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The Competitive Effects of Online Education

David J. Deming, Michael Lovenheim,
and Richard Patterson

Online education is an increasingly important component of the US higher education landscape. In 2014, one in three college students attending degree-granting US institutions took at least one course online (Allen and Seaman 2015). Millions of students from all over the world also have enrolled in massive open online courses (MOOCs) offered in partnership with major research universities such as Harvard, MIT, and Stanford (Ho et al. 2014; McPherson and Bacow 2015; Waldrop 2014). By 2012, more than 6 percent of all US bachelor's degrees were awarded online (Deming et al. 2016). The rapid rise of online course offerings and degrees has led to predictions that competition from MOOCs and other online course offerings will lead to "disruptive innovation" in higher education (e.g., Christensen and Eyring 2011; Cowen and Tabarrok 2014). While there is a growing body of research examining student outcomes among those enrolling in online degree programs or courses (Bettinger et al. 2017; Deming et al. 2016), no prior work has estimated the impact of this change in higher education markets on brick-and-mortar schools.

The exuberance over MOOCs and other high-profile online offerings obscures the fact that most of the growth in online higher education has been

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among the least selective institutions, especially for-profit colleges (Deming, Goldin, and Katz 2012). In 2013, selective institutions accounted for only about 2 percent of enrollment in fully online programs, compared to 33 percent in the for-profit sector (Deming et al. 2015).[1] Online for-profits spend very little per student and are viewed less favorably by employers than nonselective brick-and-mortar schools of all types (Deming et al. 2016).

For public institutions, the allure of online education lies in its potential to cut costs in a time of declining state support and tightening budgets (Bowen et al. 2014). Yet cost savings from larger classes and less student-faculty contact may cause instructional quality to suffer, and high-quality online courses are—at least at the time of writing—equally or even more expensive to develop and staff than in-person courses (McPherson and Bacow 2015).[2]

In this chapter, we ask whether online degree programs can improve educational productivity by exerting competitive pressure on traditional brick-and-mortar institutions. How might competition from online providers affect the market for higher education? In a well-functioning marketplace, the new availability of a cost-saving technology should increase efficiency, because colleges compete with each other to provide the highest quality education at the lowest price. The market for selective colleges is increasingly geographically integrated, and these colleges compete fiercely on the quality margin (Clotfelter 1999; Hoxby 1997, 2009). In contrast, the vast majority of students in nonselective colleges attend school close to their homes and in their home states. In 2013, 39.3 percent of students at selective colleges were from out of state, compared to just 13.8 percent of students in less-selective four-year schools and only 5.6 percent in community colleges.

In principle, local education markets can still be competitive. However, there are a few reasons to suspect that many are not. First, public colleges and universities are heavily subsidized by state and local governments and face political pressure to keep tuition low. Prices at public institutions are often set below marginal cost, which drives out private competitors who are not receiving such subsidies. Second, for political and historical reasons, public institutions are often located in communities that are not populous enough to support private competitors.

As a result of the uneven geographic dispersion of postsecondary schools and the high probability that students enrolling in nonselective schools attend close to home, nonselective public institutions in less-dense areas either are local monopoly providers of education or have considerable

1. We define selective institutions as those that received a rating of Most Competitive, Highly Competitive, or Very Competitive according to the 2009 Barron's Profile of American Colleges.

2. Several recent studies conducted by a wide variety of institutions find that online course-taking reduces student learning and lowers persistence through college (Figlio, Rush, and Yin 2013; Xu and Jaggars 2013; Hart, Friedmann, and Hill 2014; Streich 2014; Bettinger et al. 2017). Bowen et al. (2014) compare student performance in a fully online statistics course to a hybrid version across six different public research universities and find no difference in learning.

market power. Online education has the potential to disrupt these local monopolies by introducing competition from alternative providers that do not require students to leave home to attend. The impact of competition from online providers will depend on the degree of monopoly power held by incumbents as well as the extent to which students are willing to substitute online and in-person programs.

We analyze the impact of increases in prevalence and market share of online institutions on student outcomes and institutional behavior at traditional brick-and-mortar schools. Studying the impact of competitive pressure from online institutions on local education markets is inherently difficult for two reasons. First, competitive pressure is challenging to measure directly, especially since there are sparse data on online degree programs offered by traditional brick-and-mortar schools. Second, it is difficult to isolate the impact of competition from online institutions from other changes affecting the market for higher education, because online degree programs by their nature are available everywhere at the same time.

We address these challenges by exploiting a 2006 change in the federal regulation of online education called the 50 percent rule. As we discuss later, this regulatory change allowed institutions to specialize in the provision of online degrees and dramatically lowered barriers to entry into online education. Deming et al. (2015) show that the median price of an online degree dropped by 34 percent between 2006 and 2013, suggesting that online degree providers were competing with each other for students. While the regulatory change was national, we argue that it should affect local education markets differently depending on their level of competitiveness prior to 2006.

We measure competitiveness using the Herfindahl index, a standard measure of market concentration. High values of the Herfindahl index indicate that postsecondary enrollment is concentrated in a small number of institutions that are likely to enjoy monopoly power. We compare changes before and after 2006 in enrollment, prices, and other outcomes in markets with more or less market concentration using a generalized differences-in-differences framework. We define education "markets" as the metropolitan statistical areas (MSAs) or as counties if an area is not in an MSA. Finally, we calculate a Herfindahl index as of the year 2000, which predates the spread of online education.

Our results generally align with theoretical predictions of how schools should react to increased competition. We find that the impact of online competition on enrollment, prices, and educational resources is greater in markets where enrollment was more highly concentrated prior to 2006. A one-standard-deviation increase in the Herfindahl index is associated with a post-2006 enrollment decline of about 2 percent and an increase in per-student instructional expenditures of about 1.8 percent. The impacts on enrollment are largest among not-for-profit and for-profit private institutions. Finally, we show that the impacts of online competition are larger in smaller markets and are concentrated among less-selective institutions.

Online competition shifts resources toward instructional expenditures. Overall, a one-standard-deviation increase in the Herfindahl index post-2006 raises per-student instructional expenditures by 1.8 percent. This effect is largest in the public sector and among four-year schools. In the private and two-year sectors, there is no increase in per-student instructional spending, but these institutions do experience a decline in revenues per student. These declines likely are driven by enrollment decreases from increased online competition. Thus, two-year and private colleges experience a relative shift toward instructional expenditures, which are held constant in the face of declining overall resources.

Taken together, our results suggest that public and private institutions respond differently to online competition. We find little change in enrollment or resources for public institutions, but both enrollment and total resources decline in private institutions that compete with online degree programs. Schools in both sectors spend relatively more on instruction due to competition from online schools. The shifting of resources toward instruction may be a competitive response intended to stave off further enrollment losses. While we are unable to directly test why public and private institutions respond differently to competition, one possibility is that students perceive online options as closer substitutes for less-selective private schools than for public schools. The fact that public schools respond to online competition even when their enrollments do not substantially decline suggests an important role for competitive *pressure* in driving responses to online degree programs.

We examine the effect of online competition on tuition prices as well. Our tuition analysis is restricted to private schools because public school tuition is heavily subsidized and is unlikely to reflect market forces. Somewhat contrary to expectations, we find that online competition increases average tuition, particularly in the private four-year sector, and that it is associated with increased tuition dispersion, especially in the private two-year sector. One possible explanation is that tuition increases are a response to revenue losses associated with enrollment reductions from online competition. Additionally, most online institutions are for-profits that charge high prices and serve students who are heavily subsidized by federal Title IV financial aid. If students do not face the full cost of their education when making enrollment decisions, quality competition may be more salient than price competition.

A second approach we take to identifying the competitive effects of online education programs is to use the differential spread of internet availability across states (Goolsbee, Lovenheim, and Slemrod 2010). Since online enrollment requires access to the internet, competitive pressures from online schools should be greater in areas with more internet access. A drawback of this approach is that we only have comprehensive internet penetration data at the state level, which necessitates defining education markets in a more aggregated manner.[3]

Similar to the market concentration analysis, we adopt a difference-in-differences strategy to examine how postsecondary outcomes change in states with different post-2006 rates of internet penetration. Our findings are broadly consistent with those from the market power analysis: internet penetration growth post-2006 is associated with decreased log enrollment and higher per-student instructional expenditures.

