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Born under a lucky star: Financial aid, college completion, labor supply, and credit constraints

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February 15, 2017

ABSTRACT

Higher education has experienced many changes since the 1970s, including an increase in the price of college, an increase in student employment during college, a decrease in college completion rates, and an increase in time to degree. This paper ties these trends together by causally linking changes in financial aid with time to degree and student employment during college. I find that additional financial aid accelerates graduation for university seniors because they increase credits attempted and reduce earnings while in college. In reaching this finding, I use administrative education and earnings data to examine a discrete change in the amount of federal financial aid available to financially independent students. The estimates in this paper imply that roughly 50 percent of the observed increase in time to degree can be explained by changes in tuition.

JEL Classification Codes: I22, D14, H52

Key Words: financial aid, labor supply, college completion

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Brigham Young University

February 15, 2017

Abstract

Higher education has experienced many changes since the 1970s, including an increase in the price of college, an increase in student employment during college, a decrease in college completion rates, and an increase in time to degree. This paper ties these trends together by causally linking changes in financial aid with time to degree and student employment during college. I find that additional financial aid accelerates graduation for university seniors because they increase credits attempted and reduce earnings while in college. In reaching this finding, I use administrative education and earnings data to examine a discrete change in the amount of federal financial aid available to financially independent students. The estimates in this paper imply that roughly 50 percent of the observed increase in time to degree can be explained by changes in tuition.

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1 Introduction

Attending college can have large impacts on students' earnings as well as many other dimensions of students' lives.¹ Moreover, students who *complete* college have substantially higher wages than those who do not ([Oreopoulos and Petronijevic, 2013](#); [Ost et al., 2016](#)). The price of college may play a key role in determining college completion due to credit constraints and time costs of employment during college. I show that college graduation is sensitive to the amount of financial aid students receive. I also quantify the effect of the financial aid on earnings while in college.

This study makes two main contributions. First, it examines the effect of additional financial aid on graduation for inframarginal students whose enrollment was not affected by financial aid. Most existing estimates of the effect of financial aid on college completion are a combination of the effects for marginal students who were induced to enroll by financial aid as well as for inframarginal students who received more aid but who would have enrolled anyway. Several studies find increases in graduation associated with additional financial aid. In the extreme, the observed increases in graduation could come entirely from inframarginal students who did not change their initial enrollment while all students who were induced to enroll failed to graduate. Most existing estimates cannot rule out this extreme situation. I am able to separately identify the effect of financial aid on inframarginal students, and I find that financial aid has a modest effect on time to degree overall but a larger effect for lower-income students. Because most students do not change their enrollment as a result of financial aid, the effects of financial aid on inframarginal students are the effects of financial aid experienced by most students and have heretofore been largely unmeasured.

Second, this study establishes that additional financial aid results in reduced earnings while in college and increased course taking. This result is a likely mechanism for existing

¹See [Hoekstra \(2009\)](#); [Oreopoulos and Salvanes \(2011\)](#); [Zimmerman \(2014\)](#) for evidence on the effects of college on earnings and other outcomes.

estimates that find that college price affects graduation.

This paper lies at the intersection of three trends in higher education in the United States. The first is a substantial increase in the price students pay for college. Since 1982, the average amount for total tuition, fees, and room and board has increased by over 350 percent after adjusting for inflation ([National Center for Education Statistics, 2013](#)). Second, while college enrollment rates have grown since 1970, college completion rates have declined and time to degree has increased ([Bound et al., 2010, 2012](#)). In fact, less than 60 percent of students who begin a bachelor's degree will finish in six years, and approximately 20 percent of students who begin a two-year program will finish in three years ([National Center for Education Statistics, 2013](#)). Last, student employment has increased over this same time frame.² While these trends would appear to be related, there is a paucity of evidence that causally ties them together. I find that the price of college enrollment causally affects time to degree and student labor supply, which suggests that some of the growth in time to degree and student labor supply is likely a result of increases in the price of college. In fact, in a back-of-the-envelope calculation, the estimates in this paper imply that roughly 26-50 percent of the change in time to degree estimated by [Bound et al. \(2012\)](#) can be explained by changes in net tuition.

This paper first considers the effect of additional financial aid for enrolled students on educational outcomes including graduation, credits attempted, and grade point average (GPA). In order to examine already enrolled students, I study an increase in financial aid that did not change student enrollment decisions.³ The key finding is that financial aid reduces time to graduation by increasing credits attempted.

The next section of the paper examines potential mechanisms for these results including student labor supply and binding credit constraints. Financial aid is likely to reduce student labor supply, and this paper estimates the effect of financial aid on student earn-

²The rise in student work has been examined in [Scott-Clayton \(2012\)](#), and the author concludes that different factors have driven the growth at different times.

³The reasons for the null result of financial aid on enrollment will be discussed in Section 5.

ings. Most undergraduates are employed while in college—from 1989 to 2008, nearly 80 percent of undergraduates were employed.⁴ In fact, roughly 14 million people, or 8 percent of the United States’ total labor force, are both enrolled in formal postsecondary training and active in the labor market (Carnevale et al., 2015). I find that financial aid decreases earnings during college. The reduction in earnings as a result of increased financial aid provides a likely mechanism for the improvement in student outcomes. I also demonstrate that some students face binding credit constraint by using differences in yearly loan maximums for dependent and independent students, another mechanism that affects student outcomes.

To answer questions about the effect of financial aid on enrolled students’ academic performance and labor supply, I use detailed administrative data from all public institutions of higher education in Texas from academic years 2003–2004 to 2013–2014 linked to earnings records from Texas’s Unemployment Insurance (UI) system. Students who are 24 before January 1 are financially independent for the entire school year, whereas students who turn 24 on January 1 or later are financially dependent. Financial independence can induce large increases in federal financial aid such as Pell Grants as well as federal loans. I leverage this discontinuity in the availability of financial aid in a regression discontinuity framework to isolate the effect of financial aid on student outcomes. I show that financial independence has heterogeneous impacts on student financial aid packages and educational outcomes depending on family income.

The change in financial aid studied in this paper occurs for older students, who are sometimes called “nontraditional” students. However, this label may be misleading, as over 60 percent of bachelor’s degrees granted in Texas from 2002 to 2014 were to students who were 24 or older at the time of graduation. Older students constitute a large fraction of the college-going population, as evidenced by the nationally representative 2012 National Postsecondary Aid Survey, in which 51.3 percent of all undergraduate students

⁴In the estimating sample of this paper, 78 percent of students are employed in the year they are enrolled in college.

were classified as financially independent and 43.8 percent were 24 years or older ([U.S. Department of Education, 2013a](#)). Not only are older students a large part of the college-going population, they are an increasing share. In 1970, students 25 and older constituted 27.7 percent of all undergraduate enrollment, and by 2010 they accounted for 42.6 percent ([National Center for Education Statistics, 2013](#)). Despite their growing prominence, the response of older students to financial aid has rarely been studied.⁵ Financially independent students feature prominently among federal aid recipients and made up nearly 60 percent of Pell Grant recipients in 2010–11. ([U.S. Department of Education, 2013b](#)). This paper examines what has increasingly become the “typical” college student by focusing on older students.

Older students are particularly relevant when considering college graduation and labor supply. This study will consider university seniors who turn 24 during the school year. These students have accumulated substantial college credit, but many do not graduate in a timely manner. In fact, only 44 percent graduate in the year they turn 24. Some never graduate, and 17.3 percent have not received a bachelor’s degree after 4 years. These students are at the margin of graduation, and additional financial aid may enable them to accelerate their progress toward a degree or help them complete a degree when they otherwise would not.

The rest of the paper will proceed as follows. [Section 2](#) will discuss the conceptual framework and related literature. [Section 3](#) will discuss the institutional details of financial independence. [Section 4](#) will introduce the data used, and [Section 5](#) will discuss how the effect of financial aid on already-enrolled students is identified. [Section 6](#) will present the results of estimation and [Section 7](#) will conclude.

⁵[Seftor and Turner \(2002\)](#) is a notable exception that will be discussed in [Section 2](#).

2 Conceptual Framework

2.1 Educational Outcomes

Financial aid can affect a host of education outcomes. Perhaps the most obvious is that financial aid can affect a student's decision to enroll in college. The general finding is that a \$1,000 reduction in the price of college increases enrollment by 2–4 percentage points.⁶ Beyond enrollment, financial aid may affect persistence, graduation ([Castleman and Long, 2016](#)), and even later outcomes like earnings ([Bettinger et al., 2016](#)) and home ownership ([Scott-Clayton and Zafar, 2016](#)). Disentangling the effect of financial aid on enrollment from its effects on subsequent outcomes is difficult because financial aid changes the composition of who goes to college. Finding a change in financial aid that has not affected enrollment is necessary in order to uncover the effect of financial aid on longer-term outcomes apart from changes in enrollment. In fact, most students do not change their enrollment decision as a result of financial aid, and so focusing on the effect of financial aid for these students reveals the effect of financial aid for the majority of financial aid recipients.

This study examines an increase in financial aid did not affect the decision to enroll in college in the year of financial aid receipt, which allows an examination of the effect of financial aid for already-enrolled students. Most work on the effect of financial aid on graduation estimates an effect that combines an increase in enrollment and a potential increase in persistence.⁷

Far fewer papers have examined the effect of financial aid on enrolled students. [Goldrick-Rab et al. \(2016\)](#) use a randomized controlled trial to examine the effect of privately financed, need-based aid for freshman in Wisconsin and find that increased need-based fi-

⁶See [Deming and Dynarski \(2009\)](#) for a discussion of this literature.

