Getting to the Core of Credit Transfer: How Do Pre-Transfer Core Credits Predict Baccalaureate Attainment for Community College Transfer Students?*

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Over a third of undergraduate students attend community colleges—broad-access, two-year public colleges that disproportionately educate racially minoritized students and those from low-income families (National Center for Education Statistics, 2018). The majority of community college entrants aspire to earn a bachelor's degree; yet fewer than a third do (Horn & Skomsvold, 2011; Shapiro et al., 2017). Students face several challenges to meeting their "vertical transfer" aspirations; these range from making decisions about early coursework to navigating complexities in interinstitutional policies and procedures (Bailey et al., 2016; Monaghan & Attewell, 2015). States use several strategies, including statewide credit articulation agreements and credit transfer policies, to support the transfer function at community colleges (Anderson et al., 2006; Hodara et al., 2017). One often overlooked in the literature is a *transferrable core* of lower-division courses, which serves not only as a catchall for pre-major coursework but also as a pre-determined set of coursework universally accepted within a given public higher education system (Education Commission of the States [ECS], 2020).

Thirty-eight states have adopted a transferrable core, which should standardize recommended courses for transfer and create a clear transfer pathway (ECS, 2020). In practice, although core curricula can include general education coursework that overlap with pre-major and major baccalaureate requirements, lower-division requirements often vary by major (Bailey et al., 2016). For example, any college-level math course could transfer under the core, but only certain courses would count toward a STEM bachelor's degree. Students require clarity, early in their college career, about how coursework will transfer *and* apply toward a desired degree (Bailey et al., 2016; Schudde et al., 2021a). Students' transfer pathways are deeply entangled

with how institutions distill and disseminate information about credit portability (Hagedorn, 2010; Townsend & Wilson, 2006). To improve efficiency and avoid earning credits that will count as unnecessary electives, students often must navigate program requirements at their current institution and various potential destinations.

In Texas, the core curriculum was the most prevalent transfer policy described by students in a recent qualitative study examining how students make sense of state transfer policies (Schudde et al., 2021a). The authors found that students who adhered tightly to their community college's core curriculum without considering their alignment to baccalaureate requirements reported accumulating credits that transferred as excess elective credits. Despite a growing interest in community college transfer and policies that help (or harm) transfer students and the prevalence of the transferrable core, there is little evidence about how core credits, in contexts with a transferrable core, predict baccalaureate attainment among transfer students. We use statewide administrative data from Texas to address the following research questions (RQs):

1. How many core (and other) credits do community college transfer students accumulate prior to transfer?
2. How do core credits accrued at the community college predict bachelor's degree attainment and time to degree among community college transfer students? Do those relationships vary across socioeconomic status and race or ethnicity?

Our description of core credit accrual (RQ1) extends prior work on students' course-taking behaviors related to transferrable core curricula, which described core completion behavior within a small number of individual institutions (e.g., Hodara & Rodriguez, 2013; Schudde et al., 2021a). We capture core credit accrual for the entire population of community college transfer students in the second largest higher education system in the country. Our

regression analyses, addressing RQ2, allow us to predict how each additional core credit earned prior to transfer predicts transfer students' baccalaureate attainment and time to degree while controlling for a host of other predictors associated with completion.

Challenges in Community College Transfer

Despite having high aspirations, many community college entrants never earn a bachelor's degree. Entering a community college rather than a baccalaureate-granting institution is associated with a 23-percentage-point decrease in a student's probability of earning a bachelor's degree, according to a recent meta-analysis capturing estimates from the past several decades (Schudde & Brown, 2019). Institutional transfer can make it difficult for students to take an efficient pathway toward their desired degree.

Many community college transfer students lose credits in the transfer process and, among those who earn a baccalaureate, leave with excess credits upon degree completion (e.g., Cullinane, 2014; Fink et al., 2018, Monaghan & Attewell, 2015). Recent estimates suggest that community college students lose an average of 22% of their credits upon transferring to a public four-year university (Government Accountability Office, 2017, p. 51). Only 60% of community college entrants who transferred to a four-year institution were able to count the majority of their credits toward their bachelor's degree; 15% experienced severe credit loss (Monaghan & Attewell, 2015). Credit loss upon transfer decreases students' probability of earning a bachelor's degree (Monaghan & Attewell, 2015) and increases the time and money students spend to earn the degree (Belfield et al., 2017; Cullinane, 2014; Xu et al., 2018). Scholars and practitioners often conflate credit loss and credit inefficiency, two interconnected challenges faced by transfer students. *Credit transferability* refers to whether credits move from one institution to another (are

they accepted during transfer?), whereas *credit applicability* refers to whether credits count toward a degree (do credits fulfill requirements in a given degree program?).

Structuralist theories of higher education reason that inadequate support services, curricular structure, and clear guidance for transfer-intending students contribute to inefficient course taking and credit accumulation (Bailey et al., 2015; Rosenbaum et al., 2007; Scott-Clayton, 2011). Variation in institutional practices for transfer shape observed variation in transfer-out rates at community colleges and baccalaureate attainment rates among transfer students at destination four-year institutions (Jenkins & Fink, 2016). Despite an average transfer-out rates of 33% nationally, transfer-out rates at community colleges range from the single-digits to almost 80 percent (Jenkins & Fink, 2016, p. 12). Baccalaureate completion rates among community college transfer students range between zero and approximately 70 percent, with a national average of 42% at public universities (pp. 15, 22). Driven to improve student outcomes, community colleges across the country are working to streamline curricular pathways as part of sweeping *guided pathways* reforms (Bailey et al., 2015; Jenkins, 2014). Guided pathways is a whole-college redesign model through which colleges backward map programs of study to good jobs and baccalaureate transfer while redesigning advising, instruction, and technology systems to enable students to choose, plan, and complete programs as efficiently and affordably as possible. Ideally, such reforms go hand-in-hand with statewide efforts to clarify how credits move across institutions, building transparent pathways toward students' educational aspirations.

To improve the way credits move between public institutions, states use several strategies, including common course numbering (universal course numbers across public institutions) and transfer agreements (articulating how credits will transfer across institutions/programs). Research suggests that common course numbering may improve vertical

transfer, particularly among first-generation college students (LaSota & Zumeta, 2016), but there is no research, to our knowledge, linking common course numbering to post-transfer outcomes. Evidence regarding the impacts of policies like transfer articulation agreements is mixed (Baker, 2016; Boatman & Soliz, 2018; Roksa & Keith, 2008; Anderson et al., 2006), though the extant research often conflates some transfer-relevant state policies, such as a statewide transferrable core and statewide transfer articulation agreement (e.g., Roksa & Keith, 2008). Articulation agreements are often negotiated and implemented by specific institutions and degree programs, rather than at the state level (Root, 2013). Recent research evaluated transfer-oriented associate degree policies, often set by state policy (Baker, 2016; Spencer, 2019). A study from California leveraged variation in offerings across programs to estimate the effect of the state's structured associate degrees for transfer (ADT), studying the impact as the policy rolled out (Baker, 2016). Baker (2016) found that the ADT policy spurred an increase in associate degree attainment—similar to results Spencer (2019) obtained using national data—yet no significant increase in transfer rates (longer term outcomes, like baccalaureate completion, were not yet observable). The results from the California study suggested an increase in transfer as the policy matured, with marginally significant increases in transfer as colleges expanded ADT-offerings.

One common policy response intended to improve credit transfer is the development of a set of lower-division courses that are universally accepted at public colleges statewide: a transferrable core curriculum (ECS, 2018; Roksa & Keith, 2008). There is little research about the value of certain types of credits—including core credits—in predicting transfer students' outcomes. Whether and how policies like the transferrable core work for transfer students—including how transfer students accrue credits prior to transfer and how those credits predict bachelor's degree attainment and time to degree—can help inform further policy change. In the

subsequent sections, we describe the transferrable core curriculum and the extant literature on community college credit transfer, focusing on core credits.

The Core Curriculum

Over three-quarters of Association of American Colleges and Universities member institutions employ a general education core curriculum that includes cross-disciplinary courses distributed across broad fields like humanities, social sciences, and physical sciences (Hart Research Associates, 2016; Jaschnik, 2016). For community colleges, core curricula serve dual purposes: providing baseline knowledge and serving as a block of transferrable courses (Chase et al., 2014; ECS, 2018). Prior research argued that states adopt policies like a transferrable core to improve course-taking and financial efficiency of transfer pathways—saving students time and money by decreasing course repetition (Chase et al., 2014; Roksa & Keith, 2008). Reducing confusion over which courses transfer stands to benefit all students, but particularly those who are least knowledgeable about how to navigate the complex bureaucracies and procedures inherent to postsecondary transfer (Bensimon & Dowd, 2009; Rosenbaum et al., 2007). Research from several state contexts suggests that students of color and students from low-income families face disproportionate challenges during the transfer process, where their path is hindered by "overt and hidden barriers"—thus core curriculum policies could improve equity in outcomes if they overcome informational barriers (e.g., Chase et al., 2014, 2016; Wang, 2020, p. 87).

