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Creating winners and losers: Date of birth, relative age in school, and outcomes in childhood and adulthood ☆

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ABSTRACT

Using an unanticipated policy reform that shifted 4 months the cutoff date for school eligibility in the state of Tlaxcala, Mexico, we estimate the effect of relative age on test scores in grades 3–9. Different identification strategies produce similar results: 1 year of additional age confers an advantage of roughly 0.3 standard deviations. By contrasting Tlaxcala with a neighboring state that did not change the cutoff concurrently, we decompose the effect of relative age into a positive effect of age at test, and a negative effect of the position in the distribution of age. Older classmates have a positive spillover, whereas younger classmates have a negative spillover. If tested at the exact same age, younger students would outperform their older classmates. We complement the analysis with estimates of relative-age effects in six labor and marriage market outcomes in a sample of Mexican adults. Significant effects are found in the six outcomes. Lastly, we lay out a theoretical model to explain differences in relative-age effects in wages across countries, highlighting the role played by selectivity of the mechanisms used to allocate educational opportunities and the wage premium to those educational opportunities in the labor market.

1. Introduction

Everywhere in the world formal education has rules that make the birthdate of a child a determinant of how old she is relative to her classmates. Elementary instruction is organized in grades that are 1 year long. At the same time, there are cutoff dates for school eligibility: children must be of a certain age by a specific date of the year in order to be allowed to enroll in school. The combination of birthdates spread along the calendar, cutoff dates for school eligibility, and year-long grades, mechanically produces age differences of up to 1 year among classmates.

Differences in age with respect to classmates could have an impact on academic performance, educational trajectories, and, ultimately, adulthood outcomes. Estimating such effects is challenging because student age within a class can be manipulated and therefore it might be correlated with other student attributes. In most jurisdictions, parents can voluntarily hold their children out of school after they become eligible for enrollment—a practice known as redshirting. In some school systems, grade retention of underperforming students is common. Even in the absence of redshirting and retention, some parents might prefer some seasons of birth for their children, and successfully aim at the corresponding gestational seasons. The manipulation of student age—through redshirting, grade retention or selection into gestational seasons—could bias Ordinary Least Squares estimates of the effect of relative age.

Many studies have attempted to estimate the effect of relative age on test scores and educational trajectories (see Panels I and II of Table A.1). They have tried to address potential biases in different ways. Some studies use controls for season of birth (Dhuey & Lipscomb, 2008; Lawlor, Clark, Ronalds, & Leon, 2006; Robertson, 2011; Sprietsma, 2010) or use data from jurisdictions where redshirting and grade retention are not permitted (Kawaguchi, 2011).

Other studies have resorted to quasi experimental approaches. The most popular approach is to instrument relative age with "expected" or "assigned" relative age, which is defined as the relative age a student would have absent redshirting and grade-retention (Bedard & Dhuey, 2006; Black, Devereux, & Salvanes, 2011; Cascio & Schanzenbach, 2016; Datar, 2006; Dhuey & Lipscomb, 2008, 2010; Elder & Lubotsky, 2009; Grenet, 2011; Mühlenweg & Puhani, 2010; Nam, 2014; Puhani & Weber, 2007; Schneeweis & Zweimüller, 2014). The instrumental variable approach has been criticized by Barua and Lang (2009) because the instrument might not satisfy the monotonicity assumption. Additionally, that approach relies on the assumption that students' date of birth is

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unrelated to their academic outcomes, which is inconsistent with the relationship between parental characteristics and season of birth documented by Buckles and Hungerman (2013).

A couple of studies use regression discontinuity designs around cutoff date for school eligibility (Crawford, Dearden, & Greaves, 2014; McEwan & Shapiro, 2008). This approach is not free of criticism either. Birthdates can be manipulated with precision around the cutoffs (Shigeoka, 2014), and parents who decide to manipulate birthdates might differ in unobservable characteristics from those who do not. Another critique to this approach is the local nature of the estimates it produces. Based on the findings of Buckles and Hungerman (2013), we know that children born around the cutoff might differ from children born in other seasons. Thus, estimates around the cutoff might not be generalizable to children born in other seasons.

Despite using different techniques, the studies in the literature point in a similar direction: relative age has a positive and sizeable effect on test scores and educational trajectories (Panels I and II of Table A.1). However, all those studies have shortcomings, the most important of which is that their identification strategies implicitly assume the absence of selection into gestational seasons. At least for the US, we know that is an incorrect assumption.

This article presents a new approach to the estimation of relative age effects that avoids some of the shortcomings of previous studies. Its key is that it relies on a policy experiment: an unanticipated shift in the cutoff date for school eligibility. The policy change took place in the state of Tlaxcala, Mexico. The shift in the cutoff date allows estimating relative age effects using a Difference-in-Differences approach across seasons of birth, and pre- and post-reform cohorts. Additionally, following other approaches in the literature, we obtain instrumental variable and regression discontinuity estimates to contrast them with our Difference-in-Differences estimates.