⁷For examples of papers that estimated the combined effect of financial aid on enrollment and subsequent outcomes see [Angrist et al. \(2014\)](#); [Bettinger et al. \(2016\)](#); [Castleman and Long \(2016\)](#); [Cohodes and Goodman \(2014\)](#); [Dynarski \(2008\)](#); [Scott-Clayton \(2011\)](#); [Scott-Clayton and Zafar \(2016\)](#); [Sjoquist and Winters \(2012\)](#).

financial aid increased persistence and graduation within four years. [Murphy and Wyness \(2016\)](#) examine financial aid in the United Kingdom that did not affect enrollment and find that additional financial aid increases the chances of earning a “good” degree. Relative to these studies, the current paper has the advantage of examining the U.S. federal financial aid system. Other papers discuss the effect of financial aid on enrolled students by making assumptions about the behavior of marginal versus inframarginal students ([Barr, 2016](#); [Bettinger, 2015](#))⁸

Additional financial aid may affect student outcomes such as course taking or degree completion. Financial aid could act as a substitute for working during college, and, as such, students might devote more time to their studies, potentially increasing credits attempted, GPA, or even timely graduation. Financial aid may also decrease credit hours taken in a semester or increase time spent in college if a student values the time spent in college ([Jacob et al., 2013](#)). There is some evidence that higher expected prices of an additional year of college can decrease time to graduation, which suggests that students may value additional years in college ([Garibaldi et al., 2012](#)).⁹

One contribution of this study is to focus on older students. It builds off of the work in [Seftor and Turner \(2002\)](#), who examine the effect of financial independence on student enrollment and find that financial independence increases student enrollment. The current paper also examines federal financial independence but uses a different source of variation and detailed administrative data to consider longer-term outcomes.¹⁰

⁸[Barr \(2016\)](#) examines the effect of increased generosity for military veterans and finds that additional aid increases graduation. The estimates in [Barr \(2016\)](#) represent a combination of the effect on new entrants to college and the effect on students who would have enrolled without the increased financial aid. These estimates, combined with an assumption about the graduation probabilities of marginal students, suggest that some of the increase in graduation the author observes is due to increased persistence for inframarginal students. [Bettinger \(2015\)](#) examines a need-based grant in Ohio and makes similar assumptions.

⁹[Garibaldi et al. \(2012\)](#) examine Bocconi University in Italy, which is notably a different setting from public universities in the United States or, specifically, Texas. Moreover, the policies are different, as [Garibaldi et al. \(2012\)](#) examine anticipated discontinuities in tuition and the present study examines changes in financial aid that are likely to be unanticipated. The differences in these settings may lead to different graduation responses to college price.

¹⁰[Seftor and Turner \(2002\)](#) use a differences-in-differences framework to examine the impact of the change the age at which students were classified as independent. They find that decreased access to federal financial aid significantly decreased college enrollment of older students using CPS data. Their findings suggest

2.2 Mechanisms

There are at least two interrelated mechanisms by which financial aid may change student outcomes: 1) student labor supply and 2) credit constraints.

Labor Supply

This study quantifies how much students adjust their labor supply when the price of college decreases using administrative Unemployment Insurance earnings data linked to higher-education administrative records. Despite the large number of students in the labor force and the large amount of federal financial aid available, very few studies have attempted to identify the effects of financial aid on student earnings. [Broton et al. \(2016\)](#) use random assignment of a state need-based grant to examine student responses to survey questions about work. They find that students receiving financial aid reduced hours worked by about 14 percent. [Scott-Clayton \(2011\)](#) examines the effect of a merit scholarship in West Virginia that affected enrollment and finds that scholarships reduce earnings in some specifications but not in others.¹¹

In related work, many studies have tried to quantify the effect of working on educational outcomes. The general finding has been that working in college decreases GPA ([Kalenkoski and Pabilonia, 2010](#); [Stinebrickner and Stinebrickner, 2003](#)) and credits accumulated ([Darolia, 2014](#); [Triventi, 2014](#)). These studies motivate studying the effect of financial aid on labor supply. I find that students respond to financial aid by speeding up graduation, increasing credits attempted, and reducing earnings while in school. The re-

that federal financial aid policy determining independence can have large effects. One potential shortcoming of their paper is that the result may be driven by different trends in enrollment for the groups they expect to be affected. Additionally, they use one change in policy that may lead to a biased estimate, particularly if other changes occur contemporaneously. [Seftor and Turner \(2002\)](#) also examine the effect on students aged 21 to 23, where the present study focuses on students aged 23 and 24.

¹¹This may be because the identification strategies measure different local average treatment effects or because there is a bias in one or both of the estimates arising from those strategies. Also, [Scott-Clayton and Park \(2015\)](#) use a regression discontinuity to examine the effect of replacing federal loans with the Pell grants for community college students and find that grants reduce earnings and increase full-time enrollment. However, there is a discontinuity in the density of the running variable, which suggests the results may be biased.

ductions in earnings and accelerated graduation are consistent with the aforementioned prior studies on the effects of employment on student outcomes.

Credit Constraints

Financial aid may reduce time to degree because it eases binding credit constraints. This paper estimates to what degree increased financial aid eases these constraints. Many studies have attempted to identify whether binding credit constraints affect college enrollment and graduation. Early studies tended to find that credit constraints were not prevalent ([Cameron and Heckman, 1998](#); [Cameron and Taber, 2004](#); [Carneiro and Heckman, 2002](#); [Keane and Wolpin, 2001](#)). However, recent studies have shown borrowing constraints matter for educational investment ([Belley and Lochner, 2007](#); [Brown et al., 2012](#); [Cowan, 2016](#); [Lovenheim, 2011](#); [Stinebrickner and Stinebrickner, 2008](#)) .

3 Background

The U.S. federal government has several financial programs that are designed to help students pay for college. A host of factors determine students' eligibility for these programs, including income, assets, and family structure. A primary consideration is whether students' income and assets are considered separately from their parents—that is, whether they are financially independent. This distinction between dependent and independent students does not need to reflect actual financial dependence but rather deals with statutes governing the amount of financial aid disbursed. This section will discuss two programs where financial independence changes the amount of aid disbursed. The first set of programs is administered by the U.S. Department of Education, and I will refer to that set as “federal financial aid.” The second set of programs is a part of the U.S. tax code, and I will refer to that as “tax aid.”

3.1 Federal Financial Aid

Federal financial aid consists of federal grants, student loans, and work study. The largest federal grant program is the Pell Grant, which is targeted toward low-income students. In Fiscal Year 2013 the Pell Grant cost over \$33 billion and provided aid to more than nine million students. Various federal student loans are also available to students, and low-income students may take out loans at subsidized interest rates. In order to be eligible for need-based financial aid, students must file a Free Application for Federal Student Aid (FAFSA). The FAFSA requires information about student income and assets as well as family income and assets and demographic information (such as the number of siblings in college). This information is then fed into a complex formula to compute eligibility for need-based federal programs. In general, the federal financial aid awards are calculated yearly and use information for the prior year.¹²

Students must include parental information on their FAFSA if they are considered financially dependent. Undergraduate students may be classified as financially independent for several reasons, including being over 24 years old as of January 1 of the school year, being married, having dependent children, or a few other reasons.¹³ When students are independent, parental financial information is not considered, and student aid eligibility increases as a result. All else being equal, independent students qualify for larger amounts of need-based financial aid (both grants and subsidized loans) than dependent students.

The two most prominent federal student loans available to undergraduates are subsidized and unsubsidized loans. Subsidized loans have weakly better interest rates over the time period studied than unsubsidized loans. Subsidized loans do not start accruing interest until six months after a student leaves school. Unsubsidized loans start accru-

¹²This will change in the 2016–2017 school year, when students can use income data for the “prior-prior-year.” If a life event occurs that would change a student’s Expected Family Contribution (EFC), students can amend their FAFSA to reflect the new information and possibly change their eligibility for Pell Grants.

¹³See <http://studentaid.ed.gov/fafsa/filling-out/dependency> for all conditions that determine independent status.

ing interest as soon as they are disbursed. Any student can borrow unsubsidized loans regardless of financial need. Independent students are eligible for higher annual (and aggregate) federal loan limits.

Independent status based on age is determined once a year. Students who are 24 or older as of January 1 will be independent for the entire school year. Students who are 23 years old on January 1 and who meet the other conditions for dependent status will be declared dependent for the entire year. This discontinuity creates a situation in which students are very similar in age (and other characteristics) but are different in their eligibility for federal financial aid. This is the institutional oddity that will be leveraged to examine the effect of additional financial aid arising from financial independence.

