Crowding Out Community Colleges? The Enrollment Effects of Regional Campuses

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Abstract

The Ohio State University (OSU), a major public flagship university, is split between a "main" and several "regional" campuses. While OSU's regional campuses are independently accredited institutions, they also have a strong transfer function: a regional campus student with a minimum 2.0 GPA and 30 credit hours are guaranteed the option to transfer into the main campus. In this paper, I build a general theoretical framework of first-time and transfer admissions with multiple institutions. The model predicts that opening a regional campus causes community colleges to enroll less academically prepared students in first-time admissions and may cause community college students to be crowded out by less prepared regional campus students in transfer admissions. As such, opening a regional campus may be welfare improving but is never Pareto improving. I show that a social planner prefers to modestly expand enrollment at a main campus over opening a larger regional campus if the regional campus is insufficiently differentiated from a community college.

1 Introduction

Several Ohio public universities, including the state flagship (Ohio State University, OSU), consist of a main campus along with one or several regional campuses. This structure differs from public university systems in which members are independent peer institutions (e.g., the University of California or State University of New York systems) because Ohio regional campuses blend traditional four-year and two-year institutional missions: while all of OSU's regional campuses are independently accredited to confer four-year degrees, a core part of their institutional mission is to facilitate transfer into the main campus. All students enrolled at

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an OSU regional campus are guaranteed the option to transfer into the main campus if they have a minimum 2.0 GPA and 30 credit hours earned at an OSU campus.

Little is currently known about how regional campuses affect the overarching ecosystem of higher education. As a first step, this paper looks into the enrollment effects of regional campuses on institutions and student pathways. It is clear that OSU benefits from regional campuses in two ways. First, they increase overall enrollment. Second, students can be sorted between the main and regional campuses based on application strength. Put together, regional campuses allows OSU to simultaneously keep enrollment high while maintaining selective at the main campus, which is important for prestige purposes like maintaining a high college ranking.

However, local community colleges could be made worse off by regional campuses due to competition with regional campuses over first-time applicants. Also, because students at the regional campus have a streamlined pipeline to transfer into the main campus, it may become more difficult for the community college to successfully transfer students into the main campus. Therefore, community college administrators may have concerns that regional campuses make it more difficult for their colleges to fulfill their traditional institutional missions of conferring two-year degrees and facilitating transfer.

Finally, it is not immediately clear whether regional campuses make students better off. On one hand, students benefit from an increase in the options for higher education. Intuitively, this is especially beneficial for students who prefer the main campus, but are not admitted as a first-time student: regional campuses offer a pipeline into their top choice. Regional campuses are also less expensive to attend. On the other hand, students who start at the community college and later try to transfer to the main campus must now compete with transfer applicants from the regional campus.

In this paper, I build a theoretical framework of college enrollment with multiple institutions to predict the enrollment effects of introducing a regional campus. I focus on enrollment changes because all outcomes in higher education are downstream; understanding who starts at what kind of institution is therefore key to contextualizing other results. I present a model in which students differ in wealth and academic preparedness, while institutions of higher education differ in price and perceived value of attendance. Under some general assumptions, introducing a regional campus causes local community colleges to enroll academically less prepared first-time student bodies, and the university's main campus becomes more selective over transfer students from community colleges. This is because regional campuses attract some well-prepared students away from community colleges in first-time admissions, and regional campus students may "crowd out" better prepared community college students in transfer admissions.

I then consider a social welfare exercise: should a social planner who considers students and colleges complements subsidize tuition to modestly grow its main campus or open a larger regional campus? I find that subsidizing tuition at the university's main campus always increases welfare; moreover, it is also always a

Pareto improvement. This is because tuition subsidization expands overall enrollment in a way that preserves positive sorting of students to institutions: decreased tuition induces some low wealth, highly academically prepared students to enroll at the main campus instead of the community college. This opens up capacity at the community college and in transfer enrollment, allowing students who were marginally inadmissible before to gain enrollment.

However, the welfare effects of opening a regional campus are ambiguous; while it can be welfare increasing, it is never Pareto improving. The regional campus draws students away from *both* the main campus and the community college. It is welfare decreasing to draw academically well-prepared students away from the main campus, but welfare increasing to draw them away from the community college. There are also mixed welfare effects over transfer admissions if community college students are crowded out by less prepared regional campus students. The main cause of these mixed welfare results is that opening a regional campus does not maintain positive sorting between students and colleges.

After a literature review in Section 2.1, I give background on OSU's regional campuses in Section 2.2. I show how regional campuses compare to OSU's main campus as well as comparable community colleges. In Section 3, I construct a theoretical framework of first-time and transfer admissions with multiple institutions. I then present a social welfare analysis comparing the predicted welfare effects of tuition subsidization vs. opening a regional campus in Section 4, and conclude in Section 5.

2 Background

2.1 Literature Review

This paper rests within the literature on student pathways over higher education. For a comprehensive review, see Lovenheim and Smith (2023). Many students enroll at more than one post-secondary institution of education. Andrews, Li, and Lovenheim (2014) study in-state students who were enrolled for the first time at public Texas institutions between 1992-2002 and find that 31.4% of students transferred at least once, most often from a community college. Moreover, they find that transfer among students who eventually received a bachelor's degree is high: around half of eventual degree recipients transfer at least once, and 16% of degree recipients transferred more than once. Similarly, the National Student Clearinghouse Research Center reports in *Two-Year Contributions to Four-Year Completions* (2017) that almost half (49%) of students who completed a bachelor's degree in the 2015-16 academic year had enrolled at a two-year public institution in the last ten years.

These facts point to the important role community colleges have as a starting institution. Kane and Rouse (1999) provide an overview of community college's role in the U.S. ecosystem of higher education. Community colleges are associated with upwards mobility: they are more affordable than four-year institutions and are more accommodating to non-traditional and part-time students (*An Introduction to Community Colleges and Their Students* 2021). Also, more students were enrolled at community colleges than at public four-year institutions in 2019 (9.6 million vs. 7.3 million), and more first-time students started at community colleges than at four-year universities in pre-COVID years (Fink 2024). Although many students start at a community college, the majority these students report their eventual goal is a bachelor's degree (*What We Know About Transfer* 2015).

However, there are systematic differences in four-year completion based on starting institution. Only 31% of community college students in the Fall 2010 cohort eventually transferred to a four-year institution, and less than half of those transfers (that is, 14% of the cohort) went on to complete a bachelor's degree (Shapiro et al. 2017). In comparison, the 6-year graduation rate for the Fall 2010 cohort of full-time, first-time students who started at four-year institutions was 60% (de Brey et al. 2019).

Some of this attrition is expected because students may change their preferences. In Rouse (1995)'s framework, this is called the "diversion" effect: some students who would have completed a bachelor's degree had they started at a four-year university may choose not to transfer because they start at a community college and change their preferences after exposure to the community college. However, Rouse (1995) also points to a countervailing force, the "democratization" effect. Some students who start at a community college may decide to pursue a four-year degree only after becoming exposed to higher education. I partially build off of Rouse (1995) when considering transfer admissions in this work.

Empirical work by Mountjoy (2022) finds evidence of both the democratization and diversion effects. Mountjoy (2022) studies tenth grade students who enrolled at a Texas public high school between 1998-2002 and finds that increased access to two-year institutions increases educational attainment and later earnings overall, but as theoretically predicted, there are two opposing effects. Around 1/3 of community college students were diverted from a four-year institution, while the other 2/3 of students were democratized. See also research papers on the effects of "Promise" programs that make community college free (or highly cost subsidized) to local high school graduates, including Nguyen (2020), Bell (2021), Acton (2021), and Billings, Gándara, and Li (2021).

Students may also change their preferences before even entering higher education if they strategically apply to colleges. See Bound, Hershbein, and Long (2009) for a review on how students change their admissions behavior in response to increased competition, which is especially relevant to the environment I study: as I discuss in the next section, one reason OSU expanded its regional campuses is in direct response to increasing competitiveness in applications. See also Chade, Lewis, and Smith (2014), Pallais (2015), and Knight and Schiff (2022) for research on how changes in student application behavior affect enrollment.

This paper, though, concentrates on attrition that occurs due to institutional frictions preventing students from transferring. Understanding why these frictions occur and their effect on student success may be of interest to policymakers assessing the costs and benefits to investing in higher education. While policymakers often have limited leverage to affect student preferences, they are more likely to be able to affect how their public institutions of higher education operate.

Characterizing these frictions may be of interest to policymakers who are interested in assessing the costs and benefits to investing in public education: while they may have limited leverage to affect student preferences, they may have ability to affect how their public institutions of higher education operate. Thus far, this body of research has concentrated on frictions between community colleges and universities.

Finally, I add to research that build theoretical frameworks on college enrollment. I follow the matching framework from Azevedo and Leshno (2016), who show that for a large, decentralized two-sided matching environment with a continuum of agents, a stable matching can be equivalently characterized in a supply and demand framework. In the context of college admissions, prices are analogous to level of institutional selectivity; in equilibrium, a university picks a cut-off level of selectivity. Blair and Smetters (2021) uses the same framework and imposes assumptions on positive sorting that are similar to those I use to characterize the social planer's problem in Section 4. See also Che and Koh (2016), as well as Epple, Romano, and Sieg (2006) and Fu (2014) for equilibrium models of college admissions.

2.2 Information on Regional Campuses

I build the model in Section 3 based on the Ohio State University (OSU) campus system.[1] The OSU main campus is in Columbus (the "Main Campus" henceforth), and OSU regional campuses are located in Lima, Mansfield, Marion, Newark, and Wooster. The Wooster campus houses OSU's Agricultural Technical Institute; because of its specialized focus, I do not consider the Wooster campus in this analysis. When I refer to "regional campuses", I mean the Lima, Mansfield, Marion, and Newark campuses only.

I identify four key differences between the main and regional campuses: (1) institutional missions, (2) affordability, (3) profile of the student bodies, and (4) student outcomes. I conclude the section by discussing (5) differences between regional campuses and comparable community colleges.

Institutional missions. The OSU regional campuses are independently accredited and treated as separate institutions from the Main Campus by the National Center for Education Statistics (NCES). While the Main Campus primarily confers baccalaureate degrees to its undergraduate students, the OSU regional campuses have Carnegie classifications of either "Baccalaureate College: Diverse Fields" (Lima) or "Bac-

[1] However, it is important to note that OSU is not the only public university in Ohio with regional campuses: Bowling Green State University, Kent State University, Miami University, Ohio University, University of Akron, University of Cincinnati, and Wright State University have at least one regional campus. While some of these universities treat their regional campuses similarly to OSU, others treat them more as separate commuter campuses and do not prioritize transfers from regional campuses. Central State University, Cleveland State University, Shawnee State University, University of Toledo, and Youngstown State University do not have any regional campuses.

calaureate/Associate's College: Mixed Baccalaureate/Associate's" (all others). As such, OSU advertises two academic pathways at its regional campuses: (1) completing either an associate or baccalaureate degree at the regional campus, or (2) starting a degree before transferring to the Main Campus (*Undergraduate Admissions: Regional Campuses* 2023).

Regional campus students may request a "campus change" to the Main Campus after completing 30 credit hours within the OSU system with at least a 2.0 GPA (*Campus change: FAQs* 2023).[2] Campus changes are considered an internal movement within the OSU system, but because regional campuses are independently accredited, the NCES counts them as transfers. Campus change students are not required to send a separate application to the Main Campus, and there are no frictions in transferring credits.

However, there still exist frictions in the transfer process. A campus change must be proactively initiated; the default is remaining at the student's home campus. Also, the minimum requirements to enter specific programs at the Main Campus may be higher than the campus change requirements. For example, to apply for the Fisher College of Business at the Main Campus, a student must have a "[m]inimum Ohio State GPA of 3.10 or better" (*Admission to Major Program and Specialization Criteria* 2024). Business Management is offered as a bachelor's degree at all regional campuses, so a student who marginally qualifies for a campus change but has a strong preference to pursue Business Management may choose not to change campuses.

