Chapter Two

ANALYTIC FRAMEWORK

This chapter describes the models and data used in our analysis. The discussion is organized around four general factors that affect the future of California higher education (see Figure 1). The first of these, **exogenous trends**, are factors over which policymakers, in this case the members of the California Round Table, have little or no control. The second type, **policy levers**, are factors controlled by policymakers. The third type, **measures**, are ways in which to assess whether the performance of the higher education system is good or bad. **Relationships**, fourth, are the ways in which the measures are related to changes in the levers and exogenous factors.

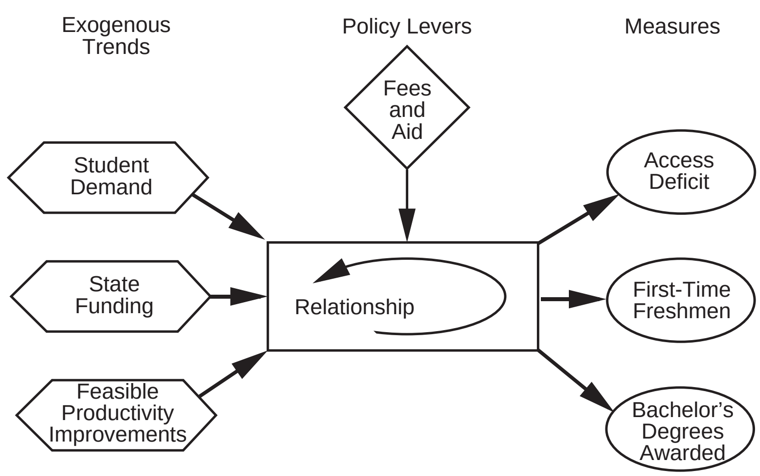

Figure 1—Key Factors Considered in Our Analysis

Our study focused on three of the key exogenous factors affecting California higher education: (1) increasing demand for higher education due to a growing population and increases in participation rates among traditionally underrepresented demographic groups, (2) potentially constrained state funding for higher education, and (3) the degree to which productivity improvements can feasibly offset rising costs for higher education and decreasing revenues. These factors are shown as hexagons in Figure 1.

We chose a range of estimates for each of these factors, constrained by the available information. This information includes past trends and future constraints such as demographic projections and limits on the state budget. We chose the ranges in the context of the conclusions of the study. For instance, we chose an especially wide range of estimates for future demand because we argue that this factor is relatively unimportant, and we chose a narrow range for future changes in productivity because we argue that this factor may be crucial to the future of California higher education.

We considered three simple measures of the performance of the higher education system. Shown as ovals in Figure 1, these are

- Access deficit: the number of individuals who wish to enroll but cannot be accommodated. This is a clear and widely used measure that refers directly to one of the goals of the Master Plan. As discussed in detail below, the access deficit is an estimate of the number of individuals who wish to attend a California institution of higher learning but either are turned away because the institution has insufficient financial resources or are deterred from enrolling because of fee increases.
- Number of first-time freshmen: a useful measure when time to graduation varies, since lingering upperclassmen can increase enrollments while reducing an institution's ability to admit new students.
- Bachelor's degrees awarded: a rough measure of an output of the higher education system that has some importance for society, recognizing that California higher education also provides training, performs research, and contributes to society in a variety of other ways. Degrees awarded is also a measure in which California is currently weak. California ranks 16th among the

states in total college enrollment per capita, but 46th in degrees awarded per capita.

We concentrated on one policy lever, student fees, the focus of significant debate in recent years. The division between exogenous factors and levers is to some extent a choice of the decision maker. For instance, the Round Table has some influence over the proportion of state funds allocated to higher education. It could choose to take actions that might expand this influence. Similarly, the Round Table could take actions to affect the feasible levels of productivity improvement in the higher education system. The choice of levers and exogenous factors in this study is meant as an initial examination of the range of policy options. In future work, we hope to expand our consideration to different policy levers, particularly those associated with improving productivity.

We considered a variety of relationships that determine how the exogenous trends and policy levers affect the measures. We focused on the flow of students and money through each of California's three public systems of higher education—UC, CSU, and the CCs. In brief, students wish to attend a public college or university. This demand is influenced by the level of fees. Each system determines how many students it will admit, based in part on its capacity as measured by the revenues available per student and by how efficiency improvements affect the revenues required per student. Each system gains revenues from state funds (CCs also get local funds) and from fees paid by enrolled students. Graduation and advancement rates affect the number of degrees awarded and the size of the student population. The student population, in turn, affects the revenues each system gains from fees, the total revenues per student, and the access deficit. In our analysis, we considered coupled flows among all three public California systems.

There are, of course, relationships that are not considered here. For instance, we did not consider the effect increased fees may have on speeding the rate at which students advance through the system. Nor did we consider the effects of other major uncertainties, such as changes in affirmative action policies or changes in immigration or citizenship rules that might affect the number of people considered eligible to enroll in California public colleges and universities. Nonetheless, the relationships we considered provide a solid basis for understanding the impacts of and interactions among the trends affecting California higher education.

The remainder of this chapter provides an overview of our analytic framework. Full mathematical details can be found in the appendices.

