Revisiting Gladwell's Hockey Players: Influence of Relative Age Effects upon Earning the PhD

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ABSTRACT

We examine the influence of relative age effects (RAE) upon whether someone earns the PhD. Drawing on the 2010 Survey of Earned Doctorates, we find no significant influence of RAE. When controlling for discipline-specific variation, we also find no influence of RAE on the age of people earning the PhD and no influence on post-graduate salary. To the extent that earning the PhD is considered an outstanding achievement, our findings support the view that redshirting is unnecessary and costly. We estimate a relative salary loss due to redshirting of over $138,000 in lifetime earnings for individuals who earn the PhD.

AUTHOR NOTE

The use of NSF data does not imply NSF endorsement of the research, research methods, or conclusions contained in this report.

1. INTRODUCTION

Parental anxieties have been stoked in recent years about the optimal time for enrolling children into kindergarten. In his best-selling book *Outliers: The Story of Success*, Malcolm Gladwell (2008) drew from an account involving Canadian hockey players to popularize the concept of "redshirting" kindergarten-aged children to delay entry into school by a year. In the analysis that Gladwell reports, children who were always relatively older than their teammates tended to enjoy significantly better outcomes – as measured by the order of their selection in the National Hockey League (NHL) draft – than children who were always relatively younger. The implication from this Relative Age Effect (RAE) is that if parents can arrange for their offspring to be relatively older than the cohort with whom they compete – in hockey or any domain – then the offspring will enjoy a comparative advantage. Indeed, Gladwell openly and explicitly encourages this inference in the 1.5 million copies of his book that have been purchased.

Gladwell's focus on Canadian hockey players is sensible because the cut-off age for participation is neatly uniform across the country and cannot be modified; however, alternate analyses of the same players' experiences have shown that Gladwell's reliance on draft selection as the outcome variable is incomplete and misleading. Specifically, Gibbs, Jarvis, and Dufur (2011) show that it is the relatively youngest Canadian hockey players who have relatively longer careers in the NHL and participate disproportionately in elite levels of competition (i.e., All-Star games and Olympic teams). To the extent that parents have drawn counsel from Gladwell's account of hockey players, the evidence presented by Gibbs et al. offers clear advice to the contrary. Indeed, research examining the impact of redshirting on academic performance and market outcomes has yielded results questioning Gladwell's assertions. Our objective is to build on this research by examining the extent to which RAE influences outcomes among

individuals earning the PhD in addition to considering the costs of redshirting – a decision taken by some parents in response to concerns about RAE.

To date, research RAEs in educational settings has been mixed in ways that are comparable to the findings drawn from Canadian hockey players. On the one hand, consistent with Gladwell's account, researchers have often highlighted the benefits that are gained by students who are relatively older than their classmates. In terms of academic performance during a child's youth, Dhuey and Lipscomb (2010), for example, report that relatively young students in primary school are disproportionately diagnosed with learning disabilities. In a study of German students for whom decisions are made at age 10 to assign students to academic or vocational schools, Muhlenweg and Puhani (2010) conclude that relatively older students are significantly more likely to be tracked into academic instead of vocational education. When tracking the impact of relative age across a span of years, McEwan and Shapiro (2008) report a positive improvement in standardized test scores in 4^{th} and 8^{th} grades for relatively older students, particularly for boys. In a more narrow range of time, Datar (2006) reports that relatively older students perform better in first and second grade if they enter kindergarten as a relatively older child.

On the other hand, just as Gladwell's account of hockey players has appeared incomplete in the face of closer scrutiny, there are numerous studies indicating mixed, or null, effects of relative age for a variety of important outcomes. For example, Cook and Kang (2013) highlight that relatively older students in North Carolina schools tend to outperform their younger classmates but they are also more likely to commit a felony offense by age 19, or drop out of high school. In separate analyses of cohorts from California and Texas, Dobkin and Ferreira (2010) report that relatively younger children underperform in school but tend to complete

higher levels of education through college. In a study showing null impacts, Graue and DiPerna (2000) report comparable outcomes on third-grade reading tests for redshirted and non-redshirted students. And, in a study that shows an opposite pattern, Cascio and Schanzenbach (2012) report that relatively young students in classrooms tend to enjoy better outcomes when they are in cohorts with students who are older than the regular range for their given academic year.

Independent of findings that support the relevance of RAEs or otherwise generate mixed results for children and adolescents, a number of studies have reported no – or minimal – longer-term influences of RAE. For example, Elder and Lubotsky (2009) find a significant influence of RAE in early grades that progressively declines before disappearing by the time of eighth grade. Similarly, Dobkin and Ferreira report no RAE for wages and employment, concluding that "this null finding is striking given the extensive literature documenting the substantial adverse impact on academic performance of being the youngest student in a cohort" (2010, p. 45-47).

Despite the lack of consensus among researchers about the importance of RAE, there remains ample evidence that some parents seek to minimize the uncertainty of their children's success by considering redshirting as a voluntary act to gain a comparative advantage. It is noteworthy that a second avenue for parents to conceivably adjust behavior in light of the cut-off rules is to time pregnancies and births so that offspring would be born in the first quartile of the relevant school year (i.e., becoming among those born during the first four months after the school's cut-off date). Dickert-Conlin and Elder (2010) examined this topic, which they label as a "suburban legend," in response partly to reports of cesarean-section births that were requested in order to make the kindergarten cut-off date in a given state. Dickert-Conlin and Elder find no systematic evidence of such a "timing" pattern in their analysis of births in the US between 1999 and 2004 and they express puzzlement in light of the estimated $2,500 that each family would

pay for childcare expenses for an extra year for a child born in the month prior to the cut-off date compared with the month following the cut-off date. As the authors specify, though, knowledge of kindergarten cut-off dates is not necessarily salient for prospective parents and, as Deming and Dynarski (2008) note, the voluntary decision to redshirt is significantly more common among families with the resources to pay for private childcare, which can substantially exceed $2,500 for a year.

While parents face additional costs in an attempt to give their child a competitive edge when they choose to redshirt, these costs may also spill over into a child's earning potential. Given that the evidence for the impact of RAEs in education is mixed, the little research regarding earnings suggests that RAEs are diminished in the longer-term. In a non-US based study, Black, Devereux, and Salvanes (2011) examine a comparable dynamic among Norwegian students and find no significant difference in incomes at age 35 based on relative age even though they found significant influences of RAE on early childhood educational performance. Given that the prevalence of redshirting in the US ranges anywhere from 4% to 9% nationally (Bassok and Reardon 2012; Graue and DiPerna 2000; Frey 2005), redshirting may set a child back a year from earning a full salary.

In this article, we build upon considerable previous research concerning RAEs in educational domains. Apart from past research, though, we present a novel focus on tertiary educational outcomes. Specifically, we investigate the degree to which RAEs might influence the probability that a person earns a research doctorate and whether RAEs affect the age or amount of time at which individuals earn the PhD. Our study does not assume that the PhD reflects the highest levels of intelligence; however, completion of a doctoral program does reflect a combined measure of academic achievement and ambition or striving. For these reasons, it is

valuable to consider whether concerns about RAE have relevance for understanding the 1.55% of the US population that has earned a doctoral degree (US Census, 2012).