3.2 Tax Aid

The United States tax code gives special treatment to dependent children. Children can be claimed as dependents as long as they are younger than 19 at the end of the year. If a child is a full-time student, that child may be claimed as a dependent if she is younger than 24 at the end of the year and meets certain conditions. Those conditions are that the child must be a full-time student for at least five months in a year, must live with her parents for at least six months of the year, and must receive more than half of her financial support from her parents. If these conditions are met, parents may claim their student children as dependents and receive exemptions and tax credits that reduce taxable income. Additionally, dependent students may qualify the taxpayer for tax credits like the American Opportunity Credit, the Lifetime Learning Credit, and the Earned Income Tax Credit. During the time period studied in this paper, the Hope Tax Credit and Tuition Deduction could also be used.¹⁴

Changes in tax aid occur at the same January 1 threshold for some students. Ultimately this paper will be able to identify the reduced-form effect of changes in tax aid and

¹⁴See [Dynarski and Scott-Clayton \(2015\)](#) for a discussion on tax benefits for college.

financial aid resulting from financial independence. However, I argue that the changes in federal financial aid are likely to dominate changes in tax aid for several reasons. The first is that tax aid is disbursed for the prior financial tax year no earlier than February. This date falls after students have made extensive and intensive margin enrollment decisions for both semesters, which likely limits the extent to which tax aid can influence student outcomes. Also, both [Bulman and Hoxby \(2015\)](#) and [Hoxby and Bulman \(2015\)](#) use administrative tax data to convincingly show that tax aid does not change whether students enroll or what types of institutions they enroll in, which suggests that the effect of tax aid on other student outcomes may also be small. Furthermore, a student's tax liability is likely to decrease as a result of the change, whereas family tax liability is likely to decrease making the effect on student finances ambiguous. Moreover, the change in financial independence for tax purposes is likely to affect a minority of students, as discussed in Appendix [A.1](#). Last, federal tax aid more than doubled in 2009. As a robustness check, I show that the results are not substantively different in the years before or after this increase in tax aid in Table [A1](#). For these reasons, the results of this study will largely be interpreted as the effects of financial aid rather than of tax aid. A more complete discussion of tax aid can be found in Appendix [A.1](#).

4 Data

The primary data for this project come from the Texas Higher Education Coordinating Board and contain the universe of students who were enrolled in public universities in the state of Texas from 2003–2004 to 2013–2014. The data contain demographic information about the students including race, gender, and birth date. They also contain records on student enrollment and credits attempted. Importantly, all financial aid disbursed by the university is also contained in the data. Many of the fields from the FAFSA are available, including including dependency status and Expected Family Contribution (EFC).

I adjust all financial aid and earnings data to be in constant 2013 dollars for comparability. Data from the Texas Workforce Commission's (TWC) Unemployment Insurance system are linked to individual student records and contain quarterly earning records.¹⁵ Importantly for this study, students employed by their college or university are not included in reporting for the Unemployment Insurance system. However, the financial aid data include total Federal Work-Study compensation, which is added to the UI earnings data. Furthermore, I winsorize the wages at the ninety-ninth percentile to avoid issues with outliers. I will discuss the implications of the unavailability of non-work-study earnings at colleges in Section 6.

The sample consists of seniors who were enrolled at a public university in Texas in the year they turned 24. However, students may respond to additional financial aid in the year they turn 24 by changing enrollment. This is checked in Section 5 and found not be a concern. The sample is restricted to seniors because graduation within a given time frame is a key outcome considered, and students with different classifications would have different relevant time frames for graduation. However, this restriction keeps the majority of university students turning 24 during the school year, as 71.5 percent are classified as seniors.¹⁶

Table 1 contains summary statistics for university seniors. University seniors receive a substantial amount of financial aid, receiving \$1,800 in grant money and taking out over \$3,900 in loans. Graduation is relatively common for these students, as 44 percent of seniors who turn 24 graduate in that year and 70 percent graduate by the end of the following year. Also, 30 percent of students received a Pell Grant in the previous year,

¹⁵The unemployment insurance records only include employers who pay at least \$1,500 in gross wages to employees in a quarter. Alternatively employers are included if the employer has at least one employee during 20 different weeks in a calendar year, regardless of the wages.

¹⁶The restriction to seniors is akin to the standard practice of examining rising freshman. It ensures that the outcomes considered have a similar meaning. For example graduation within one year is a relevant outcome for seniors but is not for freshman. Moreover, since over 70 percent of students are seniors it is the most natural group of students to examine. However, examining all students yields very similar results. The effects on graduation are attenuated but still are marginally statistically significant. These results can be obtained from the author upon request.

and students attempted an average of 22 credits hours within the current year.

I focus on university students in this paper because they see much larger changes in financial aid resulting from financial independence than do community college students. This is likely because community college students file the FAFSA at lower rates than university students. Results for community college students find no effect on persistence, graduation, GPA, or earnings in college. These results are not presented but are available upon request.

5 Identification

As previously discussed, students who are 23 years old on January 1 are counted as dependent for the entire school year if they meet other conditions. However, students who are 24 on January 1 are independent for the school year. I leverage the discrete nature of the change in classification to examine the effect of additional financial aid arising from being declared independent on student outcomes using a regression discontinuity framework. The outcomes considered include reenrollment, graduation within a certain number of years, credits attempted, financial aid, any employment, and earnings.

The estimating equation is:

$$Y_i = f(\widetilde{age}_i) + \theta \cdot 1(Ind > 0) + X_i + \mu_t + \epsilon_{it}, \text{ for } |\widetilde{age}_i| < j, \quad (1)$$

where i indexes students and t indexes school year. Y_i is a student outcome, $f(\widetilde{age}_i)$ is a flexible function of a student's recentered age as of January 1 that will be estimated using a local linear approximation, $1(Ind > 0)$ is an indicator for being 24 as of January 1, and θ is the parameter of interest and is the effect of the additional financial aid arising from students being declared financially independent because of their age.¹⁷ X_{it} contains control variables like race and gender and μ_t represents year fixed effects. Finally, ϵ_{it} is

¹⁷Some students who are less than 24 will be independent for other reasons, as previously discussed.

an idiosyncratic error term. Standard errors are clustered on \widetilde{age} to account for correlation within date of birth. (Lee and Card, 2008). This equation is estimated on a subset of the data to compare students who are similar ages, and j is chosen using the procedure outlined in Imbens and Kalyanaraman (2012) for local linear regression discontinuity frameworks though results are robust to the choice of bandwidth. Tests for sensitivity to bandwidth will be presented in Section 6. I also examine heterogeneity by other student characteristics including prior year Pell receipt and students who previously had a zero EFC as a proxy for income.

Assumptions for Identification

There are two assumptions that must be made for the estimates of Equation 1 to yield unbiased estimates of the effect of age-based financial independence. First, because the sample is conditioned on students being 24 years old, students must not respond to additional financial aid in the year they turn 24 by changing their decision to enroll in the year they turn 24. Second, birth date cannot be manipulated to gain access to treatment. If either birth date manipulation or differential enrollment occurs, this would appear as additional students who are 24 years or older as of January 1.

If students anticipate the additional financial aid available to independent students, they may change their enrollment or reenrollment in response to additional financial aid. If this occurs and enrollment is affected, then conditioning the sample on students who turn 24 will yield biased estimates that conflate the effect of additional financial aid on enrolled students and the change in sample composition arising from additional financial aid.

Students do not appear to alter their enrollment decisions in the year they turn 24 based on financial independence. To check for this, in Figure 2 and Table 2 I examine the re-enrollment probabilities of 23-year-old students. Because I focus on seniors, re-enrollment is how enrollment-induced changes in financial aid would manifest them-

selves. If financial independence altered enrollment decisions, it would appear as a discrete change in the re-enrollment probabilities of 23-year-old students. The estimated change in re-enrollment probability for students who will receive additional financial is 0.0025 with a standard error of 0.006. The lack of an enrollment effect is seen in Figure 2. This can also be seen in Figure 1, Panel B, in which there is no discontinuity in the density of students enrolling in the year they turn 24.

The lack of a response may be because the age rule governing independent status and the consequence of financial independence are not widely known. It may also be that older students who have typically accumulated substantial credits do not change their reenrollment based on financial aid. Given that there is no measured effect on reenrollment, I continue to condition the sample on enrollment in the year a student turns 24. This lack of an (re)enrollment effect allows an examination of the effect of financial aid on student outcomes apart from enrollment effects.

A second assumption for identification is that birth date is not manipulated to gain access to the financial independence. Obviously, a student's true birth date is not manipulable by the student. Students do have incentives to misreport their birth date to gain additional dollars, but the reported birth date is verified by comparison with Social Security Administration records. Students cannot manipulate their birth date, but parents may manipulate their child's birth date. There is evidence that birth dates are manipulated around January 1 by parents in response to tax incentives (LaLumia et al., 2015; Schulkind and Shapiro, 2014). This issue is discussed in Appendix Section A.2 and found to likely affect only a very small number of students born within a few days of January 1.

To avoid any issues associated with potential retiming of births, the preferred specification will be a regression discontinuity "donut" estimator (Almond and Doyle, 2011), in which the three days on either side of January 1 are omitted. The results are quantitatively and qualitatively very similar if those three days are included; these results are presented in Appendix Table A2.

Additionally Section [A.3](#) and Table [A3](#) confirm that student characteristics do not change discontinuously at the threshold.

Because of three qualifying conditions—1) there is no change in reenrollment probabilities for 23-year-olds, 2) students are unable to manipulate their date of birth, and 3) observed covariates do not vary discretely by eligibility status—the testable assumptions of the regression discontinuity estimator are met and the results can be interpreted as the causal impact of age-based financial independence on student outcomes.

