Should States Shut Colleges? Public Higher Education System Design in an Era of Declining Enrollment

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Abstract

Higher education enrollment has declined in the United States since the Great Recession, and declining birthrates forecast continued declines over the next decade or more. Should states operating systems of higher education respond by shutting campuses or operating them at smaller scale? We model this tradeoff and use data to quantify the economies of scale in campus operation and consequences of increasing distance to campus for some students. The option of closing campuses yields fiscal savings but decreases enrollment and degree attainment. The estimates imply that operating smaller campuses rather than shutting some down to preserve scale at others would cost states on the order of $300,000 for every four-year degree preserved.

1 Introduction

Public subsidization of higher education is a well-established feature of most nations. Jurisdictions, including the United States, have typically provided subsidies by operating public institutions with discounted tuition rates (OECD, 2024; Ma et al., 2024). Arizona, a state with over 7.5 million inhabitants, operates a grand total of 24 public institutions. Tennessee, slightly smaller than Arizona by population and with less than half the land area, operates twice that many.[1] In theory, operating a small set of large campuses enables states to take advantage of

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[1]This includes Tennessee Colleges of Applied Technology which are non-degree public post-secondary providers.

economies of scale, offering a broader array of educational options at lower per-student costs (Cohn et al., 1989; de Groot et al., 1991; Koshal and Koshal, 1999). Operating a large set of small campuses, on the other hand, allows states to bring higher education closer to a higher fraction of the population, which has a well-documented positive impact on enrollment and attainment (Jepsen and Montgomery, 2009; Goodman et al., 2017; Hillman and Weichman, 2016).

The fixed costs of establishing new campuses is large. Hence, as higher education enrollments expanded fourfold between the early 1960s and 2010, the predominant state response has been to expand existing campuses rather than build new ones. Since 2010, however, enrollment trends have reversed and demographic forecasts suggest they will continue to do so over the next two decades. If we presume campuses are very costly to build but relatively cheap to abandon, this creates a novel question: what is the "optimal" means of responding to declining enrollment. Should states shut institutions down, at the cost of increasing distance to the nearest campus for some residents? Or should they maintain access at the cost of declining economies of scale, which might necessitate the shutdown of certain departments or degree programs, or escalating per-student expenditures to keep them open.

This paper studies these questions, presenting a simple model of optimal higher education system design. The model embeds two key assumptions: that there are economies of scale in the provision of higher education, and that students face travel costs. The paper then analyzes records from the Integrated Post-secondary Education Data System and the American Community Survey to provide a sense of the magnitudes of these two basic factors. Simple analyses reveal that states operating larger campuses, such as Arizona, spend significantly less per student. They also reveal that states operating a broader system of campuses, bringing them in close proximity to a higher proportion of the population, witness higher enrollment, higher degree attainment rates, and higher labor market earnings. These findings echo existing literature documenting the effect of distance to college on enrollment and attainment (Card, 1993; Do, 2004; Acton et al., 2025).

The paper concludes by imagining a hypothetical campus shutdown plan in a representative state that has seen broad declines in public higher education enrollment. Based on the estimates in this analysis, the campus shutdown plan would result in cost savings, reduced enrollment, and reduced four-year degree attainment. The ratio of cost savings per foregone degree is on the order of $300,000. We take no normative stance on whether this figure represents a reasonable

investment in maintaining access, and note that it rests on a series of assumptions regarding the accuracy of our empirical estimates and the costs states would face in choosing to shut down a campus.

This work relates directly to ongoing controversies in higher education, and to recent scholarly literature with implications for the optimal design of higher education systems. By one count, seventy-eight private colleges granting four-year degrees closed between 2008 and 2024.[2] In the public sector, Georgia merged nine public institutions into other institutions between 2013 and 2018; Pennsylvania consolidated six public campuses into two institutions in 2021. Many other legislative proposals to consolidate or close public institutions have been considered.

The question of optimal higher education system design is at least implied in recent work estimating the benefits of admission to a more-selective state university (Hoekstra, 2009; Mountjoy, 2025). Flagship research-intensive institutions tend to be larger than regional public universities or community colleges, and their high degree of specialization is undergirded by scale. Most states have reacted to declining enrollment by preserving the size of their flagship universities and allowing the remainder of the system to face the consequences. Our work provides a sense of the trade-offs involved in pursuing a strategy that imposes costs on some institutions so that others might maintain their scale.

2 Demographic Challenges

Higher education is a service usually provided to consumers in a specific age range, roughly from 18-24. Enrollments are not strictly determined by the number of consumers in this age group, "non-traditional" students may enroll at advanced ages and not every person in this age group will choose to enroll.

Figure 1 depicts two time series: total post-secondary enrollment in the United States, and the total number of persons age 18-24 as estimated in the Current Population Survey. Both time series begin in 1963, when the oldest members of the "baby boom" generation had yet to reach traditional college-going age. The impact of the baby boom on cohort size is visible from the late 1960s until the early 1980s. During this time period college enrollment also increased, continuing a trend dating back to at least World War II (Vigdor, 2026).

The "baby boom" was followed by a "baby bust," the impact of which is again visible in Fig-

[2] See https://hechingerreport.org/college-closures/.

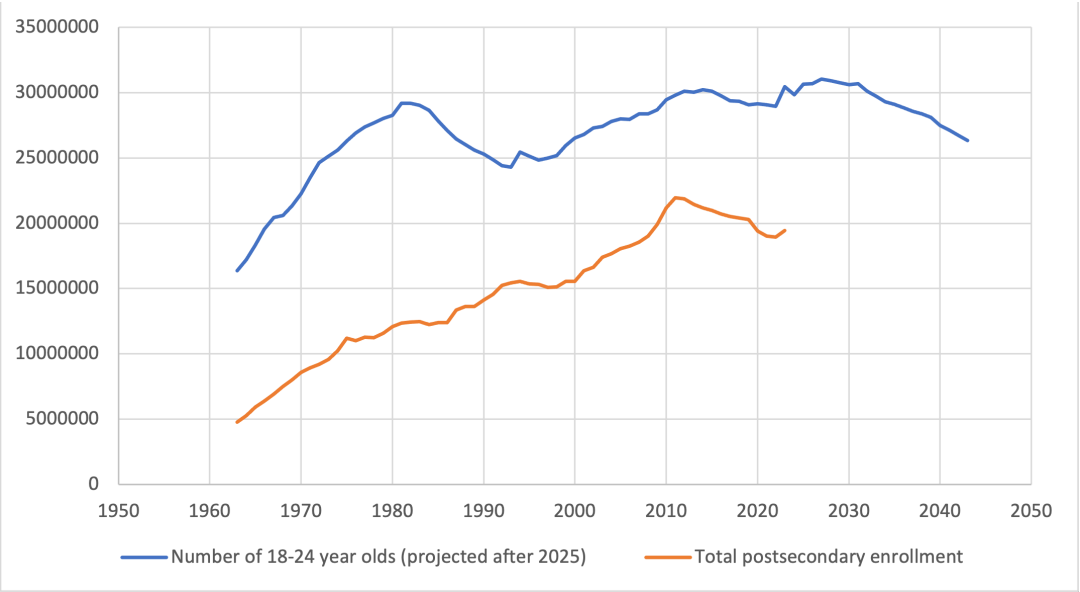


Figure 1: Demographic and Post-secondary Enrollment in the United States

ure 1. The number of persons aged 18-24 declined by nearly five million, or 17%, between 1981 and 1993. Despite this demographic shift, post-secondary enrollments generally held steady or increased over this interval. As the population of traditional undergraduate age declined, institutions managed to maintain positive growth by introducing more graduate degree programs, enrolling a larger number of international students, and enjoying an increase in the proportion of domestic high school graduates who went on to college (Vigdor, 2026).

Figure 1 documents that college-age cohort size stabilized in the 1990s and then increased for more than a decade, enrollment increasing alongside it. Cohort size reached a local maximum around 30 million between 2012 and 2015, and then dropped modestly through 2022 before showing an uptick in 2023.

Whereas enrollment trends masked changing demographics in the baby bust era, there has been a pronounced, sustained drop in post-secondary enrollment since the all-time high witnessed in 2011. The enrollment trend break predates the demographic turnaround point by four years, suggesting factors other than demography played a role. And indeed, there's evidence to suggest that the "bubble" in post-secondary enrollment reflected the impact of high unemployment during the Great Recession. But there is also evidence to tie declining cohort size to reduced enrollments. Vigdor (2026) shows that public institutions tended to suffer more significant enrollment declines after 2010 in states where the ratio of elementary age to college age children was lower. This ratio is, in fact, the single strongest predictor of enrollment change over this time period.

Figure 1 extrapolates from 2025 data to forecast the number of college-age residents in the United States through 2043. This extrapolation ignores the possible impacts of migration to or from the United States, as well as the possible impact of child or adolescent mortality. With these caveats in mind, declining birth rates in the period since the Great Recession augur a sustained decline in cohort size similar in magnitude to the "baby bust," although occurring over a more extended time period.

The dim demographic forecast, coupled with the complicated history of the relationship between these two time series, creates some uncertainty regarding the future course of post-secondary enrollment. Will enrollments show the resilience they exhibited during the baby bust, or continue the general downward trend of the past decade or more?

Some of the factors that helped sustain the growth of higher education in the 1980s – the expansion of masters degree programs and the recruitment of international students – would seem to be questionable strategies for the 2030s. Many masters and professional degree programs have see their enrollments wane in recent years, and even if immigration policy were to trend in the direction of greater access birth cohort sizes have also decreased in most nations that send students to the United States, even as post-secondary systems in those nations advance. It remains plausible that enrollment could be sustained by increasing the proportion of high school graduates who go on to college, or by creating new programs for non-traditional students.

While a future decline in enrollment is not necessarily inevitable, coming on the heels of the first sustained drop in at least 80 years it would exacerbate challenges many public systems of higher education are already facing. Given the significant fixed operating costs of maintaining a college campus, a decline in enrollment forces institutions to raise per-student revenues if they seek to maintain a balanced budget at the same level of service. Raising these revenues via tuition increases risks exacerbating the declining enrollment trend; in practice public institutions have raised per-student revenues via state appropriations (Vigdor, 2026).

Institutions could, and have, also respond to declining enrollments by reducing the level of service. In many cases, this entails eliminating departments, degree programs, or cutting back on course offerings. In more extreme cases, state systems of higher education can, and have, responded to declining enrollments by shuttering or consolidating entire campuses.

