Can Community Colleges Afford to Improve Completion? Measuring the Costs and Efficiency Effects of College Reforms

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Abstract

Community colleges are under pressure to increase completion rates and efficiency despite limited evidence of the economic consequences of different reform strategies. We introduce an economic model of student course pathways linked to college expenditures and revenues. Using detailed data from a single college, we calculate baseline efficiency and differences in efficiency for students who follow different pathways. We simulate changes in output, expenditures, revenues, net revenues, and efficiency assuming that the college meets particular performance targets. Findings indicate substantial differences in efficiency across pathways and significant differences in efficiency across strategies to help students complete college. They also suggest that increasing the completion rate is difficult and typically requires additional resources beyond the costs of implementing particular strategies. The model has wide practical application for community colleges.

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1. Introduction

Colleges are under increasing scrutiny to document that they are using tax dollars appropriately, and policymakers are under pressure to implement reforms that will increase college completion rates without increasing costs (Bailey, 2011). The Obama administration has set ambitious goals for increased attainment of college credentials, particularly associate degrees and occupational certificates. Given current funding constraints, community colleges will have to make substantial improvements in institutional efficiency in order to meet the administration's goals (Jenkins, 2011). To determine whether the colleges can make such changes, it is necessary to understand what efficiency means in this context and how it should best be analyzed. Unfortunately, in many economic and policy discussions of college performance and education reforms, terms such as "efficiency," "productivity," and even "unit cost" are used loosely and sometimes interchangeably. For example, President Obama's January 2012 Blueprint for Keeping College Affordable refers to "federal support to tackle college costs" when in fact the support is intended to reduce student fees (The White House, 2012). As another example, discussed in detail in Powell, Gilleland, and Pearson (2012), college personnel sometimes equate reductions in cost, by which they actually mean expenditure, with deteriorations in quality (which would imply no change in cost, strictly defined). Moreover, as argued below, research evidence on efficiency within the postsecondary sector has not yielded results that have helped colleges to increase their efficiency levels.

In this paper we introduce an economic model that directly calculates the implications for efficiency, defined as expenditures per outcome, of reforms intended to improve college completion rates. By definition, increasing completion rates means that more students will have to stay in college longer. This will change how colleges operate—in terms of their course mix as well as advising and academic support services—thereby influencing their expenditures and revenues. It is critical, therefore, to understand how improvements in student progression and completion affect college efficiency. This paper presents simulations using the model to improve understanding of the economic implications of college efforts to strengthen student pathways to completion. As an alternative to strategies applied in most other studies of effectiveness or efficiency, which have adopted an annualized approach, we model college completion as a longitudinal process based on students' course-taking patterns and college resources over multiple years; these cannot be accurately captured in a single-year cross-sectional study. Unlike previous studies, the model also uses unit record data on student course-taking and costs, enabling a more precise estimate of resource use. At a practical level, the model is intended to help colleges plan and evaluate systemic reforms aimed at improving student retention and completion, particularly those reforms that are explicitly targeted at increasing college graduation rates.

The model starts with an economic "baseline" for a cohort of first-time students at a college: the actual completion rate, expenditures, and revenues as related to the cohort. For a given reform, we first calculated the increased proportion of students who would progress through toward completion of an award. Next, we calculated the economic implications of increases in progression and completions. These economic implications are expressed in terms of key metrics: completions, expenditures, revenues, net revenues (expenditures minus revenues), and efficiency (defined as awards per dollar of expenditure). We also derived an intermediate metric, "pathway spending," that helps explain how the model works and provides useful information on subgroups of students in the cohort. The economic model simulates the effects for these metrics relative to the cohort baseline. Different reforms can then be compared in terms of how much they might increase the numbers of students completing, how they might differentially affect expenditures and revenues, and how much they could increase efficiency. The model is populated using detailed student transcript data that is matched to credit-level cost data and funding formulae from a single community college.

This paper is structured as follows. The next section reviews the theory and evidence on efficiency in the postsecondary sector, describes the basic framework of our model, and discusses the merits of using student progression and completion data to measure efficiency. The third section provides formal definitions of each of the economic metrics and reports baseline statistics for the single college examined. The fourth section presents results for the metrics from a series of simulations of the model that are based on the college's meeting a set of key performance indicators, or intermediate measures, of student progression that they expect will increase completion rates over time. The final section summarizes our results and considers the policy implications arising from wider application of this model.

2. Economic Measures for Community Colleges

2.1 Prior Research

Efficiency is the production of a given output at the lowest possible cost. There is, however, considerable disagreement about what colleges produce, with most researchers arguing that measuring "output" in education is difficult, both conceptually and empirically (Dolan & Schmidt, 1994; Levin, 1991; National Research Council, 2012). Colleges produce more than one output, and they receive funding from multiple sources, each of which may have a different valuation of output. Moreover, there is legitimate debate over the extent to which a college is responsible for student outcomes (Winston, 1999). Community colleges may claim that their outcomes simply reflect student characteristics, aptitudes, and preferences, and that as open-access public institutions they have only limited influence over these factors. Hence, some may question whether efficiency and productivity can be accurately determined in higher education: Institutions, it is claimed, either spend whatever money they have, an assertion noted over three decades ago by Bowen (1980), or allocate resources based on internal rules and formulas rather than on strict efficiency considerations. Nevertheless, there is still considerable scope for colleges to spend efficiently or wastefully, and ultimately all public enterprises should be held accountable for their use of public funds, and increasingly this is being done. In fact, on the former point, Syverson (2011) has concluded that studies of private sector industries "have documented, virtually without exception, enormous and persistent measured productivity differences" (p. 326). By necessity, therefore, it is important to examine efficiency in higher education even as there may be much debate over how it should be measured.

There has been very limited research on efficiency within the community college sector. We are aware of only two studies, and neither is strictly an efficiency study; rather, both investigate whether colleges with more resources generate better outcomes.