TRENDS IN STUDENT DEMAND

The first key trend facing California higher education is an increasing number of potential students. Most observers expect that the demand for access to California higher education over the next 20 years will surge, though there is disagreement over how many individuals actually will and should seek to be accommodated. In our analysis, we considered four alternative estimates of the demand for higher education in California. Together they span the plausible range of assumptions about the size of what is often called Tidal Wave II.

Our estimates of future demand are based on projections of California's population and use of the "participation rate" methodology of Shires (1996). Following Shires, we assumed that the demand for higher education is equal to what the enrollment would be in the absence of financial constraints. We estimated these unconstrained enrollments in two steps, as more fully described in Appendix A. First, we used data on past higher education enrollments and California demographics to calculate the average rate at which individuals from different ethnic, age, and gender cohorts participate in the UC, CSU, and CC systems. Second, we multiplied demographic projections for the future size of each cohort by these participation rates to estimate enrollments through 2014. As in Shires's work, we tracked the number of students in each class (freshman, sophomore, junior, and senior) and the transfers between the systems. We augmented Shires's model to include advancement and graduation rates, which we used to estimate the number of seniors awarded bachelor's degrees each year by UC and CSU.

Figure 2 shows our four alternative enrollment estimates. For each estimate, we calculated the number of students enrolled in the UC, CSU, and CC systems each year from 1996 through 2014. Each estimate uses a different set of assumptions about participation rates,

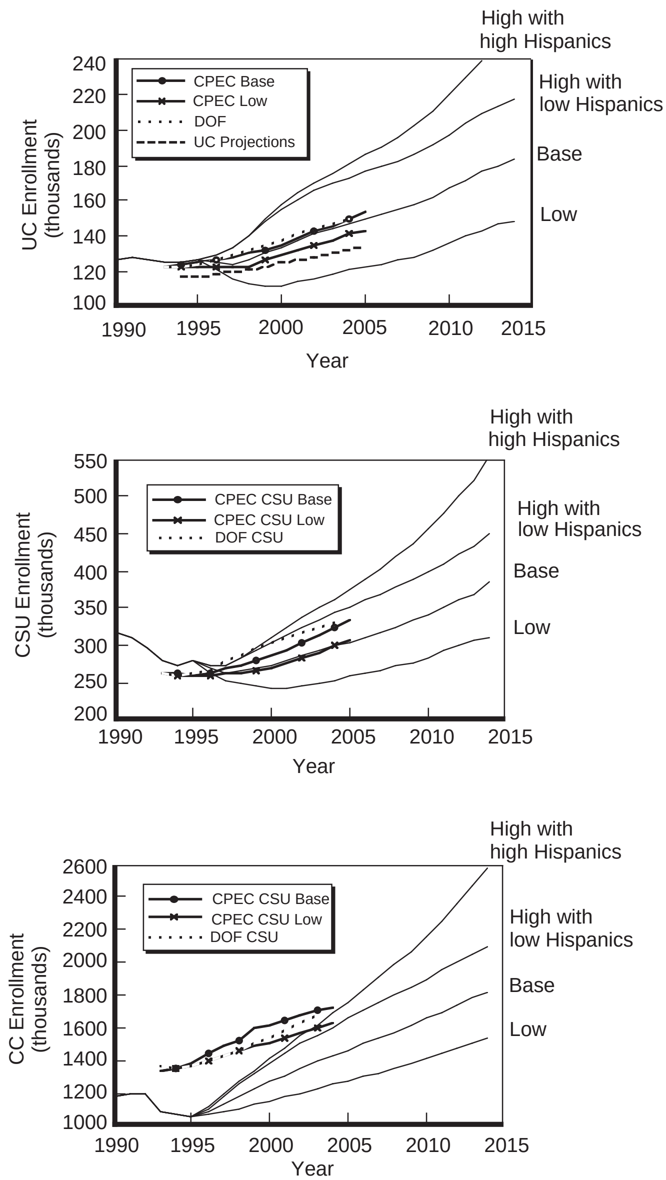

Figure 2—Alternative Enrollment Estimates Compared to Projections from Other Studies

but they all use common projections of California's future demographics. The line labeled "base" in each frame of Figure 2 shows our enrollment estimates for each system using the participation rates derived from enrollment data provided by the California Postsecondary Education Commission (CPEC, 1995b) and the California State Demographic Unit's data (1995) for 1993 through 1995. For the high and low demand estimates, we used participation rates 20% higher and 20% lower, respectively, than those used for our base estimates. For the highest demand estimate, we started with participation rates 20% higher than the base values for each cohort and then further increased the participation rates for the Hispanic cohort by 4% annually. Currently, Hispanics represent the state's fastest growing population group and have college participation rates significantly lower than do other groups. The highest demand estimate represents a case in which Hispanics are attending college with a participation rate increasing annually by 4%, chosen so that their participation rate in the UC system at the end of 20 years is nearly equal to that of non-Hispanic whites.[1]