How should states managing systems of higher education consider the trade-offs between the greater expense of operating a full system below capacity versus closing or consolidating campuses? This is a relatively novel question, as until the past ten years there had been no

experience of sustained enrollment decline. While it is related to the question of how states should accommodate rising enrollments, there is a critical asymmetry. It is very costly to construct new campuses. It is comparatively less costly to abandon them.

In the twenty years between 1965 and 1985 post-secondary enrollment doubled. This enrollment increase was managed predominantly by the expansion of existing campuses rather than creating new ones. The median public post-secondary student in 1985 attended a campus founded in 1927; the 90th percentile student attended a campus opened in 1967. These statistics are consistent with very significant fixed costs of opening new campuses, relative to expanding existing ones. They may also indicate the educational superiority of operating larger campuses that can offer a more comprehensive array of courses and degree programs. In the context of expanding enrollment, the data point to a clear strategy for states operating public systems: expand existing institutions rather than create new ones.

In the context of declining enrollment, the fixed costs of establishing institutions become moot. The state faces a trade-off between operating more institutions at lower scale, requiring either higher per-student expenses or reduced educational offerings at each campus, or shutting some campuses to maintain the scale of others. Selecting the second option may hamper educational opportunity by placing some students at greater distance from a public college. The absence of a college in a prospective student's local area has been associated with reduced likelihood of enrollment (Acton et al., 2025; Leppel, 1993), reduced likelihood of degree completion conditional on enrollment (Garza and Fullerton, 2018), and lower overall educational attainment (Card, 1993; Kling, 2000).

Regarding the benefits of the first option, maintaining scale, existing evidence supports the conclusion that attending a "flagship" public institution yields significantly better educational outcomes (Hoekstra, 2009; Mountjoy, 2025). Research-intensive, doctoral degree-granting public flagship institutions in the Carnegie R1 classification enrolled an average of 14,000 students in 2022; the average public community college enrolled about 7,000 students and the average masters-degree granting regional public university enrolled about 8,000.

Fundamentally, the question of how to manage declining enrollment at the level of a state public higher education system hinges on an empirical question: how do the returns to maintaining institution size compare to the returns of maintaining proximity to college for a greater share of the population? The following section considers the question theoretically and subsequent sections present data.

3 Model

We model a state planner who optimally sets the tuition and subsidy levels to support existing public institutions of higher education. While the planner considers mothballing campuses in the face of reduced demand or expanding existing campuses as demand increases, we abstract away from a decision to meet increasing demand by founding new colleges.

In the context of this model, we can think of the late-19th century, when a large number of public institutions were founded, as featuring high travel costs and modest economies of scale. Washington state, for example, established three public institutions with narrow and nearly identical curricular objectives – to train teachers – between 1882 and 1893. At the time the state counted perhaps one-twentieth the number of inhabitants it has today. Despite this growth, the state founded only one additional four-year public college after 1893, choosing instead to expand existing institutions. This shift reflects growing economies of scale, as higher education grew to offer a broader range of specialized courses of study, and reduced travel costs. States with later-established higher education systems, such as Arizona, tend to feature systems more tailored to these parameters. At the same time, the decision to maintain existing multi-campus systems in older states indicates that the fixed costs of establishing a campus are a main driver of economies of scale.

3.1 The Student's School Choice

A unit line segment $[0, 1]$ contains a continuum of potential students (N) with uniform density. Two public campuses $i \in \{1, 2\}$ are located at $x_1 = 0$ (satellite) and $x_2 = 1$ (flagship). Tuition p is *common* across campuses. A student at location x attending campus i has the utility:

$$U_i(x) = \theta H_i - p - \tau(x - x_i)^2, \qquad \theta > 0,\ \tau > 0$$

The outside option of not attending college is set to: $U_0 = 0$. Private willingness-to-pay is θ per unit of human capital (H, HC). To attend a campus, the student must pay a commuting cost based on distance and τ.

3.2 The School's Human Capital Production and Cost Functions

Total enrollment at campus i is $n_i \geq 0$. Human capital *per student* features concave returns to scale (n_i) and to state spending in quality (m_i). We assume that the flagship campus has a

comparative advantage in scale compared to the satellite campus:

$$H_i(n_i, m_i) = a_i + b_i \ln(1 + n_i) + \gamma \ln(1 + m_i), \qquad b_i > 0,\ \gamma > 0, \quad \text{with } b_2 > b_1$$

Campus i faces fixed cost f_i, variable cost ν_i per student, and capacity-expansion cost:

$$C_i(n_i) = \psi_i \left(n_i - K_i^0\right)_+^\alpha, \qquad \psi_i > 0,\ 0 < \alpha < 1$$

with some legacy capacity K_i^0. Per-student quality spending by the state costs linearly in welfare: $m_i n_i$ dollars.

3.3 The State's Education Financing Decisions

The state planner attempts to maximize social welfare from education by setting the common tuition p and campus-specific spending in quality, m_i. It values per unit HC at $\sigma > \theta$. The state may also choose to costlessly mothball one or both campuses ($n_i = 0$) with some reopening cost $\Omega_i \geq 0$. We assume the state provides campus-level subsidies s_i to close budget gaps net of tuition:

$$s_i = f_i + \nu_i n_i + m_i n_i + C_i(n_i) - p n_i$$

A one-unit increase in m_i costs n_i dollars and raises per-student HC by $\partial H_i / \partial m_i = \gamma/(1 + m_i)$. The *per-dollar social return* to m_i is $\frac{\sigma\gamma}{1+m_i}$. The state invests until the social return equals some public benchmark $r > 0$:[3]

$$m_i^* = \min\left\{\bar{m}_i,\ \max\left\{\frac{\sigma\gamma}{r} - 1,\ 0\right\}\right\} \tag{1}$$

Rule (1) is independent of n_i because both benefits and costs scale with enrollment. We treat m_i as fixed at m_i^*.[4]

The timing of the model is as follows:

1. The state chooses p, m_i, and regime $\mathcal{R} \in \{\mathcal{R}_0, \mathcal{R}_1, \mathcal{R}_2, \mathcal{R}_{12}\}$, corresponding to operating none of, only the satellite, only the flagship, or both campuses, respectively.[5]

[3] See A.1 for derivation.

[4] $\bar{m}_i$ is some budget ceiling. For simplicity, we assume it is unbounded.

[5] We abstract away from regimes R_0 and R_1. Shutting down both schools, R_0, implies that social returns on education is low enough to not merit any state-level investment. R_1 implies that the satellite campus draws more students than the flagship campus, despite the common tuition and comparative advantage in scale.

2. Given (p, m_i), students choose one campus or no college.

3. Costs are realized and subsidies are paid.

3.4 Student Demand

If every enrolled student attends exactly one campus, let $\widehat{x}$ be the indifferent location: $U_1(\widehat{x}) = U_2(\widehat{x})$. Then:

$$\widehat{x} = \frac{1}{2} + \frac{\theta}{2\tau}(H_1 - H_2) = \frac{1}{2} + \phi\left[(a_1 - a_2) + \gamma \ln\frac{1+m_1}{1+m_2} + b_1 \ln(1+n_1) - b_2 \ln(1+n_2)\right] \quad (2)$$

Market shares are $n_1 = N\widehat{x}$ and $n_2 = N(1-\widehat{x}) = N - n_1$. Substitute into equation (2):

$$n_1 = \frac{N}{2} + \phi N\left[(a_1 - a_2) + \gamma \ln\frac{1+m_1}{1+m_2} + b_1 \ln(1+n_1) - b_2 \ln(1+N-n_1)\right]$$

If there is non-participation, a student attends campus i if and only if $\theta H_i - p - \tau(x - x_i)^2 \geq 0$. The *participation radius* for campus i is

$$\bar{x}_i = \sqrt{\frac{(\theta H_i - p)_+}{\tau}}$$

Given the cutpoint $\widehat{x}$ from equation (2), enrollment with possible non-participation is

$$n_1 = N \cdot \max\Big\{0,\ \min\{\widehat{x}, \bar{x}_1\}\Big\}, \qquad n_2 = N \cdot \max\Big\{0,\ \min\{1-\widehat{x}, \bar{x}_2\}\Big\}$$

3.5 Equilibrium

If campus i operates alone with $n_i = N\bar{x}_i$, the tuition is:

$$p = \theta a_i + \theta b_i \ln(1+n_i) + \theta\gamma \ln(1+m_i) - \frac{\tau}{N^2} n_i^2, \qquad \theta H_i - p = \frac{\tau}{N^2} n_i^2 \quad (3)$$

With both campuses open, equating (3) across $i = 1, 2$ yields:

$$\theta b_1 \ln(1+n_1) - \theta b_2 \ln(1+n_2) + \theta\gamma \ln\frac{1+m_1}{1+m_2} - \frac{\tau}{N^2}(n_1^2 - n_2^2) = -\theta(a_1 - a_2) \quad (4)$$

3.5.1 Full Participation: $n_1 + n_2 \equiv N$

Let $n_2 = N - n_1$. The unique $n_1^* \in (0, N)$ solves:[6]

$$G(n_1) \equiv n_1 - \frac{N}{2} - \frac{N\theta}{2\tau}\Big[(a_1 - a_2) + \gamma \ln\tfrac{1+m_1}{1+m_2} + b_1 \ln(1 + n_1) - b_2 \ln(1 + N - n_1)\Big] = 0 \tag{5}$$

The common tuition then follows from equation (3).

3.5.2 Partial Participation: $n_1 + n_2 < N$

Define $Y \equiv n_1 + n_2$ (total enrollment) and $D \equiv n_1 - n_2$ (imbalance). Equation (4) implies:

$$\begin{aligned} \Delta A &\equiv \theta(a_1 - a_2) + \theta\gamma \ln\frac{1 + m_1}{1 + m_2} + \theta(b_1 - b_2) \ln 2, \\ F(D, Y) &\equiv \frac{\tau}{N^2} Y D - \theta b_1 \ln(2 + Y + D) + \theta b_2 \ln(2 + Y - D) - \Delta A = 0 \end{aligned} \tag{6}$$

which pins $D = D(S)$. Therefore:[7]

$$n_1(Y) = \tfrac{1}{2}\big(Y + D(Y)\big), \qquad n_2(Y) = \tfrac{1}{2}\big(Y - D(Y)\big), \qquad Y \in [0, N] \tag{7}$$

3.6 Welfare and regime choice

With both campuses operating, the social planner maximizes social welfare:

$$\max_{Y \in [0,N]} \; W_{12}\big(n_1(Y), n_2(Y)\big)$$

where:

$$W_{12}(n_1, n_2) = \sum_{i=1}^{2} \Big\{\sigma[a_i + b_i \ln(1+n_i) + \gamma \ln(1+m_i)]\, n_i - (\nu_i + m_i) n_i - C_i(n_i) - f_i\Big\} - \frac{\tau}{3N^2}(n_1^3 + n_2^3) \tag{8}$$

When $Y^* = N$, we recover n_i^* from equation (5). When $Y^* < N$, we recover n_i^* from equation (7). The tuition p is then given by equation (3). The final term in the welfare function is commuting costs for students:

$$\text{Commute} = \int_0^{\bar{x}_i} \tau x^2 \, (N \, \mathrm{d}x) = \tau N \frac{\bar{x}_i^3}{3} = \frac{\tau}{3N^2} n_i^3$$

[6] Uniqueness follows from $G'(n_1) = 1 - \frac{N\theta}{2\tau}\big(\frac{b_1}{1+n_1} + \frac{b_2}{1+N-n_1}\big) > 0$.