Based on individual-level data, Bound, Lovenheim, and Turner (2010) found no link between completion rates and resources, although the resource measure—the student-faculty ratio—may be questioned as a proxy for resource levels. Using individual survey data merged with IPEDS, Stange (2010) found no positive effect on student outcomes of instructional expenditures per student, faculty salaries, or the proportion of faculty who were full time. However, the outcome of analysis was community college students' attainment of a bachelor's degree, which applies to only a subset of community college students. The implications of these studies are presumably that colleges with higher spending are less efficient than colleges with lower spending: they spend more but have the same outcomes. Alternatively, the implication may be that spending on these particular inputs is inefficient and that it would be preferable to increase spending on other inputs (e.g., non-instructional expenditures). Regardless, this evidence is insufficient in two respects—it provides no obvious way to calculate the extent of inefficiency at the college level, and it offers limited policy guidance on how to become more efficient.

For four-year colleges, there is considerably more literature. Some of it includes all public institutions, but pooled evidence has limited applicability for community colleges. Typically, community colleges do not have large research budgets; they enroll few graduate students; and 40 percent of their awards are vocational certificates, not degrees (Bailey & Belfield, 2012, Table 6.2; Gainsmeyer-Topf & Schul, 2006; Laband & Lentz, 2004). Methodologically, most of this literature has either been regression-based or applied stochastic frontier models. For a clear exposition of the two and the value of the latter, see Archibald and Feldman (2008). For a more complex structural equation model using IPEDS data, see Powell et al. (2012).[1]

These two methods have advantages in that they are formal and technical. But they may have less utility for helping community colleges improve to meet new efficiency goals. First, they tend to be applied using cross-sectional annual analyses:

[1] Regression-based approaches include Webber and Ehrenberg (2010) and Zhang (2009). For stochastic frontier analysis, see Agasisti and Johnes (2009) and Kempkes and Pohl (2009). A companion strand of literature has focused either on estimating cost functions (the association between costs and input prices) or on identifying economies of scale (the association between enrollment size and output). See for example, Cohn, Rhine, and Santos (1989); De Groot, McMahon, & Volkwein (1991); Harter, Wade, and Watkins (2005); Laband and Lentz (2004); and Toutkoushian (1999).

output in a given year is expressed as a function of inputs in that year. However, college completion is a process whereby students take credits over multiple years: College completion rates in any given year reflect the resources and programs delivered to cohorts of students who enrolled a few years earlier. An annual model is most appropriate for a college in a "steady state" where dropout is a process of linear decay over time. In contrast, most community colleges have large initial enrollments and then experience very steep dropout rates in the first couple terms. The fraction of students who are close to graduation is therefore a relatively small proportion of the overall enrollment at the college (as well as being atypical in terms of credit accumulation).

Second, colleges need results that yield straightforward implications for reforms to improve college efficiency. Leaving aside the difficulties of interpreting stochastic frontier results, these models are calibrated to yield a frontier of efficient colleges and a subset of inefficient colleges (even super-efficiency scores do not appear to fully discriminate across all colleges; see Archibald & Freeman, 2008, Table A1). By implication, only the subset of inefficient colleges should improve. More importantly, these methods cannot be easily linked to any reforms that might increase efficiency. For example, it is not possible to apply the results from a stochastic frontier model to identify how improvements in advising practices, course structures, remedial testing, or math instruction will influence efficiency (see the discussion of possible efficiency-enhancing reforms in Jenkins & Rodriguez, 2013).

Finally, an economic model of college completion must address the financial implications of changes in provision. Colleges face financing constraints and cannot implement reforms—regardless of their efficiency—if these reduce college net revenues.[2] It is not sufficient that a college knows how to increase completion rates; it must also balance its budget. We suspect that funding is one reason why reforms are either short-lived (colleges simply cannot afford to implement them for long or at a sufficient scale) or ineffectual (their expense is offset by deteriorations in the quality of provision

[2] Efficiency may be increased by reallocation of existing resources such that expenditures do not increase. We suspect that this type of efficiency gain is not large and that greater efficiency gains would come from making investments in additional resources (e.g., to improve instructional quality). Regardless, even if expenditures remain constant, the change in revenue must still be calculated.

elsewhere in the college.) Therefore, changes in completion, expenditures, and revenues must all be derived simultaneously.

2.2 A New Economic Model of College Efficiency and Student Completion

The economic model outlined below is an attempt to address the challenges identified by earlier research. It is based on these key metrics: output (including paths to completion), expenditure and revenue (and hence net revenue), and efficiency (expenditure per unit of output). We link these metrics by calculating pathway spending per student: the amount the college spends on each student as he or she progresses through college. We define each of these terms here and describe the advantages of this approach.

Output. To calculate efficiency it is necessary to specify what output community colleges produce. Community colleges offer a variety of programs. The two types that are the focus of this paper are those offered for college credit, which may include as their goal transfer to a four-year program or training for employment, although some have both goals (Bailey, 2011).[3] Community colleges produce many different awards: 56 percent are associate degrees, 23 percent are short-term certificates, and 21 percent are moderate–long-term certificates (Horn, Li, & Weko, 2009). Further, large numbers of students transfer to a four-year institution with the intention of completing a bachelor's degree. A recent study by the National Student Clearinghouse Research Center (NSCRC, 2012) calculated the transfer rate (defined as any institutional change irrespective of timing or duration) by cross-referencing student enrollments at different colleges and found that one in five public two-year college students will transfer to a four-year institution. Our definition of output emphasizes completion of an award at the original community college: Output is the number of associate degrees and certificates awarded within a given year, weighted by the number of credits required to attain the award (see also Harris & Goldrick-Rab, 2010).[4] Since preparing students to transfer to a four-year

[3] An additional mission is continuing education, which includes general interest courses for individuals and customized training for firms. This mission is not analyzed here on the assumption that it is independently self-financing.

