

# Maimonides' Rule Redux

Joshua D. Angrist, Victor Lavy, Jetson Leder-Luis and Adi Shany

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## Online Appendix

### Data Appendix

The data used here are from the 2002–2011 Growth and Effectiveness Measures for Schools (GEMS) testing program. GEMS is administered by the National Authority for Measurement and Evaluation in Education. GEMS scores are used to assess school progress. Individual GEMS scores are not released to students or schools administrators.<sup>1</sup>

GEMS tests are usually taken some time between mid-March and mid-June (with the exception of the 2004–2006 school years, when the tests were given in October-November). GEMS test-takers are drawn from a representative 1-in-2 sample of all elementary and middle schools in Israel, so that each school participates in GEMS once every two years. GEMS tests fifth-graders (primary school) and eighth-graders (middle school) in math, science, native language skills, and English. In principle, all students except those in special education classes are tested; in practice, the proportion of students tested is above 90 percent.

We focus on math and language tests given in Jewish elementary schools, as in Angrist and Lavy (1999). GEMS scores are reported on a 1-to-100 scale similar to that used for the scores in the original Angrist and Lavy study. Between 2002 and 2006, students in participating schools were tested in four subjects. Since 2007, only two subjects at a time are assessed, either math and language or science and English. Our ten year sample includes the math and language scores of 240,310 fifth graders. Between 2002–2006, this sample covers an annual average of 563 Jewish public (secular and religious) schools and 1162 classes per year. Between 2007–2011, the sample covers an annual average of 286 Jewish public schools and 602 classes per year.

In our sample, the average attrition rate is 5 percent. Estimates are similar when the sample is limited to classes in which at least 50 percent of students were tested. Attrition is unrelated to

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<sup>1</sup>The Division of Evaluation and Measurement website, <http://cms.education.gov.il/EducationCMS/Units/Rama/Meitzav/>, provides additional background.

Maimonides' Rule. For the sample of 51 schools tested in consecutive years, we use the first test only.

We linked the GEMS data to MOE administrative records covering all Israeli 5th graders. Student records include gender, parents' education, number of siblings, country of birth, and parents' country of origin. We also collected MOE data on dates of birth for the population of 4th-6th graders, beyond those who participated in the math and language GEMS.

The school-level data used in this study are derived from MOE records reporting enrollment, school sector (e.g., religious), and a school's index of socioeconomic status (SES). We obtained two enrollment variables: November enrollment, reported by school headmasters to the MOE, and a June enrollment variable computed by summing spring class sizes. The November enrollment data and birthday-based imputation generate our instruments, while the June data provide the endogenous class size variable that gets instrumented.

We use birthdays to impute a measure of enrollment uncontaminated by manipulation. Appendix Figure A8 extrapolates Chanukah-based school entry into fifth-grade, showing the grade enrollment determined by application of this rule to birth dates 11 years earlier. For example, students born between December 18, 1990 (the last day of Chanukah in 1990) and December 8, 1991 (the last day of Chanukah in 1991) should have been enrolled in first grade in the school year ending Spring 1998 and, assuming no grade repetition or skipping, been seen in 5th grade in the school year ending spring 2002. Students born after December 8, 1991 should have had to wait for first grade until the school year ending in 1999 and therefore been in 5th grade one year later, in the school year ending spring 2003.

The 1991 and 1992 samples are those used by Angrist and Lavy. The 1991 data are posted at <https://economics.mit.edu/faculty/angrist/data1/data/anglavy99>. These are class-level averages.

# Appendix Tables and Figures

Table A1: Descriptive Statistics (2002–11 5th Graders)

Variable	Mean	S.D.	Quantiles				
			0.10	0.25	0.50	0.75	0.90
<b>Panel A. Class Level Data</b>							
June class size	28.1	5.85	21	24	28	32	35
Number Tested in Language	25.5	6.52	18	22	26	30	33
Number Tested in Math	25.7	6.21	18	22	26	30	33
Language score	71.7	8.12	61.5	67.0	72.5	77.3	81.2
Math score	67.6	10.7	53.7	61.6	68.7	75.3	79.9
Number of classes			8,823				
<b>Panel B. School Level Data</b>							
June enrollment	58.4	27.1	26	40	55	76	95
November enrollment	59.0	27.3	25	41	55	77	96
Birthday-based enrollment	63.8	28.7	29	43	60	82	103
SES index	5.16	2.44	2.02	3.11	5	7	9
Number of classes	2.08	0.78	1	2	2	3	3
Religious school	0.31	0.46					
Number of schools			4,245				
<b>Panel C. Student Level Data</b>							
Language score [N=225,108]	72.1	17.4	48.4	63.4	75.6	84.7	91.0
Math score [N=226,832]	68.1	20.6	37.9	55.3	72.3	84.3	91.5
Father's years of education	11.8	5.03	0	11	12	15	17
Mother's years of education	12.1	4.67	7	12	12	15	17
Number of siblings	1.75	1.24	0	1	2	2	3
Boy	0.50	0.50					
Native	0.90	0.31					
Israeli ethnicity	0.58	0.49					
Ethiopian ethnicity	0.03	0.18					
Former USSR ethnicity	0.16	0.36					
Asia-Africa ethnicity	0.12	0.32					
Europe-America ethnicity	0.11	0.31					
Number of students			240,310				

