The Effects of Grant Aid on Student Persistence and Degree Attainment: A Systematic Review and Meta-Analysis of the Causal Evidence

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Abstract

It is well established that financial aid, in the form of grants, increases the probability of enrollment in postsecondary education. A slate of studies in recent years has extended this research to examine whether grant aid also has an impact on persistence and degree attainment. This paper presents a systematic review and meta-analysis of the causal evidence of the effect of grant aid on postsecondary persistence and degree attainment. A meta-analysis of 42 studies yielding 73 effect sizes estimates that grant aid increases the probability of student persistence and degree completion between two and three percentage points, and estimates that an additional $1,000 of grant aid improves year-to-year persistence by 1.2 percentage points. Suggestions for future research and implications for policy are discussed.

Keywords: financial aid, grant aid, persistence, attainment, meta-analysis,

The Effects of Grant Aid on Student Persistence and Degree Attainment: A Systematic Review and Meta-Analysis of the Causal Evidence

The advent of widely accessible financial aid programs to support postsecondary study has been a major factor in the democratization of higher education in the United States. Nearly half (7.8 million) of the 16 million returning World War II veterans took advantage of GI Bill funds to pursue an education or training program by 1956 (U.S. Department of Veterans Affairs, n.d.). With the authorization of the Higher Education Act (HEA) of 1965, financial aid cemented its role as a federal policy tool to be wielded for the creation of a skilled labor force and a democratic citizenry. In the intervening years, individual states and institutions have adopted both need-based and merit-based grant aid programs to supplement federal affordability efforts. Where a college or university education had once been accessible only to the affluent, the wide availability of grants put postsecondary education within reach for middle- and working-class families.

As the number of Americans pursuing undergraduate education has grown, from 9.5 million in 1976 to 19 million in 2015 (NCES, 2016), receipt of financial aid to support college financing has increasingly become the norm. In academic year 2014-2015, 86 and 79 percent of first-time, full-time degree/certificate-seeking undergraduate students at 4-year and 2-year degree-granting postsecondary institutions, respectively, were awarded financial aid (McFarland et al., 2017).

Much of this substantial investment in subsidizing postsecondary education is in the form of grants. Today, over $125 billion annually flow to postsecondary students in the form of grant aid, with more than a third of that sum coming from the federal government (College Board, 2016). Need-based grants may be justified exclusively on economic equity grounds (see Baum

(2007) for an application of Rawlsian justice to financial aid). However, there is also substantial empirical evidence augmenting the equity case. Numerous studies have identified a positive relationship between both need-based and merit-based grant aid and student outcomes including college enrollment, academic performance, persistence, and degree attainment (e.g., Angrist, Oreopoulos, & Williams, 2014; Deming & Dynarski, 2009). A subset of those studies have employed experimental and quasi-experimental causal estimation methods which provide the most accurate estimates available, and these studies have confirmed the important role financial aid plays in the postsecondary access and success of undergraduate students.

Decisions regarding the prioritization of scarce dollars for student financial support should be based on a body of high-quality empirical work. Several older attempts to review the literature on the impacts of financial aid exist (Jensen, 1983; Leslie & Brinkman, 1988; St. John, 1991), but, in addition to being outdated, these studies incorrectly considered observational data and analyses as evidence of causal impacts. The application of causal quantitative analytic methods in the field of educational research has improved tremendously over the last few decades, and a modern review of the literature of the efficacy of grant aid would preference the inclusion of well-identified causal studies over observational studies prone to omitted variables bias.

One recent review of the literature did account for the differences in observational, quasi-experimental, and experimental analyses (Deming & Dynarski, 2009). After reviewing the causal literature, Deming and Dynarski (2009) found a reduction in college costs increased student enrollment, although the estimates varied substantially across studies. They concluded reducing costs by $1,000 increases the likelihood of enrollment by about four percentage points. Until very recently, the majority of causal research on the efficacy of financial aid has focused

on the effects of grant aid on college enrollment, hence their literature review necessarily concentrates on enrollment outcomes.

While measuring the effect of subsidies on college enrollment is crucial, the educational goal of individuals and society is often degree attainment. It is possible that grant aid induces students to enroll in higher education but does not help them persist or graduate. Descriptively, college enrollment has grown steadily from the mid-1990s to present, but degree completion has lagged behind (Lumina Foundation, 2017). While there is evidence of the economic returns to even just a year of college (Kane & Rouse, 1999), there is a substantial earnings premium to completing a bachelor's degree (College Board, 2016).

Fortunately, recent years have produced a growing body of research on the causal effects of grant aid on persistence and degree attainment, albeit with mixed results. While many studies found positive effects of financial aid on persistence and degree attainment (e.g., Angrist, Autor, Hudson, & Palais, 2014; Bettinger, 2015; Scrivener et al., 2015), there are other studies that found null or even negative results (e.g., Clotfelter, Hemelt, & Ladd, 2016; Cohodes & Goodman, 2014; Partridge, 2013). While the body of literature examining the causal effects of grant aid continues to expand, there is neither a systematic review of that literature nor a meta-analysis that can assess the overall impact of aid on student persistence and degree completion across these varied studies. Our systematic review and meta-analysis attempt to fill that gap in the literature.

Moreover, the results of this meta-analysis are of interest for policymakers and researchers. Increasing college affordability remains a top policy priority at the state and federal levels, particularly as public concerns about the affordability of college and the consequences of student debt continue to grow. Early indicators of the potential for financial aid to influence

persistence and student success have contributed to the rapid proliferation and growth of financial aid programs. A number of states, including New York, Oregon, and Tennessee, are undertaking considerable state-level grant aid programs to ensure that subsets of the undergraduate population can attend college free of tuition and fees. A systematic review and estimation of the causal effect of grant aid on student persistence and degree attainment presents the opportunity to reflect on the likely outcomes of such programs, and our analysis also sheds light on how much aid is necessary to achieve an effect on persistence and degree attainment. Whether grant aid plays a role in persistence also has implications institutional practice. Research on grant aid's impact on persistence outcomes informs whether "front loading," a process in which substantial grant aid is provided in the first year of college but withdrawn in subsequent years, is an effective method of allocating limited grant dollars (Avery & Hoxby, 2004; Hossler, Ziskin, Gross, Kim, & Cekic, 2009).

To provide policymakers and practitioners with insight into these important issues, our study answers three research questions:

1. What is the causal effect of grant aid on student persistence and degree attainment across extant studies that provide causal estimates?
2. Do the causal effects of grant aid on student persistence and degree attainment vary across study and program characteristics?
3. What is the estimated effect of an additional $1,000 of grant aid on persistence and degree attainment?

Our study contributes to the literature by providing the first systematic review of the causal estimates of grant aid on student persistence and degree attainment. Our meta-analysis effect estimates distill the calculated effects from forty-two U.S. studies and five

international studies and assess how those effect estimates vary by design of the grant aid program and quality of the research method. Our analysis enables us to provide an effect of $1,000 of grant aid on persistence similar to the effects widely cited on enrollment (Deming & Dynarski, 2009). Overall we find that grant aid programs increase the probability of persisting and degree completion from two to three percentage points, and, assuming a linear relationship of aid amount and impact, we estimate that an additional $1,000 of grant aid improves year-to-year persistence by 1.2 percentage points with smaller effects for degree completion.

The rest of the paper is structured as follows. In the next section, we discuss our methodology, including the eligibility criteria, literature search, the coding of primary studies, and the analytic strategy. Then we present results from the main analysis, subgroup analyses, analysis of publication bias, and risk of bias assessment. We end with a discussion of our findings, their policy implications, the limitations of our study, and recommendations for future research.

Method

Our study is designed to examine the causal estimates of grant aid on postsecondary persistence and degree completion. To define the eligibility criteria, literature search, data analysis, and reporting conventions, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis standards as defined by Moher et al. (2009).

Eligibility Criteria

Primary studies eligible for inclusion in this meta-analysis need to meet the following criteria: (a) the sample is comprised of students in postsecondary education; (b) students are eligible for grant aid programs; (c) the study reports quantitative results of students' postsecondary persistence or degree attainment; (d) the study provides plausibly causal estimates

of the effects of grant aid on persistence or degree attainment by employing experimental or quasi-experimental estimation strategies; and (e) the study provides linear probability estimates of the effects of grant aid. It should be noted that we retained studies that only provided odds ratios estimates of the causal effects of grant aid for the systematic review, but their point estimates are not comparable with linear probability estimates. Because they are focused on programs at the secondary school level, we also did not include studies that provide estimates of the effects of secondary school voucher programs or secondary school scholarships on postsecondary persistence and degree attainment (e.g., Chingos & Peterson, 2015). Lastly, we did not include studies on the effects of loans on persistence and attainment as loans are substantially different than grant aid because loans need to be repaid (e.g., Melguizo, Sanchez, & Valasco, 2016).