[4] An alternative way of concatenating output, set out by Massy (2011), is to count credits completed and perhaps to include a greater weight for students who complete their credential (Johnson, 2009). This output

institution is an explicit part of community colleges' mission, the credits accumulated by students who transfer to four-year colleges are also considered as output produced by a college (even though many of these students do not graduate from their destination college).

Our measure of output assumes that all award-based credits are equivalent and so values the outputs of higher education primarily in relation to completion.[5] The measure gives zero weight to the credits accumulated by students who never complete an award. Finally, lateral transfer is also given zero weight: the credits of students who complete an award at a different two-year college are not counted as part of the origin college's output. These students could have completed their award at the original institution but did not do so.

Pathways to completion. Critical to understanding how this output is produced is the concept of student pathways to completion, or the sequence of courses and enrollments that leads to a credential. Fundamentally, a college's annual output reflects several prior years of resources for a given cohort of students. Associate degrees, as well as many certificates and diplomas, cannot be completed in a single year. Instead, output is produced as a result of a particular cohort of students' following pathways of courses through college; the only way to increase output is to influence these pathways in ways that increase rates of student progression.

In following a path of courses through college, students take credits in various disciplines to meet the requirements for their chosen credentials. There are many ways that students' pathways influence a college's completion rate. Many students simply fail to complete an award or are unable to satisfy the college's graduation requirements. Some of them drop out of college entirely, while others transfer to a two- or four-year

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measure de-emphasizes completion: it rewards colleges based on enrollment and so provides them with very little incentive to increase completion rates. For a discussion of other alternatives, see National Research Council (NRC, 2012, Appendix A).

[5] It is possible to adjust these outputs to more closely reflect their economic value and the most straightforward way to do this is to weight student outcomes according to their economic value in the labor market or to apply a sheepskin multiplier (Kelly, 2009, Figure 2). However, based on Kelly's analysis, the overall effect is small—output would be only a couple of percentage points different—and there are practical challenges in applying such weights. Generally, although there are differences in labor market earnings across awards, the evidence is unlikely to be precise enough or complete enough to calculate these weights.

institution without first earning a degree (Crosta, 2012). Some students have been enrolled for five or more years and have accumulated many college credits but not earned a credential (Cho & Ran, in press). Many students get delayed because they must take remedial education courses. As these courses do not count toward a college credential, unnecessarily lengthy remedial education sequences mean that fewer students will ever take college courses and even fewer will graduate. Many other community college students enroll part time or intermittently, combining pursuit of an award with employment or family responsibilities (Crosta, 2012; Dadgar, 2012). Moreover, many students take "surplus" courses beyond the basic catalog requirements (for example, most associate degree holders have more than 60 credits) (Zeidenberg, 2012). Students may change their program of study, or lack awareness of the program requirements, or they may have to wait to be accepted into a high-demand program, such as nursing. Taking surplus courses slows down or even hinders progress toward completion, and it also increases expenditures.

Therefore, one important way for colleges to improve efficiency is to improve pathways, making sure that students only take courses that are necessary and that as many students as possible complete the entire sequence of coursework required for their award.[6] Research by Jenkins and Cho (2012) highlights why this is important. Fundamentally, acquiring an education credential is a process. The responsibility of college personnel is to improve that process. Registration personnel should provide accurate guidance to students on entry to college, optimally assigning students to remediation or the appropriate entry-level courses. Students who enter without clear goals for college and careers should be helped to explore options (Deil-Amen & Rosenbaum, 2003; Scott-Clayton, 2011). Advisers should provide useful information for students during their college career, identifying the optimal sequence of courses to achieve their academic and career goals and supporting students who may be struggling. For example, instructional personnel should ensure that the curriculum and coursework are well aligned internally so that students who pass courses are prepared for subsequent

[6] The other important way is to reduce expenditures for a given pathway. However, if the quality of the program is a function of expenditures, as many faculty believe, then reducing expenditures per pathway may not reduce the cost per pathway.

coursework, and well aligned externally so that programs prepare students to succeed in further education and in career programs for employment.

Critically, we argue that reforms to improve completion—and so to increase output— should be understood in terms of how they influence pathways for a given cohort of students. It is not possible to increase completion rates simply by augmenting resources to all students and probabilistically expecting more students to graduate. Most community college students leave after one year, having accumulated only a few credits. Thus, to increase the completion rate it is necessary instead to invest sufficient resources in students along their college pathway such that these students do then graduate. The completion rate will increase by only a small amount if all students accumulate a few extra credits.

Expenditures and revenues. The last part of this economic model is the financial effect on the college. Annually, community colleges spend approximately $50 billion across enrollments of over seven million students, and this expenditure must be funded from revenues (public funding or tuition fees). However, as argued above, annual expenditures are not an ideal way to understand how colleges allocate resources or should allocate them when the interest is in how efficiently their resources are spent.

Instead, the measure of expenditures used here is directly related to students' pathways. Colleges spend resources on each student as he or she progresses through college. These resources include administration and overhead as well as support services, but the largest single expense is for course instruction. Since spending is higher on students who take more courses, the further a student progresses through college, the higher are expenditures. Of course, the further a student progresses, the more likely it is that he or she will graduate from college.

We define the expenditures tied to student pathways as "pathway spending," i.e., the amount of resource required to follow a particular pathway. Spending will be higher on students who take more courses, as it will be on students who take courses in relatively expensive areas (e.g., laboratory courses or radiography programs). Colleges can measure the costs per pathway for various subgroups of students that might be of interest. In practice, a college may wish to focus on the most common pathways—e.g., students who begin in remediation or initially enroll full time or enroll in a specific program—to ascertain the cost for students who follow such a pathway. For the students in a given cohort, the sum of their individual pathway spending represents the entire expenditure of the college on the cohort. For the model used here, total expenditures are not considered annually but rather are summed across an entire cohort of students over a given period of time.