[7] See A.2 for derivation.

For the single-campus regime i, welfare is:[8]

$$W_i(n_i) = \sigma[a_i + b_i \ln(1+n_i) + \gamma \ln(1+m_i)]\, n_i - (\nu_i + m_i)n_i - C_i(n_i) - f_i - \frac{\tau}{3N^2} n_i^3 \tag{9}$$

The state selects the regime with higher welfare, adding reopening costs if relevant. Given optimal choice for tuition and per-student investment (which pins down enrollment numbers), optimal campus-level subsidies are:

$$s_i^* = f_i + \nu_i n_i^* + m_i n_i^* + C_i(n_i^*) - p^*\, n_i^* \tag{10}$$

3.7 Comparative Statics

Following the discussion in Section 2, we assume that the population of the state is such that the legacy enrollment caps in both campuses do not bind. This allows us to simplify the math by ignoring the capacity expansion costs, $C_i(n_i)$.

First, we examine the simpler case where only the flagship campus operates.

3.7.1 Flagship Regime $\mathcal{R}_2$

With welfare defined as:

$$W_2(n_2; N) = \sigma\big[a_2 + b_2 \ln(1+n_2) + \gamma \ln(1+m_2)\big]\, n_2 - (\nu_2 + m_2)n_2 - \frac{\tau}{3N^2} n_2^3$$

The FOC is:

$$\Phi_2(n_2, N) = -\frac{\tau}{N^2} n_2^2 + \sigma\Big[a_2 + b_2 \ln(1+n_2) + \gamma \ln(1+m_2)\Big] + \sigma\, \frac{b_2\, n_2}{1+n_2} - \nu_2 - m_2 = 0$$

Using the implicit function theorem:

$$\frac{\mathrm{d}n_2^*}{\mathrm{d}N} = -\frac{\partial \Phi_2/\partial N}{\partial \Phi_2/\partial n_2} = -\frac{\frac{2\tau}{N^3}(n_2^*)^2}{\sigma \frac{b_2}{1+n_2^*} + \sigma \frac{b_2}{(1+n_2^*)^2} - \frac{2\tau}{N^2} n_2^*} > 0 \tag{11}$$

due to assuming that the SOC, $\partial \Phi_2/\partial n_2 < 0$ for a well-behaved interior solution. Then, using the equation for optimal tuition (equation (3)), assuming that tuition charged to students is less than the per-student cost to the state, $p^* \leq \nu_2 + m_2^*$, and plugging in equation (11), we

[8] See A.3.

find:

$$\frac{\mathrm{d}p^*}{\mathrm{d}N} = \frac{2\tau}{N^3}\, n_2^{*2}\, \frac{(\sigma-\theta)\,\dfrac{b_2}{1+n_2^*} + \sigma\,\dfrac{b_2}{(1+n_2^*)^2}}{\sigma\dfrac{b_2}{1+n_2^*} + \sigma\dfrac{b_2}{(1+n_2^*)^2} - \dfrac{2\tau}{N^2}n_2^*} < 0$$

and using equation(10):

$$\frac{\mathrm{d}s_2^*}{\mathrm{d}N} = \frac{2\tau}{N^3}\, n_2^{*2}\left[\frac{(\theta-\sigma)\left(a_2 + b_2\ln(1+n_2^*) + \gamma\ln(1+m_2) + \dfrac{b_2\, n_2^*}{1+n_2^*}\right) - \dfrac{2\tau}{N^2}\, n_2^{*2}}{\sigma\dfrac{b_2}{1+n_2^*} + \sigma\dfrac{b_2}{(1+n_2^*)^2} - \dfrac{2\tau}{N^2}n_2^*} - n_2^*\right] > 0$$

Thus, in a state with only the flagship campus operating, a declining population of potential college-going students results in an increasing optimal tuition, decreasing optimal state subsidies, and decreasing optimal college enrollment.[9]

Next, we examine the case where the state is operating two campuses.

3.7.2 Two-campus Regime $\mathcal{R}_{12}$

We use Cramer's Rule to find closed-form expressions for $\frac{dn_1^*}{dN}$ and $\frac{dn_2^*}{dN}$.[10] With welfare from equation (8) and defining the condition for common tuition across the campuses as:

$$F(n_1, n_2; N) = \theta b_1 \ln(1+n_1) - \theta b_2 \ln(1+n_2) + \theta\gamma \ln\frac{1+m_1}{1+m_2} - \frac{\tau}{N^2}(n_1^2 - n_2^2) - \theta(a_1 - a_2) = 0$$

the Lagrangian becomes:

$$\mathcal{L}(n_1, n_2, \mu; N) = W_{12}(n_1, n_2; N) + \mu F(n_1, n_2; N)$$

and

$$M_i(n_i; N) = \frac{\partial W_{12}}{\partial n_i} = \sigma a_i + \sigma b_i \ln(1+n_i) + \sigma b_i \frac{n_i}{1+n_i} + \sigma\gamma\ln(1+m_i) - \nu_i - \frac{\tau}{N^2}n_i^2 - m_i$$
$$g_1(n_1; N) = \frac{\partial F}{\partial n_1} = \frac{\theta b_1}{1+n_1} - \frac{2\tau}{N^2}n_1, \qquad g_2(n_2; N) = \frac{\partial F}{\partial n_2} = -\frac{\theta b_2}{1+n_2} + \frac{2\tau}{N^2}n_2$$

Then FOCs of the Lagrangian are:

$$M_1 + \mu g_1 = 0, \qquad M_2 + \mu g_2 = 0, \qquad F = 0$$

[9] See A.4 for derivation.

[10] If we assume full participation, the derivatives become much simpler to calculate, as $n_1 \equiv N - n_2$ which allows one of the variables to be immediately eliminated.

Differentiating the FOCs yields:

$$\begin{aligned}(M_1' + \mu g_1')\frac{\mathrm{d}n_1^*}{\mathrm{d}N} \;+\; g_1\,\frac{\mathrm{d}\mu}{\mathrm{d}N} &= -(M_{1,N} + \mu g_{1,N}),\\ (M_2' + \mu g_2')\frac{\mathrm{d}n_2^*}{\mathrm{d}N} \;+\; g_2\,\frac{\mathrm{d}\mu}{\mathrm{d}N} &= -(M_{2,N} + \mu g_{2,N}),\\ g_1\,\frac{\mathrm{d}n_1^*}{\mathrm{d}N} \;+\; g_2\,\frac{\mathrm{d}n_2^*}{\mathrm{d}N} &= -\,F_N\end{aligned}$$

where:

$$\begin{aligned}M_i'(n_i;N) &= \sigma\frac{b_i}{1+n_i} + \sigma\frac{b_i}{(1+n_i)^2} - \frac{2\tau}{N^2}n_i, & M_{i,N}(n_i;N) &= \frac{2\tau}{N^3}n_i^2,\\ g_1'(n_1;N) &= -\frac{\theta b_1}{(1+n_1)^2} - \frac{2\tau}{N^2}, & g_{1,N}(n_1;N) &= \frac{4\tau}{N^3}n_1,\\ g_2'(n_2;N) &= +\frac{\theta b_2}{(1+n_2)^2} + \frac{2\tau}{N^2}, & g_{2,N}(n_2;N) &= -\frac{4\tau}{N^3}n_2,\\ F_N(n_1,n_2;N) &= \frac{2\tau}{N^3}\,(n_1^2 - n_2^2)\end{aligned}$$

Let:

$$A = \begin{bmatrix} Z_1 & 0 & g_1\\ 0 & Z_2 & g_2\\ g_1 & g_2 & 0\end{bmatrix}, \quad x = \begin{bmatrix}\dfrac{\mathrm{d}n_1^*}{\mathrm{d}N}\\ \dfrac{\mathrm{d}n_2^*}{\mathrm{d}N}\\ \dfrac{\mathrm{d}\mu}{\mathrm{d}N}\end{bmatrix}, \quad b = \begin{bmatrix} Q_1\\ Q_2\\ F_N\end{bmatrix}$$

where:

$$\begin{aligned}Z_i &= M_i' + \mu g_1'\\ Q_i &= M_{i,N} + \mu g_{i,N}\end{aligned}$$

The determinant is:

$$\Delta = \det(A) = -(Z_1 g_2^2 + Z_2 g_1^2)$$

Then:

$$\frac{\mathrm{d}n_1^*}{\mathrm{d}N} = \frac{-Q_1 g_2^2 + g_1 g_2 Q_2 - g_1 Z_2\,F_N}{\Delta}, \qquad \frac{\mathrm{d}n_2^*}{\mathrm{d}N} = \frac{Z_1 g_2\,F_N - Q_1 g_1 g_2 + g_1^2 Q_2}{\Delta}$$

Using equation (3), the change in optimal tuition as population changes is:

$$\frac{\mathrm{d}p^*}{\mathrm{d}N} = \left[\theta\frac{b_1}{1+n_1^*} - \frac{2\tau}{N^2}n_1^*\right]\frac{\mathrm{d}n_1^*}{\mathrm{d}N} + \frac{2\tau}{N^3}(n_1^*)^2 = \left[\theta\frac{b_2}{1+n_2^*} - \frac{2\tau}{N^2}n_2^*\right]\frac{\mathrm{d}n_2^*}{\mathrm{d}N} + \frac{2\tau}{N^3}(n_2^*)^2$$

and using equation (10), the change in optimal subsidies as population changes are:

$$\frac{\mathrm{d}s_i^*}{\mathrm{d}N} = \left[\nu_i + m_i - p^*\right]\frac{\mathrm{d}n_i^*}{\mathrm{d}N} - n_i^*\frac{\mathrm{d}p^*}{\mathrm{d}N}$$

While the signs of $\frac{\mathrm{d}n_i^*}{\mathrm{d}N}$, $\frac{\mathrm{d}s_i^*}{\mathrm{d}N}$, and $\frac{\mathrm{d}p^*}{\mathrm{d}N}$ are ambiguous, if we assume:

1. σ is large relative to θ so that the state planner has a substantive public interest in funding education (above how individuals value education). From this condition, it also follows: $p^* \leq \nu_i + m_i^*$. Tuition is not enough to cover the per-student expenses to operate the school.