Literature Search

Given the topic of this review, we obtained primary studies from searching commonly used economic and general social science databases, including ERIC, WorldCat, ProQuest, JSTOR, NBER and EconLit (see Appendix Table 1 for a complete list of databases used). Through an iterative process of balancing an inclusive search string and a reasonable number of records that can be screened and analyzed thoroughly, we created the following search string: ("need-based aid" OR "merit aid" OR "financial aid" OR grant OR scholarship OR "work-study") AND (persist* OR retention OR attrition OR graduat* OR dropout OR attain* OR degree), which returned over 21,000 studies. We also searched for “grey” literature using Dissertation and Thesis Repositories in WorldCat and ProQuest as well as a general Google search for evaluation reports of well-known financial aid programs such as the Florida Bright Futures, HOPE programs, or Pell Grant. In addition to searching databases, our literature search

also included an examination of reference lists uncovered through the process above and previous reviews of the financial aid literature (e.g. Angrist, Oreopoulos, & Williams, 2014; Deming & Dynarski, 2009). We also searched economic journals such as the *Journal of Human Resources* and policy analysis and evaluation journals such as the *Journal of Policy Analysis and Management* as they frequently publish articles evaluating the effects of financial aid on postsecondary outcomes. Our official search ended the first week of January 2018. We did not limit our search on publication date, location, or language. We focus our analyses on the effects of grant aid and postsecondary success in the United States instead of internationally as postsecondary grant aid functions differently in the United States than elsewhere. However, we also provide results for U.S. and international studies combined since the study of grant aid and postsecondary success is of scholarly and policy interest in the United States and abroad.

Studies Meeting Eligibility Criteria. Starting with the results returned from our search of databases and previous reviews, we used a three-phase process to screen for primary studies that meet all eligibility criteria, as illustrated in Figure 1. First, two authors independently read the title, abstract, and introduction for 25 percent of the studies obtained in our original search using the search string. The two coders checked if there were studies that were retained by one coder but not the other and discussed reasoning for inclusion or exclusion. We split the remaining studies between those two authors for single-author review. We retained a study if the title, abstract or introduction mentioned that the study contained empirical results pertaining to causal estimates of grant aid and postsecondary persistence and attainment. Some examples of studies excluded in this phase included quantitative reports that did not provide causal estimates or studies that estimated the effects of grant aid on other postsecondary outcomes, such as enrollment or credits taken, that are distinct from persistence or degree completion (more details

about the measures of persistence and degree completion are provided below). In all, we screened over 21,000 studies.

In phase two, we were left with 77 studies for full text reading and two coders independently assessed whether each study fit the eligibility criteria outlined above. The coders discussed any discrepancies and made exclusion decisions upon consensus. A third author resolved any disagreement. From these fully reviewed studies, we excluded studies that did not provide causal estimates of grant aid on postsecondary persistence or attainment. For multiple reports from the same study (e.g., a dissertation and corresponding journal article or reports from multiple years for the same evaluation), we kept only the most current publication.

In phase three, we contacted authors to request information when eligible studies are missing key information. We sent e-mails to lead authors requesting information and re-sent these e-mails if we did not receive a response within four weeks. We excluded eligible studies if key information such as standard errors for effect estimates could neither be calculated nor obtained from the authors. If the standard error or the *t* statistic was not provided, but the significance level was indicated, we used a conservative estimate of the standard error by calculating the *t* statistics for the *p* value corresponding to reported significance levels. This is a conservative estimate of the standard error since it provides the largest standard error for a given significance level. Further details on how we calculated standard errors are included in the Analysis section below. We note that four studies that provided odds ratios estimates instead of linear probability estimates were excluded from the main quantitative analysis, but we discuss them in conjunction with the findings. At the end of phase three, we were left with a sample of 47 primary studies, 42 primary U.S. studies and 5 international studies, which met all the eligibility criteria that provided the linear probability estimates of the effects of grant aid on

persistence and degree completion. This set of studies serves as our analytic sample for the meta-analysis.

Coding Reports

Two of the authors independently coded relevant information for each of the 47 eligible studies using a common coding schema (Appendix Table 2). A third author also coded a quarter of the studies using the same coding schema, and all three authors reviewed those studies to clarify any coding issues and resolve any discrepancies. We checked to see if all information was coded consistently and whether we selected the point estimates and standard errors from the same model if the primary authors provided multiple estimation models. Throughout the coding process, the two coders met monthly to compare codes for each study, updating the coding guide, and noting disagreements. Treating each cell of our coding matrix as an input, coder agreement occurred in 96% of the cells. Discrepancies among the remaining studies were resolved by consensus between the two coders, and the third author resolved any remaining disagreement not resolved between the first two coders. Next we describe relevant measures in greater detail.

Dependent variable. Our main outcomes of interest are causal estimates of the effects of grant aid on postsecondary persistence and degree completion and the associated standard errors of those estimates (Lipsey & Wilson, 2001; for papers that employ similar methods, see Valentine, Konstantopoulos, and Goldrick-Rab (2017) and Holme, Richards, Jimerson, and Cohen (2010)). Persistence has two distinct categories: within-year persistence and year-to-year persistence. Within-year persistence is operationalized as students persisting from term to term in the same academic year. Year-to-year persistence is operationalized as students persisting from one academic year to a subsequent academic year, which includes first-to-second year persistence, second-to-third year persistence, third-to-fourth year persistence, and first-to-fourth

year persistence. If a study estimated multiple types of persistence, such as separate estimates for first-to-second year persistence and second-to-third year persistence, then we recorded each estimate separately (e.g., Clotfelter, Hemelt, & Ladd, 2016).

Degree completion has two distinct categories: on-time attainment and delayed attainment. On-time attainment is considered to be degree completion within two years for two-year colleges and within four or five years for four-year colleges. Delayed attainment is three years or more for two-year colleges and six years or more for four-year colleges.[1] Because our measures of both persistence and degree completion are binary, our primary studies contain a blend of linear probability models and odds ratios from logit models. The vast majority of studies employ linear probability models, which are interpreted as changes in the probability of persisting or degree attainment. These estimates are often discussed as percentage point changes in the probability of the outcome occurring, and we recorded each linear probability estimate as a percentage point change.

Moderating variables. We coded a series of a priori moderators where we examined how the effects of grant aid varied by different financial aid program and study characteristics. These moderators were selected based on our reading of the literature and prior work we have conducted on financial aid. Specifically, we included the following variables as moderators: (a) the country in which the study took place; (b) the methods the study employs to obtain a causal estimate such as randomized control trial (RCT) or regression discontinuity design; (c) whether the study was peer reviewed; (d) eligibility type for the program (whether the grant aid program was need-based, merit-based, a combination of need and merit, or other); and (e) program

[1] In the literature, on-time and delayed attainments are usually referred to as 100% and 150% time. For compatibility and ease of interpretation, we have also categorized 125% time as on-time attainment and greater than 150% as delayed attainment.

characteristics such as additional treatments that might include additional academic or social supports. We expect postsecondary financial aid to function differently in the United States than other countries, particularly those in continental Europe where postsecondary tuition is either free or low cost. With regard to study quality, RCTs are the gold standard for establishing strong causal evidence of an intervention and regression discontinuity design has been shown to be a valid alternative to RCTs (Maas et al., 2017; Murnane & Willett, 2010; West et al., 2008). Furthermore, we recognize that there may be publication bias where only statistically significant results would be published, and the peer-review moderator allows us to explore the likelihood of such a bias in this context (Borenstein, Hedges, Higgins, & Rothstein, 2009; Rothstein, 2008). In terms of eligibility type, we expect the type of aid may have differential effects on persistence and degree completion since they have different requirements for award receipt, and they provide aid to different populations of students (Dynarski, 2004; Heller & Marin, 2002). Concerning program characteristics, we expect aid that has additional treatments, such as faculty advising or other academic supports, may help students acclimate to the college environment, thereby increasing persistence and degree attainment more than if the program offered grant aid alone (Angrist et al., 2014; Scrivener et al., 2015).

Analytic Strategy

Analysis of these data follow methods presented by Borenstein, Hedges, Higgins, & Rothstein (2009). Below, we describe analytical decisions in choosing between fixed-effect and random-effects models, selecting causal estimates, and assessing risk of bias from differences in study quality.

One important choice for this meta-analysis was the decision between a fixed-effect versus a random-effects model. In the parlance of meta-analysis, a fixed effect meta-analysis

assumes all studies are estimating the same treatment effect whereas a random-effects model allows for differences in the treatment effect (Riley, Higgins, & Deeks, 2011). In other words, the fixed-effect model assumes a true effect size across all studies whereas a random-effects model allows the real treatment effect to vary across populations and programs (Borenstein, Hedges, Higgins, & Rothstein, 2009). Mechanically, the fixed-effect model assigns weights (W_i) to each study (i) using the inverse of each within-study variance (V_{y_i}):

$$W_{i,Fixed} = \frac{1}{V_{y_i}} \quad (1)$$

In contrast, the random-effects model weights studies using both the within-study variance and the estimated between-study variance (T^2):

$$W_{i,Random} = \frac{1}{V_{y_i} + T^2} \quad (2)$$

For this investigation, a random-effects model is most fitting because substantial variation exists across studies in terms of the requirements for aid eligibility, the amount of aid received, whether there were additional treatments, and whether students attended two-year or four-year institutions. Moreover, we do not expect the effects of grant aid to be homogenous across different populations and settings, particularly when the treatment dosage or the amount of aid provided varied from study to study. Additionally, we relied on heterogeneity statistics to inform our decision to use random-effects models.

