State-level Federal Stimulus Funds and Economic Growth: The American Recovery and Reinvestment Act

Klaas Staal¹

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Abstract The American Recovery and Reinvestment Act encompassed a substantial federally-funded state-level fiscal stimulus. The objectives of the Act were to increase employment and stimulate economic growth. While the level of the fiscal stimulus was potentially endogenous, a direct analysis of its effects leads to biased results. To circumvent this, the effect of the stimulus on economic growth was studied using instrumental variable estimation, since the distribution of a large part of the funds was based on conditions exogenous to the economic downturn. A cross-state two-stage least squares estimation procedure was used to quantify the effect of the stimulus on economic growth and to show that the robust significant positive effect of the stimulus amounts to a fiscal multiplier of almost 1.6. The results further show that the positive effect of stimulus spending remained significant until the end of the first term of the Obama presidency.

Keywords American recovery and reinvestment act · State fiscal relief · Endogeneity · Economic growth

JEL Classification E62 · H50 · R11

Introduction

Several papers study the employment effects of the American Recovery and Reinvestment Act (ARRA) of 2009 using cross-state variations in its fiscal stimulus and economic outcomes (e.g., Feyrer and Sacerdote 2011; Chodorow-Reich et al. 2012; Wilson 2012a; Conley and Dupor 2013 and Seligman (2012) discussed the financing of the

✉ Klaas Staal
klaas.staal@kau.se

¹ Karlstad Business School, Karlstad University, 651 88 Karlstad, Sweden

stimulus). A naïve regression of economic outcomes on the size of the stimulus, however, leads to a biased estimate of the stimulus effects, as it does not take into account the endogeneity between the stimulus and the economic downturn. Therefore, the studies based on cross-state variations (including this paper) use instruments assumed to be exogenous to the downturn to circumvent this endogeneity problem.

While these papers concentrate on the employment effects of ARRA, this paper analyzes the other objective stated in the act, that is, the promotion of economic recovery. Specifically, this paper uses a two-stage least-squares regression to estimate the effect of ARRA layouts on state-level gross domestic product (GDP) growth. The instruments are based on the factors used in the statutory formulas for distributing the funds.¹ These factors, like the number of vehicle miles driven on federal highways, are assumed to be exogenous to economic conditions. Additionally, control variables are included, like the pre-crisis house-price growth, that might be correlated with both the instruments and the economic downturn.

The ARRA was one of the first laws enacted under the Obama administration and can be seen as one of the latter's main achievements (e.g., Flores 2015; Von Drehle 2016). The effectiveness of the approximate \$800 billion stimulus has been contested, not only by politicians but also by journalists (e.g., Goldman 2010; Schmid 2010). The above-mentioned papers on ARRA's employment effects using cross-state variation in stimulus and economic outcomes, however, show (using different instruments to solve endogeneity problems) that the stimulus had a positive effect on employment, either in the public or the private sector (or both). This is consistent with the results presented in Klein and Staal (2017) and in this paper, which both also exploit cross-state variation, but focus on economic growth instead of employment.

Klein and Staal (2017) only considered the effects of ARRA spending done by the Health and Human Services Department, and, therefore, merely used pre-ARRA Medicaid spending as an instrument in the estimations. However, the current paper uses a broader approach by also considering ARRA spending by other departments, and uses additional instruments based on further factors that were also used in the allocation of ARRA spending. Thus, the current analysis provides more comprehensive evidence on the effects of ARRA spending. A limitation of this paper (and of Klein and Staal 2017) is that it does not take into account the lag structure that enabled spending to influence the economy (i.e., whether 2011 growth was the result of 2009, 2010, or 2011 spending). Such an analysis is not possible, as the source of ARRA spending data, the now-extinct federal website (recovery.gov), only provided cumulative measures.

Of the Recovery Act spending, 36% was on tax cuts and tax credits, 32% on contracts, grants and loans, and 32% entitlements. Of the entitlements, spending on Medicaid was the largest component (and the single largest component of total recovery spending), and of the contracts, grants and loans, the largest components were grants to education and transport (Government Accountability Office 2014). This analysis includes most of the spending on contracts, grants and loans, and on entitlements, but excludes spending done by the Department of Labor (DoL). The two main reasons for excluding DoL spending are that (i) there is almost no source of exogenous variation in this spending since it is almost exclusively driven by a state's unemployment rate, and (ii) recovery.gov did not report this spending by state. Following the

¹ These are the same instruments used in Wilson (2012a).

other studies that are based on cross-state variation in spending, spending on tax cuts and credits was excluded. Therefore, these studies implicitly assume that the latter spending is orthogonal to the spending categories analyzed.