Analogously, we derive revenue per pathway and total revenues. College revenues come from a mix of fees and government subsidies. Both revenue sources are primarily determined by the number of credits each student accumulates: As students take more classes, fees go up and so do government subsidies, since funding formulae are at least partially enrollment-driven. Thus, revenue per pathway can be derived, i.e., the amount of revenue the college gets per particular pathway can be ascertained. Students who take more courses should generate more revenue, as would students who take courses that are either charged or funded at a relatively high rate. For the students in a given cohort, the sum of their individual pathway revenues represents the entire revenue of the college from the cohort.

Straightforwardly, costs and revenues can be compared—either at the pathway level or in the aggregate for a cohort. Absent substantial borrowing or reserve holdings, aggregate costs and revenues should be in balance. However, a particular pathway's cost need not equal the pathway's revenue. As students progress through college, some will take a relatively expensive pathway whose revenues do not fully cover the costs. These students are being "subsidized." Other students will take a low-cost pathway with revenues exceeding expenditures. These students are subsidizing other students at the college. Changing students' pathways may therefore not affect expenditures and revenues in exactly the same way.

The model emphasizes two basic elements. First, to increase completion rates it is necessary to get students into pathways that lead to awards. Second, if colleges do improve their completion rates, their costs must necessarily increase—the students must have taken more credits.[7] Yet, if revenues do not increase proportionately, then the

[7] The only way to increase completions without increasing costs would be to restrict enrollment to students with a higher probability of completion. As community colleges are open-access institutions, this option is likely not viable.

college will have to cut other programs, likely leading to a fall in the completion rates of subsequent cohorts (assuming the college cannot borrow or run deficits). In fact, increases in expenditures to exceed increases in revenue from a given reform can be anticipated: As students progress further in college they tend to take relatively more expensive courses. Typically, college-level courses are more expensive than remedial courses, since the latter are more likely to be taught by adjunct instructors, and upper-level courses are more expensive than lower-level courses, since they are more likely to be taught by full-time instructors, have smaller class sizes and, in the case of career programs, require expensive equipment. If fees are not perfectly calibrated to these differences, more student progression will result in negative net revenue. This loss in revenue will have to be offset, perhaps by increasing class sizes for other cohorts.

Efficiency. The main advantage of the model is that it links student progression to completion and, by including costs, yields a straightforward measure of college efficiency: expenditure per unit of output. For each college, efficiency is the ratio of total expenditures to total output within a given period of time. For a given completion rate, lower expenditures means greater efficiency; and for a given expenditure, higher completion rates mean greater efficiency. Expressed as a ratio, this efficiency measure captures the consequences for both completion and expenditures.

The efficiency measure is responsive to differences in how students progress through their program of study. When students accumulate surplus credits (or more than they need to graduate), expenditures increase but the number of completions does not; efficiency is therefore lower (Romano, Losinger, & Millard, 2010). When students begin in remedial education, there are expenditures even as these students are not accumulating credits to help them complete a college credential; again, efficiency is lower. Finally, when students accumulate many credits but never complete an award, efficiency is significantly lower. Only by applying a pathway model do these consequences become clear. This efficiency measure shows the economic tradeoff across different pathways. Some pathways are more efficient than others, i.e., spending is lower per completion. For example, students who enroll directly in college-level classes are more likely to progress further and so require greater spending than students who first enter into remediation. The numerator of the efficiency ratio increases. However, college-ready students are more likely to complete their credential. The denominator of the efficiency ratio also increases. For efficiency gains, the denominator (completions) has to rise proportionately more than the numerator (costs). Students who first enter into remediation are less likely to complete and more likely to drop out without accumulating a substantial number of credits. Another example might be health programs. Students who follow a nursing degree pathway will take relatively expensive courses, but as they are much more likely to complete an associate degree than other students, cost per completion may be lower for these programs.

One important implication of the model is that student persistence is only beneficial if the student actually completes the award. In fact, if students are to ultimately drop out it is better that they do so earlier—before the college has allocated substantial resources to them—than later. Least efficient for a college are students who complete most, but not all, of the courses required for an award.

For evaluating reforms, each of the economic metrics serves a separate purpose. The disaggregated metric—pathway cost—is critical for understanding how the model operates—the economic results depend on moving students onto more efficient pathways without jeopardizing completion rates.[8] But all the metrics are salient for colleges. Reforms must increase completion rates, although the fundamental test of a reform is whether the college has become more efficient. This involves moving students onto the most efficient pathways. However, even efficiency-enhancing reforms must not create financial pressures for the college: Net revenue cannot be strongly negative.

The model is designed to interpret student progression as an economic phenomenon; it can therefore be linked to evidence on how students do progress through college and what practices improve progression rates. The model should therefore help colleges plan, prioritize, and evaluate strategies for increasing completion.

[8] This model is not disaggregated at the departmental level. Students take many courses across different departments, and so a single department is not wholly responsible for ensuring that each student completes an award.

3. The Model Structure and Baseline Data

In this section we first specify the basic structure of the model and the data required to populate it and then report baseline results for the study's sample college.

3.1 Economic Metrics

The study defines the college completion rate in terms of associate degree equivalents awarded within five years of the cohort's enrollment (see Table A.1, top panel, in Appendix A). Each associate in arts (AA) degree is worth one unit, and all other awards are weighted based on the average number of non-remedial credits students actually accumulate for a given award (see Table B.1 in Appendix B). (For example, if the average AA degree holder accumulates 70 credits and the average certificate holder accumulates 35 credits, a certificate is valued at 0.5). All awards are counted, even if a student receives more than one. This definition of the college completion rate also includes transfers to a four-year institution. Each transfer student is weighted according to the credits accumulated before transfer relative to the credits needed for an associate degree. (Thus a student who transfers after earning seven credits would be weighted at 0.1). Zero weight is given for students who are no longer enrolled after five years but received no credential and did not transfer, for students who are still enrolled in the college in year five but have not received an award, and for students who initially enrolled at the college but either transfer to a two-year institution or go on to receive a sub-baccalaureate award such as a certificate or associate degree at another college.