Table 1: Undergraduate Enrollment at Ohio State University

	Main Campus	Lima	Mansfield	Marion	Newark
Total Enrollment	45,728	739	843	884	2,422
In-State Enrollment	33,993	733	824	878	2,412
In-State Pct.	74.3%	99.2%	97.7%	99.3%	99.6%
First-time, Full-time enrollment					
Fall 2023	7,983	260	843	884	2,422
Fall 2022	7,960	273	827	900	2,263
Fall 2021	8,350	279	940	1,047	2,727
Fall 2020	8,602	345	1,011	1,157	2,870
Fall 2019	7,630	360	1,075	1,262	2,939

Data from the Ohio State University Analysis and Reporting;
`https://web.archive.org/web/20240221051625/http://oesar.osu.edu/student_enrollment.aspx`

As seen in Table 1, around 90% of OSU undergraduate students are enrolled at the Main Campus, but the regional campuses have a much stronger emphasis on enrolling local students (*Regional Campus Vision and Goals* 2017). Regional campuses were founded in the 1950s to serve students living in each campus's home county and adjacent counties, but regional campus enrollment began expanding in the early 2000s in response to increased admissions competition at the OSU-Main Campus. Virtually all students at regional campuses are in-state, while around 1/4 of undergraduate students at the Main Campus are from out-of-state.

[2]OSU recommends taking at least 15 credit hours if a student's goal is to graduate in four years (*Finish in Four* 2024). A full-time regional campus student would therefore qualify to apply for a campus change and start attending the Main Campus at the start of her second year at the earliest.

Differences in enrollment characteristics reflect the fact that OSU has different strategic goals for the main and regional campuses. According to the *Accelerating Excellence, Access and Service: Strategic Enrollment Plan for The Ohio State University, 2022-2024* (2021), OSU has dual goals of expanding enrollment while improving the quality of incoming classes at the Main Campus. Admissions are selective; according to NCES data, the Fall 2023 admissions rate was 51%. In contrast, the administration is focused only on expanding enrollment at regional campuses, especially to local and under-represented students (*Autumn 2023: Enrollment Report* 2023). There are no specific goals to increase the number of campus change students. Also, regional campuses are not intended to be selective: students who have never attended a university but have completed a high school degree or equivalent can be admitted to a regional campus (*Undergraduate Admissions: Regional Campuses* 2023).

Finally, a consequence of differing institutional missions is a perceived difference in institutional prestige. OSU's Main Campus was ranked no. 43 among national universities by the *U.S. News Best Colleges* (2023), and is sometimes considered a "Public Ivy". The OSU regional campuses are unranked.

Affordability. Table 2 summarizes information on costs and financial aid across the OSU campuses. In-state tuition for the 2022-2023 academic year was $12,485 at the Main Campus and $8,944 at the regional campuses, according to the NCES College Navigator. That is, attending a regional campus costs around 30% less relative to the Main Campus. Moreover, the average net price of the OSU-Main Campus is between $4,000-$6,000 more than at the regional campuses.[3] Variance in net price at regional campuses appears to be driven by the fact that residential housing is only available at the Mansfield and Newark campuses.

The net price for the Main Campus is *lower* at the regional campuses for the two lowest income brackets ($0-$48,000), but higher at all other income levels. In spite of this, the Main Campus has the lowest proportion of students receiving federal Pell Grants, suggesting that in-state students at very low income brackets make enrollment choices do not fully base their enrollment decisions on net price. This likely reflects opportunity costs associated with enrolling at the Main Campus not captured by sticker or not price. For example, regional campuses do not require students to live on campus, and students who start at a regional campus but transfer to the main campus are not required to live on-campus if they graduated from high school more than two years ago (*Campus change: FAQs* 2023). Since most students wouldn't qualify for a campus change until completing 2-3 semesters, some campus change students may *never* be required to live on-campus. On the other hand, the Main Campus requires most students to live on campus for at least two years (*Undergraduate Admissions: FAQs for parents and families* 2023). Being untied to a specific residence may also free up students at the regional campus to continue living at home and/or more easily pursue part-time employment.

The amount and composition of financial aid also differs between campuses. Roughly the same proportion of

[3] Net price can be thought of as the "actual" price a student should expect to pay to attend a given institution, inclusive of funding sources such as financial aid and costs such as room and board.

Table 2: First-Time, Full-Time Undergraduate Financial Aid and Tuition at the Ohio State University Campuses (2021-2022)

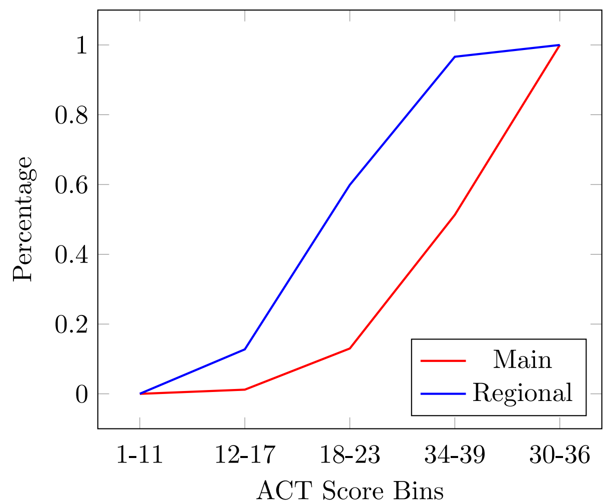
	Main	Lima	Mansfield	Marion	Newark
Avg. Financial Aid					
Num. Awarded	7,007	231	302	304	1,042
Pct. Awarded	83%	86%	84%	82%	80%
Avg. Amt Awarded	$10,993	$5,766	$7,083	$5,147	$6,718
Grants & Scholarships					
Federal, Any					
Num. Awarded	3,372	153	230	158	789
Pct. Awarded	40%	57%	64%	42%	61%
Avg. Amt Awarded	$4,094	$4,474	$5,004	$4,346	$4,852
Federal, Pell Grants					
Num. Awarded	1,527	88	140	83	475
Pct. Awarded	18%	33%	39%	22%	37%
Avg. Amt Awarded	$5,012	$4,474	$5,084	$4,871	$4,852
State					
Num. Awarded	1,013	67	111	67	371
Pct. Awarded	12%	25%	31%	18%	29%
Avg. Amt Awarded	$2,706	$724	$1,232	$704	$371
Institutional					
Num. Awarded	5,576	185	240	274	817
Pct. Awarded	66%	69%	67%	74%	63%
Avg. Amt Awarded	$9,313	$2,528	$2,486	$2,675	$2,755
Loans					
Federal					
Num. Awarded	29,666	105	202	110	540
Pct. Awarded	35%	39%	56%	30%	42%
Avg. Amt Awarded	$5,250	$4,910	$5,343	$4,825	$4,755
Other					
Num. Awarded	445	8	24	6	37
Pct. Awarded	5%	3%	7%	2%	3%
Avg. Amt Awarded	$18,192	$7,173	$8,652	$11,358	$10,194
In-State Tuition	$12,485	$8,944	$8,944	$8,944	$8,944
Net Price					
Average	$19,582	$13,086	$15,908	$13,377	$15,024
By Income Level					
$0-$30,000	$6,956	$9,465	$12,615	$9,109	$11,852
$30,001-$48,000	$8,402	$9,790	$13,529	$9,738	$12,608
$48,001-$75,000	$13,620	$11,823	$16,328	$11,158	$14,455
$75,001-$110,000	$22,528	$15,421	$19,664	$15,511	$18,098
$110,001+	$26,186	$16,878	$20,588	$16,323	$19,005

Data from NCES - College Navigator.

students receive some form of financial aid across all campuses, but the average amount received is lower at the regional campuses (between \$5,147-\$7,083) than at the Main Campus (\$10,993). Much of this difference is driven by the fact that students at the Main Campus receive around \$7,000 more in institutional aid compared to students at the regional campuses. However, regional campus students are more likely to receive any federal grant or scholarship, including Pell Grants.

Profile of student bodies. First-time students who start at the Main Campus are more academically prepared based on observable characteristics. The average ACT score for the incoming class of 2021 at the OSU-Main Campus was 28.6, and between 20.6-22.8 at the regional campuses. Moreover, as seen in Figure 1, the cumulative distribution of students in each ACT score bin at the OSU-Main Campus stochastically dominates the ACT distribution at the regional campuses.

Figure 1: Cumulative Distribution of ACT Scores at Main vs. Regional Campuses



OSU students appear to value the prestige of attending the Main Campus. The percentage of first-time students who enrolled at a regional campus but reported that the OSU-Main Campus was their first choice has risen from 38% in 2017 to 52% as of 2021 (*New First Year Students by Campus Choice* 2022).

Table 3: Full-Time Undergraduate Student Outcomes (Fall 2016 Cohort) at Ohio State University

Campus	Graduation Rate	Transfer-Out Rate
Main Campus (Columbus)	88%	7%
Lima	21%	56%
Mansfield	16%	67%
Marion	17%	62%
Newark	34%	45%

Data from the NCES College Navigator. Note that in the NCES data, changing from a regional campus to the main campus is counted as a transfer-out, although OSU considers this an internal campus change.

Student outcomes. The six-year graduation rate for full-time, full-time students who started at the Main Campus in Fall 2016 is 88%, while the transfer-out rate is 7%. In contrast, the six-year graduation rates

Table 4: Information on Comparison Community Colleges

	Central Ohio Technical University	Columbus State Community College	North Central State College	Rhodes State College
Location	Newark	Columbus	Mansfield	Lima
Total Enrollment (Fall 2022)	2,614	25,129	2,439	3,533
In-State Tuition, 2022-23	$5,016	$5,188	$4,624	$4,532
Avg. Net Price, 2021-22	$10,103	$6,964	$3,885	$8,991
Outcomes, Fall 2019 Cohort				
4-Year Graduation Rate	30%	26%	27%	27%
Transfer-Out Rate	17%	16%	13%	18%

Data from the NCES College Navigator.

for the same cohorts at the regional campuses are between 16%-34%, and the transfer-out rates are between 45%-67%. See Table 3 for institution-level details.[4]

Student outcomes are consistent with the fact that the Main Campus is selective and that regional campuses are meant to facilitate transfer into the Main Campus. They also show that students who start at the regional campus have a strong propensity to transfer. As a point of reference, the average transfer-out rate at U.S. community colleges was 31.5% for the Fall 2010 cohort.

Regional campuses vs. community colleges. To illustrate the difference between regional campuses and community colleges, I show information on the four community colleges that OSU has articulation agreements with in Table 4: Central Ohio Technical University, Columbus State Community College, North Central State College, and Rhodes State College. These community colleges are the closest external comparison to regional campuses because they have reduced transfer frictions into the OSU system. Moreover, all of the colleges except Columbus State Community College share buildings and resources with the regional campus in the same locale (*Regional Campus Vision and Goals* 2017).

That said, there are important differences between the comparison community colleges and regional campuses. First, the comparison community colleges do not confer four-year degrees. Second, they enroll proportionately more part-time students. Third, the OSU regional campuses are more expensive. Fourth, regional campuses enroll fewer students. Finally, transferring into the OSU Main Campus is a higher burden for students at the community college, who must send an application and ensure that classes taken at their original institution will count for credit at the OSU Main Campus.

While the regional campuses and comparison community colleges have similar graduation rates, the regional campuses have much higher transfer-out rates and the community colleges have higher rates of non-completion. Also, compared to the average community college, the transfer-out rate at the comparison group of community colleges is about half of the historical national average (Shapiro et al. 2017). This suggests

[4] Note that graduation rates only count students who were awarded a degree at their home institution. Given the high propensity for regional campus students to transfer, it is possible that many regional campus students eventually graduate at the Main Campus or another institution.

that the comparison community colleges are not only systematically different from regional campuses, but they are also different from other community colleges. This is suggestive evidence that regional campuses have spillover effects to similarly located community colleges.

Table 5: Number of Campus Change and External Transfer Students

Year	Campus Change	External Transfers
Fall 2023	1,124	1,827
Fall 2022	1,161	1,857
Fall 2021	1,286	2,070
Fall 2020	1,412	2,158
Fall 2019	1,372	2,415
Fall 2018	1,422	2,388

Data from *Autumn 2023: Enrollment Report* (2023).

Finally, I show the information on the profile of *all* incoming external transfer students to the Main Campus in Table 5. This includes students transferring from *any* community college as well as those transferring from other four-year institutions. The number of campus change students is consistently smaller than the number of students transferring in from external institutions.

Table 6: Academic Profile of External Transfer Students

Semester	Avg. Credits Transferred	Avg. GPA
Fall 2022	43	3.23
Fall 2021	41	3.22
Fall 2020	45	3.18
Fall 2019	46	3.17
Fall 2018	47	3.14
Fall 2017	48	3.19
Fall 2016	54	3.18
Fall 2015	54	3.18

Data retrieved from `http://undergrad.osu.edu/apply/transfer/admission-criteria` using the Internet Archive.

