"The 21st century professionalization?": online education as an instrument for bolstering individual welfare and societal equality

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Abstract

Since the start of the last decade of the 20th century, the application of digital technologies with the potential of making substantial contributions to a community's welfare have led to the creation of the literature of Public Interest Technologies and reinvigorated many areas of focus in the social sciences. A relevant subfield of this literature has been the application of new technologies to education to increase social public benefits. The traditional literature on higher education seems to agree that the expansion of this good throughout a society is desirable because it generates direct and indirect individual gains, as well as aggregate level social benefits in the form of positive externalities. However, some authors have argued that the acquisition of postsecondary education has its own drawbacks: unwanted intellectual influence of instructors on students, barriers to access for students of historically vulnerable sociodemographic groups, as well as students' perception of a reduced pay-off from going to college. While there have been some indices that online higher education could abate many of these issues, there has been relatively little formal research to test this tool's impact. Using a quantitative approach, via cross-section and time-series data analysis, the text finds some evidence that online higher education could solve many of higher education's drawbacks, while also being a feasible approach given the current technological environment of the United States. The text concludes outlining future research using a mixed-methods approach that could be highly valuable to acquire a more comprehensive view and robust evidence of online higher education's potential of expanding social public benefits.

Introduction

Starting from the final decade of the 20th century, the expansion and advancement of new technologies has become a topic of great relevance for its current and potential impact. In particular, the introduction of digital and online technologies, as well as their applications in developed and developing societies alike, gave birth to the academic study of Public Interest

Technologies (PIT) (McGuinness and Schank 2021; Sun 2022). Due to the expanding capacities of digital technologies, which have gradually evolved to the point of becoming feasible for catalyzing major transformations in societies (Maxfield Brown and Weber 2022; Wolff 2021), the application of digital technologies to solve practical needs has started to gain relevance in the fields of research and policy (Hilbert 2020; O'Neil et al. 2024; Zicari et al. 2021). Unsurprisingly, a topic of focus has recently gained traction is finding ways in which these new tools can be employed to improve the quality of life and expand the welfare of communities.

One of the fronts involved with increasing development and welfare that has become a target by numerous international organizations (UNICEF 2022; World Bank Group 2024) has been the expansion of education. Currently, his field has been one of the top investment recipients in the last 25 years: the World Bank's International Finance Corporation (2024) alone reports it has invested more than $3.1 billion in building innovative education solutions since 2000. Despite this, recent studies (Bedasso and Sandefur 2024) have argued that some of these investments in education have not made substantial returns in offering quality learning outside of primary education, and that their focus has been conventional strategies. This situation could imply that there is a noteworthy area of opportunity for the field of Public Interest Technologies (McGuinness and Schank 2021); one in which stakeholders interested in development could use the available digital infrastructure to expand social welfare through more dynamic higher education solutions. Therefore, the questions that are, how can modern digital technologies be channelized to further a population's access to higher education? What advantages does this digital approach offer as opposed to traditional higher education?

This text argues that existing digital technologies could have the potential to improve a population's quality of life by expanding the provision of higher education via the nascent online education platforms, as well as doing so in a feasible manner. The argument is that, since higher education has the potential of generating numerous individual and community level benefits (Pencavel 1991; Santiago et al. 2008), a complete society benefits from its expansion. Since online higher education is a novel approach that can leverages the current available technologies to transmit most of the knowledge from college level education, while also skirting most of its drawbacks: unwanted intellectual influence students may face from

their professors, institutional entry barriers that different demographic groups face, as well as the criticisms to the potential investment returns of higher education. Finally, the text argues that employing online postsecondary education is feasible due to the existing broadband internet adoption trends. Although the primary reach of this argument is centered on the context of the United States, much of it could be extended to other developed societies and, possibly, even developing countries.

To accomplish this, the text is divided into 3 sections. The first is an extensive literature review on the advantages and drawbacks of students acquiring higher education, as well as a summary of the findings. A second section outlines the arguments in favor of the potential and feasibility of using digital technologies to expand higher education via online programs, as well as offers the relevant hypotheses based on the literature review. A third section offers a quantitative approach that aims to test these hypotheses, as well as details the main finings. The text concludes by providing an outline of additional research that could be performed, considering the limitations of this exercise, with the main goal of obtaining greater clarity on the actual beneficial impact of online higher education.

1. Literature Review

To propose an approach that has the objective of facilitating the expansion of higher education, an important first step is to know the associated benefits of the process, as well as the challenges associated with it. Therefore, the literature review's purpose is twofold. The first part of the section focuses on gaining insights on the direct and indirect impacts that higher education has for a community at the individual level, as well as documenting these effects at an aggregate societal level. The second portion of this section delves into the literature that focuses on the multiple challenges that have been associated to the acquisition of higher education. In essence, this section displays all the types of benefits that have been associated with expanding higher education, as well as outline the different methodologies employed to argue in favor of this connection. It also shows that there is a sub-group of authors that have found evidence that the acquisition of higher education is not frictionless, and could imply additional social, monetary and opportunity costs that might hinder the overall provision of this good. A final part analyzes the main findings and provides an explanation of why expanding higher education while also attending its associated challenges would be a sizeable contribution for communities.

Benefits from obtaining higher education

The literature on the merits of higher education is vast and has many nuances. Its origin can be traced back to ancient times from the writings of Plato ([375 BC] 2007), who argued that both people, and their societies in a larger sense, would reap the benefits of education. Through philosophical argument and metaphors, he states that, since a better understanding of reality allows a person to make more informed decisions, the expectation is that educated people can make better contributions to their surroundings and, therefore, are the appropriate rulers for a society. This perspective has also been shared by other classical political thinkers, as Stuart Mill ([1861] 1958). Using a historical analysis of modern western societies and theoretical arguments, he also argues that education is a precondition to better government, as individuals who have a greater deal of knowledge can contribute insights so that a population may become freer and, consequently, can aspire to attain an aggregate higher level of societal progress.