In terms of selecting the causal estimates, we primarily used the preferred estimates of the primary authors based on the authors' explicit mention of their preferred estimates or their discussion of the estimates. If the primary authors did not have preferred estimates or if they preferred to provide all the estimates (along with their pros and cons) without emphasis, then we used our professional judgment and selected the most plausible causal estimates based on the

methods used and the extent to which they addressed internal validity issues of each estimation method.

In terms of risk of bias or bias in the estimate of the treatment effect that can come from a number of sources, such as selection bias, attrition bias, or reporting bias, we chose to use an inclusive approach that will include all studies that satisfy our eligibility criteria. Understandably, this choice may introduce bias from poorly designed studies or studies of low quality. To address this concern, we took two separate approaches. In the first approach, we limited our analysis to study designs that provide strong causal evidence: randomized control trials and regression discontinuity designs (Maas et al., 2017; Murnane & Willett, 2010; West et al., 2008). In the second approach, we used the *quality rating approach* as suggested by Lipsey and Wilson (2001). In this approach, two coders independently rated each study holistically using our professional judgment and expertise in quantitative causal analysis of the quality of the study on a scale of 1 to 5 where 1 has high risk of bias and 5 has low risk of bias. For instance, to assess the internal validity of regression discontinuity studies we considered whether the researchers provided evidence of non-manipulation of the forcing variable and showed smoothness of the forcing variable around the threshold via the McCrary test, covariate balance checks on either side of the threshold, robustness of findings across various bandwidths, parametric and non-parametric specifications, and falsification tests.[2] Appendix Table 3 contains the criteria we used to determine our rating. The two coders then discussed their rating and resolved any discrepancy by consensus. Any remaining disagreement was independently resolved by a third coder. We used these ratings as a robustness check to show that the findings from the main analyses are similar when restricted to only the high quality studies.

[2] For more information on issues of causal inference for a variety of quasi-experimental designs, please refer to Shadish, Cook, and Campbell (2002) and Murnane and Willett (2010).

Results

Table 1 presents descriptive information about the primary studies included in the meta-analysis separated into the full sample that includes international studies and U.S. only studies. Since postsecondary financial aid functions differently in the United States than other countries and the majority of the studies were from the United States, we focus our analysis and discussion on U.S. only studies although we do provide descriptive information in Table 1 and summary analysis for the full sample in Appendix Table 4, which includes U.S. and international studies.

In terms of the U.S. only studies, all 42 studies are from 2004 to 2017 with the majority of the studies published in the last ten years. The majority of the studies, 83 percent, are considered to be high quality studies by our subjective rating. Sixty percent are RCTs or employ regression discontinuity. About half are published in peer-reviewed journals. The number of students in the studies ranges from a little over a hundred students to over 110,000 students, with an average of over 17,000 students. These studies investigated grant aid receipt that ranges from less than $300 to over $19,000 with an average of nearly $2,500. About a quarter of the studies have some form of additional treatment attached to the grant aid. About 21 percent of the studies are merit-only studies, 71 percent have some form of need-based component, and 8 percent have other eligibility requirements other than merit or need requirements such as veteran status, social security benefits, and having spent high school in a particular area (e.g. Barr, 2015; Bartik, Hershbein, & Lachowska, 2015; Ramsey, 2013;). Because some studies provide multiple outcome estimates, these 42 U.S. studies provide 9 within year persistence estimates, 25 year-to-year persistence estimates, 20 on-time degree completion, and 19 delayed completion effect estimates. These statistics are comparable to the full sample that includes international studies.

Table 2 presents the meta-analysis random-effects estimates of the causal effect of grant aid on postsecondary persistence and degree completion in the U.S. In terms of within year persistence, the summary estimate from nine studies indicates that grant aid increases within year persistence by 3.2 percentage points. Although the standard error is fairly sizable due to the limited number of studies providing within year estimates, this result is still statistically significant at the 5% level. Next we find grant aid increases year-to-year persistence by a modest 1.8 percentage points with a fairly precise standard error of .005, which is highly statistically significant; the 95% confidence interval ranges from about one to three percentage points. In terms of degree completion, we find that grant aid increases on-time and delayed completion by 2.4 percentage points and 2.5 percentage points respectively with reasonably precise standard errors. Overall, our results indicate that grant aid has a substantial impact on postsecondary persistence and degree completion in the U.S. These results comport with our expectations that aid can help students persist and succeed in postsecondary education. As noted previously, although we focus our discussion on U.S. studies, our U.S. and international studies results are very comparable to the U.S. only results discussed here (Appendix Table 4).

As discussed previously, we rely on the random-effects meta-analysis model because we expect the effect of grant aid to vary by the amount of aid, the requirements, and the intended populations. However, we also present empirical evidence that random-effects models are more appropriate than fixed-effect models in Table 2. For each main outcome, we present a set of standard heterogeneity statistics of the study effects. For instance, in terms of on-time degree completion the percentage of observed variance across 20 studies that reflects true heterogeneity in effect sizes (I^2) is 85.136, indicating that less than 15 percent of the total variation can be attributed to random error. The Cochrane's *Q* statistic tests the null hypothesis of homogeneity

across studies, and with P_Q at .002, we find strong evidence to reject the null hypothesis that the true dispersion of effect sizes is zero, providing further support that there is real heterogeneity of effects across studies. Together, these measures present empirical evidence there is heterogeneity in effect sizes, justifying the random-effects models, and furthermore, we find similar evidence of heterogeneity for all four outcomes. To explore these differences further, we examine the forest plots for all four outcomes, which provide further evidence that the effect estimates vary across different study and program characteristics.

Figures 2 through 5 present forest plots for within year persistence, year-to-year persistence, on-time completion, and delayed completion respectively. For instance, Figure 3 presents a forest plot of the overall random-effects model for year-to-year persistence. Each row represents an effect size from a primary study in our meta-analysis, plotted according to the size of the effect estimates. Furthermore, the effect sizes along with the 95% confidence intervals are provided for each study as well as the weight that each study contributes to the overall effect size. Studies that provide more precise estimates are given more weight. As such studies that provide imprecise estimates are given little weight in the overall estimate such as the Upton (2016) study that contributed only .01 percent to the overall estimate. The dotted vertical line intersecting the diamond at the bottom of the graph shows the average effect size across the year-to-year persistence studies. In other words, these forest plots provide detailed information about the effect estimate, the precision of the estimate, how much they contribute to the overall result, and how much the effects vary from study to study. In general, all four graphs indicate that there is substantial variation across studies in terms of the effects of aid on persistence and degree completion. To examine whether this heterogeneity can be explained by observable study characteristics, we turn to the moderator results.

Table 3 presents the results for within year and year-to-year persistence based on different study and program characteristics. We note that there is only limited evidence of moderator effects for within year persistence due to the small number of studies that analyze this outcome. As such, we focus our discussion on the moderator effects for the year-to-year persistence outcome, although most of the results also extend to within year persistence. For year-to-year persistence, we observe that the high quality studies and RCT/RD studies provide slightly higher point estimates than the overall effect estimate, although there is substantial overlap in the 95% confidence intervals. Estimates from peer-reviewed studies are also higher than the overall estimate, suggesting there may be publication bias, which we explore further below. In terms of additional treatment, we find that the effect size is nearly doubled suggesting that both aid and the other forms of support such as faculty advising, peer support, or academic support have substantial effects on postsecondary persistence. Lastly, we find that merit-only financial aid programs do not appear to affect persistence although the standard error is fairly sizable. This novel finding suggests that, although merit-aid programs may likely affect where a student chooses to go (Deming & Dynarski, 2009; Hossler et al., 2009), it does not appear to improve persistence, most likely because students are less likely to face financial obstacles to persistence. In contrast, grant aid programs that include a need-based component seem to have a substantial impact on persistence at 2.5 percentage points with a precise standard error of .005. In other words, our meta-analytical results indicate the 95% confidence interval of the effect of need-based grant aid program on year-to-year persistence ranges from 1.4 to 3.5 percentage points. Next we discuss the moderator results for degree completion.

Similar to Table 3, Table 4 presents the moderator results for on-time and delayed degree completion. The estimates for the high quality and RCT/RD studies for both on-time and delayed

degree completion are comparable to the overall estimates. The estimate from peer-review studies is the same as the overall result for on-time completion and it is lower for the delayed completion. For delayed completion, this would indicate that the non-peer-reviewed studies' estimates are higher than the peer-reviewed studies' estimates, which we will discuss further in the next section. In terms of additional treatment, the estimates for both on-time and delayed completion for studies with additional treatment are more than 50 percent higher than the overall estimates, which reinforces our earlier results in Table 3 indicating that additional supports likely help students to persist and complete their degrees. In terms of merit- and need-based aid, for on-time completion we find that although their point estimates are the same and very comparable to the overall estimate, the merit only result is not statistically significant due to a large standard error. The need-based aid program has an estimated effect of raising on-time degree completion by 2.0 percentage points with a precise standard error of .005. For delayed completion, the point estimate for merit-only program is 1.9 percentage points but it is statistically insignificant. Need-based grant aid programs have an estimated effect of raising delayed degree completion by 2.4 percentage points with a standard error of .008.[3]

Our results thus far have shown that grant aid does indeed positively affect postsecondary persistence as well as degree completion. However, the above analysis ignores variation in aid amounts across programs and studies. Policymakers and enrollment managers are interested in understanding not only whether aid affects student outcomes but also how much aid is necessary to achieve a specific effect. For instance, previous literature has established that a $1,000 of aid approximately raises enrollment by three to four percentage points (Deming & Dynarski, 2009).

