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Education, Skills, and Technical Change

Implications for Future US GDP Growth

Accounting for the Rise in College Tuition

Edited by
Charles R. Hulten
and Valerie A. Ramey

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Prefatory Note

This volume contains revised versions of the papers presented at the Conference on Research in Income and Wealth titled "Education, Skills, and Technical Change: Implications for Future U.S. GDP Growth," held in Bethesda, Maryland, on October 16–17, 2015.

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Executive Committee, December 2016

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Accounting for the Rise in College Tuition

Grey Gordon and Aaron Hedlund

10.1 Introduction

Over the past thirty years, the perceived necessity of a college degree and a growing college earnings premium have led to record enrollments and greater degree attainment in higher education. However, a dramatic escalation in tuition looms over the heads of prospective students and their parents and serves as a stark reminder to graduates saddled with large student loans. From 1987 to 2010, sticker price tuition and fees ballooned from \$6,630 to \$14,510 in 2010 dollars. After subtracting institutional aid, net tuition and fees still grew by 92 percent, from \$5,720 to \$11,000. To provide perspective, had net tuition risen at the rate of much maligned *health care costs*, tuition would have only risen 32 percent to \$7,550 in 2010.[1]

In this chapter, we seek to account for the college tuition increase by quantitatively evaluating existing explanations using a structural model of higher education and the macroeconomy. We divide our hypotheses about driving forces into supply-side changes (Baumol's cost disease and exogenous

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1. Calculations used the health care personal consumption expenditures price index deflated by the CPI.

changes to nontuition revenue), demand-side changes (notably, expansions in grant aid and loans), and macroeconomic forces (namely, skill-biased technical change resulting in a higher college earnings premium). Our quantitative model shows that the combined effect of these changes more than accounts for the tuition increase and provides key insights about the role of individual factors as well as their complementary effects.

Existing hypotheses of why college tuition is increasing largely fall into two camps: those that emphasize the unique virtues and pathologies of higher education and those that place rising higher education costs into a broader narrative of increasing prices in many service industries. Advocates of the latter approach look to cost disease and skill-biased technical progress as drivers of higher costs in service industries that employ highly skilled labor. Cost disease, which dates back to seminal papers by Baumol and Bowen (1966) and Baumol (1967), posits that economy-wide productivity growth pushes up wages and creates cost pressures on service industries that do not share in the productivity growth. To cope, these industries increase their relative price, passing their higher costs onto consumers.

By contrast, theories emphasizing the uniqueness of higher education take several forms. Falling within our notion of supply-side shocks, state and local funding for higher education fell from $8,200 per full-time equivalent (FTE) student in 1987 to $7,300 in 2010, all while underlying costs and expenditures were rising. Several studies, including a notable study commissioned by Congress in the 1998 reauthorization of the Higher Education Act, attribute a sizable fraction of the increase in public university tuition to these state funding cuts. We take a somewhat broader view in this chapter by looking at how exogenous changes to *all* sources of nontuition revenue impact the path of tuition.

On the demand side, several expansions in financial aid have occurred over the past several decades. During our period of analysis, annual and aggregate subsidized Stafford loan limits were increased in 1987 and five years later in 1992. The Higher Education Amendments of 1992 also established a program of supplementary unsubsidized Stafford loans and increased the annual PLUS loan limit to the cost of attendance minus aid, thereby eliminating aggregate PLUS loan limits. Interest rates on student loans also fell considerably during the first decade of the twenty-first century. In a famous 1987 *New York Times* op-ed titled “Our Greedy Colleges,” then-secretary of education William Bennett asserted that “increases in financial aid in recent years have enabled colleges and universities blithely to raise their tuitions” (Bennett 1987). We evaluate this claim through the lens of our model, and we also cast light on the tuition impact of the 53 percent rise in *nontuition* costs (such as those arising from the greater provision of student amenities), which has the effect of increasing subsidized loan eligibility.

Last, we quantify the impact of macroeconomic forces—specifically, rising labor market returns to college—on tuition changes. Autor, Katz, and

Kearney (2008) find that, from the mid-1980s to 2005, the overall earnings premium for having a college degree increased from 58 percent to over 93 percent. Ceteris paribus, such an increase in the return to college has assuredly driven up demand for a college degree. We use our model to quantify how much this increase in demand translates to higher tuition and how much it contributes to higher enrollments.

Our quantitative findings can be summarized as follows:

1. The combined effect of the aforementioned shocks generates a 102 percent increase in equilibrium tuition. This result compares to a 92 percent increase in the data.
2. The rise in the college earnings premium alone causes tuition to increase by 21 percent. With all other shocks present *except* the college premium hike, tuition increases by 81 percent.
3. The demand-side shocks by themselves cause tuition to jump by 91 percent. With all other changes *except* the demand-side shocks, tuition only increases by 14 percent.
4. The supply-side shocks by themselves cause tuition to *decline* by 8 percent. With all other changes *except* the supply-side shocks, tuition increases by 116 percent.

The model we construct to arrive at these conclusions embeds a rich higher education framework based off of Epple, Romano, and Sieg (2006) and Epple et al. (2013) into a life-cycle environment with heterogeneous agents, incomplete markets, and student loan default. Imperfectly competitive colleges in the model set differential tuition and admissions policies to maximize quality, which, as a proxy for reputation, depends on investment per student and the average academic ability of the heterogeneous student body. In this chapter, we restrict attention to the case of a representative nonprofit institution that has limited market power because of unobservable student preference shocks. Even with these shocks, the representative college assumption still abstracts from important heterogeneity and strategic interactions in the higher education market. For this reason, the findings in this chapter should be used to guide further research rather than viewed authoritatively. To further simplify matters, we treat all nontuition revenue as exogenous (e.g., endowment income and state funding), which implies that the college faces a balanced budget constraint each period that equates total revenue with total spending on investment and non-quality-enhancing custodial costs. On the household side, we include several important features: heterogeneity in ability and parental income dimensions, college financing decisions, college dropout risk, and student loan repayment decisions.

Our assumption that colleges maximize quality—in line with what Clotfelter (1996) calls the "pursuit of excellence"—implicitly incorporates another prominent hypothesis for rising tuition, namely, Bowen's (1980) "Revenue Theory of Costs." Ehrenberg (2002, 11) states it best:

> The objective of selective academic institutions is to be the best they can in every aspect of their activities. They aggressively seek out all possible resources and put them to use funding things they think will make them better. To look better than their competitors, the institutions wind up in an arms race of spending.

To make matters concrete, quality in our setting depends on investment per student and the average ability of the student body. As a result, students act both as customers and as inputs to the production of quality via peer effects, as described by Winston (1999). This unique feature of higher education gives colleges an additional motive to engage in price discrimination beyond the usual monetary rent extraction—namely, to attract high-ability students by offering generous institutional aid.

To discipline the model, we use a combination of calibration and estimation. Rather than ex ante assume cost disease or a particular production structure (e.g., number of faculty, administrators, etc., needed to run a college), we directly estimate a reduced-form custodial cost function and track its changes over the period 1987–2010. Similarly, we compute average nontuition revenue per FTE student using Delta Cost Project data and feed it into the model. On the household side, we use earnings premium estimates by Autor, Katz, and Kearney (2008) and construct time series for federal student loan program (FSLP) variables.

As mentioned previously, we find that the combined effects of the supply-side changes, demand-side changes, and increases in the college earnings premium can fully account for the mean net tuition increase. Looking at individual factors, we find that expansions in borrowing limits drive 54 percent of the tuition jump and represent the single most important factor.[2] To grasp the magnitude of the change in borrowing capacity, first note that real aggregate borrowing limits increased by 56 percent between 1987 and 2010, from \$26,200 to \$40,800 in 2010 dollars.[3] Second, the reauthorization of the Higher Education Act in 1992 introduced a major change along the extensive margin by establishing an unsubsidized loan program alongside the subsidized loans. We also find that increased grant aid contributes 18 percent to the rise in tuition, which mirrors the 21 percent impact of the higher college earnings premium. These results give credence to the Bennett (1987) hypothesis.

Last, our results, while preliminary and subject to the caveat mentioned above regarding the representative college assumption, paint a more nuanced picture of cost disease as a driver of higher tuition. Although our estimated cost function shifts upward from 1987 to 2010, this isolated effect *reduces*

2. For this calculation, we take one minus the tuition increase without the borrowing limit expansion relative to the increase with the expansion, that is, 1 − (\$9,066 − \$6,146)/(\$12,428 − \$6,146). Adding the percentage contribution from each exogenous driving force need not yield 100 percent because of interaction effects.

3. We use the limits in place from 1981 to 1986 as our figure for 1987.

average tuition (a contribution of −16 percent). Importantly, our estimates suggest that the upward shift in the cost function between 1987 and 2010 comes largely in the form of higher fixed costs rather than higher marginal costs, which has important implications for how colleges respond. Intuitively, colleges face a trade-off between raising tuition and retaining high-ability students when they experience a balance sheet deterioration. If they increase tuition, fewer high-ability students may enroll, which drives down quality. Alternatively, a decision to not raise tuition forces colleges to cut back on quality-enhancing investment expenditures. We find that colleges take this latter route to the tune of almost $2,800 in cuts per student as a response to higher custodial costs. This result comports with the behavior we observe among many public universities across the country of replacing tenured faculty with less expensive non-tenure-track positions. Additionally, changes in nontuition revenue have almost no impact on tuition (a contribution of 2 percent).

We do not claim that Baumol's cost disease or changes in state support have no importance for tuition increases. Rather, we suspect that these factors affect some colleges more than others. For instance, if private research universities experience cost disease, they may increase their tuition. However, higher tuition may induce substitution of students into lower-cost universities. Given the absence of competition and college heterogeneity in our model, our estimation implicitly incorporates substitution of households across college types and any corresponding composition effects.

10.1.1 Relationship to the Literature

This chapter relates to two broad strands of the literature. First, the chapter relates to a large empirical literature that estimates the effects of macroeconomic factors and policy interventions on tuition and enrollment. Second, this chapter relates to a growing body of literature employing structural models of higher education. With a few exceptions, these models focus on student demand and abstract from many distinguishing features of the supply side.

Empirical Literature

In discussing related work, we map our categorization of supply-side shocks, demand-side shocks, and macroeconomic forces into the existing empirical literature. For supply-side shocks, we analyze the impact of upward shifts in custodial (non-quality-enhancing) costs as well as changes in nontuition revenues. The literature on Baumol's cost disease most closely relates to the former, while the literature analyzing the effect of the decline in state appropriations for higher education addresses the latter.

Supply Shocks: Cost Disease. The origins of cost disease emerge from seminal works by Baumol and Bowen (1966) and Baumol (1967). They lay out a clear mechanism: productivity increases in the economy at large drive up wages everywhere, which service sectors that lack productivity growth pass along by increasing their relative prices. Recently, Archibald and Feldman (2008) use cross-sectional industry data to forcefully advance the idea that cost and price increases in higher education closely mirror trends for other service industries that utilize highly educated labor. In short, they "reject the hypothesis that higher education costs follow an idiosyncratic path."

We find that the form of the cost increase matters. In particular, our estimates uncover a large increase in the fixed cost of operating a college from \$12 billion to \$30 billion in 2010 dollars. To pay for the higher fixed cost, the college in our model lowers per-student investment and increases enrollment, which lowers average tuition by a composition effect.

Supply Shocks: Cuts in State Appropriations. Heller (1999) suggests a negative relationship between state appropriations for higher education and tuition, asserting that "the higher the support provided by the state, the lower generally is the tuition paid by all students." Recent empirical work by Chakrabarty, Mabutas, and Zafar (2012), Koshal and Koshal (2000), and Titus, Simone, and Gupta (2010) support this hypothesis, but notably, Titus, Simone, and Gupta (2010) show that this relationship only holds up in the short run. Last, in a large study commissioned by Congress in the 1998 reauthorization of the Higher Education Act of 1965, Cunningham et al. (2001) conclude that "Decreasing revenue from government appropriations was the most important factor associated with tuition increases at public four-year institutions."

While our model fails to confirm this idea in the aggregate—that is, lumping public and private colleges together—cuts in appropriations could potentially play a role in driving up public school tuition. Extending our model to incorporate heterogeneous colleges with detailed, disaggregated funding data will shed further light on this issue.

Demand Shocks: The Bennett Hypothesis. For demand-side shocks, we focus on the effects of increased financial aid. We address the extent to which changes in loan limits and interest rates under the FSLP as well as expansions in state and federal grants to students drive up tuition—famously known as the Bennett hypothesis. A long line of empirical research has studied this hypothesis with mixed results.

Broadly speaking, we can divide the literature into those papers that find at least *some* support for this hypothesis and those that are highly skeptical. In the first group, McPherson and Shapiro (1991) use institutional data from 1978 to 1985 and find a positive relationship between aid and tuition at public universities, but not at private universities. Singell and Stone (2007), using panel data from 1983 to 1996, find evidence for the Bennett hypothesis among top-ranked private institutions but not among public and lower-ranked private universities. They also found evidence in favor of the Bennett hypothesis for public *out-of-state* tuition. Rizzo and Ehrenberg (2004,

339) come to the mirror opposite conclusion: "We find substantial evidence that increases in the generosity of the federal Pell Grant program, access to subsidized loans, and state need-based grant aid awards lead to increases in in-state tuition levels. However, we find no evidence that nonresident tuition is increased as a result of these programs." Turner (2012) shows that tax-based aid crowds out institutional aid almost one-for-one. Turner (2014) also finds that institutions capture some of the benefits of financial aid, but at a more modest 12 percent pass-through rate. Long (2004a, 2004b) uncovers evidence that institutions respond to greater aid by increasing charges, in some cases by up to 30 percent of the aid. Cellini and Goldin (2014) compare for-profit institutions that participate in federal student aid programs to those that do not participate. Institutions in the former group charge tuition that is about 78 percent higher than those in the latter group. Most recently, Lucca, Nadauld, and Shen (2015) find a 65 percent pass-through effect for changes in federal subsidized loans and positive but smaller pass-through effects for changes in Pell grants and unsubsidized loans.

