When Financial Aid is Scarce: The Challenge of Allocating College Aid Where it is Needed Most

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Abstract

Inequality in college completion by income is a persistent problem, often addressed through financial aid to students. Prior research designs have not identified effects for the poorest students most in need of financial aid. I exploit an eligibility cutoff in the timing of filing an aid application, induced by first-come first-served allocation of limited funding in the state of Wisconsin. I focus on two-year technical colleges, where there was a large funding shortage affecting students of all income levels. I find modest positive effects of grant aid in reducing dropout and supporting degree completion, driven by larger positive effects for the poorest students.

JEL: I22 (Educational Finance, Financial Aid), I24 (Education and Inequality), I28 (Government Policy on Education)

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1. Introduction: Allocating aid where it is needed most

A college education has become more expensive at the same time as it has become more beneficial to graduates (College Board, 2018; Oreopoulos and Petronijevic, 2013). This poses a problem for those least able to pay for college, who achieve lower enrollment and completion rates despite similar levels of academic preparation (Belley and Lochner, 2007; Lochner and Monge-Naranjo, 2011). Federal and state government efforts to lower the price of college have increased substantially, and these efforts have prioritized providing grants directly to students from low-income backgrounds. From school year 2004–05 to school year 2014–15, in constant dollar terms, spending on the federal Pell Grant program grew by 83% to a total of $30.3 billion (College Board, 2015). During the same period, states shifted their higher education budgets from supporting public universities toward supporting students directly, increasing their spending on need-based aid programs by 37% to a total of $7.8 billion (SHEEO, 2015; NASSGAP, 2016). Decreases in state support translate to higher tuition overall, that states offset with targeted need-based aid (Webber, 2017).

The ultimate effectiveness of the high-tuition high-aid model is not clear. Policymakers face the challenge of measuring financial need, and of delivering aid dollars where they will have the greatest positive impact. To date there has been little evidence to guide these decisions, as research designs have not estimated how effects of public aid vary by financial need (Dynarski and Scott-Clayton, 2013; Page and Scott-Clayton, 2016; Nguyen et al., 2018). Studies have either estimated average effects for all qualifying students, or have relied on income cutoffs identifying effects for relatively higher-income students. This leaves open the possibility of larger and more robust effects for lower-income students, who represent the core population served by need-based aid programs.

This study estimates the effects of the Wisconsin Grant, a state-funded, need-based financial aid program for Wisconsin residents attending in-state colleges and universities. I focus on applicants to two-year technical colleges, where the Wisconsin Grant covers up to 25% of tuition for 22,000 students each year. The program is underfunded, so that nearly half of financially eligible applicants do not receive awards. Program funds are distributed *first-come first-served* based on the date of submitting a financial aid application, the FAFSA. The date when funds run out varies with the volume of eligible applications. The date is set

retroactively as FAFSA applications are being processed, and it is not announced publicly.

My estimation strategy compares students who apply just before and just after the unpredictable cutoff date. Both groups of students are financially eligible for the Wisconsin Grant, and are otherwise similar at the time of application. Months later, the students who applied early enough will receive a bill with up to 25% of tuition charges covered by the Wisconsin Grant, potentially increasing their chances of starting college, staying enrolled, and completing a degree.

Like other need-based grants that have been studied using regression discontinuity designs, the Wisconsin Grant imposes an income cutoff. However, the population local to the *filing date cutoff* is much larger and more representative of financial aid recipients than is the population local to the income cutoff. Most importantly, the population local to the filing date cutoff includes applicants with a wide range of incomes. This allows for estimation of how effects vary by income.

Figure 1 sums up my empirical strategy. In this stylized image, a student's aid offer depends both on a measure of income and on the application date, with sharp discontinuities in each dimension. To get at varying effects by income, I break the sample into three groups. First, I replicate prior studies by focusing on the students who face a discontinuity in income eligibility (the large orange rectangle). Then, I use the discontinuity in application date to estimate effects for two remaining groups: a middle group who are financially eligible for the Wisconsin Grant but subject to the application date cutoff (medium-sized rectangle with multiple colors denoting multiple income levels), and the very lowest-income students who are also subject to the application date cutoff (smallest rectangle, but contains a much larger density of students than either of the other groups).

Overall I find small, positive effects of grant aid. Technical college students have high rates of dropout, with the vast majority not having earned a degree three years after applying for financial aid. A $1,000 Wisconsin Grant increases the rate of degree completion by 1.5 percentage points from a baseline of 19.0% among the lowest-income students. The effect among continuing students who are closer to degree completion at baseline is larger, moving completion up by 2.6 percentage points.

Effects are strongest at the lowest incomes, even though these students receive the largest

amounts in federal aid at baseline. The grant does not show evidence of increasing initial enrollment among financial aid applicants, perhaps because the benefits coming from the program are so uncertain and not salient to students until after they enroll and begin receiving aid. Taken together, these findings suggest that the positive effects on graduation operate through covering living expenses, for poor students who were intent on enrolling and already received enough grant aid to cover tuition. Living expenses are an important and sometimes overlooked component of college costs (Goldrick-Rab and Kendall, 2016; Kelchen et al., 2017).

This study contributes answers for college students whose receipt of public need-based aid has been understudied: students with the lowest incomes, who attend two-year colleges and receive a mix of state and federal aid. Studies of the introduction of the federal Pell Grant and subsequent policy changes did not isolate students with the lowest incomes (Hansen, 1983; Kane, 1995; Seftor and Turner, 2003). Studies making use of non-financial sources of exogenous variation in aid eligibility, such as family structure and age, have not been able to observe differences in eligibility for the lowest-income students, because these students tend to qualify for the maximum Pell Grant regardless of family structure and age (Bettinger, 2004; Brown et al., 2012; Denning, forthcoming). Several regression discontinuity studies have used income eligibility cutoffs to estimate effects of the smallest grants to the least needy students, finding a mix of results (Kane, 2003; Rubin, 2011; Carruthers and Welch, 2015; Marx and Turner, 2015; Bettinger et al., 2016; Castleman and Long, 2016; Turner, 2017; Park and Scott-Clayton, 2018).

Some non-governmental programs that employ randomization have provided an opportunity to study effects of aid on the lowest-income students. Studies of these programs have uncovered suggestive evidence that aid is more helpful for students with greater financial need Goldrick-Rab et al. (2016); Angrist et al. (2016, 2017); Anderson and Goldrick-Rab (2018); Anderson et al. (2018). The study that comes closest to estimating effects of public need-based aid for very low-income students is Denning et al. (2018), which exploits a cutoff at family incomes between $20,000 and $30,000 that qualifies students for the maximum Pell Grant versus a positive but smaller grant. Again results point to aid being more helpful for students with greater measured financial need.

However, most of these studies are focused mainly or entirely on university students, while

college dropout is much more severe at community colleges. Community colleges also receive more Pell Grant aid than do public universities or private non-profit universities (Office of Postsecondary Education, 2015). It is therefore important to study the effects of public aid programs as they operate in the two-year college sector. Gurantz (2018) uses a regression discontinuity design to study a state-funded need- *and* merit-based aid program for California community college students, finding precisely zero effects of grants. These findings still may not extrapolate to the lowest-income students.

A growing body of evidence shows that wraparound financial supports and educational guidance through community college can be as effective or more effective than financial aid alone (Angrist et al., 2009; Scott-Clayton, 2011; Barrow et al., 2014; Scrivener et al., 2015; Baker, 2016; Carruthers and Fox, 2016; Daugherty et al., 2016; Clotfelter et al., 2017; Carrell and Sacerdote, 2017; Evans et al., 2017). Nevertheless, the vast majority of resources dedicated to college completion interventions come in the form of need-based financial aid from state and federal governments.

Since the estimates around the filing date cutoff are local to students who would receive awards if the program budget were increased, my estimates are relevant for the legislature as they weigh budget increases for the program. Since the estimates trace out differences in effects by income, they are also relevant for the governor-appointed policymaking board that sets the eligibility formulas within the allocated budget. The results suggest that if the objective is to increase degree completions overall, then funding increases should be allocated more heavily toward the lowest-income students.

The body of the paper provides further detail on the setting, research design, data, and results. It concludes with a discussion of the policy implications of the findings.

2. The Wisconsin Grant

The Wisconsin Grant was established in statute in the same year as the historic Higher Education Act of 1965, which set in place the federal approach to funding higher education. The program was formerly known as the Wisconsin Higher Education Grant or WHEG, and it also operates under different parameters at the public university system, the private non-profit colleges and universities, and at tribal colleges (Wisconsin Legislature, 2014). This

section describes how the Wisconsin Grant is currently administered at two-year technical colleges, where there exists the largest rate of dropout, the largest funding deficit, and the clearest implications for quasi-experimental comparisons to evaluate program effects.

2.1. Technical education in Wisconsin

The Wisconsin Technical College System (WTCS) is made up of 16 technical colleges and 49 total campuses. The colleges represent geographic districts that span the state and define areas of property taxation, a key source of revenue for the system. However the tuition is the same for all state residents, and is not defined by district residency. A map of the districts is shown in Figure 2.

WTCS is focused primarily on vocational training, but also awards liberal arts degrees and prepares students to transfer to universities. The system enrolls over 300,000 students each year and offers over 500 degree programs ranging from short-term technical diplomas and employer-linked training up to two-year associate's degrees (WTCS, 2019). Separately, Wisconsin is also home to a set of 13 two-year public branch campuses of the University of Wisconsin System, which provide associate's degrees but enroll just 12,000 students each year (UW System, 2017).

Wisconsin's two-year public colleges and their students face many of the same economic forces, budgetary challenges, and attainment gaps that are faced by community colleges nationwide. A review of the evidence over many studies shows that two-year college degrees improve employment and earnings (Belfield and Bailey, 2011). Thus there is high demand for technical training, particularly when the labor market is poor and the opportunity cost of foregone earnings is lowered (Long, 2014).

As enrollments have risen and fallen, the rates of degree completion have remained objectively low. Of the students who began at a two-year public college in the 2011–12 school year, just 16% had earned any degree within three years of matriculation (Ifill et al., 2016). After six years, an additional 24% had earned a degree, with over half of those students earning a bachelor's degree (Chen et al., 2019). However 10% were still enrolled at a two-year college, demonstrating that students move in and out of two-year schooling over long periods of time, and degree completion often arrives well after the two-year mark. Rates of degree

completion are lower among children from families with lower socioeconomic status, based on their parents' occupation, highest level of education, and income: among a national cohort of students who transitioned to a two-year college out of high school, the rate of bachelor's degree completion over the following eight years was 34% for high-status students versus 15% for low-status students (National Center for Education Statistics (NCES), 2015).

The responsiveness of attainment to the labor market and to family finances suggest that a key factor influencing movement in and out of technical colleges, as well as of eventual degree completion, is the price. Denning (2017) found direct evidence that decreases in tuition led to higher enrollment at district-based two-year colleges. Even though tuition is far lower at technical colleges than at public or private universities, the total cost in terms of living expenses and foregone earnings make financing a two-year degree a challenge for some students. Students meet these costs with a combination of grants and loans, mainly from government sources. This study focuses on changes in price coming from public need-based grant aid.

Table 1 summarizes the average prices and financial aid at technical colleges, both in Wisconsin and nationwide. The table uses figures from the Integrated Postsecondary Education Data System (IPEDS), for school year 2014–15, the most recent of the focal school years in this study.

In Wisconsin and nationwide, direct costs paid to the college (tuition and fees) only represent a fraction of the official comprehensive fee, also called total cost of attendance. The total costs include books and supplies, room and board, and transportation. Importantly, students can receive federal financial aid to cover all these expenses. If a student accept grants and loans totaling more than tuition, upon enrollment they receive a check for the difference, up to the estimated cost of attendance. The costs are estimated, and the check is not based on what students actually spend. The aid system treats students living off-campus with family as having significantly lower costs than students living on their own. Nationally, 37% of technical college students live with family, and nearly all of the rest live off campus on their own. Technical colleges rarely provide on-campus housing.

The federal Pell Grant and the state-funded Wisconsin Grant, described in more detail below, are the primary sources of grant aid for technical education in Wisconsin. Both

programs are targeted to lower-income families, but the income ranges cover a majority of technical college students. Both programs share the same application, so no Wisconsin Grant recipient does not receive a Pell Grant. Among most Pell Grant recipients, the Pell award fully covers tuition. The typical Wisconsin Grant could cover a quarter of tuition and fees for WTCS students in 2014–15. Typically, however, the Wisconsin Grant was not applied to tuition but increased the size of the check a student received from their college for other expenses. The average student who received the Pell Grant and Wisconsin Grant, and took out the maximum loan available, still had some out-of-pocket charges remaining. Therefore there was typically room for the Wisconsin Grant to increase current resources, rather than directly reducing loans. Rates of borrowing were higher in Wisconsin (32% versus 42% nationally), even though Wisconsin has lower rates of low-income status (54% Pell versus 61% nationally).

The next subsection discusses in detail how public need-based grant aid is allocated by Wisconsin and the federal government.

2.2. Public financial aid in Wisconsin

Each year, to qualify for aid students must file the Free Application for Federal Student Aid, or FAFSA. The FAFSA collects information on household income, in addition to wealth, household structure, level of education, age, and criminal history, all of which help determine eligibility for federal financial aid. A complicated formula aggregates this information to calculate the Expected Family Contribution (EFC), an integer that measures the student's financial resources (Federal Student Aid, 2015).

