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Abstract

This study examined the impact of COVID-19 on academic "redshirting" in kindergarten, the practice of holding a child back for a year and enrolling them in kindergarten at age 6, using student-level data on all Delaware kindergarten students from fall 2014 through fall 2022. The rate of redshirting declined by 40% in fall 2020, then increased by 44% (relative to pre-pandemic baseline) in fall 2021, with even greater increases for some subgroups of children traditionally less likely to redshirt. Further, redshirting was not restricted to children with summer birthdays, as in previous years, with growth seen across the age distribution. Redshirting had not returned to pre-pandemic baseline by fall 2022. These findings point to changes in the motivations for redshirting kindergarten students since the pandemic.

Changes in Kindergarten Redshirting During the COVID-19 Pandemic

Kindergarten usually begins at age 5, but ~4% of students (Bassok & Reardon, 2013) are "redshirted", or held back for one year and enrolled at 6. A primary reason for redshirting is parental concern about the child's performance in kindergarten relative to their peers (Frey, 2005). Male, White, and higher-income students were most likely to be redshirted pre-pandemic, as were children who would have been young for their grade because of a summer birthday (Bassok & Reardon, 2013; Dhuey et al., 2019; Graue & DiPerna, 2000). However, the COVID-19 pandemic caused public school enrollment to decline by more than 1.1 million students, with declines concentrated in kindergarten, and these declines were not fully explained by increased homeschooling or private school enrollment (Dee, 2023). The pandemic may have caused parents to consider redshirting differently, given concerns about virus exposure or virtual learning. Such risks may have exacerbated inequality in redshirting, as more privileged families may have selected into alternative learning environments; or the increased risk of exposure for disadvantaged families may have driven redshirting among groups previously less likely to redshirt.

Using data from the Delaware Department of Education (DDOE), we ask the following two research questions:

1. How has the prevalence of redshirting changed since the COVID-19 pandemic?
2. Have the characteristics of redshirted students changed, related to demographics, age, and academic performance?

Methods

We received student-level enrollment data from the DDOE for public school kindergarten students from 2014-2015 through the 2022-2023 school year (n = 87,179). The sample was 52%

male, 29% Black, 18% Hispanic, 42% White, 11% other race[1], 37% low-income, and 9% students with disabilities (SWD). State law requires children to be 5 years old by August 31; therefore, we classified a student as redshirted if they were at least 6 on August 31 of the year they started kindergarten. We also used data from DDOE's Early Learner Survey (ELS), a school readiness assessment administered in the first month of kindergarten, available fall 2016 through 2021. Measure details are in the supplementary materials.

To test the change in the rate of redshirting, we estimated linear regression models with a binary outcome for a student being redshirted, using predictors for cohorts 2020, 2021, and 2022, with the combined pre-pandemic data (2014–2019 cohorts) as the comparison group. We estimated regressions for student subgroups and, separately, interacted ELS scores with cohort indicators. We converted these changes in percentage points (pp) to growth rates to standardize rates across subgroups. We also fit regression discontinuity models, for descriptive purposes, to test whether children born in summer (i.e., the 3 months before the age eligibility cutoff) were more likely to redshirt than children born in fall (i.e., the 3 months after the cutoff), controlling for distance from the cutoff, and tested whether this effect differed across cohorts. As robustness checks, we adjusted the bandwidth from 3 months to 1 month, and adjusted the functional form of our forcing variable using a quadratic specification. Finally, we tested whether the distribution of redshirted children's ages (in months) changed across cohorts by regressing a binary variable for each age in months *M* (from 72-83 months) on a series of cohort dummies, then testing the difference between the coefficients for the pre-pandemic combined cohort and the 2020 or 2021 cohorts. We also ran this model using 4 bins (72-74 months old, 75-77 months old, 78-80 months old, and 81+ months old), and separate models for each subgroup (Black, Hispanic, White, male,

[1] Asian and multi-racial children were excluded from subgroup-level analyses due to too few redshirters

female, SWD, and low-income). All models used heteroskedasticity-robust standard errors. Further details, equations, and robustness checks are included in the supplementary materials.

Results

Research Question 1.

Pre-pandemic, 3.9% of Delaware kindergarteners were redshirted, comparable to national estimates (Bassok & Reardon, 2013). This figure declined by 1.6pp in fall 2020 ($p<0.001$; 40% increase), increased by 1.7pp in 2021 ($p<0.001$; 44% increase) relative to the baseline, and returned to 2020 levels in 2022, with a 1.5pp decline ($p<0.001$; 38% decrease; See Figure 1a).

Research Question 2a.