Figure 2 also compares our four alternative enrollment estimates to projections made by CPEC (1995b), and to the State Department of Finance ("DOF" in the figure) and the University of California (University of California, 1996). While the methodologies used to generate these other projections differ from our model in how they handle factors such as student flow, admissions assumptions, and definitions of student status, they are all based on state demographics in terms of either total population of cohorts or high school graduates of cohorts, which is proportional to first order. The differences between the lines in the CC (lower) plot in Figure 2 arise from differences in the way students are counted; in fact, our numbers agree closely with CPEC's Student Profiles reported data for the CCs from 1989 to 1994.[2] For the period 1995 to 2005, for which enrollment

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[1]For each alternative enrollment estimate, we report the number of students in each system, since the data used to calculate the coefficients for Eqs. A4 and A5 (see Appendix A) are reported as 'headcounts.' To translate our enrollment estimates into aggregated full-year full-time equivalents (FTEs), multiply the reported values by 0.96 for the UC system, 0.75 for CSU, and 0.64 for the CCs. Unless noted otherwise, enrollments are given in headcount numbers throughout this report.

[2] See "Student Profiles, 1995," CPEC, October 1995, pp. 1–11 (www.cpec.ca.gov/stuprfl/stuprfl.html).

projections are available from all sources shown here, our baseline enrollment estimate is in general agreement with the other projections. Other studies have made different choices—for instance, estimating participation rates using 1989 enrollment and demographics data.[3]

The alternative enrollment estimates we used in this study span the breadth of plausible demand projections generally put forth for the future of California higher education. As shown in Table 1, the range of estimates spans over a million students (the projected size of Tidal Wave II) and is significantly larger than the range of estimates usually discussed in the debate on California higher education. We chose this large range in order to support the argument in the next chapter that uncertainties about future demand are not one of the key factors affecting the future of California higher education.

Table 1

Estimates of Future Demand for Higher Education

Estimate	Description in Model	Result in 2014
High, with high Hispanic participation	Participation rates 1.2 times larger than basecase. Hispanic participation rates grow an additional 4% annually.	3.2 million students in California higher education, 2.5 times 1995 enrollment. Hispanics participate at same rate as whites and Asians.
High, with low Hispanic participation	Participation rates 1.2 times larger than basecase.	2.8 million students in California higher education. Hispanics attend at current low rate compared to whites and Asians.
Base	Basecase participation rates.	2.4 million students in California higher education.
Low	Participation rates 0.8 times smaller than basecase.	2 million students in California higher education, 1.5 times 1995 enrollment.

[3]See, for instance, Shires, 1996.

TRENDS IN STATE FUNDING

Besides demographic trends, a second key issue facing California higher education is the financial support that will be available from the state government. UC, CSU, and the CCs draw their income from a variety of sources, but revenues from the state general fund constitute a substantial fraction of each system's funds for undergraduate education. (CCs are additionally supported by local property taxes.) From 1970 to 1996, the fraction of the general fund allocated to higher education dropped from 17% to 12% as state spending on other priorities—particularly corrections, health, and welfare—increased. There is much disagreement as to whether this decline in state higher education funding will continue into the future. In our analysis, we considered five alternative estimates of state general fund allocations to higher education as a way to span the plausible range of assumptions about future funds.

Our estimates of future revenues are based on data describing the current sources of revenues. It is not a straightforward task to determine the funds allocated to undergraduate education in each system: each receives funds from a variety of sources, and many types of spending benefit several missions within a system. For instance, UC building maintenance benefits both undergraduate and graduate education. We thus made the simplifying assumption that funds available for undergraduate education in each system come from three sources—the state general fund, student fees, and, for the CCs, property taxes. We estimated the current total general fund and property tax allocations to undergraduate higher education by multiplying CPEC data on 1995 spending per undergraduate in each system—$6,809 for UC, $4,734 for CSU, and $3,050 for the CCs (about equally divided between local property taxes and the state)—by CPEC's 1995 enrollment data (CPEC, 1995a,b). We estimated the current average fees per student in each system from CPEC data on total enrollment and the total revenues from fees. As described in detail in Appendix B, we then projected future general fund and property tax allocations to higher education by assuming they grow at some annual rate. We estimated future revenues from fees in each system by multiplying future fees by our estimates of the number of enrolled students. Fees can, of course, affect the number of enrolled students, as we discuss below. In this analysis, we focused only on revenues associated with the costs of current operations. We leave the important topic of capital costs for future work.

We made five alternative estimates of future allocations by the state general fund to undergraduate education, as shown in Figure 3. All five assume that the California economy, and thus the state general fund, grow at 2.7% annually.[4] For our "optimistic" funding estimate, we assumed, as does the UC Research and Planning Department (Copperud and Geiser, 1996), that the fraction of the general fund allocated to higher education remains constant at its current level, and thus that the general fund revenues allocated to each of the three systems grow at 2.7% per year. For our two "pessimistic" estimates, we assumed that the share of the general fund going to higher education rapidly declines because of increased spending on corrections, K–12 education, and other programs (Shires, 1996;

