Federal Reserve Bank of New York
Staff Reports

Credit Supply and the Rise in College Tuition: Evidence from the Expansion in Federal Student Aid Programs

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Staff Report No. 733
July 2015
Revised March 2016

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JEL classification: G28, I22

Abstract

The causes of the rapid growth in the price of college education have been the source of much debate in recent years, and the similarly quick growth in student borrowing, funded largely through federal student loan programs, has also been of substantial concern. This paper studies the relationship between these twin increases, and in particular, the extent to which increased access to student credit has contributed to rising tuition. To disentangle the simultaneity of the education cost and credit, we exploit detailed student-level financial data and changes in federal student aid programs to identify the impact of credit on tuition. We find that institutions more exposed to changes in these programs increased their tuition disproportionately around these policy changes, with a pass-through effect on tuition from changes in subsidized loan maximums per qualifying student of about 60 percent, and smaller but still positive pass-through effects of Pell Grant aid and the unsubsidized federal loan program. The subsidized loan effect is most pronounced for more expensive degrees, for those offered by private institutions, and for two-year degrees or vocational programs.

Key words: student loans, college tuition

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1 Introduction

Despite the sharp deveLeraging of U.S. households in the aftermath of the Great Recession, student debt outstanding has kept its pre-crisis upward trajectory, and at $1.3 trillion, is now the largest form of non-mortgage liability for households (Figure 1). Federal student aid programs have accounted for a large portion of new student loan originations. Student lending grew from $53 billion to $120 billion between 2001 and 2012 with about 90% of originations taking place under federal student aid programs (Figure 2). Against this backdrop, average sticker-price tuition rose 46% in constant 2012 dollars between 2001 and 2012, from $6,950 to $10,200 (Figure 3). This paper attempts to address the welfare implications of the sharp increase in student leverage by studying the effects of the student loan credit expansion on the rising cost of postsecondary education.

The possibility that an increase in student aid availability may lead to tuition increases has been at the forefront of the policy discussion for many years. Even during the more muted tuition and student aid trends in the 1980s, then-Secretary of Education William Bennett (1987) argued that "[...] increases in financial aid in recent years have enabled colleges and universities blithely to raise their tuitions, confident that Federal loan subsidies would help cushion the increase," a statement that came to be known as the "Bennett Hypothesis." Escalating tuition costs and loan balances in recent years have similarly attracted much policy attention (for example, Obama, 2013) and have driven major recent policy initiatives, such as the free community college program (White House, 2015). Despite the importance of this issue, the empirical evidence on the link between student loans and college tuition is limited. The key identification challenge is a standard simultaneity issue: a positive correlation between student funding and tuition costs may indicate that an increase in the availability of student credit caused increases in tuition, that increases in tuition costs caused increases in student loan balances, or that some other variable caused an increase in both student loans and tuition. The main contribution of this paper is to propose an identification strategy to isolate a causal effect of student loan credit on tuition.

Our identification approach exploits changes in the maximum per-student disbursable amounts in federal student aid programs known as "Title IV." We focus on the main Title IV aid programs to undergraduate students: subsidized (where the government pays interest during the enrollment period) and unsubsidized loans, as well as Pell Grants, which are grants awarded to students in financial need and, unlike loans, do not require any repayment. We study Pell Grants despite our main interest in credit, be-

cause they are economically significant and experienced program changes that partially overlapped with the ones we study for the federal loan programs.

The policy changes we exploit for identification were legislated through three separate initiatives passed between February 2006 and May 2008 and went into effect between the 2007-08 and 2010-11 school years. These changes raised the maximum amount of Pell Grants and loans that students were eligible to receive.[1] Our identification rests on the observation that while these program maximum increases technically applied to all institutions, certain institutions had many more students who were likely to take advantage of these increases, due to variation in eligibility and participation. To identify these differences in institutional "exposures" to the policy changes, we use a rich dataset from the Department of Education ("the ED"), known as NPSAS, containing student-level funding and family income information for a representative sample of postsecondary institutions in the US. This dataset allows us to calculate an exposure measure for each institution, defined as the ex-ante fraction of students borrowing at a particular policy maximum. We then interact this measure with the shifts in federal aid supply, to obtain a yearly measure of per-student supply changes at the institutional level. This approach is analogous to the one commonly used in labor economics to analyze the impact of labor demand shocks (Bartik, 1991; Blanchard and Katz, 1992).

We first study the response of aid amounts to changes in institution-specific aid maximums, constructed as the product of legislated changes in maximum aid amounts and an institution's exposure. The exposure is the fraction of students at each institution that is eligible to changes in maximums as measured in NPSAS ahead of the policy changes. We find that changes in per-student subsidized loan amounts load with a coefficient of .7 on yearly changes in institution-specific maximums, or maximums per qualifying student. We find similar passthroughs for unsubsidized loans and Pell Grants (coefficients of .56 and 1.15, respectively). These estimates suggest that the institution exposure measures proxy well for sensitivities to cap increases. We further validate demand elasticities in response to the federal aid supply shocks using data from the NY Fed CCP/Equifax panel.[2]

[1] The combined maximum subsidized-unsubsidized federal loan amount for freshmen rose in the 2007-08 academic year from $2,625 to $3,500, and for sophomores from $3,500 to $4,500; unsubsidized loan maximums rose by $2,000 in the academic year 2008-09. Finally, Pell Grant maximums rose gradually between the 2007-2008 and 2010-2011 school years as well as in prior years as a result of the yearly appropriation process of the Department of Education.

[2] We examine the distribution of student loan origination amounts around the subsidized program cap change and find that the pre-/post-distributions display a shift in the mass points of the loan distribution from the old caps to the new ones. The CCP panel does not include information on whether the loans are issued under the Federal Loan programs, but the caps for subsidized loans prior to the policy change

We next estimate the response of sticker-price tuition, enrollments, and institutional grants to changes in institution-specific aid maximums, which are again measured as the interaction of exposures and program cap changes. The point estimates indicate that increases in institution-specific subsidized loan maximums lead to a sticker-price increase of about 60 cents on the dollar, and that increases in the unsubsidized loan and Pell Grant the per-student maximums are associated with sticker-price increases of 15 cents on the dollar and 40 cents on the dollar, respectively. All of these effects are highly significant and are consistent with the Bennett Hypothesis.

Many students do not pay sticker-price tuition, but rather a smaller amount that takes into account grants and discounts, or "net tuition." To the extent that these grants and discounts result from the federal aid programs that we study, it is correct to focus on sticker tuition before netting out these forms of aid to isolate the passthrough of federal aid. However, many institutions also provide "institutional grants" to students, which could also respond to either amplify or buffer the effect of federal aid on sticker price. Reliable series of "net tuition" or institutional grants at yearly frequencies are not available to the best of our knowledge. Prior studies (e.g. Turner, 2012) find that Pell Grants tend to crowd out institutional grants meaning that institution aid amplifies tuition increases resulting from more federal aid. We find similar effects using an imperfect measure of net tuition and grants: An increase in subsidized loans decreased institutional grants by about 20 cents on the dollar and increases in Pell Grants lowered institutional grants by about 30 cents on the dollar.

A stated goals of federal student aid is to increase postsecondary access, an effect that could partly outweigh from a welfare perspective the increased tuition cost. Using the same identification method, we are able to find some evidence that increases in Pell Grants are positively associated with increased enrollment. Instead, unsubsidized loan increases are negatively correlated with enrollment, and subsidized loan increases show no effect. Intuitively, since Pell Grants do not require any form of principal repayment, as long as the passthrough on tuition is less than 100%, an increase in Pell Grants should lower the cost of attendance for a student in addition to relaxing budget constraints, and should thus boost enrollment. On the other hand, since loans require repayment, the added cost of tuition increases may outweigh the benefit of relaxed borrowing constraints in a student's decision to enroll in postsecondary education, especially for unsubsidized loans.

Many factors potentially influence changes in tuition outside of an expansion in stu-

are relatively irregular amounts (e.g. $2,625), permitting an indirect inference through the amounts.

dent loan and grant availability (Congressional Research Service, 2014, for a review.) In robustness checks we control for changes in other revenue sources at the institutional level, in addition to institution-level and year fixed effects that are included in all specifications. We also construct controls to address the possibility that certain institutional characteristics may be correlated with both our exposure measures and with tuition changes. In addition, we evaluate "parallel trends" in tuition and aid levels through placebo tests by comparing changes in tuition and aid amounts of highly and less exposed institutions outside the years of policy changes. In general, we find that the subsidized loan effect is quite robust across specifications both in magnitude and significance, and passes the placebo test, while the Pell Grant and unsubsidized loan effect are less robust to these controls and tests.

Finally, we investigate the characteristics of the institutions where the passthrough effect of aid to tuition are most pronounced. We find that the subsidized loan effect on tuition is highest among relatively expensive institutions, private institutions, and those offering two year and vocational programs. Responses of tuition to changes in unsubsidized loans is most pronounced in expensive schools while the response of tuition to changes in Pell Grants is more uniform across institutions. It is also important to note that while tuition increased steadily over our full sample period the policy changes we exploit were concentrated in a few years later in the sample. This does not necessarily rule out a role of student credit in the observed tuition trends. Previous work, for example, shows that greater aid availability tends to raise tuition levels more generally (Cellini and Goldin, 2014). While less carefully identified than our main results, we exploit between-institution variation and show that in the five-year period before our policy changes take place, more aid-dependent institutions showed larger increases in tuition prices. Taken together with our main results, this suggests that over the entire period we study, aid-dependent institutions had higher-than-average increases in tuition, and following the policy changes, those aid-dependent institutions that were particularly exposed to changes in the policy maximums experienced tuition increases that were even higher than this average level.

Related literature. This paper contributes to three main strands of the literature. First, it builds on the expanding financial literature studying the role of credit supply on real allocations and prices. In recent years, much attention has been devoted to this question in the context of the housing market, for which credit is central, in an attempt to establish whether the U.S. housing boom of 2002-6 and the ensuing bust can be explained by those years' fluctuations in mortgage rates and loan availability

to subprime borrowers (see, for example, Mian and Sufi, 2009; Adelino, Schoar, and Severino, 2012; Favara and Imbs, 2015). From a finance perspective, the market for postsecondary education has shared several features with the housing market in the past few decades, despite the fact that student loans fund a capital investment (Becker, 1962) while mortgages fund an asset. Credit plays a key role in U.S. postsecondary education, and much like housing finance, student loans are typically originated through government-sponsored programs. Our paper provides complementary evidence on the role of credit in affecting the cost of higher education.

This paper also contributes to the economics of education literature studying the role of student aid in increasing the price of postsecondary education. Most of this literature has focused only on grant aid, and in particular Pell Grants: for example, Singell and Stone (2007) show that increases in Pell Grants are captured by increased tuition at private universities and out-of-state tuition at public universities, while Turner (2012) uses a regression discontinuity approach and finds that institutions alter institutional aid (scholarships) as a means of capturing the federal aid provided through the federal Pell Grant program. Beyond Pell Grants, Cellini and Goldin (2014) find evidence that for-profit universities that are eligible for any student federal aid (Title IV) programs, including loans, charge tuition that is about 75 percent higher than comparable institutions whose students cannot apply for such aid. We add to this study in two ways: first, by studying variation within Title IV institutions (which are mostly not-for-profit), and second, by attempting to specifically isolate the role of student loans using the natural experiments provided by federal aid policy changes. Congressional Research Service (2014) overviews these are other studies. More recently, Gordon and Hedlund (2016) develop a structural model of higher education costs and find strong support for the role of federal aid in increased tuition costs.

Finally, this paper is related to the public economics literature on tax incidence (Kotlikoff and Summers, 1987), which studies how the burden of a particular tax is allocated among agents after accounting for partial and general equilibrium effects. In our setting, the student aid expansion is a disbursement of a public benefit. While one would expect these expansions to improve the recipients' welfare, for example, through lower interest payments and a relaxation of borrowing constraints, they may have actually resulted in lower welfare because of the sizable and offsetting tuition effect.

The remainder of the paper is organized as follows. We discuss major tuition and funding trends in the next section and data sources in Section 3. In Section 4, we

describe our empirical method and changes in student aid policies. Section 5 discusses the main results in the paper, while Section 6 presents robustness checks of these results and studies the attributes of institutions with the highest passthrough for the subsidized program, as well as the longer-term empirical relation between tuition, enrollment and aid before the policy changes. Finally, Section 7 concludes and discusses evidence for for-profit institutions, which, despite having received much attention in the policy debate, are heavily underrepresented in the data that we use for our main results.

2 The postsecondary education industry and student funding

This section provides basic facts about the postsecondary education industry. It then describes the Federal Student Aid programs; changes in these programs are the key identification strategy in this paper to study the effects of credit expansion on college tuition. As we discuss in this section, credit extended under these programs have also been a key contributor to the run up in overall student loan balances.

2.1 College tuition and programs

As discussed above, average undergraduate per student tuition nearly doubled between 2001 and 2012, from about $6,950 to more than $10,000 in 2012 dollars (Figure 3), corresponding to an average real rate increase of 3.5% per year.

These overall trends in college tuition mask significant variation within the postsecondary education sector. Tuition at postsecondary educational institutions varies widely depending on the type of degree the institution offers (four-year bachelor's degrees, two-year associate's degrees, or certificates generally requiring less than two years of full time study) and by the type of governance it operates under (for example, non-profit or for-profit).

In the 2011-2012 school year, there were 10.7 million undergraduate students enrolled at four-year institutions, and 7.5 million students enrolled at two-year institutions (see Figure 4). Four-year institutions also enrolled an additional 2.8 million graduate students, though we focus mainly on undergraduate loan amounts and tuition in this paper. Four-year institutions, which include public state universities (60% of enrollment in 2012), private non-profit research universities and liberal arts colleges (29%), and private for-profit institutions (11%), rely on a combination of revenue sources, from government appropriations to tuition revenue to other revenue (mostly private endowments and gifts). The two-year sector is almost entirely dominated by public

two-year colleges, also known as community colleges, which enroll about 95% of all two-year students. Tuition at these colleges is low, averaging just $2,600 in 2012. Most of the revenue (70%) of these colleges instead comes from government sources.

Finally, in addition to the 20.4 million students enrolled at degree-granting institutions (two-year and four-year institutions) in 2012, another 572,000 were enrolled at Title IV "less-than-two-year" institutions. These institutions are mostly vocational schools in fields such as technology, business, cosmetology, hair styling, photography, and fashion. In contrast to the degree-granting institutions, the majority of these institutions are private for-profit institutions and tuition revenue makes up the majority of their funding.

The above numbers only cover Title IV institutions, but several for-profit institutions exist that are not Title IV-eligible.[3] Data on these institutions is hard to find, but Cellini and Goldin (2014) construct a dataset with some of these institutions, and show that, after controlling for observables, tuition at Title-IV-eligible for-profit institutions are 75% higher than comparable non-Title-IV-eligible for-profit institutions.

2.2 Federal student aid programs

Federal student aid programs are governed by the 1965 Higher Education Act (HEA). The original HEA outlined six mandates directing federal funds to higher education; federal student aid is described in HEA's Title IV.[4] Title IV authorizes federal financial aid to support access to postsecondary education in the form of two key programs: Pell Grants and the federal loan programs.

Pell Grants are awarded to (undergraduate) students in financial need and do not require repayment of the grant amount. There are four types of federal student loans: subsidized, unsubsidized, PLUS and Perkins. The federal government pays the interest on a subsidized student loan during in-school status, grace periods, and authorized deferment periods. Qualification for subsidized loans is based on financial need, while unsubsidized loans, where the student is responsible for interest payments, are not. PLUS loans require that borrowers do not have adverse credit histories and are awarded to graduate students and parents of dependent undergraduate students. Finally, Perkins

[3] All public institutions are eligible for Title IV. Other institutions must meet certain qualifications such as being licensed, accredited from a Nationally Recognized Accrediting Agency (NRAA), and meeting standards of administrative capacity and financial responsibility (e.g., default rates of graduates in excess of 25% for three consecutive years, or a one-year default rate in excess of 40%, are grounds for losing Title IV status).

