 3: BER Construction Expenditure per Capita 2009-2012, $A per 2008 Working Age Population

Figure 4 zooms in on Australia's five major capital cities, and reaffirms the fact that BER expenditure per capita was generally higher in more remote SA4s, with smaller population sizes. SA4s in central Melbourne, Sydney and Brisbane in particular experienced amongst the lowest levels of BER expenditure per capita between 2009-2012.

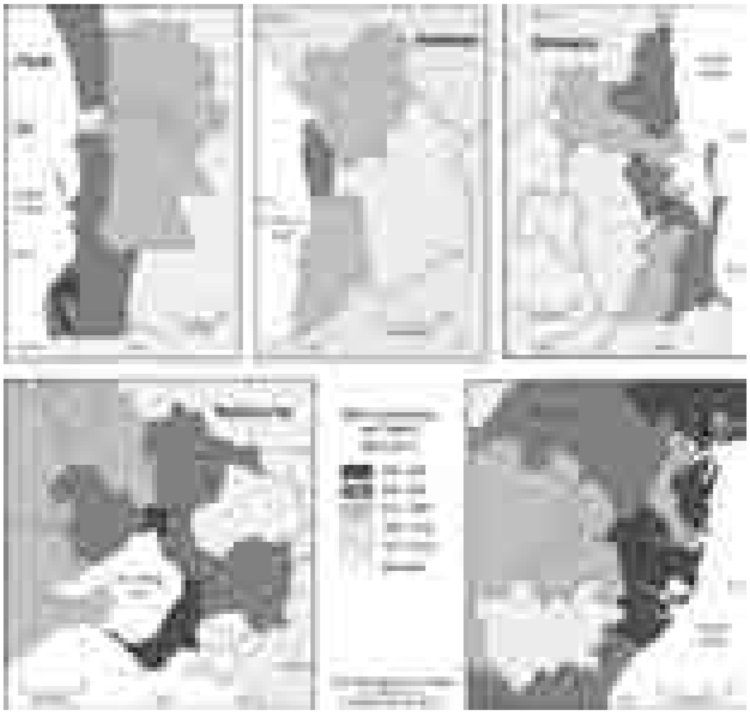


Figure 4: BER Construction Expenditure per Capita, $A per 2008 Working Age Population

Largely in response to negative press coverage, in April 2010 the BER Implementation Taskforce was established 'to ensure projects are providing value for money'. The BER Implementation Taskforce Final Report was handed down in July 2011 finding 332 complaints related to the program, amounting to around 3.5 per cent of schools involved (Australian Government, 2011). Overall, the most numerous complaints, at 55 per cent of total complaints, related to a perceived lack of 'value for money' in construction (Australian Government, 2011). In the end, the BER-premium relative to pre-BER school building projects was estimated to be in the order of 5-6 per cent overall (Australian Government, 2011). Not a particularly large premium given the time and resource pressure the program placed on the construction industry to deliver a large number of projects in a condensed time period.

An Australian National Audit Office report concerning the design of the P21 program raised no specific concerns about a lack of focus on value for money in program design;

however did observe that a lack of flexibility in program rules could have constrained the ability of education authorities to achieve program objectives at the local level, while adding to the cost and administrative complexity of program delivery (ANAO, 2010). The ANAO observed that ultimately many of the program design issues observed could be attributed to the compressed time frames involved for establishing a large and complex program in the midst of a rapidly unfolding global recession. The ANAO (2010) observed that education industry stakeholders, Education Authorities and the overwhelming majority of school principals thought that the the P21 program had improved school facilities. Over 95 per cent of principals surveyed 'were confident that BER P21 funding would provide an improvement to their school, which would be of ongoing value to their school and school community'.

When thinking about the stimulus value of the BER program, as well as aggregate spending levels, another potentially important policy dimension relates to the timeliness with which projects were delivered by the various education authorities. Victorian Government public schools were slow to undertake required works and also experienced project delays due to requirements to undertake rectification work (Australian Government, 2011). 50 per cent of Victorian Government projects were regarded as 'slow' by the BER Implementation Taskforce. On the other hand the NSW Government had less than 10 per cent of its buildings in the slow category. The WA and SA Governments had greater balance between 'slow', 'medium' and 'fast' projects. Catholic and independent schools generally built high quality facilities based on existing master plans which enabled rapid project delivery, as well as better outcomes on average in project quality and cost (Australian Government, 2011). Whether correct or not, slowness to build was associated with diminished stimulus potential. However, this analysis ignores potential expectational effects, and also ignores the fact that business cycle conditions further deteriorated towards the end of the program period following the collapse of Australia's mining boom and the terms of trade in late 2011.

3 Literature Review

Elements of BER program design make it an ideal candidate for evaluation using the techniques developed in the emerging literature concerning geographic cross-sectional employment multipliers. These multipliers measure the effect of an increase in government spending in one region of a monetary union on regional employment (Chodorow-Reich, 2019). This typically involves estimating a dynamic panel regression model based on Autor (2003) and Angrist and Pischke (2009) of the following form:

$$E_{i,t} = \alpha_i + \lambda_t + \sum_{\tau=0}^{m} \beta_{t,t-\tau} G_{i,t-\tau} + \sum_{\tau=1}^{q} \beta_{t,t+\tau} G_{i,t+\tau} + \gamma' X_{i,t} + \varepsilon_{i,t} \tag{1}$$

Where typically employment in a particular region i at time t given by $E_{i,t}$ is related to a particular aspect of government spending in that region ($G_{i,t}$), α_i which controls for time invariant regional heterogeneity, time fixed effects λ_t, and a vector of controls $X_{i,t}$. The year fixed effects λ_t control for common trends determined above the regional level including those related aggregate cyclical fluctuations, national monetary and fiscal policy. The sums on the right-hand side of the equation allow for m post-treatment effects ($\beta_{t,t}, \beta_{t,t-1}, ..., \beta_{t,t-m}$), and q expected policy effects ($\beta_{t,t+1}, \beta_{t,t+2}, ..., \beta_{t,t+q}$), such that the $\beta_{t,t\pm\tau}$ can be interpreted as the impulse response of E_i at each point in time t to all past and anticipated future values of government spending $G_{i,t\pm\tau}$.

For $\hat{\beta}_{t,t\pm\tau}$ to be a consistent estimator of $\beta_{t,t\pm\tau}$, there must be variation in $G_{i,t\pm\tau}$ conditional on $X_{i,t}$, α_i and λ_t that is uncorrelated with developments in economic activity across regions. This is equivalent to the 'parallel trends' assumption in difference-in-difference estimation. $\hat{\beta}_{t,t\pm\tau} = 0$ for time periods before the relevant government spending program started is a necessary condition for this equivalent to the parallel trends assumption holding. If every region i receives the treatment it is not possibly to demonstrate sufficiency. However, including location specific time trends $\alpha_i \times t$ to the control set adds reassurance that the parallel trends assumption holds. The choice of employment rather than output as the basis for analysis is usually dictated by data availability- with employment data more readily available at the sub-state level. Nakamura and Steinsson (2014), Shoag (2016), Fahri and Werning (2016), and Chodorow-Reich (2019) illustrate methods to relate estimates of costs per job-year saved to approximate 'closed economy, no monetary policy' response output multipliers.

A common econometric challenge associated with estimating equations like equation 1 is that fiscal stimulus is often employed in circumstances where output and employment are declining due to recession, or directed towards regions that are anticipated to be hardest hit during the recession. This raises concerns that OLS multiplier estimates derived from such equations will likely be biased downwards. The challenge for econometricians is then to find instruments $Z_{i,t\pm\tau}$ that are correlated with $G_{i,t\pm\tau}$ and satisfy the exclusion restriction $E[Z_{i,t}\varepsilon_{i,t}|X_{i,t},\alpha_i,\lambda_t]=0\ \forall t$. The first-stage regression can be represented as follows:

$$\hat{G}_{i,t}=\alpha_i+\lambda_t+\sum_{\tau=0}^{m}\beta_{t,t-\tau}Z_{i,t-\tau}+\sum_{\tau=1}^{q}\beta_{t,t+\tau}Z_{i,t+\tau}+\gamma' X_{i,t}+\upsilon_{i,t} \tag{2}$$

In the second stage-equation $G_{i,t\pm\tau}$ in equation 1 is replaced by $\hat{G}_{i,t\pm\tau}$ to allow the consistent estimation of the $\beta_{t,t\pm\tau}$. The cumulative additional increase in E_i given G_i between period t and time horizon $t+h$ can be derived from simply summing estimates of $\beta_{t,t\pm\tau}$ over the relevant time period from the following equation:

$$E_{i,t}=\alpha_i+\lambda_t+\sum_{\tau=0}^{m}\beta_{t,t-\tau}\hat{G}_{i,t-\tau}+\sum_{\tau=1}^{q}\beta_{t,t+\tau}\hat{G}_{i,t+\tau}+\gamma' X_{i,t}+\varepsilon_{i,t} \tag{3}$$

Rather than focus on employment multipliers, most studies report total employment increases related to a $1 increase in Government spending, or alternatively a cost per job-year saved. That is how much on average it cost to create an additional job of one year's duration. The need to identify variation in $G_{i,t\pm\tau}$ that can plausibly be regarded as exogenous to broader trends in economic activity in region i has resulted in the use of a range of innovative identification strategies.

Firstly, a number of studies focus on government spending that is based on formulaic apportionment plausibly unrelated to underlying economic conditions (see Chodorow-Reich et al., 2012; Wilson, 2012; Leduc and Wilson, 2013; Dupor and Saif Mehkari, 2016; and Dupor and McCrory, 2018; and Chodorow-Reich, 2019). Second, some studies use what can broadly be described as unanticipated financial windfalls to help identify variation in government spending unrelated to underlying economic conditions (see Corbi et al., 2019; Adelino et al., 2017; Shoag, 2016; Suárez Serrato and Wingender, 2016; Wilson, 2012; and Conley and Dupor, 2013). Third, the shift-share methodology of Wallis and Benjamin (1981) can also be used to identify variations in sub-regional government spending that is purely driven by changes in federal spending (see Nakamura and Steinsson, 2014; and Fishback and Kachanovskaya, 2015). In a similar fashion Dube et al. (2018) utilise Bartik (1991) shift-share instruments related to pre-GFC industry employment shares in their study of the American Recovery and Reinvestment Act (ARRA). Finally, a fourth group of papers utilise other demographic, structural or institutional features of regions to identify variation in government spending unrelated to contemporaneous economic conditions (see Clemens and Moran, 2012; Feyrer and Sacerdote, 2011; Cohen et al., 2011; Acconcia et al., 2014; Brückner and Tuladhar, 2014; Buchheim and Watzinger, 2017; Porcelli and Trezzi, 2019; and Hausman, 2016).

Appendix Table A1 provides a high-level overview of results from the recent literature on geographic cross-sectional fiscal multipliers. When all of the ARRA related studies are converted to allow for comparability, Chodorow-Reich (2019) finds costs per job year ranging from $US 26,316 to $US 131,579, with a cross study mean of $US 47,619 and a median of $US 52,632. The non-ARRA papers typically find lower cost per job-year, for example instance Adelino et al. (2017) find a cost per job-year of $US 19,608 associated with US municipal government spending following rating recalibrations; Shoag (2016) estimates a cost per job-year of $US 34,602 out of state spending driven by US state pension fund idiosyncratic returns; Suárez Serrato and Wingender (2016) estimate a cost per job-year of $US 30,769 associated with census population forecast changes; and Buchheim and Watzinger (2017) estimate a cost per-job saved of €25,000 (around $34,200 using average annual Euro/US dollar exchange rates over the duration of the program) related to government investment in improving the energy efficiency of government schools during the GFC. In a developing country context, Corbi et al. (2019) find a cost per job-year saved of $US 8,000 in Brazil where local government spending increases due to population based funding increments.

Turning to output multipliers, the majority of recent studies including Acconcia et al. (2014), Adelino et al. (2017), Chodorow-Reich (2019), Corbi et al. (2019), Dube et al. (2018), Dupor and McCrory (2018), Dupor and Saif Mehkari (2016), Feyrer and Sacerdote (2011), Hausman (2016), Leduc and Wilson (2013), Nakamura and Steinsson (2014), Shoag (2016) and Suárez Serrato and Wingender (2016) all find geographic cross-sectional multipliers equal to or in excess of one. In contrast Brückner and Tuladhar (2014), Cohen et al. (2011), Fishback and Kachanovskaya (2015), and Porcelli and Trezzi (2019) find geographic cross-sectional multipliers lower than one. Brückner and Tuladhar (2014) cannot reject that the multiplier on general government spending in Japanese prefectures equal to one, and find multipliers well in excess of one for government transfers to private businesses. Cohen et al. (2011) find evidence that government spending crowds out private investment however, Snyder and Welch (2017) find no evidence in the data used by Cohen et al. (2011) to suggest that their instrument for government spending is related to private investment. Clemens and Moran (2012) and Porcelli and Trezzi (2019) find impact multipliers of significantly below one; however, the identification strategies employed in both papers effectively isolates the 'windfall' spending component of the fiscal multiplier. Based on this benchmark, their results are actually around three times larger than theoretical predictions of Nakamura and Steinsson (2014) and Fahri and Werning (2016).

The large variation in results can be attributed to differences in instruments and study design, multiplier definition, as well as different time periods, regions, events and fiscal instruments. Spending prompted by financial windfall-like events appears to have relatively higher multipliers and lower costs per job-year (for instance Adelino et al., 2017; Corbi et al., 2019; Shoag, 2016; and Suárez Serrato and Wingender, 2016). However, the increase in multipliers related to outside financing is typically relatively low as predicted by Nakamura and Steinsson (2014) and Fahri and Werning (2016) who find that outside financing increases multipliers by less than 0.1. Also, there is no indication that financing via local taxes (Adelino et al., 2017 and Clemens and Moran, 2012); mixed (Brückner and Tuladhar, 2014), or federal taxes has an impact on multiplier size. Although the majority of papers cover situations where Federal governments transfer resources to lower level governments. Regional spillovers can also influence cost per job and multiplier estimates. Acconcia et al. (2014), Buchheim and Watzinger (2017) and Shoag (2016) find similar multipliers and costs per job-year when the potential for geographic spillovers is taken into account; whereas Dube et al. (2018), Dupor and McCrory (2018) and Nakamura and Steinsson (2014) find larger multipliers and lower costs per job-year saved.

The stage of the business cycle and the type of government spending involved may also influence costs per job-year and multiplier estimates. In a meta-analysis of empirical studies investigating fiscal multipliers Gechert and Rannenberg (2018) find that spending multipliers are typically between 0.7-0.9 larger in downturns compared to expansions. They find on average that investment multipliers (1.48) are larger than transfer multipliers (1.00) followed by government consumption multipliers (0.46). However, in recessions investment multipliers are 0.81 higher than average, transfer multipliers are 1.70 higher, and consumption multipliers are 1.03 higher. The papers in the geographic cross-sectional multiplier literature also tend to find larger multipliers in periods of economic slack (see Adelino et al., 2017; Cohen et al., 2011; Dube et al., 2018; Leduc and Wilson, 2013; Nakamura and Steinsson, 2014; Shoag, 2016; and Suárez Serrato and Wingender, 2016). Brückner and Tuladhar (2014) and Feyrer and Sacerdote (2011) find that government investment multipliers exceed broader government expenditure multipliers on average, consistent with Gechert and Rannenberg (2018). Buchheim and Watzinger (2017) and Feyrer and Sacerdote (2011) find government investment multipliers in line with the average regime in Gechert and Rannenberg (2018); while Leduc and Wilson (2013) and Acconcia et al. (2014) find larger investment multipliers on average, and Brückner and Tuladhar (2014) find lower investment multipliers on average. Leduc and Wilson (2013) also find significantly higher investment multipliers in recessionary conditions than would be expected based on Gechert and Rannenberg (2018), and large second round multiplier increases which they attribute to beneficial supply side effects of US highway investment.

4 Model, Data and Statistical Identification

4.1 Model

Following Autor (2003), Angrist and Pischke (2009) and Buchheim and Watzinger (2017), this paper adopts a generalised DiD approach to estimating the employment gains β_Y associated with the BER program for each year between 2009 and 2012. Estimates for β_Y reflect the impact of all past and expected future BER spending on average employment in the average Statistical Area (SA4) region in year Y. The gains in employment are measured relative to the December quarter of 2008, the last quarter before the program was formally announced. The dynamic response of employment to program spending is then described by the sequence β_Y, and summing the employment responses delivers estimates for the average employment difference in cumulative terms over that time period. The model to estimate the β_Y is given as follows:

$$\begin{aligned}
L_{i,t} = {} & \alpha_i + \lambda_t + \alpha_i \times t + \lambda_t \times \text{State}_j \\
& + \beta_{pre}\text{BER p.c}_i \times I(t \in [2007Q1, 2008Q3]) \\
& + \sum_{Y=2009}^{2012} \beta_Y \text{BER p.c}_i \times I(t \in [YQ1, YQ4]) \\
& + \beta_{post}\text{BER p.c}_i \times I(t \in [2013Q1, 2014Q4]) \\
& + \sum_{t:t \neq 2008Q4} \lambda_t \times \mathbf{X_i'}\mathbf{\Gamma_t} + \delta Pop_{i,t} + \epsilon_{i,t}
\end{aligned} \tag{4}$$

Multiple models are estimated with alternate dependent variables $L_{i,t}$ representing different labour market outcomes; specifically, the employed, unemployed, or those not in the labour force (NILF) respectively in each SA4 region i in quarter t all normalised by the 2008 working age population.