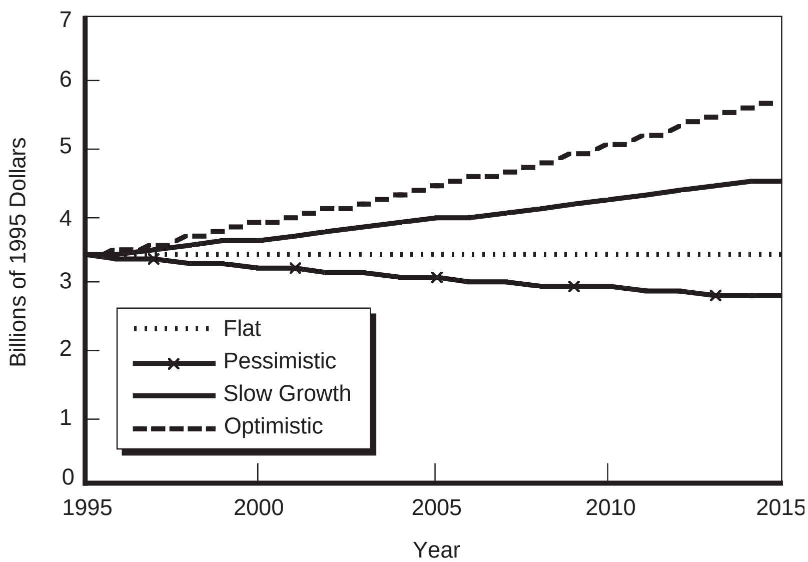

Figure 3—Alternative Estimates of State General Fund Allocations to Higher Education

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[4]This is the growth rate projected by UCLA for the California economy from 1996 to 2005. We extended this projection to 2014.

Carroll, et al., 1995), so that the net general fund revenues allocated to the three systems decline. For one of these estimates, “pessimistic, without 98,” we assumed that state revenues to all three systems decline at –1% annually. For the other pessimistic estimate, “pessimistic, with 98,” we assumed that the CC share of these declining revenues increases because of Proposition 98 mandates, so state revenues to the CCs grow at 1.5% annually while state revenues to UC and CSU decline at –3.5% annually. (Note that the two pessimistic estimates have the same total dollars allocated to higher education, so only four distinct estimates are seen in Figure 3.) We also included two intermediate estimates, “slow growth” and “flat,” which have general fund allocations to each of the three systems growing, respectively, at 1.5% and 0% annually. For each of our alternative estimates, we assumed that property tax revenues to the CCs grow at 3% per year (Shires, 1996). Note that we did not consider potential changes in federal funding that might affect UC, nor did we consider property tax revenues that might affect the CCs. We left these important topics to future work.

We summarize this range of estimates for future state funding in Table 2. Note that total state funding varies by $3 billion, which is roughly the same total amount California spends today on higher education. This large range reflects the fact that the total size of the state budget, measured as a proportion of the state economy, is currently fixed by the state constitution, and that large segments of the budget are currently growing at a rate that, if continued, will largely squeeze out the state funds available for higher education.

EFFECT OF FUNDING ON ACCESS

The state funding available for higher education may strongly influence the number of individuals able to obtain a college education. Our earlier estimates of future demand were based on enrollment projections in the absence of financial strictures. Now we present our estimate of enrollments under conditions of financial constraints and introduce the concept of an access deficit. We have followed Shires (1996) in defining the access deficit as the difference between the projected, unconstrained demand for higher education assuming fees stay at their current level, and the number of students who could

Table 2

Estimates of Future State Funding of Higher Education

Estimate	Description in Model	Result in 2014
Optimistic	Fraction of state general fund allotted to higher education remains constant.	Higher education receives $5.8 billion, about 12% of state general fund, reversing 20-year trend (1976–1997). Growth rates of state spending on health and welfare, corrections, and/or K–12 decrease significantly, or taxes increase significantly.
Slow growth	State funds allotted to higher education increase 1.5% annually.	Higher education receives $4.6 billion from state general fund.
Flat	State funds allotted to higher education remain constant.	Higher education receives $3.4 billion from state general fund.
Pessimistic, without 98	State funds to each sector of higher education decrease 1% annually.	Higher education receives $2.8 billion, about 6% of state general fund and 80% of 1995 levels, continuing 20-year downward trend.
Pessimistic, with 98	State funds to higher education decrease 1% annually. Funds to CCs increase consistent with Proposition 98.	Same as 'pessimistic, without 98,' but funds to UC and CSU drop to nearly 50% of 1995 levels while funds to CCs increase by 30% over 1995 levels.

be accommodated at some projected level of future state funding with some future level of fees

Shires argues that prior to the recession of the early 1990s, funding for California higher education was largely demand driven—the state provided funding to serve projected enrollments. Since the recession, however, funding has been budget driven—the state allocates the funds it can afford to spend on higher education, and each of the systems does what it can with that allocation. Following Shires, we estimated enrollments in each of our scenarios using two simple rules for admissions: (1) unconstrained admissions, in which students are allowed to continue to attend each system at the same rates they have in the past, and (2) constrained admissions, in which enrollment may be limited so that the level of spending per undergraduate remains constant in real terms. The unconstrained admissions rule gives demand-driven enrollment estimates; the constrained admissions rule produces budget-driven enrollment estimates. We thus calculated the access deficit for any particular scenario, as described in detail in Appendix E, as the difference between enrollments estimated using the unconstrained rules with no fee increase and enrollments estimated using constrained admission rules.