[3] We note only one study (Chen & Hossler, 2017) examined the effects of grant aid specifically for nontraditional students. Without the inclusion of this study, the estimated effect of raising delayed degree completion from 11 studies is 3.1 percentage points with a standard error of .010.

Following this tradition, we also provide an estimation of the effect of $1,000 of aid on persistence and degree completion in Table 5 using OLS regression of each study's treatment effect for the various outcomes on the average amount of aid provided in each study. We note our estimates are rough estimates due to the limited number of studies for each outcome. Furthermore, if the effect of aid is non-linear, our estimates will not be accurate.[4] Thus we provide the estimates with the caveat of the limitations of the number of primary studies that exist.

Table 5 provides the effect of $1,000 of grant aid on within year and year-to-year persistence as well as on-time and delayed degree completion. Since there are only nine within-year studies, our OLS estimates are less precise due to the limited number of studies reporting this outcome. For the year-to-year persistence estimate, we find that $1,000 of aid increases year-to-year persistence by a statistically significant 1.2 percentage points. For degree completion, we find $1,000 of aid increases on-time and delayed degree completion by a statistically insignificant 0.8 percentage points. To illustrate these findings, Figure 6 shows the effect sizes from individual studies and the treatment effect per $1,000.

Negative Effects and Gender Differences

Even though the vast majority of the primary studies find positive or null effects of grant aid on persistence and degree attainment as illustrated in Figures 2 through 5, a few studies find there may have been detrimental effects of grant aid. We consider possible reasons why the findings from these particular studies are contrary to expectations and the other studies. For instance, Partridge (2013) found that the Bright Futures program reduced year-to-year persistence by about four percentage points. The author suggested that the negative impacts may

[4] We do not have sufficient degrees of freedom to explore non-linearities in these estimates via a polynomial regression function, but we believe this is an important avenue for future research.

be due to some students gaming the system such that academically weaker students, who should not have qualified to receive the merit-based grant, received the award anyway. These students were less likely to persist. The author did provide some evidence to suggest that there may have been some gaming of continuous variables such as high school GPA and SAT scores due to discontinuities around these variables at the cutoff points (Patridge, 2013). Using a regression discontinuity design, Cohodes and Goodman (2014) found that a Massachusetts merit aid decreased year-to-year persistence as well as on-time and delayed degree attainment. The authors argued and provided some evidence that the most plausible explanation for the negative effects of this aid program was that the aid induced students around the eligibility cutoff to attend cheaper and lower quality colleges with substantially lower graduation rates than they would have otherwise. The studies and the authors' explanations of the negative impacts indicated that in some circumstances, there may be negative unintended consequences of aid that researchers and policymakers should consider, especially in regards to merit-based grants.

In terms of heterogeneous treatment effects, several studies separated the results by gender to assess whether the effects are different for men and women, and several found that treatment effects varied by gender. For instance, Bartik, Hershbein, and Lachowska (2015), Evans and Nguyen (2017), and Zhang (2013) found the effects of aid may be more positive for women than men. For example, Evans and Nguyen (2017) found that an average increase of $1,100 in grant aid reduced weekly job hours by 1.5 to 2 hours for women and marginally increased their within-year persistence by 3.3 percentage points with null effects for men. On the other hand, Barr (2016) and Scott-Clayton (2011b) found the opposite. Barr (2016) found that men who received aid were 6.2 percentage points more likely to obtain their degree relative to men who did not receive the aid, compared to women who were 1.2 percentage points more

likely to graduate. Some studies, however, found that the effects for men and women were not substantially different (Angrist, Lang, & Oreopoulos, 2006; Page, Castleman, & Sahadewo, 2016; Scrivener et al., 2015). There are not enough such studies for us to estimate separate results by gender across the four outcomes in a formal meta-analysis.

Publication Bias

A common threat in meta-analyses is publication bias in which the literature included in the study study may be systematically unrepresentative of the true population of the completed studies. We consider this threat in the context of our analysis of the effects of grant aid on persistence and degree completion. To explore this threat, we include Figures 7 and 8 that show the contoured enhanced funnel plots for persistence and degree completion respectively. The contoured enhanced funnel plots are designed to help detect publication bias and other forms of bias by looking at the asymmetry of the plots. The contour shows if studies are missing in the areas of non-significance (the inner most funnel) or in the areas of higher statistical significance (the outer funnels). If studies are missing in the areas of non-significance, this suggests the possibility that the asymmetry is due to publication bias, meaning that non-significant results are not being published, or, alternatively, that there really is a statistically significant effect. Studies missing in the area of high significance suggest the cause of the asymmetry may be more likely due to other factors than publication bias such as study quality. Asymmetry to the left or right of the center of the funnel indicates that studies are systematically more likely to have found negative or positive results respectively.

Figures 7 and 8 both provide no evidence that our analysis lacks studies with small effect estimates; we observe a substantial number of studies that have effect estimates that are non-significant. However, there are asymmetries in both figures due to a lack of negative effect

estimates because there are not many studies reporting negative results of the effects of aid on persistence and degree completion. While these plots suggest the possibility of bias in the non-publication of negative results, we argue that the extent of this bias is small. First, there is a concentration of studies around the zero effect estimates that are precisely measured. Second, our inclusive and exhaustive literature search process found non-journal publications such as working papers, research reports, and program evaluations, and the presence of these types of studies in our analytic sample alleviates the concern that insignificant or negative results are being systematically excluded. Third, we argue that large-scale studies are likely to be published regardless of whether they found negative or null effects given the substantial amount of money invested in these students and for the widespread interest among researchers and policy makers in higher education. For instance, we do find large RCTs and programs that found null or negative results (e.g., Anderson & Goldrick-Rab, 2016; Cohodes & Goodman, 2014; Scott-Clayton, 2011b). Fourth, we generally expect the effects of grant aid on postsecondary outcomes to be either null or positive, in accordance with the predictions of economic theory (Angrist et al., 2015). Consequently, we do not believe publication bias is a serious threat to our findings.

Risk of bias

We are also concerned with the possible risk of including studies with poor internal validity potentially biasing the results. We believe this risk is minimal because we find that the vast majority, 83 percent, of the studies of grant aid and postsecondary outcomes included in our analysis, are high quality studies or studies (Table 1). Tables 3 and 4 also show that the effect estimates when including only high quality studies or only RCT and RD studies are comparable to the overall estimates. In other words, our results do not change substantially when we drop the high risk of bias studies and retain only the most plausible causal estimates in our analysis.

Although we considered using a meta-regression approach, our sample size limitations across the four outcomes of interest preclude such an analysis. A sample size of at best 29 studies and at worst nine studies produces a limited opportunity to include study characteristics as independent variables in the analysis due to the small degrees of freedom. Given these concerns and limitations, we opted for subgroup analyses instead as suggested by Bartolucci and Hillegass (2010).

Discussion

The state of research in the field of higher education financial aid policy is strong. Unlike many areas of education policy, there is ample causal evidence of the efficacy of grant aid programs on a multitude of postsecondary outcomes. However, there has yet to be a comprehensive meta-analysis of these causal studies on persistence and degree completion outcomes, outcomes which are essential to the economic and civic success of our society. We provide the first such study by incorporating 73 effect estimates from 42 primary U.S. studies.

A meta-analysis is particularly useful in this context because of the heterogeneity of grant aid program structures and student response. As noted, aid amounts of the studies included in our analysis range between less than $300 and more than $19,000. Additionally, a quarter of programs studied have supplementary, non-financial, treatments. For policymakers in a state or institution, it is difficult to base financial aid decisions on results from a single study conducted in another state or institution of a program with a different structure, aid amount, and additional academic supports. Our meta-analysis mitigates these issues by consolidating results across programs and reaching a conclusion about the effects of aid on persistence and degree completion more broadly.

Our results confirm that grant aid improves persistence and degree completion. Although the results are stronger for programs with additional, non-financial supports, our meta-analysis results provide clear evidence that providing grant aid improves within-year and year-to-year persistence as well as on-time and delayed degree completion. Averaging the effects over all of the studies provides point estimates of approximately two to three percentage point increases in the probability of persisting and completing a degree. These results are consistent over robustness checks that only include the highest quality studies and studies employing strong plausible causal estimates. Considering other features of heterogeneity across aid program, we also conclude that the effects are weaker for merit-based financial aid than for need-based financial aid. Assuming a linear relationship of aid amount and impact, we estimate an additional $1,000 of grant aid improves year-to-year persistence by 1.2 percentage points, with smaller effects for graduation outcomes.

Limitations and Future Research

In addition to the limitations of our analysis highlighted above, we could not include four studies we found met every inclusion criteria except for publishing results as linear probability models. These four studies only reported outcomes in terms of log-odds ratios from logit models, making direct comparisons with the bulk of extant studies challenging. Although we did not include those four studies in our quantitative meta-analysis results, these studies demonstrate similar results qualitatively. For example, Arendt (2016) found positive effects on year-to-year persistence and delayed degree completion; Davidson (2015) found positive effects on year-to-year persistence; Henry et al. (2004) found positive effects on on-time degree completion; and Zhang (2013) found positive results for on-time degree attainment. Hence, we do not believe the inability to fully include these studies in our meta-analysis estimates biases our conclusions. We

do suggest future research efforts in all areas of quantitative research examining binary outcomes endeavor to provide estimates from both linear probability models and logit models to ease subsequent meta-analytic comparisons.