The primary independent variable is government construction expenditure in each SA4 under the BER program between 2009 and 2012 measured as a proportion of the working age population in 2008 (BER p.c$_i$). To capture the dynamic responses of employment to Government investment under the BER program, the cross-sectional data on construction expenditure under the program is interacted with time dummies representing each year of the program between 2009 and 2012, and pre and post-program dummies representing the two years before and after the relevant program spending occurred, a standard approach to identifying the dynamic effects of an intervention in the DiD literature (Angrist and Pischke,2009). Interacting date dummies with an instrument that is fixed at the cross-sectional level means that the β_Y are predicting the influence of all leads and lags of program construction expenditure on average employment during each specified year before, during and after the program period. Estimating β_{pre} allows testing for whether these are equal to zero, and therefore our instruments for BER spending are unrelated to employment trends before the program started. $\beta_{pre} = 0$ is a necessary condition for the parallel trends assumption to hold. Estimating β_Y for time periods between program announcement and the commencement of spending also allows the quantification of potential anticipation effects.

Leeper et al. (2010), Ramey (2011) and Leduc and Wilson (2013) note that failing to control for anticipation effects can downwardly bias multiplier estimates.

SA4 fixed effects α_i are included to control for time-invariant labour market heterogeneity at the SA4 level. Quarterly date fixed effects λ_t control for differences in employment driven by policies that are common to all regions. These include changes in exchange rate effects and national, or indeed international, monetary and fiscal policy settings. SA4 specific deterministic time trends $\alpha_i \times t$ are included in the model to control for SA4 specific deterministic labour market trends unrelated to the BER program. This allows SA4 employment to follow different trends in a limited way, and provides assurance that β_Y are not biased downwards (upwards) because BER spending was concentrated in regions where employment was consistently experiencing lower (higher) trend growth before, during and after the program period. Obtaining similar estimates of the β_Y with and without SA4 specific time trends provides an additional check on the DiD identification strategy, and reassurance that results are not driven by violations of the parallel trends assumption. Date and state specific fixed effects $\lambda_t \times State_j$ are included to control for different stochastic labour market trends at the state and territory level. States and territories are the middle tier of Australian government, sitting between local (municipal) governments and the National government. SA4 regions combine multiple local government areas on a regional basis within each state or territory. Further, differential trends in SA4 population growth are controlled for using the ratio of the working age population at time t relative to 2008 referred to as $Pop_{i,t}$ following Buchheim and Watzinger (2017).

Control variables $\mathbf{X_i'}$ include additional SA4 characteristics that may be correlated with both employment and BER construction expenditure. Figure 5 provides an overview of the key SA4 characteristics utilised indicating that they are all significantly positively correlated with expenditure per capita under the BER program.

First, following Buchheim and Watzinger (2017) I control for the school age population at the beginning of the 2009 school year as a ratio of the 2008 working age population. Funding allocations under the PS21 and NSP elements of the BER program were explicitly linked to school size in terms of full-time equivalent (FTE) enrolled students in the February schools census. Further, the school age population is expected to be correlated with inflows

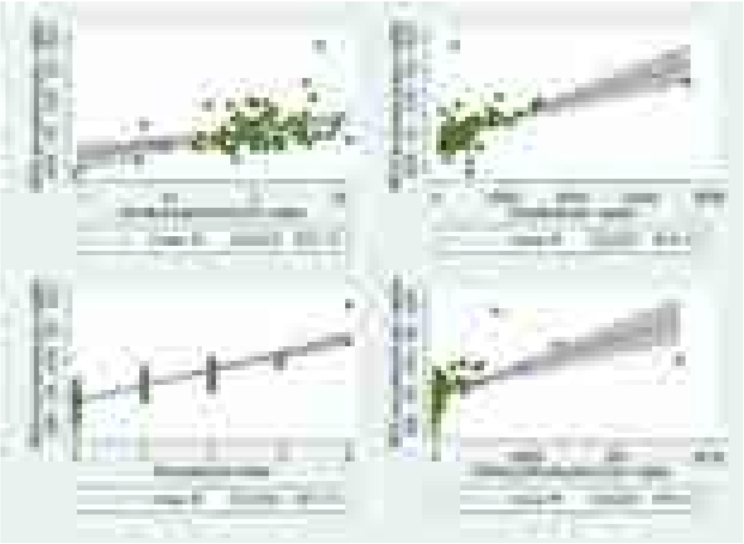


Figure 5: Relationship Between Control Variables and $BERp.c_i$

into employment and labour force participation more broadly.

Second, the years surrounding the BER program also witnessed an unprecedented boom in the Australian minerals and resources industry, which was associated with an unprecedented increase in the terms of trade that eventually crashed in the September quarter of 2011 (Aitken et al., 2014). This resources boom saw mining industry employment almost double from around 140,000 employees in February 2008 to almost 270,000 employees in November 2013 (ABS, 2022). Although, mining employment actually declined during the first 6 months of 2009, a critical period for the BER program. There is also a commonly held view that the resources boom, rather than fiscal policy, was instrumental in helping Australia avoiding a technical recession in 2009 (see Makin, 2016 and Makin, 2010). As will be seen, BER construction expenditure per capita was largely driven by the number of schools per capita. This means that BER construction expenditure per capita was highest in regional and remote Australia where there were relatively more small schools, and the number of schools per capita was typically higher. These are also the regions where Australia's mining industry primarily operates.

As can be seen from Figure 5, BER construction expenditure is positively correlated with remoteness and mining infrastructure. Given the mining boom, failing to control for different employment dynamics between remote regions, and regions with significant mineral and resources facilities, will downwardly bias estimates of BER effectiveness. To control for these factors date fixed effects are interacted with ABS Australian Remoteness Areas indicator variables and operating mines, mineral processing plants and ports at the end of 2008 measured in per capita terms relative to the 2008 working age population. Remembering that we use cumulative BER construction expenditure between 2009 and 2012 interacted with date dummies to represent the impact of all historical and expected BER construction expenditure on employment at time t, interacting mining infrastructure per capita around the start of the program and the remoteness indicator with date dummies controls for all historical and expected mining related investment during the period of interest.

Third, following Buchheim and Watzinger (2017) I also control for hospitals per capita in each SA4. This turns out to be quite important in the Australian context because the BER program period was associated with a period of comparatively high real growth in health and hospital expenditure under the auspices of the 29 November 2008 National Health Reform Agreement. Total health spending increased by over $32 billion between 2008-09 and 2011-12 in real 2017 Australian dollar terms, and $12 billion for hospital expenditure alone. Between 2008-09 and 2011-12 the ratios of growth rates of average annual health and hospital expenditure to GDP were 3.20 and 3.13 respectively, increasing from 1.25 and 1.28 respectively between 1997-98 and 2007-08, and returning to 0.05 and 0.51 respectively between 2012-13 and 2017-13 (AIHW, 2019). The correlation between hospitals and BER construction expenditure ($rho = 0.58$) means that failing to control for rapid growth in health expenditure would likely downwardly bias estimates of the impact of BER on employment. Therefore hospitals per capita in 2009-10 (the earliest available data) relative to the 2008 working age population are included as control variables. Interacting hospitals per capita with date dummies helps control for all historical and expected health related investment during the program period.

The regional basis for estimation is the Australian Statistical Geography Standard 2011 (ASGS 2011) SA4 region, which is the lowest available level of geographic disaggregation compatible with contemporary Australian Labour Force statistics. Regional spillovers are assessed by including BER construction expenditure in adjacent SA4s as controls as in Acconcia et al. (2014). To assess the possibility of state dependent effects of BER construction expenditure, following Adelino et al., (2017) additional dummy-interaction terms will be estimated to identify differential program effects in high-unemployment SA4s, where high-unemployment SA4s are defined as those with a December quarter 2008 unemployment rate above the median level. Differential labour market outcomes are also assessed on an age and gender disaggregated basis. Finally, estimates will be analytically weighted to more closely relate results to national level employment outcomes, output and wage multipliers.

4.2 Data Sources

Estimates for employment, unemployment, NILF status, and the working age population are obtained from the ABS 'Labour Force, Australia, Detailed' publication (ABS (2022), 6291.0.55.001, Table RM1). It is important to note that this is survey rather than administrative data, and estimates can be quite volatile at the monthly frequency, and for SA4 level data in particular. Therefore, average quarterly data in levels is used for estimation purposes, and BER employment effects are reported at the annual frequency.

BER construction expenditure data was obtained from the Australian Government Department of Education (DEEWR) from its historical administrative database for the BER program. The database includes a tracker of cumulative construction expenditure on the BER program at a monthly frequency between May 2009 and May 2018. The value of construction work was reported each month based on work that was completed in the preceding month. Therefore project selection by education authorities and BGAs and construction activity all proceed recorded expenditure in the database, and anticipation effects are likely to be important- another reason to prefer the empirical approach adopted here. This paper focuses on BER expenditure between the years 2009 and 2012, this period covers over 99 per cent of program construction expenditure ($16.7 billion of $16.9 billion in total program expenditure). Between 2013 and 2016 there was a long tail of minor construction work that is not utilised for the purposes of this paper. The overwhelming majority of BER construction expenditure took place between 2009-2011; however, there was still over $400 million in construction expenditure in 2012 (see Table 3). These years also included two cyclical downturns in the Australian economy associated with the GFC, and then the collapse of the mining boom and terms of trade in late-2011.

Table 3: BER Construction Expenditure

Year	2009	2010	2011	2012	2013	2014	2015	2016
$billion	3.1	10.1	3.1	0.4	0.1	0.02	0.0006	0.0006

Source: DEEWR

Estimates of the school age population in each SA4 were derived based on FTE student enrolments at the beginning of the 2009 academic year obtained from the Australian Curriculum, Assessment and Reporting Authority (ACARA) School Profile 2008-2019 dataset.[2] BER funding rules that allocated funding based on FTE enrolments were based on a February 2009 census, and using 2009 year ACARA FTE student enrolments data from the beginning of the 2009 school year is therefore the most appropriate choice in this regard.

ABS Australian Remoteness Areas indicator variables are derived by the ABS from the University of Adelaide's Accessibility and Remoteness Index of Australia (ARIA+) database. They classify Australian Statistical Area 3 (SA3) regions into five zones comprising 'major cities' (0), 'inner regional' (1), 'outer regional' (2), 'remote' (3) and 'very remote' (4). The ABS provided a geographic concordance to map remoteness area classifications to the SA4 level of geographic aggregation.

Location data concerning operating mines, mineral processing facilities and ports was obtained from the Geoscience Australia Australian Atlas of Minerals Resources, Mines and Processing Centres.[3] Location data was cross-checked against Geoscience Australia data concerning Major New Mining Projects and other publicly available sources to ensure that relevant facilities were operational by the end of 2008. Hospital location data was obtained from the Australian Institute of Health and Welfare (AIHW) 2009-10 Hospital Statistics, the earliest available resource.[4] The list of public hospitals can be found in Appendix Table A2.3, and the private hospitals in Appendix Table A2.4.

BER construction expenditure, mining infrastructure, school age population, and hospitals data were all geocoded to ASGS 2011 SA4 regions using the Australian Urban Research Infrastructure Network (AURIN) Portal.[5] Again, with the exception of Australian Remoteness Areas indicators, controls for the school age population, mining infrastructure

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[2] https://www.acara.edu.au/contact-us/acara-data-access

[3] http://www.australianminesatlas.gov.au

[4] https://www.aihw.gov.au/reports/hospitals/australian-hospital-statistics-2009-10

[5] https://aurin.org.au/

and hospitals were normalised by the 2008 working age population sourced from the ABS 'Labour Force, Australia, Detailed' publication (ABS (2022), 6291.0.55.001, Table RM1).

4.3 Instrumental Variables

The primary concern for consistent estimation of β_Y is that state and territory government education authorities and BGAs may have directed BER funding towards regions that they expected would be hardest hit by the recession. If government education authorities and BGAs acted in this way, OLS estimates of the the β_Y will be biased towards zero. Indeed, there were two clear channels where government education authorities and BGAs could act in this way.

First, the primary eligibility criteria for receiving funding under SLC21 program was 'demonstrated need or disadvantage' of the school or associated school community. Disadvantaged schools or communities were to be identified based on recognised measures of disadvantage. As can be seen from Figure 6, one such measure, the ACARA Index of Community Socio-educational Advantage (ICSEA) is negatively correlated with both expenditure per capita under the BER program, and unemployment just prior to the introduction of the BER. Significantly, unlike the PS21 or NSP programs, SLC21 funding was uncapped, providing a mechanism to direct significant funding to disadvantaged communities, and those experiencing high unemployment at the commencement of the program.

Further, under the PS21 and NSP programs although aggregate funding allocations were set with respect to both the number of schools, and school size in FTE student enrolment terms, BER funding was relatively fungible once in the hands of government education authorities and BGAs. Where an individual school received less than 10 per cent of its formulaic funding allocation, the only constraint on government education authorities and BGAs was that a letter of authority was required from the school principal.

In practice, governments and educational authorities had significant capacity to redirect PS21 and NSP funding to schools deemed to have a greater need for BER expenditure. Given that school infrastructure projects in Australian public schools are heavily supplemented out of voluntary contributions from parents, it is likely that infrastructure needs would be greatest in more disadvantaged communities featuring higher unemployment.

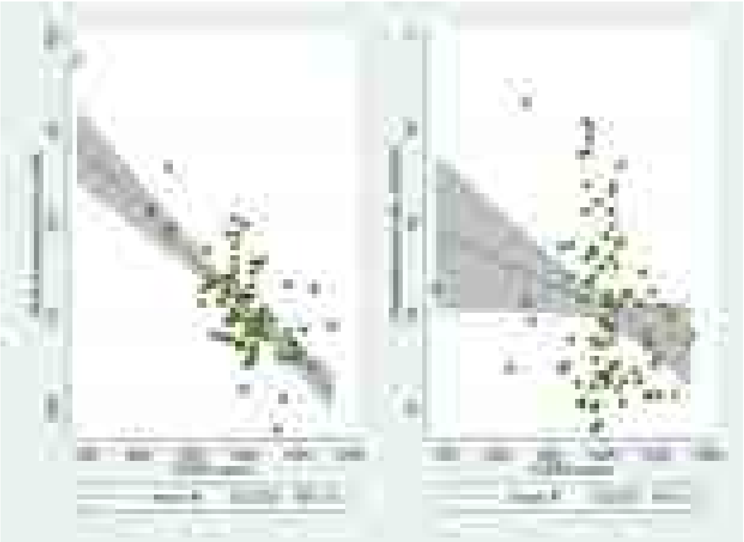

Figure 6: Relationship Between BER Construction Expenditure and Educational Disadvantage

Another way in which the Program Guidelines generate endogeneity concerns is that the funding criteria for all BER program elements reinforced the need to commence construction in 2009, and construction was expected to be completed rapidly, with the latest deadline for project completion being March 2011 under Round 3 of the P21 Project. These requirements were intended to ensure that BER program expenditure and activity were weighted towards what was expected to be the peak period of economic dislocation caused by the GFC. In this way there was also a temporal dimension to the endogeneity problem, with more spending and activity intended to occur when economic conditions were anticipated to be at their worst.

To address these endogeneity concerns this paper employs an instrumental variables strategy that makes use of elements of the BER Program Guidelines to identify factors that influenced the level of school investment under the BER that were unrelated to local economic conditions. The stated intention of the BER program was to finance small capital works programs in more or less every school with the exception of newly built schools (Australian Government, 2009). Funding allocations to state and territory education authorities and BGAs primarily varied on the basis of school type. The PS21 program applied only to primary schools and special schools, the NSP program to all schools, and the SL21 program applied only to secondary schools. Additionally, P21 and NSP funding allocations were graduated based on school size measured in terms of FTE student enrolments. However, as discussed above FTE student enrolments are likely to be correlated with both labour market variables and BER construction expenditure, making these criteria unsuitable as instrumental variables. These considerations combined with data availability issues suggest that the number of primary and special, secondary and combined schools per capita at the beginning of the school year would make appropriate instrumental variables for BER construction expenditure. Data concerning school types, numbers and locations at the beginning of the 2009 academic year are available from the ACARA School Profile database. This data was geocoded to the ASGS 2011 SA4 level using the AURIN Portal, and normalised based on the 2008 working age population consistent with other variables used in estimation.

In the model each interaction between BER construction expenditure per capita and a date fixed effect is an endogenous variable implying that the first stage for equation (4) is actually a series of equations, with one equation for each interaction of BER p.c_c with date fixed effects $\tau \in [2007Q1, 2014Q4], \tau \neq 2008Q4$ of the following form:

$$\begin{aligned} \sum_{Y=2007}^{2014} \beta_Y \text{BER p.c}_i \times I(\tau \in [YQ1, YQ4], \tau \neq 2008Q4) \\ = \alpha_i^\tau + \lambda_t^\tau + \lambda_t^\tau \times \text{State}_j + \alpha_i^\tau \times t \\ + \sum_{Y=2007}^{2014} I(\tau \in [YQ1, YQ4], \tau \neq 2008Q4)) \times \mathbf{Schools_i^{'}} \mathbf{\Theta_t^\tau} \\ + \sum_{t:t\neq 2008Q4} \lambda_t \times \mathbf{X_i^{'}} \mathbf{\Gamma_t^\tau} + \delta^\tau Pop_{i,t} + \upsilon_{i,t}^\tau \end{aligned} \tag{5}$$

Where $\mathbf{Schools_i^{'}}$=[Primary and special schools per capita, secondary schools per capita, Combined schools per capita] is a vector containing the quantity of school types per capita, $\mathbf{\Theta_t^\tau}$ vary based on each school type, and where τ indexes the date τ first stage coefficients. Again, all per capita variables are expressed as a proportion of the 2008 year working age population.