Figure 4 shows the UC and CSU access deficits for the pessimistic and optimistic estimates of future state funding with no fee increases. Note that for both systems, the access deficit is small to nonexistent for the optimistic levels of funding but large for the pessimistic levels.

TRENDS IN PRODUCTIVITY

Improvements in productivity are the third key factor affecting California higher education. Productivity is a difficult topic for a number for reasons. In recent years, many private sector organizations have significantly improved their productivity and thereby reduced their costs. Such improvements should also be possible in the public sector, and, indeed, many public sector institutions have made progress with them in recent years. Nonetheless, productivity is often more difficult to measure and improve in the public sector compared to the private sector, since the goals of the typical public sector institution and the interests of its stakeholders are more diverse than is the case for most private sector organizations. For instance, there is a danger that attempts to improve productivity in public institutions of higher education could focus only on reducing an institution's quantifiable costs, damaging some of the institution's other critical yet more intangible characteristics, such as the quality of its education.

There were not enough available data and analyses to enable us to estimate the rate of productivity improvement possible in California higher education or to recommend steps the Round Table should take to improve productivity. Instead, we explored a large range of

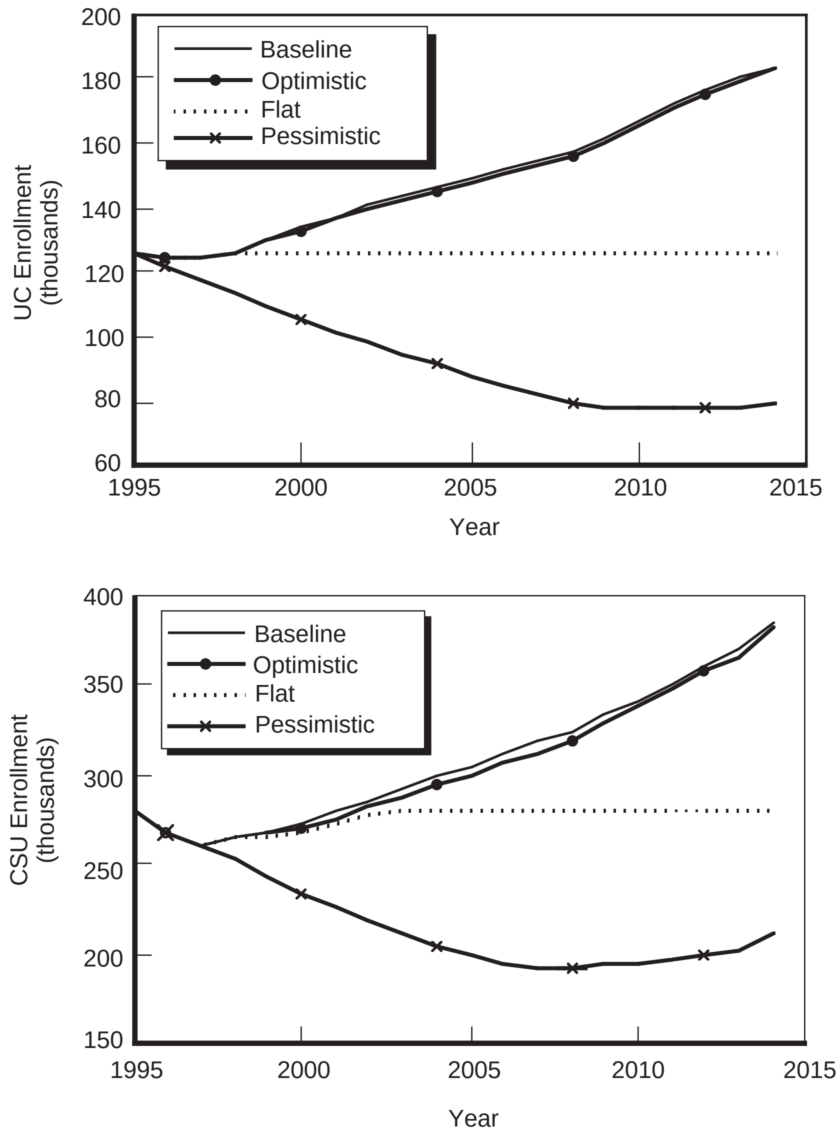

Figure 4—Effect of Alternative Estimates of State General Fund on UC and CSU Access Deficit

assumptions about the feasible rate of productivity improvements within California higher education and examined the consequences of these assumptions. We show that assumptions about feasible productivity improvements, along with assumptions about future state funding, are the key factors affecting the future of California higher education.

In his work on productivity in public sector institutions, Epstein (1992) describes two types of productivity improvements: efficiency and effectiveness. Efficiency refers to the level and quality of service an organization can produce from a given amount of input resources. Effectiveness refers to the extent to which an organization meets the needs of its stakeholders and customers. Epstein provides two specific ways to demonstrate productivity improvements. First, an organization can demonstrate a measurable reduction in cost while maintaining or improving key measures of effectiveness. Second, an organization can demonstrate a measurable improvement in one or more key effectiveness indicators without increasing input costs. We considered both of these forms of productivity improvements in our analysis.