[4] In addition to Title IV, Title I funded continuing education programs, Title II allocated money for libraries, Title III provisioned money for underdeveloped higher education institutions, Title V strengthened the quality of teaching, and Title VI was dedicated to undergraduate education.

loans are made by specific participating institutions to students who have exceptional financial need.

The two largest programs, subsidized and unsubsidized loans, have historically been administered under the Federal Family Education Loan (FFEL) and the William D. Ford Federal Direct Loan (DL) Program. Under FFEL, private lenders would originate loans to students that were then funded by private investors and guaranteed by the federal government. Under the DL program, instead, the United States Department of Education (or ED) directly originates loans to students, which are funded by Treasury. Following the passage of the Health Care and Education Reconciliation Act of 2010 the FFEL program was eliminated, making the ED the sole direct lender of federal student loans. The types of loans offered to students were, however, not affected by the funding differences in the DL and FFEL. Key features of these loans are that they may or may not require repayment while a student is still in school, and do not require a credit record or cosigner. Interest rates on undergraduate loans have also varied over time and have been both fixed and floating, but are generally lower than what a student could find in the private loan market. Rates on subsidized and unsubsidized loans currently stand at 4.29 percent. Loan repayment starts after a six-month grace period following school completion. The standard repayment plan is ten years, but this term can be extended to up to 25 years. In addition, payments can be stopped for deferments (back to school) or forbearance (hardship). More recently, under the newly adopted "income based repayment" plans, borrowers can limit their loan payments to a fraction of their income over the repayment period.

In addition to being determined by an individual student's financial need, loan and grant amounts are governed by per-student maximums that have changed over time. These changes have taken place through amendments to the HEA, which requires periodic reauthorizations, and form the basis for our identification.[5]

As shown in Figure 2, loan originations in federal programs have accounted for over 90% of all student loan originations since the 2009-2010 school year, and 75-80% in the years of our sample before the financial crisis. As shown by the red areas, the majority of these originations (about 65-70%) are for undergraduate education, and most of these are currently originated through the Direct Subsidized Loan and Direct Unsubsidized Loan programs, which have originated between $25 and $30 billion each

[5]These have occurred in 1968, 1972, 1976, 1980, 1986, 1992, 1998, 2008 and 2013. For example, most recently, under the Bipartisan Student Loan Certainty 2013 Act, student loan rates are tied to secondary market rates. Very recent student loan policy initiatives also contemplate alternative income-linked repayment methods and repayment time horizons.

in recent years, or about 85% of all federal student loans made to undergraduates. From the figure, it is also evident that a sharp rise in originations through these programs took place between 2008 and 2010, which were the years of the federal loan cap changes that we discuss in the next section.

In Figure 5, we show that Pell Grant disbursement averaged around $30 billion in recent years, compared to an average of about $70 billion for federal student loan originations to undergraduates, and also experienced large increases between 2008 and 2010. Given these coincident increases, and their large economic significance, we are careful to control for changes in Pell Grants in our empirical approach.

3 Data

We overview the data sources and sample used in the analysis and provide a more detailed description in Appendix B. We use data from three main sources from the Department of Education (ED): Integrated Postsecondary Education Data System (IPEDS), Title IV Administrative Data from the ED's Federal Student Aid Office, which we refer to as "Title IV" data, and the restricted-use student-level National Postsecondary Student Aid Survey (NPSAS) dataset.

IPEDS is a system of surveys conducted annually by the ED's National Center for Education Statistics (NCES) with the purpose of describing and analyzing trends in postsecondary education in the United States. All Title IV institutions are required to complete the IPEDS surveys. These surveys cover seven areas: institutional characteristics, institutional prices, enrollment, student financial aid, degrees and certificates conferred, student retention and graduation rates, and institutional human resources and finances. We mainly use IPEDS for a panel of sticker price tuition and enrollment. Though IPEDS began in 1980, the survey covering sticker-price tuition was changed significantly in the 2000-2001 school year, and we thus start our sample in this year. Following NCES convention, we refer to academic years with their ending year, so the 2000-01 school year will be referred to as 2001 in the rest of the paper.

In our analysis, we are interested in institutional measures of financial aid from federal loan programs. While we considered also using IPEDS to obtain these measures, we ultimately found a number of reasons to look for an alternative data source, which we describe later. One of the reasons is that the IPEDS measures of financial aid are contained in the "Student Financial Aid" survey, which is considered by most educational administrators to be the most burdensome of the IPEDS surveys (Government Accountability Office (2010)). This is likely because it requires administrators to esti-

mate the total amount of aid and number of recipients within a specific IPEDS-defined universe of students, "full-time first-time degree-seeking undergraduates." Restricting to this universe may be difficult for some institutions depending on what data sources they pull from to complete the IPEDS surveys. Thus, these data are less reliable than those obtained from the less-burdensome collection of published tuition levels and enrollment numbers. Second, this universe is not necessarily representative of the entire undergraduate body. Third, until recently, IPEDS did not distinguish between federal loans and other loans, and still does not distinguish between subsidized and unsubsidized loans, which makes our identification more difficult.

Instead of using these IPEDS series to measure institutional aid amounts, we instead use the Title IV Program Volume Reports, which report yearly institutional-level total dollar amounts and the number of recipients for each federal loan and grant program. These are available beginning with the 1999-2000 academic year and include information on each form of federal grant or loan. We only consider undergraduate policy changes and tuition in this paper, so we would want these amounts to be for undergraduates only. However, Title IV data does not break out undergraduate and graduate loans separately until 2011. Pell Grants are only available to undergraduates, so are not affected. Since imputation of an undergraduate measure requires making several assumptions, our preferred measure of loan and grant usage at an institution is just the total dollar amount scaled by the enrollment count (on a full-time-equivalent (FTE) basis) of the university. We end our sample in 2012 to exclude the year 2013 when graduate students became ineligible to receive subsidized loans as a result of the Budget Control Act of 2011.

Merging Title IV and IPEDS data, we obtain an annual panel of federal loan borrowing, Pell Grants, enrollment and sticker-price tuition for the universe of Title IV institutions. This sample contains 5,860 unique institutions. We obtain measures of institutional grants (graduate and undergraduate) from the IPEDS Finance survey, which is available for only 60% of our sample, which we use to construct a net tuition measure.

Finally, we supplement the IPEDS/Title IV panel with NPSAS, a restricted-use student-level dataset from NCES. The NPSAS data are obtained from a survey of a nationally representative sample of students from Title IV institutions. The primary objective of the NPSAS survey is to produce reliable estimates related to student financing of education. NPSAS surveys have been conducted approximately every four years starting in 1988. Because they are only conducted every four years and are a repeated cross-section of the institutions in IPEDS, we do not generally attempt to exploit the

panel dimension of NPSAS. Instead, we mainly rely on the 2004 NPSAS to document pre-policy cross-sectional variation that is only possible to observe with student-level data, since this data allows us to observe not just institutional-level loan and grant totals, but the number of students who are constrained by each of the policy maximums. The 2004 NPSAS contains this detailed financing data for students attending 1,334 unique institutions, with an average (median) of 104 (85) students surveyed per institution. We also employ the 2008 NPSAS survey for robustness, which contains 1,697 unique institutions with an average (median) of 111 (87) students surveyed per institution. Our final estimation sample is dictated by the merge of the Title IV/IPEDS data with NPSAS. Depending on the specification, the number of institutions in the merged Title IV/IPEDS/NPSAS sample ranges between 650, for specifications that require a measure of institutional grants, and 1,060, the number of institutions in our primary sticker tuition specification.

Table 2 reports summary statistics for the variables included in the regressions.

4 Empirical method

As discussed in Section 2, between 2001 and 2012, average college tuition rose 46% in real terms while aggregate student loan originations more than doubled. Absent any identification assumption these joint increases cannot be interpreted causally because of standard simultaneity issues. In this section, we describe a Bartik-like approach that we will use to isolate the impact of a credit expansion on college tuition by sorting universities ahead of the federal policy changes in terms of student-loan eligibility. Before doing so, we discuss federal student loan and grant eligibility criteria and describe the policy changes.

4.1 Eligibility for Federal Student Aid Programs

The amount of aid that students who attend Title IV-eligible institutions are eligible for is governed by individual maximums that are a function of the education cost and family income, and by overall program maximums that apply to all students. We exploit variation in each program maximum to study the (separate) impact of federal student aid and loans on tuition.

Students can qualify for federal loans and grants by filling out the Free Application for Federal Student Aid (FAFSA).[6] The primary output from the FAFSA is the student

[6] Eligible federal aid recipients must be registered with the Selective Service System; be a U.S. citizen, or eligible non-citizen; have a valid Social Security Number; have a high school diploma or GED; not owe refunds on federal grants; not be in default on a current federal student loan; and not have been

expected family contribution (EFC), which represents the total educational costs that students and/or their families are expected to contribute. This number is determined by a somewhat complex calculation, which has changed over time, and that takes into account family and student income and savings, family size, and living expenses. The EFC is forwarded to a student's prospective schools. Aid eligibility is then determined by the EFC along with the institution-specific costs and aid policies.

A student's aid package is determined through a hierarchical process starting with need-based aid, which includes Pell Grants and subsidized loans, as well as Federal Work Study and Federal Perkins Loans (which are both smaller). This form of aid is capped at a student's "financial need," which is the portion of the cost of attendance that is not covered by the EFC. The COA includes tuition, room and board, and other costs or fees. Maximum need-based aid is then:

$$\text{Pell Grants} + \text{Subsidized Loans} \leq \text{Financial Need} = \text{COA} - \text{EFC}, \tag{1}$$

where the left-hand side omits, for simplicity, other (less-important) need based aid. In addition, in order to be eligible for a Pell Grant, a student must have an EFC below a certain threshold, regardless of how large the specific COA and thus how much financial need they have. The Pell Grant amount offered also decreases with EFC. This is in contrast to subsidized loans, for which maximum amounts do not depend on EFC aside from (1). The hierarchical aid assignment is such that students who are eligible for a Pell Grant will be offered it to cover their financial need before any loan or other need-based aid.

Eligibility for non-need-based federal aid (which include Unsubsidized Loans and PLUS loans) is determined by computing the portion of the COA that is not covered by federal need-based aid or private aid (e.g. institutional grants):

$$\text{Unsubsidized Loans} + \text{PLUS Loans} \leq \text{COA} - \text{Need-Based Aid} - \text{Private Aid}. \tag{2}$$

As discussed in more detail in the next section, at the intensive margin, changes in each program maximum are the main supply-driven determinant of equilibrium federal aid amounts, but demand can also play an important role. For example, changes in EFC and COA may affect how much aid students are eligible for through the above equations. In addition, while students should always accept Pell Grants, they may or may not accept loans if they have other ways to fund their education.

been found guilty of sale or possession of illegal drugs while federal aid was being received.

4.2 Changes in Federal Student Aid policies

Yearly levels of federal aid maximums are summarized in Table 1. In this section, we discuss the policies that changed these maximums–subsidized loan maximums were raised in the 2007-2008 school year, unsubsidized loan maximums in the 2008-2009 school year, and Pell Grant maximums were raised and frozen through a series of appropriations and acts–and show that these policy changes had substantial effects on aggregate loan originations.

The first loan policy change we study is the Higher Education Reconciliation Act (HERA) of 2006. One of the HERA goals was actually to lower the amount of student borrowing through an increase in student loan interest rates. However, in addition to increasing rates on student loans, HERA also increased the yearly borrowing caps, which had remained unchanged since 1992, for freshmen to $3,500 from $2,625 and to $4,500 from $3,500 for sophomores. Borrowing limits for upperclassmen remained unchanged at $5,500. Signed into law in February of 2006, the act took effect July 1, 2007, so that the change was in place and well anticipated prior to the 2007-08 academic year. This borrowing maximum was a joint cap on combined subsidized and unsubsidized loans, since students who were constrained by their calculated financial need to a subsidized loan amount below the combined cap were allowed to take out an unsubsidized loan for the remaining cap. Thus, we expect the main effect of the policy change to be on subsidized loans, as students who had financial need exceeding the program cap were allowed to increase their subsidized loan amount, but we should also expect to see an increase in unsubsidized loans for students who had already met their subsidized loan maximum due to financial need constraints under the previous cap.

Indeed, in the 2007-08 year, subsidized loan originations to undergraduates jumped from $16.8 billion to $20.4 billion (Figure 2), and consistent with the higher usage intensity, the average size of a subsidized loan rose from under $3,300 to $3,700, as shown in Figure 6, which reports average loan amounts per borrower. Unsubsidized loan originations also show increases, though they are smaller, with the total amount borrowed by undergraduates increasing from $13.6 to $14.7 billion, and the average per-borrower amount increasing from $3,660 to $3,770.

We provide additional evidence of the effect of the policy change on loan amounts using the Federal Reserve Bank of New York Consumer Credit Panel. The panel is based on a data sample provided by the consumer credit reporting agency Equifax Inc., and provides panel information on household debt, including student loans, although with-

out distinguishing between federal subsidized, unsubsidized and private student loans.[7] Figure 7 plots a histogram of student loan amounts in the 2006-2007 school year and again for the 2007-2008 school year, after the policy change. The "before" plot shows a large mass of borrowers concentrated on the unconventional amount of $2,625, the maximum amount of combined sub/unsubsidized loans supplied to freshmen borrowers. In contrast, the "after" plot shows the largest mass of borrowers concentrated at $3,500, the new maximum combined loan amount to freshmen borrowers. The plots also show a large mass of borrowers at cap amounts established for upperclassmen before and after the policy change. This shift is evidence that there was a large and immediate effect of the policy change on loan amounts.

The second loan policy change was the Ensuring Continued Access to Student Loans Act of 2008. Prior to this act, in addition to combined subsidized and unsubsidized amounts discussed above, independent students were eligible for as much as $5,000 ($4,000 for freshman and sophomores) in additional unsubsidized loans. Dependent students were not eligible for these additional unsubsidized loans. This act made dependent students eligible for $2,000 in additional unsubsidized loans and also increased the maximums for independent students by an additional $2,000, starting in the 2008-2009 school year. Figure 2 shows that undergraduate unsubsidized loan originations jumped from under $15 billion to $26 billion in one year. It is worth noting that the act was passed in anticipation of private student loans becoming more difficult to obtain due to the financial crisis, and so some or all of these new originations may have partly replaced private loans. Additionally, the act was passed in May of 2008, after many financial aid packages had already been sent out for the academic year 2008-2009. Schools were told they could revise their offers to accommodate the new policies for the upcoming school year, which seems to have been often the case based on the data series. That said, due to the timing of the change, the full impact of the higher caps may have had real effects in more than a single year.

Finally, Pell Grant maximums were adjusted several times in our sample. They rose gradually from $3,375 to $4,050 between 2001 and 2004 through the ED appropriation process. They were then frozen at $4,050 for four years, until the Revised Continuing Appropriations Resolution of 2007 increased the maximum Pell Grant to $4,310 for the 2007-2008 school year, and the College Cost Reduction and Access Act, passed by Congress on September 7, 2007 scheduled more increases from $4,310 in 2007-2008 to

[7] A number of papers have used this data to study loan repayments (see, for example, Lee, Van der Klaauw, Haughwout, Brown, and Scally, 2014). We use this alternative source because NPSAS data is only available in the years 2004, 2008, and 2012, and is a repeated cross-section rather than a panel.

$5,400 by the 2010-2011 school year. These maximums are only available to students with an EFC below a certain threshold. However, students with slightly higher EFCs are eligible for smaller Pell Grants, according to a scale. For all of the policy changes we consider, these smaller Pell Grants increased proportionately with the maximum Pell Grant. Pell Grant disbursements are plotted in Figure 5 against aggregate loan amounts; both show large increases over our sample period.

Based on these large increases in student borrowing and grant aid disbursed, one should expect these policy changes to boost demand for education and for institutions to either accommodate this additional demand through an increase in enrollments, an increase in tuition, or a combination of the two. To the extent that seats are relatively inelastic in the short run, we would expect the price effect to always be present. Some direct evidence of the relevance of these policy changes to tuition levels can be found by looking at earnings call discussions between senior management at for-profit universities and analysts around the time of the policy changes we study.