Following Buchheim and Watzinger (2017) the first stage equation can be identified from cross-sectional variation in the data, and it is possible to get a reasonable indication of instrument strength from a cross-sectional equivalent of equation (5) alone. This is because the system of equations implied by equation (5) can be viewed as a repeated cross-sectional equation for each date and BER expenditure interaction term, and all instruments and controls, with the exception of population growth, are interacted with date fixed effects. Indeed, Table 4 indicates that school numbers per capita are a strong predictor of BER program construction expenditure. The preferred model specification in column (1) indicates that each additional primary or special school in an SA4 is associated with around \$293,000 in BER program construction expenditure. This sits within the second FTE-based funding band for the P21 program, although in practice reflects the combined entitlement to P21 and NSP funding, suggesting that average SA4 level results are likely being driven by SA4s with more smaller schools per head of population. These are likely to be regional and remote SA4s with smaller population and labour force sizes. Each additional secondary school on the other hand is associated with around \$2.2 million in additional BER construction expenditure. This is to be expected based on the fact that the SL21 program was essentially uncapped and intended to fund projects in up to 500 schools, while also factoring in the additional entitlement to NSP funding. Finally, each additional combined school in an SA4 is associated with roughly a \$662,000 average increase in BER construction expenditure - sitting between primary and special schools and secondary schools - as would be expected based on the BER Program Guidelines.

The Shea (1997) minimum partial R^2 indicates the strength of the correlation between instruments and endogenous explanatory variables, controlling for the other explanatory variables in the multivariate model. The Shea partial R^2 indicates that the instruments are highly relevant to BER construction expenditure per capita. The Sanderson and Windmeijer (2016) F statistic involves a two-step procedure where for each first stage equation the remaining endogenous variables and exogenous covariates are initially partialled out, and then the resulting residuals are regressed on the instruments. The F test is then performed on the coefficients of the instruments to assess whether the remaining explanatory power of the instruments is sufficient to identify each first stage equation. As can be seen from table 4, all Sanderson and Windmeijer (2016) F statistics exceed the commonly used critical value of 10. The companion Sanderson and Windmeijer (2016) χ^2 tests of model underidentification also indicate that the model is well identified. Collectively, the tests suggest that the model is identified and there are no concerns with respect to weak instruments.

Table 4: Cross-sectional First Stage Regressions

	BER spending p.c. in \$100,000 (1)	 (2)	 (3)
Primary and special schools p.c	2.93	2.76	2.94
	(1.31)	(1.29)	(1.28)
Secondary schools p.c	21.85	21.72	22.70
	(6.86)	(6.85)	(6.52)
Combined schools p.c	6.62	6.68	6.99
	(0.85)	(0.80)	(0.64)
School age population p.c.	0.02	0.02	0.02
	(0.01)	(0.01)	(0.01)
Hospitals p.c.	5.25	5.35	5.71
	(1.91)	(1.85)	(1.60)
Remoteness index	0.00	0.00	
	(0.00)	(0.00)	
Mining infrastructure p.c.	0.46		
	(0.63)		
State & territory dummies	Yes	Yes	Yes
min(Shea Partial R^2)	0.45	0.44	0.63
Sanderson-Windmeijer χ^2	70.11	69.49	148.62
Sanderson-Windmeijer F	19.34	19.43	42.13
Observations	87	87	87

Notes: The Shea (1997) minimum partial R^2 statistic provides a measure of instrument relevance for multivariate equations. The Sanderson and Windmeijer (2016) χ^2 and F statistics are tests for under-identification and weak identification of each endogenous regressor. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Shea partial R^2 and the Sanderson-Windmeijer F statistic. Robust standard errors are in parenthesis.

Appendix Table A2 presents the complete set of first stage equations for the full specification baseline employment equation in Appendix Table 5 below. Immediately it is clear that the coefficients along the diagonal axis are closely comparable to cross-sectional first stage equation (1) in Table 4. Both coefficients and standard errors are quite close to those contained in the cross-sectional first stage equation, particularly for the time periods closest to the end of 2008, the period to which instruments and controls most closely pertain. By contrast, off-diagonal elements are generally insignificantly different from zero. This reinforces the fact that tests for under-identification and weak instruments from the cross-sectional first stage regression can be informative with respect to the full system of first stage regressions, while economising on space. Overall, the test statistics from the full first-stage equations confirm that schools are very strong instruments for BER construction expenditure, which we would expect given the stated intention of the Australian Government to fund projects in practically every school under the BER program. Schools are relevant instruments, each first stage equation is well identified, and there are no concerns with respect to weak instruments.

The second element of the instrumental variables strategy adopted in this paper is the exclusion restriction requiring $\epsilon_{i,t}$ to be uncorrelated with the instrumental variables. This requires schools to influence employment outcomes only indirectly through their influence on BER expenditure. This partly relates to the requirement that pre-program employment outcomes are independent of BER expenditure ($\beta_{pre} = 0$). Indeed, it will be demonstrated below that estimates for β_{pre} are all indistinguishable from zero in the preferred model specifications as required. After program announcement the exclusion restriction cannot formally be tested; however, as Figure 7 demonstrates, the number of schools in Australia is highly persistent, and is unlikely to be affected by economic conditions over short periods of time such as the sample period in this study. For instance, a regression of schools in 2019 and 2009 controlling only for state and territory dummies yields an R^2 of 0.95, and the correlation between schools in 2019 and 2009 is 0.97. There may be concern that the relatively low persistence of secondary schools gives rise to a weak instruments problem; however, as previously demonstrated, this is not supported in formal testing. Further, secondary schools are excluded as instruments in robustness analysis below without significantly altering the key findings.

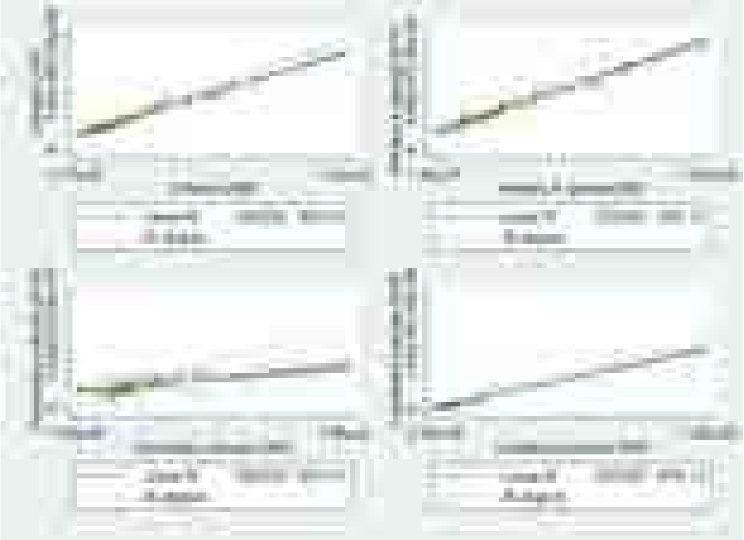

Figure 7: Persistence of Schools per Capita

5 Results

5.1 Primary Results

First, Appendix Table A3 provides underidentification and weak instruments tests for each endogenous regressor in the IV employment, unemployment and NILF equations reported in this subsection. Underidentification and weak instruments tests indicate that all IV models are well identified, and that schools per capita are strong instruments for BER spending per capita. Table 5 sets out the employment effects of the BER program for the average SA4. For the OLS specifications the employment response to program spending is only positive in 2009, and is generally not statistically different from zero at all time horizons. Where no effort is made to control for the mining boom in Appendix Table A3 columns (3) and (6), employment changes are spuriously correlated with program expenditure before the program period due to the positive correlation between mining infrastructure and schools per capita, and the significant contribution of the mining boom to employment in the pre-GFC period. This results in a violation of the parallel trends assumption requiring that β_{pre} is statistically indistinguishable from zero. Including the remoteness index, mining infrastructure per capita or both as controls helps satisfy this identification condition.

In stark contrast to the OLS models, the IV models all suggest a statistically significantly positive response between employment and BER construction expenditure in 2009. These results highlight the significant endogeneity issues surrounding BER program design, where program funding was channelled towards disadvantaged regions experiencing relatively high unemployment. Further, the IV approach of this paper also helps to address attenuation bias related to using noisy small area labour market data to construct the dependent and independent variables. Employment also appears to be higher throughout the program period and beyond; however, program effects are imprecisely estimated beyond 2009. The full model in column (1) suggests that the program created 8.58 jobs per \$100,000 in construction expenditure in the year 2009 alone. On the strong assumption that the BER only created employment in 2009, this implies a cost per job-year saved of only \$11,661 (\$US 9,212) for the Program as a whole that is statistically significant at the 5 per cent level. Assuming the BER only affected employment between 2009-2012 this would imply a cost per job-year saved under the program as a whole between 2009 and 2012 of only $4,147 ($US 3,919) in the average SA4 region; however, this estimate is not statistically significant.

Table 5: BER Average SA4 Employment Effects

	Employed p.c.					
		IV			OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 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)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
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
min(Shea Partial R^2)	0.45	0.44	0.63	-	-	-
Sanderson-Windmeijer χ^2	70.11	69.49	148.62	-	-	-
Sanderson-Windmeijer F	19.34	19.43	42.13	-	-	-
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	44615	65921	21200000
2009-2012 job-years saved	4029000	3886838	3018727	-1010436	-839974	42748
SE job-years saved	4101761	4077783	2576461	2726229	2783659	2316598
Observations	2784	2784	2784	2784	2784	2784

Notes: The minimum Shea Partial R^2 is a measure of instrument relevance derived again from the cross-sectional first stage regression. The Sanderson and Windmeijer (2016) χ^2 and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the minimum Shea partial R^2 and the Sanderson-Windmeijer F statistic. Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year=\$100,000/(β_{2009}), and cost per 2009-2012 job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$). 2009 job-years saved = 167086.24 × β_{2009}, 2009-2012 job-years saved = 167086.24 × ($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for cost per job-year 2009, cost per job-year 2009-12, 2009 job-years saved and 2009-2012 job-years saved are calculated using the Delta method.

The estimated cost per job-year saved of $11,661 ($US 9,212) in 2009 alone places the

Program amongst the lowest in terms of costs per job saved in the geographic cross-sectional employment multiplier literature. The only lower estimate of costs per job saved is Corbi et al. (2019) with $US 8,000. It should be noted that public investment programs undertaken during recessionary periods have been demonstrated to have amongst the highest geographic cross-sectional employment multipliers in the literature (see Leduc and Wilson, 2013; and Buchheim and Watzinger, 2017). Consistent with Buchheim and Watzinger (2017), the peak employment response coincides with the period of peak construction activity under the Program, which in this instance was 2009, and Program effects are statistically insignificant at other time horizons. Buchheim and Watzinger (2017) found a peak program impact of 2.90 jobs per €100,000 in 2011, interestingly converting the IV employment equations predicted job-years saved into Euro-equivalent terms implies between 2.25 and 3.06 jobs saved per €100,000 for Australia in 2011, albeit imprecisely estimated.

It should also be stressed that the effects in question relate to the employment impact in the average SA4 region, and are not directly relatable to aggregate employment outcomes. Estimates of costs per job-years saved and jobs saved based on the average SA4 level are likely to overstate aggregate program effects for a number of reasons.

First, Australian SA4s are relatively heterogeneous in size, with the average SA4 comprising 196,699 workers in 2008, with a standard deviation of 99,429, a minimum SA4 size of 29,032 workers, and a maximum size of 509,515 workers. If program spending per capita was greater in small SA4s relative to large SA4s, then the impact on employment in the average SA4 may overstate the impact on employment in the economy as a whole. Indeed, this was the case with smaller SA4s by working age population generally displaying higher school and BER investment to population ratios than larger SA4s. Alternatively, geographic spillovers between SA4s can result in upwards or downwards bias in estimates of aggregate multipliers which is formally assessed in subsection 5.5 below.

Further, the modelling framework adopted in this paper also holds variables determined at the aggregate level such as national monetary policy and the exchange rate constant. The question of more closely relating geographic cross-section employment effects for Australian SA4s to aggregate employment effects and multipliers is addressed in subsection 5.7 below. Overall, despite the caveats, the baseline results suggest that the BER program had a highly significant positive impact on employment in the average SA4, particularly in 2009.

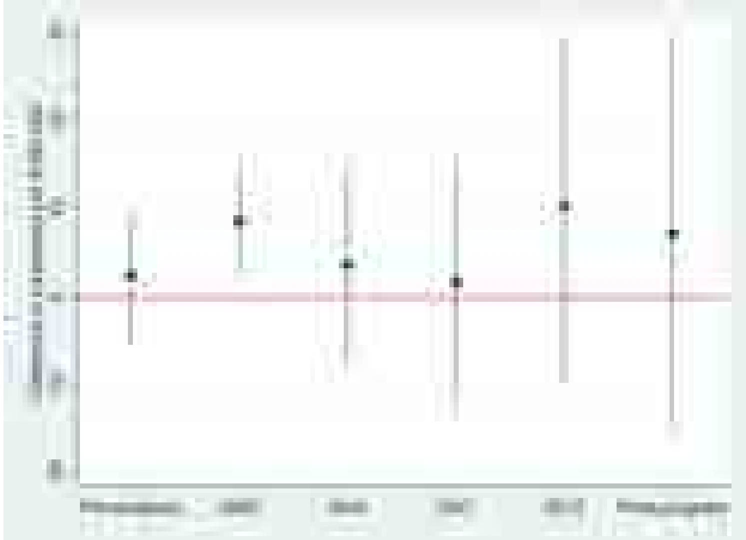

Figure 8: BER Employment Effects

Figure 8 plots annual impulse responses for the full employment equation in column (1) of Table 5. From this Figure it can clearly be seen that employment effects of the BER program were front loaded in 2009, the period of peak building activity. This front-loading of employment benefits was also observed by the BER Implementation Taskforce (Australian Government, 2010b), although it appears that they may have significantly underestimated the employment benefits of the program. There may also have been a second peak in employment multipliers associated with the 2012. This challenges the commonly held view that spending incurred later in the program period was of limited benefit (see Lewis et al., 2014), albeit with low degrees of statistical precision.

Given that this period coincides with the collapse of Australia's terms-of-trade boom in the latter part of 2011, these results may indicate that employment multipliers may have varied based on aggregate capacity utilisation as suggested by Adelino et al., (2017), Cohen et al. (2011), Dube et al. (2018), Leduc and Wilson (2013), Nakamura and Steinsson (2014), Shoag (2016), and Suárez Serrato and Wingender (2016). The question of whether employment effects varied based on pre-program capacity utilisation at the SA4 level is formally addressed in subsection 5.6 below. Alternatively, or additionally, these results also appear reminiscent of Leduc and Wilson (2013) who found a secondary spike in multipliers after six years that exceeded initial the impact multiplier related to US highway infrastructure investment. They find this secondary spike was unrelated to business cycle conditions, and hence they speculate that it is related to positive supply side spillovers associated with highway investment.

Appendix Table A4 sets out the impact of the BER program on unemployment in the average SA4. The BER is found to have a statistically significant negative impact on unemployment in 2009 in the IV specifications. Each $100,000 in BER program spending is estimated to reduce unemployment by around 3 people on average in 2009 in the average SA4. Focusing on comparing full model specifications in columns (1) of Table 5 and Appendix Table A4 respectively, around 36 per cent of the employment impact of the program in 2009 was associated with reducing unemployment. This compares to 50 per cent in the period of peak policy impact in Buchheim and Watzinger (2017). In contrast to results with respect to employment above and NILF status that will be formally examined below, there is some evidence that the reductions in unemployment generated by the program were unwound towards the end of the program, and into the post-program period. Again unemployment multipliers and estimates of costs per job-year saved, and job-years saved based on the average SA4 are only statistically significant at the 5 per cent significance level during the period of peak program impact in 2009.

Appendix Table A5 reports the impact of BER construction expenditure between 2009 and 2012 on NILF status in the average SA4 through until the end of 2014. Each $100,000 in BER program expenditure was associated with over 5 fewer workers leaving the labour force in 2009 in the average SA4, with results significant at the 10 per cent significance level. Focusing on comparing the full model specifications in columns (1) of Table 5 and Appendix Table A5 respectively, 63 per cent of the employment increase in 2009 can be associated with preventing employees exiting the labour force entirely. Therefore, roughly one third of the employment gains in 2009 related to reducing unemployment, and two thirds to preventing labour force exit. While estimates of job-years saved based on the average SA4 may be misleading with respect to the aggregate number of jobs saved nationally under the program, it is reassuring that adding estimates of job-years saved based on the unemployment equations in Appendix Table A4 and NILF equations in Appendix Table A5 aggregate closely to estimates of job-years saved in the employment equations reported in Table 5. It is also reassuring that the annual impulse responses for employment are closely mirrored by the combined changes in unemployment and NILF status over the entire post-2009 period.