Methodology

The effect of the ARRA stimulus spending on economic growth was estimated based on the following linear model:

$$\frac{GSP_{i,T}}{N_{i,T}} - \frac{GSP_{i,2008}}{N_{i,2008}} = \beta_0 + \beta_1 S_i + \beta_2 X_i + \varepsilon_i \quad (1)$$

where $GSP_{i,T}$ is the gross state product (GSP), scaled by population, in state i in year T ; S_i is cumulative ARRA spending per capita in state i ; and X_i is a vector of state-specific control variables. It would be possible to estimate (1) using ordinary least squares (OLS) if the size of the stimulus and the error terms were independently distributed. Since the stimulus depends, among other factors, on the increase in a state's unemployment, this is almost certainly not the case. This endogeneity problem is solved by using three instrumental variables in a two-stage least squares estimation procedure. These instrumental variables are based on exogenous allocation factors and are discussed, along with the other variables, in more detail in the next section.

Data

Table 1 contains the descriptive statistics of the dependent, explanatory, instrumental, and control variables.

Dependent Variables: The Bureau of Economic Analysis (BEA) provides data on GDP by state (GSP). These GSP levels are given in millions of chained dollars and, in this analysis, GSP levels are normalized by the state 16-years-and-older population. The Bureau of Labor Statistics provides estimations of these population levels in their annual Regional and State Unemployment Reports. Population figures for each of the years 2007 to 2015 were taken from Bureau of Labor Statistics (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017), respectively, and for the year 2016 from Bureau of Labor Statistics (2017). The normalized GSP levels in state i in year T are denoted by $GSP_{i,T}$.

Although the ARRA was enacted in February 2009, the analysis considers annual GSP growth also for the year 2009. This can be justified by noting that discussions on this major economic stimulus had already started in 2008, so anticipation effects may have already affected economic activity at the start of 2009. Besides that, the only data on economic growth at the state level provided by BEA is annual data.

Table 1 Descriptive statistics of dependent, explanatory and control variables

	Mean	Median	SD	Min.	Max
Dependent variables:					
GSP Growth 2008 → 2009	-1.90	-1.56	2.92	-15.74	2.04
GSP Growth 2008 → 2010	-0.30	0.43	3.05	-13.83	5.52
GSP Growth 2008 → 2011	1.62	2.13	3.62	-9.81	13.85
GSP Growth 2008 → 2012	3.24	3.54	5.51	-14.02	31.24
GSP Growth 2008 → 2013	4.30	4.77	5.79	-13.32	33.07
GSP Growth 2008 → 2014	6.34	6.52	6.63	-12.50	38.80
GSP Growth 2008 → 2015	7.84	7.88	7.18	-17.23	31.56
GSP Growth 2008 → 2016 (normalized by population in respective years)	8.85	9.35	7.89	-20.47	26.37
Explanatory variable:					
ARRA outlays (normalized by 2008 population)	449.03	431.35	149.33	269.26	1309.28
Instrumental variables:					
DoT Instrument	111.42	94.35	51.06	57.33	295.55
ED Instrument	0.26	0.26	0.01	0.24	0.32
HHS Instrument	63.47	58.63	22.85	29.16	142.43
Control variables:					
Personal Income 3-year moving average, 2005 to 2006 change	0.0008	0.0007	0.0005	-0.0002	0.0025
Tax benefits per capita	568.55	537.23	114.79	434.59	921.00
Unemployment trend, 2007.12 to 2009.02 change	0.031	0.0031	0.011	0.010	0.054
Unemployment level 2009.02	0.076	0.075	0.018	0.041	0.120
House price growth, 2003 to 2007	0.040	0.351	0.201	0.028	0.907

Source: Own calculations using data from Bureau of Economic Analysis (2017), Bureau of Labor Statistics (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017), Wilson (2012b)

Explanatory Variable: Data on the explanatory variable, cumulative ARRA spending by state, are from Wilson (2012b), who downloaded weekly Financial and Activity Reports from the recovery.gov website. These reports contain data on final payments (outlays) and cumulative sums of these final payments given the stimulus by state. (Only state-allocated data were used. This implies that, among other minor categories, spending by the DoL was excluded.) The cumulative spending levels were then normalized by state population. Three departments, Transport (DoT), Education (ED), and Health and Human Services (HHS), are responsible for approximately 80 % of stimulus spending. Therefore, the three instrumental variables are based on the exogenous factors used for the allocation of the funds of these three departments.