Modern empirical research has also pointed to important benefits from higher education. Some authors, as Becker (1994) have theorized that higher education is both a personal and aggregate level investment: individuals incur in monetary and economic costs to acquire skills and abilities that generate them long-term career benefits and offer their societies positive externalities. One of the first important proponents of this stance was John Pencavel (1991). According to his analysis on the topic, higher education has had a role in fostering individual and national economic growth, and this effect has become more pronounced over time. Focusing on the case of the United States and performing descriptive statistics on the country's aggregate historical data, he estimates that, while college education contributed to only 9% of overall educational impacts on economic growth in the early 20th century, by the decades of the 1970 and 1980, it had come to account for more than 62% of all of education's contribution to economic growth. He also finds reports showing that, from 1960 to 1980, the manufacturing industries in the country that employed more technical and college-educated workers experienced the most accelerated productivity and workforce expansion, arguing that educated workers are more capable of adapting and assimilating new technologies. Finally, by making comparisons between expected earnings from college and high school graduates, when leaving age and years of work experience constant, the author finds that graduates' earnings were, on average, 65% higher than their counterparts'. Arguing

generalizability, Pencavel also finds this trend among other developed countries. Despite this, the author acknowledges potential limitations in his methodologies and even suggests the possibility of reverse causality: economic growth may be what drives the benefits of higher education rather than the inverse.

Subsequent studies have also supported the idea of the economic benefits of higher education. Santiago et al. (2008) find evidence that points towards college education´s economic value being generalizable to different context. By measuring the historic economic growth trends among the OECD countries and using the expansion of higher education as the explanatory variable, the authors find that, as a country increases its higher education, the population sees both public benefits (infrastructure) and private benefits (higher incomes). With this, they conclude that there is evidence to think that education offers "capital returns". Other studies, as that of Olsen et al. (2004), find that the benefits of higher education tend to be aggregate. Using the data from market growth reports from Australia and New Zealand, the authors devise a tendency in which, as education expands in a country, there is an emergence of an education market where universities compete amongst each other. Aside from creating jobs and transactions, the new market creates a beneficial system: it drives market competition among secondary and tertiary education institutions to offer the highest quality product to their students, which is conducive for learners to gain skills that allow them to achieve higher performance outputs that result in them receiving higher wage premiums.

Similarly, other studies (Institute for Higher Education Policy 1998; Wolfe and Haveman 2003) have found that college education also offers indirect economic benefits. By looking into aggregate data from US Census Bureau surveys during the last decade of the XX century, aside from finding that college graduates experienced better working conditions and more professional mobility, a report from the Institute for Higher Education Policy (1998) finds that these individuals also had higher value interest earning assets, home equity, and other financial assets. Additionally, these graduates also seemed to contribute at higher rates to retirement plans, mutual funds, and other saving devices. Based on these findings, the document seems to indicate that an indirect product of higher education is the acquisition of better financial management abilities. Wolfe and Haveman (2003) also argue that the advanced knowledge of a population that comes from its volume of graduate students could affect its aggregate level development. By performing a series of regression estimations on

national data from OECD countries, they find signs that an increase in the size if a college educated population is associated to a country having a higher economic output, increases in economic innovation and the development of new technologies and their dissemination.

Another strain of this literature argues that higher education offers non-economic benefits. Lleras-Muney (2005) performs a study exploiting a natural experiment. Using a panel database constructed from the US Census data from 1960 to 1980, the National Health and Nutrition Examination Survey I Epidemiologic Follow up Study and changes in state schooling laws, the author investigates the correlation between a person's educational attainment and life expectancy. Using an approach that relies on a series of instrumental variables, the author concludes that, since higher education removes young adults from dangerous professions (construction, truck driving, etc.) and gives individuals the critical thinking skills to better manage their daily habits, adopt new medical technologies and treat chronic conditions, the result is that educated individuals reduce their mortality rate by around 3%. Other authors, as Hanushek and Woessmann (2008), propose that the academic rigor of higher education increases the population's performance in other valuable cognitive skills: as literacy skills, scientific methods and logical reasoning. Using national data from a sample of 50 developed and developing economies, the authors find a strong correlation between these variables and posit that college education bolsters people´s cognitive skills.

Finally, other studies find that higher education offers additional externalities for populations. Vila (2000) argues that populations with a larger portion of higher college graduates could obtain valuable knowledge that is reflected in improvements in their quality of life: better household management, lower infant mortality rates, increased social participation and charity donations, decreased likelihood of spreading infectious diseases, among others. After revising the literature on the topic, the author concludes that there is good reason to think that secondary and tertiary education generates these positive externalities for communities. Other studies (Bratton and Mattes 2001; McMahon 2004) argue for institutional benefits of higher education. Bratton and Mattes (2001) posit that individuals who have a greater amount of education eventually learn about the benefits of having a democratic system, resulting in them becoming supporters of these political institutions. Performing a series of regressions using cross-sectional data from surveys performed in different African communities, they find that educational attainment is among

the most important variables positively associated with democratic support. Additionally, McMahon (2004) posits that the knowledge and positive values gathered from cohabitating in a knowledge community as a college or university results in students that acquire higher education having a greater disposition of generating social development and stability. By viewing national data on a variety of countries, the author finds that a population with a higher education attainment is associated with lower crime rates, more political stability, lower levels of pollution, a greater support for human rights and a higher voter turnout.

Drawbacks of acquiring higher education

With the development of literature on the impacts of higher education, more critical approaches on the topic have also surfaced. One of the first criticisms comes from the classic political philosopher Jean-Jacques Rousseau ([1750] 2002). In his view, new technologies and education were responsible of accentuating inequalities in societies: the existing unequal and asymmetric structures of society results in these tools ending up in the hands of a small elite that tends to perpetuate its dominance over a society abusing these. Therefore, he argues that, just as education brings development, it is also responsible for generating inequality.

Other modern political philosophers and even defenders of education, as John Stuart Mill and Max Weber, also saw some drawbacks with the power that comes from the instruction of higher education. In a writing specifically on the topic of students attending the University of St. Andrews ([1867] 1984), Mill is critical on various aspects of the process: although he argues that education is beneficial to all members of society, he also notes that the universities also tend to affect the learning process by introducing bias. In the case of the University of St. Andrews and other English institutions, Mill notes that theses organizations were instructing their students on how to think about non-academic subjects, as practicing religion, which he considered unreasonable due to it limiting human development by causing students to arbitrarily accept a parochial view. Weber ([1919] 2004) also saw a similar process in western societies during the XIX century: educational institutions allowed professors to use their greater authority and influence over students to instruct them on subjective matters, such as politics, which he argued was detrimental to any rigorous scientific approach of acquiring knowledge.