We took graduation and advancement rates as our (admittedly crude) measures of effectiveness for UC, CSU, and the CCs. Graduation rates are directly related to the number of bachelor's degrees awarded, an important factor for both the individual students and the society at large; and advancement rates are directly related to average time to graduation, an important indicator used by UC and CSU to assess their performance. As described in detail in Appendix A, our model uses graduation rates to estimate the number of degrees awarded from our estimates of the number of seniors, and it uses advancement rates to estimate the number of members of one class who move on to the next. For our measure of efficiency, we took the minimum revenues required per student in each system. As described in detail in Appendices B, D, and E, we used this value to determine the maximum enrollment, and thus access deficits, in each system under conditions of financial constraints.

We considered five alternative assumptions about the feasible rate of efficiency improvement in California higher education: –2%, –1%, 0%, 1%, and 2% annually. Figure 5 shows UC and CSU enrollments

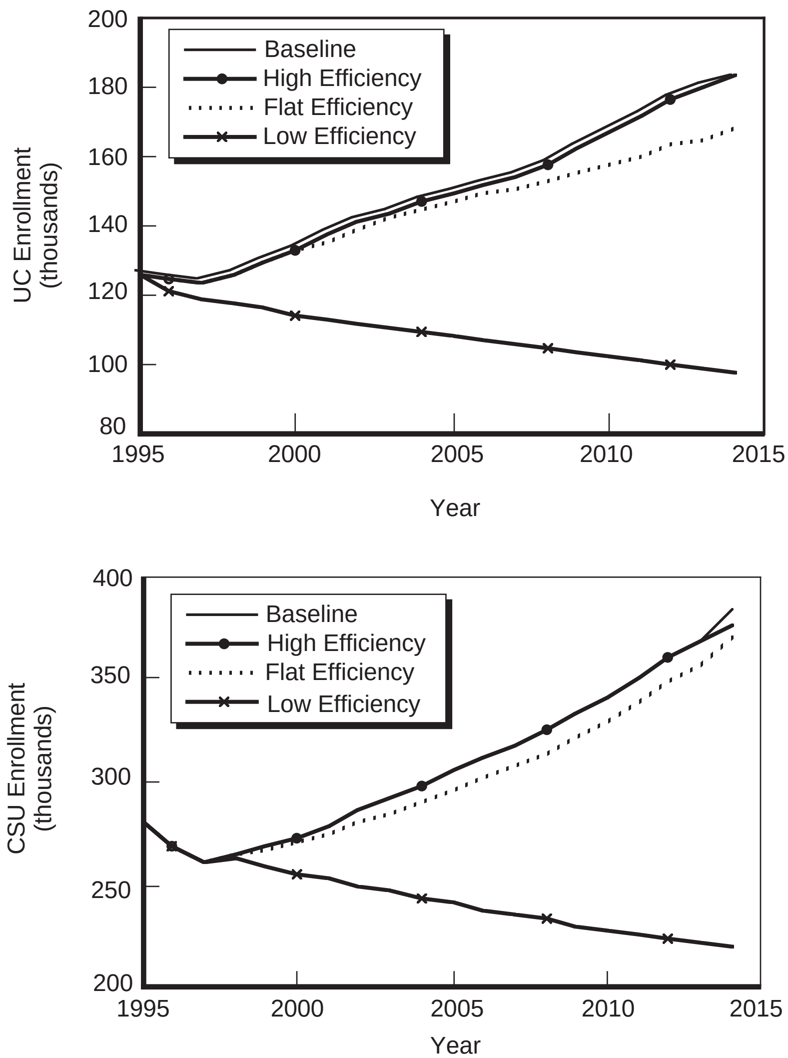

Figure 5—Effect of Alternative Assumptions About Feasible Efficiency Improvements on UC and CSU Enrollment

for the high, low, and middle values in this range. In each of these cases, we held effectiveness, as measured by graduation and advancement rates, constant. What is evident is that a high rate of efficiency growth reduces the access deficit almost to zero, while a negative rate of growth causes very large access deficits, similar to those caused by the pessimistic estimate of revenues from the state general fund (see Figure 3).

We took our plausible range of efficiency improvements from data on the costs of inputs to higher education over the last 35 years. The Higher Education Price Index (HEPI) measures the real increase in the price of the services and goods, such as salaries and equipment, that U.S. higher education institutions use in their operations. Figure 6 shows that the price of these inputs has consistently outpaced inflation in the rest of the economy, as measured by the Consumer Price Index (CPI), by up to 3% per year. On average, prices to higher education have risen 1% faster than inflation over the last 15 years. The figures shown here are nationwide averages; independent data do not exist for California institutions. Our choice of the range of annual efficiency improvements shown in Figure 5 is somewhat narrower than the range of variation in input prices shown in Figure 6. This conservative range of estimates, summarized in Table 3, should strengthen our claims that the actual, though currently unknown, level of feasible efficiency improvements will be one of the key factors determining the future of California higher education.