Although for-profit universities are under-represented in the NPSAS dataset used in our main results, much attention has been devoted to the for-profit sector in the context of federal student aid programs given their governance and the fact that a substantial fraction of their revenue (over 75% on average) comes through tuition funded through federal student aid programs. Below, we quote from an earnings call of one of the most prominent for-profit education companies, the Apollo Education Group (which operates the University of Phoenix) in early 2007:

> **<Operator>:** Your next question comes from the line of Jeff Silber with BMO Capital Markets.
> **<Q - Jeffrey Silber>:** Close, it is Jeff Silber. I had a question about the increase in pricing at Axia; I'm just curious why 10%, why not 5, and why not 15, what kind of market research went into that? And also if you can give us a little bit more color potentially on some of the pricing changes we may see over the next few months in some of the other programs?
> **<A - Brian Mueller>:** The rationale for the price increase at Axia had to do with Title IV loan limit increases. We raised it to a level we thought was acceptable in the short run knowing that we want to leave some room for modest 2 to 3% increases in the next number of years. And so, it definitely was done under the guise of what the student can afford to borrow. In terms of what we will do going forward with regards to national pricing we're keeping that pretty close to the vest. We will implement changes over time and we will kind of alert you to them as we do it.
> **Source:** Apollo Education Group, 2007:Q2 Earnings Call, accessed from Bloomberg LP Transcripts.

As evidenced by this quote, Title IV loan limit increases did appear to directly affect how this institution chose to set its tuition in those years. Additional excerpts are quoted in Appendix C. In Appendix D, we also show that the passage of the three pieces of student aid legislation were associated with nearly 10% abnormal returns for the portfolio of all publicly traded for-profit institutions. This is consistent with the fact that changes in Title IV maximums had large implications in terms of demand at these institutions. We turn to this issue in the next section using a statistical model.

4.3 Empirical model

To motivate the empirical approach in this paper, we first consider a naive OLS regression of yearly changes in sticker-price tuition on changes in per-student federal aid in 2002-2012. We include institution and year fixed effects so the coefficients are identified from within-institution variation that is not explained by aggregate trends. When included one at a time in the regression (columns 1-3, Table 3), changes in each form of Title IV aid enter with a positive and statistically significant coefficient ranging from .04 (unsubsidized loans) to about .06 (subsidized loans and Pell Grants). The point estimates are less precisely estimated and about half as large when all forms of Title IV aid are included in the regression. Interpreting these point estimates in a causal sense is subject to a number of issues. First, because of the joint determination of tuition and federal aid amounts discussed in the previous section, these coefficients could be grossly overstated. But also a number of other factors which are omitted in this regression will affect changes in tuition as evidenced by the relatively low explanatory power of the aid measures beyond the common fixed effects across the specifications. Depending on the correlation of these omitted factors with the federal aid measures, the impact of federal aid on tuition could be either over- or understated.

To resolve these identification issues, note that while in principle, these changes affected students at all Title IV institutions, in practice, changes in program maximums have a differential effect on certain institutions because of differences in eligibility and participation of students in these programs. Our identification approach exploits these cross-sectional differences. We follow a standard labor economics approach to analyze the impact of labor demand shocks (Bartik, 1991; Blanchard and Katz, 1992), and estimate the impact of the policy changes through an instrument equal to the interaction between the shift in federal aid and the pre-policy importance of this aid at each university. In other words, the logic of this instrument is that the increase in federal aid impacted institutions differently based on the pre-policy importance of this

aid for each institution, and that this difference-in-differences variation can identify the desired coefficients. We discuss the construction of these exposure variables below.

Policy exposures. As discussed in Section 4.1, key determinants of federal student loan eligibility are students' income levels and a university's cost of attendance. However, using these as measures for the pre-policy aid importance may raise concerns about other unobserved factors, since these measures may be strongly correlated with other institutional features that could affect tuition during the years of the policy change.

To help address these concerns, we use the restricted student-level dataset NPSAS to define a narrower and more precise identification criterion of the pre-policy importance of different types of aid at each institution. Consider first the case of subsidized loans. If a student's individual maximum is below the program maximum, she cannot qualify for the program maximum and is thus unaffected by any changes to it. Additionally, some students may choose to borrow less than the amount they are eligible for, and will thus also be unaffected. Thus, changes in program maximums only affect students who qualified for (their individual cap was greater than the program cap) and would accept loans at the amount of the program maximum. We thus define an institution's "exposure" to the subsidized loan policy change as the fraction of undergraduate students who borrowed subsidized loans at the policy maximum in 2004, since this corresponds to approximately the fraction of students we would expect to be able and willing to take advantage of the policy change to borrow more subsidized loans.

For unsubsidized loans, we must consider two policy changes. The first change is the 2007-2008 increase in the combined subsidized and unsubsidized cap discussed above. To measure the effect of this policy on *unsubsidized* loans, we treat students as "exposed" if they were constrained by their individual cap in the amount of subsidized loans they were borrowing, but who were borrowing additional unsubsidized loans to meet the program cap.

The second policy change was the 2008-2009 addition of $2,000 in additional unsubsidized loans. Since dependent and independent students are treated differently, we sum exposures for these two types of students. For independent students, we again take the fraction of students who were borrowing at the independent policy maximum in 2004. For dependent students, who were previously ineligible for unsubsidized loans and became eligible through the policy change, we construct a shadow participation rate since we cannot observe past participation. This measure is the subset of eligible students, or the fraction of dependent students at each institution, that borrowed the maximum amount of subsidized loans that they were eligible for, including students

who were not eligible for any subsidized loans.[8] The intuition for this rule is that a student that could, but did not, borrow in the subsidized program will not borrow in the unsubsidized program, as it is more expensive to do so, and should therefore not be counted as a student constrained by the unsubsidized program cap. However, this measure is likely not to be as reliable as the one for subsidized loans, since among other things, it assumes that any dependent student borrowing the maximum amount of subsidized loans would also borrow the maximum amount of unsubsidized loans once eligible.

Finally, for Pell Grants, changes in the maximum Pell Grant amounts shift the supply of grants for all grant recipients. Thus, the Pell Grant exposure variable is calculated as the percent of students at a given institution awarded any positive Pell Grant amount as of 2004. As we will see below, because the policy shift applies to all amounts –rather than just a certain threshold – Pell Grant exposure displays a fairly high degree of correlation with EFCs, which also may complicate identification.

Table 2 reports summary statistics for the exposure measures as of 2004. About 15% of all students that borrowed were at the subsidized loan cap in 2004 compared to 27% of students at the unsubsidized cap. In contrast, about 34% of students received a positive (not necessarily the maximum) amount of Pell Grants. The exposures also display significant variation, with a standard deviation of between 14% (subsidized loans) and and 21% (unsubsidized loans). The table also reports summary statistics for the exposure variables computed from the 2008 NPSAS, for those institutions that reported both in the 2004 (baseline sample) and in 2008 survey. Average levels of Pell Grant and unsubsidized loan exposures are very similar in the two surveys, but the subsidized exposure is significantly smaller, owing to the fact that the second NPSAS wave takes place after the increase in the subsidized loan maximum. Indeed, as the maximums are increased, the fraction of capped students should drop unless all students at the old maximum jump to the new maximums.

Empirical specification. In the main regression specification, we regress the date t yearly change in institution i characteristic Y_{it}

$$\Delta Y_{it} = \sum_a \beta_a \, \text{ExpFedAid}_{ai} \times \Delta\text{CapFedAid}_{at} + \gamma X_{it} + \delta_i + \phi_t + \epsilon_{it}, \tag{3}$$

[8] As discussed in Section 4.1, subsidized loans are need-based, while unsubsidized loans are not, it is possible to be eligible only for unsubsidized loans.

on a set of controls. The key explanatory variable is a measure of institution-specific change in aid maximums, measured as the interaction of institution i exposure to each federal aid program cap a (ExpFedAid_{ai}) and the yearly change in the program caps ($\Delta\text{CapFedAid}_{at}$). We include all three interaction measures in each regression to control for possible correlations in the exposures and timing of the policy changes and for potential substitution effects. For variables expressed in dollar terms (for example tuition and aid levels) we specify the regressions in dollar differences because the policy changes affected dollar, rather than percentage, amounts. We also include in each regression time effects and institution fixed effects. Given that the variables are specified in yearly differences, these effects control for institution specific trends, and changes that affect all institutions in a given year. Finally, we also control for a set of other controls X_{it} as described in the results section.

Our main variable of interest Y_{it} is sticker-price tuition. In the above regression, each coefficient β_a measures the sensitivity of tuition to the changes in the maximums. We also show results where we use institutional aid amounts as the dependent variable Y_{it} to verify that our exposure variables are correlated with changes in average loans and grants awarded in policy year, and as a first stage for the IV described below.

An alternative coefficient of economic interest is the sensitivity of tuition to the equilibrium institutional-level aid amounts. To obtain these, we consider an IV regression, where the first stage uses equilibrium aid amounts as the dependent variable Y_{it} in (3) to construct an instrumented change in each institution's per-student federal aid, $\widehat{\Delta\text{FedAid}}$. The second stage then regresses the date t yearly change in each institution i variable of interest T_{it}

$$\Delta T_{it} = \sum_a \phi_a \widehat{\Delta\text{FedAid}}_{ait} + \gamma X_{it} + \delta_i + \phi_t + \epsilon_{it}, \tag{4}$$

on this instrument. As before, the regression includes institution and year fixed effects and a set of additional controls X_{it}. In contrast to the OLS estimates above, which measure the sensitivity of tuition to relaxing the program maximums or caps, these IV estimates measure the sensitivity of tuition to equilibrium changes in aid amounts, which are determined by the change in the caps as well as the elasticity of aid demand. If there are high aid elasticities, we expect ϕ_a and β_a should be very similar in magnitude. As discussed in Section 3, we measure financial aid levels with error because, among other things, they include both undergraduate and graduate amounts. Because of these issues, and because of the direct effect of legislation on the program maximums, we

will be focusing mostly on the OLS estimates β_a as opposed to the IV estimates of ϕ_a below.

We also show results for other dependent variables Y_{it} and T_{it} such as institutional grants and enrollment, and for robustness, the percentage rather than level change in these variables, though this has some interpretation issues that we discuss.

5 Main empirical results

5.1 Sticker tuition and aid sensitivity to changes in program caps

Baseline specification. We regress yearly changes in student aid levels (columns 1-3, Table 4) and sticker tuition (column 4) on our interaction measure of institution-specific change in aid maximums, measured as the product of the yearly change in each program cap (only varies over time) and the fraction of students at each institution that qualify for (and are likely to accept) the increased student aid amounts. Each regression is estimated between 2002 and 2012 and includes year and institution fixed effects, with standard errors clustered at the institution level to account for serial correlation of the error terms.

In column 1, yearly changes in Pell Grants load on the institution-level change in the Pell Grant maximum with a coefficient of 1.2, which is significantly different from zero at the 1% level but not different from one at conventional statistical levels. One would expect the elasticity of Pell Grant demand to be infinite as any student should accept grant amounts given that this form of aid is not subject to any form of repayment. A coefficient of one means that an increase in Pell Grant availability results in a one-for-one increase in the equilibrium grant amount disbursed. The fact that the coefficients on the unsubsidized and subsidized loan maximums are close to zero implies that a greater availability of these other sources do not displace Pell Grants.

Moving to the subsidized (column 2) and unsubsidized (column 3) loan results, it is useful to keep in mind that although subsidized loans require a principal repayment, interest on this principal is paid by the ED while a student is in school, suggesting the elasticity of demand for these loans should be relatively high. The demand elasticity for unsubsidized loans could be in principle lower, and should depend on whether borrowers are constrained as well as the interest rate differential on these loans relative to those on other financing alternatives. From the point estimates reported in column 2 we see that subsidized loans load with a coefficient of .7 on the institution-level change in the subsidized loan maximum, while unsubsidized loans load with a coefficient of .57 on the unsubsidized maximum. Both coefficients are different from zero and one at

conventional levels. In terms of substitution across aid types, the institution-level Pell Grant maximum change enters each loan regression with a negative and statistically significant sign, suggesting that a greater availability of Pell Grants displaces these other forms of aid. This crowd-out effect may be the result of a lower demand or reduced eligibility as implied by equations (2) and (1). The crowd-out effect is also consistent with Marx and Turner (2015) who find that increases in Pell Grant aid lower student loan borrowing using a kink regression discontinuity design.

Having documented the large responses of federal aid amounts measured at the institution level to changes in the measures of institution-specific program aid maximums, we focus next on the response of sticker tuition to changes in these maximums. Point estimates (column 4) suggest that a dollar increase in the Pell Grant cap translates into a 37 cent increase in sticker price (t-stat $= 2.5$). An increase in the subsidized cap results in a 58 cents on the dollar increase in sticker price (t-stat $= 3.4$), and finally an increase in the unsubsidized maximum maps into a 17 cents on the dollar increase in sticker price (t-stat $= 4$). These estimates are with respect to the institution-specific maximums as opposed to the overall maximums, meaning that they measure the sensitivity of tuition (and per-student aid amounts) to changes in maximums per qualifying student. The estimates provide support to the Bennett Hypothesis, with an average passthrough of increased student aid supply to tuition of around 40 cents on the dollar, although there is substantial heterogeneity across aid types.

IV specification. Thus far we have estimated the direct sensitivity of sticker tuition to changes in the program aid maximums. An alternative measure of interest is the sensitivity of sticker tuition to the equilibrium aid amounts. With a unit sensitivity (infinite elasticity) of aid amounts to the caps, the coefficients of tuition to equilibrium per-student aid and caps would be identical. As shown in Table 4 the aid elasticities we estimate are close but not exactly equal to one. Table 5 reports regression estimates for the second stage of the IV regression of tuition on aid amounts where each aid measure is instrumented by the institution-specific measure of change in aid maximums. Again, each regression includes institution and year fixed effects, and standard errors are clustered at the institution level. We first regress (columns 1 to 3) changes in tuition on each form of student aid separately. Changes in sticker-price tuition have a coefficient of 0.2 on the change in Pell Grant amounts (column 1, t-stat $= 1.58$). The effect of an increase in subsidized loan amounts is higher and more significant, at 85 cents on the dollar. This effect is estimated to be statistically significant at the 1% confidence level. Finally, we see the effect of a change in unsubsidized loan amounts on sticker price

tuition to be smaller, at about 26 cents on the dollar, but still highly significant. When we include all regressors in the same regression model, the coefficients on Pell Grants, subsidized and unsubsidized loan amounts are all significant at the 1% level and equal to .49, .77, and .24, respectively. These estimates are similar to the direct sensitivities of sticker tuition to the measure of institution-specific aid maximums.

5.2 Net tuition, institutional grants and enrollments

Net tuition and institutional grants Many universities award students institutional grants based on need or merit that may reduce the amount that a student must fund through family contributions or federal aid. Therefore, it is possible that the sensitivities of changes in sticker price tuition to aid maximums that we measure are actually uninformative of the sensitivity of the price students are actually paying, because universities may be reducing (increasing the sensitivity) or increasing (reducing the sensitivity) their institutional grants alongside changes in their sticker price tuition.

Unfortunately, changes in the true average "net tuition," which would subtract institutional grants from sticker price tuition, is poorly measured in all the data sources we considered, as discussed in Section 3. We use two different approaches to show that institutional grants do not seem to be canceling out the effect we measure above (and if anything, seem to enhance it). First, we show that changes in sticker tuition are reflected in prices paid by students by comparing NPSAS waves. Second, we replicate our baseline specification with a measure (albeit imperfect) of institutional grants and net tuition.