II. DATA AND METHODS

Data

To examine the impact of RAEs on achievement and earnings of PhD recipients, we rely on the National Science Foundation's (NSF) Survey of Earned Doctorates (SED). The NSFs National Center for Science and Engineering Statistics (NCSES) administers this survey annually to individuals who earn the research doctorate in the United States. To focus on the most recent year of available data, we utilized responses from the 2010 edition of the Survey, which was administered to everyone earning a research doctorate in the US between July 1, 2009 and June 30, 2010. Fiegener (2011) reports that the 2010 Survey gained responses from 92.9% of the 48,609 people who earned the doctorate that year in the US.

For people who do not complete the full Survey, the SED records limited information based upon "administrative lists of the university, such as commencement programs and graduation lists." For example, gender is recorded for 99.7% of respondents and citizenship is known for 94.0% of the population of doctorate graduates from 2010. With respect to various kinds of doctoral degrees, the 2010 SED primarily concerns people who earned the Doctor of Philosophy (PhD) (95.8%) and Doctor of Education (EdD) (3.1%) and does not involve people with "professional doctorates" in law, medicine, or dentistry.

For our analysis, we followed Bedard and Dhuey's (2006)'s listing of state-specific cut-off dates for kindergarten entrance and categorized respondents to the SED on the basis of their Birth Month and their Birth State. Since the SED does not include continuous information on the location of respondents throughout their lives and does not ask whether respondents' parents delayed their entry into school, we assume that respondents entered formal school systems (e.g., kindergarten) in the State where they were born just as we also assume that respondents were not redshirted by their parents since that is the predominant practice across the population. Our sample is based on data provided by 14,535 freshly minted doctoral recipients since we do not consider respondents who were born in states where the cut-off occurs in the middle of a month or where the cut-off date is established by local school districts.

It is notable and important that our sample includes data from states with a diversity of cut-off dates (February 1 for Pennsylvania and Florida; September 1 for Texas, New Mexico, Kansas, and Minnesota; October 1 for Ohio, Virginia, Arkansas, Missouri, Nevada, and New Hampshire; and December 1 for California, Illinois, Michigan, and New York) in light of demographic research indicating that socioeconomic differences are manifested through variable seasonality in birth rates (e,g., Buckles and Hungerman, forthcoming). As a consequence, the range of cut-off dates provides a built-in guard against the potentially spurious influence of socioeconomic status in relation to examining the relevance of RAE for students earning the research doctorate.

Specifications

Given the information available in the data, we are able to estimate the potential impact of birth quarter on (1) the age at which an individual earns the PhD, (2) the length of time it takes to earn the degree, and (3) salary. We can highlight that our consideration of (1) age as well as (2) time-to-degree provides a robustness check since it is plausible that relatively young students within a cohort might perform just as well as relatively old students with respect to time-to-degree, while also taking additional time before starting graduate school. Likewise, it is equally imaginable that relatively young students within a cohort might start graduate school at comparable times in their lives but nonetheless take longer to earn the degree when compared with relatively old students. As a second robustness check, we utilize state cut-off dates based on the individual's birth state as well as the individual's high school location.

For the analysis in this paper, the equation is given by

$$y_{ij} = \beta_{0j} + \boldsymbol{\beta}_{1j}\boldsymbol{Quarter} + \boldsymbol{\beta}_{2j}\boldsymbol{Discipline} + \beta_{3j}Female + \beta_{4j}White + \beta_{5j}Move + \boldsymbol{\beta}_{6j}\boldsymbol{CarnegieClass} + \varepsilon_{ij}, \quad (1)$$

where y_{ij} is individual *i's* outcome for the j^{th} response (dependent) variable: age, time-to-degree, salary (thousands of dollars), and difference in the future value of lifetime earnings if the individual begins earning salary one year later (tens of thousands of dollars). It is important to note that the salary variable is self-reported salary for the individual's first position after graduate school. ***Quarter*** is a vector of dummy variables indicating the birth quarter of individual *i*

relative to the cutoff year for the individual's birth or high school graduation state. For example, if a state's cutoff date is September 1, and an individual's birthday is in June, July, or August, this individual falls within the fourth quartile (Q4) group. Similarly, an individual is counted in the first quartile (Q1) group if his/her birthday is in September, October, or November. The dummy variable corresponding to birth in the first quarter is the reference quartile; consequently, it is not included in the analysis. ***Discipline*** is a vector of dummy variables indicating the individual's PhD field. It is important to control for the individual's PhD field because of the amount of variation between fields for age of students, time-to-degree, and salary. *Female* specifies the individual's gender, which identifies potential disparities between men and women. *White* specifies whether the individual is European-American, or another ethnicity, indicating potential differences in student age, time to PhD completion, or salary compared to white students. *Move* represents whether the individual moved away from the birth state between birth and high school graduation. The vector of variables ***CarnegieClass*** makes use of the Carnegie classification system to categorize universities as having very high, high, or moderate research activity. A fourth classification is given to universities that grant PhDs but engage in a limited amount of research. For purposes of analysis, universities with the highest amount of research activity are used as the baseline. The model error, ε_ij, captures the remaining noise in the system not accounted for by the variables. Note that in the regressions for the difference in the present value of lifetime earnings, there is no quarter effect because this is differenced out.

Results are presented for both ordinary least squares (OLS) regressions with robust standard errors and Tobit regressions. Tobit regressions are used because the dependent variables, except for salary, are all truncated on the lower end of the distribution at zero. Salary,

on the other hand, is truncated because the lowest salary respondents can report is $30,000 and the upper end of the reportable salary scale is $110,000.

III. RESULTS

Descriptive statistics for data from all quarters indicates (Table 1a) that individuals were, on average, nearly 36 years of age, after spending about 8 years in graduate school; slightly more than half were women; and, 87% were white. Average salary for the first year after earning the PhD was approximately $58,000; about 38% became employed as a contingent postdoctoral researcher; and, nearly two-thirds of the respondents were married. As measures of respondents' socioeconomic status, approximately 62% of respondents have a father who earned a college degree and 55% report that their mother earned a college degree.

With respect to sex differences across the full sample, Table 1a also highlights that women tended to be slightly older when they earned the PhD (36.5 compared to 34.8 years, $p < 0.001$); were less likely to be employed as a contingent postdoctoral researcher (36.5% compared to 38.9%, $p = 0.003$); less likely to be white (54% compared to 56%, $p = 0.017$); earned less in the year after graduate school ($55,140 compared to $60,630, $p < 0.001$); and, generally took longer to complete their respective PhD programs (8 years compared to 7.7 years; $p < 0.001$). Women were also more likely to be married (67.6% compared to 66.0%, $p = 0.046$) and less likely to have parents who earned college degrees (father: 60.6% compared to 64.1%, $p < 0.001$; mother: 54.0% compared to 56.0%, $p = 0.017$).