We have several suggestions for future research that would further advance the scholarly understanding and application of financial aid to improve postsecondary outcomes. First, we highly encourage more randomized control trials that have multiple treatment arms to explore the individual and joint effects of non-aid treatments such as faculty advising, peer support, and academic support and guidance along with the provision of grant aid. Individual studies and our meta-analytic results consistently show that these additional treatments are effective in helping students persist and graduate. Second, our analysis focused on the effects of grant aid as a necessity since very few studies consider the effects of other forms of financial aid, such as borrowing. We encourage additional work to uncover the effects of borrowing on postsecondary success. Since loans are not equivalent to grant aid in many ways (Boatman, Evans, & Soliz, 2017), we would not expect that loans would have the same impact on student success. Third, there is preliminary and mixed evidence to suggesting that the effects of grant aid may not be uniform between men and women. In some instances, women responded more positively to men and vice versa. In other studies, the effects do not seem substantially different. As such, we suggest future research shows treatment results for men and women separately in subgroup analyses. Moreover, future research needs to examine the study and program characteristics, such as the size of the grant, the prestige of the grant, and how the grant is communicated to the recipients, all of which may influence these differential outcomes between men and women.

Policy Implications

Our findings have several important implications for policymakers. Although the magnitude of the persistence effect is small relative to the effect sizes observed for the impact of grant aid on college enrollment, our findings do suggest that institutions, states, the federal government, and private scholarship funds will find returns on providing grant aid to students after they have initially enrolled. Specifically, institutions often consider front loading aid by providing a greater amount of grant aid in the first year of enrollment than in subsequent years. While this financial aid packaging policy may increase the probability of initial enrollment in the institution, it may come at the cost of persistence given that subsequent receipt of financial aid after the first year has a positive effect on year-to-year persistence. Our findings also suggest that supplementing grant aid with additional treatments, such as academic or social supports, will improve impacts. These types of interventions likely help students overcome financial, academic, or social obstacles to success, and our findings support continued investment in such programs. Finally, merit aid, specifically state and institutional programs (as the federal government focuses little on merit aid), seems to have lower impacts on persistence and degree completion, suggesting policymakers should consider shifting grant aid towards students based on financial need instead of subsidizing students who would likely succeed without additional support.

In conclusion, the findings of this meta-analysis provide strong support for the continued extensive monetary investment in grant aid for postsecondary education. Students would experience worse outcomes without this investment, and expanding these financial supports would not only induce more students to attend postsecondary education but also increase their educational attainment.

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* denotes primary studies used in meta-analysis

Tables

Table 1
Descriptive information on the primary studies by study and program characteristics

	Full sample	United States
Study characteristics		
Publication year	2004-2017	2004-2017
High quality	81%	83%
RCT/RD	62%	60%
Peer review	55%	52%
Average sample size	17,551 students	17,467 students
Range of sample size	115-111,793 students	115-111,793 students
Program characteristics		
Average aid receipt	$2,489	$2,530
Range of aid receipt	$291-$19,354	$291-$19,354
Added treatment	26%	26%
Merit only	23%	21%
Any need-based	68%	71%
Other eligibility requirements	9%	8%
Number of treatment effects		
Within year persistence	9	9
Year-to-year persistence	29	25
On-time completion	22	20
Delayed completion	20	19
Number of studies	47	42

Note. All included studies use linear probability models. Some studies include multiple types of treatment effects. High quality studies include only studies with scores 3 or higher on our subjective ranking scale. RCT/RD includes only randomized control trials or regression discontinuity studies. Peer review includes only peer-reviewed studies. Additional treatment indicates the aid program includes other benefits to the students in addition to the grant aid. Merit only includes studies that are non-need-based financial aid programs. Any need-based includes all studies that have need-based components. Other eligibility requirements include veteran status, social security benefits, or having spent high school in a particular area.

Table 2

Meta-analytic results of the effects of grant aid on postsecondary persistence and degree completion in the United States

Outcomes	Main effect estimates					Heterogeneity of study effects		
	N	Effect Estimate	Standard Error	Lower Bound	Upper Bound	I^2	Q	P_Q
Persistence								
Within year	9	0.032	0.010	0.013	0.051	72.715	29.320	0.001
Year-to-year	25	0.018	0.005	0.009	0.028	72.376	86.882	<.001
Degree Completion								
On-time	20	0.024	0.008	0.008	0.039	85.136	127.828	0.002
Delayed	19	0.025	0.007	0.012	0.038	81.216	95.827	<.001

Note. Within year persistence includes studies that examine the term-to-term enrollment or within year effects of grant aid. Year-to-year includes studies that examine the persistence rate from one year to another, such as year one to year two, year two to year three, or year one to year four. On-time degree completion is the 100-125% degree completion, or four/five years and two years for four- and two-year institutions respectively. Delayed degree completion is the 150% or more degree completion, or six years or more for four-year institutions and three years or more for two-year institutions. Lower and upper bounds come from 95% confidence intervals.

Table 3
Meta-analytic results of moderators of the effects of grant aid on postsecondary persistence in the United States

Model	N	Main effect estimates			
		Effect Estimate	Standard Error	Lower Bound	Upper Bound
Within year					
Overall	9	0.032	0.010	0.013	0.051
High quality	8	0.037	0.011	0.015	0.059
RCT/RD	7	0.037	0.012	0.013	0.061
Peer review	3	0.067	0.035	-0.001	0.136
Added treatment	3	0.077	0.034	0.011	0.143
Merit only	2	0.018	0.016	-0.013	0.049
Any need-based	7	0.037	0.012	0.013	0.061
Year-to-year					
Overall	25	0.018	0.005	0.009	0.028
High quality	21	0.020	0.005	0.011	0.030
RCT/RD	16	0.022	0.007	0.008	0.036
Peer review	15	0.023	0.006	0.011	0.034
Added treatment	6	0.032	0.014	0.004	0.060
Merit only	6	0.000	0.013	-0.026	0.026
Any need-based	18	0.025	0.005	0.014	0.035

Note. High quality studies include only studies with scores 3 or higher on subjective ranking scale. RCT/RD includes only randomized control trials or regression discontinuity studies. Peer review includes only peer-reviewed studies. Additional treatment indicates the aid program includes other benefits to the students in addition to the grant aid. Merit only includes studies that are non-need-based merit studies. Any need-based includes any study that has a need-based component. Lower and upper bounds come from 95% confidence intervals.

Table 4
Meta-analytic results of moderators of the effects of grant aid on degree completion in the United States

Model	N	Main effect estimates			
		Effect Estimate	Standard Error	Lower Bound	Upper Bound
On-time completion					
Overall	20	0.024	0.008	0.008	0.039
High quality	18	0.023	0.008	0.007	0.038
RCT/RD	13	0.025	0.010	0.006	0.044
Peer review	10	0.024	0.016	-0.006	0.055
Added treatment	5	0.038	0.012	0.014	0.061
Merit only	5	0.021	0.021	-0.020	0.062
Any need-based	14	0.020	0.005	0.010	0.030
Delayed completion					
Overall	19	0.025	0.007	0.012	0.038
High quality	17	0.029	0.008	0.013	0.046
RCT/RD	12	0.028	0.012	0.005	0.051
Peer review	9	0.013	0.007	-0.001	0.028
Added treatment	6	0.048	0.017	0.015	0.082
Merit only	5	0.019	0.018	-0.016	0.054
Any need-based	12	0.024	0.008	0.009	0.039

Note. High quality studies include only studies with scores 3 or higher on subjective ranking scale. RCT/RD includes only randomized control trials or regression discontinuity studies. Peer review includes only peer-reviewed studies. Additional treatment indicates the aid program includes other benefits to the students in addition to the grant aid. Merit only includes studies that are non-need-based merit studies. Any need-based includes any study that has a need-based component. Lower and upper bounds come from 95% confidence intervals.