We found increases in redshirting in fall 2021 for subgroups of children not typically redshirted. The proportion of Black children redshirting increased by 2.5pp ($p<0.001$; 69% increase), Hispanic children by 1.6pp ($p<0.001$; 31% increase), and White children by 1.2pp ($p<0.01$; 28% increase). For girls, redshirting increased by 1.5pp ($p<0.001$; 48% increase), and for boys, redshirting increased by 2pp ($p<0.001$; 43% increase). The proportion of low-income children redshirting increased by 2.9pp ($p<0.001$; 62% increase). The only subgroup that decreased redshirting in 2021 was SWDs, by 3.5pp, or 38% ($p<0.001$). Fall 2022 redshirting rates were similar to 2020, with even lower redshirting for Hispanics, Whites, and SWDs.

Research Question 2b.

RD models showed that pre-pandemic, Delaware kindergarteners with summer birthdays were 11.9pp ($p<0.001$) more likely to redshirt than those with fall birthdays (see Table 1). We observed little change in the likelihood of redshirting at the cutoff for the 2021 cohort; only White students were more likely to redshirt at the cutoff in 2021 (2.5pp; $p<0.05$), while SWDs were 5.6pp less likely ($p<0.05$). Children redshirted in 2021 had a wider age distribution than in

previous years (see Figure 1b). In 2022, children with summer birthdays were less likely to be redshirted than pre-pandemic, suggesting continued changes to redshirting patterns.

Research Question 2c.

Redshirted children scored 1.2 percentile points higher ($p<0.001$) on a measure of school readiness pre-pandemic. The only significant interactions between ELS score and the 2021 cohort were negative, for Hispanics, males, and SWDs (-6pp, -4pp, -11pp, respectively; $p<0.05$), indicating that some children redshirted in 2021 entered with lower baseline skills than previous redshirters.

Discussion

Kindergarten redshirting increased in fall 2021, and the children being redshirted were demographically and academically different from previous data and prior studies (Bassok & Reardon, 2013; Dhuey et al., 2019; Graue & DiPerna, 2000). Subgroups of children who were not typically redshirted pre-pandemic had the most growth in redshirting in fall 2021. Redshirting was not restricted to children born close to the eligibility cutoff, who would have been young for their grade, as in previous years. Further, test scores were a weaker moderator of redshirting behavior for the 2021 cohort compared with earlier cohorts, suggesting that redshirting was not selected into by more academically prepared students than in previous cohorts. These changes suggest a shift from redshirting driven by concerns that a child would be less competitive or young for their grade, to other concerns, such as pandemic-related dangers and changes to instructional modality. We have not identified a return to baseline, with lower levels of redshirting in 2022 than pre-pandemic. The motivations are unclear; further research, particularly in-depth qualitative studies, could probe on why families may be delaying (or not) entry to school. Our findings align with other studies on the impact of COVID-19 on school

composition (e.g. Baum & Jacob, 2024; Dee, 2023), suggesting that prior trends identified by educational research may no longer hold given the pandemic's disruption to daily life and systems.

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Table 1.