In contrast to the previous literature, several papers reject or find little evidence for the Bennett hypothesis. For example, in their commissioned report for the 1998 reauthorization of the Higher Education Act, Cunningham et al. (2001, x) conclude that "the models found no associations between most of the aid variables and changes in tuition in either the public or private not-for-profit sectors." These sentiments are echoed by Long (2006). Last, Frederick, Schmidt, and Davis (2012) study the response of community colleges to changes in federal aid and find little evidence of capture.

Our model likely exaggerates the impact of the Bennett hypothesis. As we discuss in section 10.4, the representative college engages in an implausibly high degree of rent extraction despite the presence of preference shocks. We suspect that more competition in our model of the higher education market would temper the magnitude of the tuition increase attributable to the Bennett hypothesis.

Macroeconomic Forces: Rising College Earnings Premiums. According to data from Autor, Katz, and Kearney (2008), the college earnings premium increased from 58 percent in the mid-1980s to 93 percent in 2005. While we remain agnostic about the cause of the increasing premium, several papers, including Autor, Katz, and Kearney (2008), Katz and Murphy (1992), Goldin and Katz (2007), and Card and Lemieux (2001), ascribe it to skill-biased technological change combined with a fall in the relative supply of college graduates.

In recent work, Andrews, Li, and Lovenheim (2012) study the *distribution* of college earnings premiums and find substantial heterogeneity attributable to variation in college quality. Hoekstra (2009) looks at earnings of white males ten to fifteen years after high school graduation and finds a premium of 20 percent for students who attended the most selective state university relative to those who barely missed the admissions cutoff and went else-where. Incorporating this heterogeneity in college earnings premiums may help explain why tuition increases at selective schools (such as public and private research universities) have outpaced those at less selective schools.

Quantitative Models of Higher Education

Our chapter also fits into a growing body of papers that employ structural models of higher education such as Abbott et al. (2013), Athreya and Eberly (2013), Ionescu and Simpson (2016), Ionescu (2011), Garriga and Keightley (2010), Lochner and Monge-Naranjo (2011), Belley and Lochner (2007), and Keane and Wolpin (2001). In the interest of space, we discuss only the most closely related papers.

Recent work by Jones and Yang (2016) closely mirrors the objectives of this chapter. They explore the role of skill-biased technical change in explaining the rise in college costs from 1961 to 2009. Their paper differs from our chapter in several ways. First, whereas they explore the effect of cost disease on higher college costs, we quantify the role of supply-side as well as demand-side shocks. Second, Jones and Yang (2016) analyze college costs—which increased by 35 percent in real terms between 1987 and 2010—whereas we address the increase in net tuition, which went up by 92 percent. Also, whereas they use a competitive framework, we employ a model with peer effects, imperfect competition with price discrimination, and student loan borrowing with default. Fillmore (2014) also analyzes a model of price discriminating colleges, but he treats peer effects in a reduced-form way. Fu (2014) considers a rich game-theoretic framework of college admissions and enrollment but does not allow for price discrimination.

10.2 The Model

The model embeds a college sector into a discrete-time open economy. A fixed measure of heterogeneous households enter the economy upon graduating high school, make college enrollment decisions, and then progress through their working life and into retirement. A monopolistic college with the ability to price discriminate transforms students into college graduates (with dropout risk), and the government levies taxes to finance student loans.

10.2.1 Households

We describe sequentially the environment faced by youths, college students, and finally, workers and retirees. We immediately follow this discussion with a description of colleges in the model. Section 10.2.4 gives the decision problems for all agents in the economy.

Youths

Youths enter the economy at $j = 1$ (corresponding to high school graduation at age eighteen), at which point they draw a two-dimensional vector of characteristics $s_Y = (x, y_p)$ consisting of academic ability x and parental income y_p from a distribution G. Youths make a once-and-for-all choice to either enroll in college or enter the workforce. In addition to the explicit pecuniary and nonpecuniary benefits of college that we will describe momentarily, youths receive a preference shock $(1/\alpha)\varepsilon$ of attending college, where $\alpha > 0$ and ε comes from a type 1 extreme distribution. Colleges cannot condition tuition on the preference shock.

College Students

Newly enrolled students enter college with their vector of characteristics s_Y and a zero initial student loan balance, $l = 0$. Colleges charge type-specific net tuition $T(s_Y)$—equal to sticker price $\bar{T}$ minus institutional aid—which they hold fixed for the duration of enrollment.

Students also face nontuition expenses ϕ that act as perfect substitutes for consumption c. Direct government grants $\zeta(T + \phi, \text{EFC}(s_Y))$ offset some of the cost of attendance, where $\text{EFC}(s_Y)$ represents the expected family contribution—a formula used by the government to determine eligibility for need-based grants and loans. After taking into account both forms of aid, the net cost of attendance comes out to $\text{NCOA}(s_Y) = T(s_Y) + \phi - \zeta(T(s_Y) + \phi, \text{EFC}(s_Y))$.

While enrolled, college students receive additively separable flow utility $v(q)$, which increases in college quality q.[4] In order to graduate, students must complete J_Y years of college. Students in class j return to college each year with probability $\pi_{j+1} \equiv \mathbf{1}_{[j+1 \le J_Y]}$; otherwise, they either drop out or graduate.[5]

Students can borrow through the FSLP. Of primary interest, the FSLP features subsidized loans that do not accrue interest while the student is in college, where eligibility depends on financial need (NCOA less EFC). Since 1993, students can borrow additional funds up to the net cost of attendance using unsubsidized loans. Students face annual and aggregate limits for subsidized and combined borrowing.

Denote the annual and aggregate combined limits by $\bar{b}_j$ and $\bar{l}$, respectively.[6] Because students can borrow only up to the net cost of attendance, their annual combined subsidized borrowing b_s and unsubsidized borrowing b_u must satisfy

$$b_s + b_u \le \min\{\bar{b}_j, \text{NCOA}(s_Y)\}. \tag{1}$$

4. To improve tractability while computing the transition path, we assume students receive $v(q)$ each year based on the college's quality q at the time of *initial* enrollment. In the computation, we make the isomorphic assumption that students receive the net present value of $v(q)$ at the time of enrollment.

5. We do not allow endogenous dropout for reasons of tractability.

6. The aggregate limit caps maximum loan balances the period after borrowing, inclusive of interest.

Similarly, define $\bar{b}_j^s$ as the statutory annual subsidized limit and $\bar{l}_j^s$ as the statutory aggregate subsidized limit. The actual amount $\tilde{b}_j^s(s_Y)$ that students can borrow in subsidized loans depends on their net cost of attendance and the expected family contribution, both of which vary with student type. Last, define $\tilde{l}_j^s(s_Y)$ as the maximum amount of subsidized loans that students can accumulate by year j in college. Mathematically,

$$\tilde{b}_j^s(s_Y) = \min\{\bar{b}_j^s, \max\{0, \mathrm{NCOA}(s_Y) - \mathrm{EFC}(s_Y)\}\} \tag{2}$$
$$\tilde{l}_j^s(s_Y) = \min\{\bar{l}^s, \Sigma_{i=1}^j \tilde{b}_i^s(s_Y)\}.$$

Given the superior financial terms of subsidized loans, we assume that students always exhaust their subsidized borrowing capacity before taking out any unsubsidized loans. Furthermore, to increase tractability, we assume that borrowers can carry over unused *subsidized* borrowing capacity into subsequent years. These two assumptions reduce the state space and significantly simplify the student's debt portfolio choice problem.

Apart from loans, students have two other means of paying for college. First, they have earnings e_Y, which we treat as an endowment.[7] Second, they receive a parental transfer $\xi\mathrm{EFC}(s_Y)$, where $0 \le \xi \le 1$ is a parameter.

Workers/Retirees

Working and retired households receive earnings e that depend on a vector of characteristics s that includes their level of education, age/retirement status, and a stochastic component. Each period, households face a proportional earnings tax τ.

These households value consumption according to a period utility function $u(c)$ and discount the future at rate β. Workers with student loans face a loan interest rate of i and amortization payments of $p(l, t) = l\{[i(1 + i)^{t-1}]/[(1 + i)^t - 1]\}$ where l represents the loan balance and t the remaining duration. All households can use a discount bond to save at the risk-free rate r^* and borrow up to the natural borrowing limit $\bar{a}$ at rate $r^* + \iota$, where ι is the interest premium on borrowing. The price of the bond is denoted $(1 + r(a'))^{-1}$.

10.2.2 Colleges

There is one representative college. Following Epple, Romano, and Sieg (2006), the college seeks to maximize its quality (or prestige), q, which depends on the average academic ability θ of the student body and on investment expenditures per student, I. The college's other expenses include non-quality-enhancing custodial costs $F + C(\{N_j\}_{j=1}^{J_Y})$, where F represents a fixed cost and C is an increasing, twice-differentiable, convex function of enrollment $\{N_j\}_{j=1}^{J_Y}$.

7. We abstract from labor supply choice and the trade-off between increased earnings and studying.

The college finances its expenditures with two sources of revenue. First, the college has exogenous nontuition revenue per student E, which includes endowment income, government appropriations, and revenues from auxiliary enterprises. Second, the college has endogenous tuition revenue, a function of enrollment decisions and type-specific net tuition $T(s_Y)$. The college is a nonprofit and, given our assumption of an exogenous endowment stream, runs a balanced budget period-by-period.[8]

In order to avoid dealing with issues such as the college's discount factor—not to mention other difficulties associated with the transition path computation—we make the college problem static through four assumptions. First, we assume that college quality $q(\theta, I)$ depends on the academic ability of *freshmen* and investment expenditures per *freshman* student.[9] Second, we assume that colleges face a quadratic cost function for each *class* given by

$$F + C(\{N_j\}_{j=1}^{J_Y}) = F + \sum_{j=1}^{J_Y} c(n_j) \tag{3}$$

where N_j is the population measure in class j ($j = 1$ for freshmen, $j = 2$ for sophomores, etc.) and $n_j \equiv N_j/(1/J)$ is the measure relative to the age-eighteen population (for scaling purposes in the estimation). Third, we assume the college has no access to credit markets. Last, we isolate the effect of current tuition and spending decisions on *future* budget conditions. Specifically, we assume that each year the college exchanges the rights to all future budget flows generated by contemporaneous tuition and expenditure decisions in exchange for an immediate net present value payment from the government. This last assumption implicitly rules out any "quality smoothing" on the part of the college and captures the fact that administrators typically have short tenures that may make borrowing against expected future flows challenging.[10]

10.2.3 Legal Environment and Government Policy

Consistent with US law, workers in the model cannot liquidate their student loan debt through bankruptcy. However, they *can* skip payments and become delinquent. Upon initial default, workers enter delinquency status and face a proportional loan penalty of η that accrues to their existing balance. In subsequent periods, delinquent workers face a proportional wage garnishment of γ until they rehabilitate their loan by making a payment. Upon rehabilitation, the loan duration resets to the statutory value $t_{\max}$ and the amortization schedule adjusts accordingly.

The government operates the student loan program and finances itself

8. Technically, the nonprofit status of the college only implies that it cannot distribute dividends. However, we abstract from strategic decisions regarding endowment accumulation.

9. We assume the college commits to a level of I for the duration of each incoming cohort's enrollment.

10. The average tenure of a dean is five years (Wolverton et al. 2001).

with a combination of taxation on labor earnings, funds from loan repayments and wage garnishments, and the revenue flows generated by colleges discussed above. We assume that the government sets the tax rate τ to balance its budget period-by-period.

10.2.4 Decision Problems

Now we work backward through the life cycle to describe the household-decision problem. Afterward, we describe the college's optimization problem.

Workers/Retirees

Households start each period with asset position a, student loan balance l and duration t, characteristics s, and delinquency status $f \in \{0,1\}$, where $f = 0$ indicates good standing. Households in good standing on their student loans choose consumption, savings, and whether to make their scheduled loan payment. These households have the value function

$$V(a,l,t,s,f = 0) = \max\{V^R(a,l,t,s), V^D(a,l(1+\eta),s)\} \tag{4}$$

where V^R is the utility of repayment and V^D is the utility of delinquency. Note that η increases the stock of outstanding debt in the case of a default.

Households in bad standing face the decision of whether to rehabilitate their loan or remain delinquent. Their value function is

$$V(a,l,s,f = 1) = \max\{V^R(a,l,t_{\max},s), V^D(a,l,s)\}. \tag{5}$$

Household utility conditional on repayment or rehabilitation is given by

$$\begin{aligned} V^R(a,l,t,s) = \max_{c \geq 0, a' \geq \underline{a}} & \; u(c) + \beta \mathbb{E}_{s'|s} V(a',l',t',s',f' = 0) \\ \text{subject to} & \\ & c + a'/(1+r(a')) + p(l,t) \leq e(s)(1-\tau) + a \\ & l' = (l - p(l,t))(1+i), \; t' = \max\{t-1, 0\}. \end{aligned} \tag{6}$$

The value of defaulting (if $f = 0$) or not rehabilitating a loan (if $f = 1$) is[11]

$$\begin{aligned} V^D(a,l,s) = \max_{c \geq 0, a' \geq \underline{a}} & \; u(c) + \beta \mathbb{E}_{s'|s} V(a',l',s',f' = 1) \\ \text{subject to} & \\ & c + a'/(1+r(a')) \leq e(s)(1-\tau)(1-\gamma) + a \\ & l' = \max\{0, (l - e(s)(1-\tau)\gamma)(1+i)\}. \end{aligned} \tag{7}$$

In the last period of life, households have no continuation utility and no ability to borrow or save. We allow households to die with student loan debt.

11. In the case of a default, note that η has already been applied to the loan balance in equation (4).

College Students

College students with characteristics $s_Y = (x, y_p)$ and debt l choose consumption and additional loans, $l' \geq l$ (to speed up computation, we assume that students do not pay back their loans while in college). We also introduce an annual *unsubsidized* borrowing limit $\bar{b}_j^u$ that equals either the combined limit or zero (the latter case captures the pre-1993 environment).