The EFC formula applies a progressive percentage to household net income after some disregards, and adds to that to an age-based percentage of assets excluding housing. This number is truncated at zero and divided by the number of household members in college to reach the EFC. Income is the main component. Family income includes the student's parents' income, even if they are in separate households, if the student does not meet any of the qualifications for independence: over 24, married, has children or dependents, or has served in the military.

The EFC determines eligibility for need-based financial aid. Federal student loan offers

are determined mainly by the student's dependency status and year in college, with interest subsidies dependent on the EFC and unmet need (the difference between total cost of attendance and other financial aid). Pell Grant aid and Wisconsin Grant aid are direct functions of the EFC, as shown in Figure 3. For school years 2010–11 through 2014–15, the eligible EFC range is similar between the two programs. A majority of eligible students had family incomes below $20,000, and 90% had family incomes below $50,000 (Office of Postsecondary Education, 2015).

During the period of this study, each year on January 1 students began to submit FAFSAs for the coming school year starting in the fall. The school year and application period both ended in the following calendar year on June 30. Students listed up to 10 colleges on the FAFSA, and their eligibility criteria and aid information were then automatically sent to those colleges from the federal and state governments. If the student chose to enroll at a WTCS college, all of which are open enrollment and non-selective, then after application the financial aid office at the college will create a financial aid package and send it to the student. The student must then accept the aid package, and complete any additional steps to take up each type of aid, for example signing a Master Promissory Note the first time they take out loans.

To receive the Wisconsin Grant, a student must enroll at least half-time in college. A student may only accept a Wisconsin Grant to one college or university at a time, and may receive the grant for up to five years during their lifetime if they continue to file the FAFSA and remain financially eligible.

2.3. First-come first-served allocatio

The timing of filing the FAFSA does not affect Pell Grant eligibility, but it can affect Wisconsin Grant eligibility. There is a pool of money each year, that is distributed first-come first-served to financially eligible applicants, based on the date of filing the FAFSA. As the state is accepting and processing FAFSA applications, they reach a point where the awarded funds, times the expected take-up rate, rises above that year's budget. They then set a cutoff date, typically a few weeks into the past. Applications received after this date, regardless of financial need, cannot receive Wisconsin Grant awards. There is no way for students, schools,

or the state to know precisely when the cutoff date will be set. Students who miss the cutoff are not notified directly of this fact. Their aid package will be missing Wisconsin Grant aid, which could occur for several reasons besides missing the cutoff date.

This method of allocating the program budget, in combination with the EFC eligibility schedule and the volume of applications, led to significant shortages during the period of this study. Figure 4 shows that the cutoff date moved relatively early in the filing cycle, at its earliest leaving students only 73 weekdays, or until early April to file. Using the FAFSA and enrollment data (which will be described in Section 3), Figure 5 plots different measures of the shortage of Wisconsin Grant aid.

The figure shows that the overall number of applications rose and fell during this time, and a similar trend is evident among the financially eligible applications. The best measure of the gap in awards is the difference between the light blue and dark blue bars. The gap represents students who were financially eligible but filed past the cutoff date. However the light green bar, marking the number who received awards, demonstrates that many students who received awards did not enroll and take them up. Therefore the raw gap measure should be adjusted to take into account student enrollment choices. This study seeks to determine how additional funding, which would extend the cutoff date and provide more financial aid awards, affects students' enrollment and later college attainment.

Few studies have examined the implications of first-come first-served allocation of financial aid, a common choice among public and institutional programs (Cannon and Goldrick-Rab, 2016). In general, there is considerable complexity and uncertainty that is not resolved until just before enrollment. Students find out what they will pay to attend a particular college only after they have completed the lengthy FAFSA form, the results have been processed by financial aid providers and the college, and the college has communicated a financial aid package back to the student. First-come first-served allocations add to the uncertainty, and have understandably become a point of concern for policy makers.

2.4. Effectiveness of financial aid

The Wisconsin legislature convened a commission to consider reforms of the Wisconsin Grant (HEAB, 2012). The commission reported:

> Central to these discussions was the idea that the grants should remain "transformational," i.e. large enough to make a significant difference in a recipient's chances of completing an educational goal…However, the finite nature of grant funding and the grant formulae used for the programs imply a trade-off between the size of available grants and the number of potential grant recipients. This trade-off is part of the discussion of "effectiveness" of the grant programs, but the Commission noted that absolute standards or thresholds of "effectiveness" do not exist…While data on program participation are available, data on outcomes for program alumni have historically been less accessible.

The commission was constrained by both financial and informational limitations. They were interested in making effective policy, but admittedly lacked evidence on effectiveness.

Financial aid could effectively transform student outcomes by protecting them against unexpected economic hardships or by supporting more investment in goods and activities that promote educational success. Having more money to spend on food, housing, clothing, and other necessities is an important concern for two-year college students. In two recent surveys fielded at over 100 community colleges, about half of students reported being food insecure or housing insecure during the past year (Goldrick-Rab et al., 2017, 2018). When students cannot afford to eat balanced meals or pay their full utility bill, then emergency expenses like unexpected car repairs may not be affordable. Losing access to transportation may keep students from class and derail enrollment. A grant of a few hundred to a few thousand dollars can be an effective buffer in these circumstances (Affiliates, 2016). For other students, grant aid can buy time to study by lowering labor supply (Broton et al., 2016).

In some contexts grant aid helps shift enrollment choices toward particular schools, for example toward in-state or four-year universities (Cohodes and Goodman, 2014; Castleman and Long, 2016; Angrist et al., 2016, 2017). In the context of the Wisconsin Grant at WTCS, the aid is not portable to other schools. Most students list only one college on the FAFSA, meaning they are not able to use specific financial aid information to shop around among different colleges. The most immediate channel for financial aid to increase educational attainment then, is to ensure success at the chosen WTCS college. Further into the future, grant aid may also increase transfers to universities after successful completion of two-year

degrees.

The key question in this paper is whether these impacts of aid vary by measured financial need of the student, to inform where grant aid can be directed for maximum impact. Using the EFC as a measure of financial need means something different for the federal government providing first-dollar aid, than it does for a state providing supplemental aid. For a unit increase in the EFC, the Pell Grant decreases by a dollar on average, following a stairstep function with $100 jumps. At the same time the Wisconsin Grant decreases by 12 cents. It is an open question whether the Pell Grant offsets measured financial need for the lowest-income students, making Wisconsin Grant aid equally effective among all Pell recipients, or if the poorest students still have significant financial need after receiving maximum Pell Grants. The following sections describe data and an estimation strategy for estimating the effects of the Wisconsin Grant at different income levels.

3. Data

3.1. Linked longitudinal data

Estimating the effects of the Wisconsin Grant requires data on financial aid eligibility and college attainment. With cooperation from state and national partners, I built the first database in Wisconsin to include both. The Wisconsin Higher Educational Aids Board (HEAB) provided information from residents' FAFSA filings, released without direct student identifiers under a data sharing agreement. HEAB linked these data to college enrollment and degree attainment, as measured by the National Student Clearinghouse (NSC). The National Student Clearinghouse aggregates directory information from the degree-granting colleges and universities attended by 97% of American undergraduates, and has 100% coverage of two-year public colleges in Wisconsin (NSC Research Center, 2018).

For each application the data include a set of baseline characteristics from the FAFSA, financial aid eligibility in each year of filing, and college enrollment and completion for three years following the application. Baseline characteristics include gender, dependency status, and grade in college, as well as age, income, and other household finances and characteristics that determine the EFC. The timing of filing the FAFSA is measured by the day of the week it was processed. I remove weekend days, when no FAFSAs were processed.

To correspond with financial aid eligibility which lasts for one school year, college enrollment in this study is defined as a binary indicator of an enrollment spell of any length during a school year. Degrees at WTCS include 41% short-term technical diplomas, 33% associate's degrees, and 22% 1-year technical diplomas, with liberal arts and 2-year technical diplomas making up the remainder at 2% each (WTCS, 2019). All of these credentials are eligible for state and federal aid, and all of them are reported to NSC. However, in the linked NSC data obtained by HEAB, I cannot distinguish among these degree types.

The data cover the universe of FAFSA filers from Wisconsin who apply to WTCS colleges. This is an appropriate frame within which to estimate the effects of public need-based aid, but it may exclude some students for whom aid would be helpful. There are several studies showing that FAFSA completion itself can be a problem, even for continuing students who have filed before (Bahr et al., 2018; Martorell and Friedmann, 2018). Assistance and nudging have been effective at raising the rate of filing (Bettinger et al., 2012; Castleman and Page, 2016). This study necessarily takes place in a setting with some degree of non-filing by students in need. Using the panel data, I can show that of the 47% students who enroll in any college the year after they are observed filing the FAFSA, 12% do not refile the FAFSA in the second year.

3.2. Analysis sample

The analysis sample focuses on FAFSAs filed in 2010–11 through 2014–15, a span where eligbility is observed, Wisconsin Grant shortages are in effect, and at least three years of attainment outcomes can be observed. There are roughly 115,000 applications per year, with 80% of them financially eligible for the Wisconsin Grant.

For most of this study, the years are pooled together, with each observation representing a single filing. Thus some individual students appear in the sample multiple times, though no student appears multiple times within a given year. Counting by student, the majority (52%) file only once, 26% file twice, 14% file three times, 6% file four times, and 2% file in all five years. Clustered standard errors in the main regression analysis account for correlated error terms within an individual. (The model and the error terms are defined in Section 4).

Table 2 displays characteristics and outcomes of students in the sample following their

FAFSA filing. The majority of students (three out of five) are first-time college students. About three out of five are women, one out of five are married, and two out of five have children or dependents. The median age is 25, and a quarter of students are over 32. The vast majority earned below $20,000 in the prior year. Students are about evenly split when it comes to years enrolled out of the following three school years, with about even numbers enrolling zero, one, two, and three years. One in four will have completed a degree in that time, and one in eight will have transferred to a four-year college or university.

Throughout this paper, to get at varying effects by EFC, I break the sample into three groups. First, students with the highest EFCs that are above the EFC eligibility cutoffs. Second, students with positive EFCs that are Wisconsin Grant eligible and subject to the filing date cutoffs. And finally, students with zero EFCs (that are also financially eligible and subject to filing date cutoffs). The EFC groups are different at baseline, with more women and more parents in the lower-income groups. The lower-income groups are also more likely to be new students, are older, and have worse attainment outcomes. For example the three-year degree completion rate in the zero EFC group is 19.0%, compared to 29.7% in the middle EFC group and 31.3% in the high EFC group.

The remainder of the paper focuses on FAFSAs filed near the cutoff dates in a given year, which may be limiting if the students filing near cutoffs are different from others. Later in the paper, I examine balance of baseline characteristics immediately on either side of the filing date cutoffs. In Figure 6, Figure 7, and Figure 8 I use baseline measures from the FAFSA to show how students filing near the cutoff dates compare to students who file very early or very late. The figure shows every week of the filing year and plots averages by EFC group.

In all cases the applications received near the cutoff dates are central, and not on either extreme, in terms of the percent who are men, beginning students, and dependent students. Men are less likely to file early, particularly in the zero EFC group. The percent men grows steadily throughout the filing year, without any strong patterns near the cutoffs. Dependent students file at about the same rate throughout the filing cycle. Beginning students are less likely to file early, and the percent beginning students rises by about ten percentage points from the months before any of the cutoffs to the months after all the cutoffs.

In these scatter plot figures, each bubble expresses a group average among applications

received during one week of the filing year. The the sizes of the bubbles are proportional to the number of applications in that week. The timing of filing is roughly similar across all three EFC groups, but the zero EFC group does file proportionally more applications in the first few weeks and then falls behind and files proportionally fewer over the first few months. The sizes of the bubbles make clear that a significant number of students applied near these cutoff dates, making the empirical strategy for this paper feasible.

4. Regression discontinuity design

4.1. Empirical model

Consider the following model for the effect of financial aid after an application by individual i in school year t.

$$Y_{it} = \alpha + \tau G_{it} + h(x_{it}) + \varepsilon_{it}$$

The educational outcome Y_{it} is influenced by the Wisconsin Grant offer G_{it}, which is a deterministic function of an assignment variable x_{it}. Importantly, the assignment variable x_{it} is also likely to be associated with the outcome Y_{it}. The model conditions on the relationship between the assignment variable and the outcome using a flexible control function $h(x_{it})$. ε_{it} is an idiosyncratic error term.

In this model the RD effect τ is identified only if the Wisconsin Grant offer G_{it} varies conditional on the control function $h_t(x_{it})$. The control function may be arbitrarily flexible, but as long as it is continuous then τ will be identified at values x_t^* where G_{it} jumps discontinuously. In the case of the Wisconsin Grant, x_{it} represents the filing date, and jumps come from the filing date cutoffs. Alternatively, the assignment variable x_{it} may represent the EFC, which also determines Pell Grant aid. In this paper I take each assignment variable in turn, rather than estimating them jointly. My main estimates use the filing date dimension to trace out heterogeneity in effects by EFC.

4.2. Estimation

This model lends itself to estimation using a regression discontinuity (RD) design (Imbens and Lemieux, 2008). There are multiple, non-cumulative cutoffs, meaning that each

observation (a FAFSA filing) is subject to exactly one of the multiple cutoffs (Cattaneo et al., 2018b). To estimate the effect, I pool together the data, and define a recentered assignment variable $\tilde{x}_{it} = x_{it} - x_t^*$ which is the distance from the relevant cutoff date, in weekdays. Using the software packages developed by Calonico et al. (2017), I estimate a local linear regression on either side of the cutoff. The estimates use a triangular kernel, and nearest-neighbor clustered standard errors within each individual.