Notes: This table reports descriptive statistics for the sample of fifth grade students in Jewish state elementary schools who participated in the GEMS tests in math and/or language in 2002–2011. Means and standard deviations for class level data are computed using one observation per class; Means and standard deviations for school level data are computed using one observation per school; Means and standard deviations for student level data are computed using one observation per student.

Table A2: First Stage Estimates Using November Enrollment Instruments (2002–2011)

	Language			Math		
	(1)	(2)	(3)	(4)	(5)	(6)
$f_{jt}$	0.6247 (0.0186)	0.6115 (0.0189)	0.6183 (0.0186)	0.6237 (0.0186)	0.6108 (0.0189)	0.6175 (0.0186)
SES index	-0.0869 (0.0362)	-0.0769 (0.0360)	-0.0815 (0.0361)	-0.0860 (0.0362)	-0.0762 (0.0360)	-0.0809 (0.0361)
November enrollment	0.0268 (0.0031)	0.0726 (0.0093)		0.0272 (0.0030)	0.0722 (0.0093)	
Enrollment squared/100		-0.0275 (0.0055)			-0.0271 (0.0055)	
Piecewise linear trend			0.0618 (0.0061)			0.0623 (0.0061)
$R^2$	0.519	0.523	0.521	0.520	0.523	0.521
$F_{st}$	1124.6	1043.2	1105.7	1118.9	1039.1	1101.9
$N$	225,108			226,832		

Notes: This table reports first-stage estimates for the 2SLS estimates reported in Table 1 in the text. Maimonides' Rule  $f_{jt}$  is computed using November enrollment. See the notes to Table 1 for additional covariates in these models. Standard errors reported in parentheses are clustered at the school and year level.

Table A3: First Stage Estimates Using Birthday-based Imputed Enrollment (2002–2011)

	Language			Math		
	(1)	(2)	(3)	(4)	(5)	(6)
$f_{jt}$	0.3257 (0.0178)	0.3037 (0.0181)	0.3060 (0.0180)	0.3256 (0.0177)	0.3039 (0.0180)	0.3061 (0.0179)
SES index	-0.1301 (0.0449)	-0.1100 (0.0445)	-0.1123 (0.0445)	-0.1238 (0.0450)	-0.1041 (0.0446)	-0.1066 (0.0447)
Birthday-based enrollment	0.0547 (0.0031)	0.1355 (0.0110)		0.0551 (0.0030)	0.1345 (0.0109)	
Enrollment squared/100		-0.04580 (0.0062)			-0.0451 (0.0062)	
Piecewise linear trend			0.1384 (0.0066)			0.1390 (0.0065)
$R^2$	0.344	0.355	0.355	0.346	0.356	0.357
$F_{st}$	336.1	281.3	289.3	338.3	283.4	291.6
$N$		225,108			226,832	

Notes: This table reports first-stage estimates for the 2SLS estimates reported in Table 2 in the text. Maimonides' Rule  $f_{jt}$  is computed using birthday-based imputed enrollment. See the notes to Table 2 for additional covariates in these models. Standard errors reported in parentheses are clustered at the school and year level.