6 Results

Educational Outcomes

University students see substantial changes in financial aid arising from financial independence. This is documented in Figure [3](#) and Table [3](#). Students who are financially independent appear on the right of the figures and receive an additional \$930 in grant dollars, the bulk of which comes in the form of increased Pell Grants (\$807). They also take out an additional \$865 in federal loans. Between grants and loans, this represents a significant change to student finances totaling over \$1,795. One important caveat is that the data do not contain private loans. Federal loans typically offer better interest rates than private loans and offer access to a variety of repayment plans generally unavailable in the private market, including income-based repayment, income-contingent repayment, graduated repayment, or extended repayment. As a result, some of the increase in the amount of federal loans could be students switching from private loans to federal loans. Federal loans are by far the most common type of loans, and private student loans make up about 10 percent of student debt issued since 2009 ([College Board](#) , 2015). If financial independence induced switching from private loans to federal loans, the estimated increase in loan aid would overstate the degree to which students borrowed additional money.

This large change in financial aid allows an examination of whether student outcomes are affected by financial aid. The effect on student outcomes are presented in Figure 4 and Table 3. Financial independence increases student credit hours attempted by 0.39. In attempting more credits, students could see their GPA decrease if they do not change the time devoted to studying. However, in spite of this larger class load, the student GPAs are unaffected, with an estimated discontinuity of 0.001 and a 95 percent confidence interval of -0.024 to 0.026 . The additional financial aid increased student credits attempted but did not reduce performance in those credits.

Because seniors are attempting more credits and GPA is unaffected, graduation has the potential to be affected. This is seen in Figure 4 and in Table 3. Students are 1.8 percentage points more likely to graduate in the year they turn 24 (in the tables this is designated “Grad in 0y”) as a result of additional financial aid. This discontinuity is clearly visible in the figure and is statistically different from zero at the 1 percent level. There is an accompanying dip in the probability of enrolling in the next year, which provides evidence that financial aid causes some students to graduate and not enroll in the next year.

Students are more likely to graduate in the year they turn 24. This could either be a result of retiming graduation by encouraging students to graduate earlier than they otherwise would have, or it could arise from students graduating who otherwise would not. To investigate this graduation in either the year students turn 24 or the year afterward is considered. The estimated coefficient (“Grad 4yr in 1y” in the table) is 0.002, which suggests that additional financial aid retimed graduations rather than induced graduation among students who not otherwise have graduated.

While there is a positive effect on graduation in the year the money is received, it is relatively small. The 1.8 percentage point increase represents a 4 percent increase in the graduation rate. The increase comes at a cost of \$930 in grants. Assuming that all of the graduation effects are driven by grants, it costs \$53,125 in grants for one student to graduate one year earlier. The cost would be even higher after accounting for additional

subsidies received for loans. College enrollees in the sample earn \$12,219, and students who graduate in the year they turn 24 earn \$26,923 in the year they turn 25. This means that graduating a year earlier corresponds to roughly a \$14,704 difference in earnings. However, for the sample taken as a whole the benefits of an additional year in the labor market do not exceed the costs associated with one student graduating a year earlier. I will explore whether additional financial aid is cost effective by exploring students with different levels of income in [Section 6](#).

Mechanisms

Labor Supply during College

I now investigate mechanisms for the increased credits attempted and reduced time to degree, including reduced time spent working during college and binding credit constraints.

Additional financial aid may allow students to reduce time spent working. Using Unemployment Insurance earnings data, in [Figure 5](#) I explore whether students who are declared financially independent based on age change their earnings in response to the additional grants and loans they receive. Financially independent university students do not adjust the probability of positive earnings. The coefficient on whether students have positive earnings is -0.5 percentage points with a standard error of 0.5 percentage points. This rules out reasonably small reductions in the probability of earnings up to -1.5 percentage points. Despite no change in the probability of working, there is significant change in earnings during college seen in [Figure 5](#), Panel B. Students who are financially independent by age see their earnings decrease by \$529. Focusing only on students who have positive earnings yields a similar estimate of \$576. This represents about 30 percent of the increase in grants and loans, or 55 percent of the increase in grants. Financial aid crowds out earning by reducing labor supply on the intensive margin but does not seem

to affect extensive margin labor supply.

Interpreting the estimates of the effect of additional financial aid on earnings requires caution, because earnings for students employed by the university they attend are not included in UI earnings records unless the student is employed as part of the federal work-study program. There is further discussion of on-campus employment in Appendix Section [A.4](#), but if anything, the lack of on-campus, non-work-study earnings likely results in an underestimate of the effect of financial aid on earnings.

Unfortunately, in this setting, it is impossible to completely disentangle the effect of additional eligibility for student loans from the effect of additional grant money on earnings. In the section on heterogeneous effects by family income, I will examine groups of students who saw small (or no) increases in grants and larger increases in loans to see if there are differences by the type of aid received. Overall, the evidence suggests that students reduce earnings when receiving additional financial aid. Given the earlier results on completion, the findings on earnings support the idea that working during college slows down time to degree.

Binding Credit Constraints

Easing binding credit constraints may be one mechanism that induced earlier graduation. Independent students have access to higher yearly and aggregate federal student loan limits than do dependent students. This provides an opportunity to test for credit constraints among enrolled college students. Specifically, how does financial independence affect the number of students borrowing above the amount that would be allowed had they been born a few days earlier? Two potential estimates exist. First, how many students were borrowing exactly the maximum amount, and how did this change with access to higher loan amounts? Second, how many independent students are borrowing above the maximum for dependent students? Both of these estimates should capture the

number of students who are credit constrained.¹⁸

Figure 3 and Table 3 investigate this question. Panel C of Figure 3 shows that independence causes a 5 percent reduction in the number of students borrowing exactly at the dependent maximum. However, there is an accompanying increase of 15 percent of students who borrow more than the dependent maximum. Combining this result with the number of students borrowing exactly the maximum suggests that access to higher loan maximums induces 10 percent of students who would not borrow *at* the lower maximum to borrow *above* the lower maximum when given the chance. This result represents somewhat of a puzzle.

Colleges have latitude in the way they package federal loans in financial aid packages. Universities often package the maximum amount of loans that a student qualifies for. The observed increase is consistent with students being offered higher amounts of loans and accepting that offer (Marx and Turner, 2016). Unfortunately it is impossible to know exactly what caused this odd result, but behavioral explanations seem likely. However, both estimates suggest that easing binding credit constraints is a likely mechanism for increased hours attempted and decreased time to degree.

There are two important caveats for the estimation of the number of students who are credit constrained, private loans and changes in grant aid. As previously discussed, federal loans are the bulk of the market for student loans and are more attractive. As a result, students are likely to exhaust their federal loan eligibility before turning to the private loan market. In the 2012 National Postsecondary Student Aid Study (NPSAS), 9.6 percent of students who reported taking out less than the statutory maximum of federal student loans reported having taken out private loans, which suggests that nearly all students will exhaust federal student loan eligibility before taking out private loans.

Financial independence not only changes the maximum amount of loans students have access to but increases grants and eligibility for subsidized loans. To partially ad-

¹⁸Any student, regardless of assessed financial need, may borrow the maximum amount of federal unsubsidized loans as long as the amount of loans does not exceed unmet financial need.

dress this issue, I will examine students who had received a Pell Grant or a zero EFC in the previous year in the section on heterogeneity. These students see smaller (or no) changes in grants and subsidized loans, and as a result, looking at them can be more informative of what might happen if subsidized loans and grants were unchanged. The results are not substantively different for this group of students.

Heterogeneity

I examine heterogeneity by a measure of parental income, which affects the size of the change in financial aid. In Table 4, separate discontinuities are estimated for three groups of students: 1) students who had a zero EFC when they were 23 years old, 2) students who received a Pell grant when they were 23 years old, and 3) students who did not receive a Pell Grant when they were 23 years old. These groups are examined separately because changes in financial aid arising from age-induced financial independence are quite different based on family income.

Students who previously received a zero EFC are examined in Column 1 of Table 4 and see no change in grants or subsidized loans. These are the neediest students in the sample, and so the exclusion of parental income and assets does not affect their eligibility for grants or subsidized loans. However, these students do increase unsubsidized borrowing by \$842. Despite only seeing an increase in unsubsidized student loans, age-induced financial independence causes 4 percent of students to speed up graduation by one year. Students with a previously received a zero EFC appear to reduce earnings by roughly the same amount as the sample as a whole at \$566, but this is imprecisely estimated with a t-statistic of 1.55. The reduction in earnings is 65 percent of the increase in loans. The larger effects on educational outcomes is somewhat surprising given the lack of a change in grants. However, the increased loans are likely to help these students most, as they are the neediest in the sample. These estimates also demonstrate the academic benefits of increased access to student loans for the poorest students.

Students who previously received a zero EFC can be helpful in understanding how many students are credit constrained because they experience no change in grants or subsidized loans as a result of age-induced financial independence. The two estimates of credit constraints are very similar to before: there is a 4.9 percent decrease in the number of students borrowing at the unsubsidized max and a 16.3 percent increase in the number of students borrowing above the dependent unsubsidized maximum. These students are the neediest in the sample so we would expect a higher fraction of them to be credit constrained as compared to the overall population. Despite this sample change, the estimates on the number of enrolled students who are credit-constrained are very similar to the estimates for the whole sample and confirm that the number of credit-constrained students ranges from 5–16 percent.