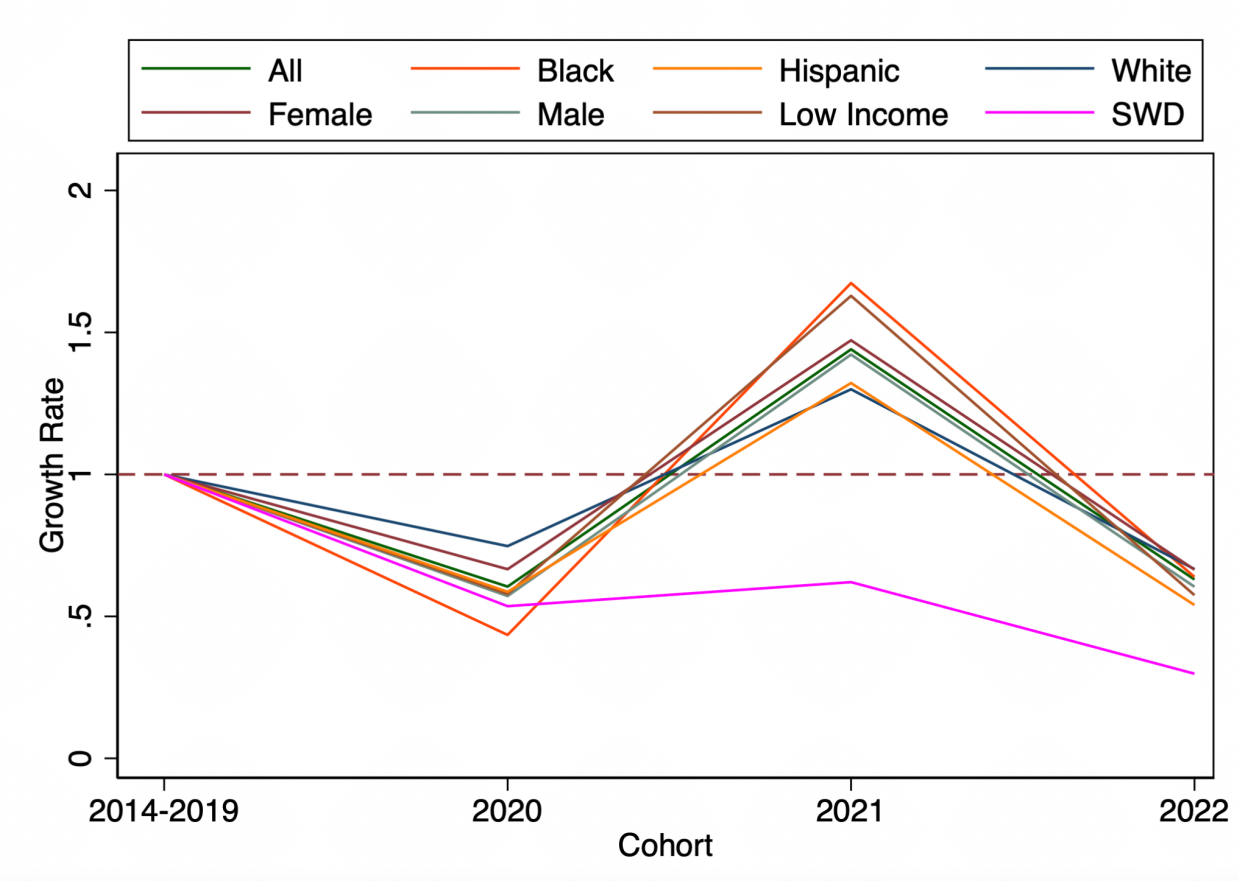
Regression discontinuity results

	All	Black	Hispanic	White	Female	Male	SWD	Low Income
Summer Birthday	0.119***	0.083***	0.094***	0.161***	0.089***	0.148***	0.229***	0.095***
	(0.005)	(0.008)	(0.011)	(0.008)	(0.006)	(0.007)	(0.020)	(0.008)
2020 x Summer Birthday	-0.025***	-0.040***	-0.037**	-0.011	-0.014	-0.033***	-0.057*	-0.042***
	(0.006)	(0.008)	(0.014)	(0.010)	(0.007)	(0.009)	(0.024)	(0.010)
2021 x Summer Birthday	0.007	0.005	-0.005	0.025*	0.005	0.008	-0.056*	0.006
	(0.007)	(0.014)	(0.017)	(0.011)	(0.009)	(0.011)	(0.024)	(0.015)
2022 x Summer Birthday	-0.025***	-0.023*	-0.016	-0.028**	-0.024***	-0.026**	-0.091***	-0.038***
	(0.005)	(0.009)	(0.013)	(0.009)	(0.007)	(0.008)	(0.021)	(0.010)
N	44,478	12,698	8,282	18,800	21,667	22,811	4,056	16,294