Despite policymakers' intentions to improve transparency, transferrable core curricula do not necessarily eliminate student confusion over credit transfer. Transfer-intending students—and the staff who serve them—may struggle to identify core courses that will both *transfer* and *apply* toward a desired degree, even in systems with a transferrable core (Bailey et al., 2016; Schudde et al., 2020). Varied degree requirements across institutions mean lower-division core

courses may not apply toward a degree in the student's major in the same way across different institutions (Bailey et al., 2016; Hodara et al., 2017). The politics and tensions surrounding credit transfer—including whether and how credits count toward a given program of study—pose a challenge to faculty, staff, and students; personnel at community colleges and public universities struggle to determine how courses will apply toward a degree and to offer adequate guidance to students (Chase, 2018; Schudde et al., 2021b). Transfer-intending students are often left to triangulate across conflicting advice from various sources. They must navigate requirements at their current college and those of their destination institution to understand whether and how coursework will count across institutions.

The Role of Credits in Community College Transfer

Accumulating transferrable credits early in college is essential to student success, where completing gateway (introductory) math and English requirements seem particularly predictive of program completion and transfer (Jenkins & Bailey, 2017). Descriptive analyses from California community colleges illustrated a positive relationship between accruing 30 credits in the first year and transfer (Johnson & Cuellar Mejia, 2020). However, taking too many (or the wrong) lower-division credits may result in excess "elective" credits; such credits transfer but do not apply toward the student's bachelor's degree. Typically, only a certain number of electives are allowed, because the bulk of degree requirements are major-specific. A transferrable core curriculum offers a simple policy signal for transfer-intending students but adopting the signal can have unintended consequences; students often assume that so long as they take courses in their institution's core, all of that coursework will apply toward a degree at any public institution, unaware of the possibility of accruing excess electives (Schudde et al., 2021a).

To understand excess credit accrual among community college transfer students, Fink and colleagues (2018) used state administrative data to compare the course-taking behaviors of community college transfer students who earned bachelor's degrees with numerous excess credits with transfer students who earned bachelor's degrees with few excess credits. They found an association between taking 100-level and 200-level courses (introductory coursework similar to the general education courses comprising the core) and excess credits, concluding that community colleges should help students identify their bachelor's degree major early to avoid unnecessary introductory coursework. Fink et al.'s results do not necessarily imply that accruing core credits is problematic but rather illustrate the importance of determining which lower-division courses contribute toward a student's desired degree.

Research using descriptive statistics in some state contexts indicates a relationship between transferrable core completion and bachelor's degree attainment. Hodara and Rodriguez (2013) examined how community colleges students in transfer-oriented programs accumulate core credits and how core credit accumulation covaries with degree completion at two community colleges in two different states. Most students did *not* complete the core (only 12% completed the 42-credit core at College A and 29% completed the 36-hour core at College B). Core credit accumulation, including earning more core credits than necessary, appeared to vary by subject area (i.e., students earned excess core credits in some component areas). The descriptive analyses suggest that students who completed the core curriculum were more likely to earn a bachelor's degree than core non-completers. However, because the analyses did not include statistical controls to account for differences between students who complete the core and those who do not, the robustness of the relationship between core credit accumulation and bachelor's degree attainment is unclear.

Research leveraging propensity score matching techniques to address selection bias in core completion bolsters support for a positive relationship between core completion and college success among transfer students (Boatman & Soliz, 2018; Gorbunov et al., 2012). Gorbunov, Doyle, and Wright (2012) examined transcript data from six public universities in Tennessee to discern the effects of pre-transfer completion of general education requirements at community colleges and other four-year institutions. Leveraging event history analysis and propensity score matching, they found that transfer students who completed the state's 41-credit core were 25 percentage points more likely to earn a bachelor's degree than core non-completers and experienced improved grades and decreased time to degree. The authors found that completing some of the state's six component subject areas improved student outcomes more than completing other components. Pre-transfer completion of math and communications offered larger improvements in degree attainment than completing the other components (humanities/fine arts, social/behavioral sciences, natural sciences, history).

Boatman and Soliz (2018) used propensity score matching to examine the effects of pre-transfer completion of the Ohio Transfer Module (TM), a set of lower-division general education courses that fulfills the common core requirement at all public institutions in Ohio. Each college determines which courses to include in the distributed 36-credit curriculum. To match across TM completers and non-completers, Boatman and Soliz excluded students without ACT scores, which eliminated half the community college entrants in the data. Their research illustrated differences between students in the sample who completed the TM and those who did not. For example, TM completion appeared to vary by major, where TM completers were more likely to be social science or humanities majors, but less likely to be in engineering or health. They acknowledged potential differences across majors in both selection into and the consequences of

TM completion, where misalignment between the core curricula and major requirements in some fields, like STEM, could either dissuade STEM aspirants from completing core courses or from majoring in STEM field, where STEM aspirants may choose a different major after transfer to ensure core credits ultimately apply toward their baccalaureate. Among community college students in the matched sample, TM completion status predicted a 21-percentage-point increase in their probability of transferring and, among those who transferred, a marginally significant 5-percentage-point increase in baccalaureate attainment. At the same time, among transfer students who earned a bachelor's degree, completing the TM prior to transfer (compared with noncompletion) was associated with a .77 term increase in time to degree, where that time was spent at the community college (students spent 1.9 fewer terms at the four-year institution).

Most research estimating the relationship between core coursework and transfer student outcomes used core completion as the independent variable of interest because it offers a clear counterfactual: core noncompletion. Yet prior studies also showed that fewer than a third of transfer students complete the core prior to transfer.[1] In this study, we use statewide administrative data from Texas to examine credit accumulation among community college transfer students and estimate how core credits accumulated before transfer (rather than core completion) predict bachelor's degree attainment and time to degree. By focusing on community college transfer students—instead of restricting the sample based on availability of standardized test scores (Boatman & Soliz, 2018) or including the entire population of transfer students (Gorbunov et al., 2012)—we illuminate how community college transfer students use the core

[1] The percentage of students completing the general education core varied across the literature. Across existing analytic samples, the percent of students who completed the core was: Boatman and Soliz (2018), 15%; Hodara and Rodriguez (2013) College A, 12%; Hodara and Rodriguez (2013) College B, 29%; Gorbunoz et al. (2012), 11%.

curriculum and how core credits predict bachelor's degree outcomes and if that relationship varies across socioeconomic status or race/ethnicity.

Texas Context

Texas community colleges educate 13% of the country's community college students (authors' calculations, IPEDS) and serve as an entryway to higher education for 40% of college students in Texas (Texas Higher Education Coordinating Board [THECB], 2014). The Texas public higher education system comprises 80 two-year institutions and 38 four-year institutions, including several university and college systems, each with its own chancellors (at the system level) and presidents (at the college level) (THECB, 2017). These 118 entities together form the public higher education pipeline for both vertical and horizontal transfer.

Eighty-one percent of Texas community college students enroll in transfer programs, but fewer than a quarter of transfer aspirants end up transferring, a pattern that mirrors national trends (THECB, 2014). Transfer of credits between institutions is a common policy concern: Three quarters of bachelor's degree recipients took at least some credits at a Texas community college (THECB, 2014). Texas employs several initiatives to improve success among transfer students, including a general education core and additional lower-division coursework that students can add to the core to ensure that credits in specific majors will transfer.

In Texas, the *core curriculum* is a set of courses that provide students with breadth of knowledge and, as mandated in state policy, are universally accepted at public colleges statewide. The core curriculum policy was passed in 1997, with revisions in 2011 that refined the objectives of the core and the current foundational component areas, such as communications, math, and social/behavioral sciences (THECB, 2018). Similar to the Ohio TM, studied by Boatman and Soliz (2018), institutions can decide which courses fulfill component areas of the

core curriculum, and students can transfer core coursework as a whole or in part (i.e., they can transfer "core complete" or with some core credits, but all core credits should transfer to other public colleges). The core curriculum and Field of Study (FOS) curricula, comprising additional lower-division coursework—available for some major fields—that must transfer between colleges, are mandated. The FOS and the core should eliminate course duplication for students who switch between public institutions.