Table 5
The effect of $1,000 grant aid on various outcomes for U.S. studies

	Persistence		Degree Completion	
	(1)	(2)	(3)	(4)
	Within year	Year-to-year	On-time	Delayed
Grant aid per $1,000	0.013	0.012*	0.008	0.008
	(0.021)	(0.005)	(0.014)	(0.005)
_cons	0.017	0.004	0.025	0.027
	(0.037)	(0.013)	(0.041)	(0.020)
N	9	24	20	18

Note. Not all studies provided a treatment contrast. Standard errors in parentheses
$^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$

Appendix Tables

Appendix Table 1
Results by Database

Database	Results
ProQuest (includes dissertation and theses)	7,034
WorldCat (includes dissertation and theses)	4,074
ERIC	3,104
Taylor and Francis Online	2,060
EconLit	1,391
NBER	1,280
JSTOR (abstract)	1,018
Google scholar (abstract)	945
Google scholar (title only)	252
JSTOR	148
Directory of Open Access Journal (DOAJ)	146
Total	21,452

Appendix Table 2
Coding Guide

Study and Program Characteristics		
Variable	**Description**	**Level of measurement**
Id	ID Number assigned to study	Continuous
Leadauth	Name of lead author	Nominal
Title	Title of paper	Nominal
Yearpub	Year paper was published	Continuous
Pubtype	Type of publication (academic journal, policy report, conference paper, etc.)	Nominal
RCT	Randomized control trial indicator	0,1
Rct_rd	RCT or regression discontinuity indicator	0,1
Peer review	Is the study a peer-reviewed publication?	0,1
Method	Identification strategy (RD, DiD, IV, PSM, RCT)	Nominal
USA	Is the study based in the U.S.?	0,1
Otherctry	Name of the country where the study was conducted if not the U.S.	Nominal
State	Name of state (if U.S.=1)	Nominal
Outcome	The dependent variable(s) of the study: within year persistence, first year persistence, year-to-year persistence, degree attainment (100%), degree attainment (150%)	Nominal
FA program	Name of program/experiment	Nominal
Need_merit_other	Type of aid: need-based, merit-based, need-based with merit component, other	Nominal
Add_treat	Any additional treatment other than the aid amount	Nominal
Requirement	Pre-test score equivalence between treatment and control	Nominal
Baseline_equivalence	Baseline equivalence of control and treatment group indicator	0,1
Sensi_robust_falsi	Does the study provide sensitivity and robust estimates? Does it provide falsification test?	Nominal
Study_quality	The author's professional judgment of the study's quality from 1-5 (1-poor, 3-average, 5-excellent)	1-5
Summary_of_FA	Qualitative note of the aid program	Qualitative
Misc_note	Miscellaneous notes	Qualitative
Study Outcomes		
Variable	**Description**	**Level of measurement**
Outcometype	Within year persistence, year-to-year persistence, degree attainment (on time, delayed)	Nominal
Inst_sector	Institutional sector (2-year, 4-year, pooled)	Nominal
Gender	Gender indicator (male, female, pooled)	Nominal
Main_ana	The main estimate (not subgroup) indicator	0,1
LOR/LPM	Logged odds ratios or linear probability model	Nominal
Beta	Regression coefficient of the causal estimate of aid on outcome	Continuous
SE	The standard error of the beta	Continuous
Tstat	T-statistics of the beta coefficient estimate	Continuous
Samplesize	Sample size of the estimate	Continuous
Treatment_contrast	The dollar difference in aid receipt between treatment and control group	Continuous
Note	Additional notes about the estimates or study	Qualitative

Appendix Table 3

Quality Criteria for Assessing Risk of Bias

Quality Rating Considerations
Was the study a randomized control trial?
Was implementation fidelity measured and adequately described, and what are the implications of implementation fidelity on outcomes?
What are the relative strengths of the study design?
Was the analytic approach adequately described, and what are the relative merits of the approach used?
Was the comparison condition adequately described, and does the comparison group provide a reasonable counterfactual?
Were threats to internal and external validity considered and addressed?
Were findings robust to different analytical decisions and model specifications?
Was baseline equivalence established between treatment and comparison groups? (This is unnecessary for some approaches such as the difference-in-difference design.)
What sampling decisions were made by the authors and did the analytic sample present any concerns to internal or external validity?

Note: Studies with a rating of three, four, or five out of five were considered low risk of bias.

Appendix Table 4

Meta-analytic results of the effects of financial aid on postsecondary persistence and degree completion for the United States and international studies

Outcomes	Main effect estimates					Heterogeneity of study effects		
	N	Effect Estimate	Standard Error	Lower Bound	Upper Bound	I^2	Q	P_Q
Persistence								
Within year	9	0.032	0.010	0.013	0.051	72.715	29.320	0.001
Year-to-year	29	0.019	0.004	0.010	0.027	69.202	90.916	<.001
Degree Completion								
On-time	22	0.025	0.007	0.012	0.038	84.170	132.663	<.001
Delayed	20	0.026	0.006	0.014	0.039	80.744	98.672	<.001

Note. Within year persistence includes studies that examine the term-to-term enrollment or within year effects of financial aid. Year-to-year includes studies that examine the persistence rate from one year to another, such as year one to year two, year two to year three, or year one to year four. On-time degree completion is the 100-125% degree completion, or four/five years and two years for four- and two-year institutions respectively. Delayed degree completion is the 150% or more degree completion, or six years or more for four-year institutions and three years or more for two-year institutions.

Figures

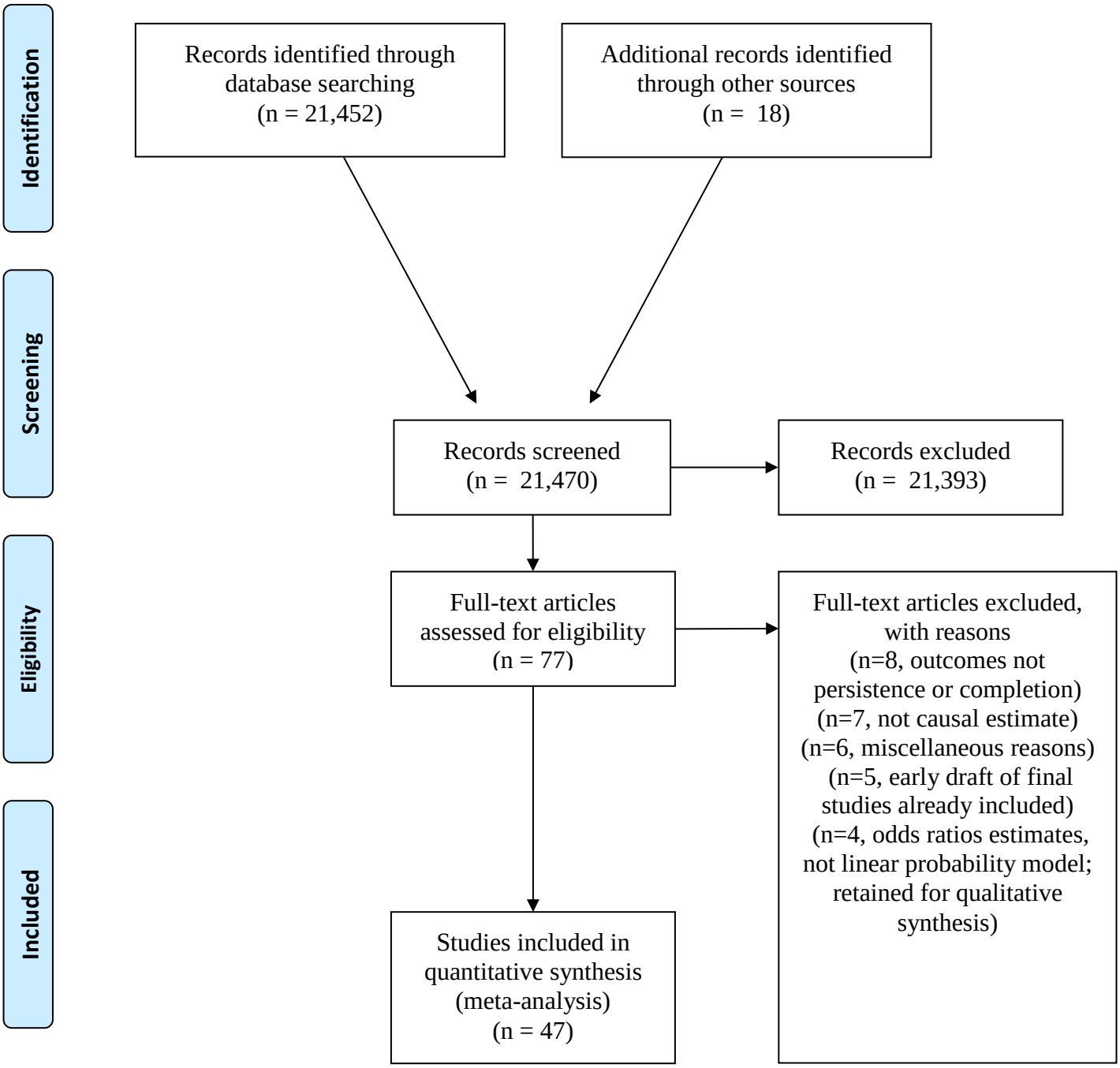


Figure 1. Flow diagram depicting the literature screening process resulting in the final sample of primary studies included in the quantitative analysis. Adapted from Moher et al. (2009).