5.2 Model Robustness

Appendix Table A6 presents a range of model robustness checks with respect to the baseline employment equation. First, two alternative estimation strategies are employed. The first alternative estimation strategy estimates the preferred model in Table 5 using limited information maximum likelihood (LIML) techniques rather than two stage least squares (2SLS). The LIML estimator is less prone to bias related to weak instruments; however, is generally less precise than the 2SLS estimator. Using the LIML estimator does not significantly alter the results based on 2SLS estimation (Row 1).

Second, following Acconcia et al. (2014) and Dupor and Saif Mehkari (2016) estimation is weighted based on each SA4s working age population. This alters the interpretation of results, as they no longer relate to employment in the average SA4, but rather average employment for the Australian economy as a whole (see Solon et al., 2013; and Autor et al., 2020). The overwhelming majority of papers in the geographic cross-sectional fiscal multiplier literature do not use probability weighting in estimation. Nonetheless, weighting estimates may help address the potential issue of less precise measurement of employment in smaller SA4s, which is likely to be the case in Australia where small area labour force data is estimated rather than administrative data. Weighted estimation results in lower, and statistically insignificant estimates of β_{2009} (Row 2), although point estimates and standard errors between the baseline estimation methodology and weighted estimation overlap. While weighting estimation might help address concerns related to measurement error in smaller SA4s, a related concern is that it mechanically reduces estimates of program effectiveness in regions where the most program expenditure actually occurred. This subject is addressed in greater detail in subsection 5.7 below which concerns relating the impact of the BER program to national employment and output outcomes.

The second set of robustness checks makes adjustments to the instrument set. First all schools per capita are used as instruments instead of disaggregated primary and special, secondary and combined schools per capita. This results in slightly lower estimates for β_{2009} than the preferred approach, although they are statistically indistinguishable (Row 3). Similar results are obtained when secondary schools per capita are dropped from the instruments list (Row 4). These differences are to be expected because information regarding how funding was allocated under the BER scheme on a differential basis determined by school type is effectively thrown away when schools are aggregated or individual school types are dropped from the instruments list.

The final set of robustness checks employs additional or variations in control variables in the full employment model in column (1) of Table 5. Firs, including SA4-specific quadratic time trends results in larger estimates of β_{2009} (Row 5), while removing all SA4-specific deterministic time trends results in lower estimates of β_{2009} (Row 6). Standard F tests support the linear time trend model, and provide some support for the quadratic model also; however, the linear model is preferred to reduce the risk of over-fitting, and bias especially later in the program period. Removing date and state and territory fixed effects (Row 7), and all deterministic time trends and date and state and territory fixed effects (Row 8) also results in lower estimates of β_{2009}; however, the differences are statistically indistinguishable from estimates derived from the baseline model. In the baseline equation mining infrastructure per capita includes operating mines, mineral processing facilities and ports. As an alternative, Row (9) uses mines per capita alone, while Row (10) excludes port facilities. The alternative mining controls have no significant effect on estimates of β_{2009}.

Row (11) includes universities per capita as at 2008 interacted with date fixed effects as an additional control. This follows Buchheim and Watzinger (2017), and in the Australian context can be motivated by the large influx of student visa arrivals into Australia with working rights just prior to the program period. Overseas students are typically the largest category of temporary residents in Australia with working rights at any point in time (ABS Census, 2016). While universities per capita are correlated with employment, they are only weakly correlated with construction expenditure under the BER program, and therefore the inclusion of universities per capita as an instrument for temporary migration does not significantly alter estimates of β_{2009}. Rows (12) through (14) control for different profiles of population growth by gender, age, and both gender and age cohort. The inclusion of these controls result in only minor differences in estimated β_{2009} values.

In summary, while there is a degree of variation between estimates of β_{2009} across different model specifications, they all predict a very large impact of BER construction expenditure on employment in the average SA4 in 2009, and all alternate estimates of β_{2009} are within one standard deviation of those presented in the baseline model specification. The estimate of β_{2009} is only statistically insignificant when estimation is conducted on a working age population weighted basis. There is no necessity to weight estimation when seeking to assess the casual impact of the BER program on employment outcomes in the average SA4. Weighting estimation by working age population is a relevant consideration when seeking to discern BER program impacts on average employment at the national level. This subject is addressed in greater detail in subsection 5.7 below.

5.3 Program Effects by Gender

The 2020 Australian Government Budget, and policy response to COVID-19 has been criticised for focusing disproportionately on male dominated sectors of the economy, including construction (see Woods et al., 2020). Meanwhile Richardson and Dennis (2020) claim that every million dollars of construction spending creates only 0.2 direct jobs for women. This is because the Australian construction industry is highly male dominated, with women comprising 13.8 per cent of the industry in 1998, declining to 12 per cent in 2018 (WGEA, 2019). Therefore, it is interesting to consider the gender differential impact of the BER program, which focused on increasing employment in the construction sector through large-scale school infrastructure investment.

Appendix Table A7 provides estimation of the full models for employment, unemployment and NILF status using gender disaggregated data. Despite the heavily gender segregated nature of the construction industry, the program is estimated to have created 3.94 job-years per \$100,000 for women in 2009, or just under two-thirds of the 5.99 job-years per \$100,000 for men, and these effects are statistically indistinguishable at the 5 per cent significance level. Although levels of confidence in the results are much lower, the cumulative job-years saved per \$100,000 between 2009 and 2012 in the average SA4 was 12.53 for women, and 13.36 for men. Job-years saved estimates over the entire 2009 to 2012 period are not significant at the standard 5 per cent significance level, and the impact of the program on men and women's employment is statistically indistinguishable over the entire 2009 to 2012 period.

Gender differential policy impacts are most pronounced with respect to the distribution of employment gains between reducing unemployment and labour force withdrawal. The program is estimated to have reduced unemployment amongst men by 2.64 job-years per $100,000 in the average SA4 in 2009, compared to a statistically insignificant 0.47 job-years for women. Between 2009 and 2012 the program reduced unemployment by 2.16 persons per $100,000 amongst men in the average SA4, and effectively zero for women. However, in 2009 there are estimated to be 3.48 more women in the labour force per $100,000 invested under the BER program in the average SA4, almost 75 per cent higher than the statistically insignificant 2.00 more men in the labour force. However, over the entire 2009 to 2012 period there were estimated to be cumulatively 12.78 more women in the labour force in the average SA4, compared to 9.13 men. Although again, confidence intervals for these estimates are very wide, and they are not significant at standard significance levels.

Overall, the evidence suggests relatively similar employment benefits for men and women under the program; however, an uneven distribution of benefits between unemployment and NILF status. Interestingly, gender disaggregated impacts on employment, unemployment and NILF status sum quite closely to total impacts at each point in time; and gender disaggregated results for unemployment and NILF status sum reasonably closely to gender disaggregated employment impacts also. These observations provided added confidence concerning the empirical validity of the model framework employed in estimation.

5.4 Employment Effects by Age

A cited benefit of the program was that it helped avert the de-skilling of the Australian economy- with training commencements falling by 20 per cent in 2008-09, but then rebounding to record levels in 2010 (Australian Government, 2010b). A much smaller and more temporary decline than was associated with the early 90s recession. If this was the case we should expect employment benefits to be concentrated amongst younger age cohorts.

Table A8 provide results disaggregated by demographic cohorts. Strikingly, employment effects are strongly concentrated amongst those aged 25-34. Indeed, statistically significant program effects at the 5 per cent significance level are *only* detectable amongst 25-34 year olds and 35-44 year olds. Focusing on results that are significant at the 5 per cent significance level only, the program is estimated to have created 3.18 jobs per $100,00 amongst 25-34 year olds in 2009, and 2.37 jobs per $100,00 amongst 35-44 year olds. Interestingly, the program also appears to have generated 8.08 jobs per $100,000 in 2012, and 8.64 jobs per $100,000 in the post-program period amongst 25-34 year olds also. This is potentially consistent with multipliers increasing following the terms of trade crash in late 2011, or alternatively beneficial second round supply side benefits, possibly related to the view expressed by the BER Implementation Taskforce that the program had a positive impact on skill and human capital development (Australian Government, 2011). The cost per job year between 2009 and 2012 for 25-34 year olds is a mere $5,000 ($US 4,725) per job-year saved that is statistically significant at the 5 per cent level, and implies over 3 million jobs saved cumulatively amongst 25-34 year olds alone- although the above caveats about translating results for the average SA4 to aggregate labour market effects continue to apply. Again, the question of national level impacts for 25-34 year olds will be addressed in subsection 5.7 below.

Returning to the theme of skill and human capital development, BER Program Guidelines (2009) stipulated that at least 10 per cent of total contract labour hours should be undertaken by apprentices and trainees. The BER Implementation Taskforce Report (Australian Government, 2011) noted that this target had been achieved nationally with 12.7 per cent of direct employment under the BER program being apprentices. Despite this fact, Table A8 column (1) suggests that the program had no discernable impact on employment amongst 15 to 24 year olds. This could reflect the fact that the program requirement for apprentice and trainee labour could be achieved without requiring employers to employ *additional* employees within the 15-24 age range. Another fascinating finding is that no statistically significant employment effects are discernable at the average SA4 level for those aged 45 and above. The fact that significant demographic groupings do not appear to have benefited from the program may help explain how program detractors were able to successfully disseminate the view that the program had not provided value for money to taxpayers.

5.5 Geographic Spillovers

A potential concern regarding any modelling approach that utilises 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. Employment effects may be over-estimated if increased employment in one region came at the expense of lower employment in neighbouring regions, and underestimated if demand spillovers helped generate higher levels of activity and employment in neighbouring regions. To empirically test the impact of geographic spillovers this paper follows the approach of Acconcia et al. (2014) by including BER investment in all neighbouring SA4s as additional controls. Appendix Table A9 provides underidentification and weak instruments tests, and suggests that all models are well identified, and weak instruments are not a significant concern.

The preferred models in columns (1) and (2) of Appendix Table A10 indicates that controlling for regional spillovers has no statistically discernable impact on the central employment estimates presented above. However, there is some weak evidence suggesting that positive geographic spillovers may have increased as the program continued. For instance, although statistically indistinguishable, cumulative employment effects between 2009 and 2012 for the models in column (1) and (2) are 28 and 55 per cent larger respectively than those in the comparable models estimated without controlling for geographic spillovers. The results are consistent with Buchheim and Watzinger (2017) who find no impact on estimates of costs per job-year saved due to geographic spillovers, and partially consistent with Acconcia et al. (2014), Dube et al. (2018), Dupor and McCrory (2018), Nakamura and Steinsson (2014), and Shoag (2016) who find positive employment spillovers.

5.6 State Dependent Employment Effects?

The BER Implementation Taskforce (Australian Government, 2010b) claimed that, up until the time of publication of their first report in December 2010, the stimulus effects of the BER program were most pronounced in regions experiencing the greatest spare capacity in the construction industry, and that in these regions the BER was the most effective in the first year following announcement. The BER implementation Taskforce engaged SGS Economics and Planning to estimate regional employment effects for the BER program for their December 2010 First Report, and based on the above evidence it already appears that this consultancy most likely significantly underestimated the size of the employment benefits of the program in its initial stages. It is also unclear how employment effects and their geographic distribution were arrived at by SGS Economics and Planning. While we have found evidence consistent with large program benefits in 2009 in the average SA4, did the program demonstrate state dependent effects related to the unemployment rate in each SA4 just before the beginning of the program?

Following Adelino et al., (2017), in order to assess whether employment multipliers varied based on the state of the business cycle, a triple interaction term is included in the model to capture the effect of BER spending in SA4s that had above median unemployment in the reference period, the December quarter of 2008. Appendix Table A12 presents the estimation results, and Appendix Table A11 presents full tests for model identification and weak instruments. Each added interaction term represents an additional endogenous regressor, and therefore the number of instrumental variables is doubled in this model. The Sanderson and Windmeijer (2016) χ^2 statistics indicate the the model is well identified in this specification, and the F statistics exceed the rule-of-thumb critical value of 10 for all but two endogenous regressors, suggesting weak instruments are not a significant concern.

As has already been discussed, it appears possible that multiplier size may have varied with respect to the *aggregate* business cycle conditions - with higher multipliers in 2009 and 2012, and lower multipliers in 2010 and 2011. However, it does not appear that multiplier size was affected by the level of economic slack in individual SA4s during the reference period in contrast to the findings of Leduc and Wilson (2013), Adelino et al., (2017), Shoag (2016), Suárez Serrato and Wingender (2016), and Dube et al. (2018). This result is however consistent with Nakamura and Steinsson (2014) who find no statistically significant difference between employment multipliers between high and low slack periods.

It is important to observe that, with the exception of Adelino et al., (2017) and Dube et al. (2018), the level of geographic aggregation used in this study is generally lower than that typically used in the other papers in the literature that seek to estimate state dependent multipliers. Potential geographic spillovers identified in subsection 5.5 may also help explain why the degree of slack in particular SA4s does not significantly influence average SA4 employment multiplier size. Further, many of the SA4s with relatively high unemployment at the outset of the program tended to be small and remote, and related structural challenges may have contributed to both high unemployment and constrained program efficacy in these areas. For instance, and related to the issue of geographic spillovers, workers from larger neighbouring SA4s may have been required to deliver projects in smaller more remote SA4s. Indeed, ANAO (2010) present evidence suggesting that this was the case.

It is also possible that BER program design elements may have contributed to the uniformity of multipliers between high and low unemployment SA4s. The prevalent use of standardised project design templates, and centralised program implementation through state and territory government education authorities and BGAs, meant that there was a relatively high degree of uniformity in project design and scope, which might have contributed to more uniform program employment effects across SA4s in comparison to other studies. A final observation is that the relative employment impact on individual regions observed by the BER Implementation Taskforce in their First Report (Australian Government, 2010b) varied over a very narrow range between 0 and 1.5 per cent. Therefore, at the time of publication of the First Report, differences in comparative employment performance between labour market regions were not very significant in any event.

5.7 Relevance of Results for National Employment, Output and Wage Multipliers

Up until this point, the geographic point of reference has been the average SA4 region in Australia. While this has helps facilitate comparison with the majority of papers in the literature, and establish that the program had a causal impact on employment outcomes at the average SA4 level, there are a number of reasons to be concerned that analysis at this level could be misleading when trying to assess the impact of the program on national labour market outcomes as a whole between 2009 and 2012.

First, as previously noted Australian SA4s are relatively heterogeneous in size varying between 29,032 and 509,515 workers. Analytical weighting using SA4 working age population can help make results more representative of average labour market effects at the national level. Further, given that Australian labour force survey data is estimated, and not administrative data, there may be concerns that estimates of labour force outcomes from smaller SA4s are less precise than those from larger SA4s. On the other hand, BER investment was skewed towards smaller SA4s that had a higher number of schools per capita, and therefore a potential concern with analytic weighting is that it mechanically down-weights evidence coming from SA4 regions where higher levels of BER construction expenditure per capita actually occurred. In the interests of full transparency both unweighted and weighted are presented in this paper. In practice, although weighted estimates of program effects are lower and less precise, as would be expected, they are within the 95 per cent confidence intervals of unweighted estimates.

Another issue that can make the results expressed at the average SA4 level unrepresentative of aggregate economic outcomes is the possibility of geographic spillovers as canvassed in section 5.5. Therefore, here we re-estimate the full employment equation from column (1) of Table 5 using working age population analytic weights, and including controls based on BER construction expenditure in neighbouring SA4s. As previously discussed, date fixed effects also control for factors determined above the SA4 level, including changes in national interest rates, and the exchange rate for example.

Table 6 presents results from estimating column (1) of Appendix Table A10 with analytic weights based on SA4 working age population. Firstly, it can be seen that weighting estimates results in lower and less precise estimates of job-years saved per $100,000 spent at all time horizons. Estimates of aggregate job-years saved per $100,000 are only significant at the 20 per cent level in 2009, although there are similar parameter estimates and statistical significance at the 10 per cent level if SA4 specific time trends are dropped. Estimation is conducted with SA4 specific time trends to retain consistency with estimates presented in the rest of the paper. The aggregate cost per job-year saved is $19,963 ($US 15,771) based on 2009 estimates alone, and $5,633 ($US 4,450) based on cumulative aggregate job-years per $100,000 between 2009 and 2012. These estimates are significantly lower than official estimates of the cost per job saved under the entire program, which were around $135,000 per job saved (Australian Government, 2010b). As in all sections above, cumulative estimates of aggregate costs per job-year saved between 2009 and 2012 are not statistically significant. These results translate into just over 800,000 job-years saved on average in 2009, and almost 3 million job-years saved cumulatively between 2009-2012; albeit again with very low confidence in the cumulative number of jobs saved between 2009 and 2012. Although less precisely estimated, the results are not statistically different to unweighted estimates presented in Appendix Table A10 column (1). While there is relatively low confidence in the results, there is suggestive evidence that the program had a very large impact on average employment nationally.