Insert Table 1 about here

When individuals in the sample are separated into their respective birth quarters, a frequency count of the birth quartile for people in our sample shows 3,708 born in Q1, 3,289 born in Q2, 3,993 born in Q3, and 3,545 born in Q4. While this distribution is significantly uneven as measured by a Pearson Chi-square test ($p < 0.001$), it would be incorrect to assume that RAE is important since we also find that the most populated category is Q3 and, more generally, there are more than 500 additional students in the relatively younger pooling of Q3 and Q4 when compared with the pooled category of Q1 and Q2. More directly stated, the frequency counts here suggest no correlation between acquisition of a PhD and the RAE. More to the point, the formal regression analyses that we specified in the previous section will examine whether relative age influenced respondents' age at time of degree as well as time-to-degree and salary. Through these models, it is possible to measure what economic benefit, if any, can be attributed to an effect of relative age.

Notably, with respect to our assumption that respondents entered kindergarten and completed schooling based on the regular cut-off dates for the state in which they were born, the second measure of respondents' educational location – the state in which they completed high school – shows that 28% of the individuals graduated high school in a different state than where they were born. Additionally, of those who moved across states from the time of birth to the time of their high school graduation, 37% reported that their father had a college degree and 30% reported the same for their mother. While the dataset does not permit finer-grained analysis in

relation to students' moves (e.g., whether the move was accompanied by a change in the progression of grades), the frequency of moving is certainly important to consider in our analyses and permits a robustness check of results based on birth location.

Panels b-e in Table 1 report descriptive statistics for measures used in our regression analysis by birth quarter, relative to the cut-off date for kindergarten enrollment in the individual's respective state. Focusing on comparisons between individuals born in the first quartile (Q1) and the fourth quartile (Q4), we can see nominal differences whereby Q1 graduates appear to be slightly younger than the Q4 graduates; earn the degree slightly faster; and, curiously, earn lower salaries than their Q4 peers. Of course, the differences are slight enough that closer analyses are required that incorporate important background variables such as discipline-specific variation.

For a broader picture of the variables considered for regression, we can highlight statistically significant correlations in Table 2 that provide justification for our model specification. First, we can point out the small, though positive correlation between those born in the fourth quartile and both age (r = 0.03) and time-to-degree (r = 0.02). Similarly, among other relationships with relevance to our main interests, age was positively correlated with salary (r = 0.17), suggesting the potential impact of experience and maturity on salary in the year after graduate school. The very significant and negative correlation between salary and employment as a postdoctoral researcher (r = -0.52) also accounts for our focus on salary as a dependent variable.

Insert Table 2 about here

While Table 2 provides an overview of interrelationships in the dataset, the regression analyses presented in Table 3 control for discipline-specific variations as well as gender and ethnicity. Notwithstanding evidence that parental education levels appear to influence decisions to pursue the PhD (e.g., Kniffin 2007), we do not include parental educational attainment in the regression analyses since we are not examining the decision to pursue a PhD, or the discipline of study..

Most generally, Table 3 shows that relatively young Q4 graduates are not significantly older than Q1 graduates and do not earn significantly less (or more) than Q1 graduates when relevant control variables are considered. With respect to time-to-degree, the OLS and Tobit results indicate that the relatively young Q4 graduates take slightly more time – approximately 1 month. Since Q1 is the reference group for the statistics presented in Table 3, the OLS and Tobit regression coefficients for Q2-Q4 are relative to the impact Q1 has on the response variable. If RAE was a significant factor for the individuals in this sample, then we would expect significant differences at least between Q1 and Q4 individuals, where Q1 individuals would be expected to take less time to earn the PhD and earn more immediately following graduation.

The importance of considering disciplinary differences through the regressions that we presented is also clear in relation to understanding the gender differences that we reported from Table 1's summary statistics. Specifically, Table 3 is clear that women took approximately one month less to earn the PhD when considering the role of discipline and ethnicity. Consistent with the descriptive statistics in Table 1, though, results reported in Table 3 suggest that women's salaries are lower and that whites tend to be older at the time they earn the PhD.

Interestingly, individuals who moved out of their birth state before high school graduation were over nine months older when they earned the PhD and their average time-to-degree in graduate school was approximately one month longer. While there was no statistical difference in reported salaries for the first year post graduation, the tendency to start graduate school approximately later in life along with the slightly longer period spent in graduate school could affect the future value of lifetime earnings for those individuals who moved.

To focus on the Carnegie classifications, there is evidence that individuals who attend universities with the highest research activity finish at an earlier age and in a shorter time span relative to those from other universities. Based on salaries for the first year immediately after graduation, it is also true that individuals who acquired their PhD from a university with some degree of research activity earned more than those who attended the highest research active schools. Individuals from the highest research active schools most likely sought a research position, which in many cases (e.g., as postdocs) results in a lower salary.

Insert Table 3 about here

Taken together, our findings indicate that redshirting a child for a year does not likely give him or her an upper edge in relation to completing a PhD more quickly, nor on potential salary immediately after graduation. Notice in Table 4 that when quarters are based on state of high school graduation, the results are very similar, indicating the robustness of the initial results. Since the average age of the individuals across quarters is comparable, this is evidence that any

potential advantage to holding back a student for a year appears irrelevant in relation to earning the PhD. In light of these patterns, it is especially valuable to calculate the costs that redshirting would have incurred for the people in our sample.

Insert Table 3 about here

IV. Estimating the Private Costs of Redshirting

Previous studies that have looked at the economic impacts of relative age tend to focus on the policy of cut-off dates and the practice of redshirting. For example, Bedard and Dhuey (2012) do not focus on the importance of relative age; however, their study of state-specific changes in the cut-off date for kindergarten generates the conclusion that moving the cut-off date backwards by one month (e.g., from October 1 to September 1) effects improved outcomes for all students in the cohort, including an increase in hourly wages for men of 0.6 percent. While Bedard and Dhuey's findings indicate a benefit for students to be relatively older as a cohort, they also acknowledge that their analysis is not designed to address what would happen in a run-away situation whereby cut-off dates spiraled backwards *ad absurdum*.

In a pair of studies that focused on the long-run economic impacts of redshirting for directly affected students, Dobkin and Ferreira (2010) find no difference for students who are redshirted while Fredriksson and Öckert (2005) report that redshirted students incur net costs. More specifically, Fredriksson and Öckert (2005) do find small but significant short-term

benefits for students who are redshirted; however, those benefits are outweighed by the opportunity costs that are incurred by students who will – later in life – have one less year in the labor market *et ceteris paribus*.

To complement our finding of no apparent benefit for redshirting in relation to people who earn the PhD, we calculated the lifetime earnings stream for an individual with a PhD. According to data available from the Bureau of Labor Statistics (BLS), the median weekly salary of these individuals was $1,387 in the second quarter of 2013, making yearly earnings approximately $72,124 (BLS 2013). Based on the data in this sample, individuals tend to earn the PhD when they are approximately 36 years of age. If we project the average for people in our sample with the assumptions that incomes are adjusted for yearly inflation of 3% and people retire at age 65, then the annual salary upon retirement will be $169,965. If an individual is held back for one year, this lifetime earnings stream begins one year later and ends with $165,015. In addition, the economic cost is incurred each year after entering the work force because inflation-adjusted income each year is lower if one begins a year later.