Taking college quality q and the net tuition function $T(\cdot)$ as given, students solve

$$(8)\quad Y_j(l, s_Y; T, q) = \max_{c \geq 0, l' \geq l} u(c + \phi) + v(q) + \beta \begin{bmatrix} \pi_{j+1} Y_{j+1}(l', s_Y; T) + (1 - \pi_{j+1}) \\ \times \mathbb{E}_{s'|j,s_Y} V(a' = 0, l', t_{\max}, s', 0) \end{bmatrix}$$

subject to

$$c + \text{NCOA}(s_Y) \leq e_Y + \xi \text{EFC}(s_Y) + b_s + b_u$$

$$(l'_s, l'_u) = \begin{cases} (l', 0) & \text{if } l' \leq \tilde{l}_j^s(s_Y) \\ (\tilde{l}_j^s(s_Y), l' - \tilde{l}_j^s(s_Y)) & \text{otherwise} \end{cases}$$

$$(l_s, l_u) = \begin{cases} (l, 0) & \text{if } l \leq \tilde{l}_{j-1}^s(s_Y) \\ (\tilde{l}_{j-1}^s(s_Y), l - \tilde{l}_{j-1}^s(s_Y)) & \text{otherwise} \end{cases}$$

$$b_s = l'_s - l_s$$

$$b_u = \frac{l'_u}{1+i} = l_u$$

$$l' + \frac{l'_u}{1+i} \leq \bar{l}$$

$$b_u \leq \min\{\bar{b}_j^u, \text{NCOA}(s_Y)\}$$

$$b_s + b_u \leq \min\{\bar{b}_j, \text{NCOA}(s_Y)\}.$$

Note from these equations that our setup allows us to easily decompose student debt into its subsidized and unsubsidized components. We deflate l'_u by $1 + i$ in the aggregate borrowing constraint because the loan limit is inclusive of interest accrued by unsubsidized loans.

Youth

Youth making their college enrollment decisions have value function

$$(9)\quad \max\left\{ \underbrace{\mathbb{E}_{s|s_Y} V_1(a = 0, l = 0, t = 0, s)}_{\text{enterthelaborforce}}, \underbrace{Y_1(l = 0, s_Y; T, q) + \frac{1}{\alpha}\varepsilon}_{\text{attendcollege}} \right\}$$

where ε denotes the college preference shock and s is the initial worker characteristics draw.

Colleges

The college problem can be written as

$$\max_{I \geq 0, T(\cdot)} q(\theta, I) \tag{10}$$

subject to

$$\mathcal{E} + \mathcal{T} = F + \mathcal{C}(N_1) + \mathcal{J}$$

$$N_1 = \int \mathbb{P}(\text{enroll}|s_Y; T(\cdot), q) d\mu_0(s_Y)$$

$$\theta N_1 = \int x(s_Y) \mathbb{P}(\text{enroll}|s_Y; T(\cdot), q) d\mu_0(s_Y)$$

$$\mathcal{T} = \sum_{j=1}^{J_Y} \frac{\pi^{j-1} \int T(s_Y) \mathbb{P}(\text{enroll}|s_Y; T(\cdot), q) d\mu_0(s_Y)}{(1 + r^*)^{j-1}}$$

$$\mathcal{E} = E \sum_{j=1}^{J_Y} \frac{\pi^{j-1} N_1}{(1 + r^*)^{j-1}}$$

$$\mathcal{C}(N_1) = \sum_{j=1}^{J_Y} \frac{c\{\pi^{j-1}[N_1/(1/J)]\}}{(1 + r^*)^{j-1}}$$

$$\mathcal{J} = I \sum_{j=1}^{J_Y} \frac{\pi^{j-1} N_1}{(1 + r^*)^{j-1}}$$

where $\mu_0(s_Y) \equiv G(s_Y)/J$ is the distribution of characteristics across the age-eighteen population.

The first constraint reflects the college balanced budget requirement, while the remaining constraints establish the definitions of enrollment, average freshman ability, tuition revenues, nontuition revenues, custodial costs, and investment expenditures, respectively.

10.2.5 Steady-State Equilibrium

A steady-state equilibrium consists of household value and policy functions, a tax rate, college policies and quality, and a distribution of households such that

1. The household value and policy functions satisfy (4–9).
2. The college policies and quality satisfy (10).
3. The government budget balances.
4. The distribution is invariant.

10.3 Data and Estimation

We calibrate the model to replicate key features of the US economy and higher education sector in 1987. These initial conditions set the stage for the results section, which feeds in the observed changes between 1987 and 2010 described in the introduction to assess their impact on equilibrium tuition. We proceed through our description of the calibration and estimation in the same order as we described the model.

10.3.1 Households

Youths

We determine the distribution G of youth characteristics $s_Y = (x, y_p)$ using data from the National Longitudinal Survey of Youth 1997 (NLSY97). The ability measure comes from percentiles on the Armed Services Vocational *Aptitude* Battery (ASVAB) test. For parental income, we use the household income measure from 1997 in those cases where the data correspond to the parents rather than the youth (98.0 percent of cases).

Conditional on our ability measure, parental income resembles a truncated normal distribution. This can be seen in figure 1 of web appendix A (http://www.nber.org/data-appendix/c13711/appendix.pdf). To handle truncation from above due to top-coding and truncation from below, we estimate a Tobit model where parental income depends on ability. Specifically, we estimate

$$y_i^* = \beta_0 + \beta_1 x_i + \varepsilon_i \tag{11}$$

$$y_i = \min\{\max\{0, y_i^*\}, \overline{y}\}$$

where y_i is the observed parental income, y_i^* is the "true" parental income, and $\varepsilon_i \sim N(0, \sigma^2)$.[12] The parameter $\overline{y}$ corresponds to the 2 percent top-coded level implemented in the NLSY97 (we find $\overline{y}$ = \$226,546 in 2010 dollars). In 2010 dollars, we find β_0 = \$40,006, β_1 = \$614.6, and σ = \$48,012, with standard errors of \$1,529, \$25.95, and \$543.4, respectively. By the construction of x in NLSY97, $x \sim U[0,100]$. Hence, our estimation implies that, all else equal, parents of children at the top of the ability distribution earn \$152,900 more on average than parents of children at the bottom of the ability distribution. We assume the joint distribution is time invariant.

Table 10.1 reports the correlation between ability, observed parental income, and enrollment. All the correlations are significant at more than a 99.9 percent confidence level. We use the correlation between ability and

12. The NLSY97 top-codes at the 2 percent level by replacing the true value with the conditional mean of the top 2 percent. In this estimation, we bound the observed value at the 2 percent threshold value.

Table 10.1 Correlations between ability, parental income, and enrollment

	Ability	Parental income	Enrollment
Ability	1.0000		
Parental income	0.3164	1.0000	
Enrollment	0.5216	0.2952	1.0000

enrollment as a calibration target and the correlation between enrollment and parental income as an untargeted prediction of the model.

College Students

For our specification of the expected family contribution function $\text{EFC}(s_Y)$, we use an approximation from Epple et al. (2013) to the true statutory formula. Specifically, we assume a mapping between raw and adjusted gross parental income of $\tilde{y}(y_p) = y(1 + .07 \cdot \mathbf{1}[y \geq \$50000])$ and an EFC formula given by $\text{EFC}(y_p) = \max\{\tilde{y}(y_p)/5.5 - \$5{,}000, \tilde{y}(y_p)/3.2 - \$16{,}000, 0\}$ in 2009 dollars.

We assume that the government grants $\zeta(T + \phi, \text{EFC}(s_Y))$ are given by

$$(12) \qquad \zeta(T(s_Y) + \phi, \text{EFC}(s_Y)) = \begin{cases} \zeta^F \overline{\zeta} & \text{if } \zeta^F \overline{\zeta} \leq T(s_Y) + \phi - \text{EFC}(s_Y) \\ 0 & \text{otherwise} \end{cases},$$

which reflects their progressive nature. First, we estimate the average value of government grants $\overline{\zeta}$ from the college-level Integrated Postsecondary Education Data (IPEDS) published by the National Center for Education Statistics (NCES). Then, we calibrate $\zeta^F \geq 1$ to match average grants per student, $\overline{\zeta}$, in the initial steady state. Over the transition path we keep ζ^F constant but vary $\overline{\zeta}$.

The utility function $u(c) = c^{1-\sigma}/(1-\sigma)$ for students as well as workers and retirees features constant relative risk aversion. We use the standard parametrization of $\sigma = 2$ and $\beta = 0.96$. We assume utility from college quality is linear, $v(q) = q$ (and so all curvature comes from the production function $q(\theta, I)$).

To determine student earnings e_Y while in college, we again turn to the NLSY97. For our sample, students enrolled in a four-year college earn on average \$7,128 (in 2010 dollars).[13] We convert this to model units and set e^Y equal to it. The mapping from dollars into model units is discussed in the web appendix, section B.1.

Recall that the annual retention rate satisfies $\pi_{j+1} = \pi \mathbf{1}[j + 1 \leq J_Y]$, which implies constant progression probabilities for students in years $1, \cdots, J_Y - 1$. Students in their last year, which we set to $J_Y = 5$, successfully graduate and

13. Students work an average of 824 hours a year in the NLSY97. Using different data, Ionescu (2011) reports similar results of 46 percent of full-time students working with mean worker earnings of \$20,431 in 2007 dollars.

earn a diploma with this same probability. We set $\pi = 0.556^{1/J_Y}$ to match the aggregate completion rate of 55.6 percent reported by Ionescu and Simpson (2016).

Last, we allow the nontuition cost of attending college, ϕ, which plays a significant part in determining eligibility for subsidized loans, to vary over the transition path. We measure ϕ using room-and-board estimates from the NCES (NCES 2015c).

Workers/Retirees

The earnings process for working households follows

$$\begin{aligned} \log e_{ijt} &= \lambda_t h_i / J_Y + \mu_j + z_{ij} + \nu \\ z_{i,j+1} &= \rho z_{ij} + \eta_{i,j+1} \\ \eta_{i,j+1} &\sim N(0, \sigma_z^2) \end{aligned} \tag{13}$$

where h_i is the number of completed years of college, i is an individual identifier, j is age, and t is time. Households who begin working at age j draw z_{ij} from an unconditional distribution with mean zero and variance $\sigma_z^2(1 + \ldots + \rho^{2(j-1)})$. For the persistent shock, we use Storesletten, Telmer, and Yaron's (2004) estimates in setting $(\rho, \sigma_z) = (0.952, 0.168)$.[14] The deterministic earnings profile μ_j is a cubic function of age with coefficients also taken from Storesletten, Telmer, and Yaron (2004).[15]

In the model, λ_t represents the earnings premium for college graduates relative to high school graduates. We compute λ_t using the estimates from Autor, Katz, and Kearney (2008), which range from roughly 0.43 in the 1960s and 1970s to 0.65 in the early twenty-first century. To deal with the fact that Autor, Katz, and Kearney (2008) estimate values only up until 2005, we fit a quadratic polynomial over 1988–2005 and extrapolate for 2006–2010.[16] We use the fitted values (both in-sample and out-of-sample) for λ_t, and they are presented in web appendix A (web appendix B gives a comparison of the raw and fitted values).

Retired households ($j > J_R = 48$) have constant earnings given by $\log e_{ijt} = \log(0.5) + \lambda_t h_i / J_Y + \mu_{J_R} + v$, which yields an average replacement rate of roughly 50 percent.

10.3.2 Legal Environment and Government Policy

We set the duration of loan repayment to its value in the federal student loan program, $t_{\max} = 10$. Two parameters—the loan balance penalty η and

14. Storesletten, Telmer, and Yaron (2004) let σ vary with the business cycle and estimate $\sigma = .211$ for recessions and $\sigma = .125$ for expansions. We average these.

15. In principle, one could include a cohort-specific term that allows for average log earnings in the economy to grow over time. However, we found that such a term is negligible in the data as we show in web appendix B.1.

16. The "1987" college premium corresponds to the average from 1981 to 1987.

garnishment rate γ—control the cost of student loan delinquency. Various changes in student loan default laws between 1987 and 2010 render obtaining values for these parameters less than straightforward.[17] Our approach sets $\eta = 0.05$ (which is half the value in Ionescu [2011], and only a fifth of the current statutory maximum) and then pins down γ in the joint calibration to match the 17.6 percent student loan default rate in 1987.

10.3.3 Colleges

We need to parametrize and provide estimates for the per-student endowment E, the quality production function $q(\theta, I)$, and custodial costs $F + C(\{N_j\}_{j=1}^{J_Y})$.

Institution-Level Data

Our primary source for college revenue and expenditures is institution-level data from the Delta Cost Project (DCP), which is drawn from the National Center for Education Statistics Integrated Postsecondary Education Data System (IPEDS). One important distinction between our DCP-based average tuition measures and those reported by the nces330p10y15 (in table 330.10) is that, for public colleges, the NCES only uses in-state tuition.[18] Consequently, the gross tuition and fees in our data are larger than those reported by the NCES. However, despite this discrepancy in levels, figure 10.1 shows that the trend growth in gross tuition and fees between the two measures is nearly identical.

For sample selection, we restrict attention to four-year, nonprofit, nonspecialty institutions (according to their Carnegie classification) that have nonmissing enrollment and tuition data in every year of the DCP data from 1987 to 2010.[19] Additionally, we drop institutions with fewer than 100 FTE students or net tuition per FTE outside of the 1st–99th percentile range.

The college budget constraint in the model features custodial costs, endowment income, quality-enhancing investment, and tuition. The corresponding data measures are as follows:

- Endowment: total nontuition revenue, which is the sum of (non-Pell) grants at the federal, state, and local levels plus all auxiliary revenue.
- Investment: total education and general expenditures including sponsored research but excluding auxiliary enterprises.
- Tuition: net tuition and fees revenue.
- Custodial costs: a residual computed as the endowment plus tuition less investment.

Web appendix A provides more details on our use of the DCP data.

17. See Ionescu (2011) for changes in student loan default laws.
18. This difference in methodologies accounts for the mismatch in reported tuition numbers brought up by our discussant, Sandy Baum.
19. The DCP data is released at a multiyear lag, and all indications are that changes in college tuition continue to outpace inflation.