In recent years, more critiques of this nature have surfaced. Raschke (2003), draws from the arguments of these classic philosophers and even goes further: while he agrees that higher education institutions provide the means for young adults to acquire valuable knowledge for their personal life and even improve their societies, he argues that these organizations had systematically been monopolizing knowledge to also instruct their students on unrelated topics, as their value systems. In the case of western societies, the author proposes that, during the youth's instruction process, these institutions arbitrarily influence the instruction process in a way that it predisposes students to accept liberal, progressive or even left-leaning views.

Another critique that has received noticeable attention in the literature is that higher education institutions tend to place barriers to entry to different groups. Page and Scott-Clayton (2015) have argued that students coming from low-income households have less access to college than their counterparts. According to the authors, attending a college is costly for any student: receiving higher education requires individuals to incur in both monetary costs (application fees, tuition, housing/transportation costs, homework costs, etc.) and opportunity costs (dedicate additional time to prepare for standardized tests, prepare applications, face credit constrains, forfeit the chance of getting a full-time job after graduating from high school). Since their households have a scarce amount of resources, low-income students coming from these backgrounds usually have to engage in part-time employment, scholarship applications and family responsibilities while studying, meaning they face greater workloads and pressures that increase their risk of dropping out. After revising the literature, the authors conclude that low-income households are clearly more vulnerable of not complete their college studies due to their constrained environment.

A second branch of research has also found differentiated access to college based on racial/ethnic origin. Using data from the second half of the XX century, Sowell (2004a) finds evidence that, despite being mandated to accept individuals from all racial and ethnic backgrounds, higher education organizations in the United States still tend to admit less students of color, likely because these students possessed a less rigorous academic background due to years of unequal access to quality primary education. Viewing data on college enrollment in the Southern States, the author notes that, by the end of the XX century, many preferential admission policies for African American students were banned from the

high ranking universities, like the University of California and University of Texas systems. This resulted in a decline in the admission of students of color in these college systems' flagship universities: UC Berkley and UT Austen.

Additional evidence has pointed towards an interaction between racial segregation and gender in schools. Specifically, that women of color face even greater difficulties than their male counterparts. A recent study (Education Law Center 2023) found that female African American students tend to experience additional hardships when pursuing education. Using an ethnographic study methodology of a series of detailed interviews to a sample of young women in public schools in Philadelphia, the report finds that this specific group experiences a high risk of discipline in the context of dress and grooming codes, classroom punishments and even racial slurs simply due to their sex. The report concludes that these existing hardships could be hindering this group's progress in completing their studies.

Modern empirical studies, as that of Polos et al. (2022), have supported the argument of higher education institutions excluding minority students. These authors argue that years of segregation in the education system have placed students of color, and specifically African Americans, at a disadvantage by having to face numerous structural issues, as community disinvestment, domestic violence, insecurity and lack of healthcare resources, which have hindered their ability to perform well in school and attain higher education. Using data from the National Longitudinal Study of Adolescent to Adult Health and building indexes of racism and structural disadvantages for households, the authors find evidence supporting this argument: African American students present a higher degree of depressive symptoms than their Caucasian counterparts, and that they are twice as likely to be in a school with a contextual disadvantage index above the median compared to White students. While the effect of depressive symptoms was present among all African American students, the effects shown by African American females were consistently larger and more statistically robust.

Additionally, a recent study from the Pew Research Center (DeSilver 2023) has found that there are reasons to believe access to education has not been as inclusive of racial minorities. According to US higher education institutions' web portals, only half of the 51 most selective colleges in the country have a consideration for students' racial/ethnic backgrounds, while less than 8% of them consider these relevant considerations for acceptance decisions. Noting that the US Supreme Court ruled on limiting the application of

affirmative action in higher education in June of 2023, the author concludes that the already precarious access to higher education for racial minorities is expected to become even more reduced in years to come.

A third critique that has surfaced in the literature is that higher education has become an unappealing investment. Clarey (2015), for example, argues that this venture has drawbacks from the point of view of its costs and expected returns. According to the author, a gradual increase in the money supply of the United States has elevated the costs of education in the country to unsurmountable levels, to the point of causing many students to go into debt via student loans to be able to afford their degrees. The main problem of this situation arises when students earn their degrees: since many fields, mainly the Humanities, Liberal Arts and Social Sciences, are highly competitive and their industries currently have not received enough investment to account for the annual increases in the supply of graduates, many aspiring professionals face prolonged unemployment or underemployment prospects. Given this situation, he argues that the total economic costs, comprised of monetary and time investments, of acquiring college studies without commensurate expected returns could make this proposition seem as counterproductive to many.

Contemporary empirical studies have also provided additional evidence questioning the investment value of higher education. According to Dale and Krueger (2002), a large portion of the value that is conventionally attributed to higher education institutions could actually be a product of omitted variable bias: namely, many of the students who graduate from universities, especially those from top performing institutions, were already going to do well in life due to their own personal qualities (as time management skills, work ethic and problem-solving abilities), regardless of them going to top universities to study. Since many of these personal qualities are very hard to measure, researchers could be constantly mistaking these for students' education, leading to an overestimation in the value of going to selective higher education institutions. After conducting a study that uses the longitudinal earnings data from non-admitted and borderline-admitted Harvard and Dartmouth graduates, the authors conclude that student motivation and talent tend to explain a great deal of graduate success compared to effect of the student attended a highly selective college.

Finally, another strain of the literature on higher education has pointed towards certain careers being more worthwhile than others. Weinberger (1999) proposes that, since the

demand for quantitative and mathematical skills has been increasing due to the development of new software and technologies, students who perform their college and university studies in majors using mathematical methods tend to earn more than their counterparts. Using earnings data from the United States during the decade of 1990s, she finds that individuals with higher mathematical abilities have, on average, more than 6% higher hourly earnings.

A more recent study from Zhang et al. (2024) offers a clearer picture on the variation of investing in education. According to the authors, as with many other markets and industries, the monetary and career value a student gets from higher education depends on the field the student chooses: more highly demanded and more skill intensive industries likely offer better returns to graduates than those that require conventional skills. By analyzing the data from the American Community Survey, the authors find that the return on investment that graduates receive seems to be highly dependent on the major they choose: while degrees in education and humanities can offer relatively low returns on investment of, on average, 3% and 4%, respectively, during their whole careers; the educational returns of investing in a computer science or engineering degrees are, on average, of 15% or more.