The regressions that we report in Table 4 provide the difference in the future value of lifetime earnings based on a one-year difference in which the individual begins work post graduation. This lifetime earnings stream is calculated using age 65 as the retirement age and salary from the previous year increases by 3% (to account for inflation). For both the OLS and Tobit regressions, the present value difference in lifetime earnings is over $138,000.

Interestingly, the difference in lifetime earnings among disciplines is generally uniform with a few notable exceptions. Individuals who pursue doctoral work in the Health Sciences, Humanities, and Education seem to be affected to a greater degree, indicating greater dispersion of initial salaries for these disciplines from the others immediately following graduation. In

addition, given the salary differential (Table 3) as well as lower lifetime earning streams for women, it would make sense for people, especially parents of girls, to begin children's education without redshirting.

Insert Table 5 about here

V. DISCUSSION AND IMPLICATIONS

To the extent that parents might tend to consider completion of a research doctorate to be a preferred educational outcome for their offspring, we find that worries about redshirting or birth timing appear to be wasteful. Gladwell's (2008) general point of drawing attention to ways in which individual success is interdependent within an "ecology" of others' activities is worthwhile; however, our findings contribute an important new dimension to literature that demonstrates that concerns with RAEs appear overwrought. In fact, our estimates show no benefit for individuals in relation to earning the PhD and a very significant private cost for any students who are delayed from starting school – and work – for a "redshirt" year. Further, to the extent that family planning for people who earn the PhD is influenced by degree progression and constrained by temporally limited fertility windows, it is notable that our estimates of lifetime earnings do not incorporate any costs that are imaginable with respect to students' reproductive fitness. In other words, when entry to the labor market is delayed by a year, it is worth recognizing that reproduction will also likely be delayed for some people.

While our study's findings provide a novel examination of RAE in relation to earning the PhD and complement previous work intended to understand characteristics that influence variables such as doctoral students' time-to-degree (e.g., Ehrenberg and Mavros 1995), we recognize several limitations to the study. First, our measurement of quartiles as an indicator of students[1] relative age is exposed to measurement error partly due to the fact that many participants did not complete all of their pre-collegiate schooling in the same school district or state. More specifically, while we find that only 28% of individuals were born and graduated from high school in different states, we do not know the exact state in which the individuals began kindergarten, making our constructed quartiles only approximations. Notably, however, there is very little difference in the results in relation to RAE whether we use birth state or state of high school graduation for constructing the quarter variables, thus providing a check on our results that relied on birth state. This suggests, at least in this context, that basing the quarters upon state of birth is fairly robust.

Two additional aspects of parental – and student – mobility potentially contribute to measurement error of our quartile estimates. First, when families move across school districts within states, there may be a new opportunity – based partly on parental discretion – for changing the regular progression of grades. Second, there is evidence that student mobility can have a negative effect on student achievement outcomes and potentially lead to holding students back for a year in primary or secondary school (Gruman et al. 2008). While our sample has no indication of this, the fact that 28% moved across states at least once between birth and high school graduation raises concerns whether those who moved were held back and such information is not available in our sample. Our more general finding that people who moved are

more likely to be older when they earn the PhD would seem to contribute to research that shows negative outcomes as a function of moving.

A structural limitation of our analysis is based on the fact that we are only able to consider RAE among those who successfully acquired the PhD. Given a potential selection that could occur as a function of RAE within graduate school, it would be valuable if future research examining attrition among graduate students (e.g., Stock, Finegan, and Siegfried 2009) were to consider the potential influence of RAE. Since we only have information for individuals who successfully completed a PhD program, the present study is not able to consider the factors that influence whether someone begins, aborts, or completes a PhD program. In a similar vein, it would be comparable to the studies of Canadian hockey players' performance at elite levels if studies of academic productivity such as publication metrics (e.g., Hilmer and Hilmer 2007) were to consider the potential influence of RAE.

Finally, as noted in section II, our analysis assumes that members of our sample were not redshirted since we do not have data for that variable and the predominant practice in the United States is to start schooling on a regular schedule. Additionally, it is notable that our salary analyses are limited to considering income for respondents' first jobs after earning the PhD. In this case, particularly when one considers the relatively low salaries that postdoctoral researchers are paid upon graduating before seeking positions that pay significantly higher salaries, the limitation in our dataset most likely biases our results downward. In other words, individuals who accept a postdoctoral position immediately after graduation will likely see a significant bump in pay once they accept a more permanent position, causing a markedly upward adjustment in their stream of lifetime earnings. As with the question of attrition among graduate

students, future research that examines mid- or late-career salaries of people who earned the PhD would provide value by examining whether RAE is relevant.

Beyond examining an important new empirical dimension in relation to the role of RAE, our results contribute to debates concerning the public and private costs and benefits of education. Based on Gladwell's assumption that relatively young students "have been dealt a big disadvantage by the educational system," he goes on to argue that public schools should create half-grades so that there are two cohorts for each year's worth of new students. In this framework, new kindergarten classes would start approximately six months apart from each other, incurring (potentially) substantial public cost (e.g., for administration) that, based on findings reported here, would be unwarranted. In the case of voluntary redshirting, parents assume an additional year's worth of costs to pay for private childcare or foregone opportunities and again, based on our findings, those costs would be unwarranted. In addition to contributing to considerations of public and parental costs, though, our paper also highlights that students whose entry into school has been delayed for a year appear to enjoy no additional benefits – in relation to the variable of educational achievement that we study – while generating significant private costs across the course of their lifetimes.

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Table 1: Summary Statistics of Regression Variables

a. All Four Quarters

	Whole Sample	Females (std err)	Males (std err)	T-statistic
Father College (%)	62.3%	60.6%	64.1%	-4.29
	(0.485)	(0.489)	(0.480)	(0.000)
Mother College (%)	55.0%	54.0%	56.0%	-2.39
	(0.498)	(0.498)	(0.496)	(0.017)
White (%)	87.0%	85.0%	89.1%	-7.44
	(0.336)	(0.357)	(0.311)	(0.000)
Age (years)	35.7	36.5	34.8	12.03
	(8.645)	(9.252)	(7.860)	(0.000)
University w/ Very High Research Activity (%)	72.8%	69.7%	76.0%	-8.51
	(0.445)	(0.459)	(0.427)	(0.000)
University with High Research Activity (%)	17.3%	18.7%	15.7%	4.89
	(0.378)	(0.390)	(0.364)	(0.000)
University with Research Activity (%)	5.0%	6.2%	3.9%	6.36
	(0.219)	(0.241)	(0.193)	(0.000)
University with Limited Research Activity (%)	4.9%	5.3%	4.5%	2.51
	(0.216)	(0.225)	(0.206)	(0.012)
Move (%)	27.9%	28.2%	27.7%	0.68
	(0.449)	(0.450)	(0.447)	(0.499)
Female (%)	51.3%	--	--	
	(0.500)	--	--	
Marital Status (%)	66.8%	67.6%	66.0%	2.00
	(0.471)	(0.468)	(0.474)	(0.046)
Salary (thousands of dollars)	$57.87	$55.14	$60.63	-11.39
	(23.270)	(21.404)	(24.717)	(0.000)
Time to Degree (years)	7.9	8.0	7.7	9.23
	(1.905)	(1.887)	(1.911)	(0.000)
Post Doc (%)	37.7%	36.5%	38.9%	-2.92
	(0.485)	(0.482)	(0.488)	(0.003)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals where data were available for cut-off dates for enrollment into elementary school.