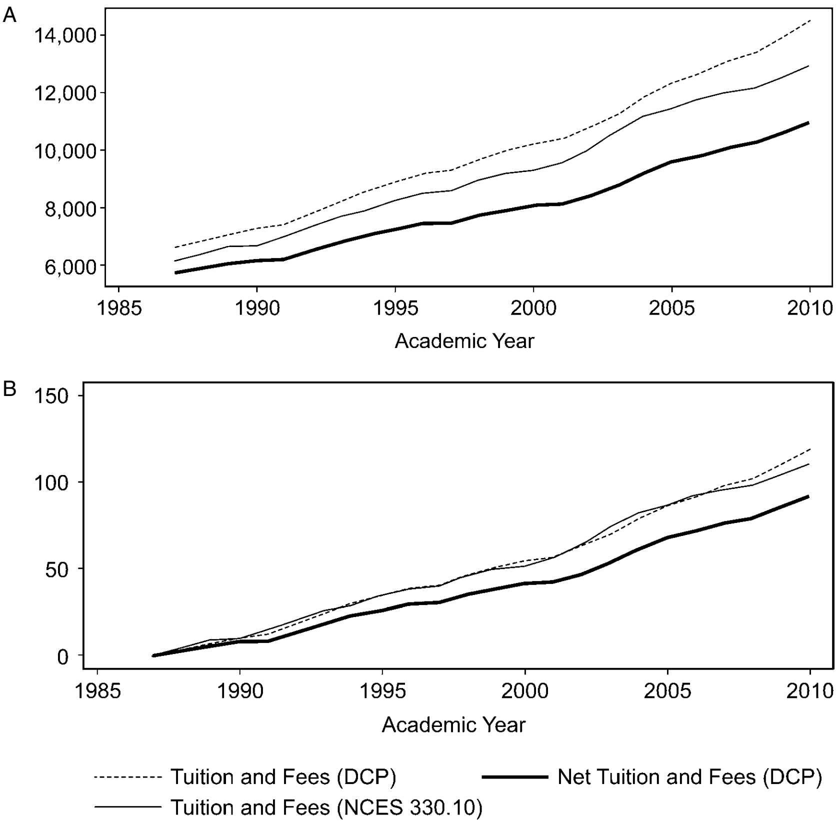

Fig. 10.1 College tuition trends: DCP versus NCES. *A*, real tuition per FTE; *B*, real tuition per FTE, percentage change since 1987.

Notes: 2010 dollars per FTE. The DCP series are authors' calculations using Delta Cost Project data. NCES 330.10 from https://nces.ed.gov/programs/digest/d13/tables/dt13_330.10.asp, retrieved 3/28/16. NCES 330.10 conversion to 2010 dollars is authors' calculation. NCES 330.10 assumes only in-state tuition is charged.

Calibrated Parameters

We set the per-student endowment E equal to nontuition revenues per FTE student in the 1987 IPEDS data, and then we vary E along the transition path. Figure 10.2 plots the time series for E and other key aggregates. For college quality, we follow Epple et al. (2013) and choose a Cobb-Douglas functional form, $q(\theta, I) = \chi_q \theta^{\chi_\theta} I^{\chi_I}$, where $\chi_I = 1 - \chi_\theta$.[20]

The local first-order conditions of the college problem provide some

20. In principle, $q(\theta, I)$ need not satisfy constant returns to scale. With one college, it is difficult to pin down—using only steady state information—what the returns should be. With multiple colleges, dispersion in θ and I translates into dispersion in q that is controlled by returns to scale.

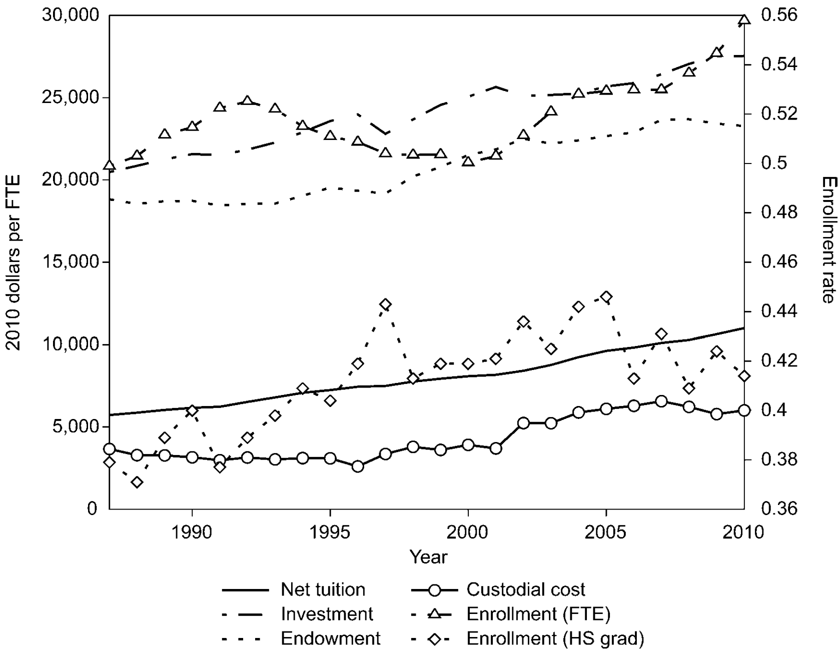

Fig. 10.2 College cost, expenditure, and enrollment trends

insight into calibrating χ_θ and χ_q. The key tuition-pricing condition comes out to

$$(14) \quad T(s_Y) + \frac{\mathbb{P}(\text{enroll} \mid s_Y; T(\cdot), q)}{\partial \mathbb{P}(\text{enroll} \mid s_Y; T(\cdot), q) \, / \, \partial T} = C'(N) + I + \frac{q_\theta}{q_I}(\theta - x(s_Y))$$

where $\mathbb{P}(\text{enroll} \mid s_Y; Ts_Y, q)$ comes from the decision rule of youths for whether to attend college, taking into account the idiosyncratic preference shock ε. Epple et al. (2013) label the collected right-hand-side terms the "effective marginal cost" (EMC) of a type-s_Y student, which captures the fact that students act both as customers *and* as inputs to the production of quality (an argument put forth by Winston [1999] and others). The above equation states that colleges admit any student to whom they can charge at least EMC(s_Y).

With our Cobb-Douglas specification, $q\theta/q_I = (\chi_\theta/\chi_I)(I/\theta) = [\chi_\theta/(1 - \chi_\theta)](I/\theta)$. The degree to which EMC(s_Y), and therefore tuition $T(s_Y)$, varies by student type depends on χ_θ. This price discrimination generates cross-sectional enrollment patterns that we use to target χ_θ and χ_q. Specifically, we target overall enrollment and the correlation between parental income and enrollment.

Cost Function Estimation

Like in Epple, Romano, and Sieg (2006), we estimate the college's custodial cost function directly. In particular, we assume that the custodial costs by class, $c(n)$, have the functional form $C^1 n + C^2 n^2$. When we explicitly allow for time-varying coefficients, custodial costs satisfy

$$F_t + C_t(\{N_{jt}\}_{j=1}^{J_Y}) = F_t + C_t^1 \sum_{j=1}^{J_Y} n_{jt} + C_t^2 \sum_{j=1}^{J_Y} n_{jt}^2 \tag{15}$$

where $n_{jt} \equiv N_{jt}/(1/J)$ is class j enrollment in year t relative to the age-eighteen population.

To identify F_t, C_t^1, and C_t^2, we estimate cost functions for individual colleges using IPEDS data and then aggregate them. Let college i's cost function at time t be given by

$$\mathfrak{c}_{it} = \alpha_i + \mathfrak{c}_t^0 + \mathfrak{c}_t^1 \sum_{j=1}^{J_Y} n_{ijt} + \mathfrak{c}_t^2 \sum_{j=1}^{J_Y} n_{ijt}^2 + \varepsilon_{it}. \tag{16}$$

Here, α_i is a fixed effect and both α_i and ε_{it} are i.d.d. normally distributed with mean zero.

The IPEDS data contains enrollment information but not its composition by class. To deal with this problem and to create consistency with the model, we assume a constant retention rate π and a five-year college term, $J_Y = 5$. Given π, J_Y, and total FTE enrollment data by school relative to the age-eighteen population, we calculate implied class j enrollment as $n_{ijt} = \pi^{j-1}\mathrm{FTE}_{it}/\sum_{\iota=1}^{J_Y}\pi^{\iota-1}$. Thus, the two summation terms in the cost function come out to $\sum_{j=1}^{J_Y} n_{ijt} = \mathrm{FTE}_{it}$ and $\sum_{j=1}^{J_Y} n_{ijt}^2 = \mathrm{FTE}_{it}^2 \sum_{j=1}^{J_Y} \pi^{2(j-1)}/(\sum_{j=1}^{J_Y}\pi^{j-1})^2$. As a result,

$$\mathfrak{c}_{it} = \alpha_i + \mathfrak{c}_t^0 + \mathfrak{c}_t^1 \mathrm{FTE}_{it} + \mathfrak{c}_t^2 \mathrm{FTE}_{it}^2 \frac{\sum_{j=1}^{J_Y} \pi^{2(j-1)}}{\left(\sum_{j=1}^{J_Y} \pi^{j-1}\right)^2} + \varepsilon_{it}. \tag{17}$$

As in Epple, Romano, and Sieg (2006), we measure custodial costs as a residual in the college budget constraint, which gives us

$$\mathfrak{c}_{it} \equiv \mathfrak{e}_{it} + \mathfrak{t}_{it} - \mathfrak{i}_{it}. \tag{18}$$

The first term, $\mathfrak{e}_{it}$, represents total nontuition revenue in IPEDS (which consists mostly of endowment revenue and government appropriations), while $\mathfrak{t}_{it}$ and $\mathfrak{i}_{it}$ equal net tuition revenues and total education and general (E&G) expenditures, respectively. Intuitively, our cost measure reflects the fact that, holding investment $\mathfrak{i}_{it}$ constant, higher costs must accompany any observed increase in revenues in order to maintain a balanced budget. Using these definitions, we run the fixed effects panel regression above to obtain $\{(\mathfrak{c}_t^0, \mathfrak{c}_t^1, \mathfrak{c}_t^2)\}_{t=1987}^{2010}$.

To translate the individual cost function estimates into the aggregate cost function, we sum costs over colleges. In particular, to calculate the total cost

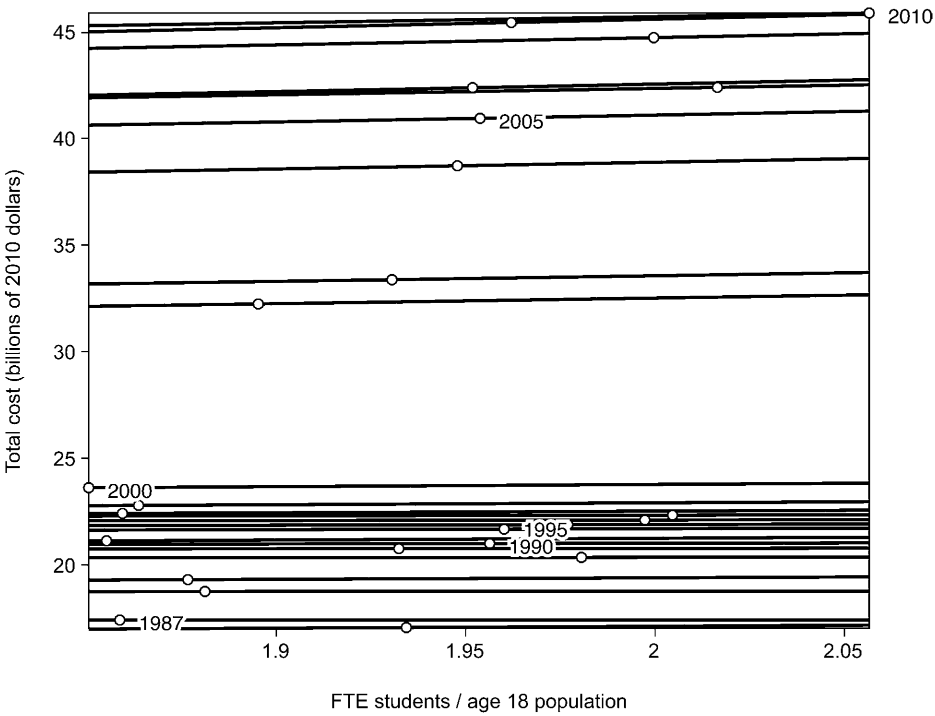

Fig. 10.3 Estimated aggregate cost function by year

of educating $\{N_{jt}\}_{j=1}^{J_Y}$ students, we assume students sort across colleges $i = 1, \ldots, K$ in proportion to the observed share in the data.[21] Define $s_{ijt} \equiv N_{ijt}/N_{jt} = n_{ijt}/n_{jt}$ as the share of students in class j at time t who attend college i. From our assumption of geometric retention probabilities, this share does not vary with j, that is, $s_{ijt} = s_{it}$. Thus, $N_{ijt} = s_{it}N_{jt}$ and $n_{ijt} = s_{it}n_{jt}$ for all j, which gives us[22]

$$(19) \qquad F_t + C_t(\{N_{jt}\}_{j=1}^{J_Y}) = K\mathrm{c}_t^0 + \mathrm{c}_t^1\sum_{j=1}^{J_Y} n_{jt} + \left(\mathrm{c}_t^2\sum_{i=1}^{K} s_{it}^2\right)\sum_{j=1}^{J_Y} n_{jt}^2.$$

This mapping between individual colleges and the representative college yields $F_t = K\mathrm{c}_t^0$, $C_t^1 = \mathrm{c}_t^1$, and $C_t^2 = \mathrm{c}_t^2\sum_i s_{it}^2$.

The web appendix presents the estimates. We found it necessary to impose $\mathrm{c}_t^1 = 0$ to ensure an increasing aggregate cost function over the relevant range

21. We allow K to vary over time in the estimation (it is the number of colleges in the sample) but treat it as fixed here to simplify the exposition.

22. We assume that $\sum_i \alpha_i = 0$ and $\sum_i \varepsilon_{it} = 0$, where the first assumption is required for identification in the fixed effects regression.

of N. Figure 10.3 plots the aggregate cost function over time and circles the realized values from each year.

10.3.4 Joint Calibration

We determine the remaining parameters (ν, ξ, γ, χ_θ, χ_q, ζ^F, α) jointly such that the initial steady state matches the following moments in 1987: average earnings, average net tuition, the two-year cohort default rate, the correlation between parental income and enrollment, the enrollment rate, the average grant size, and the percent of students with loans.[23]

Table 10.2 summarizes the calibration. Note that, while the table associates each parameter in the joint calibration with an individual moment, the calibration identifies the parameters simultaneously, rather than separately. We discuss model fit next.