Table 6: Implications for Aggregate Employment and Output

	2009	2010	2011	2012	Cumulative
Aggregate job-years per \$100,000	5.01	2.40	3.22	7.12	17.75
SE job-years	(3.85)	(6.24)	(7.29)	(9.86)	(25.10)
p value ($\beta_Y =$ Column (1) Table A10)	0.38	0.60	0.84	0.56	0.57
Aggregate cost per job-year	19963	41693	31032	14043	5633
SE cost per job-year	15350	108525	70231	19441	7967
Aggregate job-years saved	836976	400751	538421	1189815	2965963
SE job-years saved	(643556)	(1043128)	(1218521)	(1647148)	(4194414)
Output multiplier	4.14	2.00	2.71	6.12	14.96
min(Shea Partial R^2)	0.34	0.34	0.34	0.34	-
Sanderson-Windmeijer χ^2	588.33	575.96	595.45	699.57	-
Sanderson-Windmeijer F	18.50	18.11	18.72	22.00	-

Notes: Model includes time and date fixed effects, SA4 specific linear time trends, state and territory times date fixed effects. SA4 specific characteristics include date fixed effects multiplied by: the school age population per capita, hospitals per capita, remoteness index, and mining infrastructure per capita. Estimation is weighted by the working age population, and geographic spillovers are controlled for using primary and special schools, secondary schools and combined schools per capita as instruments for BER investment in adjoining SA4s. The Sanderson-Windmeijer chi-squared and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the first stage equations. The Shea Partial R^2 is a measure of instrument relevance derived again from the first stage equations for each endogenous regressor. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Shea partial R^2 and the Sanderson-Windmeijer F statistic. For aggregate job years robust standard errors clustered at the SA4 level are in parentheses. For aggregate job-years per \$100,000 robust standard errors clustered at the SA4 level are in parentheses. Aggregate cost per job-year saved=\$100,000/(β_Y), cumulative aggregate cost per job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$), aggregate job-years saved=\$167086.24/(β_Y), and cumulative aggregate job-years saved=\$167086.24/($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for aggregate cost per job-year saved and aggregated job-years saved are calculated using the Delta method. The output multiplier is calculated using the method of Chodorow-Reich (2019) where $\beta_Y \approx (1-\alpha)(1+\chi)(\text{Cost per Job-Year})^{-1} Y/E$, where $\alpha \approx 0.33$ and the elasticity of hours per worker with respect to total employment is $\chi = 0.46$ based on Dixon et al. (2004).

In Table 6 approximate ‘closed economy, no monetary policy response’ output multipliers are reported based on the approach of Chodorow-Reich (2019). Rodgers and Hambur (2018) find output multipliers of 4 in Australia in 2009 related to a private sector investment allowance, essentially identical to the results for public investment found here. Further, the results of Leduc and Wilson (2013) suggest geographic cross-sectional impact multipliers of 3.7 for US highway investment with peak impact multipliers as high as 8 after six years, with impact multipliers twice as large during recessions. The Chodorow-Reich (2019) multiplier for 2009 is roughly half as large as the impact multiplier suggested by Leduc and Wilson (2013), and the second round effects reported in 2012 roughly three-quarters as large. The finding of lower multiplier estimates is consistent with the notion that school investment may not be as complementary to private sector output as highway construction, and would not be expected to generate the same supply-side benefits as highway construction.

Obviously, a disappointing aspect of the above national level analysis is that employment effects are insignificant at conventional significance levels. How then can we be confident that the BER program influenced national level labour market outcomes? One way to address these concerns is to repeat the analysis above only with reference to the 25-34 year old cohort, where highly statistically significant results were revealed at the average SA4 level. Indeed, Table 7 suggests a cumulative cost per job-year of $8,557 ($US 8,086) between 2009 and 2012 that is statistically significant at the 10 per cent level when only 25-34 year olds are taken into account. This implies almost 2 million job-years saved on average for 25-34 year olds alone under the BER program, which is roughly two thirds of the almost 3 million imprecisely estimated using all age cohorts in table 6 above. Disaggregated estimates suggest that over 500,000 job-years were saved by the program at the national level in 2009, and over 800,000 in 2012 amongst 25-34 year olds alone- and these results are both statistically significant at the 5 per cent significance level. This provides some reassurance that the imprecisely estimated national level results for all age cohorts presented above are underpinned by stronger age-disaggregated results in the case of 25-34 year olds.

Table 7: 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	-

Notes: Model includes time and date fixed effects, SA4 specific linear time trends, state and territory times date fixed effects. SA4 specific characteristics include date fixed effects multiplied by: the school age population per capita, hospitals per capita, remoteness index, and mining infrastructure per capita. Estimation is weighted by the 25-34 year old working age population, and geographic spillovers are controlled for using primary and special schools, secondary schools and combined schools per capita as instruments for BER investment in adjoining SA4s. The Sanderson-Windmeijer χ^2 and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the first stage equations. The Shea Partial R^2 is a measure of instrument relevance derived again from the first stage equations for each endogenous regressor. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Shea partial R^2 and the Sanderson-Windmeijer F statistic. For aggregate job-years per $100,000 robust standard errors clustered at the SA4 level are in parentheses. Aggregate cost per job-year saved=$100,000/($\beta_Y$), cumulative aggregate cost per job-year=$100,000/($\sum_{Y=2009}^{2012} \beta_Y$), aggregate job-years saved=$167086.24/($\beta_Y$), and cumulative aggregate job-years saved=$167086.24/($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for aggregate cost per job-year saved and aggregated job-years saved are calculated using the Delta method. The output multiplier is calculated using the method of Chodorow-Reich (2019) where $\beta_Y \approx (1-\alpha)(1+\chi)(\text{Cost per Job-Year})^{-1} Y/E$, where $\alpha \approx 0.33$ and the elasticity of hours per worker with respect to total employment is $\chi = 0.46$ based on Dixon et al. (2004).

6 Theoretical Results- Motivating Large Geographic Cross-sectional Fiscal Multipliers

As discussed above, Chodorow-Reich (2019) demonstrates how cost per job-year saved estimates derived from applied micro-econometric approaches like those used in this paper can be related to 'closed economy, no monetary response' output multipliers. Historically, standard Real Business Cycle and New Keynesian models have difficulty generating government investment multipliers as large as those found above. Although, Leduc and Wilson (2013) and Nakamura and Steinsson (2014) develop models that can generate large sub-national fiscal multipliers utilising Greenwood, Hercowitz, and Huffman (1988) (GHH) preferences. While this preference specification has found some empirical support (see Cai et al., 2019), Auclert and Rognlie (2017) indicate that in the simple New Keynesian model they make the fiscal multiplier proportional to the elasticity of substitution on intermediate goods- a structural parameter that in the real world would appear to have little practical significance for the magnitude of fiscal multipliers.

In the below, we develop a medium scale DSGE model that can motivate large 'closed economy, no monetary policy response' fiscal multipliers utilising heterogeneous households, and learning-by-doing in the production technology. The model extends the simple open economy TANK model featuring hysteresis in Watson and Tervala (2021) to include public and private investment and a more realistic fiscal structure. In this model the government levies distortionary taxes on labour, consumption and firm profits to fund government consumption, transfer payments to non-Ricardian households, and public sector investment.

6.1 Workers

A fraction $1-\lambda$ of workers are assumed to have access to credit and asset markets and can smooth consumption over time. These workers are referred to as Ricardian workers. Conversely, λ non-Ricardian workers are liquidity constrained and can only consume out of current income and endowments. The utility function for all workers is identically given as follows

$$U_t(z) = E_t \sum_{s=t}^{\infty} \beta^{s-t} \epsilon_s^{TP} \left[logC_s - \frac{(N_s(z))^{1+1/\varphi}}{1+1/\varphi} \right] \tag{6}$$

Where E_t is the expectations operator, β is the worker's discount rate, ϵ_s^{TP} is a time preference shock, C_s is an index of real consumer goods and services, $N_s(z)$ is workers' labour supply in hours, and φ is the Frisch elasticity of labour supply.

Ricardian workers have access to debt and asset markets, receive dividends from firms, and pay income and consumption taxes to Government. The nominal resource constraint for Ricardian workers is given as follows

$$\begin{aligned}\frac{R_t^{-1}B_{t+1}}{1-\lambda} &= \frac{B_t}{1-\lambda} + (1-\tau_t^y)w_t N_{R,t} + \frac{(1-\tau_t^y)}{1-\lambda}(r_t^K K_t + v_t) \\ &- (1+\tau_t^c)P_t C_{R,t} - \frac{1}{1-\lambda}\left(P_t I_t + \frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t\right)\end{aligned} \tag{7}$$

Where $N_{R,t}$ and $C_{R,t}$ are the labour supply and consumption of Ricardian workers, B_t is the nominal price of government bonds with a pay off of \$1 dollar in period $t+1$, r_t is the nominal return on bonds, w_t is the nominal wage, v_t are financial returns of firms with full dividend imputation implying that these are taxed at the same rate as labour income, τ^y and τ^c are income and consumption tax rates respectively, r_t^k is the return to private capital, I_t is private investment, quadratic adjustment costs are given by $\phi(\cdot) = \frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2$, and δ is the depreciation rate of private sector physical capital. Capital accumulation for Ricardian households proceeds in the usual manner

$$K_{t+1} = (1-\delta)K_t + I_t \tag{8}$$

The optimality conditions for Ricardian workers are given as follows

$$\beta R_t E_t\left(\frac{\epsilon_{t+1}^{TP}(1+\tau_t^c)P_t C_{R,t}}{\epsilon_t^{TP}(1+\tau_{t+1}^c)P_{t+1}C_{R,t+1}}\right) = 1 \tag{9}$$

$$N_{R,t}(z) = \left(\frac{(1-\tau_t^y)w_t}{C_{R,t}(1+\tau_t^c)P_t}\right)^{\varphi} \tag{10}$$

$$q_t = 1 + \phi\left(\frac{I_t}{K_t} - \delta\right) \tag{11}$$

$$q_t = E_t\left\{\Lambda_{t,t+1}\left[(1-\tau_{t+1}^y)r_{t+1}^K + q_{t+1}(1-\delta) - \phi_{t+1} + \left(\frac{I_{t+1}}{K_{t+1}}\right)\phi_{t+1}^{'}\right]\right\} \tag{12}$$

Where $\Lambda_{t,t+1} = \beta\left(\frac{C_{R,t}}{C_{R,t+1}}\right)$

Each non-Ricardian worker receives income from working for firms and Government transfer payments, and pays income and consumption taxes to government. However, they do not have access to credit markets and have no residual claims over firm profits. The non-Ricardian workers optimality conditions are therefore defined as follows

$$(1+\tau_t^c)P_t C_{N,t} = (1-\tau_t^y)w_t N_{N,t} + \omega\frac{G_t^T}{\lambda} \tag{13}$$

$$N_{N,t}(z) = \left(\frac{(1-\tau_t^y)w_t}{C_{N,t}(1+\tau_t^c)P_t}\right)^{\varphi} \tag{14}$$

Aggregate consumption and labour supply are then defined as

$$C_t = \lambda C_{N,t} + (1-\lambda)C_{R,t} \tag{15}$$

$$N_t = \lambda N_{N,t} + (1-\lambda)N_{R,t} \tag{16}$$

6.2 Firms

Following D'Alessandro et al. (2019) the production technology of firms is given as follows

$$Y_t(z) = K_t(z)^{\alpha}(N_t(z)X_t)^{1-\alpha}K_{G,t}^{\phi_{kg}} \tag{17}$$

With $Y_t(z)$ representing the output of firm z, $K_t(z)$ and $N_t(z)$ representing physical capital and labour inputs respectively, $K_{G,t}$ is public capital, ϕ_{kg} is the elasticity of output with respect to public capital, and X_t represents the skill level of the average worker. According to this production technology, firm productivity increases in the skill level of the average worker as in Chang et al. (2002). 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

$$X_t = X_{t-1}^{\rho_x} N_{t-1}^{\mu_l}(z) \tag{18}$$

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

Under the assumption of competitive markets for factor inputs, cost minimisation implies a common capital-labour ratio

$$\frac{K_t(z)}{N_t(z)} = \frac{\alpha}{1-\alpha}\frac{w_t}{r_t^K} \tag{19}$$

where w_t and r_t^K denote the nominal wage rate and rental cost of private sector capital respectively. Firm marginal cost can then be defined as follows

$$MC_t(z) = \left(\frac{w_t}{1-\alpha}\right)^{1-\alpha}\left(\frac{r_t^K}{\alpha}\right)^{\alpha} X_t^{\alpha-1} K_t^G(z)^{-\phi_{kg}} \tag{20}$$

Under Calvo (1983) pricing firms seek to maximise the discounted present value of expected future profits $v_t(z)$

$$\max_{p_t(z)} v_t(z) = E_t \sum_{s=t}^{\infty} \gamma^{s-t} Q_{t,s} \frac{v_s(z)}{P_s} \tag{21}$$

where $1-\gamma$ is the probability that a firm can change its price each period. With the stochastic discount factor between periods t and s given by $\xi_{t,s}$, the solution for $p_t(z)$ is

$$p_t(z) = \frac{\theta}{\theta-1}\frac{E_t \sum_{s=t}^{\infty} \gamma^{s-t} \xi_{t,s} Q_s MC_s(z)}{E_t \sum_{s=t}^{\infty} \gamma^{s-t} \xi_{t,s} Q_s} \tag{22}$$

With

$$Q_s = \left(\frac{C_s + I_s + \phi(\frac{I_s}{K_s})K_s + G_s^C + I_s^G}{P_s}\right) \tag{23}$$

Log-linearising equation 22 results in the following price setting equation for optimising firms

$$\hat{p}_t(z) = \beta\gamma E_t(\hat{p}_{t+1}(z)) + (1-\beta\gamma)(\hat{mc}_t(z)) + \hat{\epsilon}_t^{cp} \tag{24}$$

Where $\hat{\epsilon}_t^{cp}$ is an AR(1) cost push shock process. The aggregate price level can then be defined as

$$\hat{p}_t = \gamma\hat{p}_{t-1} + (1-\gamma)\hat{p}_t(z) \tag{25}$$

6.3 Policy

Public consumption indexes are assumed to be structurally identical to private consumption indexes, and public demand functions for domestic goods are defined in an analogous way to private demand functions. The government resource constraint is then given as follows:

$$\tau_t^y(w_t N_t + r_t^K K_t + v_t) + \tau_t^c P_t C_t = B_t - R_t^{-1} B_{t+1} + P_t(G_t^C + I_t^G + G_t^T) \tag{26}$$

The Government uses real increases in the income tax burden to react to changes in the public debt to GDP ratio in the previous period relative to its target level as a proportion of steady state GDP such that

$$\tau_t^y = \tau_0^y \left(\frac{B_{t-1} - B}{Y} \right)^{\Phi_{ty}} \tag{27}$$

This is analogous to the Government relying on bracket creep to fund budget repair following a stimulus episode. Government spending evolves according to the following exogenous autoregressive processes

$$\tilde{g}_{g,t} = \rho^g \tilde{g}_{g,t-1} + \varepsilon_{g,t}^g \tag{28}$$

Where g=C, I, and T, ρ^g are between zero and one, $\tilde{g}_{g,t} = (G_{g,t} - G_g)/Y$, and $\epsilon_{g,t}^g$ is an i.i.d spending shock variable with zero mean. The public sector capital stock evolves according to the standard law of motion following Ratto et al. (2009) and Traum and Yang (2015)

$$K_{t+1}^G = (1 - \delta_g) K_t^G + I_t^G \tag{29}$$

For parameter estimation purposes monetary policy follows a conventional Henderson and McKibbin (1993) and Taylor (1993) type rule in the pre-zero lower bound period.

$$\hat{r}_t = \mu_1 \hat{r}_{t-1} + (1 - \mu_1)(\mu_2 \Delta_4 \hat{P}_t + \mu_3 \hat{Y}_t) + \varepsilon_t^r \tag{30}$$

In the simulation exercise below an interest rate peg is assumed to apply for 20 periods to approximate the 'no monetary response' dimension of empirical multipliers found above. The model steady state is set out in Appendix A and the complete log-linearised system of equations is contained in Appendix B.

6.4 Calibration and Bayesian Estimation

For the calibrated parameters, consistent with Watson and Tervala (2021) we set β to 0.995 implying an annualised real interest rate of 2 per cent. $\alpha = 0.33$ consistent with Galí (2015) and Chodorow-Reich (2019). $\theta = 6$ implying a steady state markup of 20 per cent following Galí (2015).

Keane and Rogerson (2012) suggest a range of 1 to 2 for macroeconomic applications, with values at the higher end recommended for models featuring hours of employment as here. Further, Freestone (2020) suggests a range of 1.8 to 3.3 for the Australian economy, and recommends a value of 2 in structural modelling exercises which we select. $\lambda = 0.27$ based on the latest data available from Australia on the proportion of households without debt, a value that has remained surprisingly stable since 2003-04 (ABS, 2019). The income tax rate is set equal to the average tax wedge for a single worker during the program period (0.27) calculated by the OECD (2021), while the consumption tax rate is equal 0.10 which is the rate of Australia's Goods and Services Tax (see OECD, 2020).

The steady state ratio of government debt to GDP is set equivalent to the average rate of government debt for all levels of Australian government between 1993 and 2008 which is 20 per cent obtained from the (IMF, 2022). The steady state value for government consumption is set equal to 0.18, which is the average share of government consumption in GDP between 1993 and 2008, and the steady state ratio of public investment to GDP is set to 0.03, which is equal to the 1993 to 2008 average. Based on the above parameter values steady state consumption is equal to 0.64, and steady state private investment is equal to 0.15. Transfer payments are assumed to be equal to zero in steady state.