OSU recommends that external students only apply to transfer into the Main Campus if they have a GPA of at least 2.5 (*Transfer applicants: Admission criteria* 2024). In practice, the average external transfer student has a GPA of at least 3.14 and enters with 41-54 credit hours. As OSU does not, to my knowledge, have publicly posted information on the profile of the average campus change student, I cannot directly compare between the two. However, it is reasonably likely that the marginally admitted campus change student is academically weaker than the marginally admitted external transfer student, since OSU recommends a minimum GPA of 2.5 for external transfer students, but guarantees regional campus students can transfer in with a minimum GPA of 2.0.

3 Theoretical Model

3.1 Unaffiliated Environment

First suppose that there are only two institutions: a university's main campus M and a community college C. Call this the "unaffiliated" environment (as opposed to the second environment that I will consider, in which M is affiliated with a regional campus). Denote an arbitrary institution as $j \in \{C, M\}$. Each institution has capacity for first-time, full-time students denoted $\kappa_j \in (0, 1)$ for all $j \in J_U$. Furthermore, let $\kappa_M + \kappa_C < 1$. M also has capacity for transfer students $\kappa_T \in (0, \kappa_C)$, to be discussed in more detail later.

There is a unit mass of in-state students who demand higher education and differ across two dimensions, academic preparedness $a \in [0, 1]$ and wealth $w \in [0, 1]$. That is, an arbitrary student i is described by her type $(a_i, w_i) \in [0, 1]^2$. Both a and w are independently drawn from the distribution $Uniform[0, 1]$.[5] The distribution over type is common knowledge. If an arbitrary student i applies to an arbitrary institution, then she directly reveals her academic preparedness a_i to that institution. Finally, since total capacity $\kappa_M + \kappa_C < 1$, there are always some students who are unable to enroll anywhere.

Institutions differ in price and value, which together determine a student's *initial* preference ranking. Before applying, students do not know their personal value of attending a given institution, so all students assign each institution the same expected value (say, based on the prestige of the institution or average outcome of its graduates). They also face the same expected net price at each institution.[6] Fix the price and value of attending the community college C to 0 and denote the price and value of attending the university's main campus M as $p_M \in (0, 1]$ and $v_M \in (0, 1]$ respectively.[7]

Students get utility from both wealth and the value of the institution attended; the outside option of no higher education is strictly negative. The utility that student i yields from attending C is

$$u(w_i, C) = ln(1 + w_i), \tag{1}$$

[5] Assuming a uniform distribution simplifies notation and analysis, but I can let academic preparedness follow any arbitrary probability distribution over $[0, 1]$. For example, it may be more reasonable to assume ability is normally distributed, but then I must take into account the measure of students of every academic preparedness level. This does not qualitatively change theoretical results but adds modeling complexity, hence why I use the uniform distribution.

[6] In practice, lower income students generally receive more financial aid at universities than at community colleges. However, Table 4 shows that the average net price at community colleges is lower than that of the OSU Main Campus. Also, many low income, highly academically well-prepared students do not apply to selective universities in spite of the fact that those who do apply have similar enrollment behavior and academic performance as their higher income peers (Hoxby and Avery 2013). This is likely at least partially due to information gaps, whether on the difference between sticker and net prices, or a lack of knowledge on their probability of admission (Cortes and Lincove 2018).

[7] Later, when considering the social planner's problem, I will assume that the social planner prefers for more academically prepared students to attend M; that is, the value of attending M is not constant, but increasing in a_i. But here, I assume that a student does not know how valuable attending M is for herself personally. She knows only that attending M is more prestigious than her other options.

and the utility from attending M is

$$u(w_i, M) = ln(1 + w_i - p_M) + v_M. \tag{2}$$

Students always prefer education to no education, but different types of students most prefer different institutions. First, I impose the following regularity condition:

Condition 1 (Unaffiliated preferences condition)**.** *(p_M, v_M) together satisfy $ln(1 - p_M) + v_M < 0$ and $ln(2 - p_M) + v_M > ln(2)$.*

The unaffiliated preference condition implies that (1) the student with the lowest possible wealth endowment $w_i = 0$ prefers the community college, while (2) the student with the highest possible wealth endowment $w_i = 1$ prefers the university's main campus M. Given that $u(w_i, C)$ and $u(w_i, M)$ are strictly increasing in w_i, this is enough to guarantee that Equation 2 crosses Equation 1 exactly once from below. Student preferences can be described as a threshold on wealth.

Lemma 1. *Let Condition 1 on unaffiliated preferences hold. There exists $\hat{w}$ such that i initially prefers M if and only if $w_i \geq \hat{w}$; furthermore,*

$$\hat{w} = \frac{1 - e^{v_M}(1 - p_M)}{e^{v_M} - 1} \in (0, 1). \tag{3}$$

Proof. $\hat{w}$ is determined by setting $u(\hat{w}, C) = u(\hat{w}, M)$ from Equations 1 and 2, then solving for $\hat{w}$:

$$\begin{aligned} ln(1 + \hat{w}) &= ln(1 + \hat{w} - p_M) + v_M \\ \Rightarrow \hat{w} &= \frac{1 - e^{v_M}(1 - p_M)}{e^{v_M} - 1}. \end{aligned}$$

To see that $\hat{w} \in (0, 1)$, first suppose not and that $\hat{w} \leq 0$. Since $e^{v_M} - 1 > 0$ for $v_M \in (0, 1]$, it must be the case that

$$\begin{aligned} 1 - e^{v_M}(1 - p_M) &\leq 0 \\ \Rightarrow ln(\frac{1}{1 - p_M}) &\leq v_M \\ \Rightarrow 0 &\leq ln(1 - p_M) + v_M, \end{aligned}$$

contradicting that $ln(1 - p_M) + v_M < 0$ from Condition 1. Now suppose that $\hat{w} \geq 1$. Then,

$$\begin{aligned} 1 - e^{v_M}(1 - p) &\geq e^{v_M} - 1 \\ \Rightarrow 2 &\geq e^{v_M}(2 - p_M) \\ \Rightarrow ln(2) &\geq ln(2 - p_M) + v_M, \end{aligned}$$

contradicting that $ln(2 - p_M) + v_M > ln(2)$ from Condition 1. So $\hat{w} \in (0, 1)$. $\square$

There are two time periods, $t \in \{1, 2\}$. At the beginning of $t = 1$, the first-time admissions process occurs, and then general education happens. At the beginning of $t = 2$, transfer admissions occurs.[8]

3.1.1 First-time Enrollment

The first-time admissions cut-off at institution j is characterized as a minimum level of academic preparedness a_j, such that institution j is willing to admit all students with $a_i \geq a_j$. First-time admissions happens over two steps:

1. Students who prefer the main campus M apply there. M is selective, and the best applicants based on academic preparedness are accepted up to M's chosen cut-off level of academic preparedness, $a_M \in (0, 1)$.

2. Students who prefer the community college C or were previously rejected at the main campus M apply to C. As C is not selective, the best applicants based on academic preparedness are accepted up to capacity.

The university's main campus M cares about both enrollment and selectivity; these incentives compete with each other. Denote the quantity of students above M's cut-off level of academic preparedness a_M as $q_M = 1 - a_M$.[9] Let $\pi_M \in \mathbb{R}_{++}$ be the expected and constant "profit" of enrolling a student. Let $\rho_M(q_i) : [0, 1] \to \mathbb{R}_+$ be a continuous and differentiable function that captures M's prestige concern, which satisfies $\rho_M(0) = 0, \rho_M(1) > \pi$, $\frac{\partial}{\partial q_M}\rho_M(q_M) > 0$, and $\frac{\partial^2}{\partial q_M^2}\rho_M(q_M) > 0$. Finally, denote the inverse of the prestige concern function as $\rho_M^{-1}()$.

The main campus's enrollment problem is:

$$\max_{q_M} \quad (1 - \hat{w}) \int_0^{q_M} (\pi_M - \rho_M(q_M))q_M dq_M \tag{4}$$

subject to the capacity constraint $(1 - \hat{w})q_M \leq \kappa_M$. Denote a_M^* the optimal first-time cut-off level on academic preparedness for the main campus in the unaffiliated environment.

A few points about the main campus's prestige concern merit discussion. At the highest level of selectivity, there is no prestige cost ($\rho_M(0) = 0$), so the main campus is always willing to enroll at least some students. However, the marginal prestige cost of expanding enrollment is always increasing in level of enrollment (e.g., dropping the cut-off from 0.5 to 0.45 incurs a larger prestige cost than dropping it from 0.9 to 0.85). Because

[8] I focus on enrollment effects, so I do not include a third period during which final academic outcomes are realized.
[9] Note that q_M isn't the quantity of students that M ultimately enrolls, since not all students will apply to M.

of the conditions I impose on the extreme values of $\rho_M()$, the optimal level of enrollment has a straightforward marginal benefit-cost interpretation if capacity constraints don't bind: enroll until $\pi_M = \rho_M(q_M^*)$. If the capacity constraint binds, then the main campus M would like to enroll more students, but cannot. M therefore enrolls the best applicants up to capacity.

Going forth, I restrict attention to the case where first-time capacity constraints at the main campus M do not bind for several reasons. First, this is more realistic at a highly ranked flagship institution like OSU. It aligns with OSU's strategic enrollment plan as described in *Accelerating Excellence, Access and Service: Strategic Enrollment Plan for The Ohio State University, 2022-2024* (2021): the university system prioritizes selectivity in first-time enrollment at the OSU Main Campus. Second, it ensures that M is *equally selective* over in-state students in both environments I will consider, so any differences in outcomes between the unaffiliated and affiliated environments cannot be attributed to institutional changes at M. Finally, attrition is low at institutions like OSU. Choosing to not enroll to capacity in first-time admissions may be in anticipation of admitting transfer students later.

For convenience, I summarize the condition on selectivity below:

Condition 2 (Selectivity condition)**.** *M's first-time admissions problem is not bound by its capacity constraint at the optimum.*

The community college C's enrollment decision is more straightforward: C only prioritizes enrollment and has no prestige concern, and admits the best applicants up to capacity. Denote a_C^* the optimal first-time cut-off level on academic preparedness for the community college in the unaffiliated environment.

Before I derive the first-time admissions cut-offs, I impose a regularity condition on capacity at the community college C. I restrict attention to cases such that $\kappa_C > \hat{w} \cdot \rho_M^{-1}(\pi_M) = \hat{w}(1 - a_M^*)$. This ensures that admissions is always strictly less selective at C than at the main campus M, as this more accurately reflects the actual landscape of college admissions. The main result on first-time enrollment follows.

Proposition 1. *Let Condition 1 on unaffiliated preferences and Condition 2 on selectivity hold. Also, let $\kappa_C > \hat{w} \cdot \rho_M^{-1}(\pi_M)$. Then the first-time cut-offs are:*

$$
\begin{aligned}
a_M^* &= 1 - \rho_M^{-1}(\pi_M) \\
a_C^* &= \hat{w} + (1 - \hat{w})a_M^* - \kappa_C.
\end{aligned}
$$

Proof. If capacity does not bind, then the optimal cut-off at M is determined by the optimization problem defined in Equation 4, which by the Fundamental Theorem of Calculus and the assumption that $\rho_M(0) = 0$, implies that

$$\pi_M - \rho_M(q_M^*) = 0 \iff q_M^* = \rho_M^{-1}(\pi_M) \iff a_M^* = 1 - \rho_M^{-1}(\pi_M).$$

Since C fills up enrollment to capacity from the strongest applicants,

$$\kappa_C = \hat{w}(1 - a_M^*) + (a_M^* - a_C^*),$$

and solving for a_C^*, the cut-off at C is $a_C^* = \hat{w} + (1 - \hat{w})a_M^* - \kappa_C$. □

Students with wealth $w \in [0, \hat{w}]$ and $a \in [a_M^*, 1]$ who are admissible at M always enroll at C as a first-time student due to personal preference. The capacity condition ensures that C serves not only these students, but also some students who were rejected from M. So, the cut-off at C is lower than at M: $a_C^* < a_M^*$.

Following results from Azevedo and Leshno (2016), the first-time enrollment decisions in the unaffiliated environment are *stable*. Stability implies that neither universities nor students have "justifiable regret" what institution a student enrolls at: students can do no better, because her more preferred institution would not accept her, and universities can do no better, because any students they want to enroll have been admitted to an institution that the student prefers more. All other results on optimal cut-offs will also be stable.

3.1.2 Transfer Enrollment

After first-time students enroll, general education occurs. For expositional purposes, this is when students at the community college C work on an associate's degree and/or completing courses with the intention to transfer, and students at the university's main campus work on general requirements. At the end of $t = 1$, a student at C realizes one of three outcomes: she (1) exits without a degree, (2) exits with a degree, (3) completes coursework and applies to transfer to the main campus M.

