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Replication Study of Baron (2022): School Spending and Student Outcomes

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Abstract

Baron (2022) explores the independent effects of operational expenditure and capital expenditure on student outcomes in school districts across Wisconsin from the outcomes of close referendum approvals. By utilizing a dynamic regression discontinuity framework and cubic specification, the author finds that narrowly passing an operational referendum, increases operational expenditure per pupil by \$298 each year on average, following the referendum over a ten year period. From this \$198 are spent on instructional expenses. These point estimates are statistically significant at the 10% and 5% level, respectively. We first reproduce the main results from the paper without any issues arising. Secondly, we conduct a robustness replicability to (1) dropping school districts from the top and bottom 5% of the revenue limits distribution, categorically, and (2) dividing the time frame of the school districts by revenue limits reduces the additional operational expenditure by \$140 per pupil (lower by 50 percent) and the effects of passing an operational expenditure by that the estimated effects on student outcomes rely heavily on recent observations.

1 Introduction

Baron (2022) explores the effects on student outcomes due to operational spending versus capital spending from revenue limit elections held in Wisconsin school districts. School districts have caps on the increases of revenue financed through state aid and local property taxes. In order to raise more revenue school districts must hold separate referenda and get voter approval of district residents to increase property taxes for operational expenditures and/or capital

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projects.

The author utilizes the "one-step" dynamic RD estimator developed by Cellini, Ferreira, and Rothstein (2010) to explore the causal impact of operational and capital spending. This is done by estimating treatment on treated (TOT) of the school districts that narrowly approved a referendum. The paper uses data on all referenda held in Wisconsin school districts between 1996-1997 and 2014-2015. The referendum level dataset is obtained from the Wisconsin Department of Public Instruction (WDPI). This is matched with to NCES district level K-12 revenue and expenditure data. Student outcomes on the Wisconsin Knowledge and Concepts Examination (WKCE), district dropout rate and the share of students who enroll in postsecondary education have also been matched. The final sample consisted of 404 Wisconsin school districts that initiated referendum in at least one scope.

Baron (2022) describes the main result on pp.3: "Estimates of TOT effects indicate that operational referendum approval in a narrow election leads to an increase in operational expenditures of roughly \$300 (3 percent) per pupil each year in the 10 years following the election." Secondly, Baron (2022) describes "I find that narrowly passing an operational referendum leads to an increase in test scores of approximately 8 percent of a standard deviation on the state's standardized exam, a 9 percent reduction in the district's dropout rate, and a 10 percent increase in the number of high school completers in the district who subsequently enroll in postsecondary education."

In this paper we explore if the results are reproducible and further test robustness to two specification checks: First, we drop school districts within the top 5% and bottom 5% of revenue limits, respectively. Second, we divide the time period into two parts 1996-2005 and 2005-2014. The reproduction was successfully done using the replication package provided by the author in the AEA OPENICSPR repository. All the tables and figures in the paper could be reproduced to provide the same estimates. There was a slight mislabelling of the codes for figure 5A and 5C, where they were interchanged. This did not affect the final figure once identified.

The sensitivity analysis through the mentioned robustness checks show that dropping school districts from the top 5% of revenue limits distribution reduces the impact from passing oper-

ational referendum on additional operational expenditure by \$140 per pupil (only 1.5% of the average) compared to the original estimate. The school districts from the top 5% of revenue limits are found to drive the estimated effects from passing an operational referendum. Secondly, the effects of passing operational referendum are found to be larger for the period 1996 to 2005 at almost \$700 (2010 dollars) (7% of the average) towards operational expenditure per pupil compared to \$314 (3% of average) over 2005 to 2014. School districts spent a larger portion of the increase in operational expenditure towards support services during 1996-2005 compared to 2005-2014.

2 Reproducibility

The reproduction of the paper was successful from the codes and data sets provided in the replication package by the author. The package consisted of the raw, intermediate and final data files along with the do files in Stata that create the intermediate and final data sets and the figures and tables in the main paper and online appendix. All the tables and figures reproduce the same results as published in the paper.

3 Replication

To test the sensitivity of the main results from the paper (Table 4 and 5) we do two additional checks by robustness replicability. These are described in the following subsections:

3.1 Dropping school districts by revenue limits

First, we execute the main econometric specification on a smaller sample of school districts by dropping those within the top 5% of revenue limits per pupil and next by dropping school districts in the bottom 5% of revenue limits. The distribuiton of revenue limits is based on the average of revenue limits per pupil for each school district over the period 1996 to 2014. This check can inform us if certain school districts are driving the results.