Overall, our results suggest that there may be important general equilibrium effects of online degree programs on the market for higher education. Hoxby (1997) studies how declining transportation costs and increased sharing of information and standardized testing led to geographic integration of the market for higher education over the last several decades. Those changes were most consequential for elite colleges, which increasingly compete in a national market for students. This chapter fits into the broader literature on the industrial organization of higher education by studying the impact of a technological change—online education—on less-selective, mostly open-access postsecondary institutions. Like Hoxby (1997), our results suggest that the geographic integration of higher education markets may lead to efficiency gains as institutions compete with each other for students. However, these gains accrue predominantly to students attending traditional postsecondary institutions and need to be balanced with the worse outcomes associated with online educational options.

8.1 A Brief History of Online Education in the United States

Long before the internet, distance education took the form of correspondence courses that delivered lessons by mail, radio, and television. US colleges and universities such as University of Maryland University College (UMUC) and the University of Wisconsin-Extension have been offering correspondence courses in some form for nearly a hundred years.

Fully online degrees were developed in the mid-1990s, when dial-up internet started to become available for commercial use. Early examples of such programs include CALCampus and Western Governors University. The first postsecondary institution to open an online campus was the University of Phoenix, which enrolled more than 1,200 students in the 1994–95 academic year, according to data from the US Department of Education Integrated Postsecondary Education Data System (IPEDS).

3. Dettling, Goodman, and Smith (2018) examine the effect of high-speed internet on college application behavior using Federal Communications Commission data on the number of county-level broadband internet service providers. These data are only available through 2008 but allow substate variation. We have analyzed our models using these data, but with only two years of post-2006 observations, the estimates are imprecise. Furthermore, we show below that most of our results are driven by the 2009–13 period, which is missed by these data.

The for-profit sector moved relatively slowly into online education. By 2000, only a handful of for-profits had online degree programs at all. One reason was technological—in 2000 only 37 percent of Americans had internet connections at home, and only 3 percent had high-speed broadband access (Pew Charitable Trusts 2016). By 2005, more than 60 percent of Americans had internet access, and broadband access grew 11-fold to 33 percent.

Regulatory restrictions also played an important role in the growth of online degree programs. The Higher Education Act (HEA) of 1992 required that schools distributing federal Title IV aid have no more than 50 percent of total student course time spent in distance education (the 50 percent rule). The rule was interpreted broadly to include mail-in correspondence courses as well as online degree programs.

The 50 percent rule did not prevent schools from offering online degrees, but it did limit market entry by effectively requiring all institutions to enroll one student in person for every student enrolled online. Specialized online schools could not exist under the 50 percent rule. The 1998 HEA created the Distance Education Demonstration Program (DEDP), a pilot program that allowed waivers of the 50 percent rule for selected institutions. Notable participants included the University of Phoenix, Capella University, and Western Governors University. Online enrollment grew rapidly among DEDP participants between 1998 and 2005, and in February 2006, the Higher Education Reconciliation Act (HERA) eliminated the 50 percent rule.

These regulatory changes had a large impact on enrollments in online programs. IPEDS only began tracking online enrollment directly in 2013, but the data are collected at the campus branch level. This makes it possible to measure enrollment at individual branches of "chain" institutions with multiple campuses, such as the University of Phoenix. We estimate online enrollment using the method outlined in Deming, Goldin, and Katz (2012), which classifies a school campus as online if it has the word *online* in its name or if no more than 33 percent of the school's students are from one US state. This is a conservative measure of online enrollment because many schools offer online degree programs through their in-person branches (see Deming, Goldin, and Katz 2012 for more details). Figure 8.1 plots estimated yearly enrollment in online degree programs using this method and shows the significant rise in these types of programs in the early to mid-2000s.

Figure 8.1 further divides online enrollment into two categories: (1) campuses with a significant but not complete online presence and (2) campuses or entire institutions that are online only.[4] Between 2000 and 2006, online

4. The first category includes central branches of "chain" for-profit institutions where online students from across the country are likely to be assigned. For example, in 2009 DeVry University operated 26 campus branches across the United States. The Illinois branch had an enrollment of 24,624, which was more than three times larger than the next largest branch and about 40 percent of total enrollment in DeVry. While some of these students were enrolled in

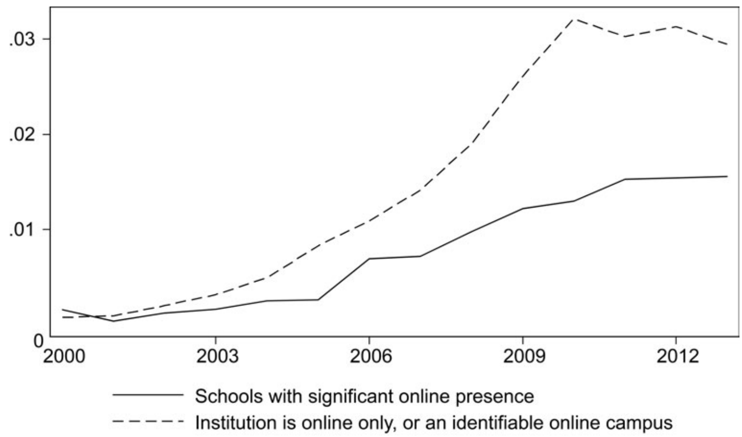

Fig. 8.1 Increasing specialization of online degree programs: Share of total US enrollment in online degree programs by year
Source: Integrated Postsecondary Education Data System (IPEDS).

institutions grew from essentially zero to about 1.75 percent of all US postsecondary enrollments. This growth was modestly larger for specialized online campuses.

In the four years following the end of the 50 percent rule, online schools grew from 1.75 to 4.5 percent of all US enrollment. Online-only campuses and institutions accounted for about 2.1 percentage points of this increase, or about 75 percent of the growth in online enrollment over the 2006–10 period. Moreover, the number of institutions satisfying our definition of *online* grew from 13 in 2004 to 24 in 2006 to 39 in 2010. These trends suggest that the market for online education grew rapidly and became significantly more competitive after 2006.

8.2 How Might Online Degrees Affect Higher Education Markets?

Online institutions affect local education markets by increasing competitive pressure. Students who previously had only a limited set of choices (or perhaps no choice at all) now can choose to enroll in online institutions instead. This increase in the number of options available to students means that local colleges and universities no longer have monopoly power and must compete for students. Thus, the impact of online institutions should be proportional both to the amount of prior market power of local institutions

the in-person Illinois branch, most were enrolled online. In contrast, University of Phoenix has a separate online campus that enrolled more than 300,000 students—about 77 percent of total University of Phoenix enrollment—in 2009. Other schools, such as Ashford University and Capella University, have only a single campus branch at which nearly everyone is enrolled online.

and to the substitutability between local nonselective schools and online degree programs.

We focus on the impact of increased competitive pressure from online schools on enrollment and resource allocation among traditional postsecondary institutions. While no prior work has examined this question, the topic relates closely to existing research on the competitive effects of K–12 school choice. A sizable body of research examines how school choice policies affect resource levels and distribution in traditional public schools (Cook 2018; Hoxby 2000, 2003; Jackson 2012). While these chapters find that elementary and secondary schools respond to competitive pressures by changing educational inputs, the direction and magnitude of effects tend to vary.

Competition in the postsecondary market has many similarities to competition in the elementary and secondary markets, although it is different in three important ways. First, postsecondary schools charge tuition. Thus, unlike with K–12 school choice, there is a price mechanism that can act to clear the market. Of course, most colleges and universities receive substantial state subsidies, and financial aid weakens the relationship between posted tuition and what students actually pay, but the fact that postsecondary schools—and in particular, private schools—can compete over prices differentiates this setting from choice in K–12 markets.

Second, institutions of higher education have broader purposes than K–12 schools. An elementary or secondary school's main objective is to increase student learning in a small set of academic subjects. Colleges and universities also aim to increase student learning, but they focus on a wider variety of subjects. Moreover, they aim to produce knowledge in the form of research. Higher education markets therefore are more horizontally differentiated than their K–12 counterparts. Colleges with different objectives and different student bodies are unlikely to compete with each other. This is a key reason we focus on nonselective schools, which offer a relatively homogenous product in a standard fee-for-service model (Hoxby 2014).

Third, nonattendance is usually not an option in the K–12 setting. In contrast, since people are not required to attend college, market entry of online degree programs might increase total postsecondary enrollment. This could happen through a direct effect of increasing access to college but also indirectly: if competition increases the quality of education offerings, more students might be pulled into higher education.