The pooled RD estimand using data local to each cutoff represents a weighted average of the average treatment effects at each cutoff. This estimator is defined and discussed by Cattaneo et al. (2016). The weights depend on the density near each cutoff and the (possibly varying) treatment effects near each cutoff.

The optimal bandwidth is estimated using the data-driven method in Calonico et al. (2014), and varies by the outcome estimated. Generally the bandwidth falls around 30 weekdays (six weeks) on either side of the cutoff, so I use a 30-day bandwidth in the main estimates. I test the robustness of results to using the optimal outcome-by-outcome bandwidth, as well as 20- and 10-day bandwidths.

Grant aid G_{it} is a binary indicator for receipt of a Wisconsin Grant offer. Outcomes Y_{it} are assessed relative to school year t when the FAFSA was filed. I focus on enrollment at WTCS in year t, retention at WTCS (enrollment in year $t+1$), transfer to a UW institution during years t, $t+1$, or $t+2$, and completing a degree at WTCS during years t, $t+1$, or $t+2$. I also consider some alternative, broader measures of enrollment, retention, transfer, and degree completion as robustness checks.

In estimates using the EFC assignment variable, the discontinuities in Wisconsin Grant eligibility occur at EFC values that are very near the EFC values with discontinuities in Pell Grant eligibility. There are multiple, cumulative cutoffs, and there are not nearly enough observations to estimate a control function in the area between the Pell Grant and Wisconsin Grant cutoff in most years. I therefore specify a cubic polynomial for the control function $h(x_{it})$, where x_{it} represents the non-recentered EFC. The functional form can generally become more flexible as sample size increases. However, higher-order polynomials can have unfavorable properties for local RD estimation, as discussed in Gelman and Imbens (2017). To exclude EFCs far from any discontinuity, I only include EFCs between 4,000 and 6,000,

for all years.

In the EFC-based estimates I add fixed effects to control for each filing year, isolating variation similarly to a difference-in-difference specification. The control function conditions out similarities among students who file on the same day of the filing cycle but in different years, and the year fixed effects control for similarities among students who file on different days of the filing cycle within a given year. τ captures differences in outcomes across cutoff values, relative to the differences in outcomes at those same values in other years when they were not the relevant cutoffs. It is also natural to include individual characteristics (gender, dependency status, and continuing student status) as covariates in this regression. In these regressions it is also natural to define grant aid G_{it} in thousands of dollars of combined Wisconsin Grant and Pell Grant aid. In both the filing date and EFC approaches, the increase in grant aid across the cutoffs is about $1,000 on average.

4.3. Validity of the RD design

For the parameter τ to represent the causal effect of grant aid, there must be a jump in grant aid at the cutoff, and potential outcomes with and without treatment must be continuous at cutoff values. The first condition can be checked in the data. The second condition could be threatened by other treatments at the same cutoffs, by manipulation of the assignment variable around the cutoff, or by other chance differences among students near the cutoff.

Figure 9 shows that there is in fact a discontinuity in treatment at the cutoff value. The figure plots the percent who received a Wisconsin Grant award within bins of one weekday during the application cycle. The bins pool together data from five years, recentering application dates around the relevant cutoff in that year. The sizes of the dots are proportional to the frequency of applications on that day. The graph divides the sample into three EFC groups: zero, middle, or high. The graph shows that the probability of receiving a Wisconsin Grant award jumps from 0% among late filers to over 80% among financially eligible applicants (zero or middle). The remaining 20% who have zero or middle EFCs and file early, but do not receive awards, can be explained by various idiosyncratic factors such as the student having run out of 10 semesters of grant eligibility.

There are no other treatments in effect at the cutoff values. Since the cutoff date moves around throughout the year, it does not coincide with any other fixed important dates. WTCS does not have an institutional FAFSA deadline to be eligible for aid.

The filing date cutoff is not set until after it passes, and is not announced publicly or reported in program documents until months later (e.g. HEAB, 2014). Therefore manipulation is impossible. There is however, significant variation in frequency of FAFSA filing by days of the week. Combined with the discrete nature of filing date, this can produce a lumpy distribution with the potential for discontinuous frequency around the cutoff date. Figure 10 shows the densities by recentered filing dates for the zero EFC and middle EFC groups. Using the test proposed by Cattaneo et al. (2018a), both groups fail to reject a difference in frequency across the cutoff.

The top panel of Table 3 estimates the main empirical approach, but with baseline characteristics as dependent variables. None of the estimated differences are larger than 2 percentage points, and the only statistically significant difference is in beginning student status within the zero EFC group. The chance imbalance of fewer beginning students applying early will tend to bias against finding positive effects of aid on degree completion. Beginning students are less likely to complete than students farther along in their studies (though the correlation between beginning status and completion is not particularly strong, -0.21 for the zero EFC group). Other baseline characteristics, such as age (which can vary even within dependency and beginning student status) and family income (which can vary within EFC groups) also do not show substantial differences across the filing date cutoffs (results not shown).

As shown in Figure 3, there is a discontinuous drop in aid eligibility at particular values of the EFC, for both the Pell Grant and the Wisconsin Grant. Several prior studies have exploited the Pell Grant cutoff (Rubin, 2011; Carruthers and Welch, 2015; Marx and Turner, 2015; Castleman and Long, 2016; Turner, 2017). Wisconsin Grant payment data demonstrate fidelity to the eligibility formula in Figure 3, and as prior studies have found, there is no evidence in the data of sorting around any EFC cutoffs (results not shown). The Wisconsin Grant schedule is not approved until after the prior tax year is over, making it impossible to manipulate the EFC in response (e.g. HEAB, 2014). Even with information about the

relevant cutoff, manipulating one's EFC would require understanding the complicated formula that calculates the EFC, and being willing to change labor supply or other core household finances. There is no evidence of imbalances in baseline characteristics (results not shown), nor are there other treatments occurring at the same EFC cutoffs. Therefore the EFC-based design also meets the conditions for RD validity.

In addition to these approaches, I replicate the birthdate discontinuity from Denning (forthcoming) and the family income discontinuity from Denning et al. (2018), both of which affect the EFC itself.

5. Effects of need-based financial aid

Overall the results indicate that Wisconsin Grant aid has small positive effects on college attainment. The positive effects are strongest among the lowest-income students who receive the largest amounts in aid. The grant appears to support degree completion, particularly among students who have been enrolled for at least a year.

This section begins by reporting the main specification based on FAFSA filing date. I report graphs and numerical estimates, as well as robustness checks altering some of the estimation choices. I then compare those results to replications of earlier approaches using other cutoffs in aid eligibility by EFC.

5.1. Results using the filing date cutoff

The scatter plots presented in this subsection display along the horizontal axis the recentered weekday of filing, within 30 weekdays on either side of the relevant cutoff date. The sizes of the bubbles are proportional to the frequency of students who filed that day and fell into one of three groups: zero EFC, middle EFC with incomes low enough to qualify for the Wisconsin Grant, and high EFC with incomes above the Wisconsin Grant threshold. The high EFC group is included as a placebo comparison, where there should be no effect of filing past the Wisconsin Grant cutoff date. The positions of the dots capture the average outcome among those filing each day.

Figure 11 shows the total Wisconsin Grant payments to each student over three years. Filing on the early side of the discontinuity yields, in an unconditional average, an additional

$360 in grant aid over the following three years, for both the zero EFC group and the middle EFC group. There is no evidence that filing just before or after the cutoff affects timing of filing in following years (results not shown). Because it is just over a third of the average grant, this figure suggests that students who apply just before the cutoff are induced to receive more aid via small positive effects on enrollment over a three-year period. This analysis is limited to the FAFSA data, which do not include enrollment outcomes for non-recipients and do not include degree completion.

As discussed above, there are several educational outcomes measured in the NSC data, which a student can attain at different time points after filing the FAFSA. Figure 12 plots the percent who enrolled at WTCS in the year of filing the FAFSA. Figure 12 is the first illustration of some consistent trends that will appear in each of the outcome graphs. The zero EFC group has a lower level of college attainment than either of the other groups, who tend to have similar levels to one another: here about 60% of FAFSA filers from the zero EFC group enrolled at all, while 65 to 70% of FAFSA filers from higher EFC groups enrolled. Also, there is some dispersion across filing days within groups, but there is not much evidence of a slope in filing date within this bandwidth. Throughout, the main differences in dot size are across EFC groups, not within groups across filing days. Aside from these similarities, the evidence for a discontinuity differs across each measure and EFC group. For enrollment there is little evidence in any group of an increase induced by the Wisconsin Grant.

Moving forward in time, Figure 13 plots the percent who were retained (who enrolled at WTCS in the year after filing the FAFSA). The levels are much lower for all EFC groups, ranging from 35% to 45% retained. The middle EFC group has the strongest evidence of a discontinuous drop in outcomes from left to right, indicating positive effects of the Wisconsin Grant. Figure 14 displays transfers from WTCS to the University of Wisconsin System, occurring at any point within three years after filing the FAFSA. The levels are even lower, ranging from 5% to 10%, with no strong indication of effects around the cutoff.

The final two figures plot degree completion at WTCS during the three years following the FAFSA. Figure 15 shows that about one in five zero EFC applicants earned a degree in three years, whereas about one in three applicants from the higher income groups did. There is a 1.5 percentage point drop in degree completion among zero EFC students who missed

out on Wisconsin Grant aid because of the funding shortage. This difference is statistically significant at the 5% level, and is evidence that Wisconsin Grant aid had positive effects on college attainment.

Timing helps to explain why Wisconsin Grant aid could affect degree completion, without evidence of effects on upstream enrollment and retention. Because of the FAFSA process, the shortage of Wisconsin Grant funds, and the financial aid packaging process, Wisconsin Grant aid is unpredictable for students and is not known until close to the time of enrollment. As such, it is less likely to change initial enrollment decisions. The main channel for its effect then, is to support success among enrolled students. Retention to a second year is not the goal for many students, who are seeking a one-year degree or who are in the second year of a two-year degree. Therefore the most important outcome is degree completion.

To remove the noise of the initial decision to enroll, and focus on students who are highly likely to be within one year of degree completion, the final outcome is measured only among continuing students. Figure 16 limits the sample to students who had enrolled in college for at least one year at the time of filing, based on their response to a FAFSA question about grade level. Also, this sample removes the concern about the chance imbalance in the rate of continuing students across the discontinuity, discussed above in the tests for RD validity. The dots in Figure 16 are correspondingly smaller than in earlier figures, since only 57% of students filing within 30 weekdays of the cutoff were continuing college students. However the effects on three-year degree completion are even stronger, particularly among the zero EFC group. This result reflects that students take a long time to earn a degree, and that financial aid is potentially more helpful among students who have demonstrated some attachment to college enrollment.

All of the results from these figures appear as numerical estimates in Table 3. The table uses a constant bandwidth of 30 weekdays and estimates nearest-neighbor standard errors, clustered within an individual student. Both EFC groups have estimated positive effects of one percentage point increased enrollment, though both are imprecise. The positive EFC group has an imprecisely estimated increase in retention of 1.8 percentage points. The baseline probability of degree completion in the zero EFC group was 19.0% over three years. This is increased by 1.3% overall, or by 2.6% when focusing on continuing students. There is

no such effect estimated for the positive EFC group.

These estimation choices can be varied in a few ways that do not change the main conclusions. For example, using broader measures of enrollment, transfer, and degree completion at any college; using other methods of calculating standard errors; scaling up the estimates in a two-stage procedure and reporting the effect in terms of dollars received; or varying the bandwidth as shown in Table 4.

5.2. Results using the EFC and other cutoff values

Because there are multiple EFC cutoffs arising from different programs within a particular year, and the cutoffs lie very close to each other, the pooling and recentering strategy used above does not work. This subsection implements estimates of the effect of aggregated public aid jointly using the cutoffs in EFC imposed by the Pell Grant and the Wisconsin Grant, conditional on a polynomial control function. I then use the standard pooling and recentering method to consider other discontinuous changes in eligibility driven by components of EFC. Throughout these analyses I restrict the data to applicants who filed before the cutoff date in their year and were thus eligible for Wisconsin Grant aid.

In general, estimating the effects of Pell Grant and Wisconsin Grant aid together, using EFC cutoffs, does not provide precise evidence of positive effects. In Table 5 the point estimates suggest some positive effects of $1,000 in aid eligibility, similar in magnitude to the effects of a Wisconsin Grant award of around $1,000 estimated above. The jumps in Pell Grant eligibility at EFC cutoffs range from $555 to $1,176 depending on the year, while the jumps in Wisconsin Grant aid range from $500 to $605.

Denning et al. (2018) exploit a cutoff in family Adjusted Gross Income that triggers an automatic zero EFC. The cutoff applies to students who are dependent or who have children or dependents of their own, and it varied from $23,000 to $31,000 in the years of this study. Restricting to this group, recentering the data around the income cutoff, and using a $20,000 bandwidth in income as in Denning et al. (2018), I estimate a large discontinuity in the probability of having an automatic zero EFC. The automatic zero allows a student to skip many of the remaining questions on the FAFSA, but students who answer these questions may still end up with a zero EFC. In the data for this study, the automatic zero cutoff raises

the probability of a zero EFC by only eight percentage points, and does not substantially change the probability of receiving a Wisconsin Grant.