In the first approach we begin by forming four portfolio quartiles of students for each of the institutions that appear in both the 2004 and 2008 NPSAS samples by sorting students within each institution and year by their net tuition, as measured by the difference between sticker tuition and institutional grants.[9] We then regress the 2004 to 2008 change in net tuition for each portfolio bucket on the (single) university 4-year change in sticker-price tuition used in our main results. As shown in Table 6, changes in net tuition in the top quartile load with a coefficient of about 0.95 on changes in sticker tuition. The loading drops uniformly through the lower quartiles to a passthrough of about 0.37 in the bottom quartile. Intuitively, these results mean that changes in the sticker price of tuition pass-through nearly one-for-one to students in the top quartile of net tuition –- those that receive the fewest institutional grants, but

[9] Because of differences in credits or in-state versus out-of-state status, sticker tuition can display within-university variation. Because NPSAS is a repeated cross-section in this exercise we simply define sticker price as the average sticker price tuition in each university.

less so for the lower quartiles –- those that receive more institutional grants. Overall, however, these estimates suggest the effect of sticker-price tuition on net tuition is sizable, and that all quartiles of net tuition changes are positively correlated with the sticker-price tuition change.

Our second approach to analyzing whether institutional grants undo increases in sticker tuition utilizes institutional grant data from the IPEDS Finance Survey. This measure records expenditures on scholarships and fellowships by each institution, but is only available for 60% of our sample, and includes both graduate students and undergraduate students, making it an imperfect measure for our purposes. We scale this measure by total (full-time-equivalent) enrollment. As shown in Table 7, an expansion in Pell Grants is associated with a reduction in institutional grants of 30 cents on the dollar (t-stat = 2), while an increase in subsidized loans is associated with a decline in institutional grants of about 20 cents on the dollar (t-stat = 1.7), and unsubsidized loans have a coefficient not significantly different from zero. The results for Pell Grants are consistent with Turner (2012), who, using a regression discontinuity approach, finds that institutions alter institutional aid to capture increases in Pell Grants. In column 2 we regress the difference in sticker price and institutional grants and find a sensitivity with respect to Pell Grant maximums of about .4 (t-stat = 1.6), to subsidized loans of about .88 (t-stat = 3) and to unsubsidized loans of about .15 (t-stat = 2.2). Although only available for a subsample of the original sample, these results suggest that the increase in federal aid resulted in increases in net tuition similar to those in sticker tuition because of (at times) significant declines in institutional grants.

Enrollments We turn our attention next to the study of enrollment decisions. In principle one would expect that as long as increased availability of Pell Grants is not completely offset by increased tuition costs, the increased availability of Pell Grant aid should positively affect students' enrollment decisions. Based on the results in the previous section, the effects of greater loan supply may be mixed, as relaxing borrowing constraints should increase participation but higher tuition would lower it. A large literature exists attempting to answer the question of whether or not, and to what degree, decreases in price influence college attendance and college choice (see for example the review of Deming and Dynarski (2009)).[10] As shown in column 3 of

[10]They conclude that most studies of federal aid find that additional grant aid is associated with significant increases in attendance (e.g. Seftor and Turner (2002) for Pell Grants; Angrist (1993), Stanley (2003), Bound and Turner (2002) for GI Bills; Dynarski (2003) for Social Security student benefit program), though, for Pell Grants the evidence is mixed, as (Hansen (1983) and Kane (1995) find no significant increase in attendance following the introduction of Pell Grants). Many fewer studies look at federal loan aid; one exception is Dynarski (2002) who finds a very small effect on attendance and

Table 7, we find a positive and statistically significant coefficient on institution-specific changes in caps for Pell Grants, and an insignificant coefficient on subsidized loan caps and a significant and negative coefficient on unsubsidized loan caps. The point estimate on Pell Grants is economically significant – for example the 2010 increase in Pell amounts at the mean Pell exposure ($(5350-4731)\times .34 = 210$) would have implied a boost in enrollment of about 3.5%. Importantly, however, this regression only measures short-run changes in enrollments while it may take time for institutions to expand their capacity. We return to this point in Section 6.3, as we study changes in funding/aid over the years preceding the policy changes that we have discussed thus far.

6 Additional empirical results

We first discuss the robustness of the empirical findings uncovered in the previous section. We then attempt to identify the set of institutions for which the passthrough from aid to tuition was strongest by interacting our measures of institution-specific changes in aid maximums with institution characteristics. Finally, we look at trends in tuition, aid, and enrollment prior to the policy changes, in order to identify what effect, if any, the grant and loan programs had on tuition outside our policy years.

6.1 Robustness of baseline specification

As noted in Section 4, the key to our identification approach is the construction of institution-level measures of changes in federal aid caps using detailed student-level data, which, up to time variation in these exposures, can pinpoint the fraction of students at each institution that will be exposed to the policy changes. A key concern to this identification is that tuition and aid at these institutions may have behaved differently, even if changes in the program maximums had not taken place. While we cannot directly run a counterfactual, we attempt to address this issue by first running a placebo regression whereby changes in aid maximums are assumed to take place in other years. We then include controls in the regression to account for other student body characteristics that may affect our treatment selection equations (1) and (2).

Placebo analysis In the baseline model (equation 3), we identified tuition and aid sensitivities to changes in institution-specific program maximums from the cross-sectional differences between more and less exposed institutions in years of policy changes, mea-

a larger effect on college choice. In general, this literature is focused on student-level choices, and does not necessarily address the question of whether institutions facing increased demand will correspondingly raise enrollments.

sured as the regression coefficients β_a, on each interaction measure of institution-level program maximum changes. To see if more and less exposed institutions experienced similar tuition and aid trends in the years when caps were not raised, we analyze how the β_as would have been estimated had we (as a placebo) analyzed cross-sectional differences in tuition and aid in years where no actual policy occurred. For each aid of type a we estimate the following:

$$\Delta Y_{it} = \sum_t \xi_{at} \, \text{ExpFedAid}_{ai} + \sum_{\alpha \neq a} \beta_\alpha \text{ExpFedAid}_{\alpha i} \times \Delta\text{CapFedAid}_{\alpha t} + \gamma X_{it} + \delta_i + \phi_t + \epsilon_{it}. \tag{5}$$

Here we control for the other aid types (α) that are not to subject to a placebo by interacting them with the corresponding actual changes in program caps as in the baseline specification (3). For aid a, instead, we estimate a series of yearly cross-sectional regressions of changes in tuition and aid on their exposures to aid. The coefficients ξ_{at} identify, in each year, abnormal changes in the dependent variables relative to the omitted or baseline year. We set the baseline year to be 2006, which is when the first of three major legislative acts affecting program caps was passed.

For each type of aid, time series estimates for ξ_{at} are shown as the orange lines in the top, middle and bottom panels of Figure 8. We also plot 95% pointwise confidence intervals, and include gray bars indicating the actual changes in each program maximum weighted by the average cross-sectional exposures (measured on 2004 NPSAS) for each aid type. For comparability, scales are set equal across all charts. For subsidized loans, the loading on subsidized exposure ξ_t of subsidized loan amounts (panel a) and tuition (panel b) spike coincident to the changes in subsidized maximums (gray bar) and are both significant at the 5% levels. For sticker-price tuition we indeed observe the largest spike in 2008, but also observe higher sensitivity in 2007 and 2009, which may be consistent with some sluggish tuition adjustment or anticipatory effects from announcement to implementation of these policies.

For unsubsidized loans we observe a very similar pattern with respect to loan amounts (panel c) with spikes on the loadings on exposure that are coincident to the policy changes (2008 and especially 2009). Tuition's loading on exposure (panel d) display higher than average levels in 2007 and 2009, and only the 2009 change is significant. Given that in equation (5) we control for the actual change in unsubsidized loans and that the 2008 change for unsubsidized maximums takes place in the context of combined subsidized/unsubsidized cap, it is perhaps not too surprising that we are unable to observe a 2008 impact on tuition. The 2009 change in unsubsidized loans

is also coincidental to the freezing of the private student loan market. This fact may help explain in part the much more significant spike in exposure sensitivity for loan amounts relative to tuition.

The bottom two panels show parameter estimates for Pell Grants. Policy changes for Pell Grants are much more gradual and take place in multiple years. In those years, the cross-sectional expansion in Pell amounts are significantly related to the institution exposures (significant at 5%) in contrast to the changes in sticker prices, which are not statistically larger in those years. In sum, the placebo tests confirm that NPSAS exposures are valid sorting variables for aid amounts. In terms of tuition, we find that cross-sectional differences in tuition changes with respect to aid exposures are coincident for subsidized and (to a lesser extent) for unsubsidized loan amounts, but not for Pell Grants.

Additional controls. As additional robustness we add a set of controls X_{it} to the baseline specification (3). In Section 4.2, we presented anecdotal evidence of management discussion at earnings calls of for-profit post-secondary institutions suggesting that changes in sticker tuition were partly driven by changes in Title IV program maximums. A first question of interest is to establish to what extent the results that we presented in Section 5 are identified by differences between education institutions in the for-profit sector in our sample versus others. It is important to recall, however, that persistent tuition differential trends between the for-profit and other sectors are absorbed in our regression setting by the institution fixed effects included in the baseline specification. Here we will include an interaction between for-profit status and each of the the three changes in the program caps: $\langle \Delta \text{PGCap}_t, \Delta \text{SLCap}_t, \Delta \text{USLCap}_t \rangle$. The inclusion of these controls do not appear to significantly change the point estimates on the measures of institution-specific program caps (column 1 in Table 8) relative to the baseline (column 4 in Table 4).

In addition to containing for-profit and not-for-profit universities, our sample also has heterogeneity along several other dimensions that could potentially affect tuition and aid changes differentially: e.g., the type of degree(s) offered, (Figure 4), how selective and expensive they are, and the average income of the students enrolled. If these characteristics are correlated with differential (relative to both institutional and aggregate trends) tuition and aid expansions in the policy years, they could potentially bias our coefficients. For example, if community colleges offering 2-year degrees experienced a boost in demand, and consequently increased tuition, amid the high unemployment levels experienced during the Great Recession. Once again, to the ex-

tent that these institutional characteristics affected tuition across all years, their effect would be absorbed by the institutional fixed effects that we include in the regressions. To control for the possibility of differential effects in policy years, we again interact a 4-year program dummy, the admission rate, average EFC, and average level of tuition (all measured in 2004) interacted with the changes in the caps. As shown in column 2 of Table 8, which includes these additional 18 controls, while the coefficient on the subsidized loan cap is largely unaffected both in magnitude and its significance, those on Pell Grants and especially the one on unsubsidized loans drop in magnitude and become insignificant. These results may be evidence of omitted factors driving the Pell Grant and unsubsidized loan result or, alternatively, evidence that it is hard to identify variation in exposures to these policies that is independent from average students' income level and tuition levels.

From cross-sectional correlations between each of the aid exposure variables with EFC and tuition (Table 9), we indeed see that EFC is highly correlated with the Pell Grant exposure but displays low to moderate levels of correlation with unsubsidized and subsidized loans. This is because the exposure to Pell Grants is based on the fraction of students receiving any positive grant amount (which is highly correlated with institution's mean student income levels) while loan exposures are only based on students at caps (which depend on a specific percentile of the income distribution).

Next we turn our attention to controlling for changes in other sources of funding that could be affecting tuition. As shown in Figure 4 and discussed in Section 2, universities fund their operations both from tuition revenue, and from other sources such as government appropriations and other sources, including private donations. Much discussion has been devoted to this topic (see, for example, Congressional Research Service, 2014) particularly in the context of changes in state funding and private contributions. To account for possible delays between the time in which these other sources of funding are known to administrators and when tuition is set we consider both current and lagged levels by including 2-year changes of other sources of institution revenues. As shown in column 3 of Table 8, it is indeed the case that a decline in state funding and private funding have been associated with an increase in tuition in the somewhat smaller sample (8,000 observations versus 10,500 in the baseline). We see that the Pell Grant coefficient again loses significance, while the coefficient on subsidized loans is unaffected, and that the coefficient on unsubsidized loans is lower in magnitude but remains marginally significant.

In Appendix A, we show additional robustness checks where we measure exposures

from the 2008 NPSAS wave rather than the 2004 one, and where we specify the dependent variables in logarithm changes rather than level changes. In sum, we find a robust passthrough of federal aid to tuition in the form of subsidized loans and a weaker effect of unsubsidized loans and Pell Grants. For unsubsidized loans in particular, this weakness may be due to limitations to our identification approach, since, as we have discussed in Section 4, the exposures are more difficult to measure, and the policy change coincided with the contraction in the private student loan market and the Great Recession. It is also quite possible that subsidized loans, which represent a more significant subsidy than unsubsidized loans and are awarded to less needy students than Pell Grants, are in fact more economically meaningful in tuition-setting decisions. We believe the results we present on subsidized loans are new to the literature. We find a sensitivity of changes in tuition to changes in subsidized loan amounts on the order of about 40-60 cents on the dollar, with estimates that are highly significant in essentially all of the specifications considered.

6.2 Attributes of tuition-increasing institutions

Results presented thus far indicate that changes in the sticker price of tuition are, on average, sensitive to changes in the supply of subsidized loans, Pell Grants, and unsubsidized loans, with a particularly robust subsidized loan effect. In this section we dig deeper into these results to characterize the attributes of institutions that displayed the largest passthrough effects of aid on tuition.

For each form of aid, we interact in Table 10 the measure of institution-level exposure with key cross-sectional characteristics: whether a program offers four-year degrees, whether the school is a private institution as well as the level of tuition and EFC as of 2004, which is when aid exposures are measured.

In terms of changes in subsidized loan caps (column 1), private institutions and non-four-year institutions (community colleges or vocation institutions) displayed the largest tuition sensitivity, as did those that charged higher tuitions (all results significant at 1% level). In addition, institutions with students having lower EFCs also displayed a higher sensitivity although the difference is not significant at conventional levels (t-stat $= 1.5$). Results for changes in the unsubsidized loan caps (column 2) are similar but are weaker in magnitude and only the (positive) coefficient with tuition levels is significant at conventional levels. Finally none of the interactions between the institution characteristics and the institution-level measures of changes in Pell Grant maximums are significant, suggesting similar effects among institutions in our sample.

In conclusion, we find that more expensive, private, and non-four-year institutions displayed the most sensitivity of tuition to changes in loan maximums, but responses of tuition to Pell Grants displayed a more uniform response across institutions.

6.3 Pre-policy change evidence

Thus far we have focused on changes in federal student aid caps as a means to identify the impact of a credit expansion on tuition. Changes in aid caps mostly occurred between 2008 and 2010, but as shown in Figure 3, the trend in tuition is present throughout the 2001-2012 sample period. Thus while these policy changes may be a useful identification device, they cannot explain this lower frequency tuition pattern. This is not to say that the simultaneous increase in tuition and loan balances only reflected non-credit-related tuition factors that drove loan demand. Indeed while our identification exploits changes in the programs, the existence of the student loan program could be a key contributing factor to the tuition trend, for example through increased enrollments. In Table 3 we regressed yearly tuition changes on federal aid, finding significant coefficients on subsidized, unsubsidized loans and Pell Grants of about 3 cents on the dollar. As discussed in Section 4.3, these estimates should not be interpreted in a causal sense and could either over- or under-estimate the impact of aid on tuition (with our baseline estimates pointing to an under-estimation). Here we discuss a simple alternative approach to evaluate the importance of federal aid to tuition and enrollments, by comparing 2002-07 cross-sectional trends as a function of the importance of federal aid as of 2002. While this approach is superior to a simple OLS estimation, it remains less identified than the cross-sectional approach presented in Section 4.3. Importantly, we showed in Section A evidence for a parallel trend assumption when including institution fixed effects. Here we drop institution effects to study pure cross-sectional differences.

The results of this analysis are shown in Table 11. Drawing an analogy to the identification strategy used before, we construct a measure of ex-ante sensitivity to subsidized loans (top panel), unsubsidized loans (middle panel) and Pell Grants (bottom panel) from the fraction of students in each institution that were recipients of each of the three aid forms as of 2002. We also interact each of these measures with a dummy variable indicating that the variable is above its median level, to study differential sensitivities for more- and less-dependent student bodies on aid. We then regress subsequent five-year (2007-2002) changes in each aid measure, log-enrollment, sticker tuition on the ex-ante dependence. Each regression controls for the original tuition level and

enrollment level.