*Note: * p < .05 ** p < .01 *** p < .001*

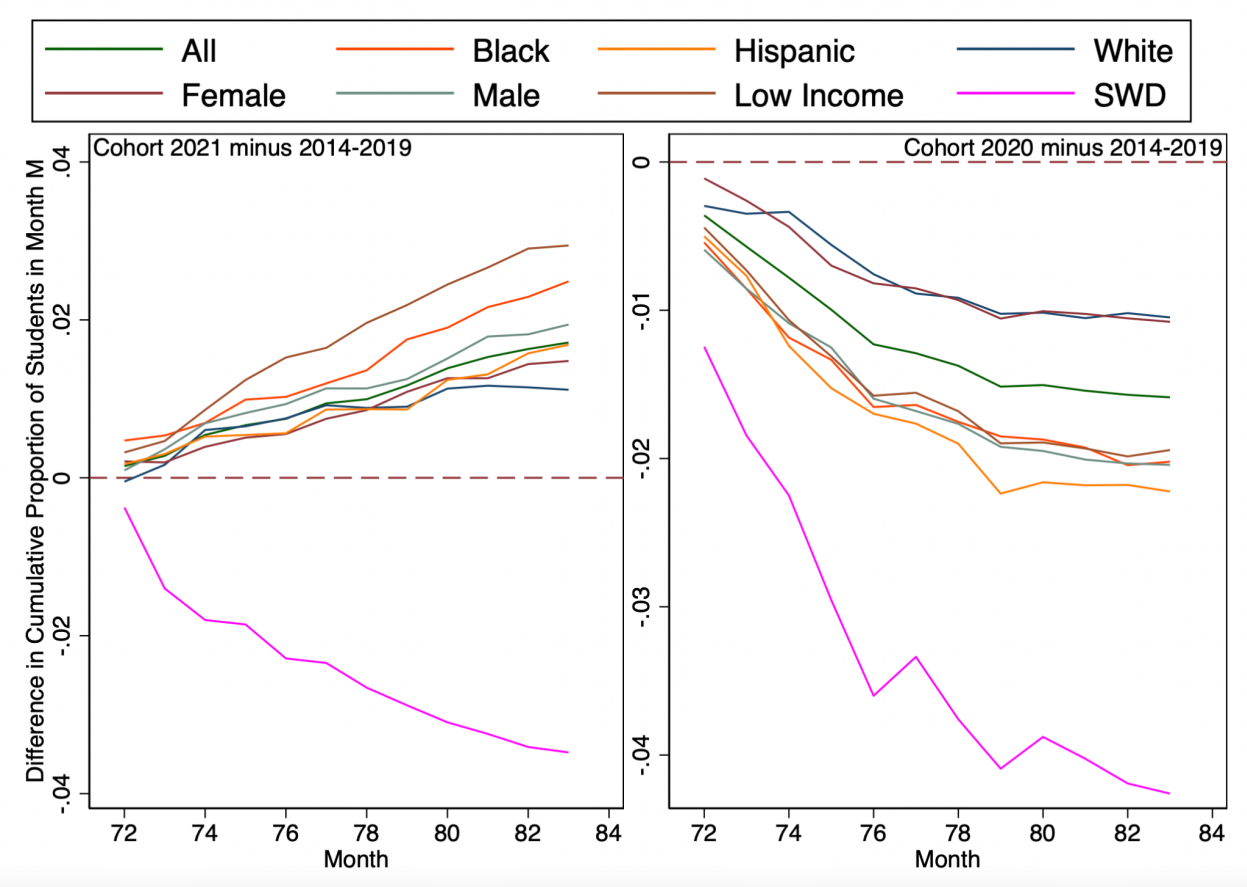
This model uses heteroskedasticity-robust standard errors and includes a control for distance from the cutoff. The interaction coefficients are relative to our combined pre-pandemic (2014-2019) data. The sample was restricted to children with summer birthdays (June-August) and children with fall birthdays (September-November), with the latter as the comparison group. We used a 3 month bandwidth as in Bassok & Reardon (2013). We also used a 1-month bandwidth as a robustness check (see supplementary materials). We tested whether children born in summer/shortly before the kindergarten entry cutoff were more likely to be redshirted than children born in fall. This effect declined in 2020 and 2022, and the lack of significance in 2021 suggests that although redshirt increased significantly, it did not just occur close to the cutoff i.e. for children born in summer, who have historically been the most likely to be redshirted. This effect is consistent across subgroups, with the exception of white children who have historically been redshirted at the cutoff, and students with disabilities, who showed large declines in redshirting in 2021 relative to their high pre-pandemic baseline rate (9.2%).

Figure 1a. Redshirting growth rates by subgroup and year



Note. This figure displays the growth rate for redshirting for the full sample as well as subgroups, relative to pre-pandemic redshirting rates. 2019 refers to all of our pre-pandemic data from fall 2014 through fall 2019, combined to establish a baseline. We calculated the proportion of children who redshirted in the full sample and within each subgroup, then divided the 2020, 2021, and 2022 proportions by the 2014-2019 baseline to estimate growth rates. The figure shows sharp declines in fall 2020 followed by a sharp increase in 2021, then a return to 2020 redshirting levels in 2022. The only subgroup who did not experience a large increase in redshirting in 2021 was students with disabilities, who may have needed to attend school in order to receive services. In 2021, we see the most growth for Black and low-income children, as well as girls.

Figure 1b. Redshirting rate differences by age in months



Note. This figure displays linear comparisons of redshirting rates by redshirted children's age in months. We calculated the proportion of children that were *M* months old in 2020 and 2021, and compared these to the same proportions in the combined fall 2014 - fall 2019 data. Pre-pandemic, children close to the cutoff were much more likely to be redshirted, as they would have been young for their grade had they entered on time (Bassok & Reardon, 2013; Graue & DiPerna, 2000). We see overall declines in redshirting in all months in fall 2020, with the most drastic difference for students with disabilities, 22.9% of whom redshirted pre-pandemic. We see significant increases in redshirting across the age distribution in fall 2021, with the exception of students with disabilities. As children who would not have been young for their grade were redshirted at much higher rates in 2021, this suggests that parents who held their child back in fall 2020 did so for different reasons than those who redshirted pre-pandemic.

Supplementary Materials

Measures

Early Learner Survey. The Delaware Department of Education began administering the Early Learner Survey (ELS) to all kindergarten students in fall 2016, in response to a 2012 law requiring the implementation of a formative kindergarten readiness assessment (Office of Early Learning [OEL], 2018). Kindergarten teachers are required to observe all students within the first 30 days of the school year, and rate children's developmental progress using the ELS, which contains items from the widely-used development assessment Teaching Strategies GOLD® (GOLD®; see OEL, 2018, p. 8 for specific items).