The remaining parameters of the model are estimated using Bayesian techniques. Datasets used in estimation include quarterly real GDP, consumption, investment, and government investment from the National Accounts (ABS, 2022), the Consumer Price Index (ABS, 2022a), and the quarterly average interbank interest rate constructed from RBA (RBA, 2022). Data are expressed in log-deviations from their Hodrick-Prescott (1997) trends (Lambda=1600), and estimation is undertaken using data for the 1993Q1 to 2014Q4 period.

For the prior means, $\delta = 0.0175$ is a common selection and follows Rees et al. (2016). $\phi_{kg} = 0.083$ is the short-term elasticity of output with respect to public capital found by Bom and Ligthart (2014). The value of the responsiveness of investment to Tobin's Q (ϕ) is set equal to 4 which is a common choice in Australian DSGE models (see Rees et al., 2016 and Langcake and Robinson, 2013).

Prior means for ρ_x and μ_l are set equal to 0.93 and 0.2 respectively based on the estimates for Australia presented by Watson and Tervala (2021). The prior mean for the Calvo parameter $\gamma = 0.75$ is a common choice in the literature (see Galí, 2015). Prior means for the autocorrelation coefficients for real time preference, investment and cost push shocks are assumed to be 0.8.

For monetary policy, prior means are $\mu_1 = 0.75$, $\mu_2 = 1.5$, and $\mu_3 = 0.5/4$ following (Smets and Wouters, 2007). We select a prior mean of $\delta_g = 0.0125$ for the quarterly depreciation rate of public capital following IMF (2015). We select a prior mean of $\Phi_{ty} = 0.075$ which is halfway between values suggested for Europe and the US suggested by Lieberknecht and Wieland (2019). Prior means for the autocorrelation coefficients for government spending shocks are set to 0.9 as in Galí et al. (2007), Corsetti et al. (2012), and Campbell et al. (2017).

Table 8 sets out priors and posteriors for the estimated parameters. Prior and posterior distributions are presented in Appendix C. All parameter estimates appear broadly reasonable with respect to the preceding literature, and the data is informative with respect to most estimated parameters with the exception of ϕ_{kg} and δ_g. Estimates for ϕ are on the high side, although well within the range of estimates in the empirical literature which can be as high as 20 (Hayashi, 1982). The interest rate smoothing parameter in the monetary policy reaction function is on the low side, but very close to contemporaneous estimates in the Australian context, for example in Li and Spencer (2016). Support for the hysteresis process in the production technology is found in the data, with values of ρ_x and μ_l essentially around the midpoint of those suggested by other studies (see Chang et al., 2002; Watson and Tervala, 2021; De Long and Summers, 2012; and Reifschneider et al., 2015 for example)

Table 8: 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

Notes: Credible intervals are Bayesian Highest Posterior Density Intervals (HPDI). The initial value of the MH chain is 0.4, the scale parameter of the jumping distributions covariance matrix in the Random Walk Metropolis-Hastings (MH) algorithm is 0.45 which delivers an acceptance rate of around 27 per cent. The number of parallel chains for the MH algorithm is 5. Following Smets and Wouters (2007), the number of replications in the MH algorithm is set to 250,000, and the burn in ratio is set to 50 per cent. The posterior mode is computed using the Covariance Matrix Adaptation Evolution Strategy (CMA-ES) algorithm proposed by Hansen and Kern (2004)

6.5 Simulated Approximate Output Multipliers

In the following policy simulation exercise, structural parameters are assumed to be identical to the calibrated and estimated values above. Further, to approximate the 'no monetary' response dimension of the empirical output multipliers approximated above, the zero lower bound is assumed to apply for $H = 20$ quarters. The zero lower bound is implemented as a 'news shock' in the monetary policy rule, implying a monetary policy reaction function of the following form

$$\hat{r}_t = \mu_1 \hat{r}_{t-1} + (1 - \mu_1)(\mu_2 \Delta_4 \hat{P}_t + \mu_3 \hat{Y}_t) + \sum_{j=0}^{H-1} \epsilon^r_{t-j} \tag{31}$$

The ϵ^r_{t-j} are policy rate shocks that are known to agents in the model for $j > 0$. After being hit by the government investment shock the model is solved for each ϵ^r_{t-j} for $j = 0, \ldots H - 1$ keeping interest rates effectively unresponsive to the shock ($\hat{r}_{t+s} = \hat{r}_{t-1} = 0$) for $s = 0, \ldots H - 1$, where H is the period during which the interest rate peg is assumed to hold.

Figure 9 presents impulse response functions for selected variables at the quarterly frequency in response to a one per cent of GDP increase in simulated BER spending. Overall, the impulse responses appear reasonable given the nature of the simulated shock. BER spending has a positive effect on output, productivity, hours worked, wages and prices. The income tax rate also rises in response to the increase in government spending and government borrowing. As a consequence, although the impact of BER spending on consumption is net positive for three years, beyond three years there is crowding out of private sector consumption. On the other hand, there is *crowding-in* of private sector investment due to the BER- such that the model attributes the economic benefits of the BER to higher levels of human, public and private sector capital in the economy. From a policy perspective, the model implies that it would be optimal to combine public investment stimulus with transfers, or transfer-like measures along the lines of the JobKeeper Payment which have a more beneficial impact on private sector consumption in the short-run. The case for combining public sector investment with transfer programs in stimulus is strengthened in the open economy context, where transfer-like programs are more detrimental to international competitiveness over the medium to long-run (see Tervala and Watson, 2022).

Figure 9: Quarterly Impulse Responses to a 1 per cent of GDP Increase in Simulated BER Spending

Finally, Table 9 contains simulated 'closed economy, no monetary policy' output multipliers for the BER program over the entire program period, and compares these too empirical approximations based on the method of Chodorow-Reich (2019). Generally speaking, impact and cumulative output multipliers appear reasonable compared to empirical approximations for the aggregate economy, and based on empirical results for 25-34 year olds alone. For the first three years of the program-period, the simulated multipliers track the empirical approximations relatively closely, although all model parametrisations do not pick up the second round spike in multipliers in 2012. Leduc and Wilson (2013) are able to replicate larger second-round effects in a model with unconstrained monetary policy and inter-regional trade. Further, the model presented here cannot capture the secondary cyclical downturn in Australia in late 2011 and 2012 due to the end of the mining boom, and the collapse of the terms of trade. Aggregate empirical output and employment multipliers may have increased again at this time due to the additional spare capacity in the economy (see Gechert and Rannenberg, 2018).

Table 9: 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

Notes: The aggregate model used for empirical approximations is the preferred employment model estimated using probability weights based on SA4 working age population and allowing for geographic spillovers. Empirical approximations for 25-34 year old only uses the same empirical methodology only with data for 25-34 year olds only. Empirical approximations of output multipliers are calculated using the method of Chodorow-Reich (2019).

Increasing (decreasing) the proportion of non-Ricardian workers increases (reduces) output multipliers. More persistence in the human capital accumulation process reduces the size of output multipliers due to the fact that interest rates are constrained to the lower bound. This means that the central bank cannot reduce interest rates in response to the drop in the related price level, which results in an increase in real interest rates. Increasing the elasticity of productivity with respect to employment changes the dynamic profile of output multipliers, but has a limited effect on the size of cumulative output multipliers over the program period. Increasing capitals' share to more closely match that which was experienced during the program period ($\alpha = 0.47$ based on ABS, 2022) increases cumulative output multipliers across the board. Changing the adjustment cost parameter ϕ, discount rate β, the elasticity of substitution between intermediate goods (θ) and the Calvo parameter γ have limited influence on output multiplier size. Increasing (decreasing) the Frisch elasticity of labour supply increases (decreases) simulated output multiplier size. Finally, increasing (decreasing) the elasticity of income taxation to public debt increases (decreases) output multipliers. This is because the income effect associated with higher taxation results in higher employment and productivity, which helps to counteract the negative effect of higher taxes on consumption and investment. Overall, robustness analysis suggests that the comparatively large approximate national level 'closed economy, no monetary policy response' output multipliers appear reasonable alongside model simulations.

7 Conclusion

Contrary to the popular view that the BER program represented a case study in 'government failure', public sector waste and mismanagement (see Lewis et al., 2014), the evidence presented in this paper suggests that the Program was in fact a cost effective economic stimulus program that protected the employment of a significant number of Australians during the depths of the GFC. This paper also provides a reassessment of the relative contribution of fiscal policy to helping Australia avoid a more significant recession in 2009, controlling for the effects of mining, monetary policy and the exchange rate. It provides new evidence that large scale public works programs comprised of individually small infrastructure projects can form timely and effective stimulus during economic downturns. The theoretical results suggest that public investment may provide an importantly complementary role to other forms of fiscal stimulus, including through potentially *crowding-in* private investment, as well as promoting human capital accumulation.

It is highly probable that the program represented value for money, with costs per job-year saved most likely below $8,500 ($US 8,000) on average between 2009 and 2012. Of the employment effects in 2009, roughly one third related to reducing unemployment, and two-thirds reducing labour force withdrawal. Unemployment reductions mainly benefited male workers, whereas benefits with respect to employment and connectedness to the labour market appear more evenly distributed on a gender basis. Employment benefits were highly concentrated amongst 25-34 year olds, which may have hindered the broader political popularity of the program. Contrary to prior studies, employment multipliers were not higher in regions experiencing high unemployment at the outset of the program, most likely due to a combination of the structural characteristics of these regions and highly standardised program design and delivery. Controlling for geographic spillovers has no effect on estimated costs per job-year saved from a statistical perspective, although there is weak evidence that positive demand spillovers may have grown as the program period continued. Our theoretical results support large 'closed economy, no monetary policy response' approximate output and employment multipliers related to public infrastructure stimulus. Overall, the BER program presents a number of interesting lessons for policy makers considering undertaking large-scale public works programs as a form of fiscal stimulus.

8 References

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Table A1: Recent Literature and Results

Paper	Event	Region	Financing	Persistence	Cost per job-year	Multipliers	State-dependence?	Regional Spillovers?
Acconcia et al. (2014)	Anti-mafia laws 1990-99	Italian provinces	Outside	Temporary	No	1.55 output (imp., gov. investment), 1.95 (cum.)	No	Yes (No effect on mult.)
Adelino et al., (2017)	2010 rating recalibration	US municipalities	Local	Permanent	$US 19,608	1.9 income (imp., gov. expenditure)	Yes (larger mult./lower c.p.j.)	No
Brückner and Tuladhar (2014)	Lost decade (1990s) prefecture spending	Japanese prefectures	Mixed	Temporary	No	0.93 output (cum., gov. investment), 0.76 (cum., gov. expenditure), 5.6 (cum., transfers to firms)	No	No
Buchheim and Watzinger (2017)	GFC school stimulus	German counties	Outside	Temporary	€25,000	1.5 output, 1.9 wage (cum., gov. investment)	No	Yes (No effect on c.p.j.)
Chodorow-Reich et al. (2012)	ARRA	US states	Outside	Temporary	$US 26,316	2.0 output (cum., gov. expenditure)	No	No
Chodorow-Reich (2019)	ARRA	US states	Outside	Temporary	$US 49,751	1.53 GSP (cum., gov. expenditure)	No	No
Clemens and Moran (2012)	Balanced Budget Rules 1988-2004	US states	Local	Temporary	No	0.29 output (imp., gov. expenditure)	No	No
Cohen et al. (2011)	Senators becoming committee chairs 1947-92	US states	Outside	Temporary	No	0.8 private investment (imp., gov. expenditure)	Yes (crowding out lower when slack)	No
Conley and Dupor (2013)	ARRA	US states	Outside	Temporary	$US 131,579	No	No	No
Corbi et al. (2019)	Population-based Federal transfers 1999-2014	Brazilian municipalities	Outside	Temporary	$US 8,000	2.0 output (cum., gov. expenditure)	No	No
Dube et al. (2018)	ARRA	US counties	Outside	Temporary	$US 131,579 (within county), $US 30,488 (aggregating counties within 120 miles), $US 39,277 within county when excess capacity	1.3 output (cum., gov. expenditure), 2.8 (0.6) output (cum., gov. expenditure) where high (low) excess capacity	Yes (lower c.p.j., higher multiplier when slack)	Yes (lower c.p.j., higher multiplier)
Dupor and McCrory (2018)	ARRA	US local labour markets (2-4 counties)	Outside	Temporary	$US 54,305 (including regional spillovers)	1.14 wages (cum., including regional spillovers, gov. expenditure)	No	Yes (larger mult./ lower c.p.j.)
Dupor and Saif Mehkari (2016)	ARRA	US local labour markets (2-4 counties)	Outside	Temporary	$US 105,263	1 wages (cum., gov. expenditure)	No	No
Feyrer and Sacerdote (2011)	ARRA	US states	Outside	Temporary	$US 50,251	1.06 GDP equivalent (cum., gov. expenditure), 1.85 output (cum., gov. investment)	No	No
Fishback and Kachanovskaya (2015)	Federal spending on states 1930-1940	US states	Outside	Temporary	No	0.83 output (cum., gov. expenditure), 0.96 (cum., excluding transfers)	No	No
Hausman (2016)	1936 Veterans' Bonus	US states/cities	Outside	Temporary	No	Implied closed economy multiplier of between 2.9 and 4 (cum., bonus payment)	No	No
Leduc and Wilson (2013)	Federal highway investment 1993-2010	US states	Mixed	Ongoing	No	3.4 output (imp., gov. investment), 7.8 (peak)	Yes (twice as large in recessions)	No
Nakamura and Steinsson (2014)	Military spending build-ups 1966-2006	US states	Outside	Temporary	No	1.28 output (cum., military expenditure, state), 1.43 (cum., military expenditure, region)	Yes (larger mult., not statistically significant)	Yes (larger mult.)
Porcelli and Trezzi (2019)	2009 L'Aquila earthquake	Italian municipalities	Outside	Temporary	No	0.36 output (cum., reconstruction grants)	No	No
Shoag (2016)	Pension fund windfalls 1987-2008	US states	Outside	Temporary	$34,602	2.1 output (cum., gov. expenditure)	Yes (larger mult./ lower c.p.j.)	Yes (similar income response in adjoining counties)
Suárez Serrato and Wingender (2016)	Spending due to pop. forecast changes 1980, 1990 and 2000	US counties	Outside	Permanent	$US 30,769	1.7-2 local income (cum., gov. expenditure)	Yes (larger mult./lower c.p.j.)	No
Wilson (2012)	ARRA	US states	Outside	Temporary	$US 57,143	No	No	No

Table A2: Coefficients from Full First Stage Regressions (Baseline Employment Model)

	BER spending p.c in $100,000 ×					
	Pre	2009	2010	2011	2012	Post
	(1)	(2)	(3)	(4)	(5)	(6)
Primary and special schools p.c						
× 2007-2008Q3	2.91	0.00	0.01	0.01	0.01	-0.02
	(1.32)	(0.01)	(0.02)	(0.04)	(0.03)	(0.05)
× 2009	0.05	2.92	-0.03	-0.05	-0.04	0.07
	(0.04)	(1.34)	(0.02)	(0.04)	(0.03)	(0.05)
× 2010	0.22	-0.04	2.83	-0.21	-0.15	0.27
	(0.12)	(0.04)	(1.33)	(0.11)	(0.08)	(0.15)
× 2011	0.34	-0.06	-0.16	2.60	-0.23	0.42
	(0.19)	(0.06)	(0.11)	(1.31)	(0.14)	(0.24)
× 2012	0.40	-0.07	-0.19	-0.39	2.66	0.50
	(0.22)	(0.07)	(0.12)	(0.21)	(1.32)	(0.27)
× 2013-2014	0.41	-0.07	-0.19	-0.40	-0.27	3.44
	(0.20)	(0.07)	(0.11)	(0.18)	(0.14)	(1.41)
Secondary schools p.c						
× 2007-2008Q3	22.56	-0.11	-0.31	-0.65	-0.45	0.83
	(6.94)	(0.13)	(0.23)	(0.37)	(0.27)	(0.49)
× 2009	-0.37	21.96	0.18	0.36	0.25	-0.46
	(0.25)	(7.02)	(0.13)	(0.23)	(0.16)	(0.30)
× 2010	-1.01	0.17	22.37	0.99	0.68	-1.26
	(0.64)	(0.20)	(6.94)	(0.59)	(0.42)	(0.77)
× 2011	-1.62	0.27	0.76	23.47	1.09	-2.01
	(1.03)	(0.32)	(0.56)	(6.79)	(0.69)	(1.25)
× 2012	-1.19	0.20	0.56	1.16	22.69	-1.48
	(1.01)	(0.26)	(0.52)	(0.95)	(6.82)	(1.23)
× 2013-2014	-0.27	0.04	0.13	0.26	0.18	21.56
	(0.68)	(0.12)	(0.32)	(0.66)	(0.46)	(7.39)
Combined schools p.c						
× 2007-2008Q3	6.65	-0.00	-0.01	-0.02	-0.01	0.02
	(0.83)	(0.01)	(0.02)	(0.04)	(0.03)	(0.05)
× 2009	0.03	6.63	-0.01	-0.03	-0.02	0.04
	(0.03)	(0.85)	(0.01)	(0.02)	(0.02)	(0.03)
× 2010	0.09	-0.02	6.59	-0.09	-0.06	0.11
	(0.08)	(0.02)	(0.84)	(0.07)	(0.05)	(0.09)
× 2011	0.41	-0.07	-0.20	6.23	-0.28	0.51
	(0.21)	(0.08)	(0.12)	(0.80)	(0.14)	(0.25)
× 2012	0.62	-0.10	-0.29	-0.61	6.22	0.77
	(0.29)	(0.11)	(0.17)	(0.25)	(0.83)	(0.34)
× 2013-2014	0.51	-0.08	-0.24	-0.50	-0.34	7.27
	(0.23)	(0.09)	(0.14)	(0.20)	(0.14)	(0.95)
Sanderson-Windmeijer χ^2	314.09	345.48	348.66	379.95	373.07	368.95
Sanderson-Windmeijer F	19.15	21.06	21.25	23.16	22.74	22.49
Observations	2784	2784	2784	2784	2784	2784

Note: First Stage Equation for equation in column (1) Table 5. Robust standard errors clustered at the SA4 level in brackets. The Sanderson-Windmeijer first-stage χ^2 and F statistics are tests of underidentification and weak identification of individual endogenous regressors. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Sanderson-Windmeijer F statistic.