As shown in the first columns of the three panels, universities that were, as of 2002, more reliant on each type of federal aid experienced sharper increases in each respective aid measure. The sensitivity of the aid expansion was smaller at high levels of subsidized loan dependence, which could be consistent with binding caps (top panel, column 2). Sticker tuition does not appear to respond to the ex-ante dependence on subsidized and unsubsidized loans (columns 3, top and medium panel), however, when we separate the tuition sensitivity by the level of loan dependence, we see that sticker price loads positively on (subsidized and unsubsidized) loan dependence for low levels and negatively for high levels (columns 4, top and medium panel). One interpretation of this result is that students capacity to fund tuition is limited at high levels of dependence because of binding program caps, which remained unchanged between 2002-2007, but not at low levels of dependence when the student body can more easily accommodate tuition increases through aid. Consistent with these interpretations, higher dependence on student loans was associated with an expansion in enrollments (column 5, top and medium panel) with the entirety of this effect coming from low-dependence schools (column 6). The effects on enrollment are significant: moving from zero to 100% of subsidized (unsubsidized) borrowers implies an incremental enrollment growth rate of about 20% (27%) over five years. The tuition sensitivity to Pell Grant dependence (column 3) is negative, which may be associated with binding spending constraints at schools with a higher fraction of low income students. Nonetheless we also see that enrollment grew more at schools that were more heavily dependent on Pell Grants, although with a sensitivity that is about half as large as the one estimated for loan dependence.

In sum, up to the limited identification of the specification in this section, over the 2002-07 sample we observe a positive association between ex-ante aid dependence (as of 2002) and subsequent enrollment expansion. Similarly, more student bodies at schools that were more heavily dependent on aid as of 2002 also experienced more rapid aid growth between 2002 and 2007. In terms of tuition, we observe a positive association as loan dependence increases for low levels of aid dependence, which may be consistent with binding caps at the highest levels of loan dependence.

7 Concluding remarks and additional evidence for the for-profit sector

In this paper, we use a Bartik-like approach to identify the effect of increased loan supply on tuition following large policy changes in federal aid program maximums available to undergraduate students that occurred between 2008 and 2010. We construct institution-specific changes in program maximums as the interaction of an institution exposure to the maximums in each aid program (the fraction of qualifying students) and the legislated program maximums. We find that institutions that were most exposed to these maximums ahead of the policy changes experienced disproportionate tuition increases around these changes, with effects of changes in institution-specific program maximums of Pell Grant, subsidized loan, and unsubsidized loan of about 40, 60, and 15 cents on the dollar, respectively. We find that the effect of a change in the subsidized loan cap is robust to a placebo test and the inclusion of a large number of additional controls, but the effects of unsubsidized loans and Pell Grants are not as strong, which could reflect real differences in how changes to these programs are treated or identification issues. We also observe a decline in institutional grants to students as Pell Grants and subsidized loan caps were relaxed. Consistent with the differential subsidies to students across the aid programs, we also find that increases in Pell Grants were associated with increased enrollments as opposed to cap increases on unsubsidized (subsidized) loans, which led to declines (no change) in enrollments.

From a welfare perspective, these estimates suggest that, while in partial equilibrium one would expect a student aid expansion to benefit its recipients, the loan expansions could have been to their detriment, on net, because of the sizable and offsetting tuition effect. This is not to say that the student loan programs hurt the student population at large more generally. Indeed, these programs may facilitate student access to postsecondary education. This participation effect is especially important given the positive gap between the cost of education and its social or private benefit (Moretti, 2004). While the literature disagrees on the exact magnitude of the returns to higher education (Card, 1999; Avery and Turner, 2012), the "college wage-premium" has been shown to be rising over the past two decades due to demand for skilled workers outpacing supply, and contributing to growing wage inequality in the US (Goldin and Katz, 2009). Given this premium, to the extent that greater access to credit increases access to postsecondary education, student aid programs may help lower wage inequal-

ity by boosting the supply of skilled workers.[11] We find some impact of the policy cap changes in terms of enrollment around the policy changes, but these short run effects may mask more important ones taking place at longer horizons as aid to students and increased revenues to schools lead to expanded capacity and attendance. Consistent with this notion, we show that in the 2002-07 sample, institutions with a larger fraction of federal loan recipients experienced significantly larger growth in enrollments. This suggests that over longer horizons, student loan programs could indeed be boosting access to higher education.

Since the 1972 HEA re-authorization made for-profit institutions eligible to receive federal student aid, the market share of for-profit institutions has grown substantially (Deming, Goldin, and Katz, 2012). For-profit institutions now receive over 76.7% of their revenue on average through Title IV programs. This heavy dependence on federal aid has led to increased regulation of these institutions by the federal government in recent years. Our data contains limited information on these institutions (less than 10% of institutions in NPSAS04). We present some anecdotal evidence that for-profit institutions react to federal aid changes using earnings call discussions and stock market responses in Section 4. In Table 12, we provide additional evidence on the differential effect of these increases on for-profit institutions by comparing changes in aid amounts at for-profit (top panel) and other institutions (bottom panel) in our sample period. For each type of institution (and panel) we regress yearly changes on year dummy variables (reported at the top of each panel and with the year 2006, which is the year preceding the policy changes, serving as the omitted year) as well as on a policy year dummy variable which is equal to one for the 2008, 09 and 10 academic years when the federal aid changes went into effect (reported at the bottom of each panel). As shown in the bottom section of the panels, for-profit institutions experienced significantly larger increases in disbursed aid over the years of the aid cap changes. Correspondingly, these institutions also displayed sticker tuition increases of about $212, on average, as compared to $56 for non for-profit institutions. These larger tuition increases are consistent with the results in the paper and the heavy reliance of for-profit institutions on federal student aid. This raw comparison has obvious limitations; for example, it does not allow us to separate the effects of the different forms of aid. Given the recent policy initiatives directly targeting aid for students attending for-profit institutions, a better understanding of the role of student borrowing for these institutions remains a

[11] Lochner and Monge-Naranjo (2011) develop a theoretical model to analyze students' borrowing decisions as a function of the returns to college education.

fruitful area of research.

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Figure 1: **Non-mortgage-related Household Debt Balances** This figure shows the time-series evolution of non-mortgage-related debt balances. Amounts shown are in nominal terms. Source: NY Fed CCP/Equifax.

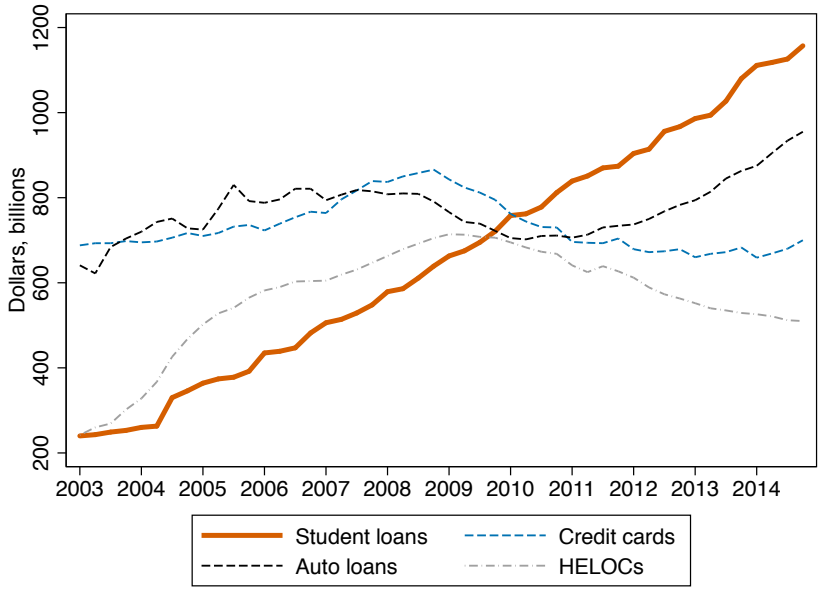


Figure 2: **Aggregate Student Loan Originations** This figure shows the time-series evolution of aggregate student loan originations by program type. Amounts shown are in nominal terms. Source: College Board.

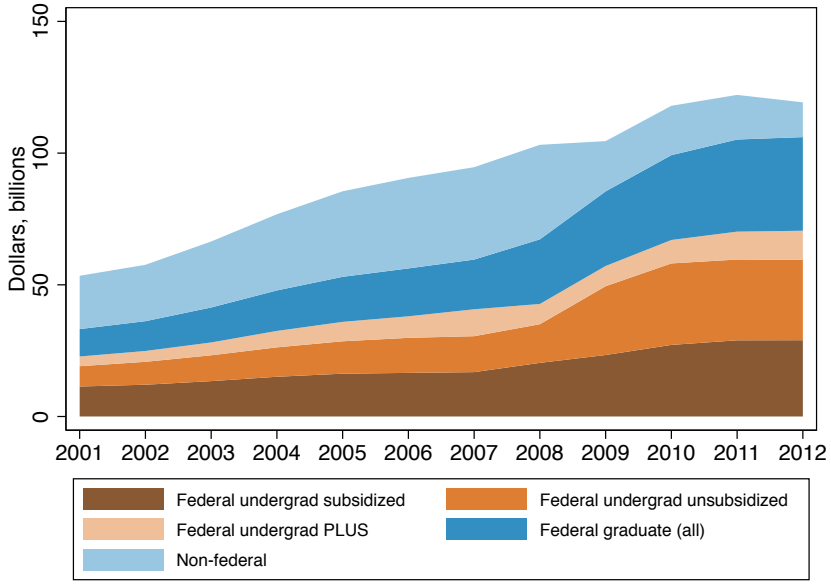


Figure 3: **Sticker Tuition and Per-student Federal Student Loans** This figure plots average undergraduate sticker-price tuition and average federal student loan amounts per full-time-equivalent student. Amounts shown are in 2012 dollars. Source: IPEDS/Title IV.

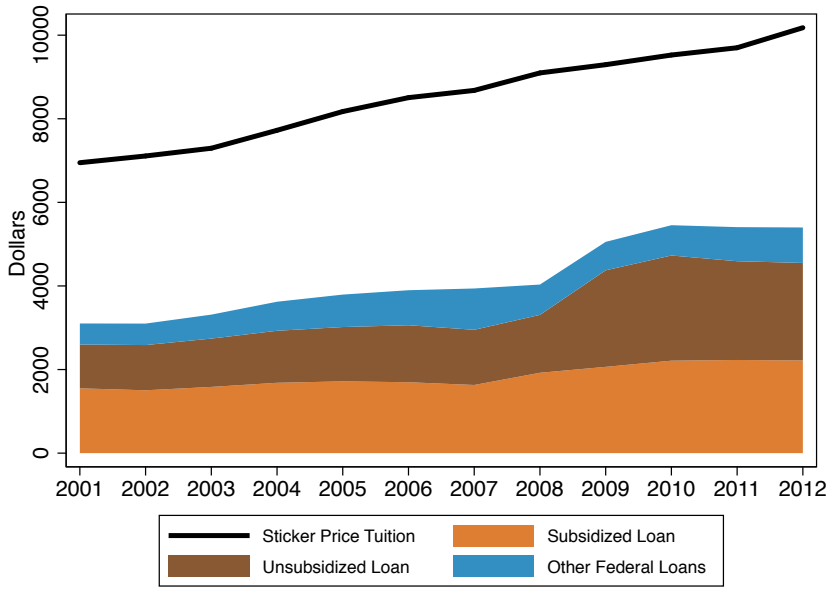
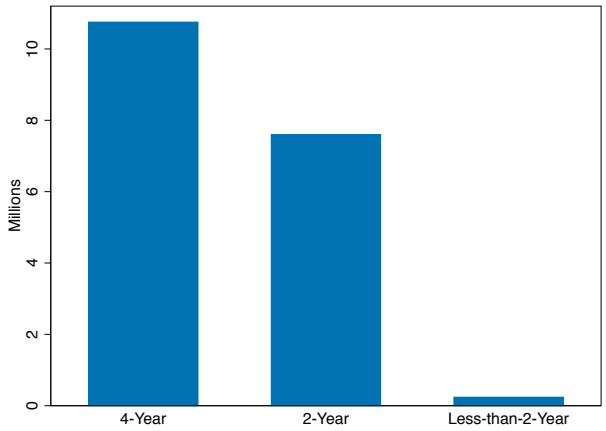
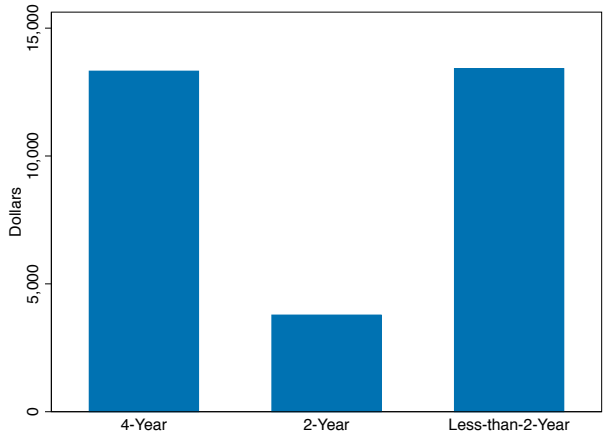


Figure 4: **Enrollments, Sticker Tuition and Revenue by Program Type** These figures plot total enrollment, average sticker price, and average revenues per student for institutions, depending on the type of program offered in the 2011-2012 school year. Source: IPEDS.

(a) **Total undergraduate enrollment by institution program type (millions)**



(b) **Average sticker price by institution program type**



(c) **Average per-student revenues by institution program type**

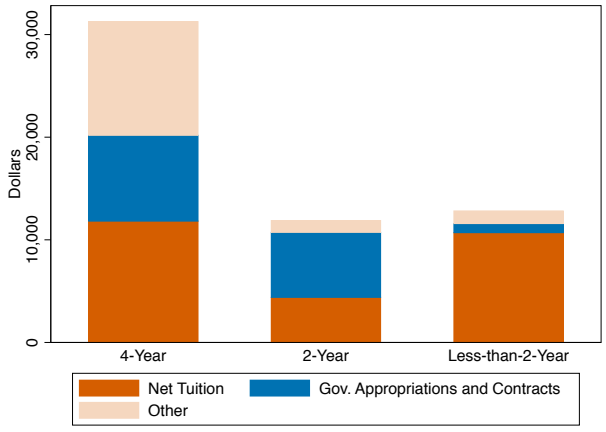


Figure 5: **Aggregate Pell Grant and Federal Loan Amounts** This figure plots Pell Grant disbursements by year as compared to total undergraduate federal student loan originations. Source: Title IV.

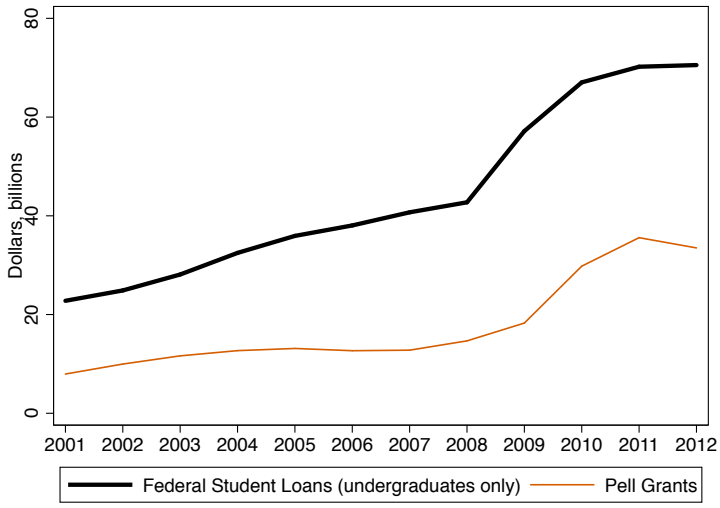


Figure 6: **Per-borrower Subsidized and Unsubsidized Federal Student Loan Amounts** This figure shows changes in the average borrowed amounts in the subsidized and unsubsidized loan programs. Source: IPEDS, Title IV.