Denning (forthcoming) exploits a cutoff in student date of birth that triggers independent status, disregarding parent income and typically lowering the EFC significantly. A student is automatically considered independent if they turn 24 on or before December 31 of the school year. Recentering the data around the birth date cutoff, and using a 100-day bandwidth as in Denning (forthcoming), I estimate a large discontinuity in the probability of independent status. Furthermore, there is an 18 percentage point jump in the probability of receiving a Wisconsin Grant. This approach is rather restrictive since it focuses on 23-year-old students only, with a final sample size of 3,566. However the point estimates, shown in Table 5, suggest positive impacts of similar magnitudes to the estimates using the filing date cutoff.

Both the EFC and birth date strategies could be used to detect differences in effects betwee very early FAFSA filers and those filing closer to the filing date cutoffs. In both cases, there is not strong evidence of differences in effects based on the timing of filing the FAFSA (results not shown).

6. Discussion and conclusion

This study was the first to estimate how effects of need-based grant aid vary by student financial need, in the setting of a large public program rather than a smaller randomized trial. I find evidence of modest positive effects from giving technical college students an additional $1,000 in grant aid, effects that are strongest among the poorest students.

To implement the regression discontinuity design in this study, I created a new, longitudinal database from multiple administrative sources. These data greatly expanded the state's capacity to examine the program: in the 50-year history of the Wisconsin Grant, there had been no reporting on the graduation rates of program alumni. Lack of data is a commmon problem, however. As of 2016 there were 48 need-based aid programs run by states, but only 24 states had data systems that included financial aid eligibility (Armstrong and Whitfield, 2016; NASSGAP, 2016). The Wisconsin Grant is only the third need-based state financial aid program to receive a large-scale causal evaluation, after Florida and California (Castleman and Long, 2016; Bettinger et al., 2016).

While the Wisconsin Grant program helps tens of thousands of students each year pay for college, the estimates here identify the marginal students for whom Wisconsin Grant aid is pivotal to continued enrollment and successful degree completion. The main estimates are identified around the filing date cutoff, which is exactly the margin that is affected by incremental changes in the program budget.

In 2016, the legislature passed a measure to increase funding for Wisconsin Grants to technical colleges by $500,000 (Wisconsin Legislature, 2016). This could provide an additional 500 students with the average-sized Wisconsin Grant, and those students would be ones who would have just missed the application date cutoff absent the expansion. Increasing their degree attainment by one to two percentage points means five to ten additional degrees among state residents, coming from this particular funding measure.

Students with technical degrees potentially earn higher wages, among other benefits. Wisconsin has a particularly large wage gap between technical degree holders and workers with some college education: $5.39 in hourly wages relative to a $3.11 gap nationally (COWS, 2016). Higher wages can lead to higher tax revenues for the state. A more complete benefit-cost analysis will be possible in future work, using actual wages of students before and after college, once those data can be added to the linked database.

In more recent funding cycles after funding increases and enrollment decreases, the shortage has become a surplus. A surplus opens the possibility of increasing grants to some students without decreasing them for others. As discussed above, policymakers face the decision of where to allocate scarce financial aid where it is needed most, with the additional scarcity of research evidence. Prior to this study, it was unclear whether students with the lowest incomes could benefit from more aid, particularly since they received the largest Pell Grants. This analysis showed that even after federal aid, students still faced economic barriers, and additional aid helped support graduation from technical colleges.

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Tables and figures

Table 1: Average prices and aid at technical colleges, school year 2014–15

	WTCS	Technical colleges
Number of colleges	16	283
Prices		
Tuition and fees	$4,150	$3,835
Indirect costs (off-campus not with family)	$12,280	$12,410
Indirect costs (off-campus with family)	$5,420	$5,240
Percent who live with family	37%	37%
Grant aid		
Maximum (and modal) Pell Grant	$5,730	$5,730
Maximum (and modal) Wisconsin Grant	$1,084	
Average grant aid from all sources	$4,520	$4,450
Percent who receive Pell Grants	54%	61%
Percent who receive state/local grant aid	32%	42%
Loan aid		
Maximum federal loan (first-year independent)	$9,500	$9,500
Maximum federal loan (first-year dependent)	$5,500	$5,500
Percent who borrow federal loans	55%	24%

Source: Higher Educational Aids Board (HEAB), Federal Student Aid (FSA), and Integrated Postsecondary Education Data System (IPEDS).

Notes: Indirect costs include room and board, books and supplies, and transportation. Sample for aid statistics is first-time, full-time, degree/certificate-seeking students, and for living situation focused on students paying in-state tuition (the vast majority of WTCS students).

Table 2: Characteristics and outcomes of FAFSA filers at WTCS in 2010–11 through 2014–15

	All	Zero EFC	Middle EFC	High EFC
Percent in column	100	53	23	24
Baseline characteristics (%)				
Male	39.5	35.5	42.6	45.2
Beginning student	61.4	65.9	56.3	56.6
Dependent	32.7	18.6	38.0	58.1
Married	19.0	16.4	24.1	19.7
Has children	38.7	58.0	25.7	9.6
Age at beginning of school year				
25th percentile	20	21	20	19
Median	25	26	25	22
75th percentile	32	33	32	30
Student income (current $)				
25th percentile	900	0	5,621	4,350
Median	10,210	7,040	14,770	14,580
75th percentile	22,400	16,730	31,750	34,310
Attainment over next 3 years (%)				
0 years enrolled	28.3	32.2	24.6	23.7
1 years enrolled	23.6	24.7	23.4	21.5
2 years enrolled	21.1	20.1	22.2	22.2
3 years enrolled	26.9	23.0	29.8	32.6
Completed degree	24.4	19.0	29.7	31.1
Transfer to four-year	12.1	9.4	14.0	16.1

Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).

Notes: Pooled data, representing 577,636 FAFSA filings. Majority of individuals appear only once.

Table 3: Impact of Wisconsin Grant eligibility around filing date cutoffs

	Zero EFC		Middle EFC	
	Coef.	(SE)	Coef.	(SE)
Selected characteristics (%)				
Male	0.36	(0.70)	0.97	(1.06)
Beginning student	−1.97	***(0.70)	0.14	(1.05)
Dependent	0.52	(0.57)	−0.70	(1.03)
Aid award and receipt				
Awarded Wisconsin Grant (%)	80.21	***(0.38)	84.21	***(0.49)
Paid Wisconsin Grant ($ over three years)	361.97	***(10.03)	357.73	***(12.02)
Outcomes				
Enrolled	1.03	(0.71)	1.07	(1.00)
Retained	0.07	(0.70)	1.78	*(1.05)
Transfer	−0.08	(0.34)	−0.58	(0.62)
Degree	1.51	**(0.60)	−0.25	(0.99)
Observations in 30 day bandwidth	93,453		44,454	
Among continuing students				
Degree	2.58	**(1.11)	−0.69	(1.52)
Continuing observations in 30 day bandwidth	36,027		21,197	

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$ Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).

Notes: Local linear estimation with triangular kernel and nearest-neighbor matching with nearest-neighbor clustering within student across multiple years of filing. Bandwidth 30 days on either side of cutoff. Pooled data from FAFSAs filed for school years 2010–11 to 2014–15, recentered around yearly cutoff values.

Enrolled: attended WTCS in the year of the FAFSA filing. Retained: attended WTCS in the year following the FAFSA filing. Degree: earned a degree at WTCS within three years of the FAFSA filing. Transfer: attended UW System within three years of the FAFSA filing. Continuing students: beyond the first year of college, according to the FAFSA. Dependent students are under 24 and have not married, had children, or served in the military.

Table 4: Alternative bandwidths, impact of Wisconsin Grant eligibility around filing date cutoffs

	Zero EFC			Middle EFC		
	Coef.	(SE)	[BW]	Coef.	(SE)	[BW]
Data-driven bandwidth selection						
Enrolled	0.94	(0.77)	[25]	1.05	(1.00)	[35]
Retained	0.07	(0.70)	[30]	1.81	*(1.03)	[31]
Transfer	0.26	(0.43)	[18]	−0.45	(0.68)	[24]
Degree	1.47	**(0.61)	[28]	−0.02	(0.95)	[32]
Degree among continuing	2.7	***(1.03)	[35]	−0.07	(1.39)	[36]
Bandwidth 20 days						
Enrolled	0.86	(0.85)	[20]	0.67	(1.21)	[20]
Retained	0.05	(0.84)	[20]	1.22	(1.27)	[20]
Transfer	0.21	(0.41)	[20]	−0.37	(0.74)	[20]
Degree	1.29	*(0.72)	[20]	−1.27	(1.19)	[20]
Degree among continuing	2.49	*(1.34)	[20]	−2.12	(1.84)	[20]
Bandwidth 10 days						
Enrolled	1.45	(1.18)	[10]	0.07	(1.67)	[10]
Retained	0.24	(1.16)	[10]	−0.14	(1.75)	[10]
Transfer	0.07	(0.56)	[10]	0.11	(1.01)	[10]
Degree	2.56	**(0.99)	[10]	−1.09	(1.64)	[10]
Degree among continuing	4.10	**(1.84)	[10]	−2.08	(2.53)	[10]

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$ Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).

Notes: Local linear estimation with triangular kernel and nearest-neighbor matching with clustering by individual. Pooled data 2010–11 to 2014–15 recentered around yearly cutoff values. Number of observations varies, but is roughly proportional to bandwidth (observations at 30 day bandwidth reported in Table 3).

Enrolled: attended WTCS in the year of the FAFSA filing. Retained: attended WTCS in the year following the FAFSA filing. Degree: earned a degree at WTCS within three years of the FAFSA filing. Transfer: attended UW System within three years of the FAFSA filing. Continuing student: beyond the first year of college, according to the FAFSA.

Table 5: Impact of $1,000 in public aid eligibility around EFC cutoffs

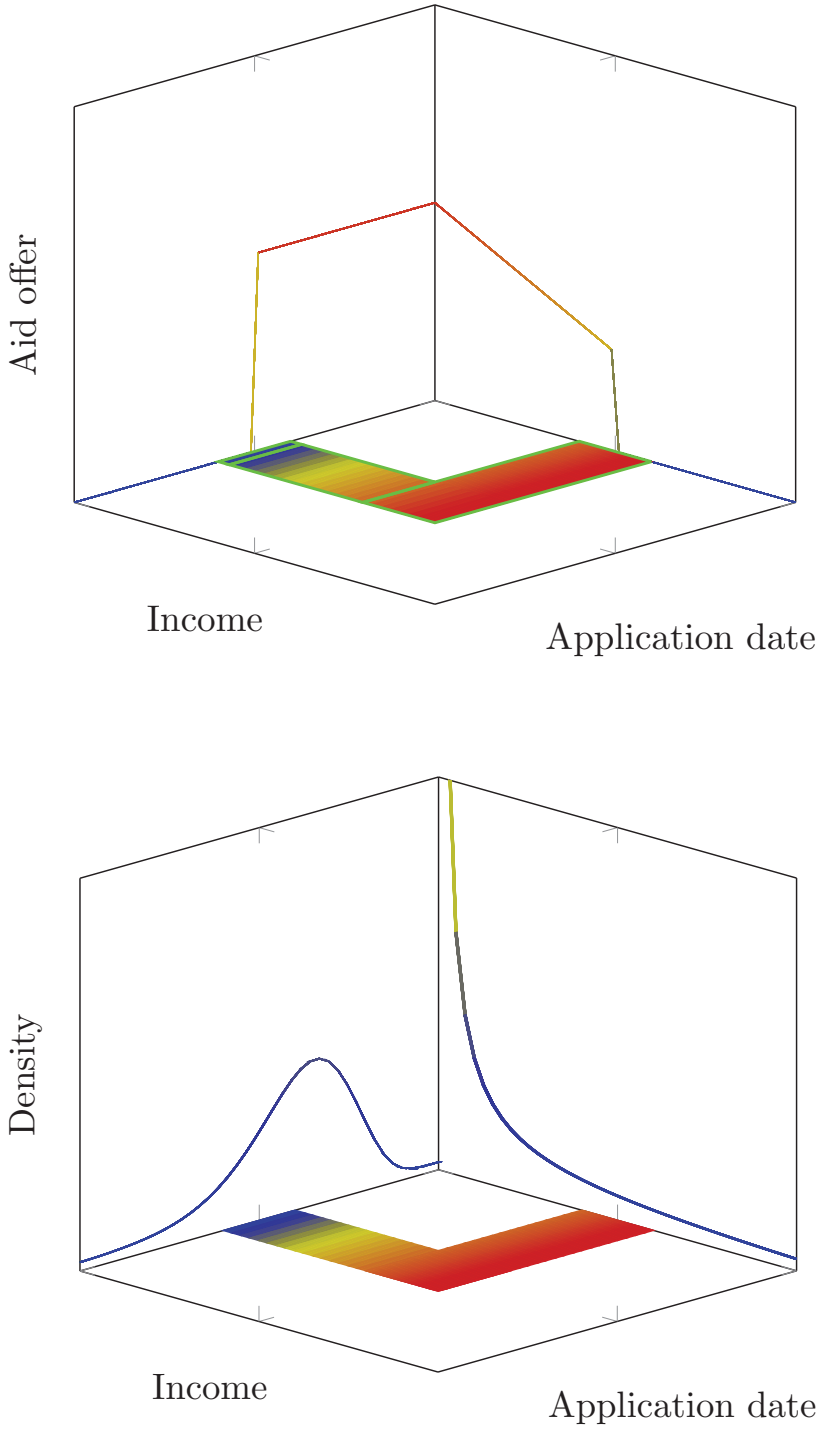
	Coef.	(SE)
Polynomial control function approach		
Enrolled	2.68	(2.03)
Retained	−1.03	(2.12)
Transfer	2.23	(1.36)
Degree	2.74	(2.00)
Observations in 1000 EFC bandwidth	18,801	
Recentered date of birth approach		
Enrolled	3.31	(3.55)
Retained	−1.04	(3.70)
Transfer	4.33	(2.38)
Degree	1.82	(3.49)
Observations in 100 day bandwidth	3,566	

* $p < 0.10$ ** $p < 0.05$ *** $p < 0.01$ Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).