Table A4: Replication of 1991 Results

	Language			Math		
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Panel A. 5th Grade Data</b>						
Class Size	-0.2772 (0.0758)	-0.2631 (0.0937)	-0.1899 (0.122)	-0.2311 (0.0985)	-0.2644 (0.123)	-0.2053 (0.1450)
November Enrollment	0.0223 (0.0091)	0.0131 (0.0262)		0.0410 (0.0117)	0.0631 (0.0355)	
Enrollment Squared/100		0.0042 (0.0100)			-0.0100 (0.0138)	
Piecewise Linear Trend			0.1369 (0.0359)			0.1940 (0.0430)
<i>N</i>	2,019	2,019	1,961	2,018	2,018	1,960
<b>Panel B. 4th Grade Data</b>						
Class Size	-0.1329 (0.0608)	-0.0739 (0.0683)	-0.1472 (0.0887)	-0.0497 (0.0747)	-0.0328 (0.0845)	-0.0982 (0.0990)
November Enrollment	0.0046 (0.0079)	-0.0396 (0.0218)		0.0198 (0.0093)	0.0072 (0.0274)	
Enrollment Squared/100		0.0210 (0.0095)			0.0060 (0.0124)	
Piecewise Linear Trend			0.1001 (0.0260)			0.1301 (0.0290)
<i>N</i>	2,049	2,049	2,001	2,049	2,049	2,001

Notes: This table reports 2SLS estimates using 1991 data and the specifications reported in Angrist and Lavy (1999). Standard errors are clustered by school. The piecewise linear control specification omits schools with enrollment over 160. Estimates in both panels are from models including controls for a school-level index of socioeconomic status.

Table A5: Maimonides' Rule Effects on Socioeconomic Status (2002–2011)

	Using November Enrollment			Using Birthday-Based Enrollment		
	(1)	(2)	(3)	(4)	(5)	(6)
<b>Panel A. Without Additional Controls</b>						
$f_{jt}$	-0.0224 (0.0083)	-0.0195 (0.0086)	-0.0198 (0.0086)	-0.0090 (0.0082)	-0.0063 (0.0083)	-0.0053 (0.0083)
Enrollment	-0.0218 (0.0022)	-0.0305 (0.0067)		-0.0217 (0.0020)	-0.0307 (0.0066)	
Enrollment squared/100		0.0060 (0.0041)			0.0058 (0.0038)	
Piecewise linear trend			-0.0407 (0.0043)			-0.0437 (0.0042)
$R^2$	0.162	0.163	0.161	0.157	0.158	0.156
<b>Panel B. With Additional Controls</b>						
$f_{jt}$	-0.0066 (0.0073)	-0.0066 (0.0075)	-0.0066 (0.0075)	0.0024 (0.0074)	0.0024 (0.0075)	0.0034 (0.0075)
Enrollment	-0.0149 (0.0020)	-0.0148 (0.0062)		-0.0144 (0.0019)	-0.0144 (0.0061)	
Enrollment squared/100		-0.00007 (0.0039)			0.00002 (0.0036)	
Piecewise linear trend			-0.0266 (0.0040)			-0.0278 (0.0040)
$R^2$	0.320	0.320	0.318	0.317	0.317	0.315
$N$	4,245			4,245		

Notes: This table reports OLS estimates of the effect of Maimonides' Rule on a school-level index of socioeconomic status. Columns 1–3 report estimates using November enrollment; columns 4–6 report estimates using birthday-based imputed enrollment. Estimates in Panel A are from models including controls for a religious school dummy and year fixed effects. Estimates in Panel B are from models adding school averages of number of siblings and father's years of education. Standard errors reported in parentheses are clustered at the school level.

Table A6: 2SLS Donuts Using 1991 Data

	Language		Math	
	(1)	(2)	(3)	(4)
<b>Panel A. 5th Grade</b>				
Donut:				
[39, 41]	-0.2340 (0.0762)	-0.2010 (0.0954)	-0.1947 (0.1019)	-0.2144 (0.1308)
[38, 42]	-0.2406 (0.0776)	-0.2072 (0.0987)	-0.2000 (0.1044)	-0.2213 (0.1370)
[37, 43]	-0.2152 (0.0777)	-0.1696 (0.0991)	-0.1930 (0.1055)	-0.2024 (0.1390)
<b>Panel B. 4th Grade</b>				
Donut:				
[39, 41]	-0.1267 (0.0612)	-0.0581 (0.0690)	-0.0544 (0.0749)	-0.0353 (0.0858)
[38, 42]	-0.1187 (0.0632)	-0.0431 (0.0719)	-0.0438 (0.0775)	-0.0208 (0.0899)
[37, 43]	-0.1166 (0.0649)	-0.0390 (0.0743)	-0.0467 (0.0794)	-0.0227 (0.0927)
<b>Controls:</b>				
Percent Disadvantaged	X	X	X	X
Enrollment	X	X	X	X
Enrollment Squared /100		X		X