GOLD® is used to measure children's development in six domains: cognitive, language (i.e. receptive and expressive vocabulary), literacy, mathematics, physical (i.e. fine and gross motor skills), and social-emotional. It requires teachers to rate children's mastery of specific skills within each domain on a 9-15 point scale, depending on the item (Teaching Strategies, LLC, 2015). For example, interacting with peers is an objective within the social-emotional domain, counting is an objective within the mathematics domain, using conventional grammar is an objective within the language domain, etc. (OEL, 2018). Within each objective, GOLD® provides indicators describing how the objective might look at different developmental stages, corresponding to numerical points. For example, for the social-emotional objective "manages feelings", a child who uses adult support to calm down (e.g. calmed by rocking, being picked up) would receive 2 points, a child who seeks out special preferred objects or people for comfort would receive 4 points, a child who is able to delay gratification or find a solution to a somewhat challenging situation (e.g. by finding a different center if the block area is full) would receive 6

points, and a child who generally appropriately controls strong emotions (e.g. manages conflict without escalating) would receive 8 points (Teaching Strategies, LLC, 2015).

The items being assessed were consistent in each year. However, the most recent year of data that we have is 2021-2022, and the assessment was not widely conducted in fall 2020 given the COVID-19 pandemic and virtual instruction. Thus, we present results from fall 2021, compared with results from fall 2016 through fall 2019. Children receive a numerical score for each domain, which we summed to calculate their total score. We then standardized these scores by school and year, to account for any school-level or time-varying factors that could influence the raw score. We tested how a child's total percentile score may have interacted their cohort to predict redshirting in our analysis shown in Supplementary Table 7.

Empirical Strategy

Growth Rate Models. We estimated redshirting proportions and growth rates using the following model:

$$Redshirt_{it} = \beta 1 Cohorts 2014-2019_t + \beta 2 Cohort 2020_t + \beta 3 Cohort 2021_t + \beta 4 Cohort 2022_t + \varepsilon_{it}$$

$Redshirt_{it}$ is a binary variable equal to 1 if a child was at least 6 years old on August 31, the state's age eligibility cutoff. $\beta 1 Cohorts 2014-2019_t$ is a binary variable equal to 1 if a student started kindergarten between fall 2014 and fall 2019; we combine the 6 available years of pre-pandemic enrollment data to serve as a baseline for growth rate calculations. $\beta 2 Cohort 2020_t$, $\beta 3 Cohort 2021_t$, and $\beta 4 Cohort 2022_t$ are binary variables equal to 1 if a student started kindergarten in fall 2020, 2021, or 2022, respectively. ε_{it} denotes the error term, which we assume has a mean of zero and is normally distributed. We use robust standard errors to account for potential heteroskedasticity in the error terms. We estimated the model separately for

subgroups (Black, Hispanic, White, female, male, students with disabilities (SWD), and low income students; see Supplementary Table 2). We also ran a growth rate model interacting a student's ELS percentile (within a school-year) with the cohort dummies to test how baseline skills may have moderated redshirting behavior (see Supplementary Table 7).

Kindergarten Age by Month Models. We conducted a series of 13 regressions, regressing binary indicators for each month-of-age over 6 years old from 72 to 83 months, top-coding at 83 months, on binary indicators for a child being in a given cohort: our combined pre-pandemic data (Cohorts2014-2019), 2020-2021, 2021-2022, or 2022-2023. We conducted these regressions with the full sample, as well as repeated for restricted samples of different subgroups: Black, White, Hispanic, Male, Female, SWD, and low-income students. We stored these estimates with heteroskedasticity-robust standard errors and conducted linear comparisons, comparing the mean proportion of students who were *M* months old at school entry pre-pandemic (from fall 2014 through fall 2019) with the proportion of students *M* months old in the 2020-2021 and 2021-2022 school years, respectively. As our samples for individual months were small for some subgroups, we also conducted these regressions and linear comparisons using 4 bins: 72-74 months, 75-77 months, 78-80 months, and 81+ months (top-coded; see Supplementary Table 3 for results).