Instrumental Variables: Since ARRA spending levels were potentially endogenous to economic outcomes, instrumental variables were used. These instruments capture the factors used in the allocation of the three departments (Transport, Education, and Health and Human Services) responsible for the largest part of ARRA spending. Note that in each of the three cases, the constructed instruments are based on pre-ARRA factors that are unlikely to be related to post-ARRA economic conditions.

About 75% of the DoT's ARRA spending was allocated to states by the Federal Highway Administration (FHWA). Half of FHWA's ARRA spending was based on the

formulaic distribution of funds within the FHWA's Surface Transportation Program (STP). According to this formula, most of the funds are distributed based on a weighted average of the three-year-lagged values of a state's lane miles of federal highways, of the number of vehicle miles on federal highways, and of a state's payments into the federal highway trust fund. The other half of FHWA's ARRA spending was based on its obligation limitations spending in 2008, which largely consists of STP spending. The inter-state variation of STP spending thus explains a large share of the inter-state variation in ARRA spending. Therefore, the *DoT Instrument* is the predicted value of the regression of the DoT's ARRA obligations in 2009 on the 2006 values of total federal highway lane miles, of total vehicle miles on federal highways, and of estimated payments into the federal highway trust funds, and the 2008 values of the FHWA obligation limitations.

More than 50% of the ED's ARRA spending was distributed to states from the State Fiscal Stabilization Fund (SFSF). Of these funds, 61% was allocated to states in proportion to their school-aged (5 to 24 years old) population and 39% in proportion to the state's total population. A state's ARRA SFSF funds are thus a linear function of its school-aged population share, which is used as the *ED Instrument*.

HHS's ARRA spending was allocated to states based on pre-ARRA Medicaid spending. For example, states received a temporary increase of 6.2% of HHS-reimbursed Medicaid spending. This Medicaid spending varies across states if the proportion of low-income families is higher or because a state's Medicaid program is more generous. Therefore, the *HHS instrument* is the state's 2007 Medicaid spending.

Control Variables: One of the characteristics of the recession preceding the ARRA was problems in the financial sector related to the foreclosures of mortgages (e.g., Council of Economic Advisers 2014). Indeed, in the years before 2009, when the ARRA was enacted into law, housing prices increased sharply and then decreased sharply in most states. It is not impossible that the price increases were related to the factors on which the instrumental variables were based, or to post-ARRA economic outcomes. Therefore, the increase in housing prices from 2003 to 2007 was included as a control variable, using the House Price Index provided by the Federal Housing Finance Agency.

States' Medicaid relief depended on, among other factors, the change in personal income per capita on a 3-year trailing moving average basis. This change from 2005 to 2006 was included as a control variable. State residents also received ARRA tax benefits, consisting of ARRA's Making Work Pay (MWP) payroll tax cut, and increase in the Alternative-Minimum-Tax's (AMT's) income threshold. Therefore, another control variable is based on the estimated ARRA tax benefits, estimated by Wilson (2012a) using data from the Council of Economic Advisers (2010) for the MWP tax cuts and the AMT benefits.

Following Wilson (2012a), state lagged employment growth per capita from the start of the recession (December 2007) to when ARRA was enacted (February 2009) and level of unemployment at the end of this period as control variables were also included in the analysis. These variables can both be related with pre-ARRA allocation factors as well as with persistent economic trends and thus with post-ARRA economic outcomes.

Results

First Stage Regressions

Table 2 presents the results of the first-stage regressions. All three instrumental variables are positively related to the allocation of ARRA spending. The DoT and HHS instruments are statistically significant, while the *ED instruments* is not, independent of whether the control variables are included.

Second Stage Regressions

Table 3 presents the two stage least squares estimates of the ARRA outlays' effect on GSP growth per capita. The estimates show that ARRA outlays had a positive effect on GSP per capita for all eight years of the Obama presidency, but that this effect was only statistically significant in the years 2010 to 2012. The estimated fiscal multiplier reached a maximum of 1.59 in 2012.