Analysis

The literature provides insightful information on the issue of the provision of higher education. First, most –if not all– authors seem to agree that higher education provides value to those that receive yet, making its acquisition desirable. The literature, by large, also seems to posit that there are both individual and aggregate level benefits from higher education. When looking into the individual level benefits:

- Some authors argue that these are direct and economic (Becker 1994; Pencavel 1991),
- Others point towards indirect monetary benefits in terms of productivity (Wolfe and Haveman 2003) and financial skills (IHEP 1998).
- Another group posits additional non-economic benefits, as reasoning abilities and life expectancy (Hanushek and Woessmann 2008; Lleras-Muney 2005).

The literature also provides evidence for aggregate level community benefits:

- A group of authors argues that these result in direct economic contributions to their societies (Santiago et. al 2008).

- Other studies find indirect economic externalities in the form of innovation (Olssen et al. 2004; Wolfe and Haveman 2003) and can even generate social and institutional benefits to countries (Bratton and Mattes 2001; McMahon 2004; Vila 2000).

The policy problems with fostering higher education arise when looking into the literature that talks about the challenges of acquiring it. According to its authors, the challenges caused by the negative influence of professors on students (Raschke 2003), access barriers to different demographic groups (Page and Scott-Clayton 2015; Polos et al. 2022) and uncertain return on investments (Clarey 2015; Dale and Krueger 2002, Zhang et al. 2024) returns on investment could be so great, that many young professionals could, understandably, find it unfeasible to acquire it.

From this information, there is reason to think that innovation in bolstering higher education represents an important step towards a holistic type of development. First, since numerous studies in the literature provide empirical evidence that expanding higher education results in tangible economic benefits at the household (Pencavel 1991) and national (Santiago et. al 2008) levels, a contribution to this phenomenon implies an increase to a country's growth and economic development (Schumpeter 1980). Moreover, the fact that expanding higher education has also been associated to substantial contributions to communities, political institutions that bolster equality (Bratton and Mattes 2001) and behaviors that are conducive to improving populations' health and preserving their environments (Lleras-Muney 2005; McMahon 2004; Vila 2000), the process could also imply a contribution to societies' sustainable development (Sanchez 2023). Thus, as this type of holistic development has acquired a larger importance during the last 3 decades (Holden et al. 2017), finding ways to expand this good could also be a part of a long-term contribution to expanding welfare and development in a sustainable manner.

In the same way, expanding higher education, while avoiding or mitigating the disadvantages involved in its acquisition, could also make for an important step towards social equality. On one hand, allowing students to acquire the valuable knowledge that comes from college and university while reducing the ideological or political influence that the providers of this resource may be trying to exert (Raschke 2003) can be seen as a step towards ideological pluralism and freedom of thought (Nickel 1989). On the other hand, reducing the

costs of a long-term investment (Clarey 2015; Dale and Krueger 2002) and enhancing disadvantaged social groups' access to it (Page and Scott-Clayton 2015; Polos et al. 2022) would be an important step towards equality and social justice (Rawls [1971] 2005). Finally, the provision of unbiased, affordable and inclusive higher education could be considered a sizeable expansion of the Human Right to Education (UN 1948), as the knowledge acquired to have a career can also be considered a contribution to a person's integral development.

2. Theory and Hypothesis

Moving away from the conventional approach

When thinking about solutions to attend the drawbacks that come with the acquisition of higher education, many approaches could come to mind. After all, the literature on public policy has argued that there are multiple ways to attend social issues (Stone 2002). One popular approach has been to rely on public institutions to provide higher education. According to its proponents (Williams 2014), since the process of students receiving higher education has positive externalities for society, but different members of the population do not possess the means to access it, the state can subsidize –in varying degrees– the costs of imparting this good. This approach has its own merits (APLU 2024) and different studies have provided evidence in favor of the advantages and feasibility of expanding higher education via investments on these institutions (Curs et al. 2011).

Despite this, the text offers an alternative approach. A first reason for deviating from simply investing in public institutions to provide the good is because this strategy might not be as reliable to solve some of the challenges outlined by the literature. First, the costs of public education rely on the state covering a great deal of the expenses. This would require different levels of state authorities to agree to this proposition and to dedicate the funds needed to subsidize education to cover the populations' demand of this good, both conditions being unlikely due to the existing separation of powers and multiple levels of government in most countries (Shafritz et al. 20117) and the underlying economic trade-offs that guide decision-makers policy choices (Sowell 2004b). Additionally, even if these two conditions were to be fulfilled, the approach does not offer much of a strategy towards some of the disadvantages of expanding higher education, like mitigating the possibility of the education providers of these institutions trying to influence students' personal opinions.

Second, and more importantly, the objective of the text is to find a more innovative approach. While expanding higher education via investing in public institutions could be highly effective, the conventional nature of this strategy could limit the creativity of proposing policy solutions. On the contrary, the text is looking about a policy solution that follows Fourier's ([1829]1989) vision: a method for new technologies to be used to solve longstanding problems in societies and improve the populations' quality of life. Therefore, a proposal that implements new technologies to solve this societal challenge is favored.

Applying new technologies: A case for Online higher education

One of the many manifestations of the expansion of digital communications in modern societies has been the creation of online higher education (Wolff 2021). Some authors, as Kentnor (2015) have summarized the systems and its main elements: users can now enroll in higher education programs, anything from an associate degree to doctoral studies, in which they receive login access to a digital platform that contains the complete coursework for their desired field of study. The providers of this type of higher education are mostly universities, but some businesses also provide platforms and even programs for students' instruction. While there is some variance in their offerings, most of these portals provide a series of audiovisual recordings and the written instruction material for the courses, recurrent and scheduled virtual classes with instructors, time-sensitive assignments, virtual discussion forums and other tools of communication between students and their instructors.

As with other Public Interest Technologies (McGuinness and Schank 2021), there are many reasons to believe that online education can offer numerous benefits to society. However, the question remains: can digital higher education overcome the drawbacks acquisition of conventional higher education and be a feasible alternative? According to the literature, to have the greatest impact, this technology should be able to provide the benefits associated with the acquisition of higher education (Becker 1994), while also addressing:

1) instructors exerting arbitrary or unjustified influence on students (Raschke 2003),
2) unequal access for students belonging to racial and gender minorities (Polos et al. 2022) or in a precarious economic situation (Page and Scott-Clayton 2015), and;
3) higher education's relatively low (Clarey 2015; Dale and Krueger 2002) or differentiated (Weinberger 1999; Zhang et al. 2024) returns on investment.