I allow for students at the community college C to potentially change their initial preferences over institutions during $t = 1$, due to being "exposed" to higher education following Rouse (1995). Students with wealth $w < \hat{w}$ and initially preferred C may become "democratized" and apply to transfer into the main campus M. Of the students who initially preferred the community college C, denote $\delta \in (0, 1)$ the fraction of students who complete their first two years of education and apply to transfer to M.

All students who initially preferred the main campus M but could not enroll as a first-time student maintain their preference. This diverges from Rouse (1995); she allows for students with wealth $w \geq \hat{w}$ and initially preferred the main campus M but had to attend the community college C to potentially become "diverted" away from transferring. However, I include in this framework *only* the democratization effect, to concentrate on how students are able to gain access to M through transfer admissions. Of course, this is a strong assumption, but I interpret this as a scenario in which all failures to transfer are institutionally driven (e.g., lacking capacity and/or M being selective). Also, this will make some analyses cleaner when comparing the unaffiliated and affiliated environments.

At the beginning of $t = 2$, students at the community college C may apply to transfer into the main campus M. I assume that M does not have a prestige concern over transfer admissions, because external measures of prestige such as the *U.S. News Best Colleges* (2023) ranking only take into account the outcomes of students who *started* at a given institution. Also, institutions are not required to submit data on graduation rates of transfer-in students to the Integrated Postsecondary Education Data System, which is used to generate publicly available information on institutional performance for the NCES College Navigator.[10] As such, the incentive to admit transfer students shifts away from selectivity and towards enrollment. To capture this, I assume that M admits the best transfer students based off of academic preparedness up to transfer capacity $\kappa_T \in (0, \kappa_C)$.

If transfer capacity κ_T is too small, then students who initially preferred the main campus M cannot transfer. They are completely crowded out by highly academically prepared, democratized students.

Lemma 2. *If $\kappa_T \leq \hat{w} \cdot \delta(1 - a_M^*)$, then first-time community college students who initially prefer the main campus M cannot enroll at M as a transfer student.*

Proof. If $\kappa_T \leq \hat{w} \cdot \delta(1 - a_M^*)$, then M's optimal cut-off for transfer admissions satisfies $a_T^* > a_M^*$. Because all students who were previously rejected from M have an academic preparedness level strictly less than a_M, they are not admitted. All capacity is filled by democratized students who initially preferred the community college and have high levels of academic preparedness. □

However, comparing the number of external transfers from Table 5 to first-time enrollment in Table 1, transfer capacity seems reasonably high. So I assume we are not in the case of Lemma 2 and summarize the two conditions on the unaffiliated capacity constraints below:

Condition 3 (Unaffiliated capacity constraints condition)**.** $\kappa_C > \hat{w}(1 - a_M^*)$ *and* $\kappa_T > \hat{w} \cdot \delta(1 - a_M^*)$.

Denote a_T^* as the optimal cut-off for transfer applicants in the unaffiliated environment: a community college student i who applies to transfer is admitted if and only if $a_i \geq a_T^*$. Transfer admissions in the unaffiliated environment is characterized as follows:

Proposition 2. *Let Condition 1 on the unaffiliated preferences, Condition 2 on selectivity, and Condition 3 on the unaffiliated capacity constraints hold. Then the transfer cut-off is*

$$a_T^* = \frac{\hat{w} \cdot \delta + (1 - \hat{w})a_M^* - \kappa_T}{\hat{w} \cdot \delta + (1 - \hat{w})}.$$

[10]To be more specific, institutions are only required to submit information on graduation rates of students who were first-time, full-time students at that institution. Transfer students who complete a degree are included in data on the number of degrees conferred, and these data do not distinguish between degrees completed by a student who started at that institution or elsewhere.

Proof. Under $\kappa_T > \hat{w} \cdot \delta(1 - a_M^*)$, both democratized students who initially preferred the community college C and non-diverted students who continue to prefer M will successfully transfer. Hence,

$$\kappa_T = (1 - \hat{w})(a_M^* - a_T^*) + \hat{w} \cdot \delta(1 - a_T^*),$$

and rearranging to solve for a_T^* gives the result. $\square$

Under Condition 3, transfer admissions are less selective than first-time admissions ($a_T^* < a_M^*$). A positive measure of students who initially preferred the main campus M can gain access as a transfer student. Therefore, in the unaffiliated environment, there are three academic pathways for students who successfully enroll somewhere as a first-time student: (1) start at the M and stay there, (2) start at the community college C and stay there, or (3) start at C and transfer to M.

3.2 Affiliated Environment

Now consider an environment with 3 institutions. In addition to the university's main campus M and community college C, there is now a non-selective regional campus R with capacity $\kappa_R \in (0, 1)$, and R affiliated with M. Call this the "affiliated" environment. I continue to use j to refer to an arbitrary institution. Capacity constraints at M and C are the same as before, and $\kappa_M + \kappa_R + \kappa_C < 1$.

Denote the price and value of attending the regional campus as $p_R \in (0, p_M)$ and $v_R \in (0, v_M)$. The utility a student i gets from attending R is

$$u(w_i, R) = ln(1 + w_i - p_R) + v_R. \tag{5}$$

Under some conditions on prices and values at the main and regional campuses, students' preferences can be characterized by a pair of cut-off rules on their wealth endowments. First, compare the main and regional campuses. Let the student with the lowest wealth endowment prefer the regional campus, and the student with the highest wealth endowment prefer the main campus. Then I can derive the "upper" wealth cut-off that determines student preferences.

Lemma 3. *Let $ln(1 - p_M) + v_M < ln(1 - p_R) + v_R$ and $ln(2 - p_M) + v_M > ln(2 - p_R) + v_R$. There exists $\bar{w}$ such that i initially prefers M over R if and only if $w_i \geq \bar{w}$; furthermore,*

$$\bar{w} = \frac{e^{v_R}(1 - p_R) - e^{v_M}(1 - p_M)}{e^{v_M} - e^{v_R}} \in (0, 1). \tag{6}$$

Proof. The proof is similar to that of Lemma 1, so I omit some set-up. The upper affiliated wealth cut-off

$\bar{w}$ is determined by setting $u(\bar{w}, R) = u(\bar{w}, M)$ and solving for $\bar{w}$,

$$ln(1 + w_i - p_R) + v_R = ln(1 + w_i - p_M) + v_M$$
$$\Rightarrow \bar{w} = \frac{e^{v_R}(1 - p_R) - e^{v_M}(1 - p_M)}{e^{v_M} - e^{v_R}}.$$

To see that $\bar{w} \in (0, 1)$, first suppose not and that $\bar{w} \leq 0$. Then there will be a contradiction on $ln(1 - p_M) + v_M < ln(1 - p_R) + v_R$. Next, suppose not and $\bar{w} \geq 1$, then there will be a contradiction on $ln(2 - p_M) + v_M > ln(2 - p_R) + v_R$. □

Similar to Lemma 1, the two conditions $ln(1-p_M)+v_M < ln(1-p_R)+v_R$ and $ln(2-p_M)+v_M > ln(2-p_R)+v_R$ imply that Equation 2 crosses Equation 5 from below exactly once.

Second, compare the regional campus and community college. Let the student with the lowest wealth endowment prefer the community college, and the student with the highest wealth endowment prefer the community college. Then I can derive the "lower" wealth cut-off that determins student preferences.

Lemma 4. *Let $ln(1-p_R)+v_R < 0$ and $ln(2-p_R)+v_R > ln(2)$. There exists $\underline{w}$ such that i initially prefers R over C if and only if $w_i \geq \underline{w}$; furthermore,*

$$\underline{w} = \frac{1 - e^{v_R}(1 - p_R)}{e^{v_R} - 1} \in (0, 1). \tag{7}$$

Proof. Structurally, the proof is identical to Lemma 1, so I omit the details. □

Finally, an additional assumption is needed to guarantee that the upper and lower cut-offs are intuitively ordered,

$$(e^{v_M+v_R} - e^{v_M})p_M > (e^{v_M+v_R} - e^{v_R})p_R.$$

This is similar to a supermodularity or convexity assumption. Given that the main campus M is more expensive than the regional campus R, the increased value from attending M must be large enough to justify the cost. For example, if the values of attending each institution v_R and v_M are very close, but R is significantly cheaper than M, then the wealth cut-offs will not be well-behaved—because students can get almost the same academic experience for cheaper. When this condition is satisfied, along with the previous restrictions, students with the highest wealth endowments prefer M, those with moderate endowments prefer R, and those with low endowments prefer C.

I summarize all of the preference conditions in the following condition:

Condition 4 (Affiliated preferences condition)**.** *(p_R, v_R) and (p_M, v_M) together satisfy:*

1. $ln(1 - p_M) + v_M < ln(1 - p_R) + v_R$

2. $ln(2-p_M)+v_M > ln(2-p_R)+v_R$

3. $ln(1-p_R)+v_R < 0$

4. $ln(2-p_R)+v_R > ln(2)$

5. $(e^{v_M+v_R}-e^{v_M})p_M > (e^{v_M+v_R}-e^{v_R})p_R$

When I refer to Condition 1 on unaffiliated preferences and Condition 4 on the affiliated preferences together, I call them conditions on "preferences" without specifying the environment.

Next, I compare student preferences in the unaffiliated vs. affiliated environments. After a regional campus is introduced, fewer students rank both the community college and the main campus as their top choice.

Proposition 3. *Let Conditions 1 and 4 on preferences hold. Then* $\bar{w} > \hat{w} > \underline{w}$.

Proof. First, for a contradiction, suppose that $\bar{w} \leq \hat{w}$. Then

$$\frac{e^{v_R}(1-p_R)-e^{v_M}(1-p_M)}{e^{v_M}-e^{v_R}} \leq \frac{1-e^{v_M}(1-p_M)}{e^{v_M}-1}$$
$$\Rightarrow e^{v_M+v_R}(1-p_R)+e^{v_R}p_R-e^{v_M}p_M \leq e^{v_M+v_R}(1-p_M)$$
$$\Rightarrow e^{v_M+v_R}(p_M-p_R) \leq e^{v_M}p_M-e^{v_R}p_R$$

contradicting that $(e^{v_M+v_R}-e^{v_M})p_M > (e^{v_M+v_R}-e^{v_R})p_R$.

Then for another contradiction, suppose that $\hat{w} \leq \underline{w}$. Then

$$\frac{1-e^{v_M}(1-p_M)}{e^{v_M}-1} \leq \frac{1-e^{v_R}(1-p_R)}{e^{v_R}-1}$$
$$\Rightarrow -e^{v_M+v_R}(1-p_M)-e^{v_M}p_M \leq -e^{v_M+v_R}(1-p_R)-e^{v_R}p_R$$
$$\Rightarrow e^{v_M+v_R}(p_M-p_R) \leq e^{v_M}p_M-e^{v_R}p_R$$

again contradicting that $(e^{v_M+v_R}-e^{v_M})p_M > (e^{v_M+v_R}-e^{v_R})p_R$.

Finally, to close the loop, suppose for a contradiction that $\bar{w} \leq \underline{w}$. Then

$$\frac{e^{v_R}(1-p_R)-e^{v_M}(1-p_M)}{e^{v_M}-e^{v_R}} \leq \frac{1-e^{v_R}(1-p_R)}{e^{v_R}-1}$$
$$\Rightarrow e^{v_M+v_R}(p_M-p_R) \leq e^{v_M}p_M-e^{v_R}p_R,$$

once again contradicting that $(e^{v_M+v_R}-e^{v_M})p_M > (e^{v_M+v_R}-e^{v_R})p_R$. $\square$

3.2.1 First-time Enrollment

There are still two time periods $t \in \{1, 2\}$, but at the beginning of $t = 1$, first-time admissions now happens over three steps:

1. Students who most prefer the main campus M apply there.
2. Students who most prefer the regional campus R or who were previously rejected at M apply to R, and the best applicants are accepted up to capacity.[11]
3. Students who most prefer the community college C or who were previously rejected at both M and R apply to C, and the best applicants are accepted up to capacity.

The main campus M has the same enrollment behavior in both environments and I continue to let Condition 2 hold. M solves the enrollment problem in Equation 4 and picks the same cut-off on academic preparedness. Denote a_M^{**} the optimal first-time cut-off level on academic preparedness for M in the affiliated environment. As a result of Proposition 3, fewer students apply to M in first-time admissions and M therefore enrolls fewer students in first-time admissions in the affiliated environment.[12]

Corollary 1. *Let the conditions from Proposition 3 hold. Also, let Condition 2 on selectivity hold. M enrolls fewer students after a regional campus is introduced.*

The community college C also has the same enrollment behavior as before. Denote a_C^{**} the optimal first-time cut-off level on academic preparedness for C in the affiliated environment.