Pathway spending and total expenditures are defined as the amounts spent on a given cohort of students from their initial entry into the college and for five years thereafter (see Table A.1, middle panel). The total expenditure amount is the sum of spending on all the pathways students take (the number and types of credits attempted during each student's time in college and how much the college spends on those credits and other services).

Pathway revenues and total revenues are defined as the amount of revenue for a given cohort of students from their initial entry into the college and for five years thereafter (see Table A.1, bottom panel). In general, revenue is composed partly of fee income, which is the sum of registration fees (initial charge on entry to college), enrollment fees (a fixed amount per semester), and tuition fees for each course taken. Revenue is also composed of public subsidies; these are a function of state and local government funding formulae, which include a mix of block grants and per-student allocations. In this case study, college revenues are derived mostly from state and county funds (tuition and fees are sent to the state and reallocated), where state funds are enrollment driven and county funds are relatively flat from year to year. To approximate these conditions, we consider a student revenue amount that is based on the number of credits and courses attempted, allowing courses that are funded at a higher rate to bring in more revenue than those funded at lower rates.

Net revenue is defined as the difference between total expenditures and total revenues for a cohort of students over the first five years. At baseline, net revenue should be calibrated to zero—the college cannot spend more than it gets in revenue (abstracting out deficit financing or reserve accumulation).

Finally, efficiency is defined as the cost per unit of output, i.e., total expenditures divided by the numbers of associate degree equivalents. Efficiency can be measured both at the college level and for each pathway. In both cases, the efficiency measure applies the metrics as defined above, where completion is expressed in terms of associate degree equivalents and all measures are calculated for a given cohort over a five-year window.

It should be emphasized that these metrics are reported for a cohort of students that enters the college within a given year and is followed over some fixed period of time (in this case, five years). The model can be calculated for any assumed duration, although it is essential that all metrics are calculated for the same duration. But the results are not "annual." There are many other students already attending the college before the study cohort enrolls, and over the course of the five-year period many new students will enroll. Importantly, there are also many students taking non-credit courses at the college; as these students are not the focus of initiatives to improve completion rates, their expenditures and revenues are not factored into the model simulations. Therefore, the expenditure and revenue figures presented here should not be interpreted as the overall totals for a given year.

3.2 Baseline Data for the Sample Community College

The study's example of the model uses data from a single community college (called here U.S.A. Community College [USACC]), for the cohort of students who first enrolled in the college in 2005-06. Data on pathways are drawn from student-level transcripts. Data on costs come from the general ledger accounts of the college, which report spending disaggregated by department and by function (instruction, student support, administration) and, in some cases, by course. Data on revenue are derived from the fee structure of the college and the state funding formula. At the most disaggregated level, expenditures and revenues are matched to student transcripts.[9]

Table 1 presents basic descriptive information about the college. At USACC, the headcount of first-time enrollment in college-credit (award-bearing) programs is 3,800. Tracked over five years, USACC will spend $13,970 on each of these students such that the total expenditure is $53.1 million.[10]

There is significant variation across pathways. As shown in column 2 of Table 1, there are large differences in pathway spending according to whether the student was full time or part time at first enrollment; the former requires approximately twice as much resource as the latter. There is one grouping shown in the table for which there is not a big difference in pathway spending: whether students enrolled college-ready or were placed into remedial education. The amount of resource USACC spends per student is quite close whether the student enters directly into a college-level program or into remediation ($15,390-$19,670).[11]

[9] The college provided the data. It should be noted that not all colleges have these data in this format; the study college has made intensive and comprehensive efforts to collect expenditure data at the appropriate level of disaggregation.
[10] The college also has substantial non-credit offerings. The headcount is 6,300, with a per student average pathway cost of $3,700 and a total expenditure for the cohort of $23 million. In fact, the model suggests that non-credit programs subsidize credit programs.
[11] These amounts are all above the average pathway spending because assessment data are not available for a substantial number of students who therefore cannot be clearly identified as college-ready or not.

Table 1
Pathway Costs, Output, and Costs per Completion at USACC

Student Characteristics	Number of students [1]	Pathway Cost [2]	Output [3]	Cost per Completion [= 1*2/3]
All students in 2005-06	3,800	$13,970	477	$111,310
Full-time in first semester	1,530	$19,580	271	$110,660
Part-time in first semester	2,280	$10,220	206	$112,930
Field:				
Allied Health	111	$30,560	24	$142,050
Mechanics/Repair	120	$21,710	15	$172,470
General Liberal Arts/Science	1,460	$17,250	222	$113,300
Business/Marketing	170	$16,320	24	$117,890
Initial Placement:				
College-ready	200	$19,670	53	$74,180
DE placement level 1	880	$18,040	157	$100,820
DE placement level 2	580	$17,860	80	$129,680
DE placement level 3	860	$15,390	76	$173,390

Notes: College credits only; not developmental education credits. Weights are based on the average duration to complete the award. Only data for curriculum (award-bearing) students are reported. Numbers rounded to nearest ten.

As a result of these expenditures USACC yielded a total output of 477 associate-degree equivalents over the five years covered in the study. The cost per unit of output is therefore $111,310. (Although this figure may seem high, estimates of the fiscal benefits per community college degree by Trostel [2010] are $137,000. These fiscal benefits are only the taxpayer benefits— not the student benefits—and the taxpayer provides less than 75 percent of total funding.)

Critically, pathways chosen by students within this college vary significantly both in terms of spending and in terms of how many students who follow a given pathway complete an award. Table 1 shows the spending for some selected pathways and the number of awards accumulated by students who follow that pathway, allowing a calculation of the efficiency of the pathway.

For some pathways the differences in efficiency are small. At USACC, students who enroll full time in their first semester follow a pathway that entails almost double the spending of students who initially enroll part time. However, these full-time students yield 56 percent of the college's output (271 out of 477) despite being only 40 percent of enrollees. Measured in terms of overall efficiency, students who enroll either part time or full time in the first semester are almost equally efficient—the pathway costs per completion are $112,930 and $110,660, respectively.