10.3.5 Model Fit

Table 10.3 presents key higher education statistics from the model and the data. The calibration of the initial steady state directly targets the first set of statistics from 1987, while the remaining statistics act as an informal test of the model. Note that, while the calibration matches mean earnings, net tuition, and the two-year default rate from 1987 quite well, the model generates too little enrollment and too many students with loans.

We pinpoint two sources for these shortcomings. First, the presence of only one college in the model generates too much market power, which results in a small calibrated value for the parental transfers parameter ξ in order to still match average net tuition. Thus, students rely more on borrowing. Second, by omitting ability terms in the postcollege-earnings process, we implicitly attribute the entire college premium to the sheepskin effect of a diploma (as opposed to selection effects). This exaggerated sheepskin effect generates a larger surplus from attending college, which the college partially captures through higher tuition.

Despite the presence of too many student borrowers, the model actually generates smaller average loans than in the data—\$4,600 versus \$7,100. Last, the model nearly matches investment per student of \$20,300 in 1987 and the ratio of assets to income of about three. The matching of the asset-to-income ratio reflects the fact that our model of households is, at its core, a standard incomplete markets life-cycle model.

10.4 Results

Now we present the main results. First, we compare the model's initial and terminal steady states to the data from 1987 and 2010. Next, we evaluate the

23. The correlation between parental income and enrollment is from NLSY97 (and so is not a 1987 moment).

Table 10.2 Model calibration

Description	Parameter	Value	Data	Model	Target/reason
Calibration: Independent parameters					
Discount factor	β	0.96			Standard
Risk aversion	σ	2			Standard
Savings interest rate	r^*	0.02			Standard
Borrowing premium	ι	0.107			12.7 percent rate on borrowing
Earnings in college	e_Y	$\$7,128_{2010}$			NLSY97
Loan balance penalty	η	0.05			Ionescu (2011)
Loan duration	$t_{\max}$	10			Statutory
Retention probability	π	$0.554^{1/5}$			55.4 percent completion rate
Earnings shocks	(ρ, σ_z)	(0.952,0.168)			Storesletten, Telmer, and Yaron (2004)
Age-earnings profile	μ_j	Cubic			Storesletten, Telmer, and Yaron (2004)
College premium	$\{\lambda\}$	Web appendix A			Autor, Katz, and Kearney (2008)
Nontuition costs	$\{\phi\}$	Web appendix A			IPEDS
Student loan rate	$\{i\}$	Web appendix A			Statutory
Annual loan limits	$\{\overline{b}_j^s, \overline{b}_j^u, \overline{b}_j\}$	Web appendix A			Statutory
Aggregate loan limits	$\{\overline{l}^s, \overline{l}^u, \overline{l}\}$	Web appendix A			Statutory
Custodial costs	$\{F, C^2\}$	Web appendix A			IPEDS regression
Endowment flow	$\{E\}$	Web appendix A			IPEDS
Grant aid	$\{\overline{\zeta}\}$	Web appendix A			IPEDS
Calibration: Jointly determined parameters					
Earnings normalization	ν	−1.25	31,385	31,686	Mean earnings
Parental transfers	ξ	0.208	5,723	6,146	Mean net tuition
Garnishment rate	γ	0.158	0.176	0.165	Two-year default rate
Ability input to quality	χ_θ	0.252	0.295	0.244	Corr. (p. income, enroll)
College quality loading	χ_q	2.68	0.379	0.358	Enrollment rate
Grant progressivity	ζ^F	1.85	0.027	0.025	Average grant size
Preference shock size	α	290	0.357	0.488	Percent with loans

Note: $\{x\}$ means x has a transition path given in table 2 in web appendix A; $\$x_{yyyy}$ means $\$x$, measured nominally in $_{yyyy}$ dollars, converted to model units.

Table 10.3 **Steady-state statistics**

	Model 1987	Data 1987	Model Final SS	Data 2010
Statistics targeted in 1987				
Mean earnings[z] ($)	31,686	31,385*	37,301	36,200
Mean net tuition[z] ($)	6,146	5,723*	12,428	10,999
Two-year default rate[a]	0.165	0.176*	0.167	0.091
Enrollment rate[b]	0.358	0.379*	0.560	0.414
Graduation rate[c]	0.554	0.554*	0.554	0.594
Attainment rate (grad × enroll)[z]	0.198	0.210*	0.310	0.246
Percent taking out loans[e,f]	48.8	35.7*	100.0	52.9
Corr. (parental income, enrollment)	0.244	—	0.301	0.295*
Untargeted statistics				
Investment per student[z] ($)	21,921	20,475	30,701	27,534
Average EFC[d,e,f,z] ($)	18,288	16,270	16,514	13,042
Average annual loan size for recipients[d,e,f,z] ($)	4,589	7,144	6,873	8,414
Total assets/total income[d,g,z]	3.05	2.94	3.07	3.06
Student loan volume/total income[d,h,z]	0.012	—	0.053	0.050
Newly defaulted/non-defaulted loans[h,z]	0.045	—	0.054	0.019
Newly defaulted/good standing borrowers[h,z]	0.029	—	0.046	0.032
Pop. with loans/age 18 + pop[h,i,z]	0.040	—	0.140	0.146
Ability of college graduates[z]	0.728	—	0.701	0.716
Corr. (ability, enrollment)	0.588	—	0.782	0.522
Nongarnishment payments/total income	0.002	—	0.006	—
Garnishments/total income	0.000	—	0.001	—

Note: Dashes indicate unknown values.
[a]US Department of Education (2015b)
[b]NCES (2015a)
[c]NCES (2015b)
[d]FRED (2015)
[e]Tables 2 and 7 in Wei et al. (2004)
[f]Tables 2.1-C and 3.3 Bersudskaya and Wei (2011)
[g]BEA (2015)
[h]US Department of Education (2015a)
[i]Howden and Meyer (2011)
[z]authors' calculations
*Targeted.

transition path of the model in light of the time-series data. Last, we undertake a number of counterfactual experiments to quantify the explanatory power of each tuition inflation theory.

10.4.1 Steady-State Comparisons

Tuition

Of central importance, the model generates a 102 percent increase in average net tuition—from approximately $6,100 to $12,400—between the initial

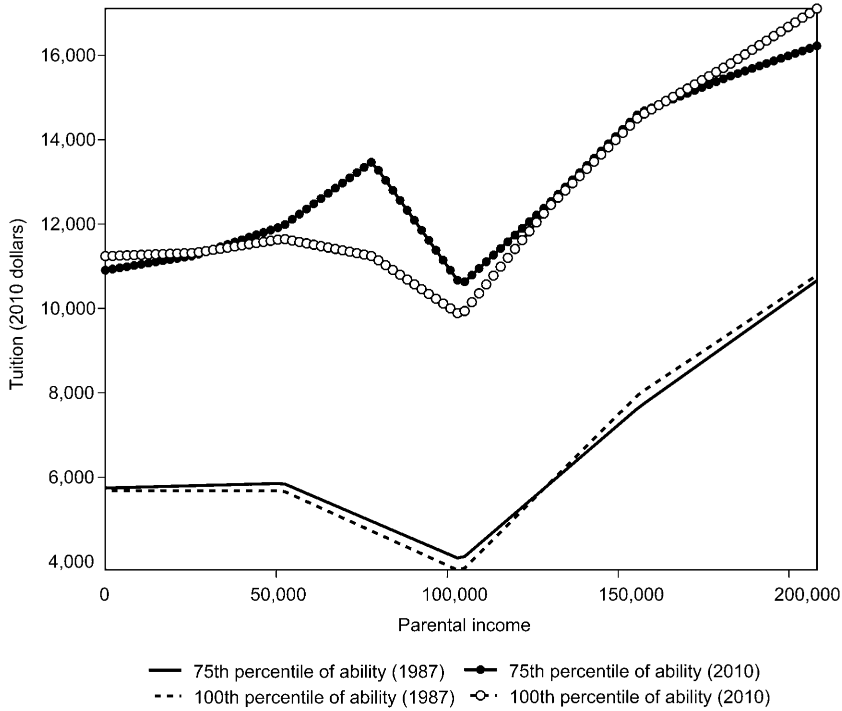

Fig. 10.4 Slices of the tuition function (equilibrium tuition for select ability levels)

and terminal steady states. This jump compares to a 92 percent increase in the data. To illustrate how tuition changes, figure 10.4 plots slices of the tuition function (web appendix C gives the entire function).

In both steady states, tuition does not move monotonically with income. Instead, tuition in the initial steady state first increases with parental income before it starts to decline at income levels between \$50,000 and \$100,000 as financial aid eligibility tightens and grants decline. After \$100,000, tuition resumes its ascent as student ability to pay increases. The tuition curves shift up noticeably between the two steady states, though not in a parallel fashion. In particular, the region of declining tuition compresses to the range between \$75,000 and \$100,000, which is largely due to the expansion in aid between 1987 and 2010.

The college engages in less price discrimination by academic ability than by parental income.[24] Inspection of the 100th percentile and 75th curves in

24. In fact, theoretically, tuition should be monotonically decreasing in ability. However, due to computational cost, we have parametrized the tuition function more flexibly in the income dimension to account for more variation there. See web appendix C for computation details.

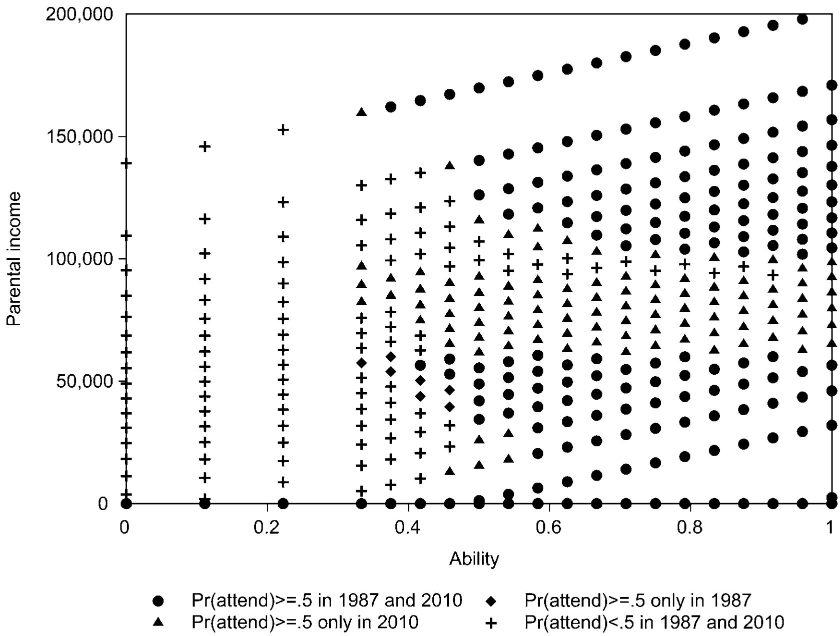

Fig. 10.5 Enrollment comparison between 1987 and 2010

1987 reveals that tuition never differs by more than $700 between moderate- and high-ability students. By 2000, the largest tuition difference between the 75th and 100th percentiles of the ability distribution rises to $2,000.

When weighing whether to offer tuition discounts to high-ability students, colleges face the trade-off between a higher-ability student body and the need for resources to fund quality-enhancing investment expenditures. In our calibration, the latter effect dominates. The data provides supporting evidence. For instance, table 10.3, which presents selected statistics from the data and the initial and terminal steady states, shows that investment in the model increases by 40 percent between the two steady states. This increase approximates well the untargeted 34 percent rise in the data. While we lack data on student ability in 1987, the model's mean college graduate ability of 0.701 in 2010 closely matches the untargeted 0.716 from the data.

Enrollment

Figure 10.5 reveals how the enrollment patterns change between the steady states. Recall that the calibration targets the correlation between parental income and enrollment, and observe that average student ability aligns closely with the data in table 10.3. However, figure 10.5 unveils a striking polarization of enrollment by income in the initial steady state.

Specifically, middle-income students find themselves priced out of college, enrolling at a rate of less than 50 percent.

As shown in equation (14), colleges set tuition by charging each student their type-specific effective marginal cost $\mathrm{EMC}(s_Y)$ plus a markup that reflects the student's willingness to pay. Given that effective marginal cost only depends on the ability component $x(s_Y)$ of each student's type, all tuition variation within ability types derives from the impact of parental income and access to financial aid on student willingness to pay.[25] Furthermore, in the absence of preference shocks (the limiting case as $\alpha \to \infty$), colleges first only admit students that have a willingness to pay that exceeds their effective marginal cost, and then they proceed to charge tuition that extracts the entire surplus.

High-income students have a high willingness to pay because of parental transfers, while low-income students, despite lacking parental resources, have a high willingness to pay because of access to financial aid. Middle-income students find both of these avenues closed, in large part because each \$1 increase in parental income reduces access to subsidized borrowing by \$1 but only delivers $\xi \approx .21$ dollars of additional resources to the student. Consequently, these students cannot afford to pay the full net tuition directly and also lack eligibility for subsidized loan borrowing, which represents the only form of student loans accessible in 1987. The college responds to the higher demand elasticity of these students by reducing their tuition, but the decrease does not prove sufficient to prevent low enrollment of middle-income students in the initial steady state.

By 2010, the introduction of unsubsidized loans and repeated expansions in grants and subsidized borrowing induces middle-income students to flood into higher education. These innovations partly explain the increase in enrollment from 36 percent to 56 percent across steady states, as reported in table 10.3. The data show a more subdued rise from 38 percent to 41 percent.