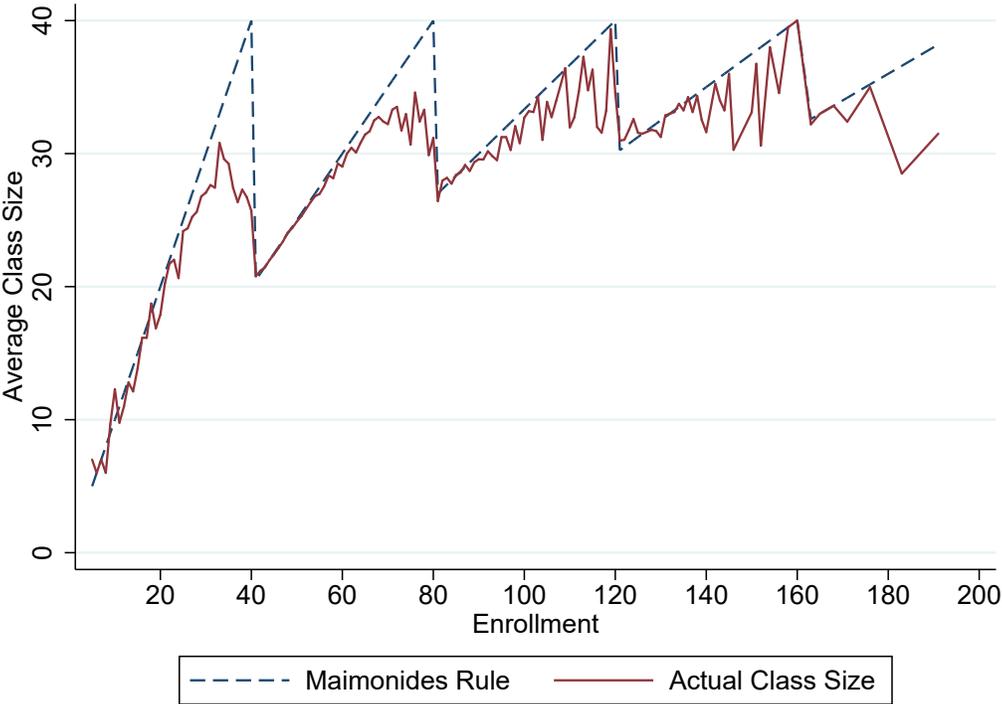
Notes: This table reports 2SLS estimates of class size effects omitting data in the intervals indicated, using the 1991 data analyzed by Angrist and Lavy (1999). Standard errors are clustered by school.

Table A7: Class Size Effects Estimated in a Sample Omitting 2004–6 Data

	Language				Math			
	OLS	2SLS	2SLS	2SLS	OLS	2SLS	2SLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>Panel A. November Enrollment</b>								
Class size	0.0261 (0.0226)	0.0064 (0.0408)	-0.0120 (0.0431)	-0.0079 (0.0419)	0.0424 (0.0311)	0.0103 (0.0586)	-0.0071 (0.0608)	-0.0085 (0.0597)
SES index	-0.6261 (0.1600)	-0.6285 (0.1600)	-0.6250 (0.1688)	-0.6211 (0.1601)	-1.0915 (0.2652)	-1.0949 (0.2653)	-1.0918 (0.2655)	-1.085 (0.2655)
November enrollment	-0.0013 (0.0047)	0.0004 (0.0056)	0.0361 (0.0192)		-0.0033 (0.0066)	-0.0005 (0.0081)	0.0336 (0.0265)	
Enrollment squared/100			-0.0210 (0.0107)				-0.0201 (0.0148)	
Piecewise linear trend				0.0087 (0.0124)				0.0090 (0.0179)
<b>Panel B. Birthday-based Imputed Enrollment</b>								
Class size	0.0239 (0.0225)	-0.0248 (0.0823)	-0.0580 (0.0925)	-0.0484 (0.0901)	0.0294 (0.0312)	-0.0603 (0.1173)	-0.0875 (0.1309)	-0.0905 (0.1282)
SES index	-0.6233 (0.1600)	-0.6300 (0.1600)	-0.6255 (0.1690)	-0.6246 (0.1601)	-1.0746 (0.2654)	-1.0844 (0.2663)	-1.0808 (0.2667)	-1.0781 (0.2667)
Birthday-based enrollment	-0.0003 (0.0045)	0.0037 (0.0083)	0.0409 (0.0260)		0.0022 (0.0062)	0.0097 (0.0116)	0.0400 (0.0353)	
Enrollment squared/100			-0.0198 (0.0118)				-0.0162 (0.0157)	
Piecewise linear trend				0.0174 (0.0212)				0.0333 (0.0299)
<i>N</i>	136,877				137,749			