Table 1, column 1 shows the original results as shown in table 4 in Baron (2022). Column 2 shows the estimates after dropping school districts within the top 5% of revenue limits per

pupil and column 3 shows the estimates after dropping school districts within the bottom 5% of revenue limits per pupil. The results from column 2 show that removing school districts in the top 5% of revenue limits per pupil reduces the estimated impact of passing operational referenda while removing school districts within the bottom 5% of revenue limits per pupil has a smaller impact.

Removing school districts in the top 5% of the revenue limits distribution reduces the revenue limits PP estimates by roughly \$100. Operational expenditure per pupil rise by only \$160 due to passing an operational referenda in the restricted sample in column 2 whereas the original estimates indicate a nearly double increment of \$300 per pupil. This is equivalent to 1.5% increase relative to the average operational expenditure per pupil (Table 3, column 2 in this paper). The highest proportion of expenditure is still spent in the instructional account (Table 1, row 3) followed by support services. The point estimate for instructional expenditures PP is no longer significant at the 5% level. The restricted sample of school districts without the top 5% of schools (in revenue limits) spend only an additional \$30 per pupil on support which is \$82 less than the entire sample of 404 school districts. Removing school districts within the bottom 5% of revenue limits give estimates which are closer to the original estimates.

Table 2 shows the results of robustness checks for table 5, panel A in the main paper which reports the preferred specification (cubic) of the author. Column 2 and 3 show the resulting estimates after removing school districts in the top 5% and bottom 5% of the revenue limits distribution, respectively. The estimates for student outcomes do not vary from the original estimates reported in the paper (shown in column 1, table 2). Removing schools in the bottom 5% of the revenue limits distribution slightly improves the percent of students who score advanced or proficient (to 6.4 compared to 5.89 percentage points reported in paper) and the average tenth grade math score (to 5.03 from 4.53 percentage points). The improvement in test scores remains at 10 percent of a standard deviation on the state's standardized exam, as found for the cubic specification in the paper ¹Overall, the the point estimates remain significant at the 5% level as reported in Baron (2022).

Overall, this robustness check shows that the school districts within the top 5% of revenue

¹This is obtained by dividing the test score improvement by 43.2 - the standard deviation of the 2002-2003 mathematics test score distribution for tenth grade.

limits can drive the outcomes from passing an operational referendum. School districts that have higher revenue limits from state aid and property taxes have larger effects from passing an operational referendum and can mobilize the extra funds towards instructional expenses and support services.

3.2 Two time periods

Next, we divide the time period used in Baron (2022) into two parts: 2005 to 2014 and 1996 to 2005. Exploring the main results separately in the two time periods can inform about the impacts of operational referenda passing in the later 2010s and the late 90s to early 2000s. The nine year average effect estimates of the two time periods are reported in columns 4 and 5 in table 1 and 2. In addition, we report the five year average effect estimates in columns 6 and 7 in table 2.

We estimate the the average effects over nine years after referendum as opposed to average effects over ten years after referendum as estimated in the paper. The effects of passing an operational referendum increased operational expenditure per pupil by nearly \$700 (in 2010 dollars) in the period 1996-2005 whereas this only increased by \$314 in 2005-2014. This corresponds to a 7 percent increase relative to the average operational expenditure during that period (please see Table 3, column 5). The increases in expenditures were used mostly towards support services in 1996-2005 (\$416) whereas in 2005-2014 the increased expenditures were roughly similar for instructional expenditure and support services per pupil (\$158).

From table 5, comparing columns 4 and 5 show that dropout rates decreased by 0.22 percentage points in 1996-2005 and this was lower at 0.18 percentage points for 2005-14. This estimate is significant at the 10 percent level. The other measures of student outcomes could not be compared due to very few observations available (350 to 355 for percent of advanced tenth grade math score, average tenth grade math score and postsecondary enrollment). The effects on student math performance as measured by percent of advanced tenth grade math score and average tenth grade math score are lower in 2005-14 period compared to the full range of years used in original paper. This is equivalent to roughly 3 percent of student-level standard deviation compared to 10 percent in the full sample. The estimate for the percent of advanced tenth grade math score is significant at the 10 percent level. Contrary to the original estimate, postsecondary enrollment decreased (negative estimate) in 2005-14 instead of increasing. Column 6 similarly show that the five year average effects for the 1996-2005 period for the three latter variables are not reproducible due to missing observations of the outcome variables. Overall, the results of table 5 are sensitive to missing observations prior to 2005.