Decisions about credit applicability and fulfilling major requirements, however, are determined by individual institutions; as such Texas exemplifies an institution-driven transfer system (Hodara et al., 2016a, 2016b). *Transfer agreements* (also called *articulation agreements*), are "encouraged, but not required" (THECB, 2014, p. 169). Articulation agreements are used to negotiate the requirements for students to move between institutions (Anderson et al., 2006). Texas transfer agreements are "bilateral"—occurring between individual institutions—and thus leave students and advisors to navigate specific agreements between colleges and programs (Root, 2013). For that reason, these agreements vary in availability and quality based on which college and which program students transfer to and from. Not surprisingly, there appears to be wide variation in transfer and degree attainment across institutions, as illustrated by the THECB's academic performance metrics for two-year colleges.[2]

In Texas, associate degrees and bachelor's degrees are not "stackable" (where the requirements for the shorter-term degree would have the same requirements as those for a longer-term degree in the same field, building a based on which additional coursework can add on to) through any policy mandate (Bailey et al., 2016). Instead, articulation agreements and the

[2] Interested readers can explore transfer destinations of community colleges and degree attainment among transfer students at public universities in Texas's publicly reported data: http://www.txhighereddata.org/reports/performance/ctctransfer/

core and FOS curricula determine whether and how credits transfer. Students must earn at least 60 credits to receive an associate degree. Unfortunately, not all credits transfer to a bachelor's degree. Because degrees from different institutions have different lower-division requirements, recent evidence from qualitative research on community college transfer suggests that many do not earn a pre-transfer associate degree to avoid credit loss or, post-transfer, feel surprised when credits do not apply toward their major (Hodara et al., 2016b; Schudde et al., 2021a).

Methods

To address our research questions, we employed state administrative data from Texas, paired with descriptive statistics and regression models. We used longitudinal, student-level data from THECB, obtained through a data agreement with the Texas Education Research Center (ERC) at the University of Texas at Austin. We fitted a series of stepwise logistic and OLS regression models, entering groups of variables sequentially into the models, to determine how core credits predict degree attainment and time to degree, respectfully, after controlling for demographic and college experience measures.

Data

The THECB data include demographic information, college enrollment records, financial aid application information, credentials awarded, and transcript measures such as course enrollment, credits attempted/completed, and grades. Our key independent variable of interest in our regression models was accumulated pre-transfer core credits. To create the variable, we used core curricula course listings from THECB's website, which includes course prefixes and numbers for core coursework at every college in Texas.[3] Using the matrices of core course numbers, we merged the data into THECB student-level data using course prefixes and numbers

[3] It is available at http://www.thecb.state.tx.us/apps/tcc/.

from students' course enrollments. We classified all community college credits into five different categories: (a) core credits, (b) vocational and technical credits, (c) other college-level credits, (d) developmental education credits in math, and (e) developmental education credits in English. From there, we created measures of total credits earned in each pre-transfer term within the five categories, along with aggregate measures of total credits earned by the time of transfer. The measures of accumulated credits captured all community college credits with the minimal passing grade of D.[4]

Given our interest in pre-transfer core credits, we focused on the community college cohorts with longitudinal transcript data available. The first year that THECB collected student schedule data, which include courses, credits, and grades, was the 2011–2012 academic year. To build our sample, we identified first-time college students enrolled in two-year colleges in the 2011–2012 and 2012–2013 academic years (fall, spring, or summer)—these are the only two cohorts with at least 6 years of follow-up data. We restricted the sample to 23,824 students who transferred to a four-year public university within 3 years of initial enrollment. We excluded students who transferred to four-year private institutions because private institutions do not provide students' course enrollment data to the ERC. We tracked students for 6 years after their initial college enrollment, which allowed 3 years after vertical transfer to observe students' progress toward bachelor's degree attainment.

Analytic strategy

We used logistic regression to examine the relationship between pre-transfer core credits and bachelor's degree attainment. For the subgroup of students who earned a bachelor's degree

[4] By default, a minimal passing grade counts toward the core, though receiving institutions may set grade standards for credit transfer that are higher than a D (however, those standards cannot differ for native and transfer students) (THECB, 2015). We use institutional and major fixed effects in our analyses, as described further below, to help absorb differences in program and institutional standards.

(N = 12,904), we used ordinary least squares (OLS) regression to examine the relationship between accumulated core credits and time to degree. We estimate the relationship between core credit accumulation and both outcomes using the same set of statistical controls, although the models were run on two distinct samples (all community college transfer students and only those who earned a bachelor's degree within 6 years).

Our models included a number of variables we expected to influence baccalaureate completion and time to degree, including demographic characteristics, enrollment patterns, and achievement measures. We included various demographic measures, such as race, gender, age, and financial aid receipt, associated with community college persistence and transfer (Bailey et al., 2005; Schudde, 2019). We could not control for family income because doing so would have drastically reduced our analytic sample (only about 30% of Texas community college entrants filed the FAFSA), but we included a measure of ever having received the Pell Grant and an indicator for whether students applied for financial aid. Enrollment patterns, such as stopping out (breaks in college followed by re-enrollment) or attending part time, have been linked to persistence and degree attainment (Bailey et al., 2015; Fike & Fike, 2008; Park, 2012). To capture student enrollment patterns, we created measures of part-time, mixed, or full-time enrollment (where students are full time when, for each semester enrolled, they took at least 12 credits) and number of stop-outs (how many times students stopped enrollment and then re-enrolled, other than taking off summer terms). In the final model, we were also able to include other academic measures likely to predict bachelor's degree attainment, such as cumulative GPA across all college credits and whether students earned an associate degree before or after transfer (Belfield, 2013). Finally, anticipating that students who switched majors after transfer might require additional credits to earn a bachelor's degree (Bailey et al. 2016), we included a

dichotomous measure of whether students had a different broad Classification of Instructional Programs (CIP) code (the first two digits) during their semester directly before transfer and during their final semester at the university.

In the first model, we included pre-transfer core credits and pre-transfer core credits squared.[5] For Models 2 and 3, we added additional types of college-level credits and developmental credits earned at the community college, respectively. In Model 4, we added background variables. In Model 5, we added measures capturing students' enrollment patterns, including enrollment intensity and stop-out counts. Finally, Model 6 included additional academic measures, such as cumulative GPA, associate degree status, and whether students switched majors after transfer. We also explored variation in the relationship between core credits and the bachelor's degree outcomes across socioeconomic status (using Pell Grant receipt as a proxy) and race/ethnicity by adding interaction effects to the final model. A complete description of covariates and outcomes is in Table 1.

As noted in our literature review, transfer rates and transfer students' bachelor's degree attainment vary across institutions, and the availability of articulation agreements and completion of core credits varies across institutions and programs of study. We included fixed effects for pre-transfer community college, destination university, pre-transfer major in all regression models, which helps us address this endogeneity (Cameron & Miller, 2015). We also used robust cluster-adjusted standard errors with pre-transfer community college as the clustering variable to

[5] We compared several model specifications capturing pre-transfer core credits, including capturing cumulative core credits, core completion status, and an interaction of the two; cumulative core credits and its squared term; and cumulative core credits, its squared term, an interaction between cumulative core credits and core completion status, and an interaction between cumulative core credits and its squared term. Model fit indices suggested that the model with cumulative core credits and its squared term best fit the data.

further account for within-cluster error correlation and heteroskedasticity (Angrist & Pischke, 2008; Cameron & Miller, 2015).

Because we relied on regression, the results do not represent causal relationships. We were interested in the role core credits (rather than core completion) play in shaping degree attainment among the full population of community college transfer students. For this reason, relying on core complete status as a treatment in order to use propensity score matching or a synthetic control group (approaches focused on causal inference) did not align with our research questions. A regression with rich covariates is the strongest analytic strategy available for examining relationships of interest and improving upon the extant literature on the role of the core credits in transfer student success. We included a variety of control variables; nevertheless, the estimated relationships could still partially be explained by unobserved factors. Several factors we expect to predict core-credit consumption, like students' motivation, social capital, and information quality, are unobservable in the data. For example, students with information constraints—i.e., less awareness of the core curriculum—may be less likely to accrue core credits or perhaps less mindful about how core courses at the community college apply to their desired bachelor's degree. Given that we cannot control for these selection mechanisms, our regression results should not be interpreted as the impact of core credits on the outcomes. Rather, the results are correlations that may still partially reflect sorting into core credit accrual (i.e., some students are more inclined to accumulate core credits than others, and those unobserved characteristics may also predict degree attainment).