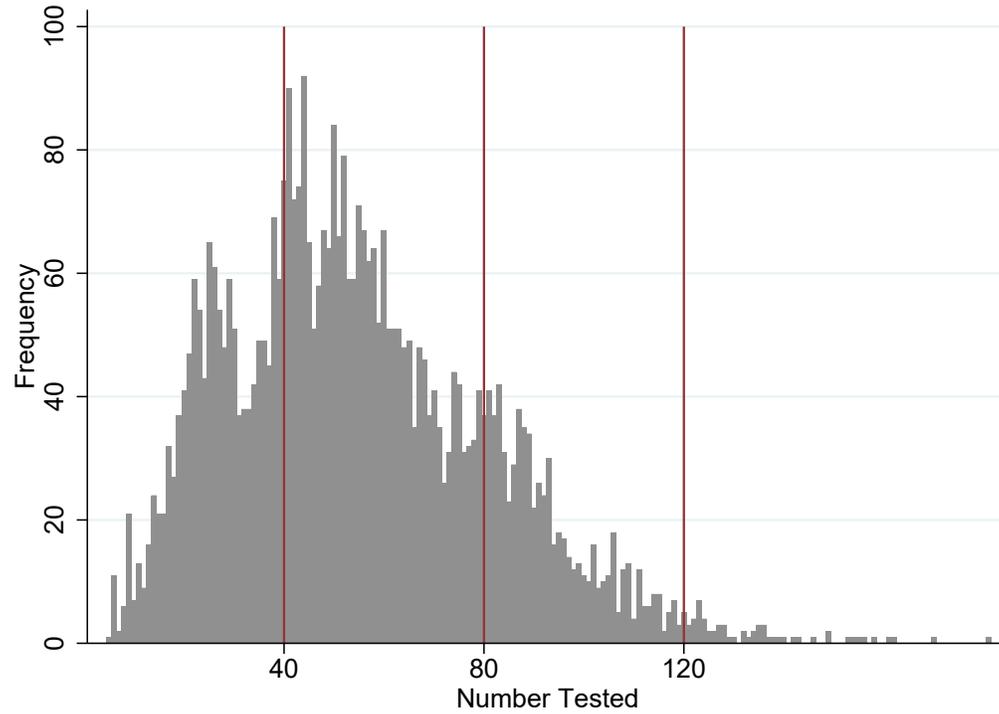
Notes: This table reports OLS and 2SLS estimates of equation (3), omitting the years 2004–2006, when the GEMS test was taken in the fall. The endogenous variable is June class size; estimates in panel A use November enrollment and estimates in Panel B use birthday-based imputed enrollment. Standard errors reported in parentheses are clustered at the school and year level. Covariates are as in Tables 1 and 2 except the reported SES coefficient which is for 2007 only.

Figure A1: June Class Size in 2002–2011, for 5th Graders, Conditional on November Enrollment



Notes: This figure plots unweighted average (June) class size and Maimonides’ Rule forecasts conditional on November enrollment in a sample containing averages for each school and year. The underlying data include an average of 563 schools each year between 2002–2006 and 286 schools each year between 2007–2011.

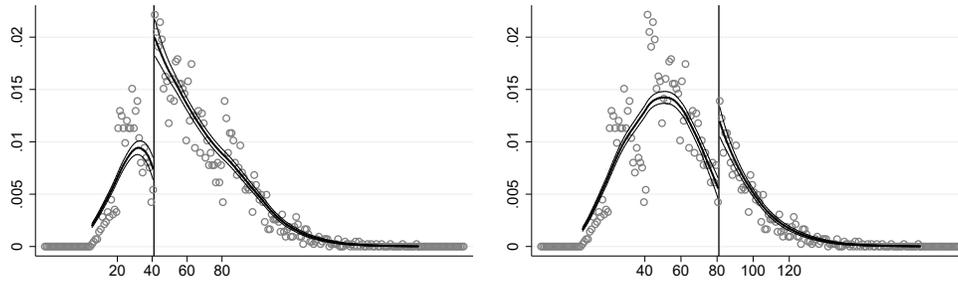
Figure A2: The Enrollment Distribution for Tested Fifth Graders (2002–2011)