The regional campus R is also non-selective and enrolls students up to its capacity κ_R. This aligns with *Accelerating Excellence, Access and Service: Strategic Enrollment Plan for The Ohio State University, 2022-2024* (2021), which states that the main enrollment goal at regional campuses is expansion. Also recall that any first-time students with a high school degree or equivalent are admissible at regional campuses (*Undergraduate Admissions: Regional Campuses* 2023). Denote a_C^{**} the optimal first-time cut-off level on academic preparedness for R.

Before I derive the new first time admissions cut-offs, I again need to impose regularity conditions on capacity. I restrict attention to cases such that $\kappa_R > (\bar{w} - \underline{w})(1 - a_M^{**})$ and $\kappa_C > \underline{w}(1 - a_R^{**})$. Together, these regularity conditions ensure that admissions is most selective at the main campus M and least selective at the community college C. It also implies that the regional campus R enrolls not only students who most prefer R but also some students who were rejected from M, and that the community college C enrolls a mix of students who most prefer M, R, or C.

[11] In practice, students use the Common Application to apply to the "OSU system" and may be admitted at multiple or a specific campus. It is equivalent to assume that students simultaneously apply to both M and R, and the university system sorts applicants by academic preparedness by choosing cut-offs for both campuses.

[12] If Condition 2 didn't hold—the case that I *don't* focus on in this paper—then M becomes strictly less selective and enrolls weakly fewer students.

I now characterize first-time enrollment in the affiliated environment.

Proposition 4. *Let Conditions 1 and 4 on preferences and Condition 2 on selectivity hold. Also, let* $\kappa_R > (\bar{w} - \underline{w})(1 - a_M^{**})$ *and* $\kappa_C > \underline{w}(1 - a_R^{**})$*. Then the first-time cut-offs in the affiliated environment are:*

$$\begin{aligned} a_M^{**} &= a_M^* = 1 - \rho_M^{-1}(\pi_M) \\ a_R^{**} &= \frac{(\bar{w} - \underline{w}) + (1 - \bar{w})a_M^{**} - \kappa_R}{1 - \underline{w}} \\ a_C^{**} &= \bar{w} + (1 - \bar{w})a_M^{**} - \kappa_R - \kappa_C \end{aligned}$$

Proof. a_M^{**} follows from Condition 2. Then,

$$\begin{aligned} \kappa_R &= (\bar{w} - \underline{w})(1 - a_R^{**}) + (1 - \bar{w})(a_M^{**} - a_R^{**}) \\ \kappa_C &= \underline{w}(1 - a_C^{**}) + (1 - \underline{w})(a_R^{**} - a_C^{**}), \end{aligned}$$

and rearranging to solve for a_R^{**}, a_C^{**} gives the result. □

A direct result following from Proposition 4 is that the community college becomes less selective after a regional campus is introduced.

Proposition 5. *Let the conditions from Proposition 4 hold. Then the cut-off at C is lower in the affiliated environment than in the affiliated environment:* $a_C^* - a_C^{**} > 0$*.*

Proof. Suppose not, and $a_C^{**} \geq a_C^*$. Then

$$\begin{aligned} \bar{w} + (1 - \bar{w})a_M^{**} - \kappa_R - \kappa_C &\geq \hat{w} + (1 - \hat{w})a_M^* - \kappa_C \\ \Rightarrow (\bar{w} - \hat{w})(1 - a_M^*) &\geq \kappa_R \\ \Rightarrow (\bar{w} - \underline{w})(1 - a_M^{**}) > (\bar{w} - \hat{w})(1 - a_M^*) &\geq \kappa_R, \end{aligned}$$

but $\kappa_R > (\bar{w} - \underline{w})(1 - a_M^{**})$, hence the contradiction. □

It is also of interest to understand *how much* less selective the community college becomes in response to the regional campus.

Corollary 2. *Let the conditions from Proposition 5 hold. Then the gap between cut-offs at the C in the two environments,*

$$a_C^* - a_C^{**} = (\hat{w} - \bar{w})(1 - a_M^{**}) + \kappa_R > 0,$$

is decreasing in $\bar{w}$*, and increasing in both* a_M^{**} *and* κ_R*.*

As the upper affiliated wealth cut-off $\bar{w}$ increases, more students initially prefer the regional campus R over the main campus M, which increases competition for limited first-time enrollment slots at R and causes the students who were marginally admissible at R to "trickle down" to the community college C. This increases selectivity at C.

On the other hand, the cut-off at the main campus a_M^{**} increases, the community college C benefits in both settings, but it benefits C *more* in the unaffiliated setting because C directly admits the students who "trickle down" from the main campus M. In the affiliated setting, those students first "trickle down" to the regional campus R, and the weakest students at R who lose enrollment seats are then enrolled at C. This dilutes the enrollment effect for C in the affiliated environment and makes C less selective.

Finally, as capacity at the regional campus κ_R increases, the regional campus R is able to enroll more students, which draws some well-prepared students away from the community college C and makes C less selective.

These insights generate the following hypotheses:

Hypothesis 1. *As more students prefer the regional campus over the main campus, average and minimum levels of academic preparedness for first-time community college students increase.*

Hypothesis 2. *Average and minimum levels of academic preparedness for first-time community college students increase as the main campus increases selectivity.*

Hypothesis 3. *Average and minimum levels of academic preparedness for first-time community college students decrease after a regional campus is introduced. Moreover, both are decreasing in the enrollment level at regional campuses.*

3.2.2 Transfer Enrollment

Now to consider transfer admissions. I continue to assume that on average, students at the regional campus who initially preferred the main campus do not change their preferences, due to being part of the same university system. Of course, this is a strong assumption at the individual level, but is not too unrealistic at the group level. Recall that about half of students entering regional campuses state that OSU's Main Campus was their first choice, and about half of regional campus students eventually transfer out.

While the main campus M remains non-selective over transfer enrollment, M treats transfers from the regional campus R and the community college C differently. M exogenously chooses an internal transfer cut-off $a_{Min} \in (a_R^{**}, a_M^{**})$ and guarantees that any transfers from the R with academic preparedness at least as high as a_{Min} will be accepted, and prioritizes filling transfer capacity with students from R before filling remaining capacity with applicants from C. I call these "internal transfers". I assume that a_{Min} is exogenously chosen because the 2.0 cut-off to internally transfer to the Main Campus in the OSU system was likely not chosen strategically. I was able to verify using the Internet Archive that the cut-off has been unchanged since at least May 2014. Also, the bounds on a_{Min} reflect that while transfer admissions is not as selective as first-time admissions, not all regional campus students can transfer to the main campus.

If transfer capacity remains after admitting internal transfers, then transfer from the community college C is the same as in the unaffiliated environment. Because C is not affiliated with M, I call transfer students from C "external transfers". As was the case in the unaffiliated environment, if transfer capacity is too low, then no community college students transfer.

Lemma 5. *If $\kappa_T \leq (1-\bar{w})(a_M^{**} - a_{Min})$, then first-time community college students who prefer M cannot enroll at M as a transfer student.*

Proof. If $\kappa_T \leq (1-\bar{w})(a_M^{**} - a_{Min})$, then because regional campus students are prioritized, capacity is completely filled by these students. □

But in practice, the OSU Main Campus admits both internal and external transfer students every year. Going forth, I only consider the case in which $\kappa_T > (1-\bar{w})(a_M^{**} - a_{Min})$.

I summarize the three conditions on the affiliated transfer capacity constraints:

Condition 5 (Affiliated capacity constraints condition)**.** *$\kappa_R > (\bar{w} - \underline{w})(1 - a_M^{**})$, $\kappa_C > \underline{w}(1 - a_R^{**})$, and $\kappa_T > (1-\bar{w})(a_M^{**} - a_{Min})$.*

Denote a_T^{**} as the main campus's optimal cut-off for external transfer applicants in the affiliated environment: a community college student i who applies to transfer is admitted if and only if $a_i \geq a_T^{**}$. Transfer admissions in the affiliated environment is characterized as follows:

Proposition 6. *Let Conditions 1 and 4 on preferences, Condition 2 on selectivity, and Conditions 3 and* **??** *on capacity constraints hold. Let M prioritize admitting transfer applicants from the regional campus with academic preparedness of at least a_{Min}. Then the optimal transfer cut-off for community college students is*

$$a_T^{**} = \frac{\underline{w} \cdot \delta + (1-\bar{w})(a_M^{**} - a_{Min}) - \kappa_T}{\underline{w} \cdot \delta}.$$

Proof. Since $a_T^{**} > a_{Min}$, there are two kinds of students who transfer. First, students from the regional campus R, who receive priority. Second, democratized community college students. Hence,

$$\kappa_T = (1-\bar{w})(a_M^{**} - a_{Min}) + \underline{w} \cdot \delta(1 - a_T^{**}),$$

and rearranging gives the result. □

Comparative statics on the external transfer cut-off a_T^{**} follow.

Corollary 3. *Let the conditions from Proposition 6 hold. The optimal transfer cut-off for community college students is increasing in $\underline{w}$ and a_M^{**}, and decreasing in $\bar{w}$ and a_{Min}.*

Proof.

$$\begin{aligned}
\frac{\partial}{\partial \bar{w}} a_T^{**} &= -\frac{a_M^{**} - a_{Min}}{\underline{w} \cdot \delta} < 0, \\
\frac{\partial}{\partial \underline{w}} a_T^{**} &= \frac{\kappa_T - (1-\bar{w})(a_M^{**} - a_{Min})}{\underline{w}^2 \cdot \delta} > 0, \\
\frac{\partial}{\partial a_M^{**}} a_T^{**} &= \frac{1-\bar{w}}{\underline{w} \cdot \delta} > 0, \\
\frac{\partial}{\partial a_{Min}} a_T^{**} &= -\frac{1-\bar{w}}{\underline{w} \cdot \delta} < 0.
\end{aligned}$$

The first inequality follows from Condition **??**; specifically, that $\kappa_T >= (1-\bar{w})(a_M^{**} - a_{Min})$. The second inequality follows from the assumption that $a_{Min} \in (a_R^{**}, a_M^{**})$. □

As the lower affiliated wealth cut-off $\underline{w}$ increases, more people prefer the community college C over the regional campus R. Transfer admissions from C is more selective, since more highly prepared students will start at C and increase competition for external transfers. As the first-time cut-off at the main campus a_M^{**} increases, some students lose access to the main university M and both R and C are able to enroll a more academically prepared first-time student body, which also increases competition for external transfers. In both cases, competition among external transfers increases selectivity.

As the upper affiliated wealth cut-off $\bar{w}$ increases, more people most prefer the regional campus R most and will not transfer. Similarly, as the internal transfer cut-off a_{Min} increases, fewer students from R are able to transfer. Both of these cause external transfer to become less selective, since regional campus transfers take up less transfer capacity.

These comparative statics generate four more hypotheses:

Hypothesis 4. *As more students prefer the community college over the regional campus, the main university becomes more selective over external transfers.*

Hypothesis 5. *The main university becomes more selective over external transfers as selectivity at the main university increases.*

Hypothesis 6. *As more students prefer the regional campus over the main university, the main university becomes less selective over external transfers.*

Hypothesis 7. *The main university becomes less selective over external transfers as the regional campus transfer cut-off increases.*

Finally, I identify conditions such that community college transfer applicants lose access to the main university M after the regional campus is added.

Theorem 1. *Let Conditions 1 and 4 on preferences, Condition 2 on selectivity, and Conditions 3 and* **??** *on capacity constraints hold. Let M prioritize admitting transfer applicants from the regional campus with academic preparedness of at least a_{Min}. The transfer cut-off for community college students is strictly higher in the affiliated environment if and only if*

$$a_{Min} < a_M^* \left(1 - \frac{(1-\hat{w})\underline{w}\cdot\delta}{(1-\bar{w})(\hat{w}\cdot\delta + (1-\hat{w}))}\right) + \frac{(1-\hat{w})\underline{w}\cdot\delta}{(1-\bar{w})(\hat{w}\cdot\delta + (1-\hat{w}))} - \frac{(\hat{w}-\underline{w})\delta + (1-\hat{w})}{(1-\bar{w})(\hat{w}\cdot\delta + (1-\hat{w}))}\kappa_T.$$

Proof. $a_T^{**} > a_T^*$ if and only if

$$\frac{\underline{w}\cdot\delta + (1-\bar{w})(a_M^{**} - a_{Min}) - \kappa_T}{\underline{w}\cdot\delta} > \frac{\hat{w}\cdot\delta + (1-\hat{w})a_M^* - \kappa_T}{\hat{w}\cdot\delta + (1-\hat{w})},$$

and rearranging to solve for a_{Min} gives the result. □

Theorem 1 says that if the regional campus transfer cut-off a_{Min} is too low, then students at the regional campus R crowd out community college students in the transfer process. The weakest regional campus transfer students (those just barely acceptable) are prioritized even above the most academically prepared community transfer applicants. However, if a_{Min} is high enough, then there is no crowd-out effect because the regional campus students who have priority would still have been able to transfer even without priority. This generates the following hypothesis:

Hypothesis 8. *M is more selective over external transfers after the regional campus is introduced.*

If the hypothesis holds, then the main campus M would be able to enroll an overall stronger transfer student body by increasing a_{Min}, which reduces crowd-out of highly academically prepared community college applicants. This is especially important to note because in this model, there is an equity implication to crowd-out: students with low wealth endowments ($w \in [0, \underline{w}]$) are exactly the students who initially most prefer C. Highly academically prepared, low wealth students who are democratized are also the students who are at most risk of being pushed out by regional campus transfers.