The second column examines students who received a Pell Grant when they were 23.¹⁹ These students see a \$402 increase in grants, a \$125 increase in subsidized loans, and a \$854 increase in unsubsidized loans for age-induced changes in financial independence. They are slightly more likely to graduate than the full sample as a result of financial aid, with 2.85 percent graduating one year earlier. They also reduce earnings and appear to be credit constrained at similar rates to the sample as a whole.

The third column of Table 4 examines students who did not receive a Pell Grant when they were 23 years old. These students are wealthier, so excluding parental income induces larger changes in need-based financial aid. They see a \$1,165 increase in grants, a \$755 increase in subsidized loans, and no change in unsubsidized loans. Despite a much larger change in financial aid, the effect on time to degree is smaller, with 1.3 percent reducing time to degree by one year. They reduce earnings by \$535 and have similar estimates to the sample as a whole for credit constraints.

The heterogeneity analysis shows that the cost of reducing time to degree by one year varies substantially by family income. For students who had previously received an EFC

¹⁹Students with a zero EFC in the year they turned 23 are a subset of this sample.

of zero, there is no direct cost from grants or subsidized loans. The increase in unsubsidized loans for independent students reduces time to graduation. Essentially, this decreased time to degree (and increased time in the labor market) comes at no cost. For students who had previously received a Pell Grant, an additional \$14,119 in grants decreases time to degree by one year.²⁰ This is very similar to how much more graduates in the sample make as compared to students enrolled in college. For students who had previously received a Pell Grant, additional grant aid is likely to be efficient, as its cost is roughly equal to the gain in earnings that a student sees from an additional year in the labor market. For students who had not previously received a Pell Grant, reducing time to degree costs \$92,492 which is substantially more costly than the benefit of an additional year in the labor market.

Taken together, the results on heterogeneity by previous Pell receipt suggest a few things: Financial independence gives more resources to relatively wealthier students. Despite this, the reduced time to graduation seems to be larger for needier students. In fact, aid to students who qualified for the Pell Grant in the year they turned 23 is likely to be efficient, as the benefits to the students are less than or equal to the costs. These results on heterogeneity highlight the educational attainment benefits of targeting financial aid to the neediest students.

Robustness

Two additional robustness checks are performed to make sure the results are not spurious. The first is to check the choice of bandwidth and is presented in Figure 6. This figure considers a main result of the paper, which finds that students who are financially independent and receive additional financial aid are more likely to graduate in the year they receive the aid and reduce their earnings. Each of the dots represents an estimated discontinuity, along with 95 percent confidence intervals for different bandwidth choices.

²⁰This abstracts from the costs of subsidized loans or program administration costs.

For graduation in the year students turn 24, the estimate is stable across bandwidths and is statistically different from zero starting with the bandwidth of 80 days. For earnings, smaller bandwidths tend to deliver smaller estimates, but once the bandwidth includes 90 days it is statistically different from zero. These figures confirm that the estimate is not sensitive to the choice of bandwidth.

I also use students turning 22 as a placebo exercise to see if student outcomes systematically vary at January 1. These results are presented in Table [A4](#) and are discussed in Appendix Section [A.5](#). If students anticipated the change in financial aid, we would likely see changes in student outcomes for these students. However, student outcomes do not significantly differ at this same threshold for 22-year-olds.

Contribution to Trends

The price of college has increased dramatically over the past 40 years. Concurrently, there has been an increase in time to degree and student employment. This paper shows that financial aid has a causal effect on time to degree and student employment. I use data from the College Board to get average tuition in the United States in 1974–1975 and 1992–1993. Tuition roughly doubles during this time frame. [Bound et al. \(2012\)](#) estimate a 0.27 year increase in time to degree for the high school graduating class of 1992 as compared to 1972. They link this to increased time working through a decomposition exercise and assumptions about the time spent working but note that student employment is endogenous to many things that are changing over the time frame. This paper can be used to help answer how much of the observed change in time to degree can be explained by changes in the price of college?

In a back-of-the-envelope exercise, I find that net tuition changed by \$2,119 annually in 1992 dollars. For details on data sources and assumptions see Appendix Section [A.6](#). The change in grants in this paper is \$559 in 1992 dollars. This implies that the change in tuition over this time would predict a 0.27 year increase in time to degree, or 100 percent

of increased time to degree. Several caveats apply to this exercise. First, the measure of net tuition is imperfect, as it is average sticker tuition minus average Pell amount.²¹ Second, while these estimates are internally valid, there is the question about how well they extend to all students. Third, the 100 percent estimate attributes all of the change in time to degree to a change in grants even though loan amounts also changed. If half of the effect operated through increased loans (the change in loans is roughly equal in size to the change in grants), then the estimate would be a 0.135 change in time to degree, or roughly 50 percent of the observed change in years to degree. If instead of net tuition I simply use sticker tuition, the estimates in this paper still account for 26 percent of the observed change. In any case, the change in time to degree implied by the change in price is nonnegligible.

This exercise illustrates that while the point estimates may not seem large, they explain a significant portion of an important trend in higher education.

7 Discussion and Conclusion

This paper causally links three trends in higher education: 1) higher tuition, 2) increasing time to degree, and 3) increased earnings in college. In particular, the price of college causally increases time to degree and increases student labor supply. The effects of college price on inframarginal students are important because they affect many students and are implicitly included in every financial aid and tuition policy considered but are rarely measured.

Several policy lessons emerge from this paper. First, proposals to change tuition or financial aid should consider the implications of their decisions on time to degree. In fact, this may be the bulk of the effect, as changes in price are likely to induce relatively small changes in enrollment while affecting all enrolled students. Moreover, roughly 50 percent

²¹Data on net tuition is generally not available until much later. The College Board now collects careful information on net tuition but did not in 1974.

of the increased time to degree and increased student employment of the last 30 years is likely due to increases in the price of college.

Second, the change in financial aid associated with financial independence is poorly targeted. The largest increases in aid go to students who come from the most affluent backgrounds. As a result, the benefits from the change in independence (namely one additional year in the labor market) do not outweigh the costs for the sample as a whole. However, for poorer students who see smaller changes in aid, the effects on time to degree are comparatively larger. For students who had previously had a zero EFC, time to degree is reduced simply by allowing additional borrowing of unsubsidized loans.

The heterogeneous effects of financial aid by family income underscore how targeting financial aid to needier students improves student outcomes relative to aid for wealthier students. This is particularly important for evaluating policy that reduces the price of college for all students.

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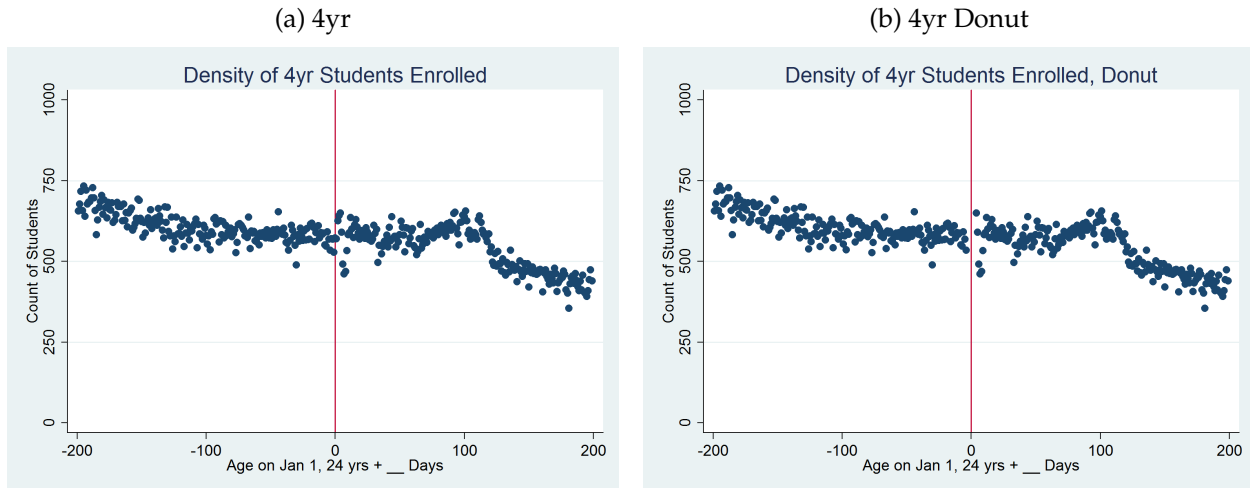
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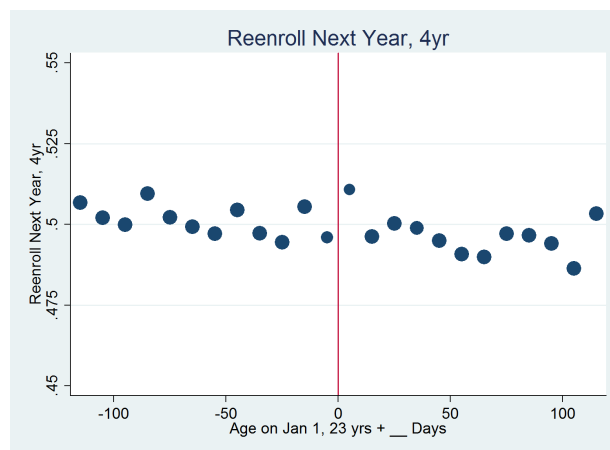
8 Figures and Tables

Figure 1: Density of Birth Dates



NOTE: Panel A plots the number of students born on each day of the year, and Panel B replicates that plot but removes students born within three days of January 1. The data come from administrative records of the THECB and include the 2003–2004 to 2013–2014 school years.