2. τ is sufficiently large enough to have commuting cost push students toward both campuses.

3. b_2 is not too much larger than b_1 so that students are not immediately steered toward the flagship campus.

Then $\frac{dn_1^*}{dN} \geq 0$, $\frac{dn_2^*}{dN} > 0$, $\frac{dp^*}{dN} \leq 0$, and $\frac{ds_i^*}{dN} \geq 0$.[11] Thus, similar to the case where only the flagship operates, in an environment of declining population, it is optimal to decrease enrollment across both campuses, raise tuition, and decrease state subsidies.

Figure 2 summarizes and demonstrates the comparative statics analysis. The vertical line labeled N^* indicates the boundary of the population size where it is optimal to operate two campuses (on the right) vs. only the flagship campus (on the left). When the satellite campus shuts down, the flagship enrollment increases, with students closer to the flagship who were attending the satellite being induced to move to the flagship. However, a substantive number of students who were attending the satellite campus choose no education after the shutdown. In addition, social welfare is optimized by substantially decreasing the tuition and increasing the subsidy to the flagship campus.

Figure 3 displays the boundary where the planner is indifferent between operating two vs. one campus, as the commuting cost τ and the "comparative advantage" of the flagship campus Δb change. There is a "goldilocks" region of τ and Δb that supports both campuses.

[11] See A.5 for details.

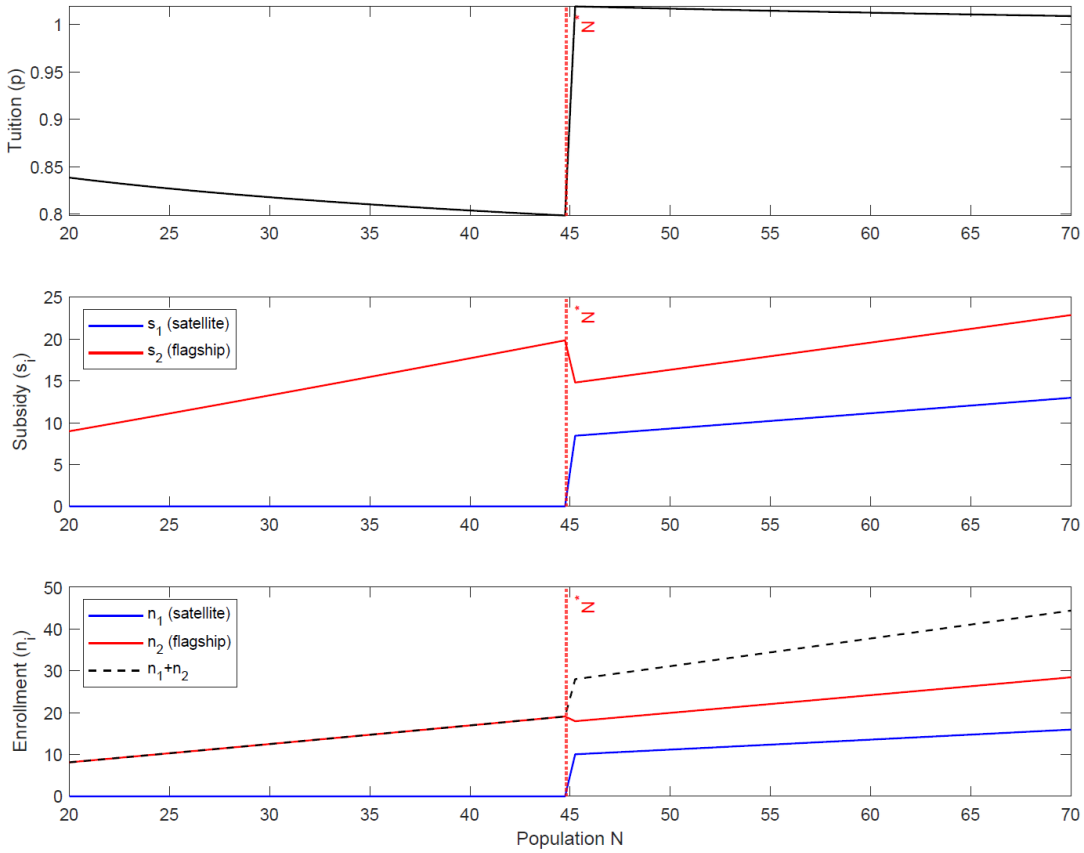


Figure 2: Optimal Tuition, Subsidies, and Enrollments vs. Population N.

Notes: The dotted-line N^* represents the population size where the planner is indifferent between operating 1 or 2 campuses. *Calibration values:* $\theta = 1$, $\sigma = 1.4$, $\tau = 7$, $\gamma = 0.7$, $r = 0.5$, $a_1 = 0.9$, $a_2 = 1.3$, $b_1 = 0.02$, $b_2 = 0.1$, $\nu_1 = \nu_2 = 0.8$, $f_1 = 1$, $f_2 = 1.5$, $K_1^0 = 20$, $K_2^0 = 30$, $\psi_1 = 0.55$, $\psi_2 = 0.30$, $\alpha = 0.9$.

As the advantage of the flagship campus increases, commuting costs must also increase to keep more students located relatively near the satellite bound to the local school. However, high commuting costs and large flagship advantage make the single campus operation optimal. While high commuting costs would seem to imply that students located near the satellite campus would prefer to attend the local campus, a too high τ value means that both campuses find it difficult to attract students who are far away. With lower enrollment in the satellite campus, the planner finds it optimal to mothball the campus and only operate the flagship.

4 Data and Methods

The analysis below seeks to illuminate two key factors relevant to a state's decision of whether to preserve economies of scale or geographic access in the face of declining enrollment. The first challenge we face is measuring these constructs.

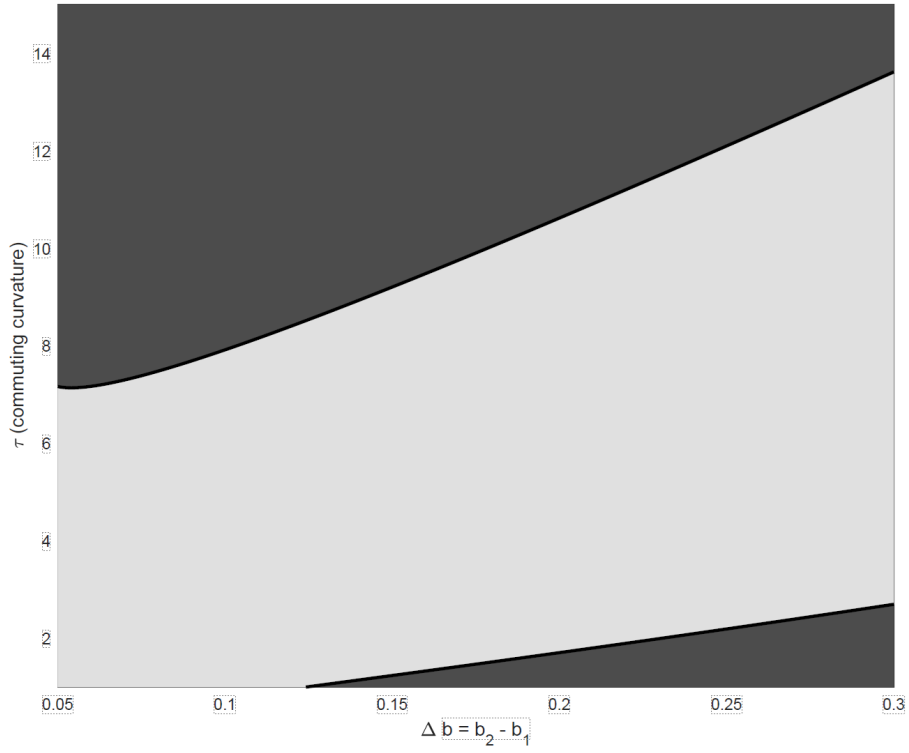


Figure 3: Indifference Curve in $(\tau, \Delta b)$ Space: Two-Campus vs. Flagship-Only.

Notes: Darker shade indicates only flagship operating. *Calibration values:* $N = 50$, $\theta = 1$, $\sigma = 1.4$, $\gamma = 0.7$, $r = 0.5$, $a_1 = 0.9$, $a_2 = 1.3$, $b_1 = 0.02$, $b_2 = 0.1$, $\nu_1 = 0.7$, $\nu_2 = 0.95$, $f_1 = 0.6$, $f_2 = 1.5$, $K_1^0 = 20$, $K_2^0 = 18$, $\psi_1 = 0.55$, $\psi_2 = 0.90$, $\alpha = 0.9$.

4.1 Geographic Access

Previous literature has measured geographic access to college in a number of ways. Card (1993), in an analysis of National Longitudinal Survey of Youth microdata, used a binary indicator of whether a respondent had a college in their labor market area. Do (2004), using High School & Beyond microdata, uses indicators for whether an individual respondent has a college, or in some cases a high-quality college, in their county of residence. Acton et al. (2025) take advantage of detailed Texas administrative data to measure the drive time between an individual's high school and the nearest two- or four-year college. They begin to find significant negative effects of drive time on enrollment once drive time reaches approximately 30 minutes.

There are just over 3,000 counties or county-equivalents in the lower 48 states, which comprise just under three million square miles of land. The mean county thus measures just under a thousand square miles, and can be thought of as something approximating a square just over 30 miles on a side. The Acton et al. result thus provides some justification for thinking of a county as a relevant catchment area for college students, as a trip from the centroid of one county to the next will, generally, take at least a half-hour.

Thus to answer the basic question "how much geographic access to higher education does a state provide," we measure the population-weighted fraction of counties with an institution of higher education identified in the Integrated Post-secondary Education Data System (IPEDS), provided by the National Center for Education Statistics. We use IPEDS county codes provided in 2009, a year close to the peak enrollment level shown in Figure 1 above. Population weights are derived from the 2020 Census. Summary statistics for this state-level measure and other variables in the analysis appear in Table 1. In the median state, 76.7% of residents have access to a public college in their county. The range extends from 33.6% in Mississippi to 100% in Connecticut, Delaware, and the District of Columbia.