Borrowing and Default

As we just explained, the enrollment surge between the initial and terminal steady states comes primarily from high-ability, middle-income youths who benefit from the introduction of unsubsidized loans and expansion of subsidized aid. In fact, in the terminal steady state, every single college student participates at least minimally in student borrowing (recall that $\beta = 0.96$ and the loan interest rate in 2010 is 3 percent, which makes student loans an attractive form of borrowing). Empirically, the percentage of students with loans increases more moderately from 35.7 percent to 52.9 percent. That

25. Replicated here:

$$T(s_Y) + \underbrace{\frac{\mathbb{P}(\text{enroll} \mid s_Y; T(\cdot), q)}{\partial \mathbb{P}(\text{enroll} \mid s_Y; T(\cdot), q) \ / \ \partial T}}_{(\partial \log \mathbb{P} / \partial T)^{-1}} = \underbrace{C'(N) + I + \frac{q_\theta}{q_I}(\theta - x)}_{\mathrm{EMC}(s_Y)}$$

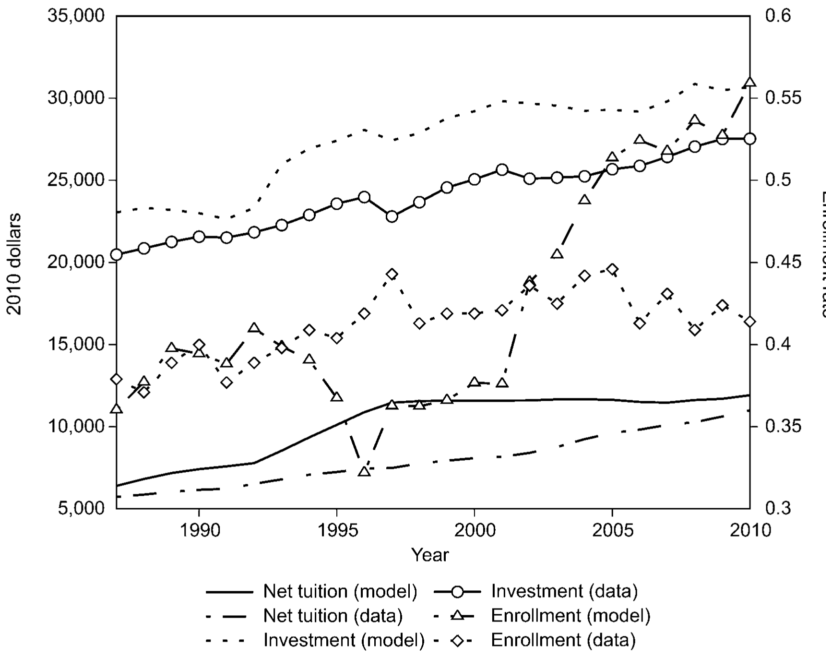

Fig. 10.6 Comparison of model and data over the transition

said, although the model greatly overestimates participation in the student loan program, it generates an average loan size of only $6,900 compared to $8,400 in the 2010 data.

The model delivers almost no change in the 17 percent student loan default rate across steady states. The data, by contrast, show a significant fall from 17.6 percent to 9.1 percent. This discrepancy largely comes from the fact that legal changes between 1987 and 2010 increased the cost of student loan default, whereas we abstract from such changes in the model.

10.4.2 Transition Path Dynamics

Given that we have constructed a rich time series of borrowing limits, the college premium, college endowments, and measured custodial costs, we can gain further insights by analyzing the entire transition path of the model. Figure 10.6 plots the path of net tuition, enrollment, and investment expenditures in both the model and the data.

While investment per student in the model lines up well with the data, equilibrium net tuition follows a different trajectory than net tuition in the data. In particular, equilibrium net tuition in the model rises by a similar amount to the data, but whereas model net tuition rises rapidly between 1993 and 1997 before stagnating, empirical net tuition increases gradually during the entire time period. As the next section will make clear, equilibrium net tuition in the model reacts strongly to the expansion in financial aid (especially the introduction of unsubsidized loans) following the reauthorization of the Higher Education Act in 1992. Although the college premium increased from 0.46 to 0.58 log points between 1987 and 1993, many middle-income households lacked the resources or borrowing capacity to take advantage by enrolling in college.

We can only speculate as to why net tuition in the data does not accelerate in 1993. To the extent that political concerns partially govern the setting of tuition, colleges may prefer to spread out tuition increases over longer time horizons rather than announce rapid escalations. Alternatively, students may not have accurately forecasted the persistent rise in the college premium, whereas our solution method assumes perfect foresight. Last, colleges may engage in some form of tacit collusion that takes time to implement, which our model does not capture because of the representative college assumption.

The overly rapid tuition increases in model may also explain the divergent pattern in enrollments between 1993 and 1998. In particular, the data enrollments increase steadily whereas model enrollments fall substantially. Had the college in the model "smoothed" tuition over this period, enrollments might not have fallen so sharply.

10.4.3 Assessing the Theories of Tuition Inflation

Our model successfully replicates the rapid increase in net tuition, and hence it is useful to now ask our main question of *why* net tuition has almost doubled since 1987. We quantify the role of the following factors in this tuition rise: (a) changes in custodial costs and nontuition sources of revenue, such as endowments and state support (supply shocks); (b) changes in student loan borrowing limits, interest rates, grant aid, and nontuition costs, such as room and board (demand shocks); and (c) macroeconomic forces, namely, the rise in the college wage premium.

We undertake the tuition decomposition from two different angles. First, we progressively solve the model by implementing only *one* of the broad categories of shocks at a time, which answers the question "How much would tuition have gone up if *only* X had occurred?" Then we sequentially shut down the supply shocks, demand shocks, and the college wage premium one at a time. This approach allows us to answer the question "How much would tuition have gone up if X had *not* occurred?" Last, we break down the effect of the individual factors that constitute our categorizations. In all the experiments, we solve for the tax rate that ensures a balanced budget for the government.

Demand Shocks: The Bennett Hypothesis

Table 10.4 summarizes the decomposition through some key statistics. With all factors present, net tuition increases from \$6,100 to \$12,400. As column (4) demonstrates, the demand shocks—which consist mostly of changes in financial aid—account for the lion's share of the higher tuition.

Table 10.4 **Experiments**

Statistic	1987	Experiment						2010
College costs				*		*	*	*
College endowment				*		*	*	*
Borrowing limits			*		*		*	*
Interest rates			*		*		*	*
Nontuition cost			*		*		*	*
Grants			*		*		*	*
College premium		*			*	*		*
Mean net tuition ($)	6,146	7,412	11,733	5,681	13,274	7,020	11,131	12,428
Std. net tuition ($)	1,263	1,328	1,347	1,558	1,270	1,138	1,405	1,320
Enrollment rate	0.36	0.37	0.38	0.53	0.35	0.54	0.52	0.56
Two-year default rate	0.17	0.15	0.32	0.17	0.17	0.15	0.32	0.17
Mean loan (recipients) ($)	4,589	4,690	6,876	4,692	6,872	4,676	6,877	6,873
Pct. taking out loans	48.8	54.1	100.00	49.6	100.00	58.6	100.00	100.00
Mean earnings ($)	31,686	34,179	31,870	33,445	33,884	37,001	33,306	37,301
Corr. (p. income, enroll)	0.24	0.20	0.36	0.20	0.33	0.10	0.32	0.30
Corr. (ability, enroll)	0.59	0.63	0.73	0.51	0.68	0.51	0.78	0.78
Ability of graduates	0.73	0.74	0.77	0.64	0.77	0.64	0.72	0.70
Investment ($)	21,921	23,304	27,653	23,684	29,019	25,140	29,007	30,701
Average EFC ($)	18,288	17,140	18,892	16,509	18,487	14,833	16,992	16,514
Ex ante utility	−40.98	−40.92	−40.84	−40.61	−40.72	−40.49	−40.51	−40.19

*The value changed over the transition.

Specifically, with demand shocks alone, equilibrium tuition rises by 91 percent, almost fully matching the 102 percent from the benchmark. By contrast, with all factors present *except* the demand shocks (column [7]), net tuition only rises by 14 percent.

These results accord strongly with the Bennett hypothesis, which asserts that colleges respond to expansions of financial aid by increasing tuition. In fact, the net tuition response to the demand shocks in isolation restrains enrollment to only grow from 36 percent to 38 percent. Furthermore, the students who *do* enroll take out $6,900 in loans compared to $4,600 in the initial steady state. The college, in turn, uses these funds to finance an increase of investment expenditures from $21,900 to $27,700 and to enhance the quality of the student body. In particular, the average ability of graduates increases by 4 percentage points. Last, the model predicts that demand shocks in isolation generate a surge in the default rate from 17 percent to 32 percent. Essentially, demand shocks lead to higher costs of attendance and more debt, and in the absence of higher labor market returns, more loan default inevitably occurs.

Importantly, we view this effect as an upper bound for the Bennett hypothesis. Given our representative college assumption, only the unobservable preference shocks prevent the college from extracting the entire surplus from its student body. Table 10.4 illustrates this market power in the small variation in ex ante utility across the decompositions (for any experiment, the consumption equivalent variation is less than 2 percent relative to 1987).

Greater competition would restrict rent extraction and give rise to different pricing patterns.

Macroeconomic Forces: The Rising College Wage Premium

The rise in the college wage premium also contributes to higher tuition, albeit more modestly. If only the college wage premium had changed between 1987 and 2010, the model predicts that net tuition would have gone up by 21 percent. In its absence, but with all other shocks present, tuition would have gone up by 81 percent. Interestingly, the rise in the college wage premium generates barely any increase in enrollment. Instead, average student body ability rises by 1 percentage point, and the correlation between ability and enrollment increases from 0.59 to 0.63, while the correlation between parental income and enrollment falls from 0.24 to 0.2. Limitations in borrowing capacity for (mostly middle-income) students in 1987 act as a binding constraint that prevents enrollments from responding strongly to labor market changes.

Supply Shocks: Cost Disease and Changing Nontuition Revenue

Last, our results paint a nuanced picture of how cost disease and movements in nontuition revenue (e.g., state support) affect tuition. In the model, tuition actually *falls* in response to the supply shocks alone. Specifically, when we feed in the empirical time-series estimates for custodial costs and college endowments (which summarize all nontuition revenue) but leave all other parameters at their initial 1987 levels, equilibrium tuition decreases from \$6,100 to \$5,700. Enrollment, by contrast, surges from 36 percent to 53 percent.

Table 10.5 decomposes the impact of each supply shock. As shown in column (2) of the experiments, omitting the change in college endowments has no impact on average net tuition relative to the 2010 equilibrium, which incorporates the endowment change. Note, however, that by aggregating all sources of nontuition revenue and lumping together public and private institutions, this analysis does not directly address the issue of stagnant state support raised by our discussant, Sandy Baum. In fact, according to figure 10.2, total nontuition revenue actually *increases* by approximately \$4,500 between 1987 and 2010. Even restricting attention to public institutions, figure 10.7 shows that the growth in auxiliary revenues dominates the initially stagnant and subsequently declining trend in state support. In future work, we plan to directly address the impact of declining state support in a disaggregated framework that explicitly distinguishes between public and private institutions.[26]

26. The negative relationship between tuition/fees and state funding per FTE mentioned by Sandy Baum—which can also be found in figure 12A of Ma et al. (2017)—has multiple possible interpretations. One way is to view state-funding reductions as a causal mechanism for tuition hikes. Alternatively, legislative delays that cause state appropriations to be adjusted with a lag may explain the correlation. In this scenario, if demand increases, students are willing to pay higher tuition while state funding per FTE falls mechanically because of higher enrollment. The countercyclicality of enrollment (established by Betts and McFarland [1995] and Dellas and Koubi [2003]) and procyclicality of public appropriations lend some credibility to this argument, but more research is needed to weigh the merits of each interpretation.

Table 10.5 **Experiments**

Statistic				Experiment				2010
College costs		*	*	*	*	*	*	*
College endowment	*		*	*	*	*	*	*
Borrowing limits	*	*		*	*	*	*	*
Interest rates	*	*	*		*	*	*	*
Nontuition cost	*	*	*	*		*	*	*
Grants	*	*	*	*	*		*	*
College premium	*	*	*	*	*	*		*
Mean net tuition ($)	13,424	12,432	9,066	12,397	12,289	11,319	11,131	12,428
Std. net tuition ($)	1,182	1,265	1,958	1,312	1,463	1,916	1,405	1,320
Enrollment rate	0.34	0.56	0.53	0.52	0.52	0.56	0.52	0.56
Two-year default rate	0.17	0.17	0.07	0.19	0.17	0.17	0.32	0.17
Mean loan (recipients) ($)	6,873	6,873	4,746	6,856	6,872	6,871	6,877	6,873
Pct. taking out loans	100.00	100.00	73.8	100.00	100.00	100.00	100.00	100.00
Mean earnings ($)	33,605	37,256	36,767	36,681	36,594	37,217	33,306	37,301
Corr. (p. income, enroll)	0.27	0.26	−0.07	0.28	0.28	0.48	0.32	0.30
Corr. (ability, enroll)	0.67	0.77	0.52	0.77	0.76	0.79	0.78	0.78
Ability of graduates	0.77	0.70	0.64	0.71	0.71	0.71	0.72	0.70
Investment ($)	33,467	26,230	27,060	30,344	30,186	29,550	29,007	30,701
Average EFC ($)	17,620	16,041	12,256	16,412	16,640	18,331	16,992	16,514
Ex ante utility	−40.76	−40.35	−40.30	−40.37	−40.38	−40.36	−40.51	−40.19

*The value changed over the transition.

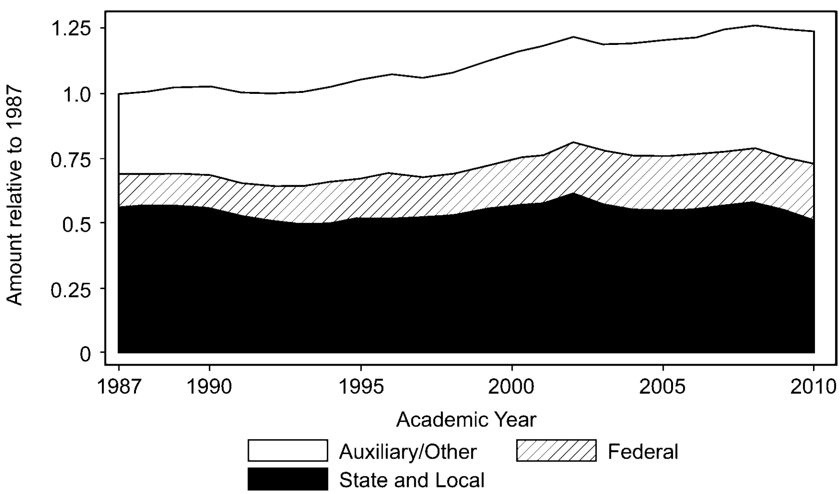

Fig. 10.7 Growth in nontuition revenue per FTE at public institutions
Note: Constant dollars, public institutions.