4 A Social Planner's Problem

Now suppose that a welfare-maximizing state policymaker (or interchangeably, social planner, SP) decides how to invest in higher education in an unaffiliated environment such that Conditions 1 and 4 on preferences, Condition 2 on selectivity, and Conditions 3 and **??** on capacity constraints hold. The SP can either expand main campus M modestly, or open a regional campus R.

Of course, under Condition 2 on selectivity, directly expanding capacity at the main campus M has no effect on first-time enrollment. Therefore, I suppose that the SP would partially subsidize the price of enrollment p_M to expand enrollment at M—this is a more realistic investment to make, since state governments appropriate funds to their public universities in part to subsidize tuition for in-state students and encourage college-going as a public investment.

Under tuition subsidization, students at the main campus M pay $p^0 = p_M - \psi$ for some $\psi \in \mathbb{R}_{++}$ small. Since we are in the unaffiliated environment, this lowers the wealth cut-off to

$$\begin{aligned}\hat{w}^0 &= \frac{1 - e^{v_M}(1 - p^0)}{e^{v_M} - 1}, \text{ and}\\ \hat{w} - \hat{w}^0 &= \frac{e^{v_M} \cdot \psi}{e^{v_M} - 1}.\end{aligned}$$

Since all students at the main campus M benefit from subsidization, the social cost of subsidizing the price of enrollment is

$$\text{Social Cost} = (1 - \hat{w}^0)(1 - a_M^*)\psi.$$

To make the comparison as clean as possible, suppose that if the SP instead spent the same amount on opening a regional campus R. Then R would have increased capacity $\kappa_R^0 \in ((\hat{w} - \hat{w}^0)(1 - a_M^*), 1)$ such that $\kappa_M + \kappa_R^0 + \kappa_C < 1$. The lower bound on κ_R^0 reflects that opening the regional campus would increase total enrollment more than subsidizing tuition at the main campus.

The SP is *positive assortative* in matching students to institutions, but cannot directly make matches.[13] Social benefit is linearly increasing in a student's academic preparedness a_i, such that for $b_M \in \mathbb{R}_{++} \setminus (0, 1]$ and $b_R \in (1, b_M]$, a student i generates social benefit $b_M \cdot a_i$ for enrolling at the main university M, social benefit $b_R \cdot a_i$ for enrolling at the regional campus R, and social benefit a_i for enrolling at the community college C. I assume that this social benefit is accrued at the *last* institution that a student attends. So if student i attends M as a first-time student, then the social benefit is $b_M \cdot a_i$. If student i' starts at C but successfully transfers to M, then the social benefit is $b_M \cdot a_{i'}$.

I limit discussion to the case where $a_M^{**} = a_M^* > a_T^{**} > a_T^* > a_{Min} > a_R^{**} > a_C^* > a_C^{**}$ and subsidies are not enough to change the ordering of these cut-offs. The first equality $a_M^{**} = a_M^*$ comes from Condition 2 on selectivity. $a_M^* > a_T^{**}$ and $a_{Min} > a_R^{**}$ come from Condition **??** on affiliated capacity constraints. $a_T^{**} > a_T^*$

[13] Positive assortative preferences imply that the SP treats institutions and students as complements. If admissions were centralized and run by the SP, then the SP would first enroll the best students based on academic preparedness who are not already admitted elsewhere to the main campus until its capacity is full, then to the regional campus (if available) until its capacity is full, and finally to the community college until its capacity is full.

assumes that the condition in Theorem 1 holds, and $a_T^* > a_{Min}$ comes from Hypothesis 4. That is, the regional campus is beneficial to some students who can only transfer to the main university M because of prioritized transfer admissions, because a_{Min} is strictly less than the transfer cut-offs. $a_R^{**} > a_C^*$ does not come from any particular result, but is true whenever $\kappa_R^0 < \kappa_C$. Finally, $a_C^* > a_C^{**}$ comes from Proposition 5.

4.1 Tuition Subsidization Increases Welfare

Here we are in the unaffiliated environment with 2 institutions only. Tuition subsidization increases social welfare in 3 ways. First, students with academic preparedness $a \in [a_M^*, 1]$ and wealth $w \in [\hat{w}^0, \hat{w})$ now enroll as first-time students at the main campus, whereas they would have previously preferred and enrolled at the community college and only a fraction δ of them would become democratized and successfully transferred. The welfare gain is

$$B^S_{Main} = \frac{1}{2}(\hat{w} - \hat{w}^0)(1-\delta)(1-(a_M^*)^2)(b_M - 1) > 0.$$

Second, the first-time enrollment cut-off at the community college C cut-off is lower. This is because some highly academically prepared students who would have attended C before now prefer the main campus M after tuition subsidization. They no longer apply to C, which allows C to admit students who were previously marginally inadmissible. Denote the new cut-off $a_C^0 < a_C^*$. The welfare gain is

$$B^S_{College} = \frac{1}{2}((a_C^*)^2 - (a_C^0)^2) > 0.$$

Finally, the transfer cut-off is lower. Previously, democratized community college students with academic preparedness $a \in [a_M^*, 1]$ and wealth $w \in [\hat{w}^0, \hat{w})$ would have transferred to the main campus M. After subsidization, these students now start at M, which frees up some transfer capacity for students who were previously marginally inadmissible. Denote the new cut-off $a_T^0 < a_T^*$. The welfare gain is

$$B^S_{Transfer} = \frac{1}{2}(\hat{w}^0 \cdot \delta + (1 - \hat{w}^0))((a_T^*)^2 - (a_T^0)^2)(b_M - 1) > 0.$$

Under subsidization, welfare increases because more students start at the main campus M, and this "trickles down" to first-time admissions at the community C and to transfer admissions. Moreover, these enrollment effects maintain positive sorting by academic preparedness. Therefore, welfare unambiguously increases.

4.2 A Regional Campus Has Ambiguous Welfare Effects

I fully back out the welfare changes from opening a regional campus in Appendix C and summarize the results here. Unlike the case of subsidization, there are both gains *and* losses to opening a regional campus.

The certain welfare gains from opening a regional campus are

$$B^R_{Gain} = \frac{1}{2}[(1-\bar{w})((a^*_T)^2 - (a_{Min})^2)(b_M - 1) + (\bar{w} - \underline{w})((a^*_T)^2 - (a_{Min})^2)(b_R - 1) + (1-\underline{w})((a_{Min})^2 - (a^{**}_R)^2)(b_R - 1) + ((a^*_C)^2 - (a^{**}_C)^2)].$$

Welfare gains are accrued by two kinds of students: (1) those who would have enrolled at the community college C and would certainly fail to transfer to the main campus M in the unaffiliated environment, but enroll at the regional campus R in the affiliated environment (first three components of the expression), and (2) those who are not enrolled anywhere in the unaffiliated environment, but enroll at C in the affiliated environment (last component of the expression). Students that fall into the first category especially benefit if they most prefer M and are only are able to transfer to M because they start at a regional campus and enjoy preferential treatment in transfer enrollment (first component of the expression). These are precisely the students who crowd out highly academically prepared community college students in transfer admissions.

The certain welfare losses are

$$B^R_{Loss} = \frac{1}{2}[(\bar{w} - \hat{w})(1 - (a^*_T)^2)(b_R - b_M) + \underline{w}((a^{**}_T)^2 - (a^*_T)^2)(1 - b_M)\delta].$$

Welfare losses are accrued by two kinds of students: (1) those who enroll at the main campus in either first-time or transfer admissions in the unaffiliated environment, but choose to enroll and stay at the regional campus R in the affiliated environment (first component of the expression), and (2) those who always initially enroll at the community college C, and can only transfer in the unaffiliated environment due to being crowded out in the affiliated environment (second component of the expression).

Finally, ambiguous welfare effects are

$$B^R_{Ambig} = \frac{1}{2}(\hat{w} - \underline{w})(1 - (a^*_T)^2)(\delta \cdot b_M + (1-\delta) - b_R)).$$

These welfare changes are accrued by highly academically prepared students who most prefer the community college C in the unaffiliated environment, but most prefer the regional campus R in the affiliated environment. In the unaffiliated environment, a fraction δ of these students would become democratized and successfully transfer to the main campus M—while the rest stay at C. But in the affiliated environment, all of these students most prefer and start at R, and will not try to transfer. If the social benefit of enrolling at M is high (b_M is very large relative to b_R, or b_R is not that much larger than 1, or both) and/or democratization is high (δ is large), then this is more likely to be a welfare loss.

It is clear that adding a regional campus is not Pareto improving. However, without adding more assumptions on the model parameters, it is unclear whether adding a regional campus would overall increase or decrease welfare. It depends on the distance between social benefit parameters as well as the distance between wealth cut-offs. On one hand, as the social benefit of enrolling at the regional campus R decreases and approaches the social benefit of enrolling at the community college C ($b_R \to 1$), welfare gains decrease, welfare losses increase, and ambiguous welfare effects are more likely to be welfare decreasing. That is, if R doesn't deliver a substantially better educational experience than C, then R is only differentiated from C due to its transfer function. But crowd-out of highly prepared community college students is welfare reducing. ON the other hand, as the social benefit of enrolling at R increases and approaches the social benefit of enrolling at the main campus M ($b_R \to b_M$), welfare gains increase, welfare losses decrease, and ambiguous welfare effects are more likely to be welfare increasing.

Second, the distances between the wealth cut-offs in the two environments, $\bar{w} - \hat{w}$ and $\hat{w} - \underline{w}$, also affect welfare. If the difference between the upper affiliated wealth cut-off and unaffiliated wealth cut-off $\bar{w} - \hat{w}$ is small, then welfare losses decrease because not many students switch their preference from the main campus to the regional campus after it opens. Also, for a small democratization level δ, if the difference between the unaffiliated wealth cut-off and the lower affiliated wealth cut-off $\hat{w} - \underline{w}$ is large, then welfare gains increase, because more students who initially preferred the community college switch to preferring the regional campus once it is introduced. Put altogether, if $\bar{w} - \hat{w}$ is small relative to $\hat{w} - \underline{w}$, then adding the regional campus is more likely to be welfare increasing. To achieve that, the regional campus needs to have similar value as the main campus ($v_M - v_R$ is small) and/or similar affordability as the community college (p_R is small).

Finally, some welfare is *always* lost because of mismatch in sorting; hence, opening a regional campus cannot be Pareto improving. Unlike tuition subsidization, some highly academically prepared community college students are crowded out by less prepared regional campus students in transfer admissions; this is welfare-reducing because social welfare is positive assortative.

5 Conclusion

This paper constructs a general theoretical framework that describes first-time and transfer admissions with multiple institutions. Using the model, I find that opening a regional campus may adversely affect community colleges in both first-time and transfer admissions. I provide some suggestions here for an empirical strategy to test the predictions generated by the theoretical framework. To summarize, there are nine hypotheses. I summarize them, reordered to group similar hypotheses, below:

1. As more students prefer the regional campus over the main university, academic preparedness at community colleges increases.

2. As more students prefer the community college over the regional campus, selectivity over external transfers increases.