Table 1: Summary Statistics

Variable	Obs.	Mean	SD
Weighted average public campus enrollment	51	14,400	5,559
Percent of population with campus in county	51	0.757	0.175
Per-student public higher education expenditures less tuition and fee	51	20,274	8,495
Enrolled in higher education (ages 18-22)	193,453	0.457	
Holds 4-year degree (ages 23+)	2,125,355	0.364	
ln(earned income) (ages 23+)	1,287,579	10.660	1.140

Notes: individual-level variables use ACS person weights.

4.2 Institution Scale

To capture the extent to which states have taken advantage of economies of scale in providing higher education, we again take advantage of the IPEDS data to measure a weighted average of enrollment across all public 2- and 4-year institutions in a state, with the weights set equal to enrollment itself. The scale measure thus answers the question "how many students attend the institution that the 'mean' student attends?" The scale measure is also derived from 2009, predating the recent downward trend in enrollment. The scale measure can thus be thought of as the "designed" scale of institutions, at or near the moment of peak post-secondary enrollment in the United States.

The median state operates public institutions with an enrollment-weighted average size of 13,553 at or around the point of peak enrollment nationwide. Institution size is smallest in the District of Columbia, which enrolled under 6,000 students total and placed most of them in a single institution, and exceeds 29,000 in two Sun Belt states, Arizona and Florida.

Figure 4 plots the measures of coverage and scale against one another. The two measures dis-



Figure 4: Coverage and Size of Colleges

Notes: Percent of a state's population with a public college (2 or 4 year) in their county vs. size of the institution attended by the "average" student.

play a weak positive correlation (r=0.164). Sun Belt states that have enjoyed recent population growth exhibit a combination of large institution scale and relatively complete coverage – in the desert states of Nevada and Arizona, this reflects the reality that the population is concentrated in a small number of counties more than the existence of colleges in each of them. Northeastern states such as New Hampshire, Massachusetts, and Maine show a combination of widespread coverage and small institution size. Mississippi stands out as having both low coverage and small institution size. And Indiana and Virginia exhibit comparatively large institutions but low coverage.

When states face declining enrollment, their policy choices can be summarized using these two basic measures. Shut campuses and coverage will decline, but scale and per-student expenditures for a given quality of education may remain relatively steady. Maintain coverage and scale will decline, forcing decisions about either increasing per-student expenses to maintain quality or reduce quality, for example through the elimination of degree programs or departments.

4.3 Estimating the Financial Trade-offs between Coverage and Scale

The model in Section 3 above presumes that post-secondary institutions operate with economies of scale, implying a direct trade-off between operating more versus larger institutions. To

examine the magnitude of this trade-off, we examine state-level data on per-full-time-equivalent spending, excluding tuition and fees, as reported by the Annual Survey of State and Local Government Finances for fiscal year 2021. Summary statistics for this variable appear in Table 1. We model this expenditure as a function of quadratics in the two variables above: the percent of a state's residents with a public post-secondary institution in their county, and enrollment-weighted average enrollment. The quadratic terms may reveal that there is an "optimal" scale or coverage rate at the state level. Expenditures are modeled in both levels and logs.

These are cross-sectional regressions without any form of exogenous variation to identify causal effects. It is therefore important to consider the likely impact of omitted variable bias in this analysis. One might reason that states with a stronger preference for higher education will invest both in greater coverage and in unmeasured determinants of expenditure, such as providing a wider array of instructional materials or more heavily subsidizing tuition. In such a scenario our estimates would overstate the impact of coverage on per-student expenditure.

It is unclear whether states with stronger preferences for higher education would favor larger campuses, other things equal. On the one hand, other things equal larger campuses offer the possibility to deliver a given quality education at lower per-student cost. On the other hand, a preference for higher education may manifest itself as a preference to operate at lower scale to mimic prestigious private colleges that heavily subsidize student attendance.

As a summary measure of a state's unobserved preference for education quality, we coded the highest-ranked public campus in each state according to the 2026 edition of U.S. News & World Report (2025). By this measure California has the highest preference for quality, given UC-Berkeley's status as the highest ranked public campus. Alaska stands at the other end of the spectrum, with the campus of the University of Alaska-Fairbanks falling outside the top 200 public 4-year institutions. The US News measure correlates negatively with a state's average institution scale and negatively with county-level coverage. Taking these results at face value would imply that Mississippi has the strongest unobserved preference for education quality. Per-student expenses other than tuition and fees correlate weakly with the US News measure.

Our analysis yields reliable information regarding the financial tradeoffs between scale and coverage to the extent that all states aim to provide a fairly common-quality educational product but have chosen varying input mixes as a function of historical idiosyncrasies.

4.4 Estimating the Attainment Trade-offs between Coverage and Scale

To study the impact of campus coverage and institution scale on individual education-related outcomes, we rely on the 2023 American Community Survey, which includes information on school enrollment, educational attainment, and earned income.

Enrollment regressions focus on individuals between the ages of 18 and 22. Because many of them will be enumerated in the location where they attend school, not necessarily the state where their families originate, we allocate state higher education system characteristics to them on the basis of birthplace. This necessarily excludes any students who were born abroad and migrated to the United States as youth. It will also lead to mis-measurement of state higher education systems for those students who moved across state lines after birth. The introduced measurement error is not likely to be classical, as cross-state mobility does not occur at random. Nonetheless, to the extent that characteristics of state higher education systems are determined by historical idiosyncrasies or can otherwise be considered uncorrelated with unobserved determinants of enrollment, the estimates generated can be considered an answer to the policy maker's question "how would changing the organization of the state higher education system affect the outcomes of persons born in this state?"

Because access and institution size are measured as state-level averages, and not personalized to each student, the results of these specification should not be interpreted along the lines of Card (1993) or Acton et al. (2025). They do not reveal the impact of access on attendance for individual students. They can be considered more along the lines of intent-to-treat effects, if the "treatment" is having access to a public campus in one's county and the state-level measure an instrument for that.

Educational attainment and earnings outcomes are analyzed for adults over the age of 22, again coding the characteristics of state education systems on the basis of birthplace rather than residence with the attendant potential consequences of mis-measurement. In addition to these state-level characteristics, regressions control for age fixed effects, sex, race, and Latino ethnicity. Summary statistics for individual-level characteristics appear in the lower panel of Table 1.

As the variables of interest in these individual-level outcome regressions are determined at the state level, standard errors are clustered at the level of state of birth. Similarly to the regressions on financial outcomes, some specifications will control for a quadratic in the state characteristics in order to assess the possibility of local minima or maxima, or other forms of

nonlinearity.

5 Results

5.1 Higher Education System Structure and Cost

Table 2 presents coefficients from a series of regressions conducted at the state level, relating a measure of cost – per-student expenditures above tuition and fee revenue – to two indicators of the breadth and scope of a state's public higher education system, the weighted average enrollment and coverage measures discussed above.

Table 2: Higher Education System Structure and Costs

Variable	Per-student costs less tuition, $		ln(per student costs less tuition)	
Weighted average enrollment	-0.436^{**}	-1.117	-1.56×10^{-5}	-2.60×10^{-5}
	(0.201)	(0.918)	(8.59×10^{-6})	(3.95×10^{-5})
Weighted average enrollment^2		2.07×10^{-5}		3.29×10^{-10}
		(2.66×10^{-5})		(1.14×10^{-9})
% with campus in county	$18,316^{***}$	-30,612	0.784^{***}	-1.250
	(6,409)	(51,509)	(0.273)	(2.190)
% w/campus in county^2		33,075		1.390
		(34,836)		(1.500)
N	51	51	51	51
R-squared	0.188	0.218	0.174	0.192

Note: Standard errors in parenthesis. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The results show a consistent pattern consistent with economies of scale. Higher education expenses tend to be lower when states operate larger campuses, conditional on the share of the population served, and higher when states serve a higher percentage of the population, holding institution size fixed. Models using expenses in dollars fit the data slightly better, and suggest that a one-standard-deviation increase in average campus enrollment, or 5,559 students, predicts per-student expenses over $2,400 dollars lower, more than a quarter of a standard deviation. Increasing coverage by one standard deviation, or 18%, predicts per-student expenses over $3,300 higher. These results suggest that the cost-minimizing approach to higher education would involve setting up a single mega-campus in a sparsely populated county. Intuitively, such a system would take full advantage of economies of scale in a setting where land values and local wage premia are likely to be low.

The second specification, which controls for quadratics in both variables to check for interior

optimal campus size or coverage, finds no significant results and a reduced adjusted R-squared. The third specification replaces per student expenses in dollars with the natural logarithm of that variable. The results tell a similar story, that a one-standard-deviation increase in average enrollment reduces log expenses by roughly 0.086, and that a one-standard deviation increase in coverage increases log expenses by roughly 0.14. Again, the implied cost-minimizing approach to higher education would appear to be a single mega-campus in a sparsely populated county. And once again, models estimating quadratics in the two variables of interest show no significant nonlinearities and reduce the adjusted R-squared.

5.2 Higher Education Structure and Enrollment

Table 3 reflects the merger of state higher education system characteristics with American Community Survey microdata, coding individual observations on the basis of the system in their state of birth. These models restrict attention to individuals between the ages of 18 and 22, and estimate the impact of the structural measures on the likelihood of the individual being enrolled in post-secondary education, using linear probability models. Standard errors are clustered at the level of birthplace and all specifications use ACS person weights.

Table 3: Higher Education System Structure and Post-secondary Enrollment

Variable	Binary indicator for post-secondary enrollment			
Weighted average enrollment	-0.002	-0.001	0.010	0.010
(thousands)	(0.002)	(0.001)	(0.009)	(0.008)
Weighted average enrollment^2			-3.17×10^{-7}	-2.81×10^{-7}
(thousands)			(2.65×10^{-7})	(2.41×10^{-7})
% with campus in county	0.234^{***}	0.234^{***}	-1.020^{***}	-1.030^{***}
	(0.070)	(0.070)	(0.355)	(0.311)
% w/campus in county^2			0.848^{***}	0.859^{***}
			(0.230)	(0.201)
Individual level controls	no	yes	no	yes
N	193,453	193,453	193,453	193,453
R-squared	0.005	0.064	0.008	0.066

Notes: Standard errors, clustered by birthplace, in parenthesis. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Estimates are derived from linear probability models. Data derived from American Community Survey; sample includes individuals age 18-22 born in the United States and matched to higher education system characteristics on the basis of birthplace. All specifications use ACS person weights. Individual controls include categorical variables for race, Latino ethnicity, sex, and age.