Table 2 First stage regressions: ARRA outlays on the instrumental and control variables

	(1)	(2)
Instrumental variables:		
DoT Instrument	0.57* (0.30)	0.88** (0.36)
ED Instrument	23.84 (1152.5)	1155.6 (1214.1)
HHS Instrument	4.60*** (0.71)	4.24*** (0.89)
Control variables:		
PI 3-years moving average 2005 to 2006 change		15,600.7 (39,009.3)
Tax benefits per capita		0.13 (0.16)
Unemployment trend, 2007.12 to 2009.02 change		-18.37 (3364.9)
Unemployment level 2009.02		1907.1 (1973.2)
House price growth, 2003 to 2007		133.1 (99.07)
Intercept	87.07 (324.61)	-516.8 (393.9)
Observations	51	51
R ²	0.51	0.59
$\bar{R}^2$	0.48	0.52

Notes: The dependent variable is ARRA outlays normalized by states' 16+ 2008 population. Standard errors are in parentheses. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level
Source: Own calculations using data from Bureau of Economic Analysis (2017), Bureau of Labor Statistics (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017), Wilson (2012b)

Table 3 Second stage regressions: GSP growth on estimated outlays and control variables, using instrumental variables

	T = 2009	T = 2010	T = 2011	T = 2012	T = 2013	T = 2014	T = 2015	T = 2016
Explanatory variable:								
Estimated payments in thousands per capita	0.255 (0.421)	0.978** (0.422)	1.533*** (0.442)	1.590** (0.756)	1.306 (0.797)	1.462 (0.949)	1.087 (1.047)	0.981 (1.129)
Control variables:								
PI 3-years MA, 2005 to 2006 change	-4.149*** (900.5)	-4.409*** (903.8)	-5.186*** (947.0)	-6.979*** (1616)	-7.053*** (1705)	-6.954*** (2029)	-7.525*** (2240)	-8.558*** (2414)
Tax benefits per capita	0.013*** (0.003)	0.010*** (0.003)	0.006* (0.003)	0.009 (0.006)	0.011* (0.006)	0.014* (0.007)	0.028*** (0.008)	0.036*** (0.009)
Unemployment trend, 2007.12 to 2009.02	112.8 (76.00)	91.41 (76.28)	74.27 (79.92)	-5.625 (136.4)	26.36 (143.9)	104.2 (171.3)	261.4 (189.0)	326.6 (203.7)
Unemployment level 2009.02	-78.21 (47.33)	-92.67* (47.50)	-1.40*** (49.76)	-140.3 (84.97)	-161.1* (89.62)	-215.8** (106.6)	-243.0** (117.7)	-242.7* (126.9)
House price growth, 2003 to 2007	1.988 (2.34)	-0.190 (2.353)	-1.546 (2.465)	-1.194 (4.209)	-3.042 (4.439)	-5.132 (5.284)	-4.574 (5.832)	-3.182 (6.286)
Intercept	-5.343** (2.221)	-2.636 (2.229)	4.605* (2.336)	8.079** (3.988)	10.70** (4.206)	12.82** (5.007)	5.448 (5.525)	0.552.8 (5.956)
Observations	51	51	51	51	51	51	51	51
R ²	0.435	0.479	0.593	0.486	0.484	0.441	0.419	0.442
$\bar{R}^2$	0.358	0.408	0.538	0.416	0.413	0.364	0.340	0.366

Notes: The dependent variable is GSP per capita growth in thousands per capita from 2008 to year T. Standard errors are in parentheses. *** Significant at the 1 % level ** Significant at the 5 % level * Significant at the 10 % level

Source: Own calculations using data from Bureau of Economic Analysis (2017), Bureau of Labor Statistics (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017), Wilson (2012b)

Additional government spending can have two effects on GSP per capita. The first is the effect of an increase (or: smaller decrease) in public sector employment as layoffs by state and local governments are (partly) prevented. The second is an increase (id.) of employment in the private sector benefitting from the ARRA outlays. Wilson (2012a, Table 7) showed, however, that both effects played a role in creating the positive effect on GSP per capita presented in this paper. A third, indirect effect, would then consist of the spillover effects of stimulus spending between the public and private sectors.