Notes: Polynomial control function approach is an OLS regression of the outcome on thousands of dollars of public aid eligibility, a cubic in EFC, indicators for the aid year, and indicators for gender, dependency status, and continuing student status. Sample includes filings before the cutoff dates, with EFCs from 4,000 to 6,000.

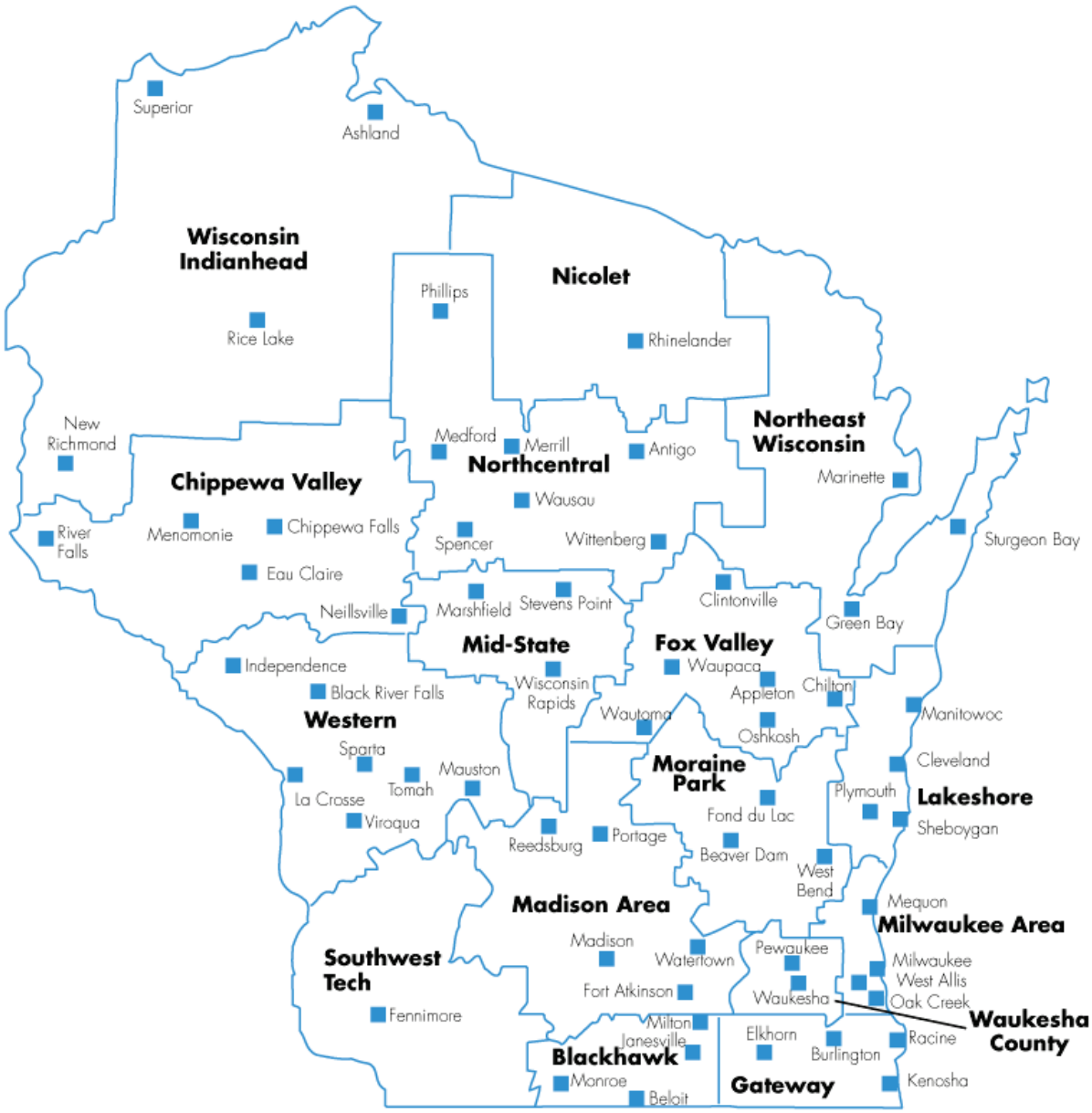
Enrolled: attended WTCS in the year of the FAFSA filing. Retained: attended WTCS in the year following the FAFSA filing. Degree: earned a degree at WTCS within three years of the FAFSA filing. Transfer: attended UW System within three years of the FAFSA filing.

Figure 1: Multi-dimensional regression discontinuity design



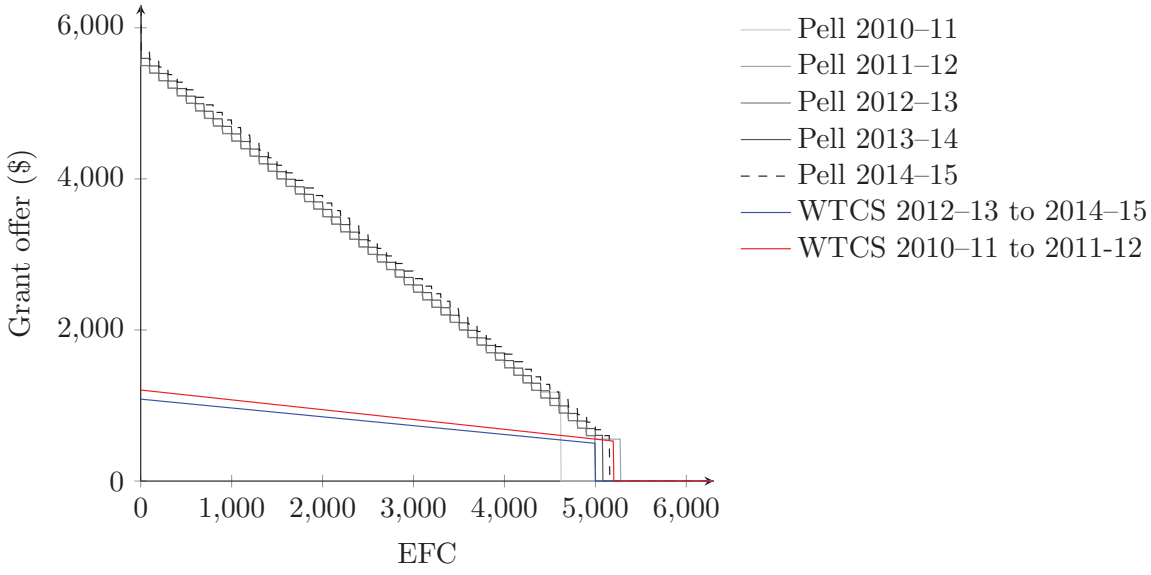
Notes: Using the income cutoff only, the estimates are limited in both power and generalizability, because such a small and relatively higher-income set of applications are local to the income cutoff. Using the application date cutoff allows for estimation of heterogeneous effects by income.

Figure 2: WTCS college districts and campuses



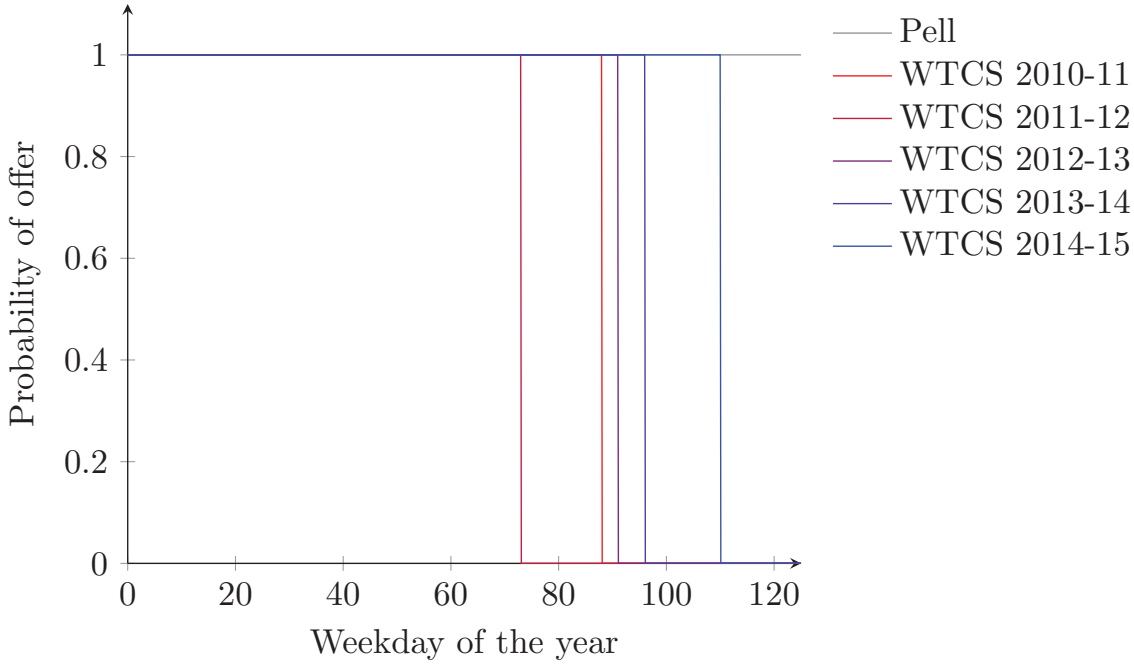
Source: Wisconsin Technical College System (WTCS).

Figure 3: Grant eligibility by Expected Family Contribution (EFC)



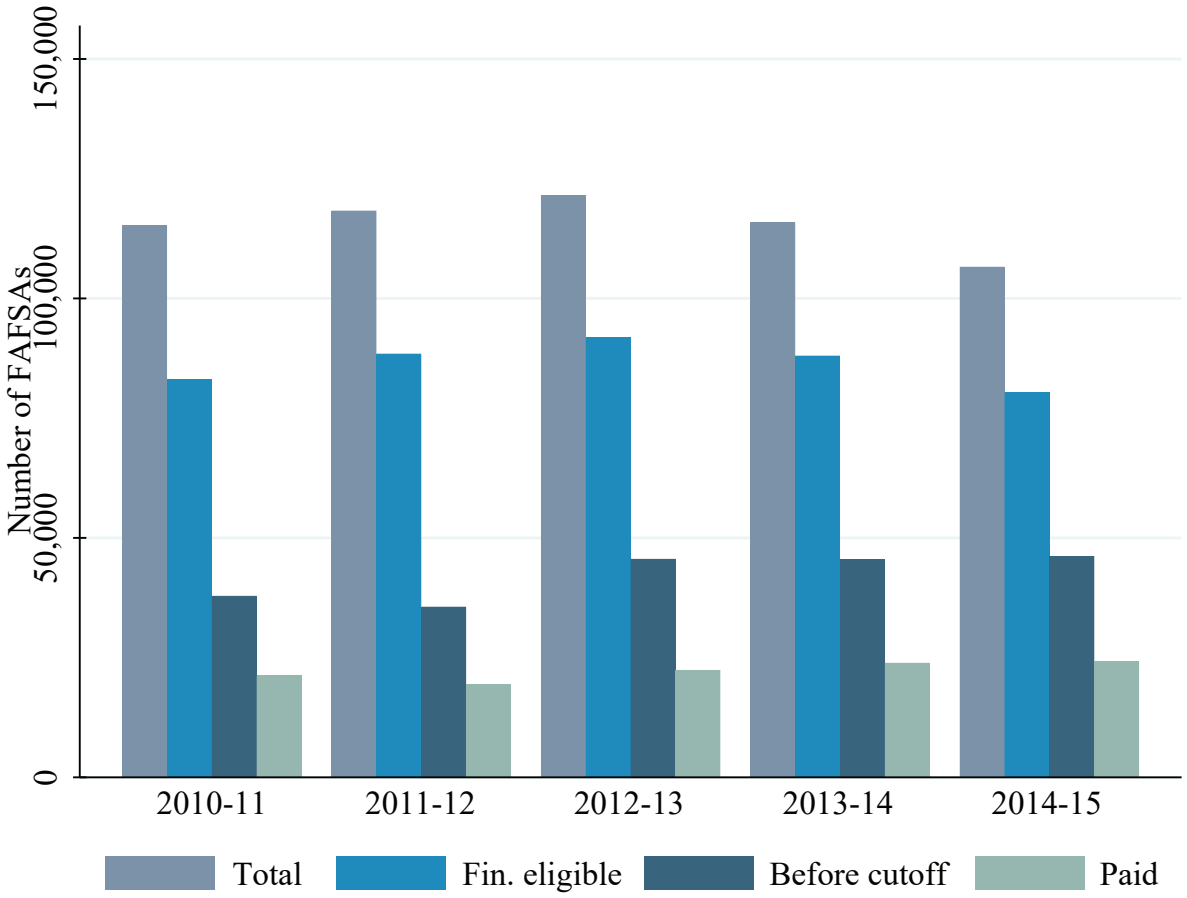
Source: Higher Educational Aids Board (HEAB) and Federal Student Aid (FSA).