We used the following model for each age-in-months *M*, regressing a binary indicator for a child being *M* months old (or in the binned case, binned ages in months) on a series of cohort dummies. ε_{it} denotes the error term, which we assume has a mean of zero and is normally distributed. We use robust standard errors to account for potential heteroskedasticity in the error terms.

$$AgeInMonths_m = \beta 1_m Cohorts2014-2019_{mt} + \beta 2_m Cohort2020_{mt} + \beta 3_m Cohort2021_{mt} + \beta 4_m Cohort2022_{mt} + \varepsilon_{mt}$$

Regression Discontinuity Models. We estimated linear regression models to test whether there was a discontinuous jump in the redshirting rate near the age-eligibility cutoff (e.g., +/- 3 months around August 31) and whether this discontinuous jump in the redshirting rate changed across kindergarten cohorts. Our basic specification was to include a main binary effect coded as 1 if the student was born within 3 months of the August 31 age-eligibility cutoff and zero otherwise, a continuous forcing variable (the centered days before and after the cutoff), main effects for each kindergarten cohort, and interactions between the age-eligibility dummy and the kindergarten cohorts. The specification uses a 3-month bandwidth, with a linear control for distance:

$$\begin{aligned} Redshirt_{it} = {} & \beta 1 SummerBirthday_i + \beta 2 Cohorts2014-2019_t + \\ & \beta 3 Cohort2020_t + \beta 4 Cohort2021_t + \beta 5 Cohort2022_t + \\ & \beta 6(SummerBirthday\ x\ Cohorts2014-2019)_{it} + \\ & \beta 7(SummerBirthday\ x\ Cohort2020)_{it} + \\ & \beta 8(SummerBirthday\ x\ Cohort2021)_{it} + \\ & \beta 9(SummerBirthday\ x\ Cohort2022)_{it} + \beta 10 DaysFromCutoff_i + \varepsilon_{it} \end{aligned}$$

We restricted our sample to children born within 3 months of the age eligibility cutoff, on either side. $\beta 1 SummerBirthday_i$ is a binary variable equal to 1 if a child was born in the 3 months prior to the age eligibility cutoff, and 0 if a child was born in the 3 months after the age eligibility cutoff. $\beta 10 DaysFromCutoff_i$ is a linear control for the distance between the child's birthdate and the cutoff. ε_{it} denotes the error term, which we assume has a mean of zero and is

normally distributed. We use robust standard errors to account for potential heteroskedasticity in the error terms. We also estimated the model separately for subgroups (Black, Hispanic, White, female, male, students with disabilities (SWD), and low income students). We also tested our model with different specifications. In the first robustness check, we generated the binary age-eligibility cutoff variable based on +/- 1 month from the August 31 date. Second, we used the 3-month age-eligibility rule but included a linear and quadratic specification for the forcing variable. Last, we used the 1-month age-eligibility rule but included a linear and quadratic specification. See Supplementary Tables 4-6 for the results of these robustness checks.

Supplementary Table 1.

Sample descriptive statistics by subgroup by year (N, %)

School Year	Asian	Black	Hispanic	Multi-racial	Other Race	White	Female	Male	SWD	Low Income	Total
2014	3.85%	29.65%	17.79%	4.32%	0.67%	43.72%	48.61%	51.39%	7.75%	43.33%	10,071
2015	4.03%	29.27%	17.68%	4.57%	0.35%	44.10%	48.06%	51.94%	8.34%	44.64%	9,908
2016	3.99%	28.23%	19.28%	5.16%	0.47%	42.87%	49.29%	50.71%	8.44%	45.14%	9,730
2017	4.74%	27.89%	18.91%	4.88%	0.66%	42.92%	48.15%	51.85%	9.06%	40.23%	9,759
2018	4.98%	28.21%	17.96%	5.57%	0.49%	42.79%	48.99%	51.01%	9.21%	36.64%	9,545
2019	4.52%	28.13%	17.72%	6.43%	0.42%	42.78%	48.43%	51.57%	9.41%	34.30%	9,740
2020	5.77%	28.41%	17.72%	5.80%	0.45%	41.86%	50.67%	49.33%	10.21%	28.90%	9,121
2021	4.77%	28.81%	18.56%	6.26%	0.50%	41.09%	48.75%	51.25%	9.51%	27.77%	9,742
2022	4.65%	29.67%	19.88%	6.53%	0.44%	38.83%	47.42%	52.58%	10.27%	29.32%	9,566
Total	4.58%	28.70%	18.39%	5.49%	0.50%	42.35%	48.69%	51.31%	9.12%	36.81%	87,182

Supplementary Table 2.

Growth rate regressions

	All	Black	Hispanic	White	Male	Female	SWD	Low Income
2020	-0.016***	-0.021***	-0.021***	-0.010***	-0.020***	-0.010***	-0.043***	-0.020***
	(0.002)	(0.003)	(0.005)	(0.003)	(0.003)	(0.002)	(0.008)	(0.003)
2021	0.017***	0.025***	0.016**	0.012**	0.020***	0.015***	-0.035***	0.029***
	(0.002)	(0.005)	(0.006)	(0.004)	(0.004)	(0.003)	(0.009)	(0.005)
2022	-0.015***	-0.013***	-0.023***	-0.013***	-0.019***	-0.010***	-0.065***	-0.020***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.002)	(0.007)	(0.003)
Constant 2014-2019	0.039***	0.036***	0.051***	0.040***	0.047***	0.031***	0.092***	0.047***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)
N	87,179	25,023	16,030	36,918	44,729	42,450	7,947	32,087

*Note: * p < .05 ** p < .01 *** p < .001*

This figure displays changes in the rate of redshirting for the full sample and subgroups, relative to our combined pre-pandemic (2014-2019) data. This model uses heteroskedasticity-robust standard errors.