Figure 2: Reenrollment of 23-year-olds



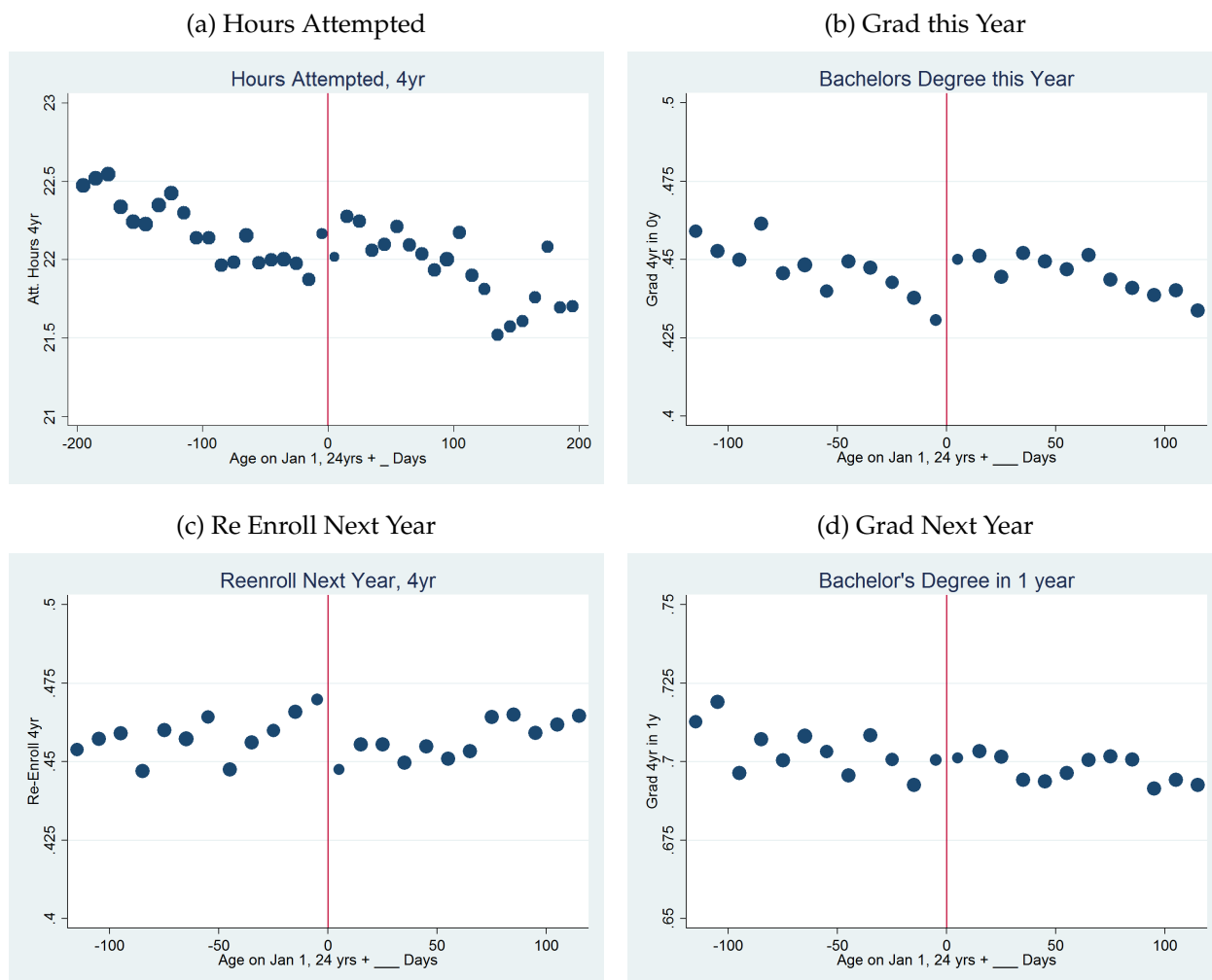
NOTE: This figure plots the fraction of 23-year-olds who re-enroll in the year they turn 24 by their recentered birth date. The data come from administrative records of the THECB and include the 2003–2004 to 2013–2014 school years.

Figure 3: Four-Year Colleges, Financial Aid



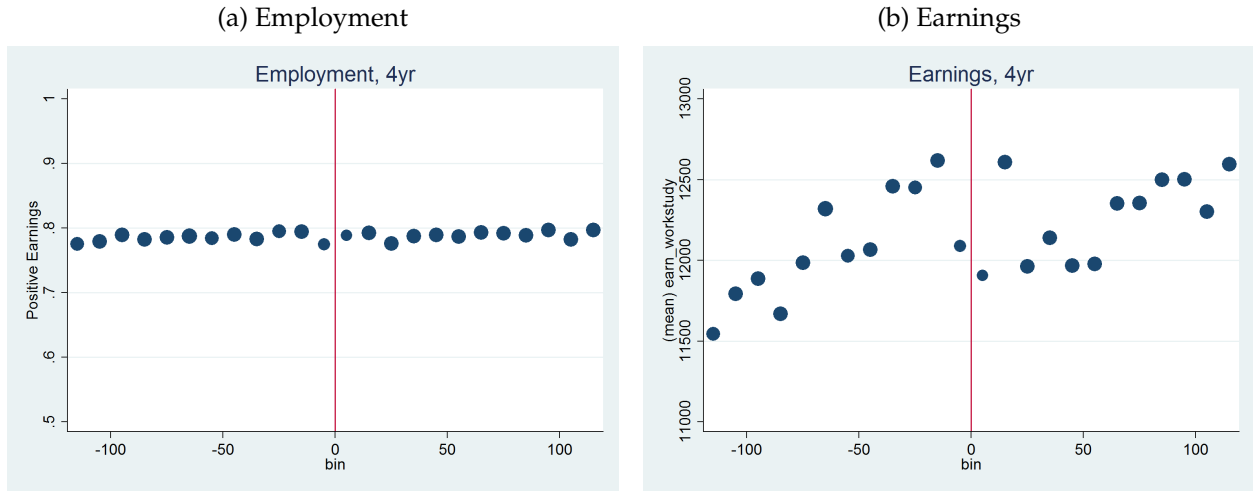
NOTE: Panel A plots the average amount of grants received by students by their age as of January 1. Panel B plots the amount of loans taken out by the students by their age as of January 1 and Panel C plots the fraction of students who borrow the annual federal maximum for dependent students. Panel D plots the fraction of students who borrow above the annual federal maximum for dependent students. Each dot represents the average for a group of 10 birth dates. The size of the dot is proportional to the number of students for which the average is computed. The data are from administrative records of the THECB and include the 2003–2004 to 2013–2014 school years.

Figure 4: Four-Year Colleges, Educational Outcomes



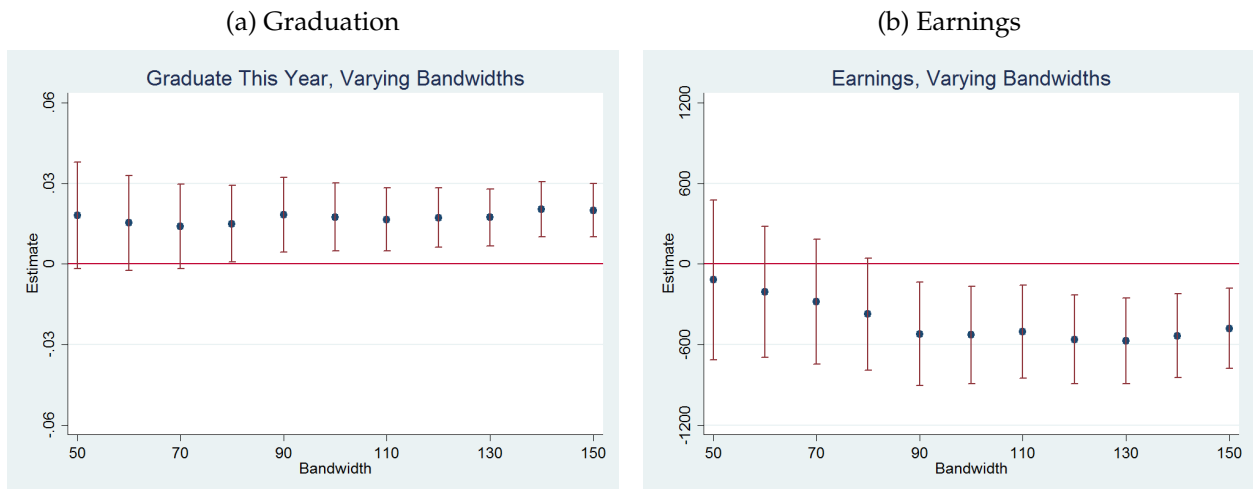
NOTE: Panel A plots the number of credit hours attempted by student age as of January 1. Panel B plots the probability of graduating in the year a student turns 24 by birth date. Panel C plots the probability of reenrolling in the year after a student turns 24 by birth date. Panel D plots the probability of graduating by the year after a student turns 24 by birth date. Each dot represents the average for a group of 10 birth dates. The size of the dot is proportional to the number of students for which the average is computed. The data are from administrative records of the THECB and include the 2003–2004 to 2013–2014 school years.