Figure 4: Grant eligibility by FAFSA filing date



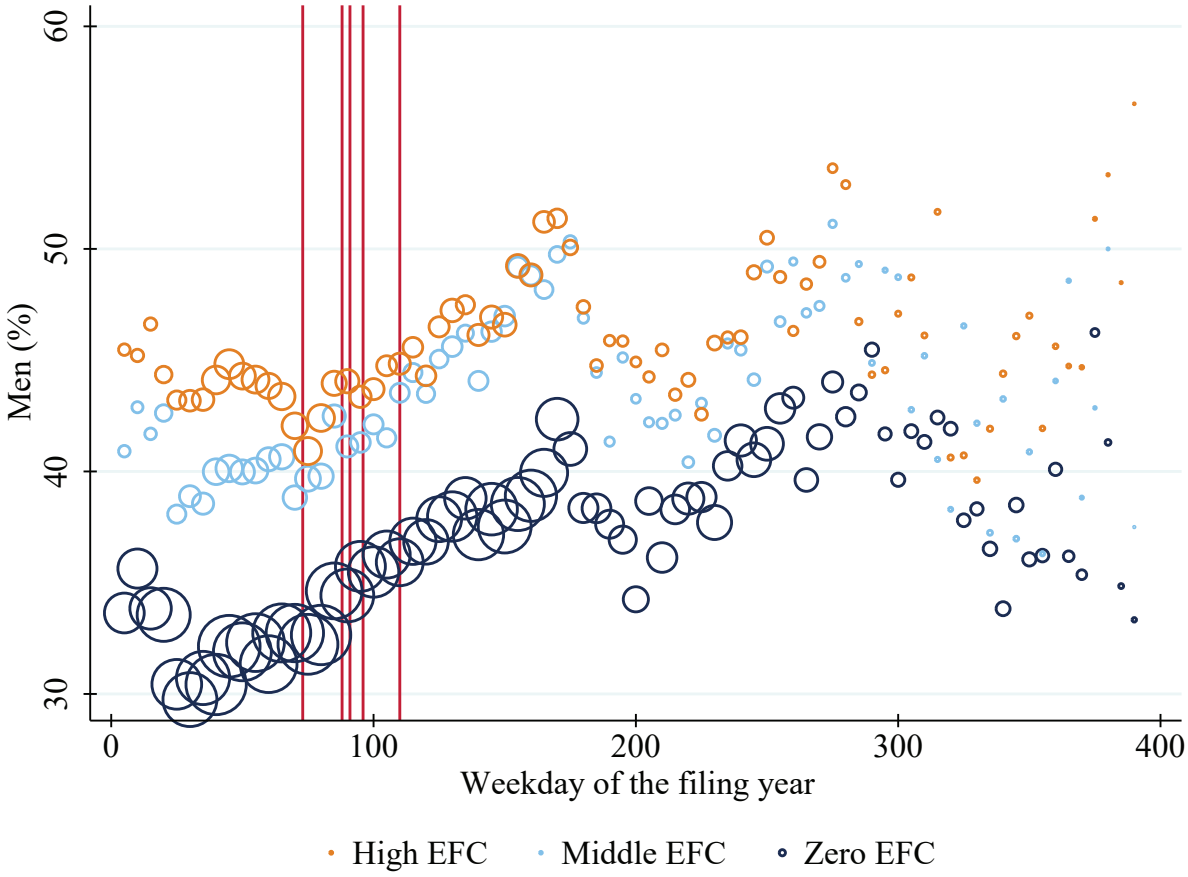
Source: Higher Educational Aids Board (HEAB) and Federal Student Aid (FSA).

Figure 5: Grant eligibility by FAFSA filing date



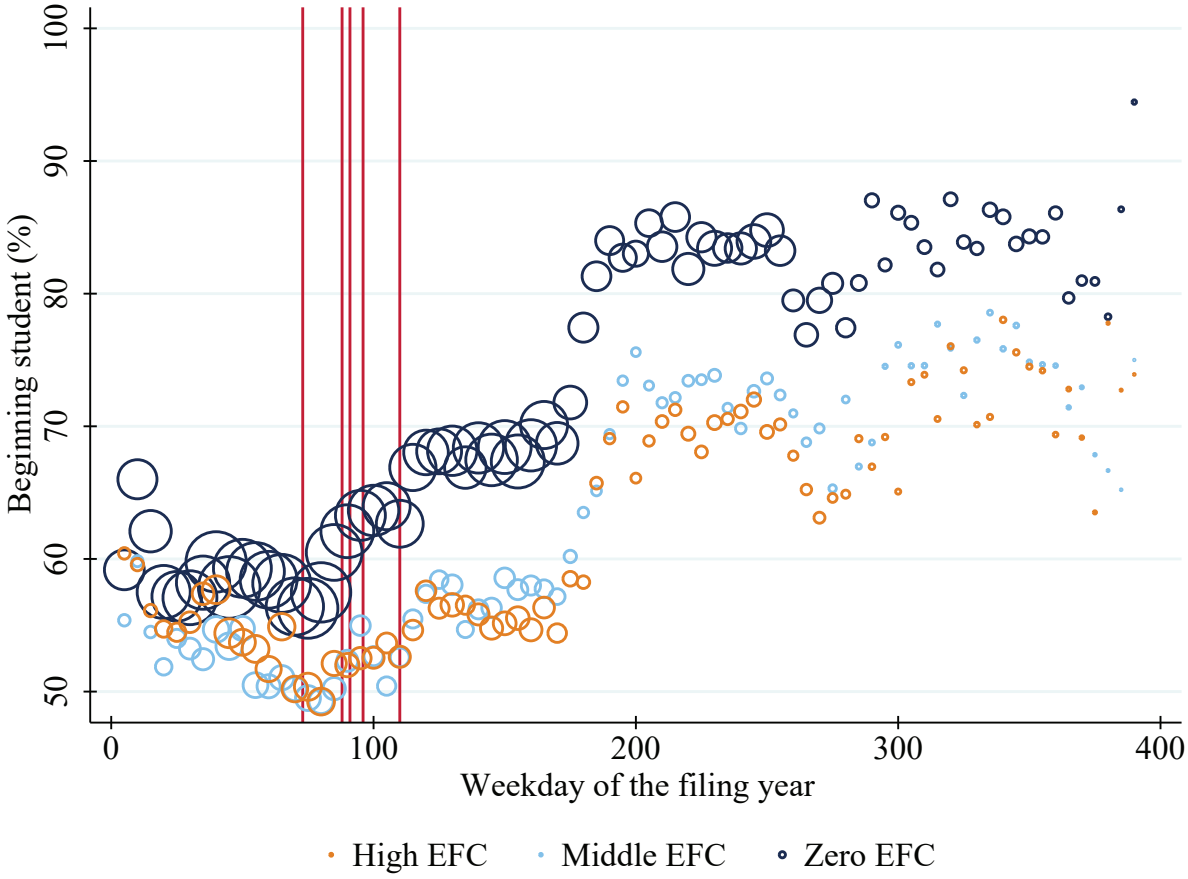
Source: Higher Educational Aids Board (HEAB).

Figure 6: Distribution of characteristics by filing date: % men



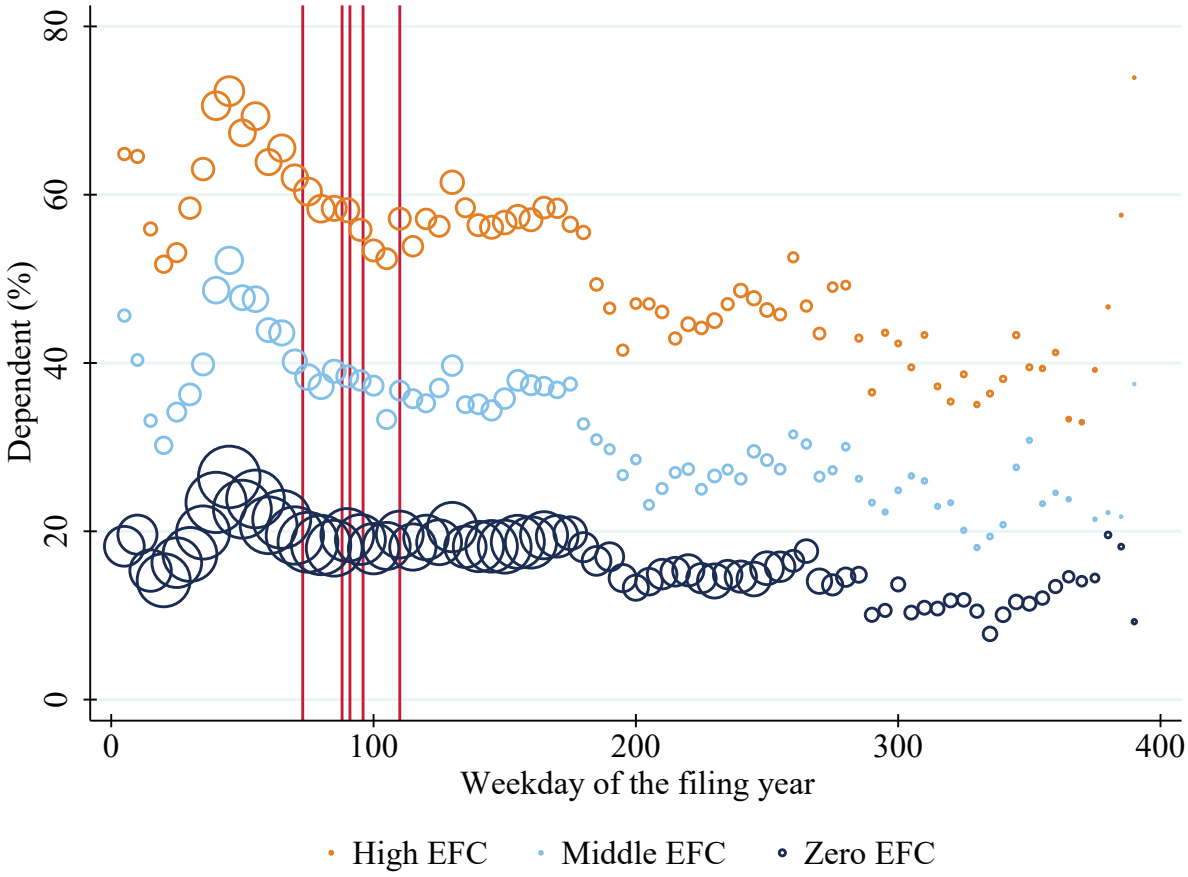
Source: Higher Educational Aids Board (HEAB).

Figure 7: Distribution of characteristics by filing date: % beginning students



Source: Higher Educational Aids Board (HEAB).

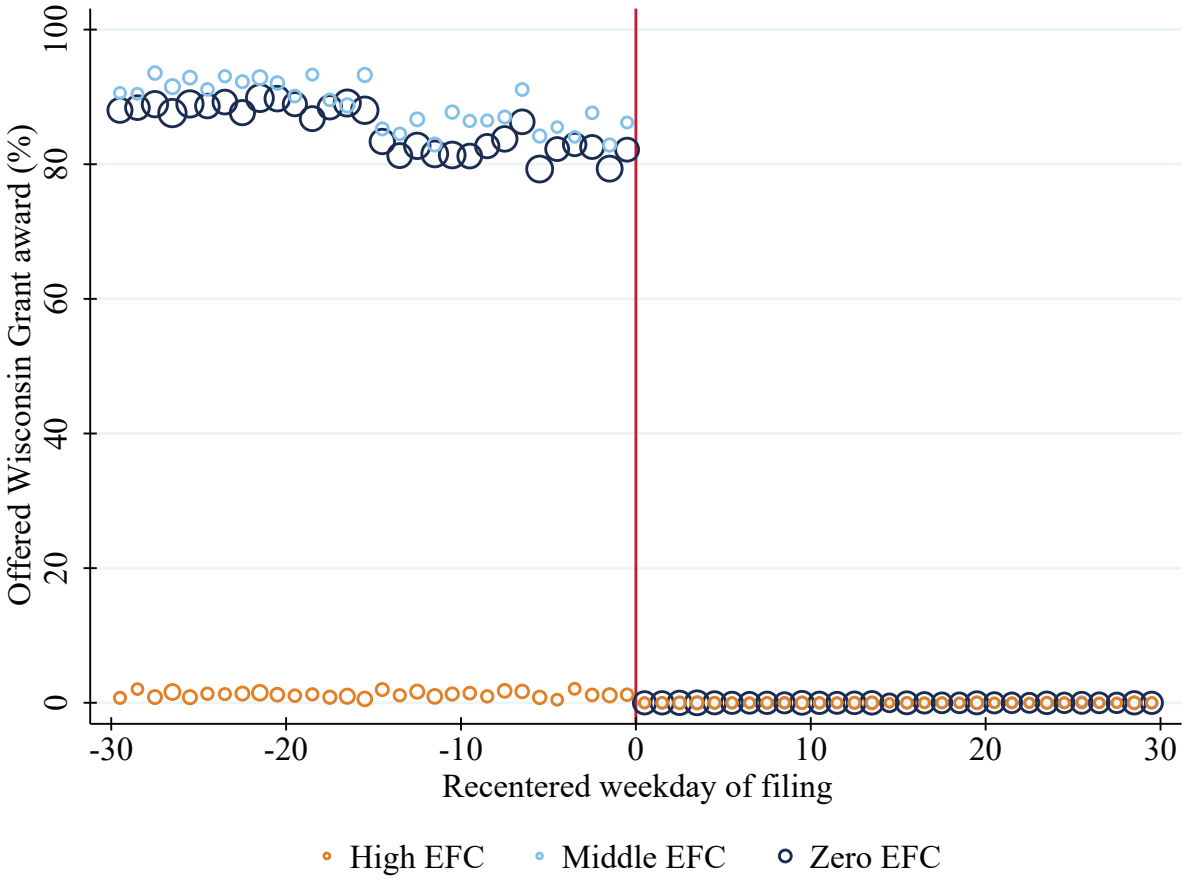
Figure 8: Distribution of characteristics by filing date: % dependent students



Source: Higher Educational Aids Board (HEAB).