Descriptive statistics

We provide descriptive statistics for the analytic sample, along with descriptions of all variables, in Table 1. Forty-four percent of the sample identified as White, 34% as Hispanic,

10% as Black, and 6% as Asian. The average age at community college entry was 19. Fifty-four percent of students identified as women. The majority of the students (80%) attended college using a mix of part-time and full-time enrollment (i.e., enrolled for less than 12 credits in some terms and 12 or more credits in others). The average student spent 4 long semesters (Fall or Spring)—equivalent to 2 academic years—at a community college before transferring to a university. Most students did not earn an associate degree; only 9% of the sample earned an associate degree prior to transfer, and 17.5% earned one post-transfer (probably as a function of the state's reverse transfer policy, which allows credits to transfer back to a community college from a university). Fifty-four percent of students earned a bachelor's degree within 6 years of initial college entry. Among the bachelor's degree recipients, the average time to degree was 14.2 terms enrolled (inclusive of summer terms)—this translates to about 4.75 years.

[PLACE TABLE 1 ABOUT HERE]

Results

To understand how community college transfer students—those who entered a community college and transferred within 3 years of entry—made use of the core curriculum, we first offer an overview of pre-transfer credit accrual among our population of community college transfer students. After outlining descriptive patterns, we leverage our regression results to illustrate the relationship between pre-transfer core credit accrual and baccalaureate outcomes.

Pre-Transfer Credit Accumulation

In Figure 1, we illustrate the breakdown of credits accumulated prior to transfer. By the time of transfer, community college transfer students, on average, had completed 35.4 college-level credits, including core, vocational/technical, and other college-level credits. Although the average core credits accumulated by the time of transfer was 26.3, there was a lot of variation,

with a standard deviation of 15.6 credits (see Table 1). About 68% of students transferred with between 10.7 and 42 core credits—those earning one standard deviation below the mean transferred with approximately four core courses, whereas those earning one standard deviation above the mean transferred core complete. Despite reports from prior research that community college staff emphasize core completion (Bailey et al., 2016; Schudde et al., 2021a), only 19% of community college transfer students in our study completed the core—accumulating 42 core credits distributed across the required component areas—before the time of transfer (see Table 1). On average, students earned 8.4 other college-level credits, 0.7 vocational credits, and 1.9 credits in developmental coursework (0.8 in English and 1.1 in math) (see full sample bar in Figure 1).

[PLACE FIGURE 1 ABOUT HERE]

If we instead focus on core completers, the average number of core credits accumulated prior to transfer was 48.1, with 59.3 cumulative college-level credits prior to transfer, whereas core non-completers finished fewer college-level credits prior to transfer, with 21.2 core credits and 7.9 other college-level credits. Similar to descriptive findings from prior research (Hodara & Rodriguez, 2013), the patterns suggest there a positive correlation between pre-transfer core credit accumulation and bachelor's degree attainment. We next turn to regression analyses to determine whether that relationship holds when statistical controls are included.

The Relationship Between Pre-Transfer Core Credits and Bachelor's Degree Outcomes

We next describe results from our regression models. For ease of interpretation, we describe results in average marginal effects, which can be interpreted as the change in predicted probability for a one-unit change in the variable while holding other variables at their mean. Figure 2 illustrates the relationship between pre-transfer core credits and bachelor's degree

attainment outcome, where Tables A1 and A2 in the Appendix provide for full results from our stepwise logistic regressions for bachelor's degree attainment. The relationship between pre-transfer core credits and time to degree was not significant. We provide a full set of regression results for the time to degree outcome in Appendix Table A3.

As illustrated in Appendix Tables A1 and A2, the relationship between core credits and bachelor's degree attainment is positive and significant across all models, but the relationship for the quadratic term of core credits is negative across all models (see Table A1, Model 6, core credits: $OR = 1.040$, $SE = 0.005$, $p < 0.001$; squared term of core credits: $OR = 0.999$, $SE = 0.000$, $p < 0.001$—an odds ratio of less than 1 illustrates a negative relationship), confirming our need for a quadratic term to understand the relationship between pre-transfer core credits and degree attainment among transfer students.

To illustrate the nonlinear relationship between core credits and bachelor's degree attainment while controlling for all other variables, Figure 2 shows the average marginal effects of core credits across predicted probability of earning a baccalaureate (all other variables are held at their means). The figure illuminates a point of diminishing returns for pre-transfer core credits. Up to about 44 core credits (two more than the "core complete" status), each additional core credit improves a transfer student's probability of earning their degree, though we see the relationship is initially steeper and starts to level off as core credits approach the turning point of 45 credits. The relationship becomes negative after the turning point, suggesting that pre-transfer core credits accumulated beyond the turning point may be detrimental to baccalaureate attainment, though we should note that the standard errors start to get larger after 50 credits because of low cell size (far fewer students take that many core credits prior to transfer).

[PLACE FIGURE 2 ABOUT HERE]

Our regression analyses also shed light on other predictors of bachelor's degree attainment among community college transfer students (see Table A2 for average marginal effects). We find that, similar to prior research, degree attainment varies across student background characteristics, such as race and gender. For example, identifying as White is associated with an increased probability of earning a bachelor's degree compared with identifying as Black, Hispanic, or more than one race/ethnicity. Identifying as a woman is also associated with increased probability of earning a degree compared with identifying as a man. Students who received a Pell Grant are less likely to earn a bachelor's degree than non-Pell students, though filing for a FAFSA is associated with an increase in the probability of degree attainment.

Moving beyond student characteristics, we find that vocational and developmental credits taken at the community college negatively predict bachelor's degree attainment, whereas other college-level credits, a catchall for college credits that were neither core nor vocational (and probably focused on major requirements), positively predict degree attainment. Each additional other college-level credit accrued prior to transfer increases a student's probability of earning a bachelor's degree by .5 percentage points—which means that taking an additional 3-credit non-core academic course at the community college stands to boost their probability of earning a baccalaureate by 1.5 percentage points (Model 6: $AME = 0.005$, $SE = 0.000$, $p < 0.001$). Students who enrolled full time are more likely to earn a bachelor's degree than those who enrolled part time only. Stopping out also negatively predicts degree attainment, as does switching majors after transferring. Finally, compared with not earning an associate degree, earning an associate degree prior to transfer is correlated with a 14.7 percentage point increase in the probability of earning a baccalaureate, whereas earning a post-transfer associate degree is correlated with a 3.0-

percentage-point decrease (Model 6: Associate pre-transfer: *AME* = 0.147, *SE* = 0.014, $p < 0.001$; Associate post-transfer: *AME* = -0.030, *SE* = 0.012, $p < 0.05$). These results bolster support for recent findings that pre-transfer associate degrees positively predict baccalaureate attainment (e.g., Belfield, 2013; Kopko & Crosta, 2016; though Wang, Chuang, and McCready (2017) found a null relationship using national data).

We next estimated the relationship between cumulative core credits and time to degree among community college transfer students who earned bachelor's degrees (see full results from stepwise OLS regression models in Appendix Table A3). The main cumulative core credit measure and its quadratic term appear to have a nonsignificant relationship with time to degree in both Model 1 (an empty model that included only the two cumulative core measures) and Model 6 (our final preferred model, which included all statistical controls). In the final model, Model 6, we find that accumulating vocational credits and developmental credits at the community college increases time to a degree for community college transfer students who earned a baccalaureate. Accumulating other college-level credits negatively predicts time to degree. This suggests that taking non-core academic credits before transfer can improve efficiency toward a bachelor's degree, where each additional credit lowers the predicted time to a degree by one-tenth of a semester (Cumulative other: ß = -0.008, SE = 0.003, $p < 0.01$). Stopping out appears to negatively predict time to degree, where each additional stopout decreased the time it took to earn the bachelor's degree by about one-third of a semester (Stopout: ß = -0.324, SE = 0.070, $p < 0.001$). This is somewhat surprising—we would expect that taking time out from schooling would increase time to degree, especially for a subset of students who transferred. However, the modal number of stopouts was 1 and it is possible that transfer students used time

off to plan their future education or were more likely to take a semester off between application and transition to their destination institution.

Exploring variation across socioeconomic status and race

For the degree attainment outcome, we also examined variation in the relationship between pre-transfer core credits and the predicted probability of earning a bachelor's degree across Pell grant recipient status and students' race and ethnicity by adding interaction terms to our final preferred model. (Because the relationship between core credits and time to degree was not significant, we did not explore variation for time to degree.) Full regression results of these additional models are available in Table A4.