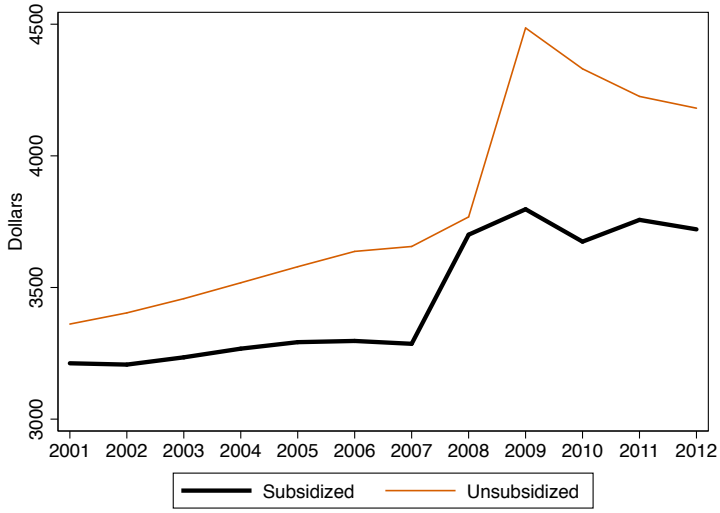
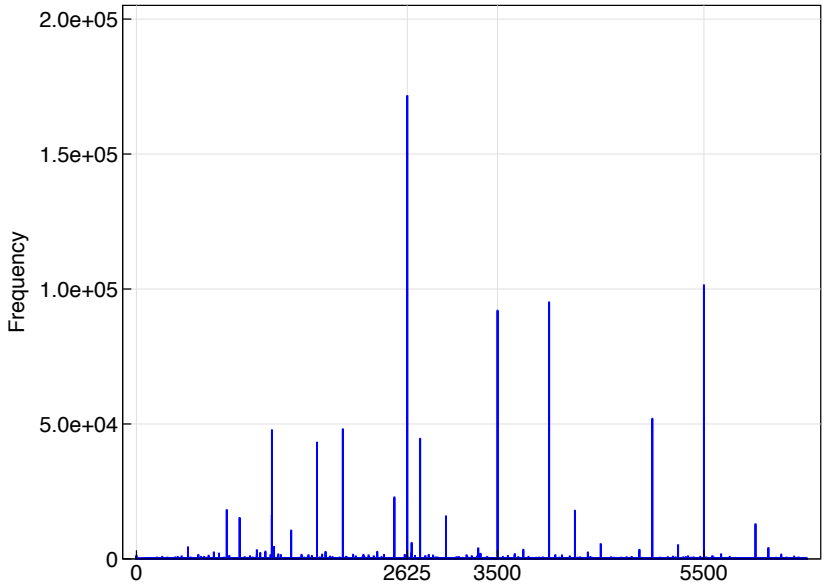


Figure 7: **Distribution of Student Loan Amounts** These figures plot the distribution of student loan amounts in the NY Fed CCP/Equifax panel in the year before (2006:Q3-2007:Q2) and after (2007:Q3-2008:Q2) the change in the subsidized loan maximum. The maximums are marked on the x-axis for each academic year. Source: NY Fed CCP/Equifax.

(a) **Student Loan Amount in 2006-2007**



(b) **Student Loan Amount in 2007-2008**

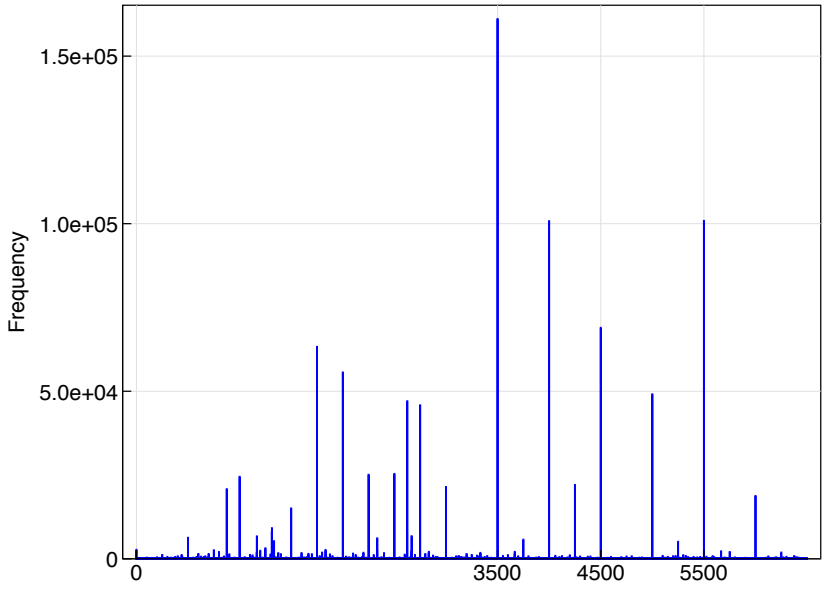
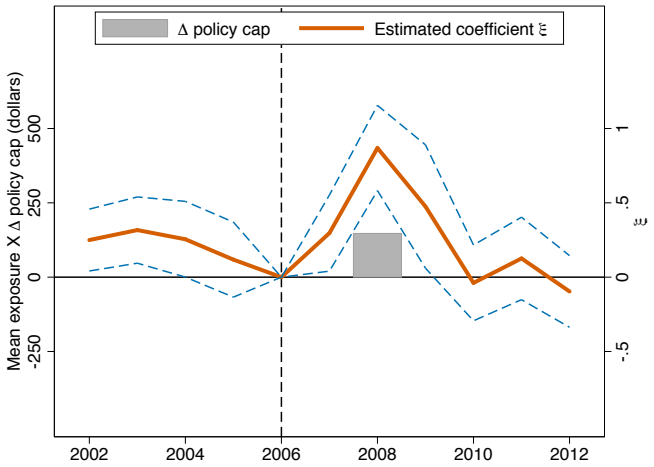
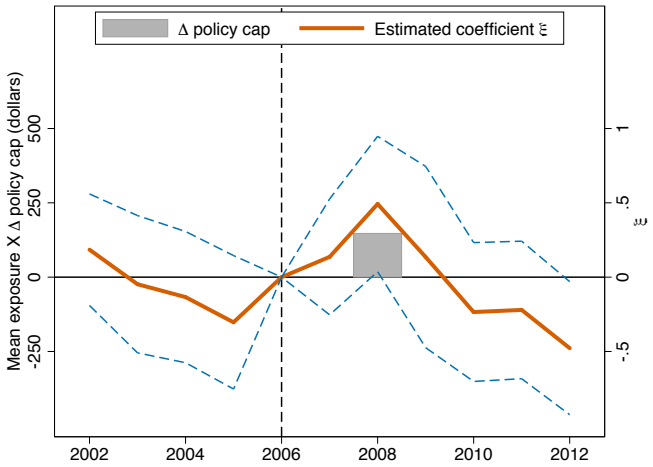


Figure 8: **Placebo tests** This figure shows a time series (orange) of estimated ξ coefficients from equation (5) measuring the sensitivity of ΔAid and ΔTuition to an institution exposure to each type of aid. Vertical dotted black line (year 2006) is the baseline/omitted year in the regression. Dotted blue lines represent 95% confidence intervals. For each aid type, the gray bars show the actual mean change in program maximums, measured as the mean of yearly cap changes times institution exposures.

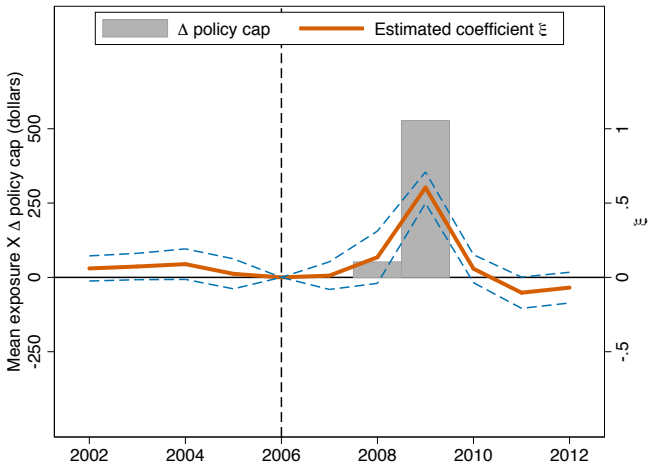
(a) **Subsidized loan exposure:** ΔSubsidized loans



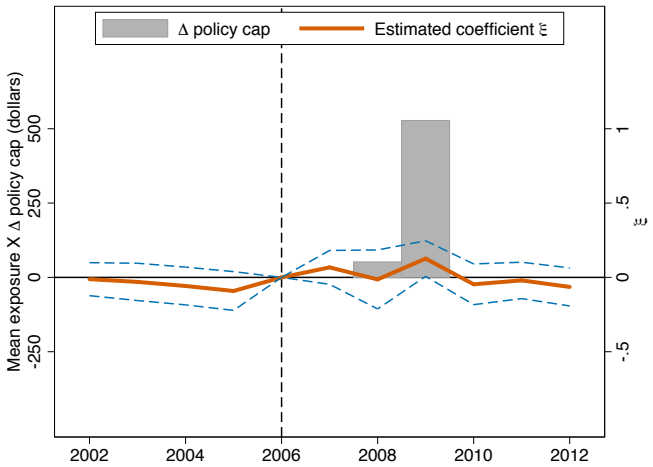
(b) **Subsidized loan exposure:** ΔTuition



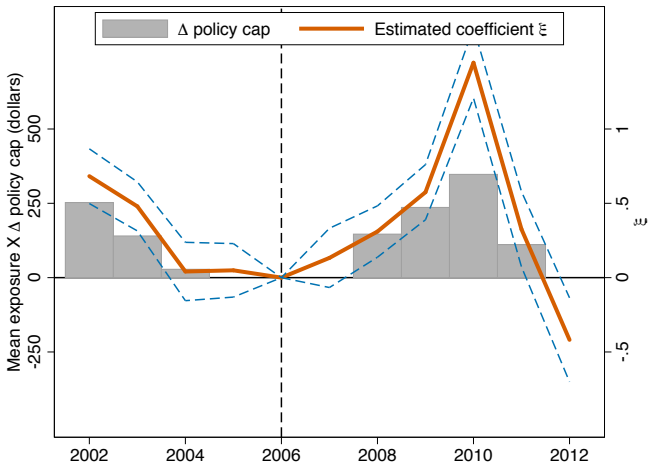
(c) **Unsubsidized loan exposure:** ΔUnsubsidized loans



(d) **Unsubsidized loan exposure:** ΔTuition



(e) **Pell Grant exposure:** ΔPell Grants



(f) **Pell Grant exposure:** ΔTuition

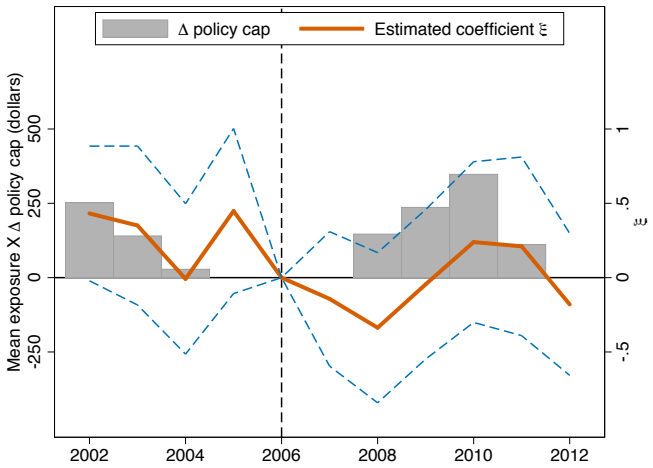


Table 1: **Changes in Title IV Federal Aid Program Maximums** This table shows changes to the maximums (caps) (reported as dollar amounts) of the Federal Direct Loan and Pell Grant Program. Y1, Y2, Y3, Y4, Grad are respectively the maximums for undergraduate freshmen, sophomores, juniors, seniors and graduate students. (D) and (I) refers to dependent and independent students. See Section 4.2 for more detail. Source: Higher Education Act, subsequent amendments and ED appropriations.

Sub. and Unsub. Loans					Additional Unsubsidized Loans				Pell Grants
Year	Y1	Y2	Y3/Y4	Grad	Y1-Y4(D)	Y1/Y2(I)	Y3/Y4(I)	Grad	Y1-Y4
2001	2625	3500	5500	8500	0	4000	5000	10000	3350
2002	2625	3500	5500	8500	0	4000	5000	10000	3750
2003	2625	3500	5500	8500	0	4000	5000	10000	4000
2004	2625	3500	5500	8500	0	4000	5000	10000	4050
2005	2625	3500	5500	8500	0	4000	5000	10000	4050
2006	2625	3500	5500	8500	0	4000	5000	10000	4050
2007	2625	3500	5500	8500	0	4000	5000	10000	4050
2008	3500	4500	5500	8500	0	4000	5000	12000	4310
2009	3500	4500	5500	8500	2000	6000	7000	12000	4731
2010	3500	4500	5500	8500	2000	6000	7000	12000	5350
2011	3500	4500	5500	8500	2000	6000	7000	12000	5550
2012	3500	4500	5500	8500	2000	6000	7000	12000	5550

Table 2: **Summary statistics** This table reports summary statistics for the variables included in the regression tables. The unit of observation is a year (t) and institution (i). Sample starts in 2002 and ends in 2012. The Δ operator indicates annual changes (between year t and $t-1$). Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Additional detail on the variables are available in Section 3 and Appendix B.

	Mean	**St.Dev.**	**Min**	**Max**	**Count**
ΔStickerTuition$_{it}$	743.97	730.09	-2832.00	4256.00	10560
ΔPellGrants$_{it}$	109.60	254.49	-1691.52	2144.92	10060
ΔSubLoans$_{it}$	84.51	270.41	-1781.18	2145.51	9790
ΔUnsubLoans$_{it}$	148.02	439.43	-3388.91	4032.98	9740
PellGrantExp$_{i}$	0.34	0.19	0.00	1.00	10560
SubLoanExp$_{i}$	0.15	0.14	0.00	0.74	10560
UnsubLoanExp$_{i}$	0.27	0.21	0.00	1.00	10560
PellGrantExp08$_{i}$	0.38	0.15	0.00	0.97	6640
SubLoanExp08$_{i}$	0.08	0.08	0.00	0.60	6640
UnsubLoanExp08$_{i}$	0.27	0.18	0.00	0.83	6640
ΔInstGrant$_{it}$	270.37	455.81	-1672.54	2330.25	5580
ΔStickerTuition$_{it}$ $-$ ΔInstGrant$_{it}$	685.94	693.46	-3478.73	4892.03	5580
$100 \times \Delta\log(\text{FTE}_{it})$	2.30	9.33	-48.81	54.39	9630
Δ^2StateFunding$_{it}$	-9.23	1007.15	-4765.55	4773.59	8650
Δ^2FederalFunding$_{it}$	84.70	581.36	-3080.62	3247.10	8580
Δ^2OtherFunding$_{it}$	268.34	1380.98	-7376.05	8011.13	8580
Δ^2PrivateFunding$_{it}$	228.88	4303.25	-25143.88	26098.26	8580

Table 3: **OLS regression of tuition on aid amounts** This table reports the estimates of a simple OLS regression of changes in sticker tuition on changes in federal aid amounts. Sample starts in 2002 and ends in 2012. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}\,p<0.1$, $^{*}\,p<0.05$, $^{**}\,p<0.01$.

ΔStickerTuition$_{it}$	(1)	(2)	(3)	(4)
ΔSubLoans$_{it}$	0.057**			0.027^{+}
	[0.01]			[0.02]
ΔUnsubLoans$_{it}$		0.040**		0.026*
		[0.01]		[0.01]
ΔPellGrants$_{it}$			0.061**	0.042*
			[0.02]	[0.02]
Inst, Year FE?	Yes	Yes	Yes	Yes
Adj R^2	0.36	0.36	0.36	0.36
N Obs	37540	37540	37540	37540
N Inst	4720	4720	4720	4720

Table 4: **Baseline regression specification** This table reports OLS regression estimates of yearly changes in Pell Grants and subsidized/unsubsidized loan amounts per full-time equivalent student, and sticker tuition on interactions between cross-sectional institution exposures and yearly changes in program caps. The unit of observation is a year (t) and institution (i). Sample starts in 2002 and ends in 2012. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$.