Although relatively new, this technology holds promise in solving many of the major challenges documented in the literature. Indeed, online higher education's qualities and capacities could make it a viable tool to expand higher education throughout societies, while solving most of the problems related to its acquisition. It is also possible that using this technology could be a viable solution, given the existing and growing digital infrastructure.

Hypothesis 1: there should be fewer negative interactions between students and their instructors among online than in-person higher education programs.

Online higher education could reduce unwanted influence from professors to students. Since this education format relies heavily on the physical distance between the members of the classroom (Kentnor 2015), the provision of this type of higher education could result in less overall interactions between professors and students. Numerous studies have found that the establishment of continuous interactions are preconditions to the exertion of influence from one individual to another (Cialdini 2007). Since this modality of education reduces the opportunity for professors and students to automatically be placed in conditions to engage in a closer relationship, it is reasonable to believe it could be conducive to reducing the unwanted influence students may receive from their instruction providers.

Of course, this does not mean that this type of education would necessarily condemn students to miss the opportunity of deepening the relationship with their instructors. After all, there would be nothing disallowing students and instructors to purposefully engage digitally or in real life, which would result in students bonding with their professors during or after their studies. However, in this approach, the process would require learners to consent to receiving that intellectual influence from their instructors and intentionally seek it, as opposed to it being imposed on them as a byproduct of being students.

Hypothesis 2: online higher education programs should be more accessible for historically vulnerable demographic groups than in-person programs.

There is reason to believe that virtual education could also make important contributions to facilitating access to students of a disadvantaged racial and gender background. Since virtual schooling does not require the physical presence of students, professors or other restrictions related to space, this allows these programs to offer education as a non-rival good and accept a higher number of students (Morris 2008). As a result, online

programs could accept more students that, as a product of historical segregation towards individual's race and gender in western societies, traditionally had fewer learning opportunities and more barriers of being accepted into college (DeSilver 2023).

Hypothesis 3: online higher education programs should be more economically accessible than their in-person counterpart.

It is also reasonable to think that online higher education is more easily accessible for students that live in economically vulnerable households. Online programs do not require land and property costs for institutions that impart education, and avoid many other additional costs involved with attending college, as transportation, housing and meals. Moreover, since online education does not require students to be physically present at the institution to take classes, this education can minimize opportunity costs for low-income learners by reducing the time they must commit to in-person responsibilities (i.e. time costs during transportation) and allowing them to dedicate a larger portion of their time performing other activities, as applying for loans, providing for their families or taking on full-time employment, that further enhance their livelihoods (Page and Scott-Clayton 2015). Therefore, it would be reasonable to expect that online programs allow economically vulnerable students, who otherwise would not have been able to attend in-person college, attain higher education.

Hypothesis 4: students should expect a higher pay-off when studying online higher education than in-person programs.

There is mixed evidence as to if online education could also have a higher investment potential. On one hand, if the knowledge and employment prospects students gain from online higher education are almost identical to their in-person counterparts, this would imply they'd be getting the same returns out of this investment as their in-person peers; just at a fraction of the cost. The available data seems to point towards this possibility. A study from the U.S. Department of Education (2010) found that students who learned in online conditions performed just as well as students learning in an in-person setting. Additionally, a recent study from the National Association of Colleges and Employers (2024) found that, from a sample of 255 surveyed companies from the United States, among the employers who tracked their employees' degree modality, 87.4% stated that they had hired new college graduates with an online degree in the last 12 months.

On the other hand, it is not clear that online education is positively associated with a higher income. One of the few studies (George Washington University Health Workforce Institute 2019) that delved into this question directly compared median earnings of both online and in-person graduates across the country, specifically, from master's degree programs in social work programs. It found that the percentage of in-person students earning an annual income of $40,000 or more was 13% larger than those who did their degree online, although this difference was not statistically significant to a robust level and did not control for the respondents' sociodemographic characteristics.

Hypothesis 5: acquiring online education should be a feasible option for the population.

Finally, online higher education should be feasible at expanding higher education among a population. Marketwise, there is reason to believe that this is the case. In theory, since this modality does not require a physical space, it is more affordable for education providers, as they do not need to incur on many logistic costs and can easily tend to more students in a class (Morris 2008). This advantage derived from the technology could potentially allow providers of this good to face substantially lower costs of entry, resulting in a market with a staunch amount of competition that offers numerous options for prospective students. The fact that almost 300,000 fully online higher education degrees were conferred to students during the 2021 – 2022 school year just in the United States (Hamilton and Swanston 2024) could be seen as evidence of a functional market system.

What remains to be seen, however, is if the current digital infrastructure is sufficient to allow the mass adoption of higher education. This seems to be a topic of debate. On one hand, numerous studies (Cullinan 2021; Skinner et al. 2022) have found that one of the main problems with online education is that there is unequal digital access among the population: anywhere between 16% to 25% of students in the United States do not have access to broadband internet in their homes, in many cases relying on cellular data. Since this situation could imply that not all students would be able to easily access online education, these gaps in digital access could hinder the feasibility of online higher education as a tool for equitable access to knowledge and its benefits.

On the other hand, there also seems to be evidence that online education is a sound long-term prospect. The current trends (Welding 2024) show that the adoption of online higher education has been gradually increasing for the last two decades, yet the start of the

COVID-19 Pandemic, resulted in hybrid program users almost doubling from 43% to 75%, while full-time online school quadrupled from 11% to 47% during the crisis. Although the adoption decreased noticeably after the worse stages of the sanitary crisis, user adoption has remained high compared to pre-pandemic levels with a more than 10% user adoption increase for the users of both programs. Additionally, numerous experts (Marani et al. 2021) have warned that other highly contagious diseases as COVID-19 are likely to surge in the years to come, arguing that the unchanging trends in globalization will likely result in other episodes as said pandemic in the future. Therefore, online higher education's resilience against sanitary emergencies could mean it will continue to be demanded in the coming years.

Hypothesis Number	Statement	Expected Effect of Online Higher Education
Effectiveness of Online Higher Education		
H1	There should be fewer negative interactions between students and their instructors in online programs than in-person learning.	Positive
H2	Online higher education programs should be more accessible for historically vulnerable demographic groups than in-person programs.	Positive
H3	Online higher education programs should be more economically accessible than their in-person counterpart.	Positive
H4	Students should expect a higher pay-off when studying online higher education than in-person programs.	Positive or Negative
Feasibility of Online Higher Education		
H5	Getting an online education should be a feasible option for the American population.	Positive or Null

Figure 1. Summary of Hypothesis of the impact of Online Higher Education, based on the Literature Review.