The interaction between Pell receipt and core credit accumulation was significant, with a negative interaction between Pell receipt and core credits and positive interaction between Pell receipt and the quadratic core credits term (see Appendix Table A4, column 1). This suggests that Pell recipients benefit less from accumulated pre-transfer core credits than non-Pell students, though the functional form of the relationship between core credit accumulation and degree attainment differs across the two groups. Figure 3 offers a visual illustration of the results. At 10 core credits and below, Pell grant recipients appear to benefit more than non-Pell students from their pre-transfer core credits. However, once students hit 20 pre-transfer core credits—where most students are in the distribution—non-Pell students benefit more from pre-transfer core credits than Pell recipients. This pattern persists all the way up through almost 60 core credits. At 60 accumulated pre-transfer core credits and above, the point estimates are imprecise (likely due to smaller cell size); we caution against making any strong conclusions based on point estimates in the upper end of the pre-transfer core credit distribution.

[PLACE FIGURE 3 ABOUT HERE]

We also explored the interaction between core credit accumulation and race/ethnicity, but did not find any consistent patterns (see Appendix Table A4, column 2).

Discussion

In this paper, we used state administrative data to understand the role that Texas's transferable core curriculum plays in baccalaureate outcomes—including attainment and time to degree—among community college transfer students. Prior research described mixed messaging to students about the value of pre-transfer core credits, where community college staff are more likely to encourage pre-transfer core completion than university staff (Schudde, et al., 2021a). Given the confusion students may experience as a result of receiving competing messages from community colleges and universities, it is not surprising that we find high variation in rates of core credit accumulation at the time of transfer. Overall, Texas community college transfer students appear slightly more likely to complete the core before transferring than students in other state contexts in the literature, such as Ohio (Boatman & Soliz, 2018) and Tennessee (Gorbunov et al., 2012). The bulk of transfer students in all three of these state contexts (TX, OH, TN) transferred before completing the core: Almost 80% in Texas transferred before completing the core, with even higher rates of non-completion observed among community college transfer students in Ohio and Tennessee. For that reason, we focused our inquiry on the relationship between core credits—rather than core completion—and baccalaureate attainment.

The results of our regression analyses suggest that each additional pre-transfer core credit improves students' probability of earning a bachelor's degree, but only up to approximately core completion status. The 42-credit limit embedded in the state mandate has meaning, since it limits the number of credits universities must accept during transfer. When students surpass the 42-credit mark, they soon experience a negative relationship between additional pre-transfer core

credits and bachelor's degree attainment (the turning point was about 3 credits—just one additional course—above the core completion mark). We were able to uncover this nonlinear relationship by examining the role of accumulated pre-transfer core credits, rather than of core completion status, in degree completion. Although we cannot know whether similar processes play out in other contexts, this suggests that the design of general education core curricula—including limits set on guaranteed credit transferability—will inform student outcomes.

Because Texas core credits must transfer but do not have to *apply* toward major-specific requirements (i.e., they may transfer as electives), students who transfer core complete should be cautious about which core courses they take at the community college and how those credits will ultimately count toward their desired bachelor's degree. It seems feasible that part of what we capture here—the decline after reaching the core completion mark—is related to efficiency of core credit accrual, where too many pre-transfer credits signal that students are taking courses that are not aligned to a given program of study. These patterns align with recent findings that taking too many introductory courses accounted for a large proportion of excess credits among community college transfer students who earned a bachelor's degree (Fink et al., 2018). Ideally, a transferable core curriculum would help students avoid such missteps, if students take courses from the varied components of the distributed curricula (which breaks down number of courses from various required topic areas)—but this assumes adequate guidance and transparency about how those courses will be counted toward requirements in the student's desired degree.

We also found that other academic credits (college-level credits that are not part of the state's core) are also positively correlated with bachelor's degree attainment and negatively correlated with time to degree (i.e., additional non-core academic credits predict completing a degree and doing so in fewer semesters). The core is often comprised of introductory lower-

division coursework and these additional academic credits accumulated outside of the core are often more targeted to progressing in a field of study. The results align with prior work that suggests that transfer-intending community college students who are strategic about taking non-general-education credits benefit from accruing non-introductory credits prior to transfer, although we cannot ascertain students' motivation or strategy from our data (Fink et al., 2018; Schudde et al., 2021a).

Policy Implications

Our study comes at a time when community colleges and public higher education systems across the country are engaged in ongoing work to implement guided pathways reforms and to improve articulation policies (Bailey et al., 2015; Jenkins et al., 2020; Spencer, 2019). As colleges attempt wholescale restructuring to implement guided pathways, they need information about how students accrue credits and make course choices in order to inform efforts to improve curricular pathways within and across institutions. Prior research illuminated confusion among transfer-intending students faced with core curricula that do not align across institutions (Schudde, 2021a). Determining how credits move across institutions can be challenging. Recent research documents inadequacies in publicly posted information about credit transfer, contributing to the burden placed on students as they try to navigate transfer policies (Government Accountability Office, 2017; Schudde et al., 2020).

Even in the contexts of a state that prioritizes institutional autonomy, our results suggest that as long as students do not "over-accumulate" core credits (i.e., go beyond the necessary 42 credits), core credits earned at the community college improve students' probability of baccalaureate attainment and their efficiency in terms of time to degree. However, it appears that some students benefit more from pre-transfer core credits than others. Research from other state

contexts suggests that students of color and students from low-income families face disproportionate challenges during the transfer process (Chase et al., 2016; Wang, 2020) and our findings suggest that students from low-income families (captured through Pell receipt status) appear to benefit less from core credits than their more affluent peers. Our data cannot address why that might be the case, but qualitative research in Texas illustrates the difficulty students face in navigating competing policy signals about which credits to take and how those credits transfer and apply toward students' desired degrees (Schudde et al., 2021a). It is possible that some students have greater access to support structures than others to help them deliberate across competing policy information—this is an area we recommend future research explore further.

Ongoing policy debates in Texas seek to strengthen the transferrable core. A recent proposal in Texas included an amended core curriculum that would incorporate tailored math and science components based on students' field of study (and guaranteed those courses *apply* toward the final bachelor's degree) (Senate Research Center, 2019). The final version of the bill, Senate Bill 25, did not include the amended core, but does require that colleges and universities across the state provide their course sequences and program plans to THECB and publicly post that information online. This may be a first step toward improved transparency of transfer information, as institutions are now mandated to post information that will illustrate variation in course requirements across degree programs. Our findings cannot directly speak to how an amended core curriculum would influence student outcomes, but we expect that offering more clarity about how core credits apply toward a degree would improve the efficiency of core credits for transfer students. We recommend that the state reconsider the design of the core curriculum related to problematic core components, which, according to extant research, include math and science coursework (Bailey et al., 2020; Schudde et al., 2021a).

The challenges students face in navigating transfer policies like the core curriculum are not unique to Texas (e.g., GAO, 2017; Hodara et al., 2017). As community colleges across the country work to improve course sequences and student advising through guided pathways reforms, they should concurrently partner with universities to develop transfer guides that encourage efficient course taking toward baccalaureate attainment. Transfer guides should highlight core courses, where the documentation illustrates both whether credits transfer *and* whether they apply toward a given degree program (Schudde et al., 2021a). This information would clarify how pre-transfer core credits can help students complete bachelor's degree requirements in a cost-effective manner and, at the same time, avoid credits that will not count toward their desired degree.

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Tables

Table 1

Variable Names and Descriptions

Variable Name	Description	Mean (SD)
Pre-Transfer Credit Accumulation		
Core Complete[a]	Dichotomous indicator of whether student completed 42 semester credit hours (SCH) from core curriculum; derived from THECB schedule data	0.190 (0.392)
Cumulative Core Credits	Cumulative number of credits earned from the Texas Core Curriculum at community college prior to transfer; derived from THECB schedule data	26.301 (15.619)
Cumulative Vocational	Cumulative number of college-level credits earned from the vocational courses at community colleges prior to transfer; derived from THECB schedule data	0.696 (3.422)
Cumulative Other	Cumulative number of college-level credits earned from the courses other than core and vocational courses; derived from THECB schedule data	8.422 (8.455)
Dev-Ed Mathematics Credits	Cumulative number of developmental mathematics credits earned at community colleges; derived from THECB schedule data	1.117 (2.282)
Dev-Ed English Credits	Cumulative number of developmental English credits earned at community colleges; derived from THECB schedule data	0.761 (2.215)
Demographics		
Race	Race/ethnicity of the student, obtained from THECB enrollment data	
White (reference)	Identified as non-Hispanic White	0.438 (0.496)
Hispanic	Identified as Hispanic	0.344 (0.475)
Black	Identified as non-Hispanic Black	0.100 (0.300)
Asian	Identified as Asian	0.063 (0.243)
Two or More Races	Identified as two or more races	0.051 (0.219)
Other Race	Identified as another race, including Native Hawaiian or Other Pacific Islander, Native American and unknown	0.005 (0.067)
Female	Identified as female; drawn from THECB enrollment data, which offers dichotomous measure of gender (male or female)	0.544 (0.498)
International Student	International student status; obtained from THECB enrollment data	0.012 (0.110)
Age	Age of the student at initial enrollment; obtained from THECB enrollment data	19.00 (0.683)
Pell Grant Recipient	Indicator of whether student ever received Pell Grant; obtained from THECB Financial Aid Data System (FADS) data	0.342 (0.474)
FAFSA Filer	Dichotomous measure of whether student had a FADS file in the financial aid data, which indicates whether the student ever filed for federal or state financial aid	0.572 (0.495)
Enrollment Patterns		
Semesters Before Transfer[a]	The number of semester students spent at community colleges before the time of transfer; derived from THECB enrollment data	4.029 (1.709)
Enrollment Intensity at the Community College	Categorical measure of whether student enrolled part time (less than 12 credits in each term enrolled), full time (at least 12 credits, in each term enrolled), or a mix of part and full time across semesters enrolled at community college	
Part Time (reference)		0.081 (0.273)