Supplementary Table 3.

Age-month results

	All	Black	Hispanic	White	Female	Male	SWD	Low Income
72-74 months								
2020 minus 2014-2019	-0.008***	-0.012***	-0.012***	-0.003	-0.004*	-0.011***	-0.023***	-0.011***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.002)	(0.002)	(0.006)	(0.002)
2021 minus 2014-2019	0.005**	0.007*	0.005	0.006*	0.004	0.007*	-0.018**	0.009*
	(0.002)	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)	(0.007)	(0.004)
75-77 months								
2020 minus 2014-2019	-0.005***	-0.005**	-0.005*	-0.006***	-0.004***	-0.006***	-0.011**	-0.005**
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)
2021 minus 2014-2019	0.004***	0.005*	0.003	0.003	0.004*	0.004*	-0.005	0.008**
	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)
78-80 months								
2020 minus 2014-2019	-0.002***	-0.002	-0.004	-0.001	-0.002	-0.003**	-0.005	-0.003**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)
2021 minus 2014-2019	0.004***	0.007**	0.004	0.002	0.005***	0.004**	-0.008**	0.008***
	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
81+ months								
2020 minus 2014-2019	-0.001	-0.002*	0.001	0.000	0.000	-0.001	-0.004	-0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
2021 minus 2014-2019	0.003***	0.006**	0.004	0.001	0.002	0.005***	-0.004	0.005*
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)

*Note: * $p < .05$ ** $p < .01$ *** $p < .001$*

This table displays the results from a series of tests of differences of coefficients of the proportion of children *M* months old in fall 2020 (*N* = 9,121) and fall 2021 (*N* = 9,742), respectively, to the pre-pandemic (2014-2019; *N* = 58,753) age distribution. We created 4 bins (72-74 months, 75-77 months, 78-80 months, and 81+ months) due to low *N*s for individual months-by subgroup-by year. For most subgroups, there were significantly more children in each age bin through 78-80 months; this continues on for the full sample, as well as Black, male, and low-income children through 81+ months. These findings support our conclusion that the 2021 increase in redshirting did not just occur within children close to the age cutoff, as in previous years and previous studies. The changing age distribution suggests that children were redshirted in 2021 for different reasons than in previous years.

Supplementary Table 4.

Regression discontinuity robustness check - linear model with 1-month bandwidth

	All	Black	Hispanic	White	Female	Male	SWD	Low Income
August Birthday	0.132***	0.084***	0.116***	0.169***	0.109***	0.155***	0.243***	0.118***
	(0.009)	(0.014)	(0.019)	(0.014)	(0.011)	(0.013)	(0.036)	(0.014)
2020 x August Birthday	-0.034**	-0.064***	-0.039	-0.017	-0.009	-0.056***	-0.083	-0.059**
	(0.011)	(0.015)	(0.025)	(0.020)	(0.014)	(0.017)	(0.048)	(0.018)
2021 x August Birthday	0.014	0.038	0.010	0.017	0.021	0.009	-0.036	0.029
	(0.014)	(0.027)	(0.031)	(0.022)	(0.017)	(0.020)	(0.046)	(0.025)
2022 x August Birthday	-0.043***	-0.053**	-0.020	-0.047**	-0.034*	-0.051***	-0.102*	-0.053**
	(0.010)	(0.017)	(0.022)	(0.018)	(0.013)	(0.015)	(0.041)	(0.018)
N	15,092	4,274	2,841	6,411	7,350	7,742	1,415	5,447

*Note: * $p < .05$ ** $p < .01$ *** $p < .001$*

This model serves as a robustness check for Table 1 from the paper. Similar to Table 1, this model uses heteroskedasticity-robust standard errors and a linear control for distance. This model used a 1-month bandwidth, restricting the sample to children born in either August or September. We tested whether children born in August/shortly before the kindergarten entry cutoff were more likely to be redshirted than children born in September. Pre-pandemic, children born in August were 13.2pp more likely to be redshirted than children born in September. The interaction between having an August birthday and the 2021 school year is not significant, suggesting that although redshirting increased significantly in 2021, it was not restricted to children born close to the cutoff.

Supplementary Table 5.