Pathways by field show more heterogeneity. The pathway spending for students who are in Allied Health are significantly higher than those in Mechanics/Repair, Business/Marketing, and General Liberal Arts/Science. However, when we adjust for differences in completion rates, the Mechanics/Repair field is the least efficient pathway. Its cost per completion is $172,470, compared with $142,050 for students in Allied Health, $117,890 for those in Business/Marketing, and $113,300 for those in General Liberal Arts/Science. The most striking difference across pathways is by initial placement level. Students who are college-ready follow pathways that require more resources than students who are placed into remedial education (Table 1, column 2). But their much higher completion rates are such that their pathways are much more efficient. The cost per completion for a student who initially places into college-level courses is $74,180; the cost per completion for students who place into remedial education are higher by 36 percent, 75 percent, and 134 percent, respectively, depending on whether students were referred to remedial coursework at one, two, or three levels below college-level.

4. Increasing Completion Rates and Efficiency by Improving Student Progression

The model used in this study can be easily applied to evaluate the economic consequences of specific policies or interventions that are intended to improve completion rates. As noted above, the menu of reforms is extremely large, even as supportive evidence for any particular reform is thin (see the full discussion in Jenkins & Rodriguez, 2013). Indeed, perhaps the lack of positive evidence reflects the fact that many strategies consist of discrete practices—if colleges are to improve completion rates substantially, they will most likely have to implement changes in practice at each stage along the student's pathway (Jenkins, 2011). Reforms focused on one phase of the student experience—for example, efforts to improve the readiness of incoming students or to increase the effectiveness of college remediation for those who arrive unprepared—are unlikely to be sufficient. Indeed, they may be more costly if they simply defer dropout until a later semester.

Rather than choose specific policies or interventions for evaluation, we look at intermediate measures of student progression that correlate with graduation rates. We refer to these intermediate measures as key performance indicators (KPIs). Using intermediate measures should give colleges an early indicator of the likely efficiency consequences of a reform, thereby allowing them to implement a set of interventions aimed at increasing each KPI along the pathway from entry to completion.

4.1 Key Performance Indicators

Here, KPIs are specified in relation to a student's initial entry into college, progression through college, and completion of an award. Colleges may choose their own KPIs (or targets for each KPI) based on their own practices. Those used here reflect principles of practice drawn from the literature on organizational effectiveness in community colleges and other sectors (Jenkins & Cho, 2012).

Examples of KPIs that relate to students' initial period in college and how connection to and entry into college may ultimately influence completion rates include the number of students who are recent high school graduates who are placed into remedial education and the number of students who pass college math in their first or second year or college English in their first or second year.

Potential strategies to bring about improvements in these KPIs might include early diagnostic testing and remediation in high school, improved high school–college curriculum alignment, more effective college "on-ramps" to help students explore options for college and careers and choose a program area of interest, mainstreaming readier students with supports, and improved integration of basic skills instruction with college-level content.

Examples of KPIs that relate to progress—from program entry to completion of program requirements—include the number of students who persist from year one to year two, who earn 12 or more credits by the end of the first year, and who earn 24 or more credits within two years.

Potential strategies to improve these KPIs include the creation of structured, coherent programs of study aligned with requirements for further education and employment, stepwise guidance for students toward selection of a major, and the requirement that students have an education plan or a prescribed course map. Other more general strategies include enhanced monitoring of student progress and more frequent feedback and support for students.

Finally, two KPIs that relate explicitly to completion of a credential are the number of students who transfer to a four-year institution with an award and the number who obtain an associate degree conditional on already having 30 or more credits after five years in college.

Potential strategies to bring about an increase in these two KPIs include alignment of program requirements to ensure transfer students have junior standing in their major and alignment of Career Technical Education (CTE) program requirements to allow for career advancement for graduates. Colleges might also encourage concurrent enrollment with a four-year college, and states could adopt state policy incentives for completing an associate degree prior to transfer, as is the case in Florida.

4.2 Simulations to Meet Key Performance Indicator Targets

We used our data from USACC to simulate the economic effects of increasing these key performance indicators relative to the baseline. In these simulations, we chose 20 percent improvements for illustration purposes only. In practice, colleges would choose target KPI improvements based on what they believe is feasible given the strategies they plan to implement.

The simulations for each KPI worked as follows. First, we "moved" 20 percent more students from the baseline sample of students into the desired category. Second, we calculated the economic consequences of having a different composition of students. Finally, we reported these consequences relative to the baseline. For example, the first progress KPI target is to improve persistence from year one to year two by 20 percent. Thus we randomly removed students from the baseline sample who were not persisting and randomly added more students who were persisting. Keeping the total number of students constant, we made these replacements until the persistence rate was 20 percent higher. This increase changed the college's expenditures because the pathway costs of the removed students differed from the pathway costs of the added students. We then calculated the new completion rates, expenditures, revenue, net revenues, and efficiency consequences. We performed this simulation 1,000 times and took the average of the 1,000 simulations.

We simulated the economic effects on the assumption that these KPIs had been met, i.e., by calculating them based on the new sample created by the simulations. The strategies identified above offer plausible ways that such increases might occur. However, since we did not calculate how much these strategies would cost to implement, it is not appropriate to compare reforms directly. Clearly, costs should be factored into the decision-making process, but they will depend on which strategies are selected.

4.3 Model Simulation Results

The results for meeting the KPI targets are shown in Tables 2-4. For each KPI target, the direction of the results is the same—there are increases in completions, expenditures, and revenues; and, with one exception, efficiency increases. There are, however, variations in effects with respect to net revenue.[12]

[12] Net revenue is calibrated to zero at baseline. Therefore comparisons of net revenue reflect the difference between the simulated expenditure and revenue as a proportion of the baseline expenditure.