The structure of higher education markets gives rise to several predictions, which we test empirically below. Our first prediction is that the impact of competition from online degree programs on enrollment will be greater in markets where enrollment is more concentrated in a small number of institutions. This is because in the absence of outside competitors, local institutions with monopoly power will generally be providing a lower-quality education for the price.

Our second prediction is that online degree programs should increase price competition and reduce economic rents for schools with monopoly power. Given that prices at public institutions are only weakly market driven at best, we might expect price competition to be most important for private institutions. If institutions compete primarily over price, then the introduction of a common (online) option should lead to a decline in the variance of tuition prices across local education markets. Again, this effect should be larger for private institutions.

Finally, we might also expect competitive pressure to lead to changes in institutional resource allocation, such as increased spending on instruction and/or student support services. The predicted effects for tuition and resources are linked: schools can compete on both prices and quality, but they might not do so equally. If competition is mainly over quality, the level and variance of tuition prices actually could increase. This might occur in an environment where tuition is subsidized by financial aid, making the actual prices faced by prospective students less salient. Thus, how postsecondary schools will respond to heightened competition is determined in part by the factors over which they compete.

8.3 Data

8.3.1 Main Analysis Data

Our main source of institutional data for this study is IPEDS, which contains institution-level information on enrollment, posted tuition prices, revenues, expenditures, and educational resources for all US postsecondary institutions that distribute federal Title IV financial aid (Pell Grants and Stafford Loans). We collected IPEDS data at the institution-year level for years 1990–2013.[5] Our analysis is mostly restricted to the years 2000–2013, which provides several years in which online degree program prevalence was low and also insulates us from biases related to many changes in how IPEDS measures core variables of interest in the 1990s. Using 2000 as our base year allows us to obtain market concentrations that are not affected by online degree programs but that are recent enough to accurately reflect market power in later years.

It is important to distinguish selective from nonselective institutions in our context because selective schools are much more geographically integrated, which means they have considerably less geographic market power (Hoxby 2009, 2014). In 2000, 44.3 percent of first-time freshmen in selective four-year institutions were from out of state, compared to only 15.2 percent in less-selective four-year public schools and 7.5 percent in community col-

5. We refer to school years by the calendar year of the spring term. For example, we refer to school year 2012–13 as 2013.

leges. Additionally, most online programs are open enrollment—very few practice selective admissions.[6] As a result, schools that have selective admissions policies are unlikely to be in direct competition with online degree programs. We therefore focus on less selective and nonselective institutions that serve highly local markets, which we define as any institution that has a rating of Most Competitive, Highly Competitive, or Very Competitive according to the 2009 Barron's Profile of American Colleges.

The main variables of interest in this study are enrollment, in-state tuition charges, per-student revenues, total expenditures per student, and instructional expenditures per student. The IPEDS revenue and expenditure data contain outliers that are likely to reflect measurement error and that can cause undue influence on mean estimates. We therefore winsorize these variables by cutting the top and bottom 1 percent of revenues, expenditures, and instructional expenditures per student.[7] Table 8.1 shows means and standard deviations of the outcome variables we employ in this study, both overall and by institution type. The means generally conform to expectations, with four-year and private institutions having higher per-student revenues and expenditures than their public and two-year counterparts. Furthermore, public institutions are much larger and charge lower tuition than private colleges and universities. Because we focus on nonselective institutions, our sample is composed of 8,782 schools, about one-third of which are public and a little over half of which are four-year.

8.3.2 Measuring Market Concentration

There is little reason to expect that the distribution of public institutions across metropolitan areas reflects a competitive equilibrium. While private colleges may enter markets endogenously in response to potential profit opportunities, the location of public institutions largely reflects historical and political factors. There has been almost no new entry of public colleges or universities in the United States over the last 25 years. Many public institutions are located in nonurban areas that would not otherwise support a market for higher education—for example, in 2013, 18 percent of nonselective public enrollment was in nonurban areas, compared to only 8 percent for private nonselective institutions.

The uneven distribution of colleges and universities across areas in the United States drives heterogeneity in the competitive effects of online postsecondary programs. To measure local market power, we first define a postsecondary market as the MSA in which a school is located. If a school is not located in an MSA, we define the market as the county. This definition

6. In our data, only one online-only institution reports practicing selective admissions—Grand Canyon University.

7. Winsorizing the data in this way has little impact on the log estimates but does affect the level estimates as expected. Results using the full sample are available from the authors upon request.

Table 8.1 Descriptive statistics of analysis variables

Variable	Full sample	Public institutions	Private institutions	Four-year institutions	Two-year institutions
Nonselective Herfindahl index	0.312	0.453	0.249	0.284	0.327
	(0.309)	(0.363)	(0.257)	(0.292)	(0.316)
Public Herfindahl index	0.404	0.539	0.342	0.370	0.423
	(0.322)	(0.355)	(0.286)	(0.308)	(0.329)
Private Herfindahl index	0.290	0.376	0.261	0.285	0.293
	(0.294)	(0.332)	(0.274)	(0.298)	(0.292)
No public Herfindahl index	0.013		0.019	0.023	0.008
	(0.115)		(0.137)	(0.151)	(0.087)
No private Herfindahl index	0.024	0.078		0.014	0.030
	(0.154)	(0.268)		(0.119)	(0.170)
Total enrollment	2,337	5,769	816	3,292	1,799
	(5,669)	(7,465)	(3,763)	(7,170)	(4,528)
Log total enrollment	6.218	7.719	5.553	6.994	5.782
	(1.847)	(1.728)	(1.470)	(1.583)	(1.842)
In-state tuition	11,064	4,161	14,384	13,959	9,694
	(7,658)	(2,848)	(7,001)	(8,318)	(6,915)
Log in-state tuition	9.018	8.094	9.463	9.342	8.865
	(0.866)	(0.742)	(0.487)	(0.680)	(0.902)
Revenues per student	18,058	15,227	19,332	23,126	15,057
	(19,167)	(20,347)	(18,470)	(21,834)	(16,686)
Expenditures per student	16,359	13,302	17,737	21,132	13,516
	(16,469)	(17,204)	(15,936)	(18,531)	(14,373)
Instructional expenditures per student	6,062	5,512	6,310	7,112	5,437
	(5,933)	(6,146)	(5,818)	(6,326)	(5,593)
Number of institutions	8,782	2,176	6,606	3,077	5,705
Number of observations	88,249	27,090	61,159	28,679	50,788

Source: 2000–2013 IPEDS data as described in the text. All Herfindahl indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Each cell shows the mean for each variable with the standard deviation directly following in parentheses.

presumes that students have more options in cities and can easily move across counties within the city to enroll. In less-urban areas, the local schooling option is typically the community college or the nonselective four-year school located in one's county.

As stated earlier in the chapter, our measure of market concentration is the Herfindahl index of enrollment shares. The Herfindahl index is a measure of the extent to which enrollment is spread out evenly among many postsecondary schools or whether it is concentrated in one or only a couple of schools. It is preferable to raw counts of the number of different types of schools because it takes into account the size of enrollment at each local college; a small school affects local competition less than a larger one. Formally, the Herfindahl index is the sum of squared enrollment shares across colleges within a market:

$$H_j = \sum_{i=1}^{N_j} E_{ij}^2,$$

where E_{ij} is the enrollment share in institution i in market j and N_j is the total number of postsecondary institutions in market j; $H \in [0,1]$, with values closer to 1 indicating less competition (i.e., more concentrated enrollment).

We calculate Herfindahl indices using 2000 enrollment data for all nonselective schools in a market as well as separately by level (two-year, four-year) and control (public, private). Thus H_j is a fixed characteristic of the market that does not change over time. Table 8.1 provides means of Herfindahl indices. The mean Herfindahl index value is about 0.31. However, the standard deviation is also about 0.31, suggesting that there is significant variation in college concentration across markets.[8] Private schools on average have less market power, with a mean Herfindahl index of 0.29. Table 8.1 also shows that for a small number of local markets, sector-specific Herfindahl indices cannot be calculated because there was no school of that type in the market in 2000.

Table 8.1 includes tabulations separately for public and private institutions as well as for two-year and four-year schools. Public institutions and community colleges tend to be located in markets in which there is more market power.[9] Across school types, there is in general much less competition from public institutions than from private institutions. This probably reflects endogenous decisions by private institutions to enter markets based on the supply of potential students. We examine below whether there are heterogeneous effects of online competition across the different types of sector-specific market concentration.