b. Quarter 1

	Quarters based on birth place				Quarters based on place of high school graduation			
	Whole Sample	Female	Male	T-statistic	Whole Sample	Female	Male	T-statistic
	(se)	(se)	(se)	(p-value)	(se)	(se)	(se)	(p-value)
Father College (%)	61.6%	60.6%	62.6%	-1.24	62.2%	61.3%	63.2%	-1.20
	(0.486)	(0.489)	(0.484)	(0.214)	(0.485)	(0.487)	(0.482)	(0.230)
Mother College (%)	54.4%	54.1%	54.7%	-0.40	54.6%	54.9%	54.3%	0.43
	(0.498)	(0.498)	(0.498)	(0.690)	(0.498)	(0.498)	(0.498)	(0.666)
White (%)	87.8%	85.5%	90.3%	-4.46	84.7%	82.7%	87.0%	-3.77
	(0.328)	(0.352)	(0.296)	(0.000)	(0.360)	(0.379)	(0.337)	(0.000)
Age (years)	35.9	36.9	34.8	7.24	35.7	36.5	34.8	6.28
	(8.690)	(9.422)	(7.673)	(0.000)	(8.622)	(9.280)	(7.745)	(0.000)
University w/ Very High Research Activity (%)	71.6%	68.5%	75.0%	-4.38	71.6%	68.6%	74.9%	-4.38
	(0.451)	(0.465)	(0.433)	(0.000)	(0.451)	(0.464)	(0.434)	(0.000)
University with High Research Activity (%)	17.7%	19.2%	16.0%	2.52	17.7%	18.6%	16.7%	1.60
	(0.381)	(0.394)	(0.367)	(0.012)	(0.382)	(0.389)	(0.373)	(0.110)
University with Research Activity (%)	5.4%	6.6%	4.2%	3.28	5.3%	6.7%	3.6%	4.35
	(0.227)	(0.249)	(0.200)	(0.001)	(0.223)	(0.251)	(0.187)	(0.000)
University with Limited Research Activity (%)	5.3%	5.7%	4.9%	1.20	5.4%	6.0%	4.8%	1.73
	(0.224)	(0.233)	(0.215)	(0.230)	(0.226)	(0.238)	(0.213)	(0.083)
Move (%)	28.4%	29.1%	27.7%	0.99	28.3%	29.1%	27.4%	1.16
	(0.451)	(0.455)	(0.447)	(0.322)	(0.451)	(0.455)	(0.446)	(0.247)
Female (%)	52.2%				52.2%			
	(0.500)				(0.500)			
Marital Status (%)	68.3%	67.7%	69.0%	-0.78	66.6%	66.5%	66.8%	-0.18
	(0.465)	(0.468)	(0.463)	(0.433)	(0.472)	(0.472)	(0.471)	(0.855)
Salary (thousands of dollars)	$57.69	$55.19	$60.32	-5.43	$57.48	$54.80	$60.26	-6.04
	(23.042)	(21.150)	(24.624)	(0.000)	(23.004)	(21.218)	(24.425)	(0.000)
Time to Degree (years)	7.9	8.0	7.7	4.79	7.8	8.0	7.7	4.28
	(1.909)	(1.888)	(1.919)	(0.000)	(1.913)	(1.899)	(1.920)	(0.000)

Post Doc (%)	36.5%	35.2%	38.0%	-1.79	37.7%	36.3%	39.2%	-1.83
	(0.482)	(0.478)	(0.486)	(0.074)	(0.485)	(0.481)	(0.488)	(0.067)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school. Those who were born within the first three months, after the cutoff date, are included in this table.

c. Quarter 2

	Quarters based on birth place				Quarters based on place of high school graduation			
	Whole Sample	Female	Male	T-statistic	Whole Sample	Female	Male	T-statistic
	(se)	(se)	(se)	(p-value)	(se)	(se)	(se)	(p-value)
Father College (%)	61.8%	60.1%	63.4%	-1.96	61.8%	58.9%	64.8%	-3.59
	(0.486)	(0.490)	(0.482)	(0.050)	(0.486)	(0.492)	(0.478)	(0.000)
Mother College (%)	55.5%	54.5%	56.5%	-1.14	55.5%	54.7%	56.4%	-0.99
	(0.497)	(0.498)	(0.496)	(0.253)	(0.497)	(0.498)	(0.496)	(0.322)
White (%)	87.7%	85.8%	89.6%	-3.40	84.4%	82.2%	86.7%	-3.66
	(0.328)	(0.350)	(0.305)	(0.001)	(0.363)	(0.382)	(0.340)	(0.000)
Age (years)	35.4	36.3	34.5	5.81	35.2	35.9	34.5	5.13
	(8.542)	(9.150)	(7.795)	(0.000)	(8.417)	(8.946)	(7.764)	(0.000)
University w/ Very High Research Activity (%)	74.6%	71.0%	78.1%	-4.69	75.6%	71.5%	79.7%	-5.70
	(0.436)	(0.454)	(0.414)	(0.000)	(0.430)	(0.451)	(0.402)	(0.000)
University with High Research Activity (%)	16.4%	18.5%	14.4%	3.24	15.9%	18.2%	13.4%	3.90
	(0.371)	(0.389)	(0.351)	(0.001)	(0.365)	(0.386)	(0.341)	(0.000)
University with Research Activity (%)	4.4%	5.2%	3.6%	2.12	4.3%	5.1%	3.5%	2.42
	(0.205)	(0.221)	(0.188)	(0.034)	(0.203)	(0.221)	(0.183)	(0.016)
University with Limited Research Activity (%)	4.6%	5.3%	3.9%	1.91	4.3%	5.1%	3.4%	2.60
	(0.209)	(0.224)	(0.193)	(0.056)	(0.202)	(0.221)	(0.180)	(0.009)
Move (%)	27.0%	27.0%	27.0%	0.02	26.9%	28.1%	25.6%	1.62
	(0.444)	(0.444)	(0.444)	(0.985)	(0.443)	(0.450)	(0.436)	(0.106)
Female (%)	50.0%				51.0%			
	(0.500)				(0.500)			
Marital Status (%)	66.9%	68.0%	65.7%	1.37	66.2%	67.9%	64.6%	2.00
	(0.471)	(0.466)	(0.475)	(0.170)	(0.473)	(0.467)	(0.478)	(0.046)
Salary (thousands of dollars)	$57.56	$55.35	$59.72	-4.31	$57.15	$54.98	$59.43	-4.56
	(23.298)	(21.553)	(24.702)	(0.000)	(23.078)	(21.143)	(24.747)	(0.000)
Time to Degree (years)	7.9	8.1	7.7	4.78	7.9	8.0	7.7	4.36
	(1.915)	(1.889)	(1.928)	(0.000)	(1.920)	(1.891)	(1.940)	(0.000)