3. Methodology

To test these hypotheses and visualize the potential impact of Online Higher Education, the text employs a quantitative methodology using two datasets. The first is the Baccalaureate & Beyond (B&B) Longitudinal Study (US Department of Education 2022), which is a survey conducted by the Institute of Education Sciences. The survey's sample is composed of a stratified random sample of graduating seniors enrolled in postsecondary

institutions in the 50 states of the country, DC and Puerto Rico. It is a longitudinal study that follows graduates for 4 and 10 years after they complete college and gathers information about their sociodemographic characteristics and their academic experience. The study is composed of a preliminary survey in 2016 and a follow-up in 2017 and in 2020. With the goal of measuring the effects during a longer timeframe, the data from 2020, which received more than 17,000 responses from graduates, was selected. It is restricted-use data, so it is not possible to create additional metrics (i.e. custom interaction terms between variables).

The second dataset is from the Survey of US Adults by the Pew Research (2023), a study that relies on polls performed on adults from 2000-2021 via phone, and, starting in 2023, also using mail. The organization used randomized stratified sampling to gather, on average, around 3,000 effective responses from adults belonging to different sociodemographic groups. The data from their surveys has been aggregated into a timeseries with irregular timeframes, yet only lacks full-year data for 2014, 2017, 2020 and 2022. With the objective of performing trend analysis to answer the hypothesis about the feasibility of online education, the organization's data is standardized into a yearly format, electing only the first observation in a year when multiple figures are available for said time period.

The main methodology of the text is finding evidence of a relationship between the drawbacks of higher education outlined in the literature and online postsecondary education. To do so, the document uses a series of generalized linear estimations to observe if there is a robust association between the variables in question and higher education. With the objective of making accurate estimations, the models contain a series of additional variables to control for alternative explanations (Wooldridge 2014), while also following the Parsimonious Principle (Balasubramanian 1997) by adding only a relatively few variables to minimize the introduction of bias and prioritize precision. Additionally, the text performs a linear model trend analysis between the main variable associated as a precondition to the implementation of online higher education to get a better image about the feasibility of adopting this policy.

Model Specifications

Since the assumption is that there is a linear relationship between online higher education and its benefits, the text opts for a series of generalizable models that can estimate the extent of this association. The exact specification of the tools, however, is determined by the wording of the survey's items (US Department of Education 2022). The main variable of

the survey is dichotomous and derived from the survey question: "Is your entire degree program at [National Postsecondary Student Aid Study] online?". If the answer is positive, the response is coded as 1, whereas a negative response is assigned a value of 0.

The first model measures the existence of a relationship between online higher education and negative influence professors can generate on students. To measure the latter, the most appropriate item in the survey is a question that asks graduates who pursued a teaching career to state if they experienced "positive, negative or neutral teaching influence" in college. Given the comparatively small sample size of students who qualify for this specification (n = 1400), the variable is recodified into a dichotomous scale of negative influence (1) and non-negative (0) influence to obtain a more precise and robust measure. Alongside it, the model adds controls to guarantee that the sample is balanced from the baseline, as sex (1 if female, 0 if male), being a member of a minority group (1 if non-white, 0 if white)[1], age when starting college (continuous variable) and the socioeconomic status of the student, measured by the adjusted gross income of students' households (continuous variable) in a date prior to them having finished their studies (i.e. 2014).

The second model attempts to find a relationship between online higher education and its accessibility to historically vulnerable groups. For the purposes of maintaining a sound causal logic (i.e. a person's choice of studying an online college program can't change their race or sex assigned at birth), studying online higher education is used as the dependent variable, while a person's race, sex and socioeconomic situation are used as parameters. Race and sex are measured in the survey as a series of nominal interaction variables composed of the 4 main demographic groups in the US. (Caucasian, African American, Hispanic and Asian) and additional dichotomous categories based on respondent´s assigned sex at birth. Graduates' socioeconomic situation is measured by using their aggregated gross income in 2014. Additional to these variables, graduates' age at the start of college is also introduced, as some authors (Sowell 2004b) have argued that differences pertaining the average age of certain demographic groups have often been mistaken for characteristics specific to these.

The third and fourth models look to measure if students who study online higher education are getting a greater pay–off than their in-person counterparts. Due to the ambiguity involved in defining this term, the measurement will be performed via two

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[1] There are not enough observations from the different interactions between race and sex to obtain

separate metrics. To measure graduate's subjective value of online education, the first model uses respondent's retrospective satisfaction with higher education as the dependent variable, measured by a dichotomous question that asks respondents if they thought their undergraduate education was "worth the financial cost" (1 if yes, 0 if no). Aside from controlling for respondent's age, race, sex, and economic situation prior to finishing college, a variable controlling for the graduate's college major and the graduate's cumulative loan debts in 2020 are introduced to make sure that the effects of online education cannot be mistaken with having studied majors that seem to provide larger income returns (Zhang et al. 2024) nor simply to the feelings of having a high amount of college debt (Fry et al. 2024).

The second measurement on the pay-off of online higher education seeks a more objective metric. Therefore, the respondent's gross income (continuous variable) from the year prior to the survey (2019) is selected as the dependent variable for this model, as it offers a more tangible economic valuation that is compatible with the idea of a return on investment of higher education (Clarey 2015; Zhang et al. 2024). The same variables from the subjective satisfaction valuation of higher education are added to this model.