Table 10.5 also addresses the isolated impact of custodial costs. Perhaps surprisingly, upward shifts in the custodial cost function between 1987 and 2010 actually *reduce* tuition inflation by approximately \$1,000, as seen by comparing the first experiment with the 2010 column. Rather than raise tuition, the college responds to higher custodial costs by cutting quality through reduced investment and expanded enrollment of lower-ability students. Two factors account for this divergence from the familiar cost disease narrative: the quality-maximizing objective function of the college and the role of fixed costs.

For intuition, consider a simplified framework with homogeneous students who each have ability x and some fixed parental income. Further, assume there are no preference shocks. In this context, the college sets tuition T to extract the entire student surplus, independent of the custodial cost function. Thus, given T (which is common across students due to their homogeneity), the college simply chooses the number of students to admit:

$$\max_{I,N} q(x,I) \text{s.t.} IN + C(N) = TN + EN \Leftrightarrow \max_{N} q\left(x, T + E - \frac{C(N)}{N}\right).$$

With x constant, quality is effectively only a function of investment I, which the college maximizes by minimizing average costs $C(N)/N$. In the case of a quadratic cost function, $C(N) = c_0 + c_1 N + c_2 N^2$, average costs are minimized at $N = \sqrt{c_0/c_2}$, which is *increasing* in the fixed cost term and *does not depend* on the marginal cost term c_1. Consequently, in this simple model, higher fixed costs lead to increased enrollment, unchanged tuition, and reduced investment. By contrast, if the college were to maximize *total* investment IN, enrollment would satisfy $T + E = C'(N)$, which more closely resembles the familiar optimality condition of a profit-maximizing firm where changes in fixed costs have no effect on the optimal quantity (here, enrollment) choice.

Our regression estimates show that rising fixed costs between 1987 and 2010 are the dominant cost trend, and the simple model provides some intuition as to why the college responds by increasing enrollment. With student heterogeneity, the increased enrollment results in admission of lower-ability students and/or students with lower willingness to pay. The result is lower expenditures I (as in the simple example) and lower average ability θ.

Several factors caution us from boldly claiming that Baumol's cost disease is unimportant for tuition increases. First, the current model abstracts from the possibility of a rising relative price of college investment (i.e., pI instead of I). Second, we assume that colleges can freely reoptimize each period without regard for their previous investment and hiring choices. In reality, the need to pay the salaries of tenured faculty and cover maintenance on existing buildings may alter a college's response to shifting costs. Last, even if Baumol's cost disease were to cause higher tuition at an individual college, aggregate tuition may be unaffected if students substitute into lower-cost colleges. Our representative college framework does not allow us to explore the heterogeneous response of tuition across different college types. Even with these caveats, however, our finding that the *form* of cost increases (i.e., fixed vs. marginal) matters for tuition is an important and novel finding.

10.5 Conclusion

Existing demand-side and supply-side theories can explain the full increase in net tuition between 1987 and 2010. However, our model suggests that demand-side theories—namely, the role of financial aid expansions and the rise in the college premium—generate the strongest effects. However, given the limitation of our representative college assumption, the results likely exaggerate the quantitative sensitivity of tuition to changes in students' willingness to pay. Interestingly, upward shifts in the cost structure consistent with Baumol's cost disease have different effects on tuition depending on whether marginal costs or fixed costs move by more. We plan on addressing issues related to college heterogeneity in future work.

References

Abbott, B. G. Gallipoli, C. Meghir, and G. Violante. 2013. "Education Policy and Intergenerational Transfers in Equilibrium." NBER Working Paper no. 18782, Cambridge, MA.

Andrews, R. J., J. Li, and M. F. Lovenheim. 2012. "Quantile Treatment Effects of College Quality on Earnings: Evidence from Administrative Data in Texas." NBER Working Paper no. 18068, Cambridge, MA.

Archibald, R. B., and D. H. Feldman. 2008. "Explaining Increases in Higher Education Costs." *Journal of Higher Education* 79 (3): 268–95.

Athreya, K., and J. Eberly. 2013. "The Supply of College-Educated Workers: The Roles of College Premia, College Costs, and Risk." Working paper no. 13-02, Federal Reserve Bank of Richmond.

Autor, D. H., L. F. Katz, and M. S. Kearney. 2008. "Trends in U.S. Wage Inequality: Revising the Revisionists." *Review of Economics and Statistics* 90 (2): 300–323.

Baumol, W. J. 1967. "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis." *American Economic Review* 57 (3): 415–26.

Baumol, W. J., and W. G. Bowen. 1966. *Performing Arts: The Economic Dilemma; A Study of Problems Common to Theater, Opera, Music, and Dance*. Cambridge, MA: Twentieth Century Fund.

Belley, P., and L. Lochner. 2007. "The Changing Role of Family Income and Ability in Determining Educational Achievement." *Journal of Human Capital* 1 (1): 37–89.

Bennett, W. J. 1987. "Our Greedy Colleges." *New York Times*, Feb. 18. https://www.nytimes.com/1987/02/18/opinion/our-greedy-colleges.html.

Bersudskaya, V., and C. C. Wei. 2011. "Trends in Student Financing of Undergraduate Education: Selected Years 1995–96 to 2008–08." Report NCES 2011-218, National Center for Education Statistics.

Betts, J., and L. McFarland. 1995. "Safe Port in a Storm: The Impact of Labor Mar-

ket Conditions on Community College Enrollments." *Journal of Human Resources* 30:741–65.
Bowen, H. R. 1980. *The Costs of Higher Education: How Much Do Colleges and Universities Spend per Student and How Much Should They Spend?* San Francisco, CA: Jossey-Bass Publishers.
Bureau of Economic Analysis (BEA). 2015. "Table 2-1, Current-Cost Net Stock of Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type." Washington, DC, Bureau of Economic Analysis. Accessed June 18, 2015. http://www.bea.gov.
Card, D., and T. Lemieux. 2001. "Can Falling Supply Explain the Rising Return to College for Younger Men?" *Quarterly Journal of Economics* 116:705–46.
Cellini, S. R., and C. Goldin. 2014. "Does Federal Aid Raise Tuition? New Evidence on For-Profit Colleges." *American Economic Journal: Economic Policy* 6 (4):174–206.
Chakrabarty, R., M. Mabutas, and B. Zafar. 2012. "Soaring Tuitions: Are Public Funding Cuts to Blame?" *Liberty Street Economics*, Federal Reserve Bank of New York. http://libertystreeteconomics.newyorkfed.org/2012/09/soaring-tuitions-are-public-funding-cuts-to-blame.html. Accessed Aug. 28, 2015.
Clotfelter, C. T. 1996. *Buying the Best: Cost Escalation in Elite Higher Education*. Princeton, NJ: Princeton University Press.
Cunningham, A. F., J. V. Wellman, M. E. Clinedinst, J. P. Merisotis, and C. D. Carroll. 2001. *Study of College Costs and Prices, 1988–89 to 1997–98*, vol. 1. Report NCES 2002-157, National Center for Education Statistics.
Dellas, H., and V. Koubi. 2003. "Business Cycle and Schooling." *European Journal of Political Economy* 19:843–59.
Ehrenberg, R. G. 2002. *Tuition Rising: Why College Costs So Much*. Cambridge, MA: Harvard University Press.
Epple, D., R. Romano, S. Sarpca, and H. Sieg. 2013. "The U.S. Market for Higher Education: A General Equilibrium Analysis of State and Private Colleges and Public Funding Policies." NBER Working Paper no. 19298, Cambridge, MA.
Epple, D., R. Romano, and H. Sieg. 2006. "Admission, Tuition, and Financial Aid Policies in the Market for Higher Education." *Econometrica* 74 (4): 885–92.
Federal Reserve Economic Database (FRED). 2015. FRED Data Series (CPIAUCSL, GDP, LFWA64TTUSA647N, DHLCRG3Q086SBEA). Federal Reserve Economic Database. Accessed June 18, 2015. https://research.stlouisfed.org/fred2/.
Fillmore, I. 2014. "Price Discrimination and Public Policy in the U.S. College Market." Working paper, Washington University in St. Louis.
Frederick, A. B., S. J. Schmidt, and L. S. Davis. 2012. "Federal Policies, State Responses, and Community College Outcomes: Testing an Augmented Bennett Hypothesis." *Economics of Education Review* 31 (6): 908–17.
Fu, C. 2014. "Equilibrium Tuition, Applications, Admissions, and Enrollment in the College Market." *Journal of Political Economy* 122 (2): 225–81.
Garriga, C., and M. P. Keightley. 2010. "A General Equilibrium Theory of College with Education Subsidies, In-School Labor Supply, and Borrowing Constraints." Working paper, Federal Reserve Bank of St. Louis and Congressional Research Office.
Goldin, C., and L. F. Katz. 2007. "The Race between Education and Technology: The Evolution of U.S. Educational Wage Differentials, 1890 to 2005." NBER Working Paper no. 12984, Cambridge, MA.
Heller, D. E. 1999. "The Effects of Tuition and State Financial Aid on Public College Enrollment." *Review of Higher Education* 23 (1): 65–89.

Hoekstra, M. 2009. "The Effect of Attending the Flagship State University on Earnings." *Review of Economics and Statistics* 91 (4): 717–24.
Howden, L. M., and J. A. Meyer. 2011. "Age and Sex Composition: 2010, Table 1." United States Census Bureau. Accessed June 18, 2015. http://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf.
Ionescu, F. 2011. "Risky Human Capital and Alternative Bankruptcy Regimes for Student Loans." *Journal of Human Capital* 5 (2): 153–206.
Ionescu, F., and N. Simpson. 2016. "Default Risk and Private Student Loans: Implications for Higher Education Policies." *Journal of Economic Dynamics and Control* 64:119–47.
Jones, J. B., and F. Yang. 2016. "Skill-Biased Technological Change and the Cost of Higher Education." *Journal of Labor Economics* 34 (3): 621–62.
Katz, L. F., and K. M. Murphy. 1992. "Changes in Relative Wages, 1963–87: Supply and Demand Factors." *Quarterly Journal of Economics* 107:35–78.
Keane, M. P., and K. I. Wolpin. 2001. "The Effect of Parental Transfers and Borrowing Constraints on Educational Attainment." *International Economic Review* 42 (4): 1051–103.
Koshal, R. K., and M. Koshal. 2000. "State Appropriation and Higher Education Tuition: What Is the Relationship?" *Education Economics* 8 (1): 81–89.
Lochner, L. J., and A. Monge-Naranjo. 2011. "The Nature of Credit Constraints and Human Capital." *American Economic Review* 101 (6): 2487–529.
Long, B. T. 2004a. "How Do Financial Aid Policies Affect Colleges? The Institutional Impact of the Georgia Hope Scholarship." *Journal of Human Resources* 39 (4): 1045–66.
———. 2004b. "The Impact of Federal Tax Credits for Higher Education Expenses." In *College Choices: The Economics of Where to Go, When to Go, and How to Pay for It*, edited by C. M. Hoxby, 101–68. Chicago: University of Chicago Press.
———. 2006. "College Tuition Pricing and Federal Financial Aid: Is There a Connection?" Technical report, Testimony before the US Senate Committee on Finance.
Lucca, D. O., T. Nadauld, and K. Shen. 2015. "Credit Supply and the Rise in College Tuition: Evidence from Expansion in Federal Student Aid Programs." Staff Report no. 733, Federal Reserve Bank of New York.
Ma, J., S. Baum, M. Pender, and M. Welch. 2017. *Trends in College Pricing*. New York: The College Board.
McPherson, M. S., and M. O. Shapiro. 1991. *Keeping College Affordable: Government and Educational Opportunity*. Washington, DC: Brookings Institution Press.
National Center for Education Statistics (NCES). 2015a. "Table 302.10. Recent High School Completers and Their Enrollment in 2-Year and 4-Year Colleges, by Sex: 1960 through 2013." National Center for Education Statistics. Accessed June 18, 2015. http://nces.ed.gov/programs/digest/d14/tables/dt14_302.10.asp.
———. 2015b. "Table 326.10. Graduation Rate from First Institution Attended for First-Time, Full-Time Bachelor's Degree-Seeking Students at 4-Year Postsecondary Institutions, by Race/Ethnicity, Time to Completion, Sex, Control of Institution, and Acceptance Rate: Selected Cohort Entry Years, 1996 through 2007." National Center for Education Statistics. Accessed June 18, 2015. http://nces.ed.gov/programs/digest/d14/tables/dt14_326.10.asp.
———. 2015c. "Table 330.10. Average Undergraduate Tuition and Fees and Room and Board Rates Charged for Full-Time Students in Degree-Granting Postsecondary Institutions, by Level and Control of Institution: 1963–64 through 2013–14." National Center for Education Statistics. Accessed June 20, 2015. http://nces.ed.gov/programs/digest/d14/tables/dt14_330.10.asp.