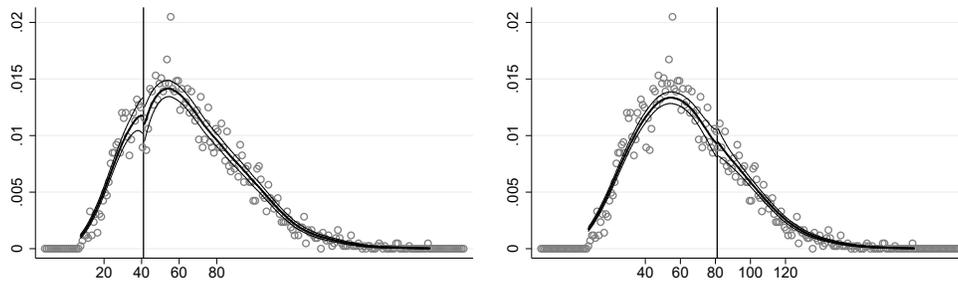
Notes: This figure plots the distribution of the number of 5th graders tested (given by the larger of the number tested in math and the number tested in language).

Figure A3: Density Discontinuity Tests (2002–2011)

A. November Enrollment

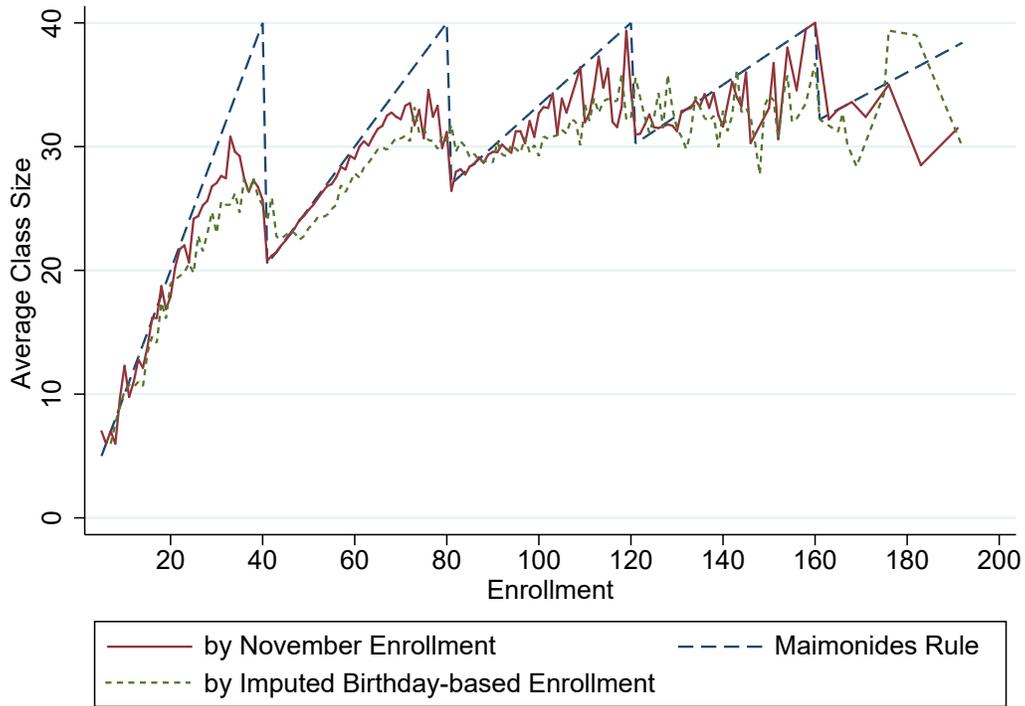


B. Birthday-Based Imputed Enrollment



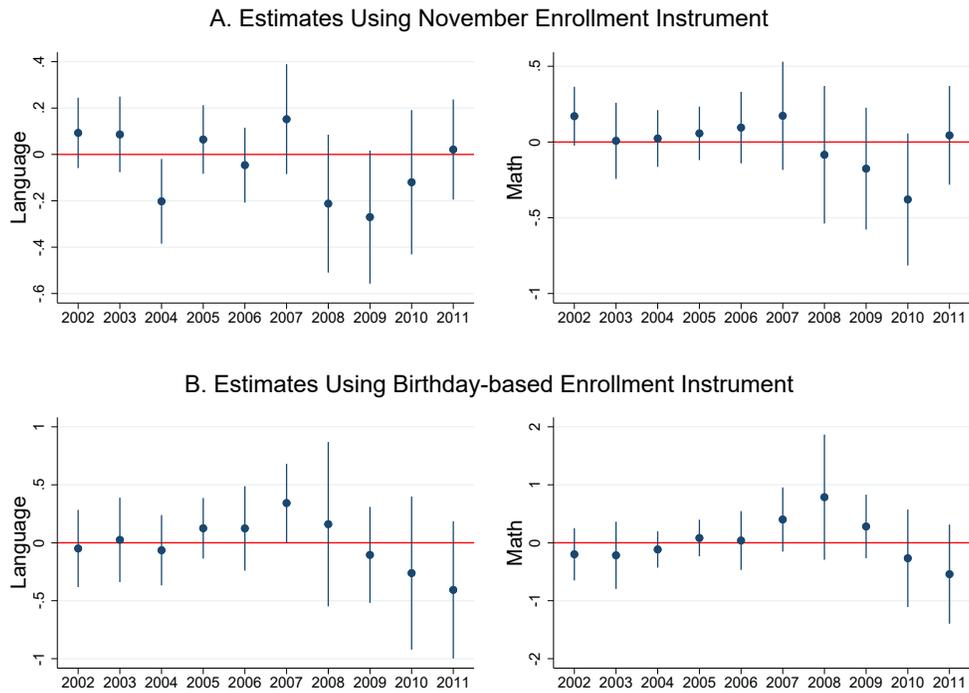
Notes: This figure plots empirical and fitted densities of November enrollment (Panel A) and birthday-based imputed enrollment (Panel B). The fitting procedure allows for discontinuities at 41 (left) and 81 (right), with a bin size of 1. Bandwidth, standard errors, and the density plot were produced using McCrary's DCdensity package, following McCrary (2008).

Figure A4: Average June Class Size in 2002–2011  
 (Conditional on November Enrollment and Birthday-based Imputed Enrollment)



Notes: This figure plots Maimonides' Rule predictions (in blue dash line) and unweighted average June class size, conditional on November enrollment (in red solid