Regression discontinuity robustness check - quadratic model with 3-month bandwidth

	All	Black	Hispanic	White	Female	Male	SWD	Low Income
Summer Birthday	0.117***	0.082***	0.093***	0.156***	0.088***	0.145***	0.225***	0.094***
	(0.004)	(0.008)	(0.011)	(0.007)	(0.006)	(0.007)	(0.019)	(0.007)
2020 x Summer Birthday	-0.024***	-0.040***	-0.037**	-0.009	-0.013	-0.033***	-0.057*	-0.042***
	(0.006)	(0.008)	(0.014)	(0.010)	(0.007)	(0.009)	(0.024)	(0.010)
2021 x Summer Birthday	0.008	0.005	-0.004	0.026*	0.006	0.009	-0.054*	0.006
	(0.007)	(0.014)	(0.017)	(0.011)	(0.009)	(0.011)	(0.024)	(0.015)
2022 x Summer Birthday	-0.025***	-0.023*	-0.016	-0.028**	-0.024***	-0.026**	-0.090***	-0.038***
	(0.005)	(0.009)	(0.013)	(0.009)	(0.007)	(0.008)	(0.021)	(0.010)
N	44,478	12,698	8,282	18,800	21,667	22,811	4,056	16,294

*Note: * $p < .05$ ** $p < .01$ *** $p < .001$*

This model serves as a robustness check for Table 1 from the paper. In addition to a linear control for distance, this model also includes a squared term for distance from the cutoff. This model used a 3-month bandwidth, as in Table 1, as well as heteroskedasticity-robust standard errors. This model replicates the findings from Table 1: the interaction between the 2021 school year and having a summer birthday was largely nonsignificant with the exception of white children who have historically been redshirted at the cutoff, and students with disabilities, who showed large declines in redshirting in 2021 relative to their high pre-pandemic baseline rate (9.2%).

Supplementary Table 6.

Regression discontinuity robustness check - quadratic model with 1-month bandwidth

	All	Black	Hispanic	White	Female	Male	SWD	Low Income
August Birthday	0.131***	0.084***	0.116***	0.166***	0.106***	0.153***	0.116***	0.241***
	(0.008)	(0.014)	(0.018)	(0.014)	(0.010)	(0.013)	(0.014)	(0.035)
2020 x August Birthday	-0.033**	-0.064***	-0.038	-0.016	-0.009	-0.056***	-0.059**	-0.084
	(0.011)	(0.015)	(0.025)	(0.020)	(0.014)	(0.017)	(0.018)	(0.048)
2021 x August Birthday	0.014	0.038	0.011	0.017	0.021	0.008	0.029	-0.038
	(0.014)	(0.027)	(0.031)	(0.022)	(0.017)	(0.020)	(0.025)	(0.046)
2022 x August Birthday	-0.043***	-0.053**	-0.020	-0.048**	-0.034*	-0.052***	-0.054**	-0.104*
	(0.010)	(0.017)	(0.022)	(0.018)	(0.013)	(0.015)	(0.018)	(0.041)
N	15,092	4,274	2,841	6,411	7,350	7,742	1,415	5,447

*Note: * $p < .05$ ** $p < .01$ *** $p < .001$*

This model serves as a robustness check for Table 1 from the paper. In addition to a linear control for distance, this model also includes a quadratic term for distance. This model used a 1-month bandwidth, restricting the sample to children born in either August or September. We tested whether children born in August/shortly before the kindergarten entry cutoff were more likely to be redshirted than children born in September. As above, children born in August were significantly more likely to be redshirted than children born in September pre-pandemic. The interaction between having an August birthday and the 2021 school year is not significant, suggesting that although redshirting increased significantly in 2021, it was not restricted to children born close to the cutoff.

Supplementary Table 7.

Interaction between Early Learner Survey percentile scores

	All	Black	Hispanic	White	Male	Female	SWD	Low Income
ELS Percentile	0.012***	0.016*	0.035***	0.009	0.024***	0.004	0.080***	0.031***
	-0.004	-0.007	-0.009	-0.005	-0.005	-0.005	-0.02	-0.007
2021	0.028***	0.037***	0.044***	0.012	0.046***	0.005	0.013	0.039***
	-0.006	-0.011	-0.013	-0.009	-0.009	-0.007	-0.018	-0.011
2021 x ELS Percentile	-0.014	-0.018	-0.058*	0.008	-0.040**	0.016	-0.111**	-0.015
	-0.01	-0.019	-0.025	-0.015	-0.015	-0.013	-0.038	-0.021
N	48816	13348	9098	21139	24770	24046	4036	17415

*Note: * p < .05 ** p < .01 *** p < .001*

This model examined the impact of a child's score on Delaware's Early Learner Survey (ELS) with their likelihood of redshirting, as well as the interaction between ELS score and school year. We used a child's total score, standardized by school and year. Pre-pandemic, redshirted children largely scored higher on the ELS. However, the interaction between the 2021 school year and a child's ELS score suggests that some redshirted children entered kindergarten less academically prepared than redshirted children in previous years. Note that ELS data was only available from Fall 2016 through Fall 2021.

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