This study also takes on a more challenging question: what explains relative-age effects in test scores? In particular, we explore the extent to which relative-age effects are explained by differences in age at the moment of testing versus differences in the position of students in the distribution of age in their class. In other words, if ceteris paribus students were tested at the exact same age, would older students still outperform their younger classmates? Since in general tests are given at the same time to all students in a class, age at the moment of the test and the position in the distribution of age are perfectly collinear. In most situations, collinearity makes impossible to decompose relative-age effects into the effect of age at the moment of test and the effect of the position in the distribution of age. Only two studies have produced such decomposition (Black et al., 2011; Cascio & Schanzenbach, 2016). Here we do it using test scores from a neighboring state where students took the same tests at the same time, but where the cutoff date did not change concurrently. Using a Difference-in-Differences approach between states and cohorts, we obtain estimates of the effect of age at the moment of testing, and the effect of the position in the distribution of age. Consistent with the other two studies, we find that the effect of age at the moment of test is positive, and the effect of the position in the distribution of age is negative. In other words, being older gives an edge in test scores. However, if tested at the same age, younger students would outperform their older classmates.

Relative-age effects on test scores are relevant to the extent that they translate into meaningful differences in adulthood outcomes associated with wellbeing, such as educational attainment, wages, or occupation. The evidence of relative-age effects in adulthood outcomes is scarce and mixed (Black et al., 2011; Dobkin & Ferreira, 2010; Fredriksson & Ockert, 2013; Grenet 2011; Kawaguchi, 2011; Nam, 2014; Zweimüller 2013). Using date of birth as a proxy for relative age in school in a sample of Mexican adults, this study provides estimates of relative-age effects in six labor and marriage market outcomes: college attainment, employment status, earnings, having employer-provided medical insurance, college attainment of the spouse, and number of children. We find significant relative-age effects in the six outcomes. Our results contrast with some of the results from other studies (Panel III, Table A.1). Particularly puzzling are the differences with respect to countries that track students, like Austria (Zweimüller, 2013) and Korea (Nam, 2014), which in principle we would expect to show larger relative-age effects in adulthood. Mexico has a comprehensive educational system (with no tracks) and our estimates for relative-age effects in wages exceed those for Austria and Korea.

This study presents a theoretical model to investigate the reasons behind the contrast between our findings in adulthood outcomes for Mexico and the findings for other countries with tracking. The focus of the model is the mechanisms that countries use to allocate educational opportunities among students. The parameters of the model are the degree of age bias in the allocation mechanism, the extent of selectivity in the allocation, and the wage premium associated with the educational opportunity being allocated. The model establishes explicit relationships between those parameters and the magnitude of relative-age effects in wages. The main lesson from the model is that the extent of selectivity and the wage premium can result in larger relative-age effects even under less age-biased allocation mechanisms. That result is helpful in interpreting apparent conflicts between the results for different countries. It implies that it is possible for a country without tracking to have larger relative-age effects in wages than a country that tracks students at early ages.

The remainder of the article is organized as follows. Section 2 presents the estimates of relative-age effects in test scores. Section 3 shows the decomposition of relative-age effects in test scores into the effects of absolute age at testing and the position in the distribution of age. Section 4 presents the estimates of relative-age effects in adulthood outcomes. Section 5 lays out the theoretical model of relative-age effects in adulthood outcomes. Section 6 presents our conclusions.

2. Relative-age effects in test scores

In this section we present the estimates of the effect of relative-age on test scores in grades 3–9 using a sample of students in the state of Tlaxcala, Mexico. The novelty of our estimates lies in the use of an unanticipated change in the cutoff date for school eligibility, and the use three different identification strategies with the same data. In addition, this is the first study of relative-age effects in test scores in a low-income context.

2.1. Institutional background

The state of Tlaxcala is located 75 miles east from Mexico City. It has a population of 1.17 million and a land area of approximately 1550 miles^2—it is similar to Rhode Island in both respects. In 2006, Tlaxcala had an income per capita of roughly half the national average.

As the rest of Mexico, Tlaxcala has a comprehensive educational system—without academic tracking. Students can enroll in preschool approximately at age three, and they start school approximately at age six. They are expected to attend 3 years of *preescolar* (preschool including kindergarten), 6 years of *primaria* (grades 1–6), 3 years of *secundaria* (grades 7–9), and 3 years of *bachillerato* (grades 10–12). In order to enroll in preschool, students in Tlaxcala must be at least 3 years old by December 31 of the year of enrollment. To enroll in elementary school, they must be at least 6 years old by December 31 of the year of enrollment.