From Table 3 it follows that the positive effect of the federally-funded state-level of the ARRA is robust with respect to the time period considered. Table 4 presents some further robustness checks. Estimating the relationship between ARRA outlays and GSP growth with OLS still produces a positive and significant effect, albeit smaller than the two-stage estimates. The latter is in line with the negative bias due to the endogeneity problem discussed in the methodology section. Then consider whether the analysis of the effect of outlays on growth was affected by the choice of the instrument. It follows from Table 4 that especially the variation linked to the variation in the Health and Human Services Department was an important driving force behind the relationship between outlays and growth. Finally, following Wilson (2012a), five sparsely populated Western states (Alaska, Montana, North Dakota, South Dakota, Wyoming and Washington D.C.) were excluded, to check the robustness with respect to these outliers. The estimated effect of outlays on growth was then even larger and still significant.

Table 4 Robustness checks: GSP growth on (estimated) ARRA outlays

	Explanatory variable: (Estimated) Payments in thousands per capita
OLS Estimate	1.463*** (0.483)
Robustness to instruments:	
Drop DoT Instrument	1.782** (0.849)
Drop ED Instrument	1.502** (0.767)
Drop HHS Instrument	0.729 (1.623)
Robustness to outliers:	
Drop Alaska, Montana, North Dakota, South Dakota, Washington DC, Wyoming	1.778** (0.747)

Notes: The dependent variable is GSP per capita growth in thousands per capita from 2008 to 2012, the control variables are included but reported in the table. Except for the OLS estimates, second-stage regression estimates are reported. Standard errors are in parentheses. *** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level

Source: Own calculations using data from Bureau of Economic Analysis (2017), Bureau of Labor Statistics (2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017), Wilson (2012b)

Concluding Remarks

This paper presents the effects of fiscal stimulus spending on economic growth exploiting inter-state variation between ARRA spending levels (outlays). To avoid potential endogeneity problems between spending and economic outcomes, an instrumental variable approach was used based on pre-ARRA factors used to allocate ARRA spending. Two-stage least squares estimates show that ARRA outlays had a positive and significant effect on economic growth, measured as growth in income per capita. This positive effect of stimulus spending, with a maximum fiscal multiplier of 1.59, became significant in 2010 and remained significant until the end of the first term of the Obama-presidency.

The estimated fiscal multiplier of 1.59 is close to the estimate of 1.61 reported by Klein and Staal (2017), which was also based on inter-state variations. However, the estimate is among the lower values in the range of estimated multipliers of 1.5 to 2.1 found in other empirical studies mentioned in the Council of Economic Advisers (2014, p.146) final report to Congress. It is important to note in this respect that estimates based on inter-state variations are local multipliers (similar comments can be made with respect to Feyrer and Sacerdote 2011; Chodorow-Reich et al. 2012; Wilson 2012a; Conley and Dupor 2013; for a survey on the fiscal multipliers literature, see Ramey 2011). Due to factor and goods mobility, these local multipliers can differ from national multipliers. Factor mobility lessens the crowding out of private-sector production. The local multiplier would be an upper bound, but goods mobility could lead to positive spillovers to other states and then the local multiplier would be a lower bound for the national fiscal multiplier. Ilzetzki et al. (2013) found that the multiplier is higher in closed economies than in open economies. If state economies are more open than the national economy, then the estimates based on inter-state variations will be a lower bound on the national multiplier.

In comparing ARRA multipliers with fiscal multipliers of government spending in other situations, however, one should also keep in mind that the pre-ARRA recession was unusually severe and that the accompanying stark underutilization of productive resources might increase the fiscal multiplier, as was found by Auerbach and Gorodnichenko (2012). Moreover, the monetary policy response was restricted, as there was no room left to decrease interest rates further, which can also increase the fiscal multiplier as is argued by Christiano et al. (2011).

As mentioned, the positive effect of stimulus spending became significant in 2010. This contrasts with Klein and Staal (2017), who found a positive and significant effect of the stimulus from the first year (2009) onwards. This is an important difference, as one of ARRA's objectives was to offer a quick response to the economic crisis (e.g., GAO 2014). It carries an important policy implication, i.e., it shows that the response to increasing Medicaid transfers, (Klein and Staal 2017), is potentially swifter than the other components that were also included in this analysis. However, to substantiate such conclusions further analysis is required to take into account that, by the end of 2009, about a third and, by the end of 2010, about two thirds of the expected 10-year ARRA spending had been paid out (Wilson 2012a). Such an analysis should then exploit how, for example, the 2010 recovery depends on the stimulus spending levels in 2009 and 2010.

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