The models show a consistent pattern. Weighted average enrollment shows no significant relationship with the likelihood of an individual student enrolling in any specification, in either linear or quadratic form, with or without student-level controls. The coverage variable, by

contrast, strongly predicts higher enrollment rates with a coefficient that is identical to the third decimal place in models with and without student-level controls. The magnitude of the effect, if interpreted as a simple linear effect, suggests that the presence of a public campus in a prospective student's county increases the likelihood of post-secondary enrollment by 23 percentage points. This effect size is larger than that reported in Acton et al. (2025), who suggest that having no campus within roughly 40 minutes reduces enrollment by between 5 and 10 percentage points.

Quadratic specifications indicate that the effect of coverage on enrollment is not linear. The parabola implied by the model with student-level controls suggests a local minimum around 60% coverage, below the state-level average. This pattern suggests that adding or deleting coverage in a low-coverage state does not make much difference, on the margin. By contrast, the effects of expanding coverage are amplified in states where the coverage rate is already high. This is not necessarily an intuitive result. It may be the case that states dedicated to near-universal campus access omit only those regions that are particularly remote or difficult to serve. The island of Nantucket, one of the few Massachusetts jurisdictions without a public post-secondary institution, would be one example. And it may also be the case that campus access in these remote regions has a more significant impact than, say, one in a suburban county adjoining a central city with a public university. By contrast, the marginal campuses built in states where many counties have no access may make little difference if they are relatively close to existing public options.

Across all specifications, there is no statistically detectable relationship between weighted average enrollment and the propensity of individual students to enroll. This empirically verifies the basic trade-off described in our model: the enrollment-maximizing strategy calls for geographically dispersed campuses, no matter how small, while the cost-minimizing strategy calls for a single campus exploiting economies of scale.

5.3 Higher Education Structure and Graduation

Table 4 continues the analysis of ACS data, shifting the focus to persons above the age of 22. Once again coding individuals according to the higher education system of their birth state, the regressions here examine whether an adult possesses a four-year college degree. Reported results continue to reflect linear probability models, with birthplace-clustered standard errors and ACS person weights.

Table 4: Higher Education System Structure and Degree Attainment

Variable	Binary indicator for 4-year degree attainment			
Weighted average enrollment (thousands)	-0.003^{***} (0.001)	-0.003^{***} (0.001)	0.006 (0.007)	0.005 (0.006)
Weighted average enrollment^2			-2.46×10^{-7} (1.76×10^{-7})	-1.91×10^{-7} (1.48×10^{-7})
% with campus in county	0.179^{***} (0.047)	0.196^{***} (0.046)	-0.304 (0.367)	-0.405 (0.287)
% w/campus in county^2			0.329 (0.255)	0.409^{**} (0.201)
Individual level controls	no	yes	no	yes
N	2,125,355	2,125,355	2,125,355	2,125,355
R-squared	0.004	0.040	0.005	0.041

Notes: Standard errors, clustered by birthplace, in parenthesis.*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Estimates are derived from linear probability models. Data derived from American Community Survey; sample includes individuals age 23 and up born in the United States and matched to higher education system characteristics on the basis of birthplace. All specifications use ACS person weights. Individual controls include categorical variables for race, Latino ethnicity, sex, and age.

The findings here continue to support a role for local college access in determining educational attainment, including a non-linear pattern similar to that found in Table 3. The magnitudes of estimated effects are somewhat smaller here than they were when studying enrollment. There are multiple possible explanations for this pattern. It could be that local access is more important at present than it was in the past, perhaps because in earlier generations marginal students were less distance-sensitive. It could also be that the marginal students drawn to college because of its proximity are less likely to persist to a four-year degree.

A new pattern emerges with regard to weighted average enrollment and degree attainment. There is a small but statistically significant negative relationship apparent in models both with and without individual student-level controls. The magnitude suggests that a one-standard-deviation in average campus size reduces the probability of completing a degree by between one and two percentage points.

Again, since we are studying older cohorts here compared to the enrollment analysis, there are multiple possible explanations. This could be a pure cohort effect, where institution size depressed educational attainment in the past but no longer does. It could also indicate a negative impact of institution size on completion rates, that students are more likely to "slip through the cracks" at larger campuses. This interpretation would be inconsistent with Mountjoy (2025), who attributes positive attainment impacts of attending a larger flagship campus, but Mountjoy's analysis pertains to a single state at a single point in time, and moreover to students on

the specific margin of admission to a selective public university.

If we accept the possibility that institution scale has a modest negative impact on the probability of graduating conditional on enrollment, it would only heighten the tradeoff between cost-minimization and attainment-maximization. We would continue to conclude that the attainment-maximizing higher education system involves a diffuse array of necessarily small campuses, at odds with the cost-minimizing "mega-campus."

5.4 Higher Education Structure and Earnings

Table 5 extends the analysis by studying the logarithm of earned income. In general, the results here are consistent with those found in Table 4. Adults born in states with more universal access to public college campuses earn significantly more than others, with or without individual-level controls. A quadratic specification continues to show increasing returns to coverage as it approaches the universal level. Moreover, the results show a modest but statistically significant negative relationship between weighted average enrollment and earnings, indicating that a one-standard deviation increase in the enrollment measure predicts a reduction in log earnings of between 0.01 and 0.02. This serves as further evidence that the benefits of public higher education are best pursued with a system of diffuse campuses.

The final specification in Table 5 adds a control for whether the adult has attained a four-year degree. This is a potentially endogenous regressor, as Table 4 established that attainment is potentially a function of the college system characteristics of interest here. The regression also adds interaction terms between four-year degree attainment and the system characteristics. We might expect to see a pattern whereby the apparent returns to being born in a state with a broader higher education system accrue predominantly to those individuals who complete a college degree. In fact this is not the case. The results show that adults without a college degree enjoy higher earnings when they were born in states with greater public college access, enjoying roughly two-thirds of the benefits that accrue to degree holders. It may be that these beneficiaries without degrees enjoy higher earnings because of greater access to two-year degree programs or the skills they acquired even without graduating. It may also be the case that the effect among the non-college educated reflects, at least in part, the employment impacts of operating a larger system of public colleges. Alternately, it may be the case that states that pursue more universal access to higher education also tend to pursue unrelated policies that improve the earnings of those without four-year degrees. Whatever the reason for this pattern,

Table 5: Higher Education System Structure and Adult Earnings

Variable	ln(earned income					
Weighted avg. enrollment	-0.004^{**}	-0.003^{**}	0.014	0.009	-0.001	-0.001
(thousands)	(0.002)	(0.002)	(0.009)	(0.008)	(0.001)	(0.001)
Weighted avg. enrollment^2			$-4.94 \times 10^{-7**}$	-3.02×10^{-7}		
			(2.34×10^{-7})	(2.07×10^{-7})		
% with campus in county	0.333^{***}	0.366^{***}	-0.831	-1.100^{**}	0.244^{***}	0.202^{***}
	(0.074)	(0.075)	(0.629)	(0.494)	(0.046)	(0.043)
% w/campus in county^2			0.788	0.993		
			(0.419)	(0.324)		
Four-year degree holder					0.611^{***}	0.540^{***}
					(0.006)	(0.027)
Degree holder x Wtd. avg. enrl.						-0.001
						(0.001)
Degree holder x % w/campus						0.100^{***}
						(0.035)
Individual level controls	no	yes	no	yes	yes	yes
N	1,287,579	1,287,579	1,287,579	1,287,579	1,287,579	1,287,579
R-squared	0.002	0.096	0.003	0.096	0.163	0.163

Notes: Standard errors, clustered by birthplace, in parenthesis.*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Estimates are derived from linear probability models. Data derived from American Community Survey; sample includes individuals age 23 and up born in the United States and matched to higher education system characteristics on the basis of birthplace. All specifications use ACS person weights. Individual controls include categorical variables for race, Latino ethnicity, sex, and age.

it introduces reason to question whether the relationships revealed in this and earlier tables are truly causal or instead reflect the tendency to adopt pro-education or pro-earnings policies alongside a broader higher education system.

5.5 Distributional Impacts of Higher Education Structure

One might hypothesize that close proximity to higher education would have a disproportionate impact on disadvantaged students. Having an institution nearby might promote learning about the options available in higher education, and also presents the possibility of saving on room and board expenses by attending while continuing to reside with one's parents. Acton et al. (2025) found some evidence suggesting differential effects of distance to college based on socioeconomic or racial characteristics.

Table 6 uses American Community Survey data to assess whether higher education system structure variable exert differential impacts based on student race, coding race in terms of whether an individual is categorized as an "under-represented minority," including Black, Native American, or Hispanic. We might expect to see concentrated effects of college proximity, in particular, on enrollment, degree attainment, and earnings within this subgroup.

Table 6: Tests for differential returns to system structure by race

Variable	Enrolled (ages 18-22)	4-year degree (ages 23+)	ln(earnings) (ages 23+)
Weighted average enrollment (thousands)	-0.001	-0.003^{***}	-0.003
	(0.001)	(0.001)	(0.002)
% with campus in county	0.270^{***}	0.231^{***}	0.412^{***}
	(0.065)	(0.046)	(0.075)
Under-represented minority × Wtd. avg. enrl. (thousands)	-1.33×10^{-4}	4.15×10^{-4}	0.001
	(0.002)	(0.001)	(0.002)
Under-represented minority × % with campus in county	-0.120^{***}	-0.181^{***}	-0.232^{***}
	(0.030)	(0.024)	(0.044)
Individual level controls	yes	yes	yes
N	193,453	2,125,355	1,287,579
R-squared	0.064	0.041	0.096

Notes: Standard errors, clustered by birthplace, in parenthesis. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Estimates are derived from linear probability models. Data derived from American Community Survey; sample includes individuals born in the United States and matched to higher education system characteristics on the basis of birthplace, with age restrictions as noted at the head of each column. All specifications use ACS person weights. Individual controls include categorical variables for race, Latino ethnicity, sex, and age.

In fact we see the opposite. While the results suggest that students of all races are more likely to enroll, more likely to graduate, and earn more as adults when they are born in states

with more universal access to a local college, the effects are consistently weaker among under-represented minorities. This may reflect the fact that in practice making a higher education system more universal means operating institutions in more sparsely populated areas, while the under-represented minority population is not necessarily more concentrated in those areas. It may also be the case that operating a broader higher education system, in the presence of residential segregation at the state level, may lead under-represented minority students to attend campuses with fewer resources.

Whatever the reason, it is not necessarily the case that operating a larger set of campuses serves the interests of under-represented minority students.