Figure 5: Four-Year Colleges, Earnings Outcomes



NOTE: Panel A plots the fraction of students with nonzero earnings in the year they turn 24 by their age as of January 1. Panel B plots earnings by birth date. The size of the dot is proportional to the number of students for which the average is computed. The data come from administrative records of the TWC and include the 2003–2004 to 2013–2014 school years.

Figure 6: Bandwidth Sensitivity, University Students



NOTE: The estimated discontinuity is plotted with 95% confidence intervals when estimated with different bandwidths. Panel A plots the effect of independence on graduation in the year students turn 24. Panel B plots the estimate of independence on earnings. The data are from administrative records of the TWC and THECB and include the 2003–2004 to 2013–2014 school years.

Table 1: Summary Stats

Variable	University Seniors		
	Obs	Mean	Std. Dev.
Male	227,848	0.49	0.50
White	227,848	0.49	0.50
Black	227,848	0.10	0.30
Hispanic	227,848	0.30	0.46
Asian	227,848	0.05	0.21
Hours	227,848	22.09	10.36
Borrow at unsub max	227,848	0.06	0.24
Borrow at sub max	227,848	0.12	0.32
Enroll next year	227,848	0.46	0.50
Graduate, current year	227,848	0.44	0.50
Graduate by next year	227,848	0.70	0.46
GPA	227,848	2.70	0.97
Receive Pell last year	227,848	0.30	0.46
Borrow more unsub max	227,848	0.17	0.38
Positive earnings	227,848	0.79	0.41
Total grants	227,848	1,838.90	2,668.65
Pell	227,848	1,449.75	2,111.77
Total loans	227,848	3,904.35	4,936.33
Earnings	227,848	12,218.71	12,908.41

NOTE: Summary statistics for the sample of students at Texas public universities and community colleges from 2003 to 2013 who are within 200 days of turning 24 during the school year. The data are from administrative records of the THECB and TWC and include the 2003–2004 to 2013–2014 school years.

Table 2: Reenrollment Probability of 23-Year-Old Students

	Reenroll
Discontinuity	0.0025 (0.0065)
Observations	121,333

NOTE: This table estimates the change in the probability of reenrolling in the next school year for students who turn 23 during the current school year. Students born December 29 through January 3, are excluded as discussed in the text. The discontinuity is estimated using a window of birth dates of 100 days from January 1, which corresponds to the IK bandwidth. Standard errors are clustered on recentered birth date and are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

Table 3: Estimated Discontinuities

	Total grants	Pell amount	Unsub. loans	Sub. loans	
Discontinuity	929.7*** (28.15)	806.9*** (20.51)	304.6*** (36.46)	561.8*** (27.72)	
Observations	111,793	111,793	111,793	111,793	
	Att. hours	Grad in 0 yr	Grad in 1 yr	Reenroll	GPA
Discontinuity	0.389*** (0.088)	0.018*** (0.006)	0.002 (0.006)	-0.015** (0.006)	0.001 (0.012)
Observations	223,772	111,793	111,793	111,793	111,793
	Earnings >0	Earnings	Nonzero earnings	Borrow at unsub. max	Borrow unsub. max
Discontinuity	-0.005 (0.005)	-528.6*** (185.1)	-575.9*** (214.6)	-0.052*** (0.003)	0.149*** (0.003)
Observations	111,793	111,793	88,104	111,793	111,793

NOTE: Each column has an estimate of the discontinuity in student outcomes for students born before January 1. The estimates arise from estimating Equation 1. The regressions also include controls for gender and race. Each discontinuity is estimated using a window of birth dates of 100 days around January 1. This bandwidth corresponds to the IK bandwidth except in the case of attempted hours, where a bandwidth of 200 days is used. Students born December 29 through January 3 are excluded, as discussed in the text. The data are administrative records of the THECB and TWC and include the 2003–2004 to 2013–2014 school years. Standard errors are clustered on recentered birth date and are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

Table 4: Heterogeneity Analysis

	Previous 0 EFC	Previous Pell	No previous Pell
Total grants	-69.81 (92.87)	402.4*** (57.28)	1165.4*** (25.98)
Unsub. loans	842.5*** (79.33)	854.2*** (58.12)	55.39 (42.05)
Sub loans	60.59 (74.04)	125.8** (57.88)	755.5*** (27.32)
Grad in 0 yr	0.040*** (0.0137)	0.026*** (0.011)	0.013* (0.008)
Grad in 1 yr	0.013 (0.015)	0.009 (0.011)	-0.001 (0.006)
GPA	0.026 (0.030)	0.021 (0.021)	-0.008 (0.013)
Earnings	-566.2 (364.5)	-533.4** (267.0)	-547.5** (217.7)
Borrow at unsub. max	-0.049*** (0.006)	-0.053*** (0.006)	-0.051*** (0.003)
Borrow > unsub. max	0.163*** (0.013)	0.174*** (0.010)	0.137*** (0.005)
Observations	18,994	33,845	77,948

NOTE: Each entry is an estimate of the discontinuity in student outcomes for students born before January 1. The estimates arise from estimating Equation 1. The rows represent different outcomes and the columns represent different estimating samples based on student characteristics in the year they turn 23. The regressions also include controls for gender and race. Each discontinuity is estimated using a window of birth dates of 100 days from January 1. Students born December 29 through January 3 are excluded as discussed in the text. The data are administrative records of the THECB and TWC and include the 2003–2004 to 2013–2014 school years. Standard errors are clustered on recentered birth date and are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

A Appendix

A.1 Changes resulting from Tax Aid

Dependent status for tax purposes changes for a minority of students. In particular, students must live at home for at least six months and provide less than half of their own support. An upper bound on the number of students experiencing a change in dependency status for tax purposes can be gleaned from the 2007–2008 National Postsecondary Student Aid Study. The NPSAS contains information students' residence with parents while they are enrolled. Students at four-year schools in Texas who are from 23.5 to 24.5 years old on January 1 live with their parents 15.0 percent of the time ([U.S. Department of Education, 2013a](#)). This number is an upper bound on the number of students affected by the change in tax status, because some of those who live at home may receive less than half of their support from their parents.

If a student is declared independent, all else being equal, the parent's tax liability will increase, as they no longer can claim a dependent exemption or any of the education tax credits. If parents were eligible for the Earned Income Tax Credit (EITC), they are likely to see EITC benefits decrease, as the number of eligible children will be reduced. The students will have their personal tax liability decrease, as they will be able to use the education tax credits on their tax return instead of their parents' using the education tax credits. In general, the family's total tax liability will weakly increase as credits or deductions are shifted from parents with relatively high marginal tax rates to students with relatively low marginal tax rates.²²

Financial independence is associated with (weakly) reduced family tax aid but increased student tax aid. How this affects total resources toward college depends on how parents and older students split changes in wealth from marginal tax changes. I am not aware of any studies that examine how families split such tax changes, and data

²²For very high income families who are not eligible for education tax credits, the total tax burden may decrease, as students will become eligible for tax credits.

on within-family transfers would be required to answer the question. Tax aid is never “disbursed” per se, and households may differ in the timing of realizing tax benefits.

One test for the impact of tax credits for college is to consider the time before the large expansion of tax credits that occurred in 2009. Tax expenditures increased by 140 percent in 2009. Results from 2003–2004 to 2007–2008 are presented in Table A1 and do not vary substantially from the results presented for all years, except for the expected loss for precision. While imperfect, this test shows that more than doubling the generosity of the tax credits for college does not substantially effect the interpretation of the results.

A.2 Birth Retiming

LaLumia et al. (2015) and Schulkind and Shapiro (2014) find that there is a small amount of manipulation in response to tax incentives that is less than half the amount of retiming of births that is typically seen on a weekend. A \$1,000 change in taxes leads to about 1 percent of births being retimed.²³ This may be a concern for identification if children of parents who retime their births in response to tax incentives produce children who systematically respond differently to financial independence 24 years later. It is not obvious how these students would differ systematically, but it is a possibility.

To explore the amount of retiming of births or differential reenrollment that occurs, Figure 1 plots the number of students with each birthday among students turning 24 in a given school year for community college students and university seniors. The panels on the left include all students. Panels on the right remove students who were born within three days of January 1, and the distribution is much more smooth through the cutoff. There is some retiming of births evident, but the distribution appears to be smooth after removing the three days surrounding January 1.²⁴

²³Schulkind and Shapiro (2014) find that the manipulation is due to increased cesarean rates before January 1.

²⁴There does appear to be a decrease in births associated with Christmas, though that is unlikely to be problematic for the identification strategy.

A.3 Student Characteristics

If either differential (re)enrollment or birth retiming were an issue, student observed and unobserved characteristics may discretely vary across the threshold.²⁵ I test for observable differences by looking for discontinuities in predetermined characteristics like race, gender, grant aid received in the previous year, loans received in the previous year, and EFC for students who had filed a FAFSA in the previous year. Results from these checks for balance of the covariates are found in Table A3. In these regressions there are eight discontinuities considered; one is statistically significant at the 10 percent level, and the estimated discontinuities are small. A joint test for significance reveals that the discontinuities in characteristics are not jointly different from zero. Overall, the lack of discontinuities in predetermined covariates suggests that students on either side of the age discontinuity are similar in observable characteristics.