Table A3: Underidentification and Weak Instruments Tests for Tables 5, A4 and A5

Table 5, A4, and A5 column	(1)		(2)		(3)	
	SW χ^2	SW F	SW χ^2	SW F	SW χ^2	SW F
BER spending p.c						
× 2007-2008Q3	314.09	19.15	284.24	17.56	574.32	35.95
× 2009	345.48	21.06	315.81	19.51	583.00	36.49
× 2010	348.66	21.25	320.49	19.80	635.94	39.81
× 2011	379.95	23.16	339.18	20.95	655.00	41.00
× 2012	373.07	22.74	332.17	20.52	676.73	42.36
× 2013-2014	368.95	22.49	316.57	19.56	701/47	43.91

Notes: The Sanderson-Windmeijer χ^2 (SW χ^2) and F statistics (SW F) are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Sanderson-Windmeijer F statistic.

Table A4: BER Average SA4 Unemployment Effects

	Unemployed p.c.					
		IV			OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 2007-2008Q3	1.24	1.27	0.67	0.28	0.26	0.19
	(1.47)	(1.50)	(0.81)	(1.00)	(1.00)	(0.69)
× 2009	-3.08	-3.12	-2.97	-0.63	-0.60	-1.34
	(1.47)	(1.51)	(1.06)	(1.08)	(1.08)	(0.80)
× 2010	-0.63	-0.60	-1.61	0.14	0.24	-0.68
	(1.58)	(1.61)	(1.13)	(1.30)	(1.30)	(0.86)
× 2011	0.61	1.08	-0.65	0.39	0.62	-0.30
	(2.18)	(2.21)	(1.44)	(1.63)	(1.68)	(1.21)
× 2012	1.55	2.18	-0.78	1.01	1.31	-0.26
	(2.88)	(2.91)	(1.87)	(2.00)	(2.03)	(1.56)
× 2013-2014	3.54	3.98	1.07	1.98	2.21	0.97
	(3.59)	(3.66)	(2.43)	(2.72)	(2.74)	(2.14)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
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
min(Shea Partial R^2)	0.45	0.44	0.63	-	-	-
Sanderson-Windmeijer χ^2	70.11	69.49	148.62	-	-	-
Sanderson-Windmeijer F	19.34	19.43	42.13	-	-	-
Cost per 2009 job-year	32497	32094	33715	158492	167601	74745
SE cost per job-year	15546	15524	12004	272041	303316	44899
2009 job-years saved	514160	520619	495585	105423	99693	223543
SE job-years saved	245972	251827	176439	180951	180420	134282
Cost per 2009-2012 job-year	64617	220881	16637	-110504	-63672	38747
SE cost per job-year	315129	3745900	14123	663003	222233	58407
2009-2012 job-years saved	258580	75645	1004306	-151205	-262417	431220
SE job-years saved	1261068	1282860	852530	907202	915905	650008
Observations	2784	2784	2784	2784	2784	2784

Notes: The minimum Shea Partial R^2 is a measure of instrument relevance derived again from the cross-sectional first stage regression. The Sanderson-Windmeijer χ^2 and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the minimum Shea partial R^2 and the Sanderson-Windmeijer F statistic. Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year=\$100,000/(β_{2009}), and cost per 2009-2012 job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$). 2009 job-years saved = 167086.24 × β_{2009}, 2009-2012 job-years saved = 167086.24 × ($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for cost per job-year 2009, cost per job-year 2009-12, 2009 job-years saved and 2009-2012 job-years saved are calculated using the Delta method.

Table A5: BER Average SA4 Effects on Labour Force Withdrawal

	NILF p.c.					
		IV			OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 2007-2008Q3	-3.72	-2.64	4.65	-1.17	-0.97	3.20
	(4.34)	(4.46)	(2.45)	(3.02)	(3.24)	(2.42)
× 2009	-5.42	-5.22	-1.64	-1.75	-1.83	-0.56
	(3.03)	(3.03)	(1.99)	(2.42)	(2.43)	(1.95)
× 2010	-2.77	-2.07	-0.57	0.99	0.79	0.94
	(5.32)	(5.26)	(3.63)	(4.56)	(4.63)	(3.57)
× 2011	-2.08	-2.48	-1.37	3.56	2.96	2.07
	(6.45)	(6.48)	(4.16)	(4.75)	(4.79)	(3.94)
× 2012	-11.35	-12.07	-7.63	2.65	1.87	0.33
	(8.82)	(8.79)	(5.27)	(5.80)	(5.92)	(4.95)
× 2013-2014	-10.22	-10.84	-7.96	4.86	4.21	1.18
	(9.85)	(9.81)	(6.57)	(6.33)	(6.43)	(5.50)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
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
min(Shea Partial R^2)	0.45	0.44	0.63	-	-	-
Sanderson-Windmeijer χ^2	70.11	69.49	148.62	-	-	-
Sanderson-Windmeijer F	19.34	19.43	42.13	-	-	-
Cost per 2009 job-year	18443	19161	61006	57213	54540	177455
SE cost per job-year	10294	11136	74134	79161	72252	613758
2009 job-years saved	905960	872005	273883	292040	306355	94157
SE job-years saved	505672	506781	332820	404070	405847	325657
Cost per 2009-2012 job-year	4624	4578	8927	-18326	-26376	-36016
SE cost per job-year	4676	4574	11060	52997	111778	172442
2009-2012 job-years saved	3613346	3649414	1871663	-911748	-633479	-463918
SE job-years saved	3653485	3646544	2318807	2636686	2684597	2221191
Observations	2784	2784	2784	2784	2784	2784

Notes: The minimum Shea Partial R^2 is a measure of instrument relevance derived again from the cross-sectional first stage regression. The Sanderson-Windmeijer χ^2 and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the minimum Shea partial R^2 and the Sanderson-Windmeijer F statistic. Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year=\$100,000/(β_{2009}), and cost per 2009-2012 job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$). 2009 job-years saved = 167086.24 × β_{2009}, 2009-2012 job-years saved = 167086.24 × ($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for cost per job-year 2009, cost per job-year 2009-12, 2009 job-years saved and 2009-2012 job-years saved are calculated using the Delta method.

Table A6: 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) Weighted by working age population	5.42	3.73	18456	12713
Instruments				
(3) All schools	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 $Date_t \times State_t$	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

Notes: Standard errors for β_{2009} values are clustered at the SA4 level. Cost per 2009 job-year=$100,000/(\beta_{2009})$. Standard errors for costs per 2009 job-year are calculated using the Delta Method.

Table A7: Average SA4 Program Effects by Gender

	Employed p.c.		Unemployed p.c.		NILF p.c.	
	Women	Men	Women	Men	Women	Men
			IV			
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 2007-2008Q3	2.29	2.73	0.82	0.40	-3.07	-0.48
	(2.02)	(2.80)	(0.76)	(1.08)	(2.26)	(2.55)
× 2009	3.94	5.99	-0.47	-2.64	-3.48	-2.00
	(1.79)	(2.70)	(0.66)	(1.08)	(1.74)	(2.34)
× 2010	1.71	3.12	0.15	-0.92	-1.88	-0.96
	(3.60)	(3.64)	(0.87)	(1.09)	(3.35)	(3.09)
× 2011	0.73	0.80	-0.12	0.62	-0.66	-1.54
	(3.25)	(5.22)	(1.41)	(1.24)	(3.00)	(4.46)
× 2012	6.15	3.45	0.56	0.78	-6.76	-4.63
	(5.68)	(6.04)	(1.61)	(1.89)	(5.08)	(4.87)
× 2013-2014	1.44	3.95	0.84	2.29	-2.36	-7.73
	(6.56)	(6.48)	(1.95)	(2.28)	(5.67)	(5.47)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals p.c.	Yes	Yes	Yes	Yes	Yes	Yes
Remoteness Index	Yes	Yes	Yes	Yes	Yes	Yes
Mining inf. p.c.	Yes	Yes	Yes	Yes	Yes	Yes
2009 women = 2009 men (p value)	0.45		0.04		0.53	
min(Shea Partial R^2)	0.45	0.45	0.45	0.45	0.45	0.45
Sanderson-Windmeijer χ^2	70.11	70.11	70.11	70.11	70.11	70.11
Sanderson-Windmeijer F	19.34	19.34	19.34	19.34	19.34	19.34
Cost per 2009 job-year	25392	16684	212359	37859	28762	49936
SE cost per job-year	11514	7512	296399	15319	14390	58378
2009 job-years saved	658032	1001455	78681	441337	580936	334604
SE job-years saved	298384	450920	109819	178580	290655	391175
Cost per 2009-2012 job-year	7981	7483	-841471	46441	7827	10941
SE cost per job-year	8251	9430	30500000	104989	7146	16587
2009-2012 job-years saved	2093647	2232760	-19856	359786	2134688	1527137
SE job-years saved	2164465	2813428	719586	813374	1948835	2315148
Observations	2784	2784	2784	2784	2784	2784

Notes: The minimum Shea Partial R^2 is a measure of instrument relevance derived again from the cross-sectional first stage regression. The Sanderson-Windmeijer χ^2 and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the minimum Shea partial R^2 and the Sanderson-Windmeijer F statistic. Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year=\$100,000/(β_{2009}), and cost per 2009-2012 job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$). 2009 job-years saved = 167086.24 × β_{2009}, 2009-2012 job-years saved = 167086.24 × ($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for cost per job-year 2009, cost per job-year 2009-12, 2009 job-years saved and 2009-2012 job-years saved are calculated using the Delta method.

Table A8: Average SA4 Employment Effects by Age

	Employed p.c.					
	15-24	25-34	35-44	45-54	55-64	65+
	IV					
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 2007-2008Q3	0.58	-1.96	0.98	-0.95	0.66	-1.37
	(1.34)	(1.63)	(1.05)	(1.25)	(1.38)	(1.07)
× 2009	1.52	3.18	2.37	1.77	0.82	0.22
	(1.34)	(1.24)	(1.09)	(1.07)	(1.83)	(2.48)
× 2010	-0.57	3.90	1.25	1.39	0.96	-1.73
	(1.51)	(1.65)	(1.42)	(1.52)	(2.44)	(2.54)
× 2011	-0.36	4.45	1.27	-0.67	1.65	-3.16
	(2.19)	(2.13)	(2.15)	(1.83)	(3.05)	(2.59)
× 2012	-0.30	8.08	2.68	2.08	3.77	-5.45
	(2.34)	(2.57)	(2.66)	(2.78)	(3.65)	(3.43)
× 2013-2014	-3.47	8.64	1.34	0.56	4.99	-3.56
	(3.34)	(3.40)	(3.23)	(3.13)	(3.99)	(3.33)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
Hospitals p.c.	Yes	Yes	Yes	Yes	Yes	Yes
Remoteness Index	Yes	Yes	Yes	Yes	Yes	Yes
Mining inf. p.c.	Yes	Yes	Yes	Yes	Yes	Yes
min(Shea Partial R^2)	0.45	0.45	0.45	0.45	0.45	0.45
Sanderson-Windmeijer χ^2	70.11	70.11	70.11	70.11	70.11	70.11
Sanderson-Windmeijer F	19.34	19.34	19.34	19.34	19.34	19.34
Cost per 2009 job-year	65932	31476	42204	56464	121732	464665
SE cost per job-year	58060	12256	19335	34239	271372	5345887
2009 job-years saved	253423	530833	395897	295915	137258	35958
SE job-years saved	223168	206688	181371	179437	305984	413695
Cost per 2009-2012 job-year	346967	5100	13211	21902	13893	-9875
SE cost per job-year	7720474	1822	12054	30769	20091	10141
2009-2012 job-years saved	48156	3275988	1264743	762877	1202659	-1692042
SE job-years saved	1071540	1170421	1153992	1071720	1739202	1737712
Observations	2784	2784	2784	2784	2784	2784

Notes: The minimum Shea Partial R^2 is a measure of instrument relevance derived again from the cross-sectional first stage regression. The Sanderson-Windmeijer χ^2 and F statistics are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the minimum Shea partial R^2 and the Sanderson-Windmeijer F statistic. Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year=\$100,000/(β_{2009}), and cost per 2009-2012 job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$). 2009 job-years saved = 167086.24 × β_{2009}, 2009-2012 job-years saved = 167086.24 × ($\sum_{Y=2009}^{2012} \beta_Y$). Standard errors for cost per job-year 2009, cost per job-year 2009-12, 2009 job-years saved and 2009-2012 job-years saved are calculated using the Delta method.

Table A9: Underidentification and Weak Instruments Tests for Table A10

Table A10 column	(1)		(2)		(3)	
	SW χ^2	SW F	SW χ^2	SW F	SW χ^2	SW F
BER spending p.c						
× 2007-2008Q3	834.60	26.24	771.19	24.58	8594.25	277.55
× 2009	1013.52	31.87	839.68	26.76	8915.63	287.92
× 2010	1123.76	35.33	830.95	26.48	9254.28	298.86
× 2011	1246.30	39.19	903.89	28.81	8507.11	274.73
× 2012	1593.20	50.09	949.83	30.27	9523.47	307.55
× 2013-2014	2170.84	68.26	1102.14	35.12	8759.74	282.89
Adjoining SA4 BER spending p.c						
× 2007-2008Q3	3379.23	106.25	6887.95	219.51	12784.95	412.88
× 2009	3892.04	122.37	7833.56	249.64	12900.43	416.61
× 2010	3894.98	122.47	7622.08	242.90	11803.15	381.17
× 2011	4446.27	139.80	8895.19	283.47	14481.78	467.68
× 2012	4515.81	141.99	8495.01	270.72	15171.10	489.94
× 2013-2014	4385.78	137.90	8289.50	264.17	10959.41	353.93

Notes: The Sanderson-Windmeijer χ^2 (SW χ^2) and F statistics (SW F) are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Sanderson-Windmeijer F statistic.

Table A10: Geographic Spillovers

	Employed p.c.					
		IV			OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 2007-2008Q3	4.41	2.56	-5.42	1.72	1.94	7.04
	(4.11)	(4.96)	(2.45)	(3.34)	(3.63)	(3.76)
× 2009	7.93	8.80	4.89	2.51	2.62	1.64
	(3.33)	(3.49)	(1.93)	(2.51)	(2.51)	(2.34)
× 2010	5.65	5.69	1.83	0.51	0.80	-1.72
	(6.17)	(6.77)	(3.10)	(5.64)	(5.73)	(5.52)
× 2011	4.58	5.44	1.78	-2.43	-2.09	-4.61
	(6.93)	(7.78)	(4.00)	(5.82)	(5.89)	(5.73)
× 2012	12.79	16.24	7.49	-0.32	0.10	-5.05
	(9.65)	(10.82)	(4.89)	(7.61)	(7.70)	(7.31)
× 2013-2014	11.40	15.03	5.13	-2.61	-2.29	-7.16
	(11.18)	(12.03)	(5.97)	(8.18)	(8.25)	(8.07)
Adjoining SA4 BER spending p.c						
× 2007-2008Q3	3.56	4.30	0.56	2.50	3.65	4.36
	(2.45)	(2.87)	(2.27)	(2.11)	(2.69)	(2.45)
× 2009	0.84	1.24	-0.59	0.28	0.45	0.38
	(2.19)	(2.11)	(1.64)	(2.18)	(2.18)	(2.16)
× 2010	4.81	5.41	3.63	4.58	5.14	4.96
	(4.55)	(4.51)	(3.39)	(4.80)	(4.79)	(4.77)
× 2011	5.71	5.85	4.36	4.01	4.03	4.14
	(5.35)	(5.22)	(3.68)	(5.73)	(5.58)	(5.46)
× 2012	11.08	11.76	7.93	9.18	9.09	8.95
	(7.54)	(7.40)	(4.86)	(8.35)	(8.01)	(7.99)
× 2013-2014	15.42	15.94	11.52	11.64	11.39	11.37
	(7.69)	(7.59)	(5.18)	(8.37)	(8.15)	(8.00)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
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	12612	11358	20456	39783	38228	60930
SE cost per job-year	5300	4503	8056	39726	36733	86833
2009 job-years saved	1324845	1471075	816794	419998	437076	274225
SE job-years saved	556766	583269	321656	419407	419987	390802
Cost per 2009-2012 job-year	3232	2765	6255	358289	70269	-10271
SE cost per job-year	2536	2070	5071	25400000	991726	20229
2009-2012 job-years saved	5170468	6043517	2671066	46635	237780	-1626853
SE job-years saved	4057337	4524186	2165259	3307296	3355827	3204228
Observations	2784	2784	2784	2784	2784	2784

Notes: Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year=\$100,000/(β_{2009}), and cost per 2009-2012 job-year=\$100,000/($\sum_{Y=2009}^{2012} \beta_Y$). 2009 job-years saved = $167086.24 \times \beta_{2009}$, 2009-2012 job-years saved = $167086.24 \times (\sum_{Y=2009}^{2012} \beta_Y)$. Standard errors for cost per job-year 2009, cost per job-year 2009-12, 2009 job-years saved and 2009-2012 job-years saved are calculated using the Delta method. Sanderson-Windmeijer χ^2 and F statistics are contained in Table A9.