3. As more students prefer the regional campus over the main university, selectivity over external transfers decreases.

4. Increasing selectivity at the main university increases academic preparedness at community colleges.

5. Increasing selectivity at the main university increases selectivity over external transfers.

6. Increasing the regional campus transfer cut-off decreases selectivity over external transfers.

7. Opening and/or expanding a regional campus decreases academic preparedness at community colleges.

8. Opening and/or expanding a regional campus increases selectivity over external transfers.

9. The main university sets a higher "minimum requirement" for external transfers than for regional campus transfers.

However, not all of these hypotheses are testable. Hypotheses (1), (2), and (3) require truthfully eliciting student preferences. Hypotheses (4) and (5) cannot be empirically tested using Ohio as a case study because OSU did not become a selective institution until *after* the regional campuses were founded.[14] Enrollment changes would partially reflect that the value of attending the OSU-Main Campus was changing and attracting a different pool of applicants, and it is not clear how to untangle changes in student application behavior from institutional changes in selectivity. Finally, Hypothesis (7) cannot be tested because OSU has not had any variation in the regional campus cut-off; as discussed earlier, the minimum GPA requirement has been set at 2.0 for at least a decade.

Combining the insights from the hypotheses generated, though, there are still two things that can potentially be tested with internal validity. First, is the OSU-Main Campus more selective over external transfer students? Second, does enrollment at regional campuses indirectly affect enrollment at community colleges? I propose several empirical strategies that could be employed with data on OSU transfer applicants to test the first question. Ideally, data on external transfers would have information on *all* applicants, including those who are rejected. It is also preferred to have data linking applicants to student outcomes, in order to get a more standardized measure of "academic preparedness".[15] Identifying variation is in the type of students' home institutions: regional campus or community college.

First, I suggest using a regression discontinuity approach to verify that the minimum GPA cut-off for regional campus student transfer-ins works as expected. I propose a modified version of the approach in Hoekstra (2009), using application GPA as the running variable. Second, it would be illustrative to graphically show the distributions in different measures of student preparedness for external vs. regional campus transfer-ins,

[14] The regional campuses were founded 1957-1960 and the OSU-Main Campus was an open admissions university through the 1980s.

[15] That is, students at different community colleges could have the same entering GPA, but different levels of "true" preparedness, due to idiosyncrasies in grading at the institution level. By tracking students by their performance at the OSU-Main Campus after enrollment, one could measure student performance when measured across the same benchmark.

and test for a difference in sample means (e.g., a t-test) and/or a difference in probability distributions (e.g., a Kolmogorov-Smirnov test).

Next, I suggest an empirical test based on Arcidiacono, Kinsler, and Ransom (2023), who model admissions at selective institutions. The underlying model for external admissions is

$$x_i = z_i\beta + \varepsilon_i,$$

where for applicant i, x_i is a measure of applicant quality, z_i is a vector of observable characteristics, and ε_i are unobservable characteristics following a logistic distribution. In the presence of a regional campus, applicants from the community college are admitted if:

$$z_i\beta + \varepsilon_i + \geq a_T^{**}.$$

The empirical specification is therefore a logit model on the probability of admission as the outcome of interest, using the student's application characteristics as controls, and the coefficient on the type of home institution is a measure of the average marginal effect of being an external transfer (relative to a regional campus student) on transfer admissions.

Finally, I suggest using a quantile regression approach to test for differences in the distribution of academic preparedness at different percentiles between the two transfer-in groups, especially if there is evidence that the cut-off (as tested in the regression discontinuity approach) is strongly predictive of regional campus transfers. Because regional campus students potentially benefit from facing less selective transfer-in criteria, the distribution of academic preparedness in this group may be positively skewed; conversely, the distribution of academic preparedness for external transfer-ins may be negatively skewed. It would therefore be instructive for measuring the potential size of incorrect sorting (which is welfare-reducing) to understand if there is a pile-up of regional campus students at the minimum 2.0 GPA cut-off for a campus change.

Another contribution of this work is a policy recommendation on how to expand higher education enrollment. If a state policymaker can choose between subsidizing tuition at a flagship institution or opening a regional campus, I characterize when each policy is more welfare-improving. I find that subsidization is socially preferred if enrollment at the main university can be substantially expanded and/or the social returns and the perceived value to students of attending the main university are relatively high compared to the alternatives. On the other hand, opening a regional campus is socially preferred when the previous conditions don't hold, but additionally if the regional campus's value is similar to the main university's value, and/or the regional campus's price is close to the community college's price. Finally, the stronger the preferential treatment in transferring students from the regional campus, the less preferred opening a regional campus becomes, because transfers from the regional campus will crowd out highly academically prepared transfer applicants from the community college.

I conclude with some additional remarks on how this work may additionally be useful for policymakers. Enrollment at selective institutions of higher education has not kept pace with increased student demand for it (Bound, Hershbein, and Long 2009). Whether or not a state policymaker can improve upon this situation depends on if institutions *choose* not to enroll to capacity, or if they *cannot* increase capacity (e.g., the campus cannot physically expand). In the latter case, opening a regional campus may be the only feasible way to increase enrollment. However, policymakers should be aware that this may have spillover effects onto community colleges and readjust to prevent these institutions from unintentionally losing state appropriations—especially if states use or are considering switching to performance funding—or other forms of governmental support.

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A Unaffiliated Environment

Recall that the unaffiliated wealth cut-off in the environment with a main university M and community college C is

$$\hat{w} = \frac{1 - e^{v_M}(1 - p_M)}{e^{v_M} - 1} \in (0, 1),$$

where $p_M, v_M \in (0, 1)$ are the price and value of attending M respectively. The unaffiliated wealth cut-off $\hat{w}$ determines a student's initial preferences over institutions: a student i prefers M if and only if $w_i \geq \hat{w}$. Comparative statics from Lemma 1 follow:

Corollary 4. *Let Condition 1 on the unaffiliated wealth cut-off hold. $\hat{w}$ is increasing in p_M and decreasing in v_M.*

Proof.

$$\frac{\partial}{\partial p_M}\hat{w} = \frac{e^{v_M}}{e^{v_M} - 1} > 0,$$
$$\frac{\partial}{\partial v_M}\hat{w} = \frac{-e^{v_M} p_M}{(e^{v_M} - 1)^2} < 0,$$

since for $v_M \in (0, 1)$, $e^{v_M} > 1$. □

Next, recall that the transfer cut-off in the unaffiliated environment is

$$a_T^* = \frac{\hat{w} \cdot \delta + (1 - \hat{w})a_M^* - \kappa_T}{\hat{w} \cdot \delta + (1 - \hat{w})},$$

where $a_M^* \in (0, 1)$ is the first-time enrollment cut-off at the main university M, $\delta \in (0, 1)$ is the fraction of community college students who are democratized and apply to transfer to M, and $\kappa_T \in (0, 1)$ is capacity at M for transfer students. Students at the community college who apply to transfer are admitted if and only if $a_i \geq a_T^*$. Comparative statics from Proposition 2 follow:

Corollary 5. *Let Condition 1 on the unaffiliated wealth cut-off, Condition 2 on selectivity at M, and Condition 3 on the unaffiliated capacity constraints hold. a_T^* is decreasing in transfer capacity κ_T and increasing in the democratization fraction δ. Also, a_T^* is increasing in the unaffiliated wealth cut-off $\hat{w}$ if and only if $a_M^* < (1 - \delta)a_T^* + \delta$.*

Proof. First,

$$\frac{\partial}{\partial k_T} a_T^* = -\frac{1}{\hat{w} \cdot \delta + (1 - \hat{w})} < 0,$$
$$\frac{\partial}{\partial \delta} a_T^* = \frac{\hat{w}[(1 - \hat{w})(1 - a_M^*) + \kappa_T]}{(\hat{w} \cdot \delta + (1 - \hat{w}))^2} > 0,$$

since $\hat{w}, a_M^*, \delta \in (0,1)$. Next,

$$\frac{\partial}{\partial \hat{w}} a_T^* = \frac{\delta(1-a_M^*) - (1-\delta)\kappa_T}{(\hat{w}\cdot\delta + (1-\hat{w}))^2},$$

so $\frac{\partial}{\partial \hat{w}} a_T^* > 0$ if and only if $\delta(1-a_M^*) > (1-\delta)\kappa_T$. Substitute in $\kappa_T = (1-\hat{w})(a_M^* - a_T^*) + \hat{w}\cdot\delta(1-a_T^*)$ and suppose not:

$$\begin{aligned}\delta(1-a_M^*) &\leq (1-\delta)((1-\hat{w})(a_M^* - a_T^*) + \hat{w}\cdot\delta(1-a_T^*)) \\ \Rightarrow a_M^* &\geq (1-\delta)a_T^* + \delta,\end{aligned}$$

contradicting that $a_M^* < (1-\delta)a_T^* + \delta$ by assumption. □

Increasing transfer capacity always reduces transfer selectivity, and increasing the fraction of democratized community college students increases transfer selectivity. However, an increase in the unaffiliated wealth cut-off $\hat{w}$, which increases the measure of students who initially prefer the community college C, has two effects that work in opposite directions. First, more students will most prefer the C over the main university M. This also means the level of academic preparedness at the community college increases. Second, it increases competition for transfer slots among democratized community college students. So an increase in $\hat{w}$ decreases transfer competition from the group of students who switched their preferences from M to C (recall that students who start at C but prefer M will always want to transfer), but the democratized community college students who apply to transfer have higher academic preparedness than before. The expression $a_M^* < (1-\delta)a_T^* + \delta$ could be interpreted as a check on which of those effects is stronger.

B Affiliated Environment

Recall that the upper affiliated wealth cut-off in the environment with a main university M, regional campus R, and community college C is

$$\bar{w} = \frac{e^{v_R}(1-p_R) - e^{v_M}(1-p_M)}{e^{v_M} - e^{v_R}} \in (0,1),$$

where $p_R, v_R \in (0,1)$ are the price and value of attending R respectively. The upper affiliated wealth cut-off determines if a student initially prefers the main university M over the regional campus R: a student i prefers M over R if and only if $w_i \geq \bar{w}$. Comparative statics from Lemma 3 follow.

Corollary 6. *Let $ln(1-p_M)+v_M < ln(1-p_R)+v_R$ and $ln(2-p_M)+v_M > ln(2-p_R)+v_R$. $\bar{w}$ is increasing in p_M and v_R and decreasing in p_R and v_M.*

Proof. First,

$$\frac{\partial}{\partial p_M}\bar{w} = \frac{e^{v_M}}{e^{v_M} - e^{v_R}} > 0,$$
$$\frac{\partial}{\partial p_R}\bar{w} = -\frac{e^{v_R}}{e^{v_M} - e^{v_R}} < 0,$$

since $v_M, v_R \in (0,1)$ and $v_M > v_R$. That is, e^{v_M}, e^{v_R}, and $e^{v_M} - e^{v_R}$ are strictly positive. Next,

$$\frac{\partial}{\partial v_M}\bar{w} = -\frac{e^{v_M}(1-p_M)}{e^{v_M} - e^{v_R}} - \frac{e^{v_M}[e^{v_R}(1-p_R) - e^{v_M}(1-p_M)]}{(e^{v_M} - e^{v_R})^2} < 0.$$

The first component is strictly negative, since $v_M, p_M \in (0,1)$ and $v_M > v_R$. The second component is strictly positive, since e^{v_M} is strictly positive and from Lemma 3, the numerator is also strictly positive. So $\frac{\partial}{\partial v_M}\bar{w} < 0$. Finally for similar reasoning,

$$\frac{\partial}{\partial v_R}\bar{w} = \frac{e^{v_R}(1-p_R)}{e^{v_M} - e^{v_R}} + \frac{e^{v_R}[e^{v_R}(1-p_R) - e^{v_M}(1-p_M)]}{(e^{v_M} - e^{v_R})^2} > 0.$$

□

The intuition is straightforward. As the price of the main university p_M or the value of the regional campus v_R increases, the relative utility of the main university M relative to the regional campus R decreases, so more students will prefer R. Conversely, as the value of the main university v_M of price of the regional campus p_R increases, the opposite occurs.