A.4 On-Campus Employment

Work-study is a need-based federal program in which wage subsidies are offered to universities to employ students, typically on campus (Scott-Clayton and Minaya, 2014). Financial independence increases a student's eligibility for work-study because parents' income and assets are excluded from need calculations. However, the earnings measure in this study includes student earnings from work-study, which eliminates this as a concern.²⁶ There is still the issue of non-work-study employment at universities and colleges. Employment on campus is a small fraction of employment for students age 23.5 to 24.5. In fact, only 8.1 percent of students at public four-year universities work on campus or

²⁵There may be unobserved variables that also differ on each side of the age cutoff. One example that may be relevant is insurance coverage. In the state of Texas during this time frame employers were required to cover dependent children with health insurance until age 25, so insurance status is not likely to vary discretely at this threshold (Dillender, 2014). Starting in 2011, the Affordable Care Act mandated that all children under the age of 26 be eligible for inclusion on their parents' plans, which would not affect the identification strategy of this paper.

²⁶Turning 24 is associated with a very small increase in student earnings from work study.

both on and off campus.²⁷

If financial aid displaces non-work-study employment at colleges and universities in the same way that it does for employment observed in the UI data, then the UI earnings will understate the true effect of financial aid on earnings. This is because there are additional reductions in earnings for students who turn 24 that are not captured by UI and work-study data. If non-work-study employment by universities is insensitive to financial aid, then the estimates in the UI data will be accurate. For the estimates presented to overestimate the effect of financial aid on earnings, an unusual result is required in which students respond to additional financial aid from turning 24 by reducing hours worked off campus and increasing non-work-study hours worked on campus. However, this unusual situation seems less plausible, since work-study earnings are accounted for and there is no other clear mechanism that would drive student behavior in this way.

A.5 Placebo—22 years old

One concern is that students born before and after January 1 are unobservably different and have differential outcomes as a result of these differences rather than differences in financial aid. One way to test this is to perform a placebo test with students turning 22. I perform the same analysis as before, but instead use students who are turning 22 in a school year. These students do not experience any differential change in financial aid if they are 22 by January 1 and so the students should have the same outcomes irrespective of whether they are 22 by January 1 unless there are some unobserved underlying differences.²⁸ This is exactly what is found in Table A4, in which discontinuities are estimated and none are significant the 5 percent level.

²⁷ Author's calculations based on the 2012 NPSAS. Additionally, 5.4 percent of students work exclusively on campus, and 2.7 percent work both on an off campus.

²⁸ Students turning 22 are chosen because students who are 23 may be looking ahead to the next year and financial independence (or lack thereof) and adjusting their schooling decisions accordingly. There is no evidence of this occurring, but I focus on turning 22 out of caution

A.6 Time to Degree

Data on college tuition come from the College Board ([College Board, 1998](#)). Data on the enrollees come from NCES ([National Center for Education Statistics, 2015](#)). Data on the Pell Grant come from the Department of Education ([U.S. Department of Education, 1993](#)). All of the dollar amounts that follow are in 1992 dollars. To perform this exercise, I construct a crude measure of net tuition. I start by using the published tuition from the College Board. I then use data from the Department of Education on the average Pell Grant disbursed in the relevant years to Pell recipients. I multiply this by the number of Pell recipients and then divide by the total number of enrollees in higher education to get the average Pell Grant received including zeroes. This is an imperfect measure of total grants, but it does capture the largest source of federal grants. I then calculate net tuition by subtracting the average Pell Grant from the average tuition. In 1992 the net tuition was \$1842 and the net tuition in 1974–1975 was -\$277. This number was negative in 1974–1975 because the Pell Grant in those years was designed to cover 100 percent of cost of attendance. Hence the change in net tuition was \$2,119. I take this number and divide by the measured change in tuition in this paper, \$559, and multiply by the size of the effect, 0.018. Last, I multiply this by 4 because this is annual tuition and at least four years are required for graduation. This yields a increase in time to degree of 0.27 years. This is 100 percent of the change in time to degree estimated in [Bound et al. \(2012\)](#).

An important caveat is that financial independence changed not only net tuition by changing grants but also changed loans. The change in loans is about the same magnitude as the change in grants. Unfortunately it is not clear how much of the effect on graduation to attribute to loans or grants. Conservatively, if half of the change in graduation is attributable to grants and half to loans (matching the proportional change in amounts) then the estimate would shrink to 0.135 years, or 50 percent of the observed change in time to degree in [Bound et al. \(2012\)](#). Loans are likely to have a smaller effect than grants because they must be repaid. Hence, assuming that loan aid and grant aid

have the same effect is conservative.

The implied change in time to degree is smaller if sticker tuition is used instead of net tuition. This is largely because net tuition incorporates both the change in sticker tuition and the decline in the Pell Grant as a fraction of tuition that occurred from 1974 to 1993. As a result, this should be seen as a more conservative exercise than when accounting for Pell Grants. If sticker tuition is used, the implied change in time to degree is 0.14 years, or 52 percent of the observed change. After conservatively accounting for half of the effect being loans, this would still be 26 percent of the observed change in time to degree.

Table A1: Results Pre-2008

	Total grants	Pell amount	Unsub. loans	Sub. loans	
Discontinuity	813.3*** (41.36)	684.4*** (28.56)	275.2*** (36.96)	614.5*** (39.12)	
Observations	57,611	57,611	57,611	57,611	
	Att. hours 4 yr	Grad in 0 yr	Grad in 1 yr	Reenroll	GPA
Discontinuity	0.210 (0.136)	0.0157* (0.009)	-0.007 (0.0008)	-0.016* (0.009)	-0.013 (0.018)
Observations	114,820	57,611	57,611	57,611	57,611
	Earnings>0	Earnings	Nonzero earnings	Borrow at unsub. max	Borrow > unsub. max
Discontinuity	-0.00957 (0.00728)	-554.3** (247.5)	-426.4 (282.3)	-0.070*** (0.005)	0.139*** (0.007)
Observations	57,611	57,611	46,887	57,611	57,611

NOTE: Each column has an estimate of the discontinuity for a student outcome for students born before January 1. The sample only includes students in 2003–2004 to 2006–2007, in order to focus on a time with smaller available tax aid. The estimates arise from estimating Equation 1. The regressions also include controls for gender and race. Students born December 29 through January 3 are excluded, as discussed in the text. Each discontinuity is estimated using a window of birth dates of 100 days from January 1, which corresponds to the IK bandwidth. The data are administrative records of the THECB and TWC and include the 2003–2004 to 2013–2014 school years. Standard errors are clustered on recentered birthdate and are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

Table A2: Estimated Discontinuities, No Donut

	Total grants	Pell amount	Unsub. loans	Sub. loans	
Discontinuity	925.2*** (29.99)	799.6*** (23.37)	306.3*** (29.15)	559.4*** (27.03)	
Observations	115,869	115,869	115,869	115,869	
	Att. hours 4 yr	Grad in 0 yr	Grad in 1 yr	Reenroll	GPA
Discontinuity	0.384*** (0.087)	0.015** (0.006)	-0.003 (0.005)	-0.014** (0.006)	-0.001 (0.011)
Observations	227,848	115,869	115,869	115,869	115,869
	Earnings >0	Earnings	Borrow at unsub. max	Borrow > unsub. max	
Discontinuity	0.053*** (0.004)	486.8*** (171.4)	-0.048*** (0.003)	0.146*** (0.004)	
Observations	115,869	115,869	115,869	115,869	

NOTE: Each column has an estimate of the discontinuity in student outcomes for students born before January 1. The estimates arise from estimating Equation 1. The regressions also include controls for gender and race. Each discontinuity is estimated using a window of birth dates of 100 days from January 1, which corresponds to the IK bandwidth except in the case of attempted hours, which uses a bandwidth of 200 days. The data are administrative records of the THECB and TWC and include the 2003–2004 to 2013–2014 school years. Standard errors are clustered on recentered birth date and are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

Table A3: Covariate Balance

	Male	White	Black	Hispanic
Discontinuity	-0.001 (0.007)	-0.001 (0.007)	0.000 (0.004)	0.010 (0.006)
Observations	111,793	111,793	111,793	111,793

	Asian	Previous grants	Previous loans	Previous EFC
Discontinuity	-0.006** (0.003)	10.31 (30.04)	65.84 (54.81)	-1092.8 (2487.90)
Observations	111,793	111,793	111,793	65,633

NOTE: This tests for discontinuities in covariates for students who were born before January 1. Each discontinuity is estimated using a window of birth dates of 100 days from January 1 which corresponds to the IK bandwidth. Students born December 29 through January 3 are excluded as discussed in the text. The data are administrative records of the THECB and include the 2003–2004 to 2013–2014 school years. Standard errors are clustered on birthdate are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.

Table A4: Placebo Check—22-Year-Olds

	Total grants	Pell amount	Total loans	
Discontinuity	2.43 (24.07)	-0.513 (14.55)	-53.09 (35.44)	
Observations	237,357	237,357	237,357	

	Reenroll 4 yr	Grad in 0 yr	Grad 4 in 1 yr	GPA
Discontinuity	0.003 (0.004)	-0.007 (0.004)	-0.007* (0.003)	-0.008 (0.006)
Observations	237,357	237,357	237,357	237,357

NOTE: This tests for differences in student outcomes among students turning 22 as a placebo test. The data are administrative records of the THECB and include the 2003–2004 to 2013–2014 school years. Robust standard errors are in parentheses, with * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$.