With regards to each models' precise specifications, these vary by the nature of the dependent variable. For models with binary dependent variables, there is a preference for maximum likelihood estimation using a logistic regression. For continuous dependent variables, there is a preference for multivariate linear regression estimations. Since the answers from all survey responses were obtained in the same year, the models don't control for temporal variance in responses. The model's specifications can be summarized as follows:

Model 1: Effect of Online Higher Education on Negative Influence from Professors.

$$log\left(\frac{P(Neg.\ Influence)}{1-P(Neg.\ Influence)}\right) = \beta_0 + \beta_1(Online\ H.Ed.) + \beta_2(Age) + \beta_3(Sex) + \beta_4(Non-white) + \beta_5(S.Econ\ Sit.) + \in$$

Model 2: Effect of Race, Gender and Economic Situation on Online College.

$$log\left(\frac{P(Online\ H.Ed)}{1-P(Online\ H.Ed)}\right) = \beta_0 + \beta_1(Age) + \beta_2(Race)(Sex) + \beta_3(S.Econ\ Sit.) + \in$$

Model 3: Effect of Online College on Retrospective Satisfaction with Higher Ed.

$$log\left(\frac{P(R.Satis\ with\ H.Ed)}{1-P(R.Satis\ with\ H.Ed)}\right) = \beta_0 + \beta_1(Online\ H.Ed.) + \beta_2(Age) + \beta_3(Race)(Sex) + \beta_4(Major) + \beta_5(S.Econ\ Sit.) + \in$$

Model 4: Effect of Online Higher Education on Graduate's Income.

$$G.Income = \beta_0 + \beta_1(Online\ H.Ed.) + \beta_2(H.Ed.Loans) + \beta_3(Age) + \beta_4(Race)(Sex) + \beta_4(Major) + \beta_5(S.Econ\ Sit.) + \in$$

With regards to the time series model, the variable of interest is American household's rate of adoption of broadband internet access. Since the objective is to see if online college is a feasible solution to expanding higher education in the US, the model uses data from the percentage of American households that have access to broadband internet since the development of this technology (2000) up to the most recent survey (2023). To get a clearer image about the adoption of this technology, aside from showing the current reported data, the text employs a constant average trend model to perform forecasts on internet broadband access in the 5 coming years, assuming stable trends. This type of model is chosen over more expansive estimations (i.e. ARIMA models) because the constant average trend model is favorable when analyzing timeseries comprised of relatively few observations ($n < 30$) and because of its capacity of capturing a consistent linear trend over time. The models' general formula and prediction estimations are as follows:

Time Series Model : Broadband Internet Adoption.

$Percent.of\ US\ households\ with\ b.band\ internet = Percent.of\ US\ households\ with\ b.band\ internet_{t-1} + \delta + \in_t$

Time Series Model Estimation: Broadband Internet Adoption Forecast.

$Percent.of\ US\ households\ with\ b.band\ internet\ in\ 2029 = Percent.of\ US\ households\ with\ b.band\ internet + 5\ years\ (\delta)$

Results

The main results of the estimations are summarized in the tables below. The estimated figures show mixed evidence in favor of online higher education's versatility. Regarding online education's capacity of reducing negative influence from professors, the first model shows that, on top of the fact that only 1,400 graduates went into teaching, only 7% of this sample reported having experienced a negative teaching experience in college. The standardized full sample coefficients show that, controlling for all other variables, going into online education had a positive effect of making graduates 23% more likely of experiencing negative influence from their teachers, although this effect is not statistically significant to even marginally robust levels (p-value > 0.10). Conversely, as graduates get older, they are up to 57% less likely to stating they experienced negative teaching experience, while female students seem to be 30% more likely of experiencing negative influence from their professors; both effects being robust at a significance level of above 5%.

	Full sample weight	WTB000
	Number of replicates	200
	Percentage of observed over total case	7%
	Coarsened number of cases	1,400
	Model Includes	5 variables and Intercept
	Problems detected	None
	Dependent variable	Teaching influences, as of 4 yrs after BA: Teacher accountability Event/Desired Outcome: Negative influence

	Standardized b	Standard Error	t	p-value
Distance education: entire program at NPSAS was online				
Reference Group: No				
Yes	0.228	0.171	1.339	0.182
Age, as of BA completion				
Age, as of BA completion	-0.568	0.238	-2.384	0.018
Adjusted Gross Income (AGI)				
Adjusted Gross Income (AGI)	0.057	0.124	0.460	0.646
Sex assigned at birth				
Reference Group: Male				
Female	0.300	0.115	2.615	0.010
Race/ethnicity (with multiple)				
Reference Group: White				
Non-White	-0.067	0.128	-0.521	0.603

Figure 2. Logistic Regression Model 1: Effect of Online Education on Professor Influence (B&B 2016/20)

The results of the second model seem mostly consistent with the arguments in favor of online higher education being more accessible. When looking into race and gender, the standardized full sample coefficients indicate that, controlling for all other variables, African American men are 12% more likely to enroll on an online collage program compared to Caucasian males, while African American women are 10% more likely to do so. Caucasian

women are also 11% more likely to enroll in an online program, compared to their male counterparts. These effects endure at a significance level of above 5%. Conversely, Hispanic males and females, as well as their Asian counterparts are less likely to go into online programs, and these results are also mostly statistically significant. With regards to students' economic situation, leaving all else constant, increases in students' household income are associated with up to a 35% decrease in their likelihood of being part of an online education program, achieving a significance level of above 0.1%. Finally, as a student's age increases, it is positively associated with an up to 47% increase in likelihood of enrolling in an online higher education institution, also at a high statistical significance level.

With regards to online programs' ability of increasing the value of postsecondary education, the results are mixed. On one hand, the third model shows that, all things equal, online programs seem to be associated with a 3% increase in students' satisfaction with their undergraduate studies, but this finding is not statistically significant to an even marginally robust level ($p > 0.10$). Asian males and females seem to be between 8% to 10% more satisfied with their education compared to Caucasian males, while an increase in age also seems to be associated with an up to 23% increase in satisfaction, all of these at a significance level of above 5%. Finally, while none of the majors seem to be associated with a statistically significant decrease in satisfaction with their college education, graduates from computer science, engineering and health services show modest positive and statistically significant effects of being satisfied with their undergraduate studies.