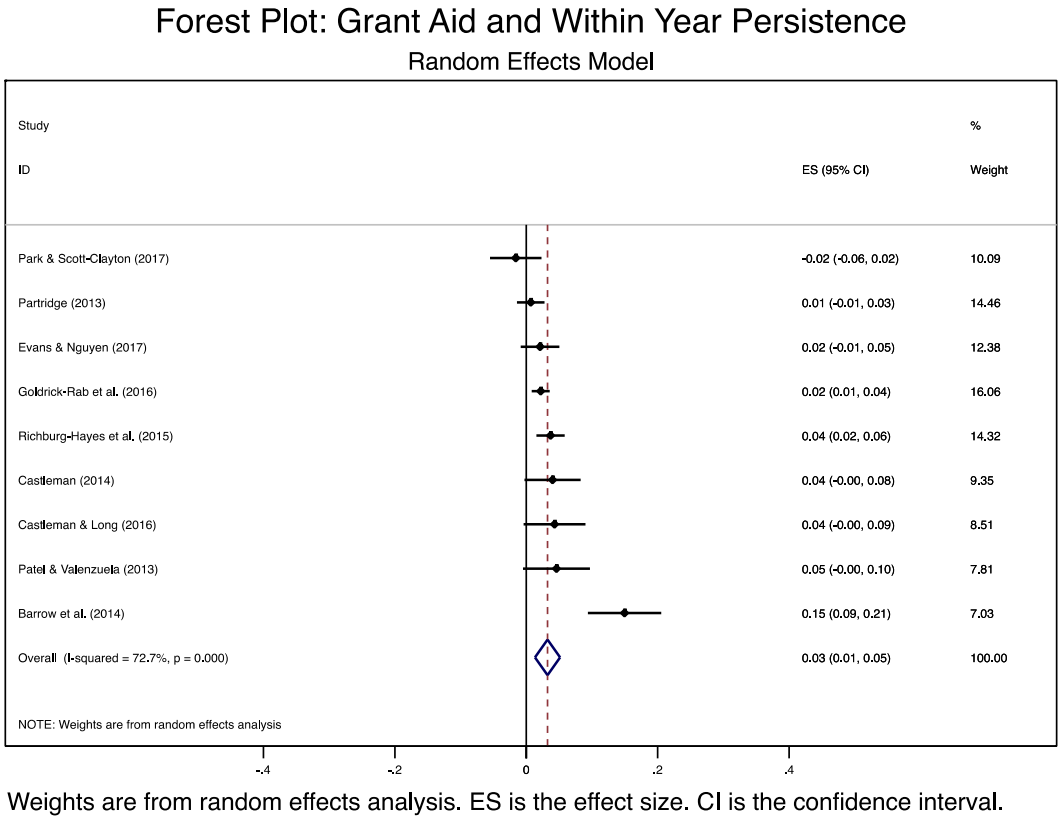


Figure 2. Forest plot for overall effect estimates of grant aid on within year persistence from primary U.S. studies.

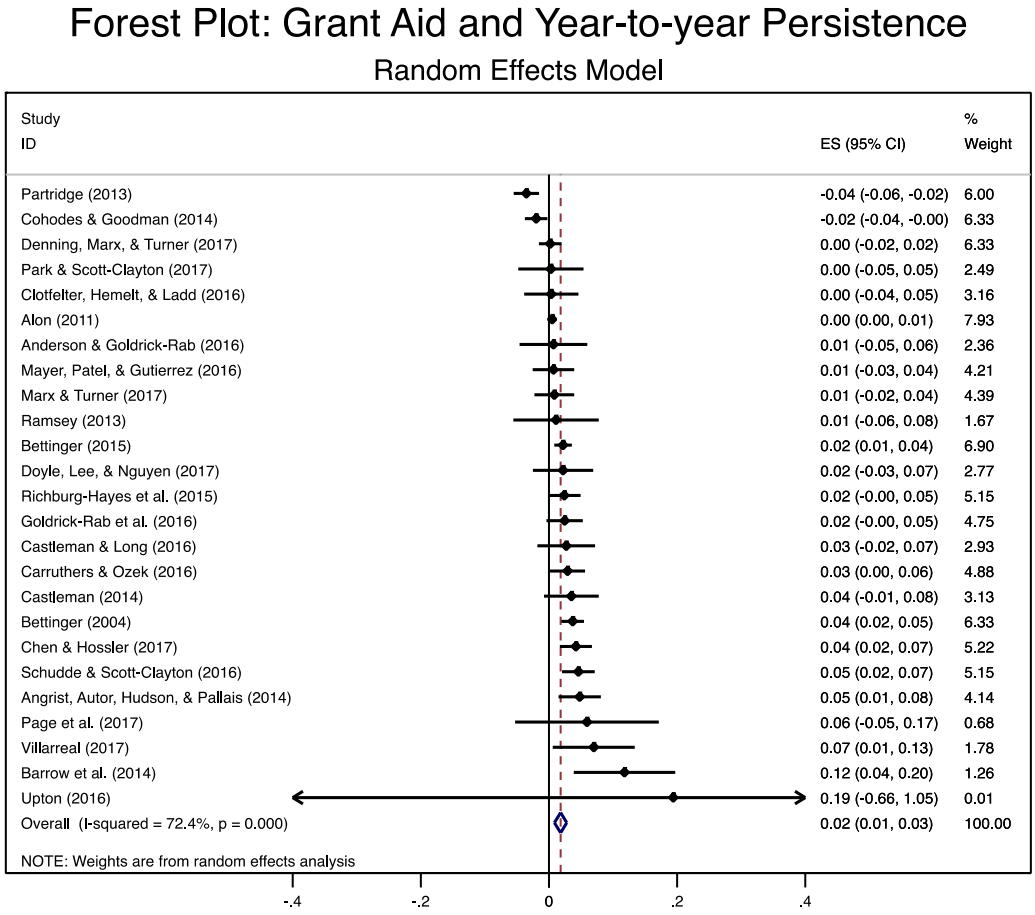
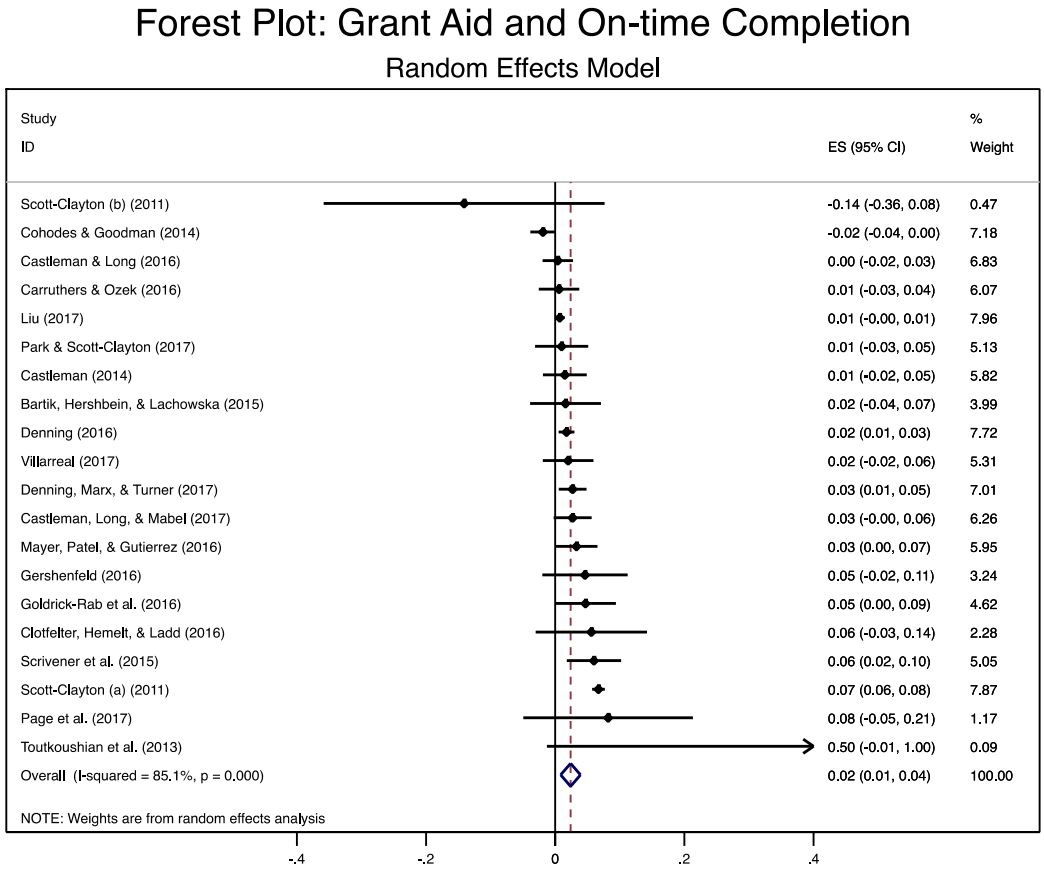
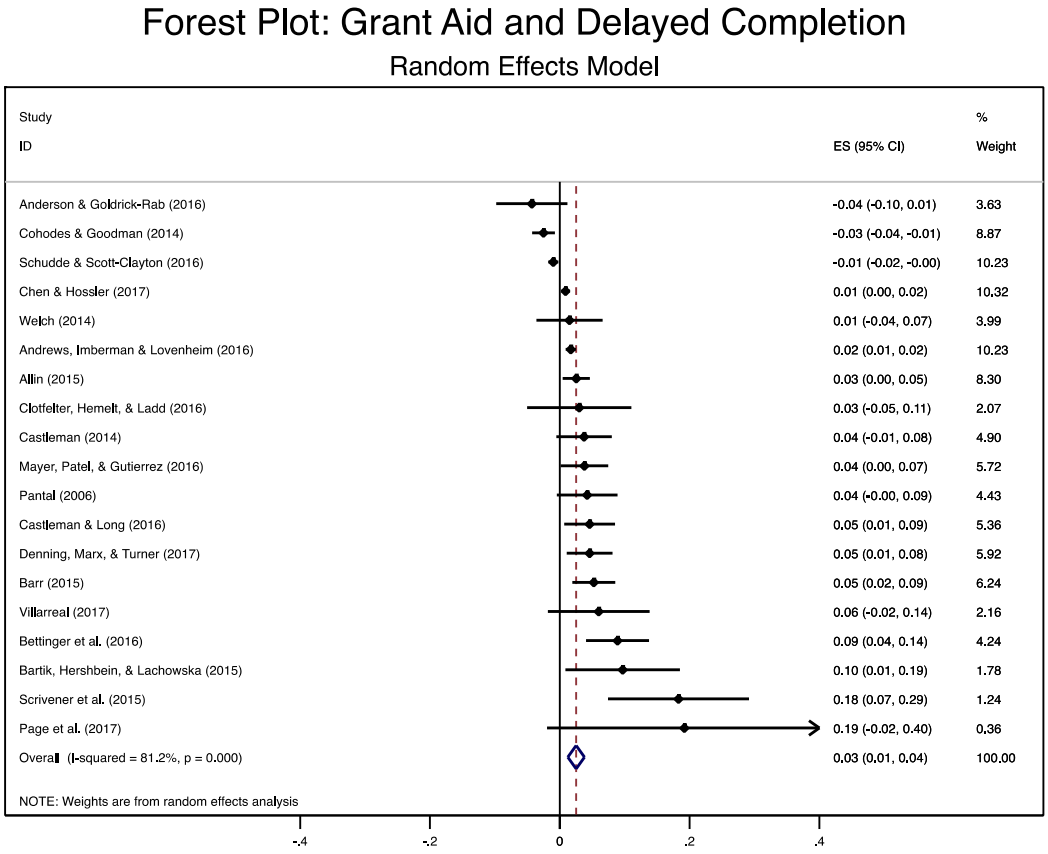