Table 2
The Economic Consequences of Meeting Early Key Performance Indicator Targets

KPI Target of a 20 Percent Increase in an Outcome	Improvement Over Baseline	Percent Change in Economic Metric: Completions	Cost	Cost per Completion (Inverse of Efficiency)	Revenue	Net Revenue
Passing college math in first year	231 pass college math in first year (+20% = 46 more passing)	2.5%	0.9%	-1.5%	0.8%	-0.1%
Passing college English in first year	245 pass college English in first year (+20% = 49 more passing)	1.9%	1.1%	-0.8%	1.1%	0.08%
Passing college math within two years	409 pass college math within two years (+20% = 82 more passing)	5.1%	2.0%	-2.9%	1.8%	-0.1%
Passing college English within two years	468 pass college English within two years (+20%=94 more passing)	3.5%	2.7%	-0.7%	2.8%	0.09%
Recent high school graduates who start college-ready and not in developmental education	121 recent grads start college-ready (+20% = 24 more passing)	4.5%	0.7%	-3.6%	-0.2%	-0.9%

Table 3
The Economic Consequences of Meeting Progress Key Performance Indicator Targets

KPI Target of a 20 Percent Increase in an Outcome	Improvement Over Baseline	Percent Change in Economic Metric: Completions	Cost	Expenditure per Unit of Output (Reciprocal of Efficiency)	Revenue	Net Revenue
Persisting from year one to year two	364 additional students persist	12.0%	12.9%	0.8%	12.2%	-0.7%
Earning 12+ credits (vs. not earning 12+ credits)	234 additional students earn at least 12 credits	8.8%	6.4%	-2.2%	6.6%	0.2%
Earnings 24+ credits (vs. not earning 24+ credits)	185 additional students earn at least 24 credits	10.9%	7.3%	-3.2%	7.1%	-0.2%

Table 4
The Economic Consequences of Meeting Award Key Performance Indicator Targets

KPI Target of a 20 Percent Decrease in:	Improvement Over Baseline	Percent Change in Economic Metric				
		Completions	Cost	Expenditure per Unit of Output (Reciprocal of Efficiency)	Revenue	Net Revenue
Lingerers (30+ credits with no award after 5 years)	46 lingerers continue on to receive an associate degree	12.4%	0.7%	-10.4%	0.1%	-0.6%
Transferees without credential (from transfer with credential group)	123 more students transfer with credential	21.8%	5.3%	-13.5%	5.8%	0.5%

Table 5
The Economic Consequences of Increasing the Completion Rate by 10 Percent

Strategy	Improvement Over Baseline	Percent Change in Economic Metric				
		Completions	Cost	Expenditure per Unit of Output (Reciprocal of Efficiency)	Revenue	Net Revenue
Increase college math pass rate in one year	309 (75%) more students would need to pass math in first year	+10%	3.4%	-5.4%	2.9%	-0.6%
Increase persistence from first to second year	273 (15%) more students would need to persist	+10%	9.7%	0.6%	9.1%	-0.5%
Decrease lingering	35 (15%) fewer students would need to linger	+10%	0.5%	-7.9%	0.0%	-0.4%

Table 2 shows that helping more students pass college math in the first year has a bigger impact on five-year completion rates than helping students complete college English in the first year, even as the latter KPI will affect more students (49 instead of 46). The simulations show that the KPI for English raises completions by 1.9 percent, compared with 2.5 percent for math. Correspondingly, improving English pass rates also leads to much lower gains in efficiency than improving math pass rates (0.8 percent compared with 1.5 percent). For both targets, costs and revenues increase but the effect on net revenue is opposite in sign. A similar pattern is observed if the window for passing college math or English is extended to two years. Improving math pass rates leads to more completions and larger efficiency gains. These targets yield the same net revenue pattern, with increases in passing college math resulting in more spending than increases in passing college English. The final early KPI target is to increase the number of recent high school graduates who start college-ready rather than being placed into developmental education. As shown in Table 1, college-ready students have much higher completion rates and are much more efficient. This is reflected in the results in Table 2: A 20 percent increase in college-ready students would increase completions by 4.5 percent, and efficiency would improve by 3.6 percent.

Table 3 shows the economic consequences of meeting each of the three progress KPI targets. Achieving these benchmarks would be a much more ambitious endeavor than meeting the early KPI targets: The number of completions is much higher (at 8.8 to 12 percent), but expenditures also increase significantly more (6.4 to 12.9 percent). Increasing the persistence rate is extremely expensive—costs for this cohort are predicted to be 12.9 percent higher than baseline. Of course, revenues will increase. Meeting two of these three KPI targets will increase expenditure more than it will increase revenue, resulting in a loss of net revenue. Although completions will rise, efficiency is actually reduced in the case of the persistence KPI target. This surprising result arises because helping students persist from the first to second year would yield more completions but at a very high cost. Effectively, many more students are persisting, but for a large fraction remaining in college longer simply postpones the point at which they drop out. Despite increasing the completion rate by the largest amount (+12 percent), strategies to improve persistence from the first to the second year by themselves are inefficient in terms of cost per completion.

Table 4 shows the results from meeting the two award KPI targets: a 20 percent increase in awards for those with 30 or more credits and a 20 percent increase in students who transfer with an award. Meeting either KPI target would substantially improve the outcomes picture with mixed results on the economic picture. The number of completions would increase by 12.4 percent for awards for those with 30+ credits or by 21.8 percent for those who transfer with an award. The gains in efficiency would also be very high, at 10.4 percent and 13.5 percent, respectively. However, these two targets have very different implications for costs. Reducing the number of "lingerers" would only add 0.7 percent to costs; decreasing the number of students who transfer without a credential would increase costs more significantly (5.3 percent).

As a final illustration of the model, we can simulate results for a given increase in the completion rate. That is, rather than report results based on targeted increases in intermediate KPI measures (e.g., through persistence with outcomes achieved more quickly) we simulate what improvements in KPIs would be necessary to increase completion by a given percentage and then estimate the economic effects.