Figures 8.2 and 8.3 show the geographic distribution of nonselective market shares by MSA and by county, respectively. In the cases where the counties in figure 8.3 overlap with an MSA in figure 8.2, the MSA is the relevant market. The different shading in figure 8.2 corresponds to quartiles of the Herfindahl index. For counties, more than 40 percent have a Herfindahl index of one. We therefore split counties into terciles of the distribution with an index value less than one and then a category with only single-school counties. As expected, there is much higher market concentration when markets are defined as counties rather than MSAs. The main conclusions from these figures are that there is considerable variation in local market power

8. The US Department of Justice considers a market to be highly concentrated when the Herfindahl index is higher than 0.26, which illustrates the high level of market power in the nonselective higher education market. Appendix figure 8.A1 contains Herfindahl index distributions and highlights the large amount of variation across areas in the amount of market concentration: many areas have a Herfindahl index below 0.1, while a substantial number have an index above 0.25.

9. Appendix figure 8.A1 shows the distribution of the nonselective Herfindahl index for public and private institutions. While the modes of the distributions are similar, there is a much larger mass of public institutions with considerable market power.

Fig. 8.2 Herfindahl indices of nonselective school market share by city
Source: Authors' calculations from 2000 IPEDS. Nonselective schools are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges.

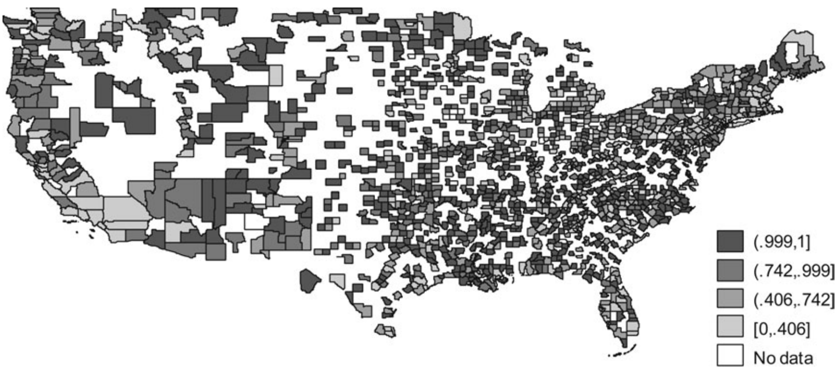

Fig. 8.3 Herfindahl indices of nonselective school market share by county
Source: Authors' calculations from 2000 IPEDS. Nonselective schools are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges.

across space and that there is little geographic clustering of market power. Thus our market power measures are not simply picking up unobserved aspects of higher education markets that are correlated with geographic region or state.

Figures 8.2 and 8.3 also demonstrate that many areas of the country are characterized by a high degree of nonselective market power. Among MSAs, the top quartile has a Herfindahl index above 0.68, and among counties, it is 0.94. In contrast, the bottom quartile of the distribution has little market power, especially among MSAs. Thus, there is much geographic variation in the scope for online postsecondary options to have competitive effects on local higher education markets.

8.3.3 Measuring Internet Penetration Rates

Internet penetration rates are calculated at the state-year level using the Current Population Survey (CPS). Beginning in 1989, the CPS has included

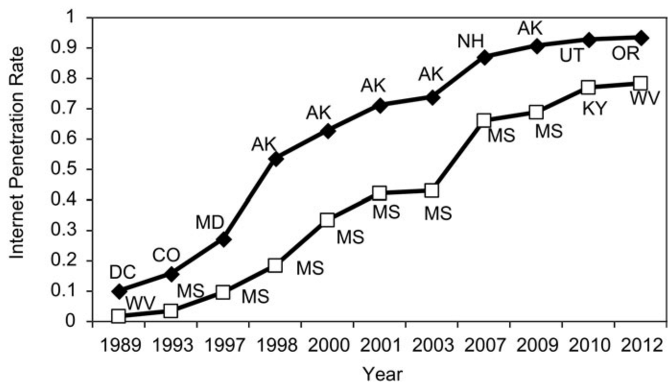

Fig. 8.4 Internet penetration rates

Source: 1989, 1993, 1997, 1998, 2000, 2001, 2003, 2007, 2009, 2010 CPS data as described in the text. The state listed next to each data point shows the state with the highest (diamond) and lowest (square) internet penetration rate in that year.

questions in various forms about internet access and usage. These questions were asked in 1989, 1993, 1997, 1998, 2000, 2001, 2003, 2007, 2009, 2010, and 2012. We follow the approach developed in Goolsbee, Lovenheim, and Slemrod (2010) to construct a state-year panel of internet access rates that accounts for the fact that the wording of the questions changes over time. In 1989 and 1993, a respondent is defined as having internet access if he or she reports having email or a computer with a modem. In the 1997–2003 surveys, we code respondents as having internet access if they respond that they have access to the internet at home, school, or work. Post-2003, the CPS directly asks if respondents have internet access. Between survey years, state-level internet penetration rates are linearly interpolated.

Figure 8.4 contains trends in internet penetration rates between 1989 and 2012 for the highest and lowest internet penetration states in each year. The maximum and minimum states change over time, so the figure also shows which state constitutes each observation. Internet access generally trends upward strongly over this period, but it does so unevenly across states. There hence is significant cross-state variation in the time pattern of internet access. Below, we explore whether this time pattern is related to postsecondary outcomes among nonselective institutions in a state and in particular whether changes in internet penetration rates have differential impacts after 2006, when the supply of online enrollment options increased.

8.4 Empirical Strategy

We first examine how postsecondary outcomes change after 2006 as a function of 2000 market concentrations in a difference-in-difference setting.

In particular, we estimate the following regressions at the institution-year level:

$$(1) \qquad Y_{ismt} = \alpha + \beta_1(H_m \times POST_t^{2006}) + \beta_2 X_{imt} + \delta_i + \theta_{st} + \varepsilon_{ismt},$$

where i indexes institutions, s indexes state, m indexes market (county or MSA) and t indexes year. The variable H_m is the nonselective market Herfindahl index in 2000. We control for time-varying characteristics of markets, such as the market-year unemployment rate, total population, poverty rate, proportion that is black, proportion that is Hispanic, proportion that are veterans, and proportion that is male, and our models also include institution fixed effects (δ_i) and state-by-year fixed effects (θ_{st}). Note that the main effect of H_m is absorbed by the institution fixed effects, since institutions do not move across markets. Standard errors are clustered at the market level throughout.

The coefficient of interest in this equation is β_1, which shows how the relationship between market power (as measured by the Herfindahl index) and postsecondary outcomes changes in 2006 when online programs became more prevalent. Similar to any difference-in-difference design, this approach embeds two main assumptions: (1) schools in markets with different levels of market power would have exhibited similar trends absent the rise of online programs and (2) there are no shocks or policies that occur after 2006 that differentially affect markets with different values of H_m.

We provide evidence of the validity of the first assumption by estimating event studies of the following form:

$$(2) \qquad Y_{ismt} = \alpha + \sum_{j=2000}^{2013} \gamma_j H_m \times I(t = j) + \beta_2 X_{imt} + \delta_i + \theta_{st} + \varepsilon_{ismt}.$$

This model estimates a separate coefficient on H_m in every year, and the coefficients $\gamma_{2000} - \gamma_{2005}$ provide evidence of whether there are differential pre-2006 trends as a function of 2000 market share. Note that our model does not necessarily predict a sharp break in 2006, since online schools were growing in prevalence prior to 2006. However, the 2006 regulatory change sped up the rate of entry of online programs. We therefore expect a shift in how 2000 market shares relate to postsecondary outcomes after 2006, although the exact timing is unclear. Furthermore, there are likely to be some "pretreatment" trends that reflect the rise of online programs prior to 2006.

The second assumption is much more difficult to test. We control for market-year-level observable characteristics to account for any compositional changes across areas that may be correlated with 2000 market shares. Our estimates also include state-by-year fixed effects that account for any state-specific postsecondary policies or state-specific shocks. Additionally, we estimate models using selective colleges and universities, as they may face similar unobserved shocks but should not be affected by online competition. Because we cannot perfectly test the assumptions underlying our preferred approach, we implement a second empirical strategy that uses differences in internet penetration rate changes across states. While this approach relies on assumptions about the exogeneity of internet penetration rate changes, these assumptions differ substantially from those needed to justify our preferred approach. To the extent that the estimates from both methods are similar, this alternate approach provides support for our results.