Post Doc (%)	38.7%	37.2%	40.3%	-1.87	39.5%	38.6%	40.4%	-1.07
	(0.487)	(0.483)	(0.491)	(0.062)	(0.489)	(0.487)	(0.491)	(0.285)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school. Those who were born within months four through six, after the cutoff date are included in this table.

d. Quarter 3

	Quarters based on birth place				Quarters based on place of high school graduation			
	Whole Sample	Female	Male	T-statistic	Whole Sample	Female	Male	T-statistic
	(se)	(se)	(se)	(p-value)	(se)	(se)	(se)	(p-value)
Father College (%)	62.9%	61.3%	64.6%	-2.11	62.8%	61.0%	64.7%	-2.52
	(0.483)	(0.487)	(0.478)	(0.035)	(0.483)	(0.488)	(0.478)	(0.012)
Mother College (%)	55.7%	54.8%	56.7%	-1.16	54.8%	54.3%	55.4%	-0.77
	(0.497)	(0.498)	(0.496)	(0.245)	(0.498)	(0.498)	(0.497)	(0.440)
White (%)	87.4%	86.2%	88.7%	-2.45	84.4%	83.1%	85.8%	-2.43
	(0.332)	(0.345)	(0.316)	(0.014)	(0.363)	(0.375)	(0.349)	(0.015)
Age (years)	35.3	35.8	34.7	4.14	35.3	35.8	34.7	4.38
	(8.468)	(8.910)	(7.948)	(0.000)	(8.444)	(8.883)	(7.916)	(0.000)
University w/ Very High Research Activity (%)	73.5%	70.2%	76.9%	-4.84	73.9%	70.5%	77.6%	-5.25
	(0.442)	(0.458)	(0.422)	(0.000)	(0.439)	(0.456)	(0.417)	(0.000)
University with High Research Activity (%)	16.9%	18.7%	15.0%	3.11	16.4%	18.0%	14.8%	2.88
	(0.374)	(0.390)	(0.357)	(0.002)	(0.371)	(0.385)	(0.355)	(0.004)
University with Research Activity (%)	4.9%	6.0%	3.8%	3.19	4.9%	6.0%	3.7%	3.42
	(0.217)	(0.238)	(0.192)	(0.001)	(0.216)	(0.237)	(0.190)	(0.001)
University with Limited Research Activity (%)	4.7%	5.2%	4.3%	1.32	4.7%	5.4%	3.9%	2.34
	(0.212)	(0.221)	(0.202)	(0.186)	(0.212)	(0.227)	(0.194)	(0.019)
Move (%)	27.5%	26.8%	28.1%	-0.92	28.3%	28.4%	28.2%	0.16
	(0.446)	(0.443)	(0.450)	(0.356)	(0.450)	(0.451)	(0.450)	(0.872)
Female (%)	50.9%				51.4%			
	(0.500)				(0.500)			
Marital Status (%)	65.0%	65.9%	64.1%	1.15	64.7%	66.1%	63.3%	1.86
	(0.477)	(0.474)	(0.480)	(0.251)	(0.478)	(0.473)	(0.482)	(0.063)
Salary (thousands of dollars)	$58.02	$54.82	$61.16	-6.87	$58.27	$55.72	$60.81	-5.72
	(23.417)	(21.556)	(24.720)	(0.000)	(23.174)	(21.706)	(24.293)	(0.000)
Time to Degree (years)	7.8	7.9	7.7	3.50	7.8	7.9	7.7	3.71
	(1.909)	(1.899)	(1.913)	(0.000)	(1.912)	(1.909)	(1.910)	(0.000)

Post Doc (%)	37.4%	36.5%	38.3%	-1.16	37.8%	36.3%	39.4%	-2.04
	(0.484)	(0.482)	(0.486)	(0.245)	(0.485)	(0.481)	(0.489)	(0.041)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school. Those who were born within months seven through nine, after the cutoff date, are included in this table.

e. Quarter 4

	Quarters based on birth place				Quarters based on place of high school graduation			
	Whole Sample	Female	Male	T-statistic	Whole Sample	Female	Male	T-statistic
	(se)	(se)	(se)	(p-value)	(se)	(se)	(se)	(p-value)
Father College (%)	62.9%	60.3%	65.7%	-3.30	63.9%	61.7%	66.3%	-2.89
	(0.483)	(0.489)	(0.475)	(0.001)	(0.480)	(0.486)	(0.473)	(0.004)
Mother College (%)	54.3%	52.6%	56.1%	-2.05	54.7%	53.0%	56.5%	-2.17
	(0.498)	(0.499)	(0.496)	(0.040)	(0.498)	(0.499)	(0.496)	(0.030)
White (%)	85.0%	82.4%	87.9%	-4.52	82.8%	80.7%	85.0%	-3.44
	(0.357)	(0.381)	(0.327)	(0.000)	(0.378)	(0.395)	(0.357)	(0.001)
Age (years)	36.2	37.1	35.1	6.78	36.1	36.9	35.1	6.25
	(8.858)	(9.473)	(8.008)	(0.000)	(8.813)	(9.421)	(8.001)	(0.000)
University w/ Very High Research Activity (%)	71.6%	69.5%	74.0%	-2.98	72.2%	70.1%	74.6%	-3.03
	(0.451)	(0.461)	(0.439)	(0.003)	(0.448)	(0.458)	(0.436)	(0.002)
University with High Research Activity (%)	18.0%	18.6%	17.4%	0.88	16.9%	17.4%	16.3%	0.84
	(0.384)	(0.389)	(0.379)	(0.379)	(0.375)	(0.379)	(0.370)	(0.399)
University with Research Activity (%)	5.4%	6.8%	3.8%	3.89	5.6%	7.4%	3.6%	4.97
	(0.225)	(0.251)	(0.192)	(0.000)	(0.229)	(0.261)	(0.187)	(0.000)
University with Limited Research Activity (%)	5.0%	5.2%	4.8%	0.58	5.3%	5.2%	5.5%	-0.43
	(0.218)	(0.222)	(0.213)	(0.560)	(0.224)	(0.221)	(0.228)	(0.669)
Move (%)	28.8%	29.7%	27.8%	1.23	26.2%	26.9%	25.6%	0.87
	(0.453)	(0.457)	(0.448)	(0.218)	(0.440)	(0.443)	(0.436)	(0.382)
Female (%)	52.1%				52.0%			
	(0.500)				(0.500)			
Marital Status (%)	67.3%	69.1%	65.5%	2.20	66.2%	67.2%	65.2%	1.22
	(0.469)	(0.462)	(0.475)	(0.028)	(0.473)	(0.470)	(0.476)	(0.224)
Salary (thousands of dollars)	$58.17	$55.26	$61.19	-6.07	$58.47	$55.59	$61.46	-6.06
	(23.325)	(21.390)	(24.827)	(0.000)	(23.508)	(21.524)	(25.063)	(0.000)

Time to Degree (years)	8.0	8.1	7.8	5.45	8.0	8.1	7.9	4.02
	(1.884)	(1.868)	(1.886)	(0.000)	(1.882)	(1.867)	(1.890)	(0.000)
Post Doc (%)	38.1%	37.3%	39.0%	-1.02	38.3%	36.9%	39.7%	-1.69
	(0.486)	(0.484)	(0.488)	(0.310)	(0.486)	(0.483)	(0.489)	(0.091)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school. Those who were born within months ten through twelve, after the cutoff date, are included in this table.