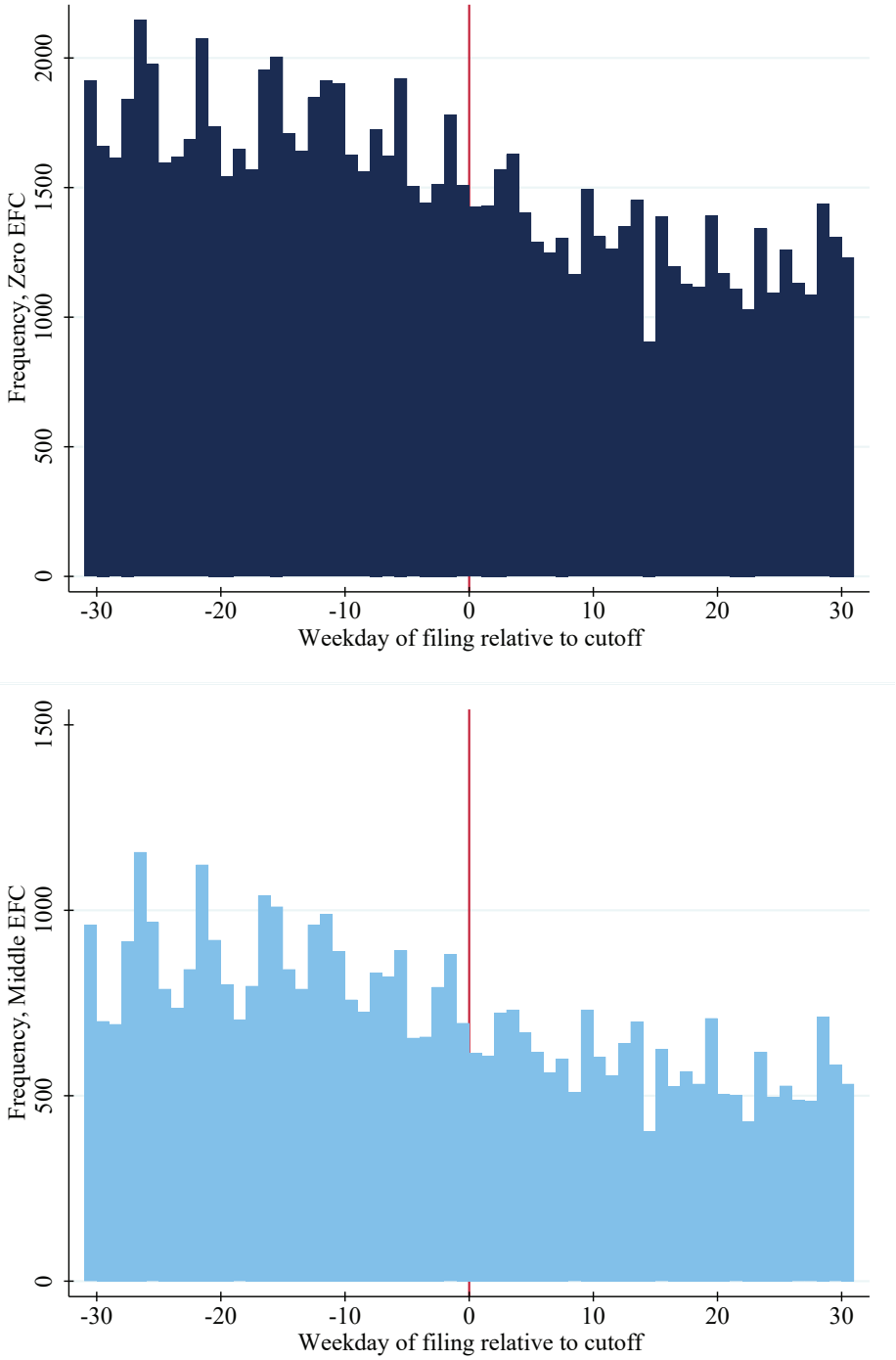
Dependent students are under 24 and have not married, had children, or served in the military.

Figure 9: Effects by EFC category: Wisconsin Grant award



Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).
Awarded: eligible to receive a Wisconsin Grant if the student enrolls at WTCS.

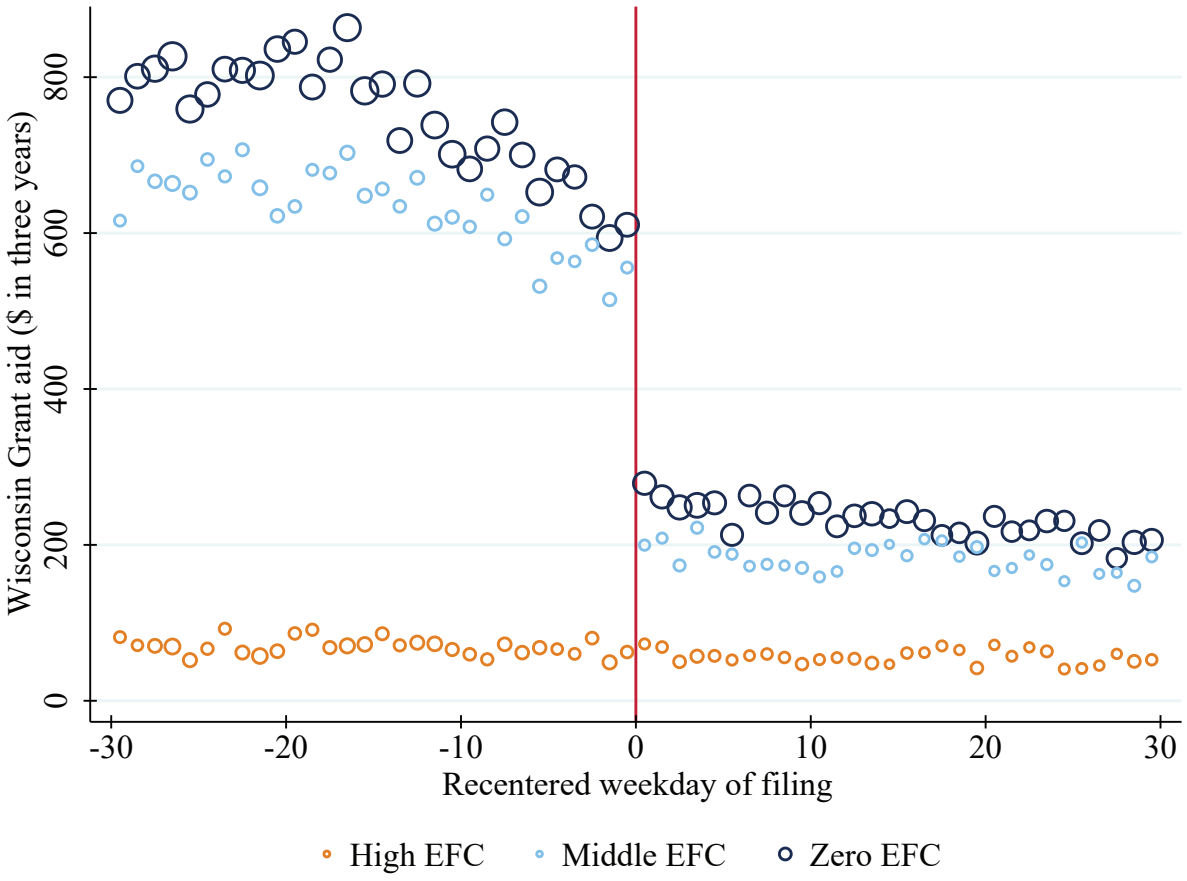
Figure 10: Frequency of application volumes, by recentered filing date



Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).

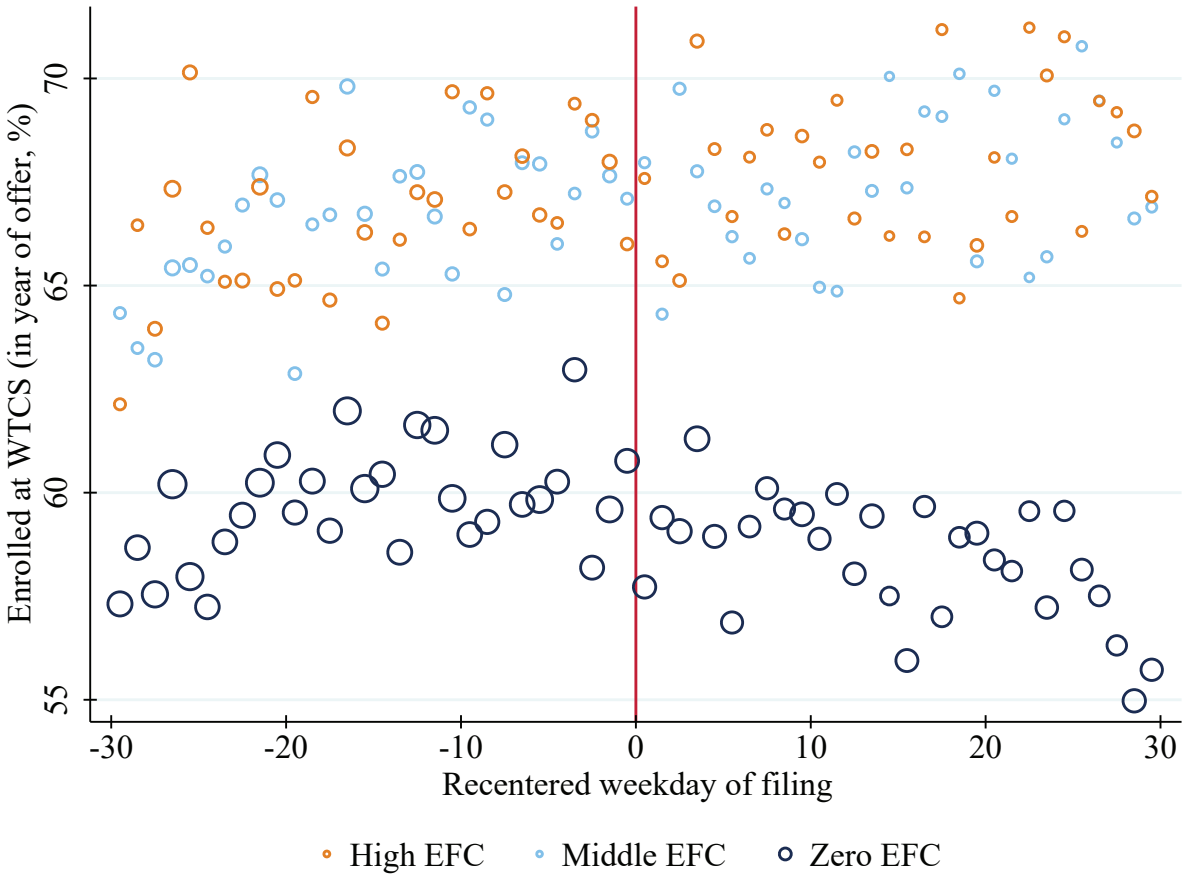
Notes: Using the test described in Cattaneo et al. (2018a), with a bandwidth of 30 days on either side of the cutoff, the p-value of the test for RD manipuation in the zero EFC group is 0.59, and the p-value in the middle EFC group is 0.91.