Variable Name	Description	Mean (SD)
Full Time		0.116 (0.321)
Mixed Intensity		0.803 (0.398)
Stop-out Count	The number of periods of non-enrollment followed by enrollment (when a student did not enroll during a Fall/Spring semester before returning to college); derived from THECB enrollment data	0.209 (0.463)
Other Academic Measures		
Associate Degree	Categorical measure of whether the student earned an associate degree and timing; obtained from THECB graduation data	
No Degree (reference)		0.734 (0.442)
Earned Before Transfer		0.091 (0.288)
Earned After Transfer		0.175 (0.380)
Major Switch	Indicates whether student switched their major after transferring to a four-year institution. Measure derived from program codes in THECB enrollment data file; we captured students who switched broad Classification of Instructional Programs (CIP) codes (first two digits) between the time of transfer and their last enrolled term at university coded as switching majors post-transfer	0.441 (0.497)
Cumulative college-level GPA	Cumulative grade point average from college-level courses (excludes remedial coursework grades); derived from THECB schedule data	3.287 (0.630)
Outcomes:		
Bachelor's Degree	Dichotomous measure of whether student earned a bachelor's degree within six years of initial enrollment; obtained from THECB graduation data	0.542 (0.498)
Time to a Bachelor's Degree	Number of semesters student takes to complete a bachelor's degree within six-years (analytic sample restricted to degree-earners; N = 12,894); derived from THECB graduation data and enrollment data	14.246 (2.370)

Note. N = 23,824

[a] Two variables above, core complete status and semesters before transfer, were not included in our regression models due to collinearity with other measures in the model (total core credits and enrollment intensity, respectively). We present them here to illustrate descriptive patterns for the students in the analytic sample.

Figures

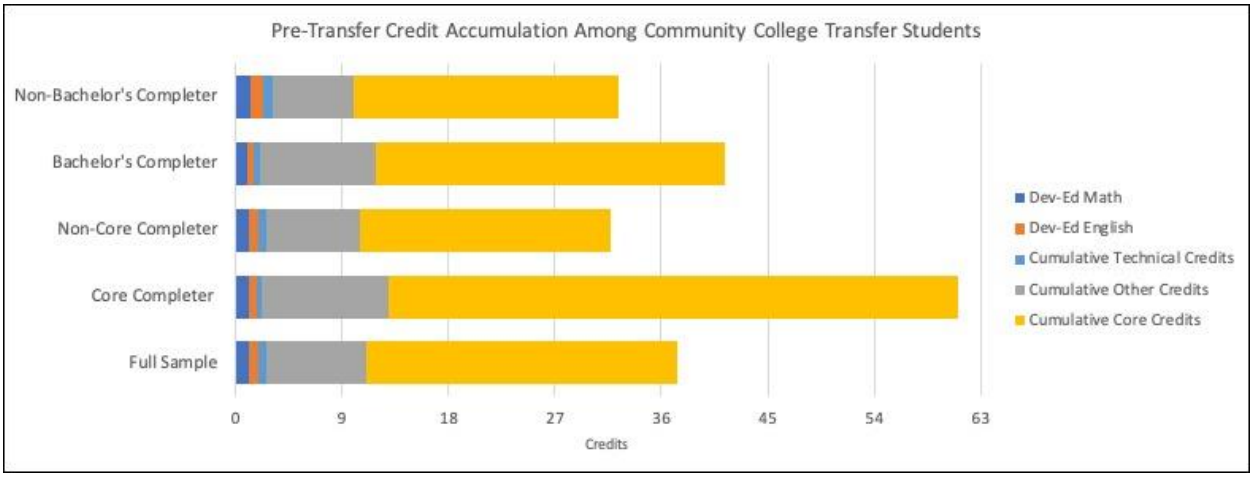

Figure 1. Pre-Transfer Credit Accumulation Among Community College Transfer Students. The figure illustrates the cumulative credits students earned before transfer disaggregated by credit type (core, technical, and other college-level credits and developmental math and English credits). We present this information for the full analytic sample of community college transfer students (N = 23,824) and for subgroups based on core completion and bachelor's degree completion status.

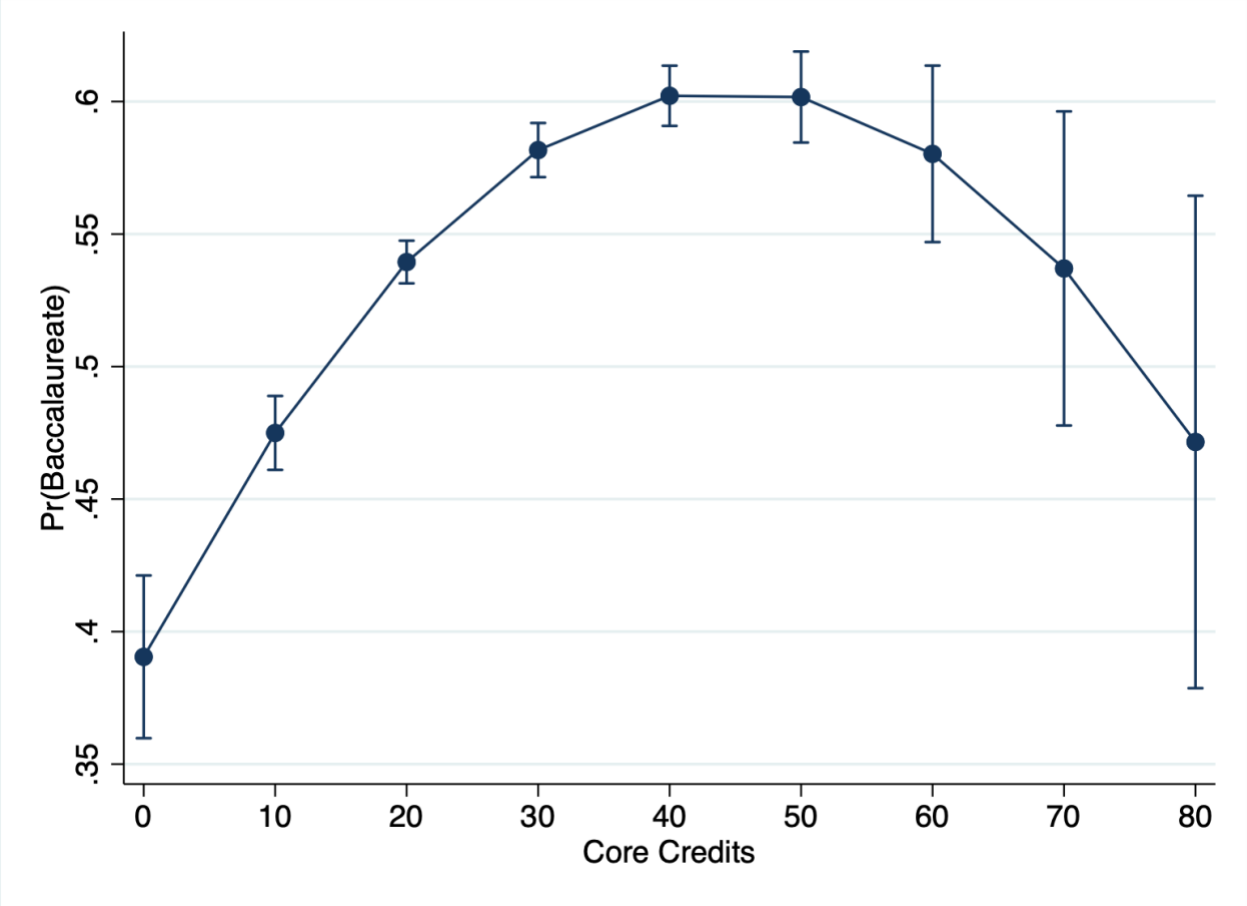

Figure 2. Pre-Transfer Core Credit Accumulation and the Predicted Probability of Earning Bachelor's Degree. N = 23,819. The figure presents the relationship (in average marginal effects with 95% confidence intervals) between core credits accumulated before transfer and bachelor's degree attainment among community college entrants who transferred within 3 years of initially entering community college. The estimates are drawn from our final preferred model (see Appendix Table A1 and Table A2), which included all covariates, cluster-robust standard errors (clustered by community college), and fixed effects for cohort, community college, pre-transfer major, and university.