Table 2: Correlation Coefficients of Variables Used in Analysis

	Father College	Mother College	White	Age	Very High Research University	High Research Univ	Research Univ	Univ	Move	Female	Married	Salary	Time to Degree	Post Doc	Quarter 1	Quarter 2	Quarter 3
Mother College	0.59*																
White	0.18*	0.20*															
Age	-0.19*	-0.20*	0.07*														
University w/ Very High Research Activity	0.11*	0.11*	0.00	-0.22													
University with High Research Activity	-0.07*	-0.07*	0.01	0.13*	-0.74*												
University with Research Activity	-0.08*	-0.07*	0.01	0.19*	-0.37*	-0.10*											
University with Limited Research Activity	-0.04*	-0.04*	-0.02	0.03*	-0.39*	-0.11*	-0.05*										
Move	0.18*	0.08*	0.01	0.04*	0.03*	-0.03*	-0.01	0.00									
Female	-0.01	0.02*	0.04*	0.09*	-0.06*	0.02*	0.05*	0.03*	0.01*								
Married	-0.06	-0.06*	0.07*	0.20*	-0.06*	0.04*	0.05*	0.02*	0.03*	0.02*							
Salary	-0.01	-0.01*	0.02*	0.17*	-0.02*	0.00	0.09*	-0.05*	0.00	-0.10	0.07*						
Time to Degree	-0.11	-0.13*	-0.07	0.58*	-0.12*	0.09*	0.10*	0.00	0.03*	0.06*	0.17*	0.10*					
Post Doc	0.04*	0.03*	-0.10	-0.25	0.09*	-0.07*	-0.09*	0.03*	0.00	-0.05	-0.10*	-0.52*	-0.20*				
Quarter based on state where born																	
Quarter 1	-0.01	-0.01	0.01	0.02	-0.02	0.01	0.01	0.01	0.01	0.01	0.02*	0.00	0.00	-0.01			
Quarter 2	-0.01	0.01	0.01	-0.02*	0.02*	-0.01	-0.02	-0.01	-0.01	-0.01	0.00	-0.01	0.00	0.01	-0.32*		
Quarter 3	0.01	0.01	0.01	-0.03*	0.01	-0.01	0.00	-0.01	-0.01	-0.01	-0.028	0.00	-0.02	0.00	-0.36*	-0.33*	
Quarter 4	0.01	-0.01	-0.03*	0.03*	-0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.02*	0.01	-0.33*	-0.31*	-0.35*
Quarter based on state where graduated high school																	
Quarter 1	-0.01	0.00	0.01	0.01	-0.02*	0.02	0.01	0.01	0.01	0.01	0.01	-0.01	-0.01	-0.01			
Quarter 2	-0.01	0.01	0.00	-0.02*	0.03*	-0.01	-0.02*	-0.02*	-0.01	-0.01	0.00	-0.02	0.00	0.01	-0.32*		
Quarter 3	0.00	0.00	0.01	-0.02*	0.01	0.00	0.00	-0.01	0.01	0.00	-0.02	0.01	-0.02*	-0.01	-0.36*	-0.34*	
Quarter 4	0.01	0.00	-0.02*	0.03*	-0.01	0.00	0.01	0.01	-0.02	0.00	0.00	0.01	0.03*	0.00	-0.33*	-0.30*	-0.35*

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school. Bold values are significant at the 0.05 level.

Table 3: Birth Quarter Has Little Impact on the Age At Which Individuals Obtain A PhD, the Time It Takes Them to Acquire the Degree, and Salary Upon Graduation

	Age at Degree (years)		Time to Degree (years)		Salary (thousands of dollars)	
	OLS	Tobit	OLS	Tobit	OLS	Tobit
Quarter 2	-0.362*	-0.465***	0.054	0.079	-$0.30	-0.421
	(0.182)	(0.189)	(0.041)	(0.063)	(0.628)	(0.704)
Quarter 3	-0.469**	-0.552**	-0.012	-0.018	$0.09	0.117
	(0.173)	(0.180)	(0.039)	(0.060)	(0.588)	(0.670)
Quarter 4	0.194	0.209	0.095*	0.132*	-$0.07	-0.172
	(0.181)	(0.185)	(0.040)	(0.062)	(0.607)	(0.690)
Biological Sciences	-3.090***	-3.243***	-0.828***	-1.125***	-$8.41***	-8.489***
	(0.466)	(0.495)	(0.117)	(0.161)	(1.249)	(1.850)
Health Sciences	4.453***	4.460***	0.601***	1.047***	$13.64***	14.738***
	(0.594)	(0.559)	(0.136)	(0.185)	(1.619)	(2.077)
Engineering	-3.203***	-3.589***	-0.970***	-1.228***	$17.39***	18.222***
	(0.485)	(0.522)	(0.124)	(0.169)	(1.481)	(1.936)
Computer Sciences	-2.608***	-3.008***	-0.842***	-1.092***	$12.84***	13.814***
	(0.521)	(0.559)	(0.134)	(0.181)	(1.631)	(2.062)
Mathematics	-3.927***	-4.369***	-1.082***	-1.401***	$0.64	0.524
	(0.474)	(0.519)	(0.122)	(0.168)	(1.385)	(1.915)
Physical Sciences	-0.267	-0.297	-0.021	-0.033	$1.57	1.081
	(0.477)	(0.494)	(0.119)	(0.161)	(1.291)	(1.839)
Social Sciences	1.904***	1.963***	0.935***	1.423***	-$4.66***	-6.685***
	(0.487)	(0.502)	(0.118)	(0.165)	(1.288)	(1.894)
Humanities	7.121***	7.173***	1.259***	2.357***	$14.14***	14.959***
	(0.506)	(0.504)	(0.118)	(0.168)	(1.336)	(1.872)
Education	4.156***	4.121***	0.520**	0.889***	$41.46***	49.181***
	(0.706)	(0.655)	(0.158)	(0.219)	(1.795)	(2.446)
Business Management	2.418**	2.408**	0.438**	0.671**	$2.96	3.084
	(0.744)	(0.698)	(0.162)	(0.230)	(1.763)	(2.608)
Communication	6.676***	6.746***	1.306***	2.347***	$5.72**	5.444**
	(0.776)	(0.660)	(0.143)	(0.232)	(1.931)	(2.453)
Female	-0.152	-0.211	-0.114***	-0.175***	-$5.27***	-6.220***
	(0.130)	(0.138)	(0.030)	(0.046)	(0.458)	(0.515)
White	0.569**	0.531**	-0.161***	-0.204	-$0.80	-1.054
	(0.189)	(0.197)	(0.042)	(0.067)	(0.690)	(0.774)
Move	0.771***	0.821***	0.119***	0.195***	$0.27	0.375
	(0.141)	(0.146)	(0.032)	(0.049)	(0.484)	(0.547)
University with High	2.213***	2.231***	0.252***	0.450***	$0.84	0.831
Research Activity	(0.202)	(0.179)	(0.041)	(0.061)	(0.591)	(0.677)
University	5.321***	5.359***	0.611***	1.195***	$7.19***	8.066***
Research Activity	(0.394)	(0.307)	(0.064)	(0.113)	(1.081)	(1.116)
University with Limited	1.668***	1.689***	0.090	0.211*	$2.45**	2.812**