These simulations are shown in Table 5 (see above), based on the assumption that the college wishes to increase its completion rates by 10 percent, i.e., from 477 to 521. To accomplish this goal by increasing the first-year math completion rate would require an increase in the number completing first-year math from 412 to 721 students, i.e., a 75 percent increase. College expenditures would increase by 3.4 percent and efficiency would improve by about 5 percent (not including the cost of a strategy to bring about an increase in the math passing rate). Alternatively, the college might seek to attain a 10 percent increase in completion by improving persistence. To do so, an additional 273 students would need to persist, i.e., 15 percent more students would need to persist from the first to the second year. This increase would raise college expenditures by 9.7 percent and efficiency would fall, in this case by almost 1 percent. Finally, a third alternative is to reduce the number of lingerers (those with 30 or more credits but no award). To increase the completion of lingerers by 10 percent, their number would have to fall from 231 to

196, i.e., by 15 percent. College expenditures would increase, although only by 0.5 percent. The college's efficiency would increase by about 8 percent.

Thus, the economic model is structured so that simulations can be run either forward—from changes over time in first-time student behavior to estimated completion rates—or backward—from desired changes in completion rates to the necessary changes in student behavior. However, it should be emphasized that in all models the cost of bringing about the change is not included; only the cost should a given change occur is included.

5. Conclusions and Research Implications

Despite expenditures of approximately $50 billion annually, very little is known about efficiency within the community college sector. Research evidence is limited and yields technical results that may be hard to interpret and that do not reflect the "production process" of students enrolling in a sequence of courses that must be completed to ensure graduation.

The model used in this study is intended to address both issues as well as to calculate the economic consequences of reforms undertaken to improve efficiency. By emphasizing student pathways over time, it is possible to calculate the resources required both for students who complete their awards and for the large fraction of students who do not do so. These pathways are then linked to a parsimonious set of economic metrics—expenditures/revenues, net revenues, and efficiency—that allow for a full economic evaluation of how reforms would affect a college. Ultimately, policymakers are interested in efficiency, but colleges must also balance expenditures with revenues.

The model and these metrics are broadly applicable across the spectrum of community colleges; the model is also flexible in that colleges can choose their own definition of output (for example, excluding transfers and only counting credential completers). However, the main advantage of this model-based approach is that it allows simulation of the effects of actual strategies that colleges might adopt to improve completion rates. One can calculate the increase in completion rates relative to a baseline when colleges move students to more efficient pathways and thereby increase student progression and completion rates. Then the changes across the economic metrics can be derived.

Results from simulations using data from the study college highlight several concerns. First, it is quite difficult to increase the college completion rate substantially—many students who fail to complete are far short of the program requirements. Second, increasing the completion rate requires sizeable increases in expenditure. Some of this expenditure will be offset by increases in fees. But for colleges with historical public funding formulae or absolute funding constraints, or with pricing policies that involve significant cross-subsidies, improving completion rates for one cohort of students may mean fewer resources for subsequent cohorts (in all likelihood leading to lower completion rates). Third, these first two conclusions imply that efficiency gains may be very hard to achieve—it is hard to increase the completion rate and doing so will typically require more resources. Therefore, although there are efficiency gains from meeting these performance targets, such gains are constricted.

Finally, it is not the case that all reforms are equal in terms of improving efficiency or balancing expenditures to revenues. Strategies for increasing completion rates have very different implications for costs, revenues, net revenues, and efficiency levels. For the sample college at least, there would be substantial gains in completion rates and efficiency from helping students transfer with an award and from helping students with 30+ credits to graduate. In contrast, simply getting students to persist is both an expensive and inefficient reform. Strictly, these model results only apply to the single college for which we have data. Other colleges, with different baseline completion rates, expenditures, and funding formulas may have different results. With data from additional colleges, it should prove possible to validate these general findings as well as provide specific information for other colleges on the economic consequences of reforms to raise the completion rate.

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Appendix A

Measurement of the College Completion Rate

Table A.1
Economic Metric Equations

	Completions (Q)
Equation	$Q = \alpha AA + \beta CS + \delta CL + \rho TR1 + \varepsilon TR2 + \gamma TR3 + \lambda Z$
AA	Associate degrees
CS	Certificate <1 year
CL	Certificate 1+ year
TR1	Transfer with award to 4-year college
TR2	Transfer with no award to 4-year college
TR3	Bachelor's degree at other college
Z	No longer enrolled, no credential, no transfer, still enrolled after five years, certificate at other 2-year college
	Expenditures (E)
Equation	E = DI + II + NI + K
DI	Direct Instructional Expenses
	Wages of FT and PT faculty in the classroom (including their SS payments)
II	Indirect Instructional Expenses
	Equipment, materials and other expenses
NI	Non-instructional Expenses
	Source_1: IPEDS (Instsupp01, Acadsupp01, Studserv01, Opermain01)
	Source_2: Sample College general ledger (Presidential, Administrative, Instructional, Educational support, Finance/administrative)
K	Capital Expenses
Allocation formulae	Per enrollee, per credit, multiples of DI
	Revenues (R)
Equation	R = F + T + G
F	Fees paid by students
T	Tuition charges per course
G	Government subsidy per student based on state funding formula
Allocation formulae	Per enrollee, per credit

Note: α =1.00, λ=0.00, β δ ρ ε γ vary per college.

Appendix B

Outcomes for "U.S.A. Community College"

Table B.1
Weights for Outcomes

Outcome	Mean Number of Credits	Outcome Weight
AA degree	80	1.000
AS degree	94	1.172
AAS degree	87	1.086
Certificate ≥ 1 yr.	71	0.885
Certificate < 1 yr.	60	0.753
Transfer to 4-year institution without credential	20	0.252
No longer enrolled; no credential no transfer		0.000
Still enrolled at college in Year 5 with 30+ credits		0.000
Certificate or associate (other two-year college)		0.000

Notes: College credits only; not remedial education credits. Weights are based on the average duration to complete the award.