We estimate difference-in-difference models that examine how the relationship between internet penetration rates in state s and year t (I_{st}) changes in 2006:

$$(3) \qquad Y_{ismt} = \alpha + \beta_1(I_{st} \times POST_t^{2006}) + \beta_2 X_{imt} + \beta_3 I_{st} + \delta_i + \theta_t + \varepsilon_{imt}.$$

Note that I_{st} varies over time within states. The identifying variation in this model thus comes both from changes in the relationship between internet penetration rates and postsecondary outcomes in 2006 and from changes in internet penetration rates within states. The main assumption underlying this model is that the only reason the relationship between I_{st} and the outcomes changes in 2006 is because of the growth of online education. We also need to assume that there are no shocks or other policies that occur in 2006 that are correlated with I_{st}. Because I_{st} and H_m are not highly correlated—the correlation coefficient between the Herfindahl index and the growth in internet penetration between 2000 and 2012 is −0.05—it is highly unlikely that any unobserved shock that would bias the first approach would also bias the second approach in the same direction.

8.5 Results

8.5.1 Enrollment

Table 8.2 shows estimates from equation (1) of the impact of post-2006 online competition on enrollment. Panel A presents results in levels, and panel B shows the natural log of enrollment. Because of the large variance in enrollment, we prefer the log estimates. However, we present both for completeness. Column 1 presents pooled results for all nonselective colleges. Columns 2 and 3 present results for public and private enrollment (including both not-for-profit and for-profit institutions), while columns 4 and 5 split by four-year and two-year colleges, respectively.

We find consistent evidence across specifications that less-competitive markets experienced relative declines in enrollment after the expansion of online degree programs. A one-standard-deviation increase in market concentration (0.31, as measured by the Herfindahl index) leads to a decline in post-2006 enrollment of about 2 percent. We find larger impacts for private institutions; a one-standard-deviation increase in market concentration reduces post-2006 enrollment by 2.5 percent. Public schools in panel A

Table 8.2 **The effect of online competition on traditional school enrollment**

Independent variable	All nonselective	Public	Private	4-year	2-year
			Panel A: Total enrollment		
Nonselective H-index	–356.0***	–730.4***	–489.3***	–467.0*	–185.6***
× Post-2006	(113.0)	(121.7)	(179.3)	(258.2)	(45.2)
Observations	88,169	27,075	61,094	31,747	56,422
R^2	0.048	0.276	0.036	0.075	0.103
			Panel B: Log Total Enrollment		
Nonselective H-index	–0.064***	–0.002	–0.080***	–0.062**	–0.059***
× Post-2006	(0.017)	(0.019)	(0.031)	(0.027)	(0.020)
Observations	88,169	27,075	61,094	31,747	56,422
R^2	0.130	0.232	0.130	0.144	0.137

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. Each column in each panel comes from a separate regression that controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Standard errors clustered at the market (MSA/county) level are in parentheses; *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

show evidence of a sizable and statistically significant decline in enrollment, but the results in panel B indicate these results are not robust to measuring enrollment in logs. This is likely because of the existence of some very large public schools, which have an undue influence on the estimates in panel A. We thus conclude that enrollment in public schools does not respond to competitive pressures overall. The last two columns show that effects are similar in percentage terms for four-year and two-year schools; a one-standard-deviation increase in the Herfindahl index leads to an enrollment reduction of about 2 percent after 2006.

Figure 8.5 presents estimates of equation (2) graphically, following the less-restrictive specification in equation (2). Note that we have excluded 2005 in these results, which essentially normalizes all estimates to be relative to this pretreatment year. All event study estimates that follow use this convention. When we allow the impacts of market concentration to vary by year, we find a borderline significant decline of about 4 percent in log enrollment for private institutions in 2007, exactly one year after the end of the 50 percent rule. The coefficients remain negative in nearly every year from 2007 to 2013. In contrast, we find no statistically significant impact on log enrollment at public institutions for any year after 2006, which is consistent with the evidence in panel B of table 8.2.

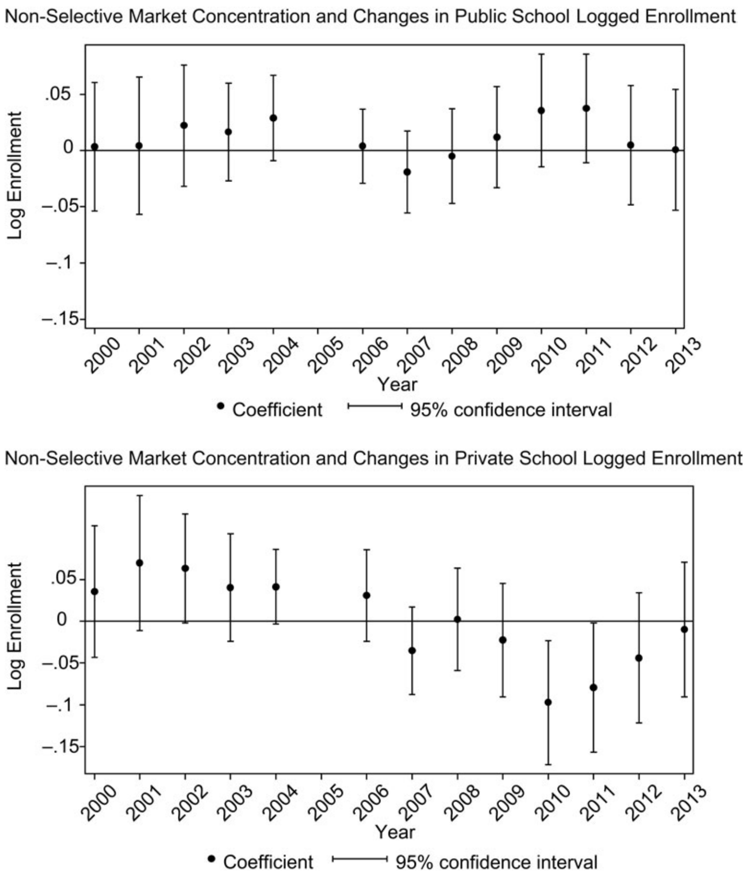

Fig. 8.5 The effect of online competition on traditional school enrollment: Event study estimates by school type

Source: Authors' estimation of equation (2) using 2000–2013 IPEDS data as described in the text. Each point is an estimate of γ_j, and the bars extending from each point show the 95 percent confidence interval calculated from standard errors that are clustered at the market (MSA/county) level. γ_{2005} is set to zero, so all estimates are relative to that year. The regression controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges.

8.5.2 Tuition

In section 8.2, we predicted that competition from online degree programs would cause price convergence across local education markets. Figure 8.6 presents some initial evidence on this question by plotting the enrollment-weighted coefficient of variation (the standard deviation divided by the mean) for tuition in public and private nonselective colleges between 1990

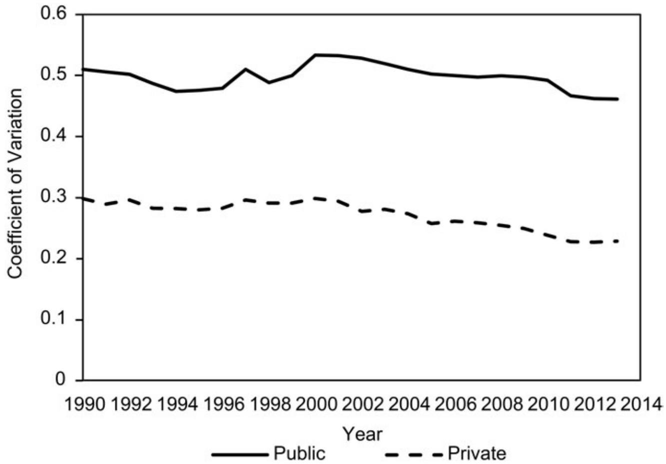

Fig. 8.6 Cross-market coefficient of variation in in-state posted tuition

Source: 1990–2013 IPEDS. The coefficient of variation is the cross-market (MSA/county) standard deviation divided by the year-specific mean. Tuition is only for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges.

and 2013. Figure 8.6 shows that variation in tuition at private nonselective institutions held steady throughout the 1990s but started to decline in the early 2000s. In contrast, there is little change in the variance of tuition at public institutions over this period.

While time series evidence is suggestive, in table 8.3 we present estimates of equation (1) with tuition as the outcome in order to more closely link any tuition changes with underlying market shares. Because public tuition is not primarily determined by market competition, we focus on private institutions. Column 1 presents results for all private schools, while columns 2 and 3 focus on private four-year and two-year institutions, respectively.