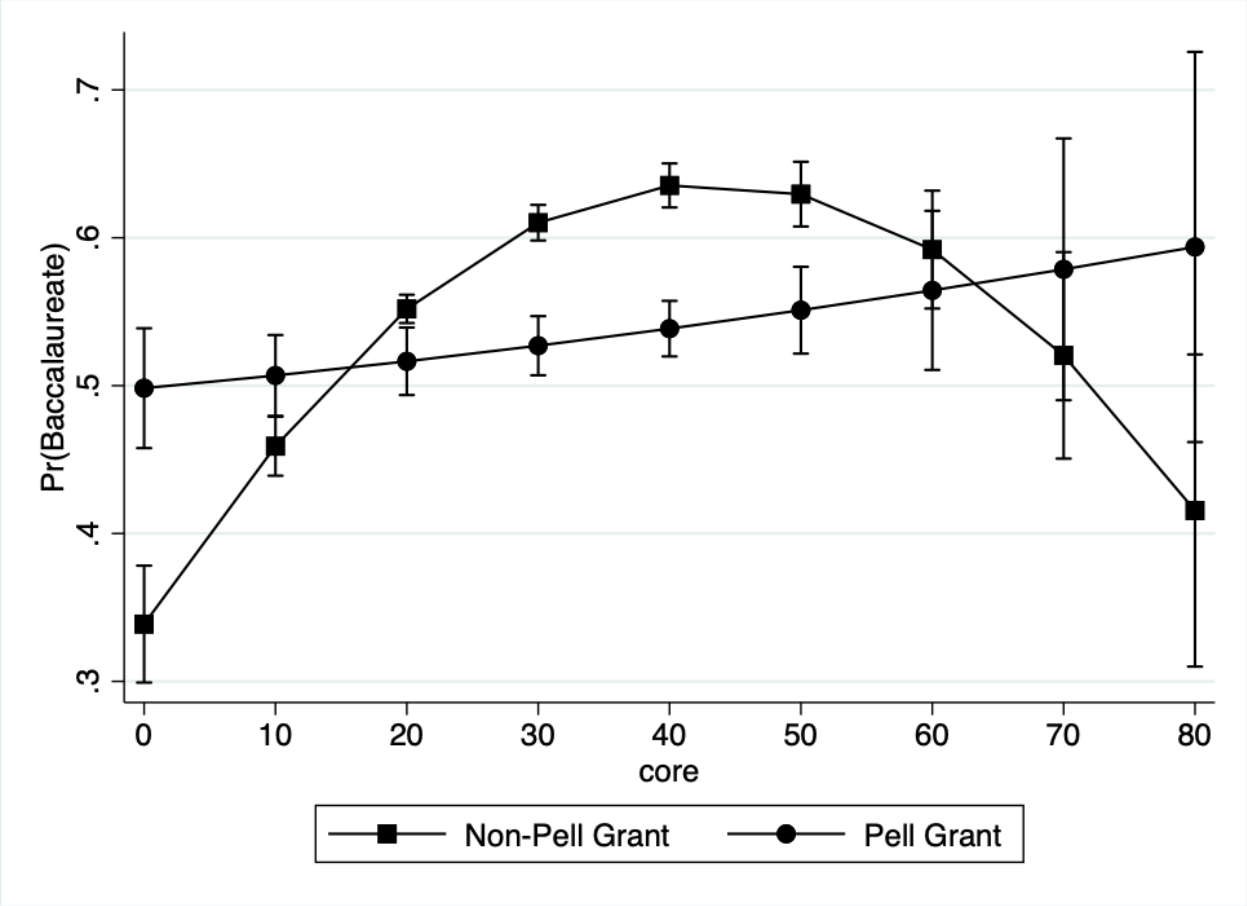

Figure 3. Pre-Transfer Core Credit Accumulation and the Predicted Probability of Earning Bachelor's Degree by Pell Grant Recipient Status. N = 23,819. The figure presents the relationship (in average marginal effects with 95% confidence intervals) between core credits accumulated before transfer and bachelor's degree attainment among community college entrants who transferred within 3 years of initially entering community college by Pell Grant recipient status. The estimates are drawn from a version of our final preferred model, run with an interaction between Pell status and the core credit measures.

Appendix

Table A1

Logistic Regression Results Examining Relationship Between Community College Core Credit Accumulation and Bachelor's Degree Attainment: Odds Ratios

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variables	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)
Cumulative Core	1.052***	1.039***	1.043***	1.046***	1.046***	1.040***
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)
Cum. Core (Quadratic)	0.999***	0.999***	0.999***	0.999***	0.999***	0.999***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cumulative Vocational		0.989*	0.989*	0.987*	0.985**	0.974***
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Cumulative Other		1.035***	1.034***	1.033***	1.032***	1.019***
		(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Cumulative Dev-Math			0.965***	0.963***	0.962***	0.979**
			(0.006)	(0.006)	(0.006)	(0.008)
Cumulative Dev-English			0.954***	0.961***	0.960***	0.959***
			(0.006)	(0.006)	(0.006)	(0.006)
Hispanic				0.815***	0.831***	0.904*
				(0.033)	(0.033)	(0.040)
Black				0.681***	0.691***	0.884*
				(0.037)	(0.038)	(0.049)
Asian				1.017	1.021	1.008
				(0.085)	(0.085)	(0.088)
Two more races				0.746***	0.769***	0.837*
				(0.053)	(0.056)	(0.060)
Other				0.823	0.809	0.860
				(0.167)	(0.182)	(0.230)
Female				1.535***	1.580***	1.392***
				(0.049)	(0.054)	(0.048)

International				1.447*	1.424*	1.176
				(0.252)	(0.248)	(0.222)
Age				1.016**	1.021***	0.994
				(0.006)	(0.006)	(0.005)
Pell Grant				0.839***	0.848***	0.872**
				(0.036)	(0.038)	(0.038)
FAFSA Filer				1.191**	1.292***	1.218**
				(0.078)	(0.086)	(0.077)
Enrollment Intensity (Reference: Part time)						
Full Time					2.166***	1.744***
					(0.233)	(0.177)
Mixed					1.115	1.092
					(0.101)	(0.099)
Stop-out Count					0.467***	0.488***
					(0.019)	(0.021)
Associate (Reference: None)						
Before Transfer						1.885***
						(0.126)
After Transfer						0.884*
						(0.044)
Major Switch						0.818***
						(0.031)
Cumulative GPA						3.110***
						(0.139)
Constant	0.371***	0.211***	0.216***	0.124***	0.111***	0.009***
	(0.064)	(0.033)	(0.034)	(0.023)	(0.020)	(0.002)

Notes. N = 23,819. Table presents odds ratios with robust standard errors within community colleges in parentheses from a series of logistic regression models performed on a pooled sample of community college students who entered college in 2011–2012 or 2012–2013 and transferred within 3 years of entry. All models include cluster-robust standard errors (clustered by community college) and fixed effects for cohort, community college, pre-transfer major, and university. Five observations were dropped due to multicollinearity when using both community college fixed effects and clustered standard errors.