line) and conditional on birthday-based imputed enrollment (in green short-dash line), in a sample containing averages for each school and year. The underlying data include an average of 563 schools each year between 2002–2006 and 286 schools each year between 2007–2011.

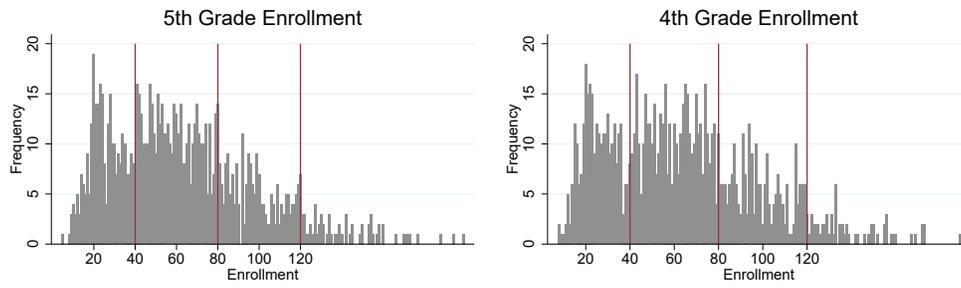
Figure A5: Estimates of Class Size Effects by Year (2002–2011)



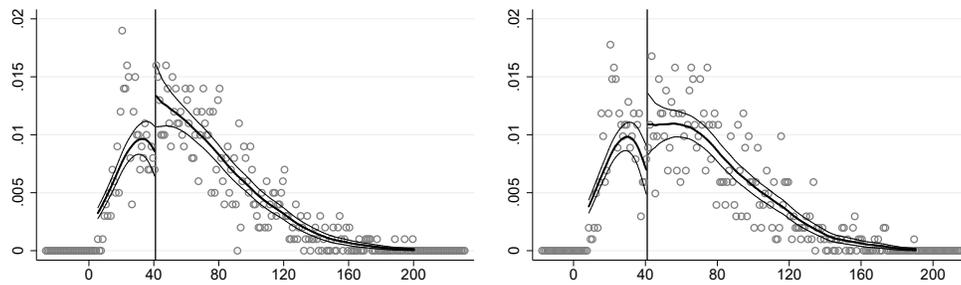
Notes: The figure plots 2SLS estimates and 95 percent confidence intervals for class size effects estimated by year, from 2002 to 2011. The endogenous variable is June class size. Panel A reports estimates using November enrollment to construct instruments. These estimates come from single-year versions of the models used to construct the estimates in columns (2) and (6) of Table 1. Panel B reports estimates using birthday-based enrollment to construct instruments. These estimates come from models analogous to those used to construct the estimates in columns (2) and (6) of Table 2. Standard errors are clustered at the school and year level.