4 Conclusion

In conclusion, the results from the robustness replicability shows that dissecting the sample of the study can give further information about the school districts. The first robustness exercise indicates heterogeneity of results when the top revenue limits school districts are removed from the sample. Furthermore, the the second robustness check also provides evidence of sensitivity of results due to missing observations prior to 2005. In future studies, the replication of the results from Baron (2022) can be tested using data from other states besides Wisconsin.

5 Tables

Table 1: Robustness	checks for	main	$\operatorname{results}$	from	table 4 in	paper
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		Removing	by revenue limits	Two time periods	
Dependent variable	Original	top 5%	bottom 5%	2005-14	1996-2005
Revenue limits PP	316	213	320	293	464
	(116)	(79)	(123)	(130)	(129)
Op. expenditures PP	298	156	302	314	669
	(160)	(118)	(166)	(143)	(261)
Inst. expenditures PP	198	134	211	157	286
	(95)	(83)	(97)	(67)	(157)
Support services PP	111	29	101	159	416
	(86)	(63)	(90)	(119)	(138)
Other expenditures PP	-11	-7	-10	-2	-33
	(9)	(10)	(10)	(8)	(21)
Number of school districts	404	383	383	362	392

Standard errors in parantheses, clustered by school district

		Removing	by revenue limits		Two time	e periods	
Dependent variable	Original	top 5%	bottom 5%	2005 - 14	1996-2005	2005 - 14	1996-200
$Cubic\ specification$				9 yec	ır avg.	5 yec	ır avg.
Dropout rate	-0.11	-0.11	-0.11	-0.18	-0.22	-0.10	-0.28
	(0.07)	(0.02)	(0.08)	(0.10)	(0.21)	(0.11)	(0.13)
Percent adv. or prof. tenth grade math	5.89	5.6	6.4	1.94	N/A	2.30	N/A
	(1.8)	(1.81)	(1.92)	(1.16)		(1.21)	
Average tenth grade math score	4.53	4.25	5.03	1.04	N/A	1.44	N/A
	(1.81)	(1.82)	(1.92)	(1.18)		(1.23)	
log(postsecondary enrollment)	0.07	0.08	0.08	-0.02	N/A	-0.02	N/A
	(0.05)	(0.05)	(0.05)	(0.04)		(0.04)	

Table 2: Robustness checks for table 5 in paper

	Original	Removing by revenue limits		Two time periods	
Dependent variable	Column (3)	Top 5%	Bottom 5%	2005-14	1996-2005
Panel A. Fiscal outcomes					
Revenue limits PP	9,525	9465	9586	9790	9281
	(972)	(838)	(970)	(895)	(969)
Total expenditures PP	10,375	10332	10443	10786	10005
	(1,286)	(1220)	(1282)	(1206)	(1233)
Instructional expenditures PP	6,353	6335	6389	6515	6215
	(758)	(743)	(757)	(749)	(733)
Support services PP	3,645	3619	3676	3861	3443
	(648)	(591)	(651)	(637)	(583)
Other expenditures PP	377	377	378	409	347
	(99)	(96)	(98)	(93)	(94)
Panel B. Student outcomes					
Dropout rate (percent)	0.99	0.998	0.99	1.02	0.93
	(1.04)	(1.04)	(1.06)	(1.06)	(1.0)
Percent adv. or prof., tenth grade	46.86	46.79	47	47	49
	(12.1)	(12)	(12.2)	(12.1)	(11.8)
Average scale score, tenth grade	567.9	567.8	568	567.9	569
	(12.35)	(12.3)	(12.5)	(12.3)	(12.7)
Postsecondary enrollment share	0.42	0.42	0.42	0.42	0.39
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)

Table 3: Summary statistics from table 2, column 3 in paper

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- Baron, E. J. (2022) 'School spending and student outcomes: Evidence from revenue limit elections in wisconsin,' American Economic Journal: Economic Policy 14(1), 1–39
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