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table A2

Logistic Regression Results Examining Relationship Between Community College Core Credit Accumulation and Bachelor's Degree Attainment: Average Marginal Effects

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	AME	AME	AME	AME	AME	AME
Variables	(Robust SE)	(Robust SE)	(Robust SE)	(Robust SE)	(Robust SE)	(Robust SE)
Cumulative Core	0.007***	0.005***	0.005***	0.006***	0.005***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cumulative Vocational		-0.003*	-0.003*	-0.003*	-0.004**	-0.006***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cumulative Other		0.009***	0.008***	0.008***	0.008***	0.005***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cumulative Dev-Math			-0.009***	-0.009***	-0.009***	-0.005**
			(0.002)	(0.002)	(0.002)	(0.002)
Cumulative Dev-English			-0.011***	-0.010***	-0.010***	-0.010***
			(0.002)	(0.002)	(0.002)	(0.002)
Hispanic				-0.050***	-0.045***	-0.025*
				(0.010)	(0.010)	(0.011)
Black				-0.095***	-0.091***	-0.030*
				(0.014)	(0.014)	(0.014)
Asian				0.004	0.005	0.002
				(0.020)	(0.020)	(0.021)
Two more races				-0.073***	-0.065***	-0.044*
				(0.018)	(0.018)	(0.018)
Other				-0.048	-0.052	-0.037
				(0.051)	(0.056)	(0.067)
Female				0.105***	0.112***	0.081***
				(0.008)	(0.008)	(0.008)
International				0.087*	0.083*	0.039
				(0.039)	(0.039)	(0.045)
Age				0.004**	0.005***	-0.002
				(0.001)	(0.001)	(0.001)

Pell Grant	-0.043***	-0.040***	-0.034**
	(0.011)	(0.011)	(0.011)
FAFSA Filer	0.043**	0.063***	0.048**
	(0.016)	(0.016)	(0.016)
Enrollment Intensity (Reference: Part time)			
Full Time		0.175***	0.130***
		(0.022)	(0.022)
Mixed		0.027	0.022
		(0.022)	(0.022)
Stop-out Count		-0.186***	-0.176***
		(0.010)	(0.010)
Associate (Reference: None)			
Before Transfer			0.147***
			(0.014)
After Transfer			-0.030*
			(0.012)
Major Switch			-0.049***
			(0.009)
Cumulative GPA			0.278***
			(0.011)

Notes. N = 23,819. Table presents average marginal effects (AMEs) with robust standard errors within community colleges in parentheses from a series of logistic regression models performed on a pooled sample of community college students who entered college in 2011–2012 or 2012–2013 and transferred within 3 years of entry. All models include cluster-robust standard errors (clustered by community college) and fixed effects for cohort, community college, pre-transfer major, and university. Five observations were dropped due to multicollinearity when using both community college fixed effects and clustered standard errors. We do not report AMEs for the quadratic term of cumulative core credits because the margins command only produces AMEs for the main coefficient (core credits).[1]

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

[1] Williams, R. (2012). Using the margins command to estimate and interpret adjusted predictions and marginal effects. *The Stata Journal, 12*(2), 308–331. https://doi.org/10.1177/1536867X1201200209

Table A3

Regression Results Examining Relationship Between Community College Core Credit Accumulation and Semesters to Degree Attainment Among Baccalaureate Recipients

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	ß	ß	ß	ß	ß	ß
Variables	(SE)	(SE)	(SE)	(SE)	(SE)	(SE)
Cumulative Core	0.006	0.014	0.007	0.005	0.006	0.005
	(0.009)	(0.010)	(0.010)	(0.008)	(0.008)	(0.008)
Cum. Core (Quadratic)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cumulative Vocational		-0.003	-0.003	0.014	0.013	0.020*
		(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Cumulative Other		-0.022***	-0.020***	-0.015***	-0.015***	-0.008**
		(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Cumulative Dev-Math			0.076***	0.099***	0.097***	0.081***
			(0.010)	(0.008)	(0.008)	(0.008)
Cumulative Dev-English			0.081***	0.062***	0.061***	0.057***
			(0.011)	(0.011)	(0.011)	(0.011)
Hispanic				-0.020	-0.017	-0.050
				(0.039)	(0.038)	(0.035)
Black				0.091	0.091	-0.036
				(0.087)	(0.086)	(0.085)
Asian				-0.213*	-0.208*	-0.200*
				(0.081)	(0.080)	(0.080)
Two more races				-0.167	-0.152	-0.181*
				(0.090)	(0.090)	(0.087)
Other				0.108	0.120	0.085
				(0.284)	(0.278)	(0.268)
Female				-0.376***	-0.362***	-0.288***
				(0.041)	(0.041)	(0.037)
International				-0.769*	-0.716*	-0.653*

				(0.322)	(0.316)	(0.308)
Age				-0.108***	-0.106***	-0.093***
				(0.007)	(0.007)	(0.007)
Pell Grant				0.166**	0.173**	0.153**
				(0.061)	(0.059)	(0.057)
Fads filing Status				1.963***	1.988***	1.973***
				(0.058)	(0.059)	(0.053)
Enrollment Status (Reference=Part-time)						
Full Time					-0.146	0.007
					(0.152)	(0.139)
Partial					-0.123	-0.058
					(0.125)	(0.114)
Stop-out count					-0.351***	-0.324***
					(0.071)	(0.070)
Associate (Reference= None)						
Associate before trans						-0.526***
						(0.082)
Associate after trans						0.028
						(0.058)
Major Switch						0.013
						(0.037)
GPA						-0.798***
						(0.056)
Constant	12.687***	13.144***	13.014***	15.187***	15.349***	17.563***
	(0.188)	(0.213)	(0.217)	(0.236)	(0.221)	(0.281)
R-squared	0.073	0.079	0.088	0.284	0.286	0.310

Notes. N = 12,904. Table presents coefficients with standard errors in parentheses from a series of ordinary least squares regression models performed on a pooled sample of community college students who entered college in 2011–2012 or 2012–2013, transferred within 3 years of entry, and earned a bachelor's degree within 6 years. All models include cluster-robust standard errors (clustered by community college) and fixed effects for cohort, community college, pre-transfer major, and university.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table A4

Logistic Regression Results Examining Relationship Between Community College Core Credit Accumulation and Bachelor's Degree Attainment: Odds Ratios

	Model 1 (Pell and Core Interactions)	Model 2 (Race and Core Interactions)
Variables	Odds Ratio (Robust SE)	Odds Ratio (Robust SE)
Cumulative Core	1.059***	1.047***
	(0.007)	(0.007)
Cum. Core (Quadratic)	0.999***	0.999***
	(0.000)	(0.000)
Cumulative Vocational	0.974***	0.974***
	(0.005)	(0.005)
Cumulative Other	1.019***	1.019***
	(0.003)	(0.003)
Cumulative Dev-Math	0.979**	0.980*
	(0.008)	(0.008)
Cumulative Dev-English	0.959***	0.960***
	(0.006)	(0.006)
Hispanic	0.902*	0.930
	(0.040)	(0.128)
Black	0.878*	0.913
	(0.049)	(0.143)
Asian	1.025	1.063
	(0.088)	(0.260)
Two more races	0.831*	1.204
	(0.060)	(0.235)
Other	0.886	0.513
	(0.236)	(0.369)
Hispanic* Cumulative Core		0.987

		(0.009)
Black*Cumulative Core		0.982
		(0.010)
Asian*Cumulative Core		1.002
		(0.013)
Two more races*Cumulative Core		0.973*
		(0.013)
Other*Cumulative Core		1.068
		(0.056)
Hispanic*Cumulative Core (Quadratic)		1.000*
		(0.000)
Black*Cumulative Core (Quadratic)		1.000**
		(0.000)
Asian*Cumulative Core (Quadratic)		1.000
		(0.000)
Two more races*Cumulative Core (Quadratic)		1.000
		(0.000)
Other*Cumulative Core (Quadratic)		0.999
		(0.001)
Female	1.401***	1.394***
	(0.049)	(0.047)
International	1.193	1.185
	(0.236)	(0.211)
Age	0.997	0.994
	(0.005)	(0.005)
Pell Grant	1.939***	0.871**
	(0.231)	(0.038)
Pell Grant*Cumulative Core	0.948***	
	(0.006)	
Pell Grant*Cumulative Core (Quadratic)	1.001***	
	(0.000)	
FAFSA Filer	1.218**	1.218**

	(0.078)	(0.076)
Enrollment Intensity (Reference: Part time)		
Full Time	1.738***	1.745***
	(0.173)	(0.177)
Mixed	1.088	1.090
	(0.098)	(0.100)
Stop-out Count	0.487***	0.487***
	(0.021)	(0.021)
Associate (Reference: None)		
Before Transfer	1.863***	1.874***
	(0.124)	(0.126)
After Transfer	0.883*	0.877**
	(0.044)	(0.043)
Major Switch	0.812***	0.819***
	(0.030)	(0.031)
Cumulative GPA	3.105***	3.107***
	(0.138)	(0.140)
Constant	0.007***	0.009***
	(0.002)	(0.002)

Notes. N = 23,819. Table presents odds ratios with robust standard errors within community colleges in parentheses from a series of logistic regression models performed on a pooled sample of community college students who entered college in 2011–2012 or 2012–2013 and transferred within 3 years of entry. All models include cluster-robust standard errors (clustered by community college) and fixed effects for cohort, community college, pre-transfer major, and university. Five observations were dropped due to multicollinearity when using both community college fixed effects and clustered standard errors.

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$