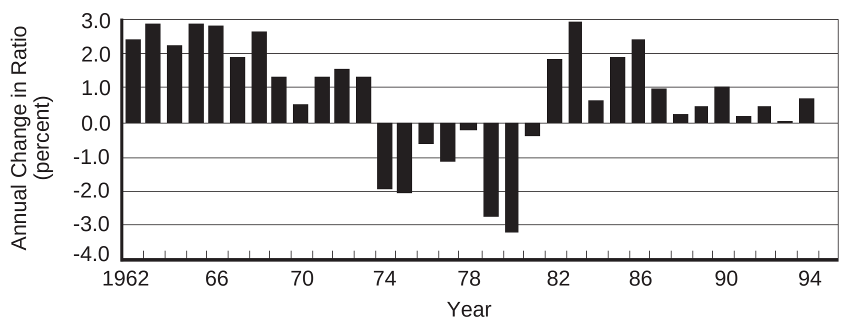

Figure 6—Cost of Inputs to Higher Education, 1962–95

Table 3

Estimates of Future Changes in Productivity

Estimate	Description in Model	Result in 2014
Efficiency	Changes in efficiency, as defined in Eq. D1 (Appendix D), range from -2% to 2% per year.	At -2% annual change, institutions would need 50% more dollars per student than in 1995. At 2% annual change, institutions would provide same quality education for 30% fewer dollars per student than in 1995.
Effectiveness	Changes in effectiveness, as defined in Eq. D2, range from -0.5% to 1.5% per year.	Virtually all students would graduate in 4 years if effectiveness improved at 1.5% per year.

We also considered five estimates of the rate of improvement in effectiveness (advancement and graduation rates): –0.5%, 0%, 0.5%, 1.0%, and 1.5%. As with efficiency, few data and analyses are available for estimating what improvements are possible. Thus, we based our range of effectiveness improvement on comparisons of the number of bachelor's degrees awarded per enrolled student in different states. As Table 3 shows, we chose a high estimate (1.5%) of annual effectiveness improvement as the rate necessary to achieve a four-year time to degree for nearly all UC cohorts and for a majority of CSU cohorts. Figure 7 compares the enrollment and number of degrees awarded in 2014 by CSU for the –0.5% decrease in effectiveness ("low") and the 1.5% effectiveness improvement ("high"). In both cases, we held efficiency constant. Note that high efficiency increases the total number of degrees awarded even with reduced enrollment (since students flow through the system faster), whereas low efficiency produces fewer degrees but increases enrollment by "clogging up" the system with students repeating grades.

EFFECTS OF STUDENT FEES AND AID

Higher student fees can increase the revenues available for undergraduate education, but they can also affect potential students'

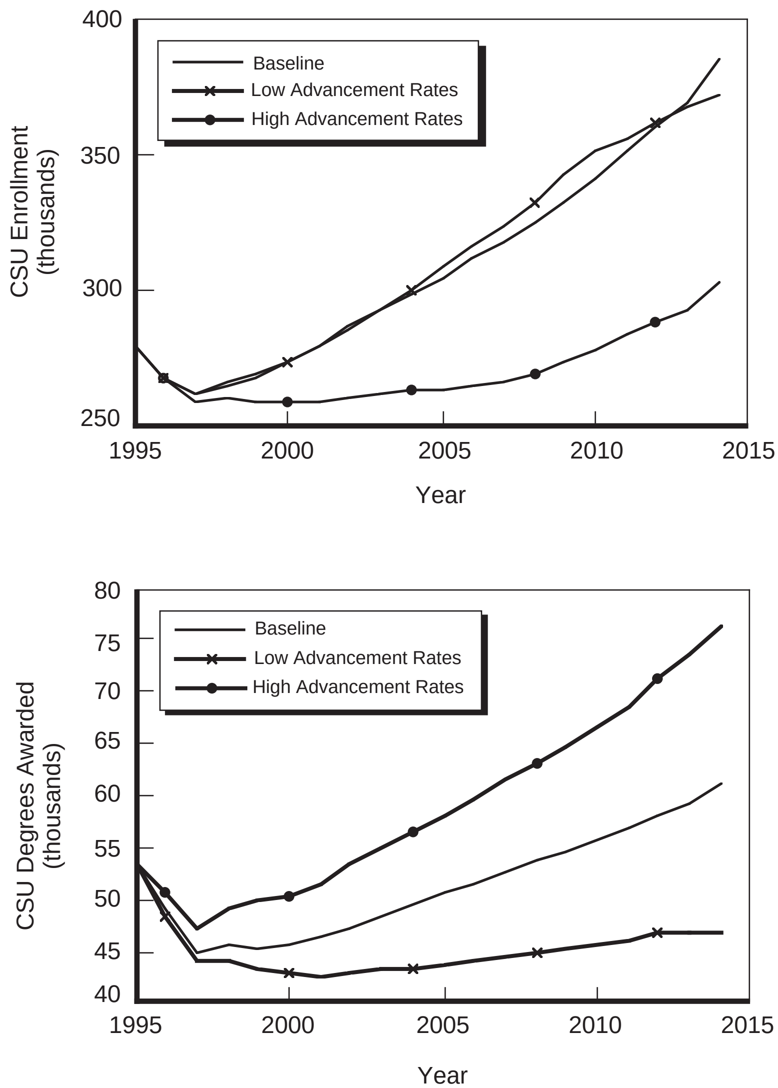

Figure 7—Effect of Alternative Assumptions About Feasible Effectiveness Improvements on CSU Enrollment and Degrees Awarded

decisions on whether to enroll in a public college or university. Thus, fees represent an important decision for policymakers and have been a topic of much debate in recent years.