Surprisingly, we find little evidence that competition from online institutions lowers tuition in more-concentrated markets. The coefficients in column 1 are positive but are not statistically significant at even the 10 percent level. They suggest a small positive effect on average tuition of about 0.5 percent for a one-standard-deviation increase in the Herfindahl index. There is a negative but not significant effect for private two-year schools in column 3 that is very small in absolute value, while the results in column 2 actually imply *increases* in private four-year tuition in more-concentrated markets. Figure 8.7 shows event study estimates for nonselective private schools. These results show that private tuition increases as a function of the 2000 market share after 2006, with all the increases coming after 2009. Furthermore, there is little evidence of pre-2006 differential trends in tuition that would lead to a bias in our estimates.

Table 8.3 **The effect of online competition on in-state posted tuition among private institutions**

Independent variable	All private	Private 4-year	Private 2-year
	Panel A: Tuition levels		
Nonselective H-index × Post-2006	267.9	860.7***	–264.6
	(182.7)	(278.6)	(242.3)
School-year observations	53,744	18,780	34,964
Unique schools	5,977	4,345	1,971
R^2	0.254	0.254	0.320
	Panel B: Log tuition		
Nonselective H-index × Post-2006	0.0169	0.0354***	–0.006
	(0.0118)	(0.0136)	(0.0181)
School-year observations	53,731	18,775	34,956
Unique schools	5,971	1,968	4,342
R^2	0.318	0.360	0.329
	Panel C: Tuition coefficient of variation		
Nonselective H-index × Post-2006	0.036***	0.0069	0.046***
	(0.010)	(0.012)	(0.015)
School-year observations	53,744	18,780	34,964
Unique schools	5,977	4,345	1,971
R^2	0.034	0.098	0.185

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. Each column in each panel comes from a separate regression that controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates include state-by-year fixed effects and institution fixed effects. The coefficient of variation is the absolute deviation from the national year-specific mean divided by the national year-specific mean. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Standard errors clustered at the market (MSA/county) level are in parentheses; *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

What could explain the positive effect on private-sector tuition? One explanation is that the enrollment declines in table 8.2 forced private colleges to charge more to cover their fixed costs. In other words, private schools might be forced to raise tuition in order to make up for the loss in resources associated with declining enrollment. Another explanation is that price competition is not particularly strong in higher education markets where enrollment is heavily subsidized by federal Pell Grant and Stafford Loan dollars, and thus price is not very salient to consumers. This suggests that schools will compete over other features, such as resources. While these explanations are not mutually exclusive, we lack the ability to distinguish them in the data.

Panel C shows the impact of online competition on market-level variation in tuition prices. The dependent variable is the absolute difference between the institution's posted tuition and the national average tuition divided by

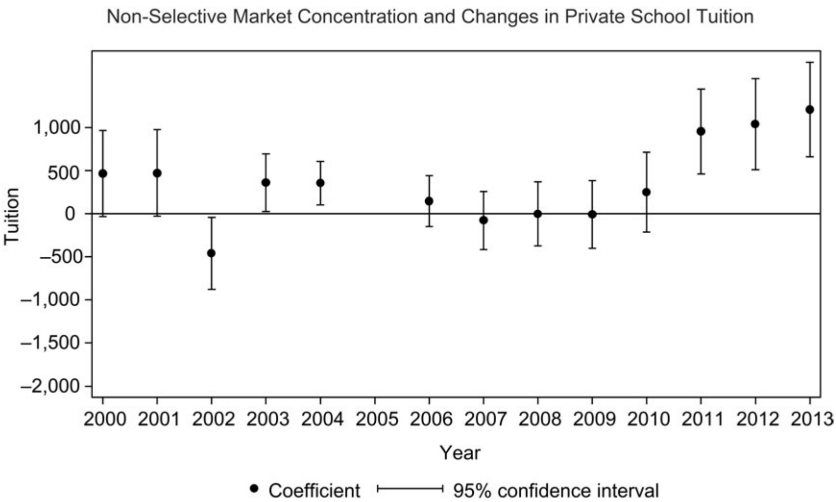

Fig. 8.7 The effect of online competition on traditional private school tuition: Event study estimates

Source: Authors' estimation of equation (2) using 2000–2013 IPEDS data as described in the text. Each point is an estimate of $\gamma\gamma_{jj}$, and the bars extending from each point show the 95 percent confidence interval calculated from standard errors that are clustered at the market (MSA/county) level. γ_{2005} is set to zero, so all estimates are relative to that year. The regression controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges.

the national average tuition. Thus the estimates yield the effect of increased competition on the coefficient of variation (the standard deviation divided by the mean). Interestingly, the estimates indicate an *increase* in price dispersion post-2006 as a function of 2000 market share. These estimates are driven by private two-year schools, where a one-standard-deviation increase in the Herfindahl index leads to a 1.4 percentage point increase in the coefficient of variation. Again, this evidence suggests that schools likely are not competing over posted prices, which is sensible given the sizable subsidies offered to students through the financial aid system.[10] Indeed, if prices are difficult for students to observe, higher competition could cause an increase in posted prices that are driven by university expansions in educational resources.

10. It is possible that these schools are competing over net price with institutional aid. However, nonselective schools in general and two-year schools in particular tend to offer little institutional aid.

Table 8.4 **The effect of online competition on traditional school resources**

Dependent variable form	Independent variable	All nonselective	Public	Private	4-year	2-year
		Panel A: Total expenditures per student				
Level	Nonselective H-index	–328.9	1,620	–564.0	1,094*	–383.1
	× Post-2006	(576.3)	(1,036)	(766.5)	(659.8)	(794.4)
Log	Nonselective H-index	–0.041**	–0.010	–0.045	0.015	–0.056**
	× Post-2006	(0.017)	(0.024)	(0.027)	(0.019)	(0.024)
		Panel B: Instructional expenditures per student				
Level	Nonselective H-index	–155.6	740.7**	–151.7	456.8**	–284.2
	× Post-2006	(210.0)	(364.6)	(269.0)	(197.5)	(304.0)
Log	Nonselective H-index	0.059***	0.060*	–0.008	0.101***	0.037
	× Post-2006	(0.022)	(0.033)	(0.031)	(0.022)	(0.032)
		Panel C: Total revenues per student				
Level	Nonselective H-index	–1,185*	1,953	–1,982**	–117.3	–941.9
	× Post-2006	(703.3)	(1,298)	(884.1)	(928.6)	(999.3)
Log	Noselective H-index	–0.055***	–0.015	–0.074***	–0.015	–0.064***
	× Post-2006	(0.016)	(0.024)	(0.027)	(0.022)	(0.022)

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. Each cell comes from a separate regression that controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Total expenditure per student, instructional expenditures per student, and total revenues per student are top and bottom coded (or winsorized) at the 99th and 1st percentiles to address measurement issues generated by extreme outliers. Standard errors clustered at the market (MSA/county) level are in parentheses; *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

8.5.3 Spending

Table 8.4 presents estimates of equation (1) where the outcomes are expenditures (panel A), instructional expenditures (panel B), and revenues (panel C) per student. Given the enrollment declines shown in table 8.2, there can be a mechanical positive effect on per-student expenditures if expenditures react slowly to enrollment changes or if expenditures are nonlinear with enrollment. However, we view it as unlikely that all the resource changes we document are due to enrollment effects.