Research Activity	(0.309)	(0.309)	(0.065)	(0.103)	(1.060)	(1.185)
Constant	34.100***	34.105***	7.935***	8.385***	$56.04***	56.350***
	(0.510)	(0.524)	(0.123)	(0.172)	(1.443)	(1.974)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school.
*** p<0.10. ** p< 0.05 level. ***p< 0.001 level.**

Table 4: Robustness Check of Table 3 Results with Quarters Based on State at Time of High School Graduation

	Age at Degree (years)		Time to Degree (years)		Salary (thousands of dollars)	
	OLS	Tobit	OLS	Tobit	OLS	Tobit
Quarter 2	-0.317	-0.411**	0.066	0.106	-$0.04	-0.050
	(0.184)	(0.191)	(0.042)	(0.063)	(0.616)	(0.698)
Quarter 3	-0.412**	-0.486**	0.000	0.008	$0.65	0.799
	(0.175)	(0.181)	(0.039)	(0.060)	(0.585)	(0.662)
Quarter 4	0.261	0.274	0.134**	0.193**	$0.59	0.631
	(0.186)	(0.189)	(0.041)	(0.063)	(0.607)	(0.690)
Biological Sciences	-3.165***	-3.321***	-0.831***	-1.137***	-$9.74***	-9.823***
	(0.483)	(0.501)	(0.119)	(0.162)	(1.315)	(1.855)
Health Sciences	4.358***	4.376***	0.641***	1.113	$12.21***	13.245***
	(0.603)	(0.564)	(0.136)	(0.186)	(1.667)	(2.073)
Engineering	-3.127***	-3.513***	-0.929***	-1.183	$16.45***	17.334***
	(0.503)	(0.529)	(0.126)	(0.170)	(1.551)	(1.949)
Computer Sciences	-2.623***	-3.036***	-0.815***	-1.064	$11.53***	12.457***
	(0.541)	(0.565)	(0.135)	(0.182)	(1.680)	(2.064)
Mathematics	-4.050***	-4.538***	-1.105***	-1.439	-$0.25	-0.280
	(0.490)	(0.524)	(0.123)	(0.169)	(1.451)	(1.919)
Physical Sciences	-0.303	-0.337	-0.052	-0.088	-$0.29	-0.899
	(0.494)	(0.500)	(0.120)	(0.162)	(1.354)	(1.845)
Social Sciences	1.913***	1.969***	0.933***	1.415***	-$6.04***	-7.858***
	(0.503)	(0.507)	(0.119)	(0.166)	(1.350)	(1.900)
Humanities	6.916***	6.972***	1.250***	2.338	$12.41***	13.174***
	(0.520)	(0.509)	(0.120)	(0.169)	(1.396)	(1.878)
Education	4.196***	4.183***	0.486**	0.836	$38.34***	45.228***
	(0.714)	(0.655)	(0.158)	(0.217)	(1.878)	(2.417)
Business Management	2.379**	2.365**	0.418*	0.631**	$1.96	2.166
	(0.763)	(0.708)	(0.164)	(0.232)	(1.841)	(2.614)
Communication	6.392***	6.463***	1.264***	2.286***	$3.23	2.847
	(0.775)	(0.662)	(0.145)	(0.231)	(1.958)	(2.435)
Female	-0.253	-0.320**	-0.124***	-0.195	-$4.70***	-5.528***
	(0.132)	(0.140)	(0.030)	(0.046)	(0.455)	(0.512)
White	0.572**	0.546**	-0.123**	-0.155*	-$0.71	-0.875
	(0.190)	(0.199)	(0.042)	(0.067)	(0.684)	(0.764)
Move	0.997***	1.043***	0.150***	0.249***	$0.36	0.454
	(0.146)	(0.148)	(0.032)	(0.049)	(0.483)	(0.546)
University with High	2.331***	2.354***	0.275***	0.502***	$1.16	1.263
Research Activity	(0.202)	(0.181)	(0.041)	(0.061)	(0.595)	(0.675)
University	5.732***	5.760***	0.643***	1.272***	$6.78***	7.578***
Research Activity	(0.402)	(0.311)	(0.064)	(0.114)	(1.078)	(1.104)
University with Limited	2.062***	2.080***	0.127	0.291**	$2.60*	2.989*

Research Activity	(0.328)	(0.316)	(0.067)	(0.104)	(1.059)	(1.181)
Constant	34.110***	34.108***	7.889***	8.325***	$56.72***	56.797***
	(0.528)	(0.531)	(0.124)	(0.173)	(1.488)	(1.974)

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school.
*** p<0.10. ** p< 0.05 level. ***p< 0.001 level.**

Table 5: Estimates Indicate that Holding an Individual Back for One Year Results in a Significant Difference in the Future Value of Lifetime Earnings

Future Value of Accumulated Annual Salary Differences				
	OLS		Tobit	
	Coefficient	Std Err.	Coefficient	Std Err.
Biological Sciences	-$11.62	6.830	-10.836	7.961
Health Sciences	$9.56	8.466	10.178	9.124
Engineering	$58.07***	8.238	58.812***	8.418
Computer Sciences	$46.99***	8.791	47.721***	8.953
Mathematics	$23.75**	7.832	24.388	8.298
Physical Sciences	$9.73	7.118	10.371	7.914
Social Sciences	-$15.55*	7.059	-15.802	8.140
Humanities	$8.34	7.146	8.866	8.067
Education	$80.16***	11.695	80.934***	10.480
Business Management	$3.82	10.171	3.582	12.013
Communication	$0.59	10.269	1.382	10.939
Female	-$13.73***	2.241	-13.847***	2.279
White	-$2.89	3.545	-2.995	3.589
Move	-$2.30	2.444	-2.386	2.449
University with High Research Activity	-$4.44	2.991	-4.461	3.026
University with Moderate Research Activity	-$0.12	4.498	-0.152	4.663
University with Limited Research Activity	-$2.31	4.129	-2.508	4.914
Constant	$138.48***	7.767	137.895***	8.471

Data are from the NSF Survey of Earned Doctorates. The sample includes US born individuals who were born in states where data were available for cut-off dates for enrollment into elementary school.
*** p<0.10. ** p< 0.05 level. ***p< 0.001 level.**