Figure 11: Effects by EFC category: Wisconsin Grant received over three years



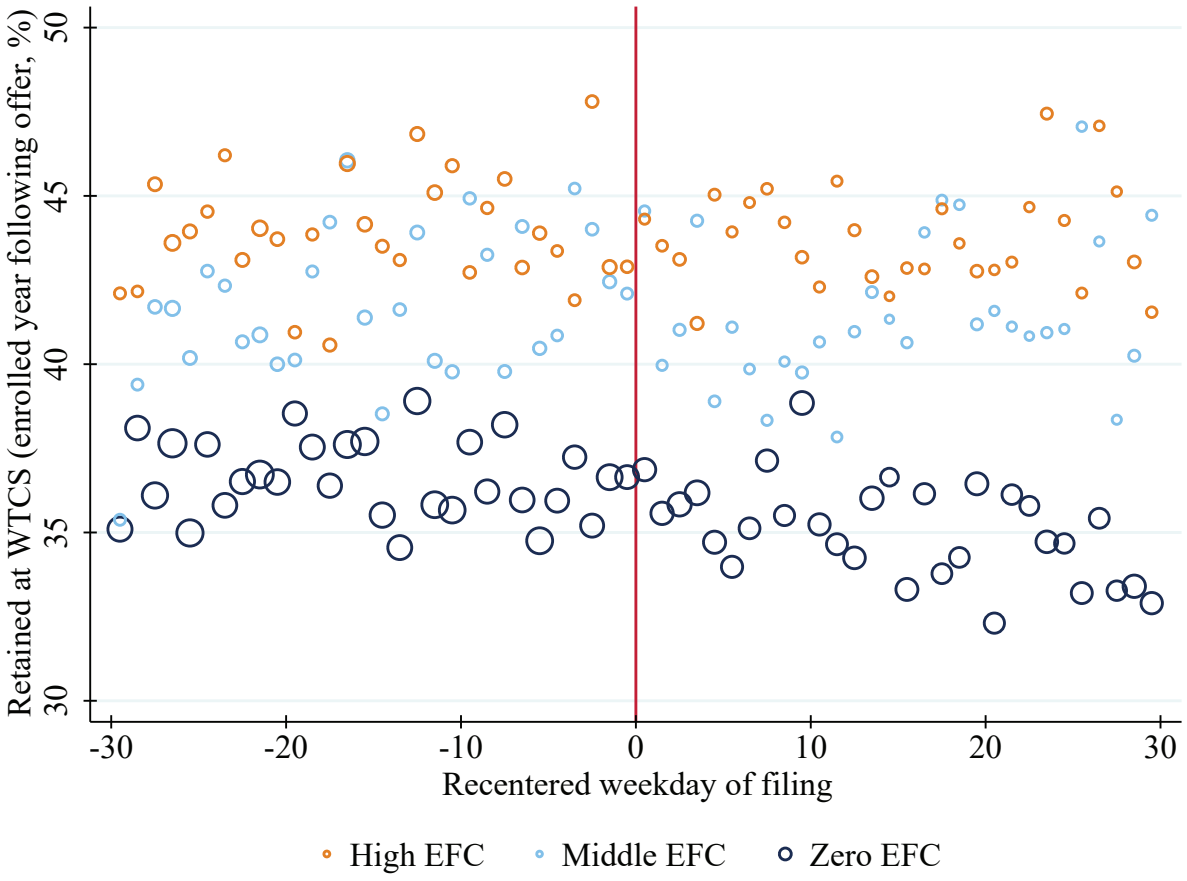
Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).
Net payment: all grants received while enrolled at WTCS, less refunds.

Figure 12: Effects by EFC category: Enrolled



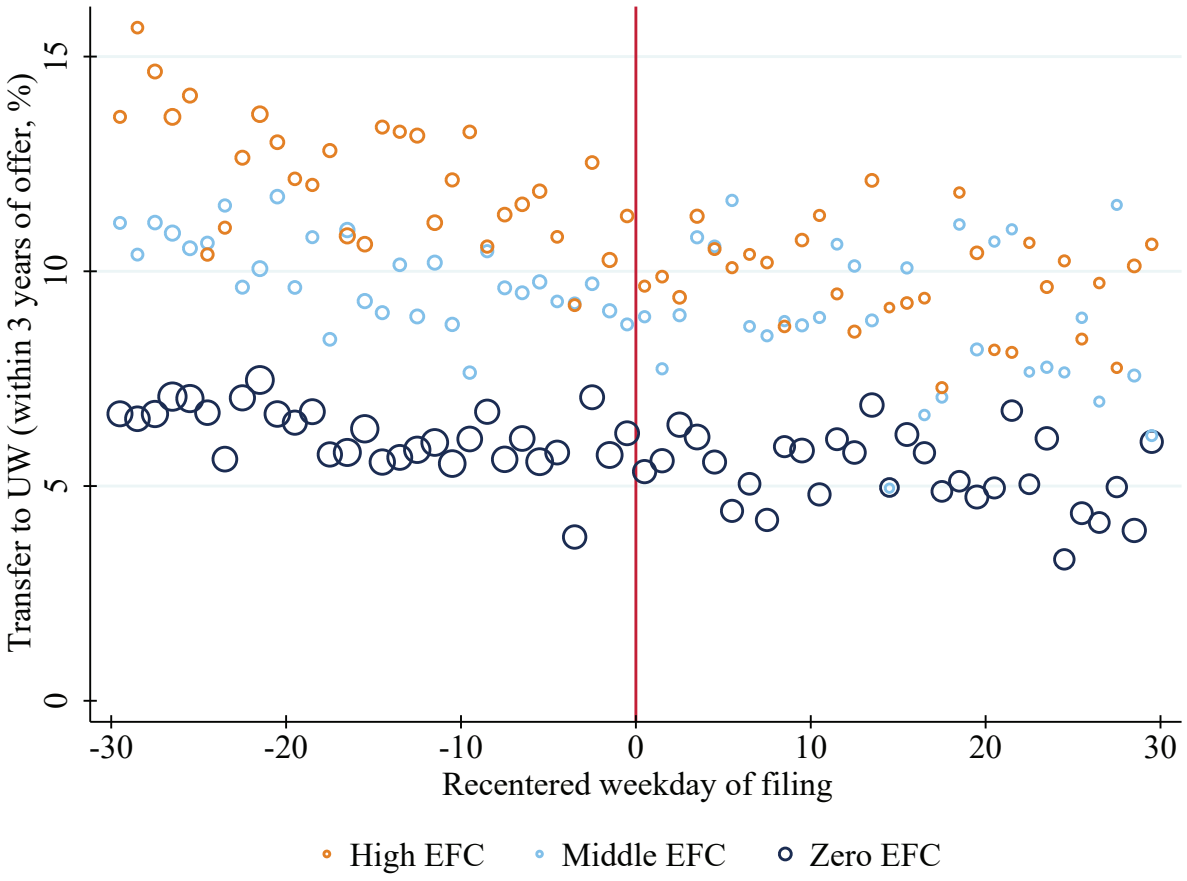
Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).
Enrolled: attended WTCS in the year of the FAFSA filing.

Figure 13: Effects by EFC category: Retained



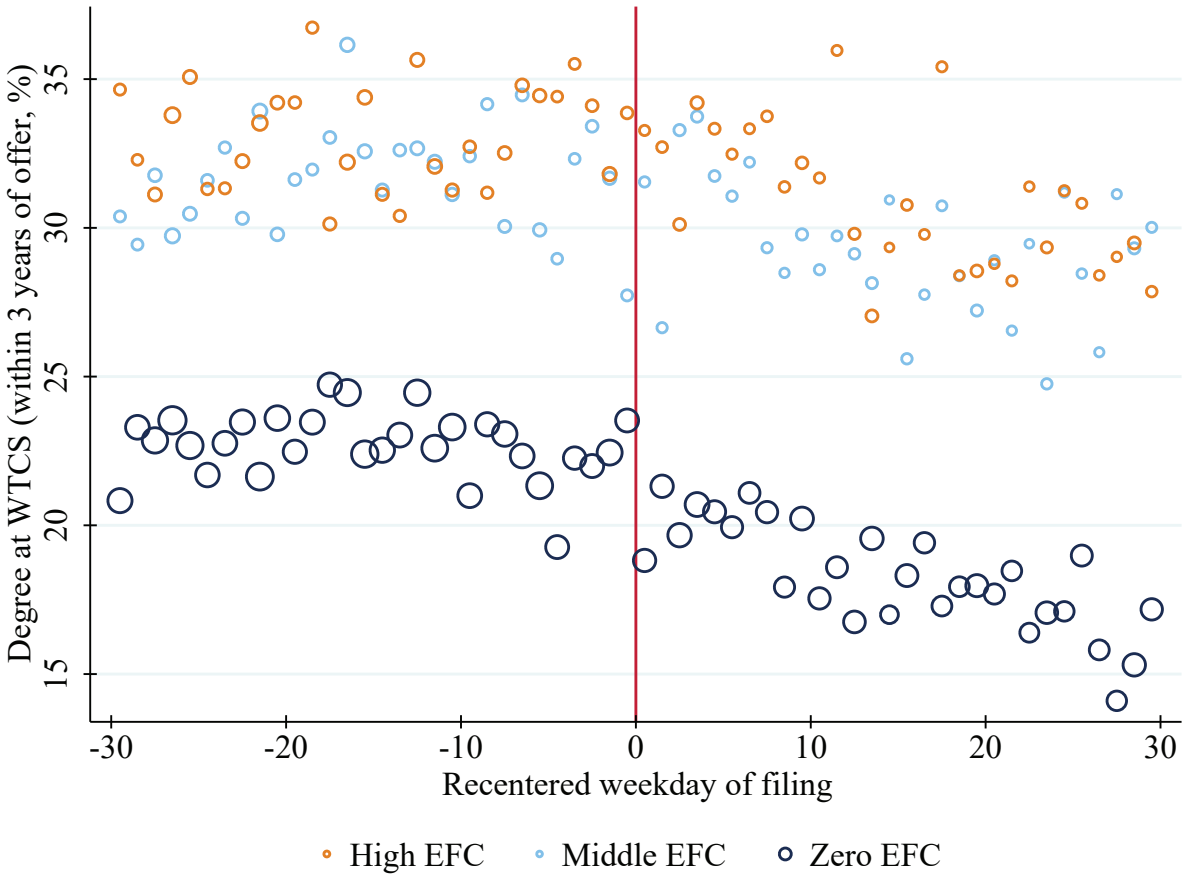
Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).
Retained: attended WTCS in the year following the FAFSA filing.

Figure 14: Effects by EFC category: Transfer



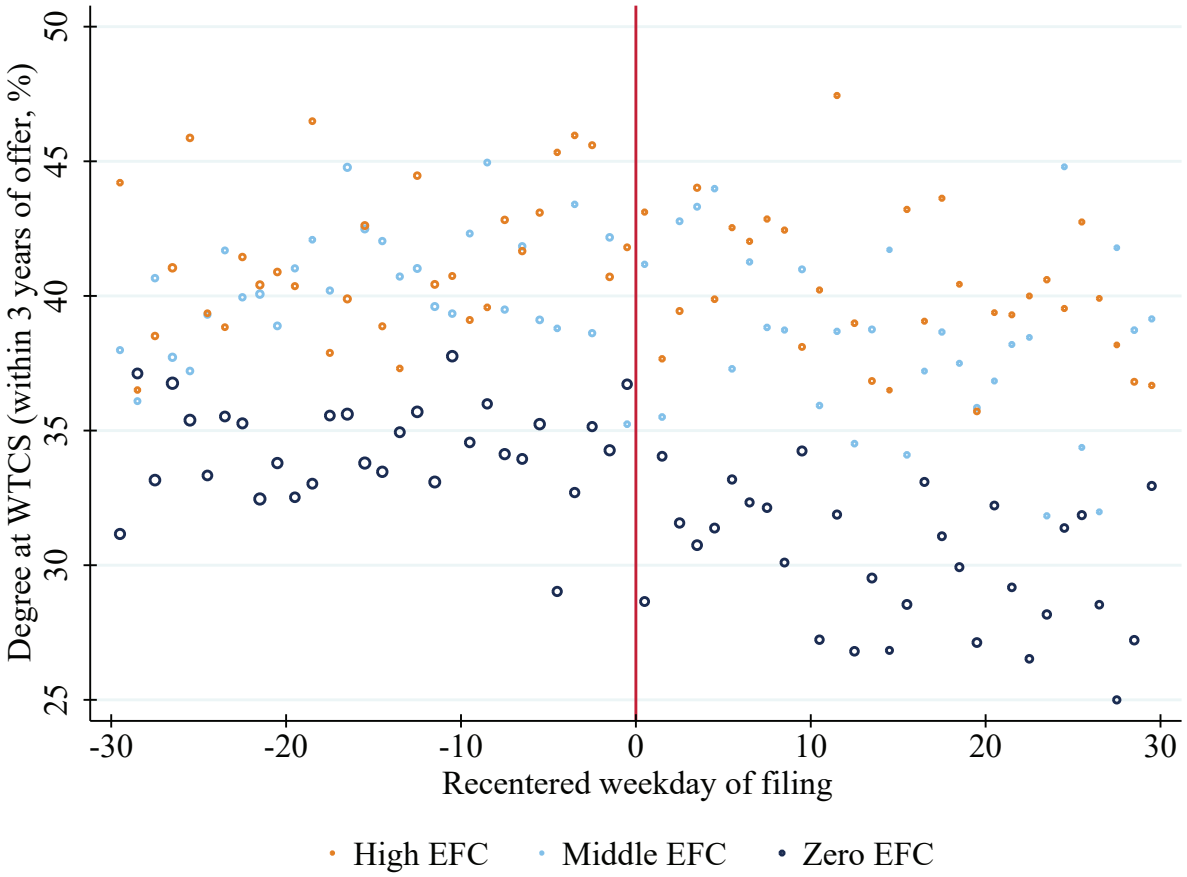
Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).
Transfer: attended UW System within three years of the FAFSA filing.

Figure 15: Effects by EFC category: Degree



Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).
Degree: earned a degree at WTCS within three years of the FAFSA filing.

Figure 16: Effects by EFC category: Degree among continuing students



Source: Higher Educational Aids Board (HEAB) and National Student Clearinghouse (NSC).

Degree: earned a degree at WTCS within three years of the FAFSA filing. Continuing student: beyond the first year of college, according to the FAFSA.