As in table 8.2, we show results for all nonselective schools as well as separately for public and private institutions and for two-year and four-year institutions. Because there is a lot of variation in expenditures, these estimates are necessarily noisier than those discussed above. But we find evidence that expenditures per student increased more after 2006 in more-concentrated markets. The impacts are largest for instructional expenditures—a one-standard-deviation increase in market share leads to an increase in instructional expenditures per student of about 1.8 percent. As shown in table 8.1,

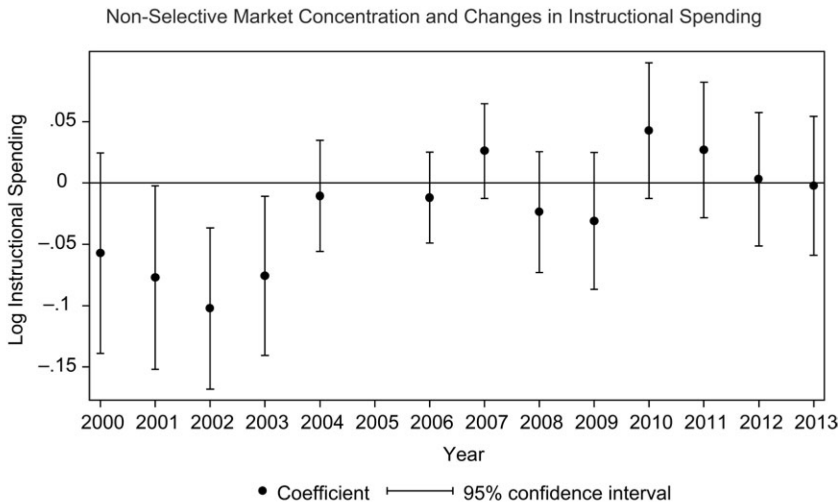

Fig. 8.8 The effect of online competition on traditional school resources: Event study estimates

Source: Authors' estimation of equation (2) using 2000–2013 IPEDS data as described in the text. Each point is an estimate of $\gamma\gamma_{jj}$, and the bars extending from each point show the 95 percent confidence interval calculated from standard errors clustered at the market (MSA/county) level. γ_{2005} is set to zero, so all estimates are relative to that year. The regression controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges.

there is significant variance associated with these outcomes, so we favor the log model; we focus on these, although we present both for interested readers.

The impact on instructional expenditures is largest for four-year schools (3.1 percent for a one-standard-deviation increase in the Herfindahl index) and for public schools (1.9 percent for a one-standard-deviation increase in the Herfindahl index). We find no statistically significant impact of market concentration on instructional spending in two-year schools or private schools.

Figure 8.8 shows event studies for instructional expenditures per student. The estimates are imprecise, but there is some evidence of an increase in per-student instructional spending after 2006, most of which occurs after 2009. However, the pretrend for this outcome actually begins around 2004. One possible explanation is that schools increased instructional spending in anticipation of increased competition from online schools.

The results for overall spending per student are consistent with those for instructional spending but are less precise. The one exception is that we see a reduction in overall spending due to increased competition among all nonselective schools, which is driven by the private sector. Panel C shows that the expenditure declines in the private sector that we document are driven in large part by changes in per-student revenues. Both private and two-year schools experience significant declines in revenues due to heightened competitive pressures.

Private schools are heavily reliant on tuition funding. Table 8.2 shows that these institutions experience sizable declines in enrollment when there is increased competition. We also find—in table 8.3—that they increase tuition in response to online competition. However, table 8.4 shows that these tuition increases do not fully offset the impact of declining enrollment on per-student revenues.

Comparing the revenue changes to the expenditure changes, one possible explanation is that while private and two-year schools are shifting resources toward instruction, they nonetheless face increasingly binding financial constraints that reduce the total amount of resources available to them. The result is that these institutions are able to hold instructional expenditures per student relatively constant in the face of declining total resources. Despite the fact that revenues decline, there is a relative shift to instructional expenditures in the private and two-year sectors.

In contrast, there is no impact on per-student revenue in public schools and four-year schools. This could be because state appropriations counteract reductions in tuition revenue from enrollment declines in the four-year sector (we do not see a consistent enrollment effect in the public sector). It also is the case that four-year schools tend to be less reliant on tuition revenues, which reduces their exposure to revenue losses when enrollment declines. Instructional expenditures per student rise considerably, which suggests that public schools may respond to threats from online competitors by increasing the breadth of course offerings, lowering class sizes, or increasing instructional expenses. Unfortunately, the IPEDS data do not allow us to examine more specific categories of instructional spending.

8.5.4 Heterogeneity in Market Power across Sectors and by County Size

Throughout the analysis, we have characterized competition using nonselective enrollment concentrations. This aggregation may miss important heterogeneity in market power across sectors. As table 8.1 shows, private colleges tend to have less market power than public colleges. If institutions in these sectors compete within but not across sectors, our aggregation of all enrollments will miss important aspects of how competition operates. In table 8.5, we present results from a model similar to equation (1) but where we control separately for how the private Herfindahl index and the public Herfindahl index interacted with a post-2006 indicator. We also separately control for the interaction of post-2006 indicators and indicators for

Table 8.5 **The effect of online competition on traditional schools using sector-specific market share measures**

Independent variable	All nonselective	Public	Private
	Panel A: Log enrollment		
Public H-index	–0.00206	0.0103	0.0587**
	(0.0162)	(0.0199)	(0.0271)
Private H-index	–0.0608***	–0.0205	–0.1297***
	(0.0168)	(0.0184)	(0.0279)
	Panel B: Log expenditures per student		
Public H-index	–0.0494***	–0.0214	–0.0514***
	(0.0171)	(0.0260)	(0.250)
Private H-index	0.0093	0.0288	–0.0026
	(0.0178)	(0.0223)	(0.0261)
	Panel C: Log instructional expenditures per student		
Public H-index	0.0290	0.0600*	–0.0531*
	(0.0217)	(0.0358)	(0.0279)
Private H-index	0.0043	0.0039	0.0228
	(0.0219)	(0.0278)	(0.0294)

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. Each column in each panel comes from a separate regression that controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Standard errors clustered at the market (MSA/county) level are in parentheses: *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

whether the market is missing each Herfindahl index. This occurs when the market does not have a school of the given type in it in 2000.

Panel A shows log enrollment estimates; the results load completely on the private sector Herfindahl index. The enrollment effect on all nonselective schools is similar to the effect in table 8.2, at 1.8 percent for a one standard deviation change in the private Herfindahl index (0.29). Reassuringly, the market concentration of private institutions has a greater impact on private college enrollment.

While private enrollment responds to heightened competition in both the public and private sectors, the effects are in opposing directions: A one-standard-deviation increase in the public institution Herfindahl index leads to an *increase* in private college enrollment of about 1.7 percent, whereas a one-standard-deviation increase in the private institution Herfindahl index leads to a 3.8 percent *decline* in enrollment. In contrast, we find no evidence that increased public or private market concentration affects enrollment at public institutions after 2006.

In the last two panels of the table, we provide expenditure and instruc-

Table 8.6 **The effect of online competition on traditional schools, by county size**

Independent variable	Enrollment	Log enrollment	Log expenditures per student	Log instructional expenditures per student	Log revenues per student
			Panel A: Below-median population counties		
Nonselective H-index × Post-2006	–446.8*	–0.0472**	–0.0171	0.0623**	–0.0473*
	(246.3)	(0.0221)	(0.0267)	(0.0301)	(0.0250)
Observations	42,915	42,915	38,982	38,830	38,986
R^2	0.087	0.152	0.048	0.052	0.050
			Panel B: Above-median population counties		
Nonselective H-index × Post-2006	76.41	0.0274	–0.0101	–0.130	0.0320
	(202.4)	(0.0772)	(0.0734)	(0.0896)	(0.0791)
Observations	44,037	44,037	39,644	39,481	9,615
R^2	0.108	0.128	0.024	0.027	0.022

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. Each cell comes from a separate regression that controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Above- and below-median population counties determined by quantile of 19- to 23-year-old population as of 2000 in the CPS. Total expenditure per student, instructional expenditures per student, and total revenues per student are top and bottom coded (or winsorized) at the 99th and 1st percentiles to address measurement issues generated by extreme outliers. Standard errors clustered at the market (MSA/county) level are in parentheses; *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

tional expenditure estimates overall and separately for the public and private sectors. In general, we find that expenditure and instructional expenditure at both public and private institutions are more responsive to competition among public schools, although the estimates are somewhat imprecise. Specifically, we find that per-student expenditure and instructional expenditure at private institutions decline with public-school market concentration after 2006, while public per-student instructional expenditure increases with public-school market concentration. Private college market concentration does not affect public or private institutional expenditures.