	(1) $\Delta\text{PellGrants}_{it}$	(2) $\Delta\text{SubLoans}_{it}$	(3) $\Delta\text{UnsubLoans}_{it}$	(4) $\Delta\text{StickerTuition}_{it}$
$\text{PellGrantExp}_i \times \Delta\text{PGCap}_t$	1.152**	-0.428**	-0.459**	0.374*
	[0.09]	[0.09]	[0.12]	[0.15]
$\text{SubLoanExp}_i \times \Delta\text{SLCap}_t$	0.057	0.705**	0.153	0.579**
	[0.07]	[0.12]	[0.14]	[0.17]
$\text{UnsubLoanExp}_i \times \Delta\text{USLCap}_t$	-0.039**	0.038	0.565**	0.167**
	[0.01]	[0.02]	[0.05]	[0.04]
Inst&Year FE?	Yes	Yes	Yes	Yes
Adj R^2	0.44	0.08	0.21	0.38
N Obs	10060	9790	9750	10570
N Inst	1040	990	990	1060

Table 5: **IV regression specification** This table reports IV regression estimates of the effect of changes in federal loans and grants on sticker price tuition. The dependent variable is the annual change in sticker price tuition at the institution level. Observed changes in federal grants and loans per enrolled student are instrumented by the products of the corresponding aid exposures and changes in program caps, as described in the text. The unit of observation is a year (t) and institution (i). Sample starts in 2002 and ends in 2012. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$.

$\Delta\text{StickerTuition}_{it}$	(1)	(2)	(3)	(4)
$\Delta\text{PellGrants}_{it}$	0.190			0.492**
	[0.12]			[0.18]
$\Delta\text{SubLoans}_{it}$		0.850**		0.772*
		[0.31]		[0.33]
$\Delta\text{UnsubLoans}_{it}$			0.255**	0.237*
			[0.08]	[0.10]
Inst&Year FE?	Yes	Yes	Yes	Yes
N Obs	9330	9330	9330	9330
N Inst	970	970	970	970

Table 6: **Changes in net tuition and sticker price tuition** This table reports OLS estimates of a regression of 4-year changes in average net tuition on sticker tuition interacted by a net-tuition bucket indicator. These buckets are formed in each school and year by sorting students in quartiles based on the net tuition that they pay. Portfolio Q4 is the highest net tuition student bucket. The index i refers to an institution and the index q for a quartile within that institution. To be included in the sample, a school must be in both the NPSAS 04 sample and the NPSAS 08 sample. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$.

	Δ^4AverageNetTuition$_{q,i,08}$	
Δ^4StickerTuition$_{i,08} \times \mathbb{I}_q$(Q1)	0.368***	[0.035]
Δ^4StickerTuition$_{i,08} \times \mathbb{I}_q$(Q2)	0.574***	[0.038]
Δ^4StickerTuition$_{i,08} \times \mathbb{I}_q$(Q3)	0.773***	[0.040]
Δ^4StickerTuition$_{i,08} \times \mathbb{I}_q$(Q4)	0.944***	[0.038]
Observations	910	

Table 7: **Regression estimates for institutional grants and enrollments** This table reports OLS regression estimates of yearly changes in institution grant expenditure per FTE, difference between sticker price and institution grant expenditure and percentage growth rate of FTE on interactions between cross-sectional institution exposures and yearly changes in program caps. The unit of observation is a year (t) and institution (i). Sample starts in 2002 and ends in 2012. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$.

	(1) ΔInstGrant$_{it}$	(2) ΔStickerTuition$_{it} - \Delta$InstGrant$_{it}$	(3) $100 \times \Delta\log$(FTE$_{it}$)
PellGrantExp$_i \times \Delta$PGCap$_t$	-0.303*	0.411	0.016**
	[0.15]	[0.26]	[0.00]
SubLoanExp$_i \times \Delta$SLCap$_t$	-0.198^{+}	0.875**	-0.004
	[0.12]	[0.30]	[0.00]
UnsubLoanExp$_i \times \Delta$USLCap$_t$	-0.038	0.153*	-0.002**
	[0.04]	[0.07]	[0.00]
Inst&Year FE?	Yes	Yes	Yes
Adj R^2	0.03	0.02	0.05
N Obs	5790	5580	10210
N Inst	670	650	1000

Table 8: **Regression estimates with additional controls** This table reports OLS estimates of the baseline model (Table 4) with the inclusion of additional controls. The additional cross-sectional controls (for which coefficients are not reported) are each interacted with the three changes in program caps $\Delta\mathbf{Caps}_t = \langle \Delta\text{PGCap}_t, \Delta\text{SLCap}_t, \Delta\text{USLCap}_t \rangle$. Changes in other sources or funding are computed over a two year period (Δ^2). The unit of observation is a year (t) and institution (i). Sample starts in 2002 and ends in 2012. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}\,p < 0.1$, $^{*}\,p < 0.05$, $^{**}\,p < 0.01$.

	(1)	(2)	(3)
ΔStickerTuition$_{it}$			
PellGrantExp$_i \times \Delta$PGCap$_t$	0.336*	0.176	0.002
	[0.16]	[0.24]	[0.20]
SubLoanExp$_i \times \Delta$SLCap$_t$	0.575**	0.459*	0.447*
	[0.18]	[0.21]	[0.20]
UnsubLoanExp$_i \times \Delta$USLCap$_t$	0.164**	0.002	0.089^{+}
	[0.04]	[0.06]	[0.05]
Δ^2StateFunding$_{it}$			-0.049**
			[0.01]
Δ^2FederalFunding$_{it}$			-0.002
			[0.01]
Δ^2OtherFunding$_{it}$			0.002
			[0.01]
Δ^2PrivateFunding$_{it}$			-0.006**
			[0.00]
Inst&Year FE?	Yes	Yes	Yes
ForProfit$_i \times \Delta\mathbf{Caps}_t$	Yes	Yes	Yes
Four-year$_i \times \Delta\mathbf{Caps}_t$	No	Yes	No
AdmitRate04$_i \times \Delta\mathbf{Caps}_t$	No	Yes	No
EFC04$_i \times \Delta\mathbf{Caps}_t$	No	Yes	No
Tuition04$_i \times \Delta\mathbf{Caps}_t$	No	Yes	No
Adj R^2	0.38	0.38	0.37
N Obs	10570	10480	8070
N Inst	1060	1040	950

Table 9: **Correlation among institution characteristics** This table reports a correlation matrix between institution level characteristics measured as of 2004. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}\ p < 0.1$, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$.

	PellGrantExp_i	SubLoanExp_i	UnsubLoanExp_i	EFC_i	Tuition_i	AdmitRate_i
PellGrantExp_i	1					
SubLoanExp_i	0.193	1				
UnsubLoanExp_i	-0.0414	0.783	1			
EFC_i	-0.731	-0.0421	0.218	1		
Tuition_i	-0.395	0.276	0.499	0.660	1	
AdmitRate_i	0.255	-0.147	-0.322	-0.424	-0.591	1

Table 10: **Sensitivity of aid exposures to institution attributes** This table expands on the baseline results of Table 4 by allowing the coefficients to vary across these institution characteristics: a dummy for private institutions, a dummy for 4-year programs, the 2004 levels of tuition and average EFC (both in thousands). See notes to Table 4 for more details. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}\,p < 0.1$, $^{*}\,p < 0.05$, $^{**}\,p < 0.01$.

ΔStickerTuition$_{it}$	(1)	(2)	(3)
PellGrantExp$_i$ × ΔPGCap$_t$	0.384*	0.506**	0.541^{+}
	[0.15]	[0.16]	[0.32]
SubLoanExp$_i$ × ΔSLCap$_t$	0.258	0.538**	0.594**
	[0.28]	[0.17]	[0.17]
UnsubLoanExp$_i$ × ΔUSLCap$_t$	0.170**	-0.174	0.184**
	[0.04]	[0.11]	[0.04]
SubLoanExp$_i$ × ΔSLCap$_t$×Private$_i$	0.307**		
	[0.11]		
SubLoanExp$_i$ × ΔSLCap$_t$×FourYear$_i$	-0.320**		
	[0.11]		
SubLoanExp$_i$ × ΔSLCap$_t$×Tuition04$_i$	0.022**		
	[0.01]		
SubLoanExp$_i$ × ΔSLCap$_t$×EFC04$_i$	-0.015		
	[0.01]		
UnsubLoanExp$_i$ × ΔUSLCap$_t$×Private$_i$		0.062	
		[0.04]	
UnsubLoanExp$_i$ × ΔUSLCap$_t$×FourYear$_i$		-0.047	
		[0.04]	
UnsubLoanExp$_i$ × ΔUSLCap$_t$×Tuition04$_i$		0.009**	
		[0.00]	
UnsubLoanExp$_i$ × ΔUSLCap$_t$×EFC04$_i$		0.000	
		[0.00]	
PellGrantExp$_i$ × ΔPGCap$_t$×Private$_i$			-0.040
			[0.13]
PellGrantExp$_i$ × ΔPGCap$_t$×FourYear$_i$			0.041
			[0.14]
PellGrantExp$_i$ × ΔPGCap$_t$×Tuition04$_i$			-0.010
			[0.01]
PellGrantExp$_i$ × ΔPGCap$_t$×EFC04$_i$			-0.007
			[0.02]
Inst&Year FE?	Yes	Yes	Yes
Adj R^2	0.38	0.38	0.38
N Obs	10570	10570	10570
N Inst	1060	1060	1060

Table 11: **Relationship of pre-policy changes in aid amounts, tuition and enrollment** This table reports the results of cross-sectional regressions (by institution) using the 5-year pre-policy change (2002-2007) in loans/grants, enrollment, tuition as dependent variables, on the fraction of students in each of the loan/grant programs as the independent variable. $SPct_{i02}$, $UPct_{i02}$, $PPct_{i02}$ are the fractions of students that received subsidized, unsubsidized loans and Pell Grants as of 2002. The variable $HighSPct_{i02}$ is an indicator for $SPct_{i02}$ being above its median. $HighUPct_{i02}$ and $HighPPct_{i02}$ are defined accordingly for unsubsidized loans and Pell Grants. The regression also controls for 2002 tuition and enrollment levels. Tuition and enrollment data is from IPEDS; loan amounts and number of borrowers are from Title IV. Robust standard errors are reported in brackets. Significance: $^{+}\ p < 0.1$, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$.

Subsidized loans

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ^5SubsiLoans$_{i07}$		Δ^5StickerTuition$_{i07}$		Δ^5Log(Enrollment$_{i07}$)	
$SPct_{i02}$	1044.85**	1574.21**	40.42	1552.78**	0.20**	0.24**
	[117.92]	[193.44]	[183.44]	[310.67]	[0.03]	[0.06]
$SPct_{i02}$×$HighSPct_{i02}$		-440.52**		-1264.29**		-0.03
		[141.27]		[238.84]		[0.05]
Constant	459.55**	389.85**	378.37**	188.73**	0.09**	0.09**
	[38.31]	[39.36]	[51.35]	[55.30]	[0.01]	[0.01]

Unsubsidized loans

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ^5UnsubLoans$_{i07}$		Δ^5StickerTuition$_{i07}$		Δ^5Log(Enrollment$_{i07}$)	
$UPct_{i02}$	2062.28**	2180.79**	-90.78	1263.29*	0.27**	0.28**
	[193.24]	[342.50]	[237.52]	[496.22]	[0.05]	[0.09]
$UPct_{i02}$×$HighUPct_{i02}$		-102.20		-1152.81**		-0.01
		[233.90]		[390.31]		[0.07]
Constant	452.51**	443.54**	406.42**	309.77**	0.10**	0.10**
	[42.50]	[47.64]	[51.08]	[55.82]	[0.01]	[0.01]

Pell Grants

	(1)	(2)	(3)	(4)	(5)	(6)
	Δ^5PellGrants$_{i07}$		Δ^5StickerTuition$_{i07}$		Δ^5Log(Enrollment$_{i07}$)	
$PPct_{i02}$	567.83**	466.80*	-913.02**	-1230.96*	0.11**	0.07
	[96.79]	[196.47]	[245.08]	[575.30]	[0.04]	[0.10]
$PPct_{i02}$×$HighPPct_{i02}$		79.99		242.50		0.03
		[115.39]		[375.50]		[0.07]
Constant	200.99**	215.26**	768.63**	816.75**	0.12**	0.12**
	[39.86]	[50.39]	[102.81]	[135.42]	[0.02]	[0.02]
$Tuition_{i02}$ & FTE_{i02}?	Yes	Yes	Yes	Yes	Yes	Yes
N Obs	2940	2940	2480	2480	2930	2930
Adj R^2	0.07	0.07	0.62	0.62	0.01	0.01
N Inst	2940	2940	2480	2480	2930	2930

Table 12: **Years of Federal Loan, Pell Grant, and Tuition increases for For-Profit and Not-for-Profit institutions** These tables regress annual changes in federal subsidized and unsubsidized loans, Pell Grants, and sticker price tuition against year dummies. The omitted dummy is for the year 2006. The Year = 2008,09,10 is a dummy varaible corresponding to those years, which is when the federal aid cap changes take effect. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

For-Profits

	ΔPellGrants$_{it}$		ΔSubLoans$_{it}$		ΔUnsubLoans$_{it}$		ΔStickerTuition$_{it}$	
Year = 2002	178**	[14]	-74**	[19]	-246**	[29]	25	[49]
Year = 2003	110**	[13]	-64**	[17]	-194**	[27]	226**	[46]
Year = 2004	-28**	[12]	-84**	[17]	-210**	[26]	36	[25]
Year = 2005	-112**	[14]	-115**	[18]	-252**	[27]	86**	[25]
Year = 2007	-35**	[14]	-50**	[18]	-317**	[27]	83**	[25]
Year = 2008	89**	[14]	460**	[20]	-117**	[27]	205**	[27]
Year = 2009	252**	[14]	-53**	[18]	670**	[29]	269**	[29]
Year = 2010	728**	[17]	-264**	[18]	-485**	[27]	269**	[29]
Year = 2011	106**	[16]	-215**	[18]	-576**	[28]	88**	[28]
Year = 2012	-485**	[18]	-249**	[19]	-374**	[30]	-102**	[30]
Constant	85**	[8]	164**	[10]	371**	[15]	487**	[15]
	ΔPellGrants$_{it}$		ΔSubLoans$_{it}$		ΔUnsubLoans$_{it}$		ΔStickerTuition$_{it}$	
Year = 2008,09,10	386**	[8]	148**	[9]	272**	[13]	212**	[16]
Constant	50**	[2]	67**	[2]	126**	[4]	523**	[5]
Inst FE?	Yes		Yes		Yes		Yes	
N Obs	18750		16980		16760		16880	
N Inst	2050		1910		1900		2090	

Not-for-Profits

	ΔPellGrants$_{it}$		ΔSubLoans$_{it}$		ΔUnsubLoans$_{it}$		ΔStickerTuition$_{it}$	
Year = 2002	-106**	[7]	-260**	[9]	-513**	[12]	-164**	[12]
Year = 2003	-157**	[7]	-165**	[9]	-456**	[12]	-38**	[13]
Year = 2004	-229**	[7]	-174**	[9]	-477**	[12]	60**	[14]
Year = 2005	-252**	[7]	-201**	[9]	-483**	[12]	33**	[13]
Year = 2007	-262**	[7]	-257**	[9]	-588**	[12]	6	[12]
Year = 2008	-161**	[7]	-22**	[10]	-445**	[13]	46**	[12]
Year = 2009	-76**	[7]	-223**	[9]	10	[16]	79**	[12]
Year = 2010	294**	[9]	-186**	[9]	-452**	[14]	54**	[13]
Year = 2011	-32**	[8]	-237**	[10]	-688**	[14]	36**	[13]
Year = 2012	-315**	[8]	-241**	[9]	-560**	[13]	90**	[12]
Constant	260**	[5]	292**	[5]	630**	[7]	618**	[7]
	ΔPellGrants$_{it}$		ΔSubLoans$_{it}$		ΔUnsubLoans$_{it}$		ΔStickerTuition$_{it}$	
Year = 2008,09,10	159**	[4]	16**	[4]	94**	[7]	54**	[7]
Constant	118**	[1]	134**	[1]	241**	[2]	623**	[2]
Inst FE?	Yes		Yes		Yes		Yes	
N Obs	39420		38390		37830		37850	
N Inst	3550		3440		3420		3630	

A Additional robustness tests

Using 2008 NPSAS exposures: In the baseline specification we measure institution exposures using the 2004 NPSAS wave, the closest available wave that still predates the changes in loan (and most of the grant) maximums. Despite the results in Table 4, one may worry about the time gap between when the exposures are computed and when the policy changes take place. In Table A1 we re-estimate the baseline specification using exposures computed from 2008 NPSAS for robustness. Aid sensitivities to changes in the institution-specific program aid maximums as of 2008 maximums (columns 1-3) are very similar to the 2004 ones, with the exception of the subsidized loan sensitivity response to the subsidized loan maximums, which increases to 1.25 from .7 in Table 4. Subsidized loan maximums are increased in 2008, so that the 2008 subsidized loan exposure is measured at the post-policy maximum amounts. To the extent that not all students fully expanded their borrowing (as suggested by comparing the 2004-08 subsidized exposures in Table 2 and the loading in Table 4), the sensitivity of 2008 to 2004 subsidized exposures drops, resulting in a higher point estimate in column 3. Sticker tuition displays a very similar sensitivity to the institution-level change in program maximums (compare columns 4 in Tables 4 and A1), although the point estimate on Pell Grants is less precisely estimated (t-stat = 1.66). In Table A2, we repeat the IV estimates of Table 5 using exposures computed as of 2008 NPSAS and obtain very similar results, except for a lower sensitivity of sticker tuition to subsidized loans owing to the overstated pre-policy exposure discussed above.