Figure 3. Forest plot for overall effect estimates of grant aid on year-to-year persistence from primary U.S. studies.



Weights are from random effects analysis. ES is the effect size. CI is the confidence interval.

Figure 4. Forest plot for overall effect estimates of grant aid on on-time completion from primary U.S. studies.



Weights are from random effects analysis. ES is the effect size. CI is the confidence interval.

Figure 5. Forest plot for overall effect estimates of grant aid on delayed completion from primary studies.

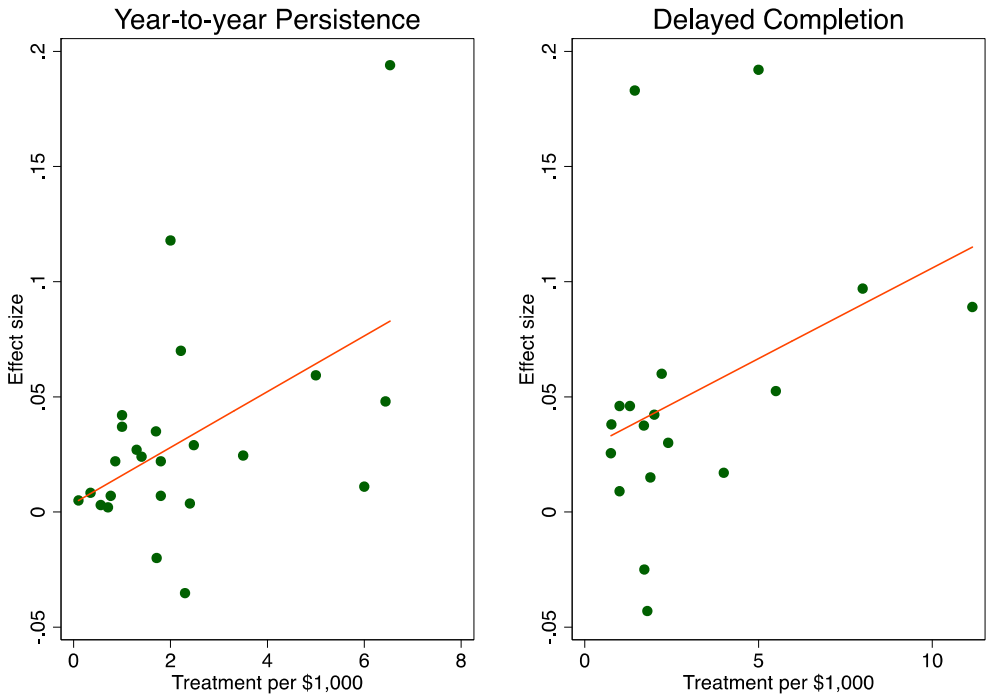


Figure 6: Grant aid amount plotted against effect size, percentage point increase per $1,000 of grant aid for two outcomes

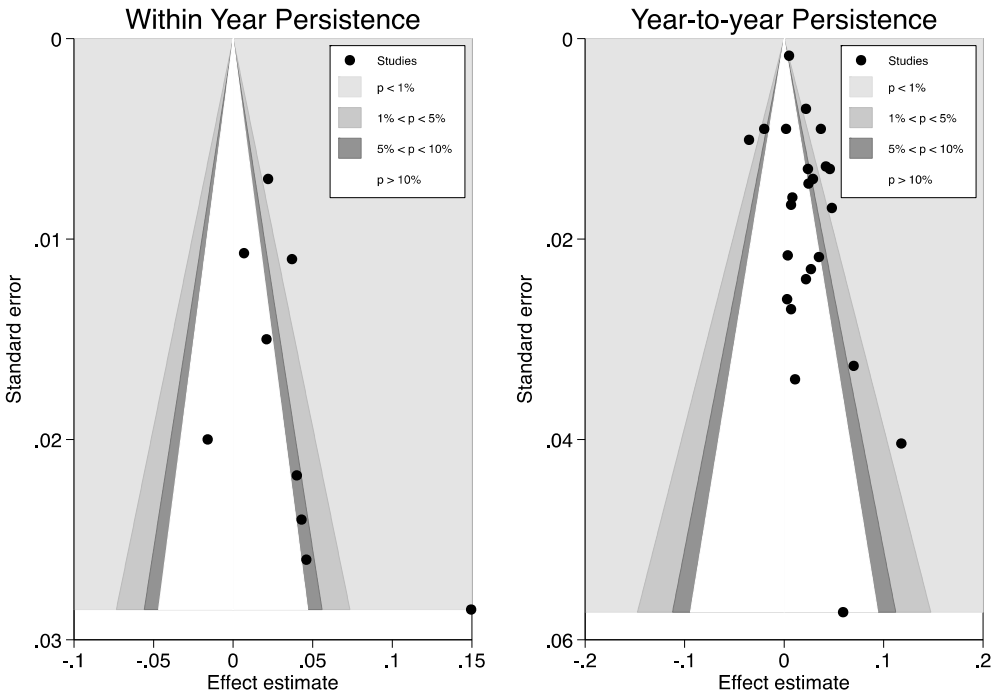


Figure 7. Contoured enhanced funnel plots of grant aid and persistence from primary U.S. studies.

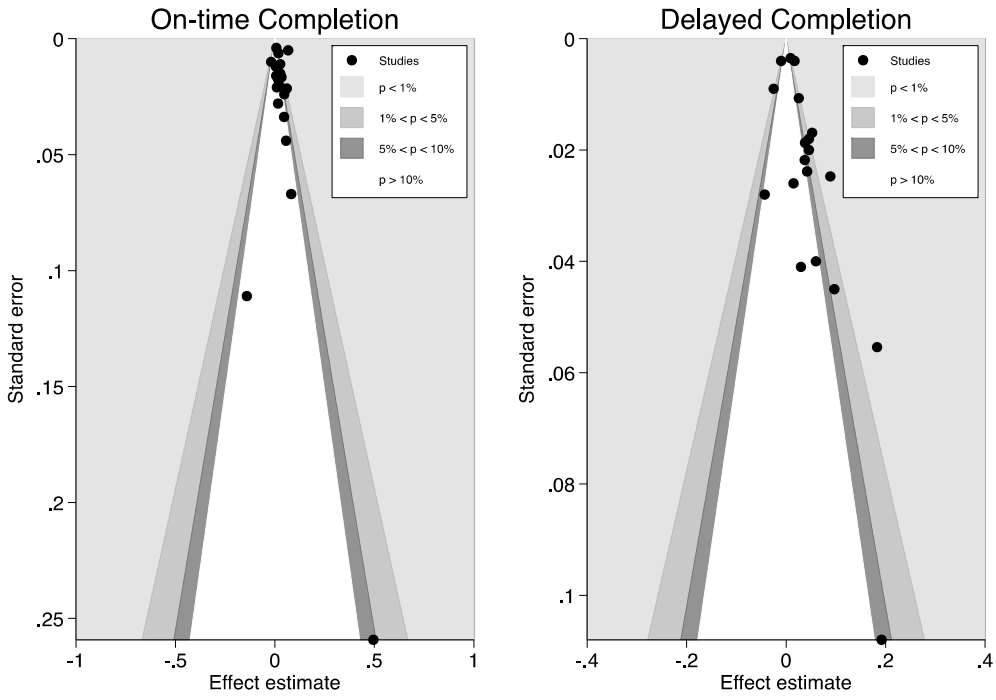


Figure 8. Contoured enhanced funnel plots of grant aid and degree completion from primary U.S. studies.