Next, recall that from Proposition 4, the first-time cut-off for the regional campus R in the affiliated environment is

$$a_R^{**} = \frac{(\bar{w} - \underline{w}) + (1-\bar{w})a_M^{**} - \kappa_R}{1-\underline{w}},$$

where κ_R is capacity at the regional campus R and $\underline{w}$ is the lower affiliated wealth cut-off which determines if a student initially prefers the regional campus R over the community college C: a student i prefers R over C if and only if $w_i \geq \underline{w}$. A student i who applies to R is accepted if $a_i \geq a_R^{**}$. Comparative statics follow:

Corollary 7. *Let Conditions 1 and 4 on the wealth cut-offs and Condition 2 on selectivity at M hold. Also, let $\kappa_R > (\bar{w} - \underline{w})(1 - a_M^{**})$ and $\kappa_C > \underline{w}(1 - a_R^{**})$. a_R^{**} is increasing in $\bar{w}$ and a_M^{**}, and decreasing in $\underline{w}$ and κ_R.*

Proof.

$$
\begin{aligned}
\frac{\partial}{\partial \bar{w}} a_R^{**} &= \frac{1-a_M^{**}}{1-\underline{w}} > 0, \\
\frac{\partial}{\partial \underline{w}} a_R^{**} &= \frac{(a_M^{**}-1)(1-\bar{w})-\kappa_R}{(1-\underline{w})^2} < 0 \\
\frac{\partial}{\partial a_M^{**}} a_R^{**} &= \frac{1-\bar{w}}{1-\underline{w}} > 0, \\
\frac{\partial}{\partial \kappa_R} a_R^{**} &= -\frac{1}{1-\underline{w}} < 0.
\end{aligned}
$$

since $\bar{w}, \underline{w}, a_M^{**}, \kappa_R \in (0,1)$. □

As the upper affiliated wealth cut-off $\bar{w}$ increases, more students prefer the regional campus R over the main campus M; this increases selectivity at R due to increased competition for enrollment at R. An increase in the first-time cut-off at the main university a_M^{**} has a similar effect. Conversely, as the lower affiliated wealth cut-off $\underline{w}$ increases, more students prefer the community college C over R; this decreases selectivity at R. An increase in capacity at the regional campus κ_R has a similar effect.

Also from Proposition 4, the first-time cut-off for the community college C in the affiliated environment is

$$a_C^{**} = \bar{w} + (1-\bar{w})a_M^{**} - \kappa_R - \kappa_C,$$

where κ_C is capacity at C. A student i who applies to C is accepted if $a_i \geq a_C^{**}$. Comparative statics follow:

Corollary 8. *Let Conditions 1 and 4 on the wealth cut-offs and Condition 2 on selectivity at M hold. Also, let $\kappa_R > (\bar{w} - \underline{w})(1 - a_M^{**})$ and $\kappa_C > \underline{w}(1 - a_R^{**})$. a_C^{**} is increasing in $\bar{w}$ and a_M^{**}, and decreasing in κ_R and κ_C.*

The math is straightforward so is omitted. The first-time affiliated cut-off at the community college a_C^{**} is increasing in the upper affiliated wealth cut-off $\bar{w}$. As $\bar{w}$ increases, more students initially prefer the regional campus R over the main university M, which has an indirect enrollment effect on the community college C. R is able to enroll a more academically prepared student body (due to more students initially preferring R), and this implies students who were previously marginally accepted at R must instead enroll at C, which causes academic preparedness to also increase at C. An increase in the first-time cut-off at the main university a_M^{**} has a similar effect. Finally, a_C^{**} is decreasing in capacities at the regional campus and community college, κ_R and κ_C, which is straightforward: as R increases capacity, we know from Corollary 7 that R becomes less selective and will enroll some students who previously had to enroll at C. This indirectly causes C to also become less selective. If κ_C increases, then C enrolls students who were previously marginally inadmissible and lowers selectivity.

C Full Welfare Analysis

As a brief reminder, I consider in Section 4 whether a state policymaker who is positive assortative in matching students to institution prefers to expand the main university M or open a regional campus R. Here, I show the details of welfare changes in the latter case. I consider the welfare analysis in subgroups, first based on the student's level of academic preparedness (which determines where she can enroll), and then by wealth endowment (which determines her preference over institutions). Recall that under Conditions 1 and 4 on the wealth cut-offs, $\bar{w} > \hat{w} > \underline{w}$, and students with wealth $w \in [\bar{w}, 1]$ always most prefer the main university M, students with wealth $w \in [\hat{w}, \bar{w})$ most prefer M in the unaffiliated environment but most prefer the regional campus R in the affiliated environment, students with $w \in [\underline{w}, \hat{w})$ most prefer the community college C in the unaffiliated environment but most prefer R in the affiliated environment, and students with $w \in [0, \underline{w})$ always most prefer C. Also recall that for this welfare analysis, I assume that $a_M^{**} = a_M^* > a_T^{**} > a_T^* > a_{Min} > a_R^{**} > a_C^* > a_C^{**}$.

Group 1. Students with $a \in [a_M^{**}, 1]$. These students are accepted at all institutions as both a first-time and transfer applicant.

1. $w \in [\bar{w}, 1]$: Students always most prefer and enroll at M as a first-time student. There are no changes in welfare.

2. $w \in [\hat{w}, \bar{w})$: In the unaffiliated environment, these students most prefer and enroll at M as a first-time student. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting loss in welfare is:

$$B_1^R = \frac{1}{2}(\bar{w} - \hat{w})(1 - (a_M^*)^2)(b_R - b_M) < 0.$$

3. $w \in [\underline{w}, \hat{w})$: In the unaffiliated environment, these students most prefer and enroll at C as a first-time student, and a fraction δ transfer to M. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting change in welfare is:

$$B_2^R = \frac{1}{2}(\hat{w} - \underline{w})(1 - (a_M^*)^2)\underbrace{(b_M \cdot \delta + (1 - \delta) - b_R)}_{\text{Ambiguous sign}}.$$

4. $w \in [0, \underline{w})$: Students always enroll at C as a first-time student, and a fraction δ always transfer to M. There are no changes in welfare.

Group 2. Students with $a \in [a_T^{**}, a_M^*)$. These students are accepted at both R and C as first-time students, and can always transfer to M.

1. $w \in [\bar{w}, 1]$: Students always most prefer M, but cannot enroll there as a first-time student. Regardless of environment, they always successfully transfer to M. There are no changes in welfare.

2. $w \in [\hat{w}, \bar{w})$: In the unaffiliated environment, these students most prefer M but must enroll at C as a first-time student, and always successfully transfer. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting loss in welfare is:

$$B_3^R = \frac{1}{2}(\bar{w} - \hat{w})((a_M^*)^2 - (a_T^{**})^2)(b_R - b_M) < 0.$$

3. $w \in [\underline{w}, \hat{w})$: In the unaffiliated environment, these students most prefer and enroll at C as a first-time student, and a fraction δ transfer to M. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting change in welfare is:

$$B_4^R = \frac{1}{2}(\hat{w} - \underline{w})((a_M^*)^2 - (a_T^{**})^2)\underbrace{(b_M \cdot \delta + (1 - \delta) - b_R)}_{\text{Ambiguous sign}}.$$

4. $w \in [0, \underline{w})$: Students always enroll at C as a first-time student, and a fraction δ always transfer to M. There are no changes in welfare.

<u>Group 3.</u> Students with $a \in [a_T^*, a_T^{**})$. These students are accepted at both R and C as first-time students. In the unaffiliated environment, students at C can transfer. In the unaffiliated environment, students at R can transfer, but students at C cannot.

1. $w \in [\bar{w}, 1]$: Students always most prefer M, but cannot enroll there as a first-time student. Regardless of environment, they always successfully transfer to M. There are no changes in welfare.

2. $w \in [\hat{w}, \bar{w})$: In the unaffiliated environment, these students most prefer M but must enroll at C as a first-time student, and always successfully transfer. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting loss in welfare is:

$$B_5^R = \frac{1}{2}(\bar{w} - \hat{w})((a_T^{**})^2 - (a_T^*)^2)(b_R - b_M) < 0.$$

3. $w \in [\underline{w}, \hat{w})$: In the unaffiliated environment, these students most prefer and enroll at C as a first-time student, and a fraction δ transfer to M. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting change in welfare is:

$$B_6^R = \frac{1}{2}(\hat{w} - \underline{w})((a_T^{**})^2 - (a_T^*)^2)\underbrace{(b_M \cdot \delta + (1 - \delta) - b_R)}_{\text{Ambiguous sign}}.$$

4. $w \in [0, \underline{w})$: Students always enroll at C as a first-time student. A fraction δ transfer to M in the

unaffiliated environment, but cannot transfer in the affiliated environment. The resulting loss in welfare is:

$$B_7^R = \frac{1}{2}\underline{w}((a_T^{**})^2 - (a_T^*)^2)(1 - b_M)\delta < 0.$$

<u>Group 4.</u> Students with $a \in [a_{Min}, a_T^*)$. These students are accepted at both R and C as first-time students. Students at R can transfer to M, while students at C cannot.

1. $w \in [\bar{w}, 1]$: Students always most prefer M, but cannot enroll there as a first-time student. In the unaffiliated environment, they enroll at C and cannot transfer. In the affiliated environment, they enroll at R and successfully transfer to M. The resulting increase in welfare is:

$$B_8^R = \frac{1}{2}(1 - \bar{w})((a_T^*)^2 - (a_{Min})^2)(b_M - 1) > 0.$$

2. $w \in [\hat{w}, \bar{w})$: In the unaffiliated environment, these students most prefer M but must enroll in C as a first-time student, and cannot transfer. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting increase in welfare is:

$$B_9^R = \frac{1}{2}(\bar{w} - \hat{w})((a_T^*)^2 - (a_{Min})^2)(b_R - 1) > 0.$$

3. $w \in [\underline{w}, \hat{w})$: In the unaffiliated environment, these students most prefer and enroll at C as a first-time student, and cannot transfer. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting increase in welfare is:

$$B_{10}^R = \frac{1}{2}(\hat{w} - \underline{w})((a_T^*)^2 - (a_{Min})^2)(b_R - 1) > 0.$$

4. $w \in [0, \underline{w})$: Students always enroll at C as a first-time student and cannot transfer. There are no changes in welfare.

<u>Group 5</u>. Students with $a \in [a_R^{**}, a_{Min})$. These students are accepted at both R and C as first-time students, and can never transfer.

1. $w \in [\bar{w}, 1]$: Students always most prefer M, but cannot enroll there as a first-time student. In the unaffiliated environment, they enroll at C and cannot transfer. In the affiliated environment, they enroll at R and cannot transfer. The resulting increase in welfare is:

$$B_{11}^R = \frac{1}{2}(1 - \bar{w})((a_{Min})^2 - (a_R^{**})^2)(b_R - 1) > 0.$$

2. $w \in [\hat{w}, \bar{w})$: In the unaffiliated environment, these students most prefer M but must enroll in C as a

first-time student, and cannot transfer. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting increase in welfare is:

$$B_{12}^{R} = \frac{1}{2}(\bar{w} - \hat{w})((a_{Min})^2 - (a_R^{**})^2)(b_R - 1) > 0.$$

3. $w \in [\underline{w}, \hat{w})$: In the unaffiliated environment, these students most prefer and enroll at C as a first-time student, and cannot transfer. In the affiliated environment, they most prefer and enroll at R as a first-time student and will not apply to transfer. The resulting increase in welfare is:

$$B_{13}^{R} = \frac{1}{2}(\hat{w} - \underline{w})((a_{Min})^2 - (a_R^{**})^2)(b_R - 1) > 0.$$

4. $w \in [0, \underline{w})$: Students always enroll at C as a first-time student and cannot transfer. There are no changes in welfare.

<u>Group 6</u>. Students with $a \in [a_C^{*}, a_R^{**})$. These students are only accepted at C as first-time students in both environments, and can never transfer. There are no changes in welfare for this group.

<u>Group 7.</u> Students with $a \in [a_C^{**}, a_C^{*})$. These students are only accepted at C as first-time students in the affiliated environment, and can never transfer. The resulting gain in welfare is:

$$B_{14}^{R} = \frac{1}{2}((a_C^{*})^2 - (a_C^{**})^2) > 0.$$

<u>Group 8.</u> Students with $a \in [0, a_C^{**})$. These students are never enrolled. There are no changes in welfare for this group.

Putting it altogether, the certain welfare gains from opening a regional campus are

$$\begin{aligned} B_{Gain}^{R} = \frac{1}{2}[&(1 - \bar{w})((a_T^{*})^2 - (a_{Min})^2)(b_M - 1) + \\ &(\bar{w} - \underline{w})((a_T^{*})^2 - (a_{Min})^2)(b_R - 1) + \\ &(1 - \underline{w})((a_{Min})^2 - (a_R^{**})^2)(b_R - 1) + ((a_C^{*})^2 - (a_C^{**})^2)], \end{aligned}$$

the certain welfare losses are

$$B_{Loss}^{R} = \frac{1}{2}[(\bar{w} - \hat{w})(1 - (a_T^{*})^2)(b_R - b_M) + \underline{w}((a_T^{**})^2 - (a_T^{*})^2)(1 - b_M)\delta],$$

and ambiguous welfare effects are

$$B_{Ambig}^{R} = \frac{1}{2}(\hat{w} - \underline{w})(1 - (a_T^{*})^2)(b_M \cdot delta + (1 - \delta) - b_R)).$$