In our analysis, we estimated the impact of fees on enrollment by varying the participation rates based on data concerning the sensitivity of students to changes in the price of higher education. As discussed in detail in Appendix B, we used data compiled by Kane (1995) of the National Bureau of Economic Research. Using national data, Kane estimated the effects of tuition increases on enrollment in systems within the same state. He found that a $1,000 tuition increase (in 1991 dollars) at public four-year universities decreases enrollment in four-year public institutions by 1.2%, increases enrollment at public two-year colleges by 0.5%, and increases enrollment at private colleges and universities by 0.5%. Kane also found that a $1,000 tuition increase at public two-year colleges decreases enrollment in these colleges by 4.7%, increases enrollment at public four-year universities by 1.8%, and increases enrollment at private colleges and universities by 0.4%. While Kane's data are among the best available, they are hardly definitive. Thus, we considered alternative estimates of the sensitivity of student demand to changes in tuition, ranging from no sensitivity to a sensitivity three times that measured by Kane (see Table 4).

In our analysis, we treated potential fee increases differently than we did the other parameters. We regard fees as a policy lever that can be influenced by the California Education Round Table, whereas we regard the other parameters as exogenous factors largely outside the Round Table's control. Rather than examine the implications for access and our other measures for a range of potential fee increases, we examined (see Chapter 3) what fee increases are necessary to preserve access as a function of the other uncertainties. To help defray the cost of a higher education, many students receive financial assistance from a variety of sources, including federal and state grants and loans, as well as grants and loans from the institutions they attend. For our purposes, we assumed that state and federal aid remains constant as fees change, but that each institution recycles part of the revenues it receives from fee increases into its need-based institutional aid programs. Thus, our fee increases represent the net,

Table 4

Estimates of Price Elasticity and Future Fee Increases

Estimate	Description	Result in 2014
Price elasticity	The constant K in Eq. B3 is a scaling factor for elasticities estimated by Kane (1995) and ranges from 0 to 3.	With K=3 (3 times Kane's estimates), a 3% annual increase in UC and CSU fees would reduce enrollment (and thus decrease access) by about 10%.
Fees	Fee increases reduce admissions of first-time freshmen as described by Eq. B2.	With a 7% annual increase, net fees would increase 360% over 1995 levels. Students at UC, CSU, and the CCs would pay on average $13,500, $6,500, and $700 in fees, respectively.

average increase in the price of education seen by students after receiving financial aid. As a comparison to the fee increases we consider in Chapter 3, note that a report issued by the California Higher Education Policy Center (Callan, et al., 1996) recommends that (1) fee increases not exceed 6%, 5%, and 4% per year at UC, CSU, and the CCs, respectively; and (2) the state provide student financial aid equal to one-third of student fee increases. Many also advocate that fees should rise no faster than the rate of inflation.

Figure 8 shows the effects of a 3% annual fee increase on UC enrollment for a scenario comprising optimistic funding from the state and low efficiency improvements, and using Kane's data for the sensitivity of enrollments to tuition (K=1 in Eq. B3). Note that while fee hikes increase the revenues per student for the systems (allowing more students), they simultaneously price out students through price elasticity (reducing enrollment). Thus, fee increases help preserve access only to the extent that the revenue increase compensates for the fact that increased prices tend to reduce the number of students willing or able to enroll.

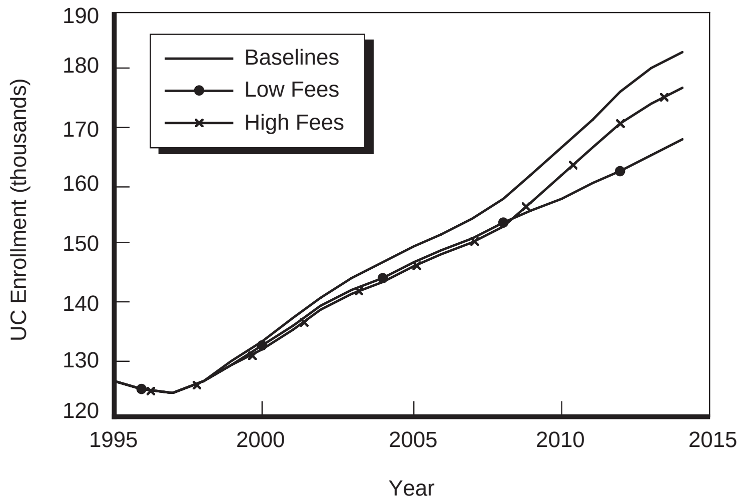

Figure 8—Effect of Student Fees on UC Enrollment