Table A11: Underidentification and Weak Instruments Tests for Table A12

Table A12 column	(1)		(2)		(3)	
	SW χ^2	SW F	SW χ^2	SW F	SW χ^2	SW F
BER spending p.c						
× 2007-2008Q3	194.22	21.99	183.06	21.00	679.52	78.99
× 2009	201.41	22.80	115.87	13.29	91.68	10.66
× 2010	280.88	31.80	146.84	16.85	664.86	77.29
× 2011	327.43	37.07	256.49	29.43	623.55	72.49
× 2012	342.35	38.76	305.33	35.03	823.48	95.73
× 2013-2014	327.97	37.13	286.85	32.91	870.88	101.24
BER spending p.c $\times I$(U 2008Q4>median)						
× 2007-2008Q3	84.32	9.55	101.55	11.65	199.42	23.18
× 2009	108.17	12.24	179.24	20.56	359.59	41.80
× 2010	81.81	9.26	150.76	17.30	272.71	31.70
× 2011	104.33	11.81	121.84	13.98	285.32	33.17
× 2012	102.78	11.64	122.80	14.09	284.52	33.07
× 2013-2014	88.38	10.01	197.88	22.70	504.83	58.69

Notes: The Sanderson-Windmeijer χ^2 (SW χ^2)and F statistics (SW F) are tests for under-identification and weak identification of the individual endogenous regressor in the cross-sectional first stage equation. Primary and Special Schools p.c., secondary schools p.c. and combined schools p.c. are the excluded instruments for the purposes of the Sanderson-Windmeijer F statistic.

Table A12: State Dependent Employment Effects?

	Employed p.c.					
		IV			OLS	
	(1)	(2)	(3)	(4)	(5)	(6)
BER spending p.c						
× 2007-2008Q3	3.27	0.83	-6.55	-0.19	-0.39	5.14
	(5.00)	(4.80)	(3.76)	(3.13)	(3.35)	(3.88)
× 2009	8.86	8.45	4.62	2.19	2.24	1.30
	(3.59)	(3.65)	(3.14)	(2.65)	(2.46)	(2.35)
× 2010	5.21	3.58	3.74	-1.51	-1.42	-3.76
	(6.57)	(6.68)	(5.66)	(4.99)	(5.04)	(4.92)
× 2011	3.64	2.99	4.72	-4.53	-4.17	-6.60
	(7.63)	(7.81)	(6.67)	(5.19)	(5.23)	(5.15)
× 2012	12.54	11.94	11.58	-3.67	-3.19	-8.32
	(10.58)	(10.89)	(8.49)	(6.30)	(6.40)	(6.14)
× 2013-2014	10.64	10.55	12.78	-7.08	-8.03	-11.50
	(11.92)	(12.11)	(11.06)	(7.37)	(0.83)	(7.07)
BER spending p.c ×I(U% 2008Q4 > median)						
× 2007-2008Q3	-1.36	0.74	1.00	1.56	1.58	0.89
	(1.74)	(2.10)	(1.88)	(0.77)	(0.583)	(0.98)
× 2009	-0.43	-0.02	0.06	0.29	0.30	0.37
	(1.18)	(1.27)	(1.17)	(0.56)	(0.56)	(0.54)
× 2010	-2.53	-0.96	-1.16	0.56	0.59	0.77
	(2.25)	(2.62)	(2.60)	(1.10)	(1.09)	(1.07)
× 2011	-2.71	-1.67	-2.05	0.84	0.89	1.06
	(2.57)	(2.96)	(3.05)	(1.22)	(1.20)	(1.15)
× 2012	-3.19	-1.99	-2.30	-0.01	0.05	0.42
	(3.67)	(4.15)	(4.10)	(1.70)	(1.68)	(1.66)
× 2013-2014	-5.12	-4.44	-4.72	0.42	0.89	0.93
	(4.41)	(5.03)	(5.30)	(1.98)	(1.96)	(1.90)
SA4 fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
SA4 × time	Yes	Yes	Yes	Yes	Yes	Yes
State × date fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Population growth	Yes	Yes	Yes	Yes	Yes	Yes
Date fixed effects ×						
School age p.c.	Yes	Yes	Yes	Yes	Yes	Yes
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 (High U%)	11858	11862	21359	40299	39329	59749
SE cost per job-year	4007	4109	9796	37040	35460	82448
Cost per 2009-2012 job-year (High U%)	4673	4480	5205	-17105	-21305	-6781
SE cost per job-year	4479	4214	4048	47266	74916	7558
Observations	2784	2784	2784	2784	2784	2784

Notes: Robust standard errors clustered at the SA4 level are in parentheses. Cost per 2009 job-year (High U%)=\$100,000/($\beta_{2009} + \beta_{2009}^{\text{High U\%}}$), and cost per 2009-2012 job-year (High U%)=\$100,000/($\sum_{Y=2009}^{2012}(\beta_Y + \beta_Y^{\text{High U\%}}$). Standard errors for cost per job-year 2009 (High U%) and cost per job-year 2009-12 (High U%) are calculated using the Delta method. Sanderson-Windmeijer χ^2 and F statistics are contained in Table A11.

Appendices

A Aggregation and Steady State

Combining equations (7), (13), (26) and the firm profit maximisation condition yields the combined resource constraint

$$R_t^{-1}B_{t+1} = B_t + p_t(z)y_t^d(z) - P_tC_t - P_tI_t - \frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t - P_t(G_t^C + I_t^G) \tag{32}$$

Assuming prices are the numeraire and the level of output normalised to one using the calibration parameter Ω_0, the stochastic steady state of the model can be defined as:

$$I = \delta K \tag{33}$$

$$I^G = \delta^G K^G \tag{34}$$

$$(R^{-1} - 1)B = Y - C - I - G^C - I^G \tag{35}$$

$$r = \frac{1}{\beta} - 1 \tag{36}$$

$$r^K = \frac{\delta + r}{1 - \tau_0^y} \tag{37}$$

$$w = (1 - \alpha)MC\frac{Y}{N} \tag{38}$$

$$MC = \frac{\theta - 1}{\theta} \tag{39}$$

$$N = \left[\frac{(1 - \tau_0^y)}{(1 + \tau^c)}\frac{(1 - \alpha)}{C}\frac{(\theta - 1)}{\theta}\right]^{\frac{1}{1 + \frac{1}{\varphi}}} \tag{40}$$

$$K = (1 - \tau_0^y)\left(\frac{\alpha}{\delta + r}\right)\left(\frac{\theta - 1}{\theta}\right) \tag{41}$$

$$X = N^{\frac{\mu_l}{1 - \rho_x}} \tag{42}$$

$$\Omega_0 = K^{-\alpha}(XN)^{\alpha - 1}K_G^{-\phi_{kg}} \tag{43}$$

$$Y = \Omega_0 K^{\alpha}(XN)^{1 - \alpha}K_G^{\phi_{kg}} \tag{44}$$

B Complete Log Linearised Equilibrium Conditions

The aggregate consumer Euler equation can be defined with respect to total consumption and labour supply alone following Watson and Tervala (2021):

$$\hat{c}_t = E_t\{\hat{c}_{t+1}\} - \sigma(\hat{r}_t - E_t\{\hat{\pi}_{t+1}\} - E_t\{\Delta\hat{\epsilon}^{tp}_{t+1}\}) - \Gamma E_t\{\Delta\hat{n}_{t+1}\} - \kappa E_t\{\Delta\hat{g}^{T}_{t+1}\} \tag{45}$$

Where

$$\sigma = (1-\lambda)\left(1 - \frac{\lambda\chi(1+\psi)}{(1+\chi\psi)}\right)^{-1} \tag{46}$$

$$\Gamma = \left(\frac{\lambda\chi(1+\psi^{-1})}{(1+\chi\psi)}\right)\left(1 - \frac{\lambda\chi(1+\psi)}{(1+\chi\psi)}\right)^{-1} \tag{47}$$

and

$$\kappa = \frac{\lambda\xi}{(1+\chi\psi)}\left(1 - \frac{\lambda\chi(1+\psi)}{(1+\chi\psi)}\right)^{-1} \tag{48}$$

The log-linear equations describing the relationship between Tobin's Q and investment are given as follows

$$\begin{aligned}\hat{q}_t = {} & \beta E_t\{\hat{q}_{t+1}\} + [1-\beta(1-\delta)](E_t\{\hat{r}^{K}_{t+1}\} - \frac{1}{1-\tau^{y}_{0}}\hat{\tau}^{y}_{t}) \\ & - ((1-\beta)\hat{r}_t - E_t\{\hat{\pi}_{t+1}\} + E_t\{\Delta\hat{\epsilon}^{tp}_{t+1}\})\end{aligned} \tag{49}$$

and

$$\hat{i}_t = \frac{1}{\phi}\hat{q}_t + \hat{k}_t + \hat{\epsilon}^{is}_t \tag{50}$$

Capital accumulation

$$\hat{k}_{t+1} = \delta\hat{i}_t + (1-\delta)\hat{k}_t \tag{51}$$

Labour supply

$$\hat{n}_t = \psi\left(\hat{w}_t - \hat{p}_t - \hat{c}_t - \frac{1}{(1-\tau^{y}_{0})}\hat{\tau}^{y}_{t}\right) \tag{52}$$

Marginal cost

$$\hat{mc}_t = (1-\alpha)\hat{w}_t + \alpha\hat{r}^{K}_t + (\alpha-1)\hat{x}_t - \phi_{kg}\hat{k}^{G} \tag{53}$$

Wages

$$\hat{w}_t = \hat{r}^{k}_t + \hat{k}_t - \hat{n}_t \tag{54}$$

Optimising firms' price level

$$\hat{p}_t(z) = \beta\gamma E_t(\hat{p}_{t+1}(z)) + (1-\beta\gamma)(\hat{mc}_t(z)) + \hat{\epsilon}_t^{cp} \tag{55}$$

Aggregate price level

$$\hat{p}_t = \gamma\hat{p}_{t-1} + (1-\gamma)\hat{p}_t(z) \tag{56}$$

Noting adjustment costs are approximately zero to a first order approximation, aggregate demand

$$\hat{y}_t = C\hat{c}_t + I\hat{i}_t + \hat{g}_t^C + \hat{i}_t^G \tag{57}$$

Production technology

$$\hat{y}_t = \alpha\hat{k}_t + (1-\alpha)\hat{n}_t + (1-\alpha)\hat{x}_t + \phi_{kg}\hat{k}_t^G \tag{58}$$

Human capital accumulation

$$\hat{x}_t = \rho_x\hat{x}_{t-1} + \mu_l\hat{l}_{t-1} \tag{59}$$

For the initial $h = 20$ quarters $\hat{r}_t = 0$, and then the monetary policy reaction function is given by

$$\hat{r}_{t+h} = \mu_1\hat{r}_{t+h-1} + (1-\mu_1)(\mu_2\Delta_4\hat{P}_{t+h} + \mu_3\hat{Y}_{t+h}) + \varepsilon_{t+h}^r \tag{60}$$

Income taxation

$$\hat{\tau}_t^y = \Phi_{ty}\hat{b}_{t-1} \tag{61}$$

Public capital accumulation

$$\hat{k}_{t+1}^G = \delta_g\hat{i}_t^G + (1-\delta_g)\hat{k}_t^G \tag{62}$$

The equilibrium condition for bonds derived from the government budget constraint is:

$$\begin{aligned}\beta\hat{b}_{t+1} = {} & \hat{b}_t + (B + t_0^y + t^cC + IG + GC)(1-\beta)\hat{r}_t \\ & - t_0^y\hat{y}_t - t^cC\hat{c}_t + (GC + IG - t^cC - t_0^y)\hat{p}_t \\ & + \hat{g}_t^C + \hat{i}_t^G + \hat{g}_t^T\end{aligned} \tag{63}$$

Government spending

$$\hat{g}_t^C = \rho_{gc}\hat{g}_{t-1}^C + \varepsilon_t^{gc} \tag{64}$$

$$\hat{i}_t^G = \rho_{ig}\hat{i}_{t-1}^G + \varepsilon_t^{ig} \tag{65}$$

$$\hat{g}_t^T = \rho_{gt}\hat{g}_{t-1}^T + \varepsilon_t^{gt} \tag{66}$$

Real time preference, cost and investment shock processes respectively

$$\hat{\epsilon}_t^{tp} = \rho_{tp}\hat{\epsilon}_{t-1}^{tp} + \varepsilon_t^{tp} \tag{67}$$

$$\hat{\epsilon}_t^{cp} = \rho_{cp}\hat{\epsilon}_{t-1}^{cp} + \varepsilon_t^{cp} \tag{68}$$

$$\hat{\epsilon}_t^{is} = \rho_{is}\hat{\epsilon}_{t-1}^{us} + \varepsilon_t^{is} \tag{69}$$

C Prior and Posterior Distributions

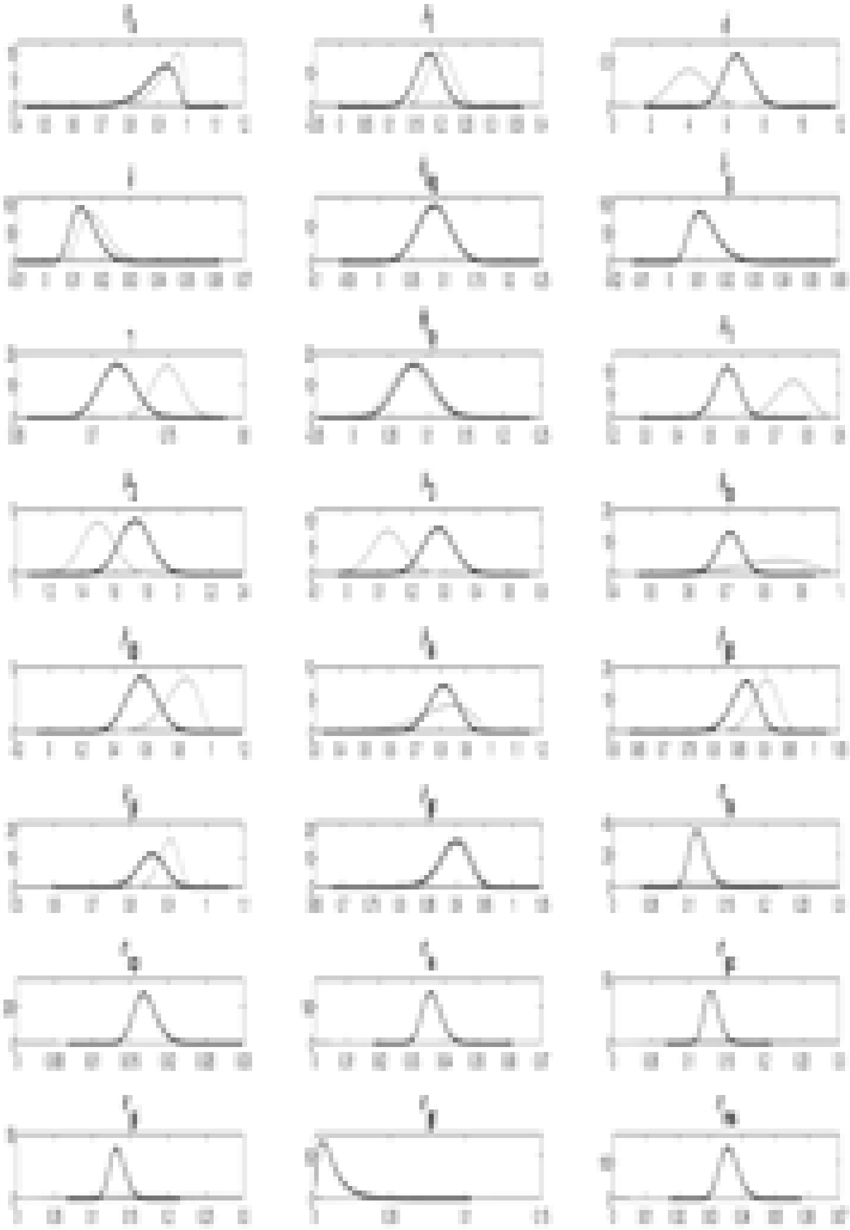

Figure D1: Prior (**grey**) and posterior (**black**) densities