Dependent variables in logarithms: Because changes in federal aid policies affected dollar levels, rather than percentage changes, of the program maximums, the dependent variables in our baseline specification are expressed in dollar changes. In Table A3 we re-estimate the specification with the dependent variable expressed in logarithmic changes. While this specification does not directly match the policy change, it can be informative about the magnitude of percentage effects of the changes in program caps. Starting with the percentage change response of aid levels, Pell amounts (column 1) now load with an incorrect (negative) sign on changes in Pell caps.[12] Subsidized and unsubsidized loans (columns 2 and 3) load positively on changes in their respective caps and negatively on the Pell Grant caps suggesting substitution from loans to grants, as in the baseline specification in dollar changes. Finally, in terms of percentage changes in tuition, a $100 increase in the program caps resulted in .4%, .2% and .1% (statistically significant) increases, respectively, for Pell Grants, subsidized, and unsubsidized loans.

[12] This may owe to the percentage-change specification along with the fact that, because of the program design, Pell Grant exposures include all recipients receiving a positive, rather than only those at the program maximums as it is the case for subsidized and unsubsidized loans.

Table A1: **Baseline regression specification using 2008 NPSAS exposures** This table replicates Table 4 using NPSAS aid exposures as of 2008 as opposed to 2004 ones. See notes to Table 4 for more details. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}\ p < 0.1$, $^{*}\ p < 0.05$, $^{**}\ p < 0.01$.

	(1) ΔPellGrants$_{it}$	(2) ΔSubLoans$_{it}$	(3) ΔUnsubLoans$_{it}$	(4) ΔStickerTuition$_{it}$
PellGrantExp08$_i$ $\times$ ΔPGCap$_t$	0.997**	-0.355**	-0.440**	0.283
	[0.09]	[0.09]	[0.14]	[0.17]
SubLoanExp08$_i$ $\times$ ΔSLCap$_t$	0.108	1.264**	0.098	0.610**
	[0.08]	[0.11]	[0.15]	[0.23]
UnsubLoanExp08$_i$ $\times$ ΔUSLCap$_t$	-0.057**	0.035^{+}	0.654**	0.233**
	[0.01]	[0.02]	[0.04]	[0.04]
Inst&Year FE?	Yes	Yes	Yes	Yes
Adj R^2	0.48	0.10	0.22	0.39
N Obs	14000	13610	13550	14500
N Inst	1410	1340	1350	1420

Table A2: **IV regression specification using 2008 NPSAS exposures** This table replicates Table 5 using NPSAS aid exposures as of 2008 as opposed to 2004 ones. See notes to Table 5 for more details. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$.

	(1)	(2)	(3)	(4)
ΔStickerTuition$_{it}$				
ΔPellGrants$_{it}$	0.259			0.518**
	[0.16]			[0.18]
ΔSubLoans$_{it}$		0.547**		0.477*
		[0.20]		[0.21]
ΔUnsubLoans$_{it}$			0.331**	0.340**
			[0.06]	[0.07]
Inst&Year FE?	Yes	Yes	Yes	Yes
N Obs	13110	13110	13110	13110
N Inst	1340	1340	1340	1340

Table A3: **Baseline regression specification with dependent variables in logarithmic changes** This table replicates Table 4, but uses percentage changes in the dependent variables rather than changes in absolute terms. See notes to Table 4 for more details. Sample sizes are rounded to the nearest 10 in compliance with NPSAS nondisclosure policies. Standard errors clustered at the institution level reported in brackets. Significance: $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$.

	(1) Δ logPellGrants$_{it}$	(2) Δ logSubLoans$_{it}$	(3) Δ logUnsubLoans$_{it}$	(4) Δ logStickerTuition$_{it}$
PellGrantExp$_i$ $\times$ ΔPGCap$_t$	-0.016**	-0.018**	-0.027**	0.004*
	[0.00]	[0.00]	[0.01]	[0.00]
SubLoanExp$_i$ $\times$ ΔSLCap$_t$	0.009^{+}	0.009^{+}	0.000	0.002^{+}
	[0.00]	[0.01]	[0.01]	[0.00]
UnsubLoanExp$_i$ $\times$ ΔUSLCap$_t$	-0.003**	0.001	0.014**	0.001**
	[0.00]	[0.00]	[0.00]	[0.00]
Inst&Year FE?	Yes	Yes	Yes	Yes
Adj R^2	0.49	0.08	0.19	0.04
N Obs	10040	9750	9730	10480
N Inst	1040	990	990	1060

B Data Appendix

This Appendix complements Section 3 in providing a more detailed data description.The data used in the empirical analysis throughout this paper comes from three sources: IPEDS, Title IV, and NPSAS. Below, we describe in detail the variables we constructed using the data from each of these sources.

Sample: Our sample begins in the 2000-2001 school year, the first year that the tuition sticker price survey from IPEDS more or less takes the current form. We end our sample in 2011-2012, since in 2012-2013, changes to graduate financial aid occur that may interfere with our identification. IPEDS and NPSAS data are reported at institution level (UNITID), while Title IV is reported at the OPEID level. This is because there may be multiple UNITIDs associated to one OPEID, as branches (UNITID) of the same institution are sometimes surveyed separately. Our regressions are done at the OPEID level, where when we are using averages of variables in IPEDS, we take enrollment-weighted averages of the UNITIDs.

Sticker-Price Tuition: Our main dependent variable is yearly changes in the sticker-price tuition at the institutional level. This data comes from the IPEDS Student Charges survey. For full academic-year programs, we use the sum of the out-of-state average tuition for full-time undergraduates and the out-of-state required fees for full-time undergraduates. For other programs, we use the published tuition and fees for the entire program. For public universitites we use out-of-state tuition rather than average tuition to abstract from variation driven by changing fractions of in-state versus out-of-state students. We generally find that the in-state and out-of-state differences are highly correlated.

Enrollment: Enrollment can be measured both as headcount and full-time equivalent students. In general, we use an IPEDS formula to calculate a full-time-equivalent (FTE) enrollment measure. In certain cases though, we use total headcounts from the IPEDS enrollment survey, which are available by student level and attendance status.

Federal Loan and Grant Usage: For federal loan and grant totals, we rely on Title IV administrative data rather than the student financial aid survey from IPEDS, which appears to be somewhat unreliable as it is survey based. Title IV data contains the number of recipients, and total dollar amount of loans originated or grants disbursed for each institution and each of subsidized loans, unsubsidized loans, and Pell Grants. We only consider undergraduate policy changes and tuition in this paper, so we would want these amounts to be for undergraduates only. However, Title IV data does not break out undergraduate and graduate loans separately until 2011. Pell Grants are only available to undergraduates, so are not affected. Since imputation of an undergraduate measure requires making several assumptions, our preferred measure of loan and grant usage at an institution is just the total dollar amount scaled by the FTE count of the university. We also report results for robustness when we scale the total dollar amount by the total enrollment count. Finally, also for robustness, we make an attempt to impute an undergraduate measure as follows: Since the maximum subsidized loan amount changes only for undergraduates in our sample, we assume a constant average graduate loan amount over time, $\bar{g}_i$ conditional on borrowing. In addition, we assume that the fraction of all subsidized loan borrowers at an institution who are graduate

students also does not change, γ_i. To calculate $\bar{g}_i$ and γ_i, we take the averages of the 2011 and 2012 values. [13] For prior years, given the total subsidized loan amount S_{it}, we calculate the undergraduate dollar amount borrowed as: $S_{it} - \gamma_i \bar{g}_i$. We then scale this measure by total undergraduate enrollment.

Exposures: We calculate exposures using confidential NPSAS data as described in Section 4.3.

Net Tuition and Institutional Grants: Our institutional grant data comes from the IPEDS Finance Survey, which records as an expenditure item total grant dollars spent on scholarships and fellowships. We scale this measure by the FTE enrollment. We compute net tuition by subtracting institutional grants per FTE from sticker price.

Financing Controls: We follow the Delta Cost Project data in separating revenue data into a few main parts. The first is net tuition revenue, as described above. The next is federal funding, excluding Pell Grants. The third is state (and local) funding through appropriations and contracts. The fourth is private funding (from donations, or endowment investment income), and the fifth is revenue from auxiliary operations (e.g. hospitals, dormitories). We use changes in these amounts, scaled by FTE enrollment, as controls in our regressions.

Other Controls: Average EFC comes from NPSAS data, and the admission rate comes from IPEDS.

C Earnings calls

In this Section we provide additional passages taken from earnings calls of the Apollo Group discussing the changes in federal student aid maximums.

> **<Q - Mark Marostica>:** My question first relates to Brian's comment on the national pricing strategy, and I was wondering if you can give us some more specifics around that and whether or not you are actually planning to lower prices as part of that.
> **<A - Brian Mueller>:** It is something that we are considering. I have talked about it the last couple of conferences we've attended. We have a very unique opportunity in July. Loan limits go up for first and second level students, which is fairly long overdue. By the time we get to July I am estimating that upwards of 70% of all students who are studying at the University of Phoenix at the level one and level two at those levels will be at Axia College at Axia College tuition rates. So there will be some room for us to raise tuition there from maybe 265 to 295 and from 285 to maybe 310, without putting a burden on students from a standpoint of out-of-pocket expense. At the graduate level there is a lot of room. We are actually quite a bit under the competition in our graduate programs, and there is a lot of room from a Title IV standpoint so that, again, we wouldn't put a burden on students from an out-of-pocket expense.
> **Source:** Apollo Education Group, 2006:Q4 Earnings Call, accessed from Bloomberg LP Transcripts.

> **<Q - Mark Hughes>:** And then any early view on whether Axia, with the price increase there affecting start levels in May?

[13] We drop institutions from our sample where the 2011 and 2012 values differ significantly.

<A - Brian Mueller> Whether it's affecting start levels in May?
<Q - Mark Hughes>: Right. 10% increase in tuition. Is anybody balking at that, or trends steady?
<A - Brian Mueller>: No, thank you for asking that. No, because loan limits are raised on July 1, for level 1 and 2 students. And so students know as they go in if they're going to have enough title IV dollars to cover the cost of their tuition, so, no, it's not impacting new student starts.
Source: Apollo Education Group, 2007:Q2 Earnings Call, accessed from Bloomberg LP Transcripts.

<Q - Brandon Dobell>: One final one. Maybe as you think about discounting, at least the philosophy around affordability, pricing, discounting across the different brands or different programs, maybe, Brian, if you could speak to, has there been any change in terms of how you guys think about that? Do you think that discounting generates the wrong type of student or the right type of student, or how flexible do you think it will be going forward in terms of how you think about affordability issues?
<A - Brian Mueller>: We're not changing our thinking about that. It's really clear what's going on in the country economically, with the middle class getting squeezed. People don't have disposable income to spend for private school education but they understand its impact on their long-term career so they're willing to borrow the money at really good rates from a Title IV standpoint. And so if you can build your operations to the point that you can be profitable and keep those tuition rates inside Title IV loan limits you're going to do positive things with regards to retention, which will offset maybe the 4 to 6% increases that we would have gotten in the past.
Source: Apollo Education Group, 2007:Q2 Earnings Call, accessed from Bloomberg LP Transcripts.

D Stock market evidence

Here we discuss stock market responses of publicly traded for-profit institutions to the three legislative changes discussed in Section 4.2. Table A4 reports event studies for abnormal returns over 3-day windows surrounding the passage of the three legislative changes to the HEA. Fourteen for-profit education companies were publicly traded around at least one of these legislative changes (and eight across all changes), including the Apollo Education Group among others. The cumulative abnormal returns are computed as each stock's excess return to the CRSP index returns, summed over the 3-day event window. We then calculate the (market cap) weighted and unweighted average of the cumulative abnormal returns of the eight publicly traded for-profit institutions to the index.

In the top panel of Table A4, we see that average 3-day cumulative abnormal returns around the 2006 re-authorization of HEA, which increased the subsidized loan limits for freshman and sophomores, were 3.64% and 2.9% under the value- and equally-weighted market benchmarks, respectively. The abnormal returns are statistically significant and economically large. As shown in the middle panel, three-day cumulative abnormal returns surrounding the 2007 legislative passage that increased Pell Grant amounts were 2.17% and 2.22%, respectively. Finally, we consider two separate event windows for the passing of the Ensuring Equal Access to Student Loans Act of 2008

which increased unsubsidized borrowing amounts.[14] Depending on the exact window used, abnormal returns on the for-profit institution portfolio ranged between 4.8% and 3.3%.

In sum, we find evidence that the passage of three pieces of legislation were associated with sizable abnormal stock market responses for the portfolio of publicly traded for-profit institutions. The nearly 10% abnormal return is consistent with the fact that students at for-profit institutions rely heavily on federal student aid to fund their education. In addition, anecdotal evidence also supports the view that changes in Title-IV programs boosted tuition at these institutions. We turn to this issue in the next section using a statistical model.

Table A4: **Stock Market Reactions to Changes in Federal Aid Policy** This table reports 3-day cumulative abnormal returns for a portfolio of 14 publicly traded for-profit universities surrounding dates of legislative passage to changes in Federal Aid Policy. Returns are computed in excess of the CRSP index on a value-weighted and equal-weighted basis.

Event	Date	Mkt Weights	Policy	Event Window	Mean Cum. Abnormal Ret.	Z score
Congress reauthorized the Higher Education Act	2/1/2006	v	Sub./Unsub. Loans	(-1,+1)	3.64%	(3.216)
		e	Sub./Unsub. Loans	(-1,+1)	2.90%	(2.545)
College Cost Reduction and Access Act Passes Congress	9/7/2007	v	Pell Grants	(-1,+1)	2.17%	(2.204)
		e	Pell Grants	(-1,+1)	2.22%	(2.242)
Ensuring Equal Access to Student Loans Act of 2008 is passed by the Senate	4/30/2008	v	Unsub. Loans	(-1,+1)	4.86%	(2.570)
		e	Unsub. Loans	(-1,+1)	4.80%	(2.480)
Ensuring Equal Access to Student Loans Act of 2008 is passed by Congress	5/1/2008	v	Unsub. Loans	(-1,+1)	3.30%	(1.752)
		e	Unsub. Loans	(-1,+1)	3.62%	(1.933)

[14] On April 30, 2008 the Senate passed the Act, after already having received approval by the House. However, the Senate's approving vote included some changes that had to be subsequently ratified by the House. Thus, the bill essentially passed on April 30, 2008, but the changes made by the Senate were not voted on, and subsequently passed by the House, until May 1, 2008. For completeness, we estimate three-day abnormal returns around both event dates, though the two event window obviously overlap on one day.