6 Discussion

As of 2009, the state of Washington operated a public higher education system with two doctoral-degree granting institutions, three master's-degree granting institution, one four-year college, and 31 community colleges across 39 counties. Just over 91% of the state's 2020 population resided in a county with access to a college.[12] Weighted average enrollment stood at just over 13,000 at the Great Recession-era peak.

As in most states, public post-secondary enrollment in Washington has declined since 2010, from 386,303 students to 292,552 as of fall 2022. In response to this drop of nearly one quarter, the state has held the number of institutions steady. The decline has been uneven across institutions. The flagship University of Washington has grown modestly over the past fifteen years, while smaller Evergreen State College saw its enrollment cut in half. While proposals to close institutions have been floated in the state legislature, they have not gained traction. With the state's budget in poor condition as of 2025, discussions on the topic of closing or consolidating institutions will likely re-emerge in the near future.

Using the results of the previous section, we can sketch out a hypothetical counterfactual for Washington, where the state had chosen to react to declining enrollment by proactively shutting down institutions. Specifically, we will imagine a scenario where the legislature had eliminated a set of community colleges with full-time equivalent enrollment summing to 50,000 as of 2010, representing the total decline in community college FTE enrollment over the next 15 years.

[12]This figure likely understates college access as some institutions operate satellite facilities in otherwise unserved areas. Washington State University, for example, has operated WSU Tri-Cities in Benton County, the most populous county without an institution reporting to IPEDS, since 1989. The state community college system had expanded to 34 campuses by 2025.

The trajectory for the state's four-year institutions has been somewhat different, with a later peak in enrollment (2018), and a more modest 10,000 student decline. We will thus imagine a scenario where the state shut down campuses with a total 2018 enrollment around 10,000.

In the four-year sector, a net capacity reduction of 10,000 students could have been accomplished by shutting down the Evergreen State College and the Bothell campus of the University of Washington. The access impact of these closures would likely have been muted, as both lie in counties served by other institutions. UW-Bothell sits in King County, already served by UW-Seattle and no fewer than nine community colleges – including one immediately adjacent to the UW-Bothell campus. The Evergreen State College lies in Thurston County, home to South Puget Sound Community College. In theory, the loss of these two institutions would be virtually costless in terms of access, with the stipulation that local students seeking 4-year degrees would have to transfer after two years.

Among community colleges, there would be some "low-hanging fruit." There are three community colleges in the 84-square-mile City of Seattle. Collectively, they have witnessed full-time equivalent enrollment drop by more than 8,000 – a figure greater than the size of any one of them at peak enrollment. There would be capacity enough to shut one and accommodate enrollment at the other two. The suburban portion of King County hosts another six community colleges; while some have seen relatively steady enrollment thanks in part to population growth on the suburban fringe, closing one or two more would result in redirecting students to an alternate campus no more than a few miles away. Similar strategies could be employed in other counties with multiple campuses – Pierce County, which includes Tacoma, Spokane County, and Thurston County which includes Bellingham.

It is not possible to reach a capacity reduction of 50,000 students without targeting at least some colleges that would leave their respective counties without access. For purposes of this exercise, we will consider the closing of two: Centralia College in Lewis County and Walla Walla Community College in Walla Walla County. Students located in Centralia would have two alternate options within an hour's drive, but none within 25 minutes. Students in Walla Walla would have an alternate option just under an hour away.

This hypothetical capacity reduction plan would shut eleven campuses that collectively served 39,037 FTE students in fall 2024. The average enrollment of 3,548 places these campuses well below the student-weighted average. Two counties with 1.9% of the state's total population between them would be left without a college. The net impact on weighted average enrollment

would depend on where the displaced students enrolled, if they enrolled at all. If we make the simplifying assumption that the displaced students are spread evenly across the remaining system, the weighted average enrollment would increase by roughly 1,500 students at the state level.

With this basic information and the results of our regression analysis, coupled with the assumption that the results reasonably approximate the causal impacts of higher education structure on cost and educational outcomes, we can sketch the net impact of the campus closure plan.

The sensible place to begin the sketch is by examining impacts on enrollment, since those effects will potentially change our estimates of what happens to average institution size. The estimates in Table 3 suggest that a loss of access to 1.9% of the population would predict a 0.4% drop in enrollment, which in Washington state would equate to just over 1,000 lost students. The two shuttered institutions in counties that would be left devoid of public higher education options collectively enrolled just under 5,000 FTE students in fall 2024, thus the losses would amount to just over one-fifth of them, a magnitude in line with the estimates in Table 3. We will thus assume that the remaining institutions increase enrollment by only 38,000, or about 1,460 per campus if spread evenly.

The prospective consequences in terms of reduced degree attainment can be inferred on the basis of estimates in Table 4. Here, the increase in average institution size and the reduced access in two counties have predicted impacts of similar magnitude, suggesting that in every birth cohort of roughly 100,000 persons, Washington state could expect to see about 800 fewer bachelor's degrees attained each year as a result of the campus closures.

On the cost side, the estimates in Table 2 indicate that reducing coverage by 1.9% and increasing average enrollment by 1,460 would lead to cost savings of roughly $985 per student per year. In fall 2024, the state enrolled 262,000 FTE students. Subtracting 1,000 from the total to reflect enrollment losses caused by the campus closures, the aggregate savings would sum to just over $250 million per year.

From this perspective, the decision to continue operating the complete system, rather than shut some campuses to maintain scale at others, costs the state of Washington upwards of $300,000 per bachelor's degree preserved. From another perspective, the state is spending roughly $50,000 per year for every student who preserves access to a within-county public campus.

It bears emphasizing that these computations rely on a series of assumptions. First, we assume that the figures in Tables 2 and 4 are reasonable estimates of the relationship between institution scale and coverage on the one hand, and costs and degree attainment on the other. Second, we assume that there are no shut-down costs. If shutdown costs amounted to roughly $23 million per campus or less, the state would recoup the one-time expenses in the first year of reduced operating costs.

Shutdown costs would presumably need to include the costs of severance packages, or at minimum covering unemployment benefits, for displaced faculty or staff. Walla Walla Community College, to take one example, had 215 FTE employees in the 2024/25 academic year. If severance costs amounted to $100,000 for each of them, the total cost would equate to $21.5 million.

7 Conclusion

The results of this analysis suggest that public higher education systems could realize significant per-student cost savings, at what would appear to be a modest cost in terms of reduced educational opportunity, by winding down some campuses in order to maintain scale economies at others. This is particularly the case for systems that operate what might be considered redundant institutions. The State of North Carolina operates two public universities and a technical and community college in the city of Greensboro alone; the City University of New York operates 25 campuses in an area of 300 square miles.

If the economics of campus closure are so straightforward, and dozens of private institutions have already closed, it bears asking why more states have not responded to recent enrollment trends and projections with proactive moves to shutter campuses. The relatively straightforward answer invokes simple interest-group politics. A proposal to shutter a specific campus creates a concentrated set of "losers" – the students, faculty, staff, and administrators who would be displaced – and a diffuse set of "winners" – taxpayers. Taking the hypothetical Washington state example above, the proposal to shutter eleven campuses would likely result in a lobbying campaign targeting state legislators – given the nature of legislative districting in Washington state, over one-fifth of the legislature would be implicated. The projected savings would amount to something on the order of $40 per capita per year, a sum not likely to inspire many citizens to take the initiative to register their support for the plan.

A similar dynamic has affected other efforts to close or consolidate public facilities comprising a system. In the realm of national defense, the Base Realignment and Closure Act of 1990 was passed with the intent of avoiding targeted lobbying campaigns against closing a specific military installation. A similar initiative would likely be fruitful, if not necessary, in any jurisdiction seriously contemplating the systematic closure of one or more public campuses in response to dwindling enrollment.

In the absence of action to reduce the number of institutions, given demographic trends pressure will escalate to continue what is already a common pattern at many colleges: eliminate degree programs, departments, and otherwise react to the loss of scale economies. Public subsidies to higher education, measured on a per-student basis, will also likely increase.

A choice between operating weaker institutions or reducing access by closing some will, by this analysis, always be an effort to select the lesser of two evils. This paper outlines the potential consequences of the decision.

References

R. Acton, K. E. Cortes, L. Miller, and C. Morales. Distance to degrees: How college proximity shapes students' enrollment choices and attainment across race-ethnicity and socioeconomic status. *Economics of Education Review*, 2025.

D. Card. Using Geographic Variation in College Proximity to Estimate the Return to Schooling. NBER Working Paper 4483, National Bureau of Economic Research, October 1993.

E. Cohn, S. L. W. Rhine, and M. C. Santos. Institutions of Higher Education as Multi-product Firms: Economies of Scale and Scope. *The Review of Economics and Statistics*, 71(2):284–290, May 1989.

H. de Groot, W. W. McMahon, and J. F. Volkwein. The Cost Structure of American Research Universities. *The Review of Economics and Statistics*, 73(3):424–431, August 1991.

C. Do. The Effects of Local Colleges on the Quality of College Attended. *Economics of Education Review*, 23(3):249–257, June 2004.

A. N. Garza and A. S. Fullerton. Staying Close or Going Away: How Distance to College Impacts the Educational Attainment and Academic Performance of First-Generation College Students. *Sociological Perspectives*, 61(1):164–185, 2018.

J. S. Goodman, M. Hurwitz, and J. Smith. Access to 4-Year Public Colleges and Degree Completion. *Journal of Labor Economics*, 35(3):829–867, July 2017.

N. W. Hillman and T. Weichman. Education Deserts: The Continued Significance of "Place" in the Twenty-First Century, 2016.

M. Hoekstra. The Effect of Attending the Flagship State University on Earnings: A Discontinuity-Based Approach. *The Review of Economics and Statistics*, 91(4):717–724, November 2009.

C. Jepsen and M. Montgomery. Miles to Go Before I Learn: The Effect of Travel Distance on the Mature Person's Choice of a Community College. *Journal of Urban Economics*, 65(1): 64–73, January 2009.

J. R. Kling. Interpreting Instrumental Variables Estimates of the Returns to Schooling. NBER Working Paper 7989, National Bureau of Economic Research, October 2000.

R. K. Koshal and M. Koshal. Economies of Scale and Scope in Higher Education: A Case of Comprehensive Universities. *Economics of Education Review*, 18(2):269–277, April 1999.

K. Leppel. Logit Estimation of a Gravity Model of the College Enrollment Decision. *Research in Higher Education*, 34(3):387–398, 1993.

J. Ma, M. Pender, and M. Oster. Trends in College Pricing and Student Aid 2024, 2024.

J. Mountjoy. Marginal Returns to Public Universities. NBER Working Paper 32296, National Bureau of Economic Research, September 2025.