Cities and counties vary widely in both geographic size and population. Metro areas tend to have higher concentrations of postsecondary options than do nonmetropolitan counties in our sample, and so the effect of increased competition from online options might be particularly strong in lower-population areas. We test for such heterogeneity in table 8.6, which splits the sample by the median number of 19- to 23-year-olds in the 2000 CPS.[11] The effects of competition from online options are concentrated in

11. Another way to examine the role of population in our estimates would be to exclude the market-year population control. However, the institutional fixed effects absorb any fixed

Table 8.7 **The effect of online competition on selective postsecondary institutions**

Independent variable	Enrollment	Log enrollment	Log expenditures per student	Log instructional expenditures per student	Log revenues per student
Nonselective H-index × Post-2006	–93.48 (208.5)	–0.0225 (0.0152)	–0.0298 (0.0216)	–0.0255 (0.0277)	–0.0151 (0.0204)
Observations	6,418	6,418	6,333	6,333	6,262
R^2	0.340	0.369	0.331	0.307	0.380

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. The sample consists of institutions with an admissions profile of "Very Competitive" or higher in the 2009 Barron's Profile of American Colleges. Each cell comes from a separate regression that controls for market-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates also include state-by-year fixed effects and institution fixed effects. Herfindahl (H-) indices are for nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Total expenditure per student, instructional expenditures per student, and total revenues per student are top and bottom coded (or winsorized) at the 99th and 1st percentiles to address measurement issues generated by extreme outliers. Standard errors clustered at the market (MSA/county) level are in parentheses: *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

below-median population counties. In these counties, the effects of competition mirror those from the sample overall: enrollment declines, instructional expenditures increase, and revenues decline. However, we find little evidence of a response in above-median population areas.[12] This heterogeneity is likely due to the fact that there already is a high degree of competition in larger markets, which mutes the competitive effects of online competition.

8.6 Robustness Checks

8.6.1 Estimates for Selective Institutions

Throughout the analysis, we have restricted attention to less-selective institutions, as they are most directly in competition with online postsecondary schools. As a specification check, we show results for "selective" colleges and universities that have a 2009 Barron's ranking of Very Competitive or higher. We expect online competition to have little impact on this higher education sector, and indeed that is what we find. Table 8.7 reports

characteristics of the markets they are in, including differences in population. As a result, examining heterogeneous treatment effects by area size is a more straightforward way to assess the role of population size.

12. We have examined similar heterogeneous effects separately for public/private and two-year/four-year schools as well. The results are very similar to those from table 8.6 in showing that the effects of online competition are concentrated in the lower-population counties. These results are excluded for parsimony but are available from the authors upon request.

Table 8.8 **The effect of online competition on traditional schools' internet growth**

Independent variable	Enrollment	Log enrollment	Expenditures per student	Instructional expenditures per student	Revenues per student
Internet rate	–2,368*	0.056	8,477	3,578	3,442
	(1,276)	(0.173)	(7,033)	(2,236)	(8,986)
Internet rate × Post-2006	64.91	–0.074	–1,675	–447.3	–3,681
	(543.7)	(0.151)	(3,421)	(1,231)	(4,396)

Source: Authors' calculations as described in the text using 2000–2013 IPEDS data. Each column comes from a separate regression that controls for state-year unemployment rate, total population, poverty rate, proportion black, proportion Hispanic, proportion veterans, and proportion male. All estimates include institution and year fixed effects. The estimation sample includes all nonselective schools, which are those with an admissions profile below "Very Competitive" in the 2009 Barron's Profile of American Colleges. Total expenditure per student, instructional expenditures per student, and total revenues per student are top and bottom coded (or winsorized) at the 99th and 1st percentiles to address measurement issues generated by extreme outliers. Standard errors clustered at the state level are in parentheses; *** indicates statistical significance at the 1 percent level, ** indicates significance at the 5 percent level, and * indicates significance at the 10 percent level.

the results from this robustness check: there is no statistically significant evidence of a change in enrollment or resources due to online competition among selective schools. Several of the coefficients are in the opposite direction from the nonselective results shown previously, and those that are in the same direction are attenuated. That we find no evidence of a response among more-selective institutions suggests we are identifying a causal effect of competition from the online sector rather than secular trends or shocks in postsecondary outcomes that are correlated with the Herfindahl index and the relaxation of the 50 percent rule.

8.6.2 Results from Internet Penetration Variation

Finally, in table 8.8 we present results from a complementary identification strategy that exploits state-by-year variation in internet penetration, following equation (3). This identification strategy has considerably less power than our preferred approach, so we only show estimates for all nonselective schools. Despite the reduced statistical power, these results present supporting evidence that is important given the potentially strong assumptions underlying causal identification in equation (1).

The results in table 8.8 are qualitatively similar to those shown above. A 10 percentage point increase in the internet penetration rate post-2006 leads to a 0.7 percent reduction in nonselective enrollment and an increase of $1,587 per student in instructional expenditures. We also find positive coefficients on overall expenditures and revenues per student. Only the instructional expenditures effect is significant at even the 10 percent level. While imprecise, the fact that these results are broadly consistent with our baseline estimates suggests our conclusions are not being overly affected by biases driven by differential trends or shocks correlated with 2000 market shares and with the timing of federal guidelines supporting online postsecondary options.

8.7 Conclusion

In this chapter, we study the impact of increased competition from online degree programs on traditional postsecondary institutions. Following a regulatory change that increased the market entry of and enrollment in online institutions after 2006, local schools in less-competitive markets experienced relative declines in enrollment. The impacts on enrollment were concentrated among less-selective private institutions that are likely to be online schools' closest competitors. We also find that institutions responded to competitive pressure by increasing instructional spending, a broad proxy for quality. These impacts are driven by public institutions, suggesting that they also felt pressure to improve quality in response to online competition. In contrast, we find no evidence that increased competition lowered prices for in-person degree programs, perhaps because federal Title IV subsidies weaken price competition in higher education.

Our results show the importance of thinking broadly about the impact of online degree programs on US higher education. Several recent studies have found that online courses and degree programs lead to less learning, lower degree completion rates, and worse labor market outcomes. However, our findings suggest that online education can be an important driver of innovation and productivity in US higher education even if (at least at the time of writing) online institutions are producing a lower-quality product. Our results provide preliminary evidence that the threat of "disruption" from online education may cause traditionally sluggish and unresponsive institutions to improve quality or risk losing students. Another direct benefit—unexamined in this chapter—is the impact of online schools on access to higher education for students who do not live near a traditional campus or who must enroll during irregular hours. While we are still in the early days, online degrees are likely to be a disruptive force in the market for US higher education, and so they remain an important topic for future work.

Appendix

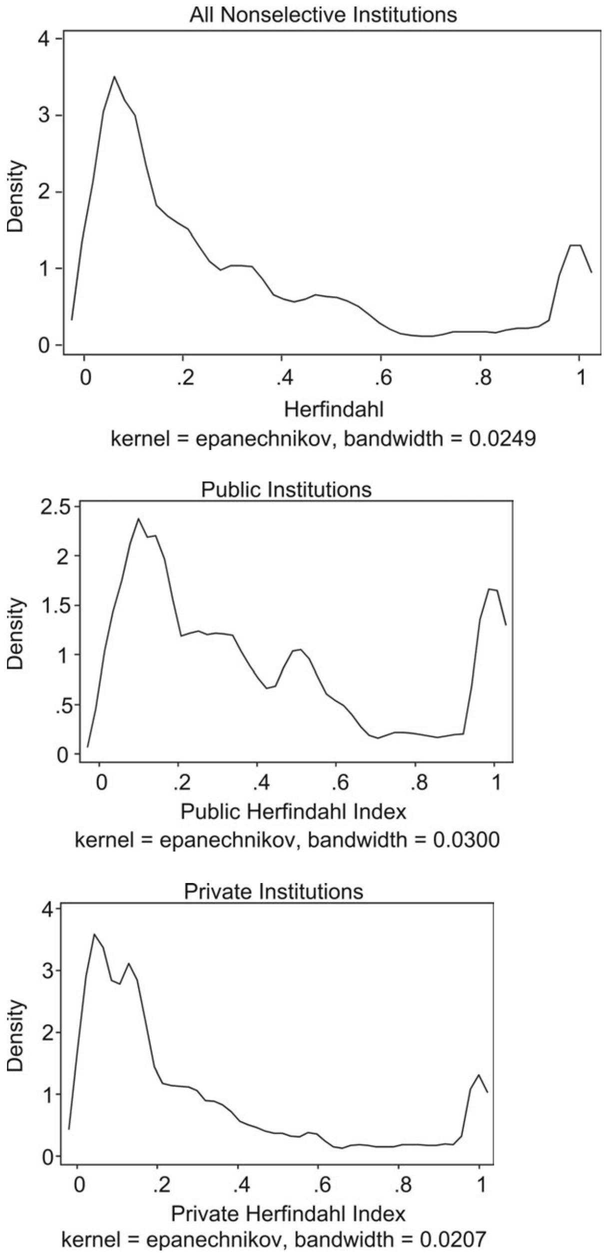

Fig. 8A.1 Distribution of Herfindahl indices

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