Figure A6: Density Discontinuity Tests in 1991 Data

A. Histograms

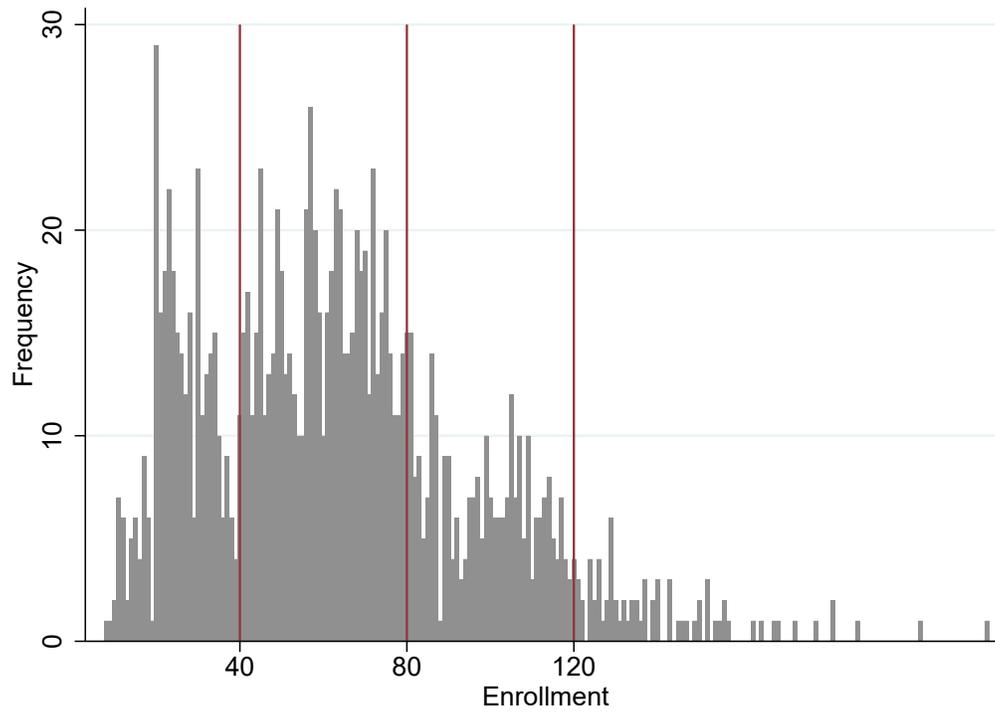


B. McCrary Tests



Notes: Panel A plots the distribution of 4th and 5th grade enrollment as reported by school headmasters in November 1990, for the 1990–91 school year. Reference lines indicate Maimonides' Rule cutoffs at which an additional class is added. Panel B plots the densities generating McCrary (2008) tests for discontinuities at 41, estimated using the same data.

Figure A7: The Enrollment Distribution for Third Graders (1992)



Notes: This figure plots the distribution of 3rd grade enrollment as reported by school headmasters in November 1991, for the 1991–92 school year. Reference lines indicate Maimonides' Rule cutoffs at which an additional class is added.

Figure A8: Chanukah-Based Birthday Cutoffs for 5th Grade Enrollment

Date of Birth	5th Grade in School Year (t)	Month and Day of Birth																																																											
		December dates in year t-1															January - November dates in year t	December dates in year t																																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Dec '90 - Dec '91	2002	Enroll 5th grade in 2002																																																											
Dec '91 - Dec '92	2003	Enroll 5th grade in 2003																																																											
Dec '92 - Dec '93	2004	Enroll 5th grade in 2004																																																											
Dec '93 - Dec '94	2005	Enroll 5th grade in 2005																																																											
Dec '94 - Dec '95	2006	Enroll 5th grade in 2006																																																											
Dec '95 - Dec '96	2007	Enroll 5th grade in 2007																																																											
Dec '96 - Dec '97	2008	Enroll 5th grade in 2008																																																											
Dec '97 - Dec '98	2009	Enroll 5th grade in 2009																																																											
Dec '98 - Dec '99	2010	Enroll 5th grade in 2010																																																											
Dec '99 - Dec '00	2011	Enroll 5th grade in 2011																																																											

Notes: This sketch shows birthday cutoffs for school entry, and their implications for 5th grade enrollment in a pure birthday-based world with no grade repetition or skipping. For example, students born between Dec 18 1990 and December 7 1991 should be enrolled in 5th grade in Spring 2002. Our predicted enrollment variables for 2002–2011 applies these rules to the birthday distribution of children observed enrolled in 4-6th grade in Spring of each year.