OECD. *Education at a Glance 2024: OECD Indicators*. OECD Publishing, Paris, 2024.

U.S. News & World Report. *Best Colleges 2026*. U.S. News & World Report, L.P., Washington, DC, 2025. Print/ebook guidebook for the 2026 U.S. News & World Report Best Colleges rankings.

J. L. Vigdor. The Ebbing Tide: How Will Higher Education Adapt to Demographic Change? In J. Y. Campbell and K. Husbands Fealing, editors, *Financing Institutions of Higher Education*. University of Chicago Press, Chicago, 2026. NBER Conference Report.

A Appendix

A.1 Quality choice derivation

A one-unit increase in the *per-student* quality outlay m_i costs n_i dollars. It raises per-student HC by:

$$\frac{\partial H_i}{\partial m_i} = \frac{\gamma}{1+m_i}$$

Then the total social marginal benefit from m_i is: $\sigma\gamma\frac{n_i}{1+m_i}$. Dividing by the marginal dollar cost n_i gives the per-dollar social return: $\frac{\sigma\gamma}{1+m_i}$. The state benchmarks public dollars against $r > 0$ and chooses m_i s.t. per-dollar return equals r, respecting $m_i \geq 0$ and any cap $\bar{m}_i$:

$$\frac{\sigma\gamma}{1+m_i} = r \quad \Longrightarrow \quad m_i^* = \min\Big\{\bar{m}_i,\ \max\Big\{\frac{\sigma\gamma}{r} - 1,\ 0\Big\}\Big\}$$

A.2 Reducing to one variable via (Y, D) and computing $D'(Y)$

Using equation (6), by the implicit function theorem, if $\partial F/\partial D \neq 0$ we can solve $D = D(Y)$ with slope:

$$\begin{aligned}\frac{\partial D}{\partial S} &= -\frac{\partial F/\partial S}{\partial F/\partial D} \\ &= -\frac{\frac{\tau}{N^2}D - \theta\frac{b_1}{2+S+D} + \theta\frac{b_2}{2+S-D}}{\frac{\tau}{N^2}S - \theta\frac{b_1}{2+S+D} - \theta\frac{b_2}{2+S-D}}.\end{aligned} \tag{12}$$

The denominator of equation (12) is positive, giving a well-defined $D(Y)$ on $[0, N]$. Feasible enrollments are then:

$$n_1(Y) = \tfrac{1}{2}\big(Y + D(Y)\big), \qquad n_2(Y) = \tfrac{1}{2}\big(Y - D(Y)\big). \tag{13}$$

A.3 Reducing the planner's problem to one dimension

Differentiating equation (8) w.r.t. Y:

$$\begin{aligned}\frac{\mathrm{d}W_{12}}{\mathrm{d}S} &= \sum_{i=1}^{2}\frac{\partial W_{12}}{\partial n_i}\cdot\frac{\partial n_i}{\partial Y} \\ &= \sum_{i=1}^{2}\Big[\sigma a_i + \sigma b_i\ln(1+n_i) + \sigma b_i\frac{n_i}{1+n_i} + \sigma\gamma\ln(1+m_i) - \nu_i - C_i'(n_i) - \frac{\tau}{N^2}n_i^2 - m_i\Big]\cdot\frac{\partial n_i}{\partial Y}\end{aligned}$$

From equations (12) and (13):

$$\frac{\partial n_1}{\partial Y} = \frac{1}{2}\Big(1 + \frac{\partial D}{\partial Y}\Big), \qquad \frac{\partial n_2}{\partial Y} = \frac{1}{2}\Big(1 - \frac{\partial D}{\partial Y}\Big)$$

A.4 Flagship-only regime $\mathcal{R}_2$ comparative statics

Welfare is:

$$W_2^{(1)}(n_2; N) = \sigma\big[a_2 + b_2 \ln(1+n_2) + \gamma \ln(1+m_2)\big]\, n_2 - (\nu_2 + m_2)n_2 - \frac{\tau}{3N^2} n_2^3$$

FOC is:

$$\Phi_2(n_2, N) \equiv -\frac{\tau}{N^2} n_2^2 + \sigma\Big[a_2 + b_2 \ln(1+n_2) + \gamma \ln(1+m_2)\Big] + \sigma\, \frac{b_2\, n_2}{1+n_2} - \nu_2 - m_2 = 0$$

By Implicit Function Theorem (IFT):

$$\frac{\mathrm{d}n_2^*}{\mathrm{d}N} = -\frac{\partial \Phi_2/\partial N}{\partial \Phi_2/\partial n_2} = -\frac{\frac{2\tau}{N^3}(n_2^*)^2}{\sigma \frac{b_2}{1+n_2^*} + \sigma \frac{b_2}{(1+n_2^*)^2} - \frac{2\tau}{N^2} n_2^*}$$

As the denominator, $\partial \Phi_2/\partial n_2$ is equivalent to the SOC of the welfare function, it is negative. Thus: $\frac{\mathrm{d}n_2^*}{\mathrm{d}N} > 0$

Tuition identity is:

$$p^* = \theta a_2 + \theta b_2 \ln(1+n_2^*) + \theta\gamma \ln(1+m_2) - \frac{\tau}{N^2}(n_2^*)^2$$

Differentiating, we have:

$$\frac{\mathrm{d}p^*}{\mathrm{d}N} = \left[\theta \frac{b_2}{1+n_2^*} - \frac{2\tau}{N^2} n_2^*\right] \frac{\mathrm{d}n_2^*}{\mathrm{d}N} + \frac{2\tau}{N^3}(n_2^*)^2.$$

Let:

$$\mathcal{A} = \theta \frac{b_2}{1+n_2^*} - \frac{2\tau}{N^2}\, n_2^*.$$

$$\frac{\mathrm{d}p^*}{\mathrm{d}N} = \mathcal{A}\left(-\frac{\frac{2\tau}{N^3} n_2^{*2}}{\frac{\partial \Phi_2}{\partial n_2}}\right) + \frac{2\tau}{N^3} n_2^{*2} = \frac{2\tau}{N^3} n_2^{*2}\left(1 - \frac{\mathcal{A}}{\frac{\partial \Phi_2}{\partial n_2}}\right).$$

Then:

$$\frac{\mathrm{d}p^*}{\mathrm{d}N} = \frac{2\tau}{N^3}\, n_2^{*2}\, \frac{(\sigma-\theta)\,\dfrac{b_2}{1+n_2^*} + \sigma\,\dfrac{b_2}{(1+n_2^*)^2}}{\sigma\dfrac{b_2}{1+n_2^*} + \sigma\dfrac{b_2}{(1+n_2^*)^2} - \dfrac{2\tau}{N^2}n_2^*}$$

From above, $\partial\Phi_2/\partial n_2 < 0$, therefore, $\frac{\mathrm{d}p^*}{\mathrm{d}N} \leq 0$.

Total derivative of subsidy s_2^* is:

$$\frac{\mathrm{d}s_2^*}{\mathrm{d}N} = \Big[\nu_2 + m_2 - p^*\Big]\frac{\mathrm{d}n_2^*}{\mathrm{d}N} - n_2^*\frac{\mathrm{d}p^*}{\mathrm{d}N}.$$

Note that as we know $\frac{\mathrm{d}n_2^*}{\mathrm{d}N} > 0$ and $\frac{\mathrm{d}p^*}{\mathrm{d}N} \leq 0$, as long as $\nu_2 + m_2 \geq p^*$, $\frac{\mathrm{d}s_2^*}{\mathrm{d}N} \geq 0$.

$$\frac{\mathrm{d}s_2^*}{\mathrm{d}N} = \big[\nu_2 + m_2 - p^*\big]\left(-\frac{\frac{2\tau}{N^3}n_2^{*2}}{\frac{\partial\Phi_2}{\partial n_2}}\right) \;-\; n_2^*\cdot\frac{2\tau}{N^3}n_2^{*2}\left(1 - \frac{\mathcal{A}}{\frac{\partial\Phi_2}{\partial n_2}}\right).$$

$$\frac{\mathrm{d}s_2^*}{\mathrm{d}N} = \frac{2\tau}{N^3}\, n_2^{*2}\left[-\frac{\nu_2 + m_2 - p^*}{\frac{\partial\Phi_2}{\partial n_2}} \;-\; n_2^* \;+\; \frac{n_2^*\,\mathcal{A}}{\frac{\partial\Phi_2}{\partial n_2}}\right] = \frac{2\tau}{N^3}\, n_2^{*2}\left[\frac{p^* - \nu_2 - m_2 + n_2^*\,\mathcal{A}}{\frac{\partial\Phi_2}{\partial n_2}} \;-\; n_2^*\right].$$

$$p^* - \nu_2 - m_2 + n_2^*\,\mathcal{A} = (\theta-\sigma)\left[a_2 + b_2\ln(1+n_2^*) + \gamma\ln(1+m_2) + \frac{b_2\,n_2^*}{1+n_2^*}\right] \;-\; \frac{2\tau}{N^2}\,n_2^{*2}.$$

$$\frac{\mathrm{d}s_2^*}{\mathrm{d}N} = \frac{2\tau}{N^3}\, n_2^{*2}\left[\frac{(\theta-\sigma)\left(a_2 + b_2\ln(1+n_2^*) + \gamma\ln(1+m_2) + \dfrac{b_2\,n_2^*}{1+n_2^*}\right) \;-\; \dfrac{2\tau}{N^2}\,n_2^{*2}}{\sigma\dfrac{b_2}{1+n_2^*} + \sigma\dfrac{b_2}{(1+n_2^*)^2} - \dfrac{2\tau}{N^2}n_2^*} \;-\; n_2^*\right]$$

A.5 Two-campus regime $\mathcal{R}_{12}$ comparative statics

The assumptions to sign the total derivatives are:

1. $n_2^* > n_1^*$, which implies $F < 0$: the flagship campus is always larger than the satellite campus.

2. $g_1 > 0$ and $g_2 < 0$: this keeps the common tuition identity in balance. and $\mu > 0$.

3. $Z_1 < 0$ and $Z_2 < 0$: local concavity of Lagrangian to ensure stable, well-behaved interior equilibrium.

4. $\mu \geq 0$ and μ is 'modestly' sized.

5. Q_1 and Q_2, the direct N effect on stationarity, is very small in magnitude.

Finally,

$$\begin{aligned} -Q_1 g_1 g_2 + g_1^2 \max\{Q_2, 0\} &\leq -Z_1 g_2 F \\ Q_1 g_2^2 - g_1 g_2 \max\{Q_2, 0\} &\leq Z_2 g_1 F \end{aligned}$$