Rizzo, M. J., and R. G. Ehrenberg. 2004. "Resident and Nonresident Tuition and Enrollment at Flagship State Universities." In *College Choices: The Economics of Where to Go, When to Go, and How to Pay for It*, edited by C. M. Hoxby, 303–53. Chicago: University of Chicago Press.
Singell, Jr., L. D., and J. A. Stone. 2007. "For Whom the Pell Tolls: The Response of University Tuition to Federal Grants-in-Aid." *Economics of Education Review* 26:285–95.
Storesletten, K., C. Telmer, and A. Yaron. 2004. "Cyclical Dynamics in Idiosyncratic Labor Market Risk." *Journal of Political Economy* 112 (3): 695–717.
Titus, M. A., S. Simone, and A. Gupta. 2010. "Investigating State Appropriations and Net Tuition Revenue for Public Higher Education: A Vector Error Correction Modeling Approach." Working paper, Institute for Higher Education Law and Governance Institute Monograph Series.
Turner, L. J. 2014. "The Road to Pell Is Paved with Good Intentions: The Economic Incidence of Federal Student Grant Aid." Working paper, University of Maryland.
Turner, N. 2012. "Who Benefits from Student Aid: The Economic Incidence of Tax-Based Aid." *Economics of Education Review* 31 (4): 463–81.
US Department of Education. 2015a. "Federal Student Loan Portfolio." Accessed June 18, 2015. https://studentaid.ed.gov/sa/about/data-center/student/portfolio.
———. 2015b. "National Student Loan Two-Year Default Rates." Federal Student Aid. Accessed June 18, 2015. https://www2.ed.gov/offices/OSFAP/defaultmanagement/defaultrates.html.
Wei, C. C., X. Li, L. Berkner, and C. D. Carroll. 2004. "A Decade of Undergraduate Student Aid: 1989–90 to 1999–2000." Report NCES 2004-158, National Center for Education Statistics.
Winston, G. C. 1999. "Subsidies, Hierarchy, and Peers: The Awkward Economics of Higher Education." *Journal of Economic Perspectives* 13 (1): 13–36.
Wolverton, M., W. H. Gmeich, J. Montez, and C. T. Nies. 2001. *The Changing Nature of the Academic Deanship: ASHE-ERIC Higher Education Research Report*. San Francisco, CA: Jossey-Bass Publishers.

Comment Sandy Baum

Gordon and Hedlund have developed a detailed model to shed light on the important question of why college prices rose so rapidly between 1987 and 2010. They appropriately focus on net tuition revenues of institutions, rather than on the sticker prices they charge. They consider both the demand and supply sides of the market.

The authors take many historical trends into account, including prices, student aid, the college earnings premium, and nontuition revenue sources. But as the authors acknowledge, the model makes many assumptions that

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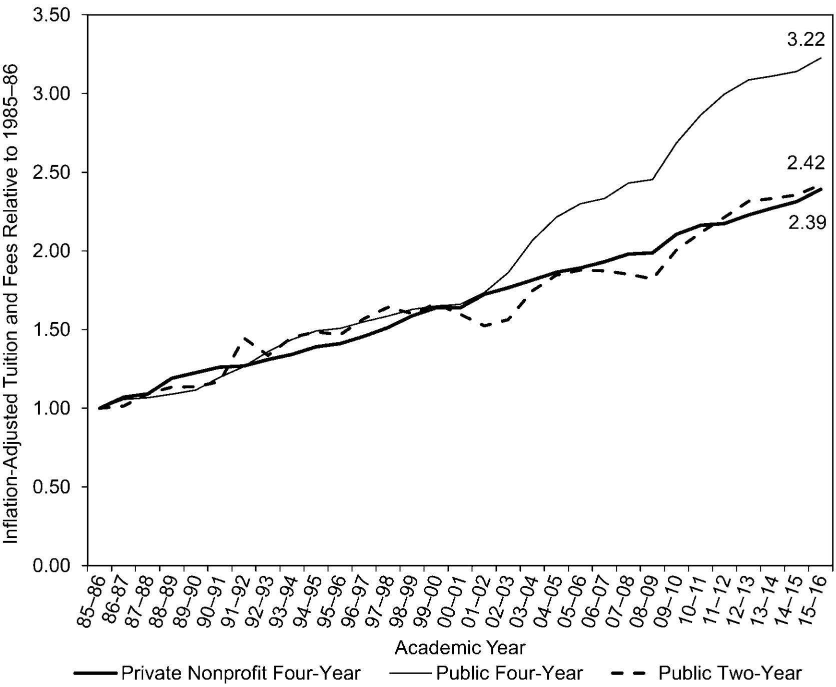

Fig. 10C.1 Inflation-adjusted published tuition and fees relative to 1985–1986, 1985–1986 to 2015–2016 (1985–1986 = 1.0)
Source: Ma et al. (2015).

are not consistent with how higher education institutions are structured and operate in the real world and with how students make decisions.

There is one representative institution, combining characteristics of the public and private nonprofit four-year sectors. There is no competition for the institution, which maximizes quality and prestige.

In reality, public and private institutions operate in very different worlds. They have very different funding sources and, as figure 10C.1 illustrates, the paths of tuition prices in these institutions have been quite different. The graph displays the path of sticker prices over time, illustrating the fact that prices in public four-year institutions rose much more rapidly than prices in the private nonprofit sector during the period of time covered by Gordon and Hedlund's work.

The model focuses on net tuition revenues, not sticker prices. But the discount rates at private institutions are higher and have increased more over time than those in the public sector, magnifying the divergence in prices. It is not at all clear that combining public and private price increases can generate an accurate estimate of the forces driving those price increases.

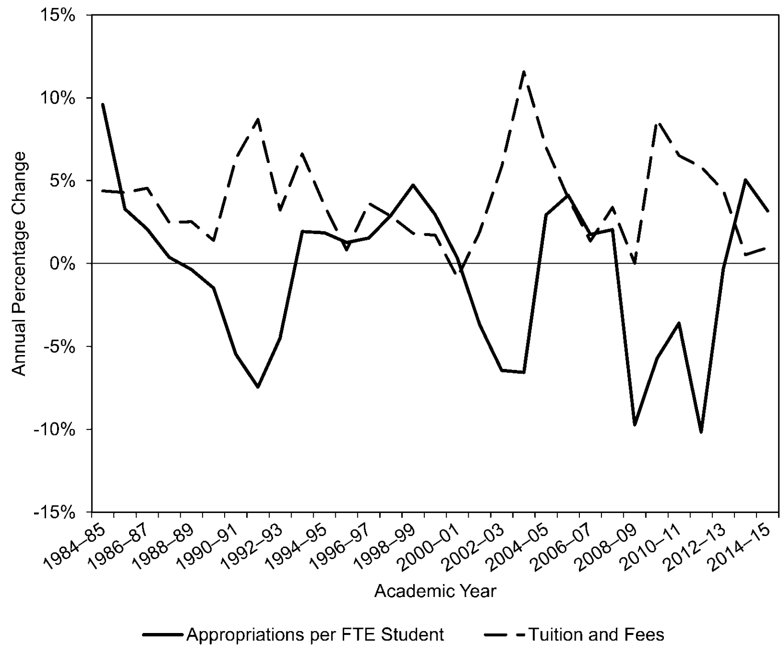

Fig. 10C.2 Annual percentage change in inflation-adjusted per-student state funding for higher education and in tuition and fees at public institutions, 1984–1985 to 2014–2015

Source: Ma et al. (2015).

The main conclusions emerging from the model in this chapter are both counterintuitive and inconsistent with existing evidence. In particular, the authors find that declines in nontuition revenues (including both state appropriations and endowments) are associated with price *reductions*, as are increases in institutional costs. These "reverse" effects leave increases in federal loan limits with the dominant positive impact on increasing tuition.

Looking at the actual patterns of changes in state funding for higher education and public college tuition levels, reported in figure 10C.2, raises serious questions about the conclusions emerging from the model. If the authors really want to argue that public colleges are not raising tuition to fill in the gaps left by declines in state per-student funding, they should provide strong logic and empirical evidence, not just the numbers that emerge from a model of a hypothetical institution.

Several other assumptions in the model deserve attention. The college only admits students who have a willingness to pay that exceeds marginal cost. When "custodial costs"—basically expenditures on student amenities—increase, colleges lower expenditures on instruction for fear that

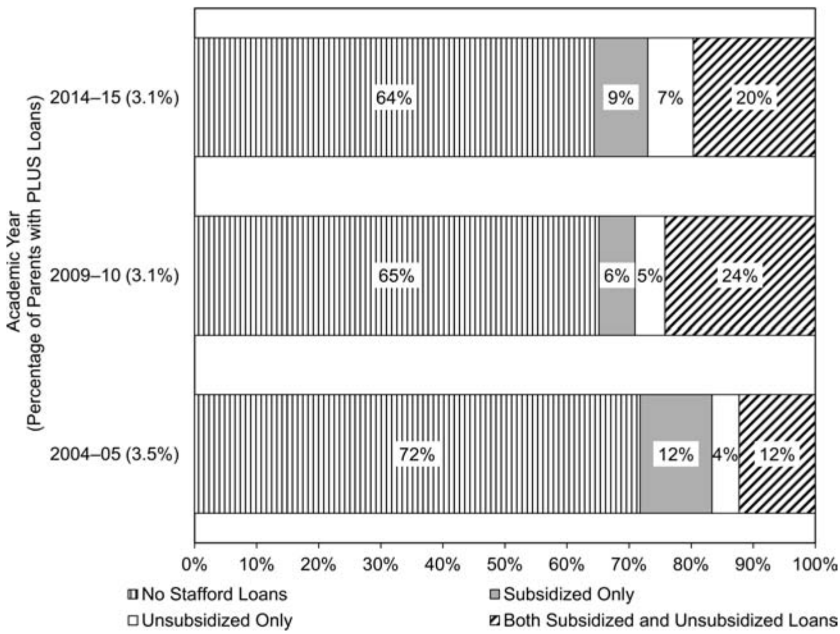

Fig. 10C.3 Percentage of undergraduate students borrowing federal subsidized and unsubsidized loans, 2004–2005, 2009–2010, and 2014–2015
Source: Baum et al. (2015).

they will lose high-quality students if they raise tuition. So costs do not drive tuition—in fact, the reverse is true.

In fact, the goal of maximizing quality and prestige that underlies the model actually applies only to a subset of four-year institutions—almost 50 percent of public and private nonprofit four-year colleges accept at least 75 percent of applicants (Ma et al. 2015). And selective institutions face considerable competition for students—a phenomenon not incorporated into the model.

A key question is which assumptions really matter for making the model a good representation of reality. Simplification is obviously necessary, but the model overestimates tuition increases and the number of students with loans. It underestimates enrollment. It predicts a 17 percent default rate on student loans over the entire time period. The authors acknowledge that this bears little relationship to reality, but nonetheless appear to have confidence about their analysis of the role of loans in driving net tuition.

According to the model, all undergraduates take federal students loans in 2010. But in fact, in any given year, the majority of undergraduates do not borrow (figure 10C.3). Just over two-thirds of bachelor's degree recipients graduate with debt. Many students borrow, but not every year.

Table 10C.1 Federal and nonfederal education borrowing, 2006–2005 to 2010–2011 ($)

	Federal loans	Nonfederal loans	Total borrowing
2005–06	70.5	20.8	91.3
2006–07	71.7	23.7	95.3
2007–08	78.5	25.6	104.1
2008–09	93.6	12.5	106.1
2009–10	110.7	9.0	119.6
2010–11	116.1	7.9	124.0

Source: Baum et al. (2015).

A critical question about the impact of the availability of federal student loans relates to alternative financing mechanisms, such as private loans. Nonfederal loans constituted 25 percent of education borrowing in 2007–2008, but declined sharply to 12 percent the following year, as financial markets collapsed and the federal government increased its borrowing limits. The increase in federal loan limits had almost no impact on total borrowing. As table 10C.1 shows, it was just associated with a substitution of federal borrowing for nonfederal borrowing. Is this reality consistent with such a large impact of federal loan limits on tuition prices? Information like this has to be incorporated into the logic and the conclusions of the model.

It is certainly useful to develop a stronger theoretical foundation for analyzing changes in college prices. But starting with a model that does not distinguish between public and private colleges or between endowments and state appropriations and that assumes that all colleges are selective—and presenting the results emerging from that model as reliable—has the potential to do real damage to the higher education financing system.

This chapter has already generated headlines including "Economists Confirm Financial Aid is Inflating Student Loan Bubble" (ShiffGold 2015). An article in *Forbes* titled "Cause of High Tuition? It's the Government, Stupid" reports that "Gordon and Hedlund attribute the big rise in tuition charges almost entirely to the federal student financial assistance programs. Bill Bennett is, by and large, right. Student loan programs do not help students, they help the permanent citizens of college campuses—the administrators, the faculty, the research assistants, and so forth" (Solis 2016).

The authors do not clearly distinguish between their measure of the net tuition revenue institutions receive and the net prices students pay. Even if federal aid does increase net tuition revenues of institutions, it can lower the net prices students pay. This is the case as long as the increase in net tuition per student is lower than the aid per student—a point the *Forbes* discussion misses. There is no measure of the distribution of those net tuition prices across students from different income categories, making it even more difficult to consider the impact on college access.

The question underlying this chapter is of critical importance in the real world. Of immediate concern, how should the student aid system be structured to meet goals of access, success, and attainment? How can any potential impact on increasing the net price of college for students be diminished?

The main conclusion of the chapter is that increases in the availability of federal student loans more than account for the full increase in net tuition prices over the years in question. As the authors note, a number of empirical analyses by prominent higher education economists have generated results contradicting this conclusion. So the evidence behind this assertion should be strong.

If the availability of federal student loans is as significant a driver of college prices as this chapter suggests (despite much evidence contrary to this finding in existing literature)—is it time to abolish or dramatically reduce this stream of funding for students?

The authors acknowledge that their model "likely exaggerates the impact of the Bennett hypothesis. . . . The findings in this chapter should be viewed as an initial exploration to guide further research, rather than being authoritative or definitive." The exploration should continue before conclusions from this work become arguments for policy changes not really supported by evidence.

References

Baum, Sandy, Jennifer Ma, Matea Pender, and D'Wayne Bell. 2015. *Trends in Student Aid*. Report, Trends in Higher Education Series, The College Board. https://files.eric.ed.gov/fulltext/ED572541.pdf.

Ma, Jennifer, Sandy Baum, Matea Pender, and D'Wayne Bell. 2015. *Trends in College Pricing 2015*. Report, Trends in Higher Education Series, The College Board. https://trends.collegeboard.org/sites/default/files/2015-trends-college-pricing-final-508.pdf.

ShiffGold. 2015. "Economists Confirm Financial Aid Is Inflating Student Loan Bubble." *ShiffGold*, Dec. 22. http://schiffgold.com/key-gold-news/economists-confirm-financial-aid-is-inflating-student-loan-bubble/.

Solis, Brian. 2016. "Cause of High Tuition? It's the Government, Stupid." *Forbes*, Feb. 10. http://www.forbes.com/sites/ccap/2016/02/10/cause-of-high-tuition-its-the-government-stupid/#21373b9155e8.

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