		Standardized b	Standard Error	t	p-value
Full sample weight	WTB000				
Number of replicates	200				
Percentage of observed over total case	88%				
Coarsened number of cases	17,900				
Model Includes	9 variables and Intercept				
Problems detected	None				
Dependent variable	Distance education: entire program at NPSAS was online Event/Desired Outcome: Yes				

	Standardized b	Standard Error	t	p-value
Race/ethnicity (with multiple) and gender				
Reference Group: White male				
Asian male	-0.133	0.068	-1.974	0.050
Asian female	-0.148	0.056	-2.628	0.009
Black or African American male	0.121	0.044	2.771	0.006
Black or African American female	0.102	0.045	2.263	0.025
Hispanic or Latino male	-0.106	0.042	-2.506	0.013
Hispanic or Latino female	-0.053	0.043	-1.235	0.218
White female	0.111	0.048	2.322	0.021
Adjusted Gross Income (AGI)				
Adjusted Gross Income (AGI)	-0.348	0.071	-4.907	0.000
Age at start of postsecondary education				
Age at start of postsecondary education	0.472	0.042	11.126	0.000

Figure 3. Logistic Regression Model 2: Access of Vulnerable Groups to Online Education (B&B 2016/20)

		Standardized b	Standard Error	t	p-value
Full sample weight	WTB000				
Number of replicates	200				
Percentage of observed over total case	70%				
Coarsened number of cases	14,300				
Model includes	20 variables and Intercept				
Problems detected	None				
Dependent variable	Undergraduate education worth the financial cost, as of the B&B:16/20 survey Event/Desired Outcome: Undergraduate education worth financial cost				
Distance education: entire program at NPSAS was online					
Reference Group: No					
Yes		0.027	0.037	0.733	0.465
Race/ethnicity (with multiple) and gender					
Reference Group: White male					
White female		0.005	0.033	0.140	0.889
Black or African American male		0.009	0.026	0.362	0.718
Black or African American female		-0.064	0.033	-1.959	0.052
Hispanic or Latino male		-0.023	0.032	-0.708	0.480
Hispanic or Latino female		0.032	0.028	1.140	0.256
Asian male		0.083	0.028	2.931	0.004
Asian female		0.104	0.035	2.992	0.003
Age, as of BA completion					
Age, as of BA completion		0.238	0.042	5.739	0.000
Adjusted Gross Income (AGI)					
Adjusted Gross Income (AGI)		0.025	0.022	1.119	0.264
Cum. amount owed, principal & interest, all loans for undergraduate					
Cum. amount owed, principal & interest, all loans for undergraduate		-0.557	0.036	-15.375	0.000
Field of study: undergraduate (11 categories)					
Reference Group: Other applied					
Computer and information sciences		0.130	0.034	3.781	0.000
Engineering and engineering technology		0.202	0.030	6.816	0.000
Bio & phys science, sci tech, math, agriculture		0.042	0.027	1.565	0.119
General studies and other		-0.020	0.026	-0.775	0.439
Social sciences and humanities		-0.051	0.033	-1.555	0.122
Personal and consumer services		-0.030	0.024	-1.236	0.218
Military technology and protective services		-0.032	0.031	-1.040	0.300
Health care fields		0.126	0.033	3.821	0.000
Business		0.037	0.033	1.126	0.261

Figure 4. Logistic Regression Model 3: Online Education on Satisfaction with College (B&B 2016/20)

On the other hand, the fourth model shows that, controlling for all other variables, online higher education is positively associated with a more than $5,000 yearly income increase compared to in-person education, and this finding surpasses a significance level of above 1%. Each year a person has is associated to a 500$ dollar increase in annual earnings, while a person's prior household income is associated to an additional 25 cents per dollar. Excluding Caucasian females, all other demographic groups experience earnings between

$4,000 and $15,000 dollars less than their male counterparts. There is variance between the associated income increase of each major, but computer science and engineering majors are top earners with $20,000 increases, while biology and math majors tend to be the ones earning the lowest (–$4,600). All these figures also achieve a significance level of above 5%.

	b	Standard Error	t	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
Full sample weight				WTB000		
Number of replicates				200		
Percentage of observed over total case				70%		
Coarsened number of cases				14,300		
Model Includes				20 variables and Intercept		
Problems detected				None		
Dependent variable				Gross income in 2019		
Intercept	33,264.139	2,646.982	12.567	0.000	28,076.055	38,452.222
Distance education: entire program at NPSAS was online						
Reference Group: No						
Yes	5,905.649	1,916.729	3.081	0.002	2,148.861	9,662.437
Adjusted Gross Income (AGI)						
Adjusted Gross Income (AGI)	0.025	0.005	5.022	0.000	0.015	0.035
Age, as of BA completion						
Age, as of BA completion	497.795	115.075	4.326	0.000	272.248	723.343
Race/ethnicity (with multiple) and gender						
Reference Group: White male						
White female	6,149.273	4,746.482	1.296	0.197	-3,153.833	15,452.378
Hispanic or Latino male	-9,230.065	2,097.066	-4.401	0.000	-13,340.313	-5,119.816
Hispanic or Latino female	-10,923.147	2,394.878	-4.561	0.000	-15,617.109	-6,229.186
Black or African American male	-15,506.516	1,602.240	-9.678	0.000	-18,646.908	-12,366.125
Black or African American female	-4,623.187	2,075.795	-2.227	0.027	-8,691.747	-554.628
Asian male	-8,825.074	1,543.363	-5.718	0.000	-11,850.066	-5,800.082
Asian female	-7,473.553	1,083.549	-6.897	0.000	-9,597.310	-5,349.796
Cum. amount owed, principal & interest, all loans for undergraduate						
Cum. amount owed, principal & interest, all loans for undergraduate	-0.060	0.020	-2.943	0.004	-0.099	-0.020
Field of study: undergraduate (11 categories)						
Reference Group: Other applied						
Computer and information sciences	28,611.038	3,906.804	7.323	0.000	20,953.702	36,268.373
Engineering and engineering technology	24,897.041	1,892.659	13.155	0.000	21,187.428	28,606.653
Bio & phys science, sci tech, math, agriculture	-4,467.858	1,090.635	-4.097	0.000	-6,605.503	-2,330.213
General studies and other	-1,304.074	2,868.238	-0.455	0.650	-6,925.820	4,317.672
Social sciences and humanities	-2,369.023	1,260.501	-1.879	0.062	-4,839.605	101.558
Personal and consumer services	-4,230.254	1,870.266	-2.262	0.025	-7,895.977	-564.532
Military technology and protective services	7,211.433	2,117.701	3.405	0.001	3,060.739	11,362.126
Health care fields	15,167.990	1,455.223	10.423	0.000	12,315.753	18,020.228
Business	13,118.205	1,434.275	9.146	0.000	10,307.025	15,929.384

Figure 5. Multivariate Linear Regression Model: Effect of Online Education on Income (B&B 2016/20)

With regards to the estimates of the Constant Average Trend Model, the results seem to show a rapid year to year increase in the US populations' adoption of broad internet access. According to the model, when accounting for the variance in the figures caused by the estimates from the previous year, the growth of broadband internet access in the US has followed a relatively stable average drift δ = 3.43% in the last 25 years.
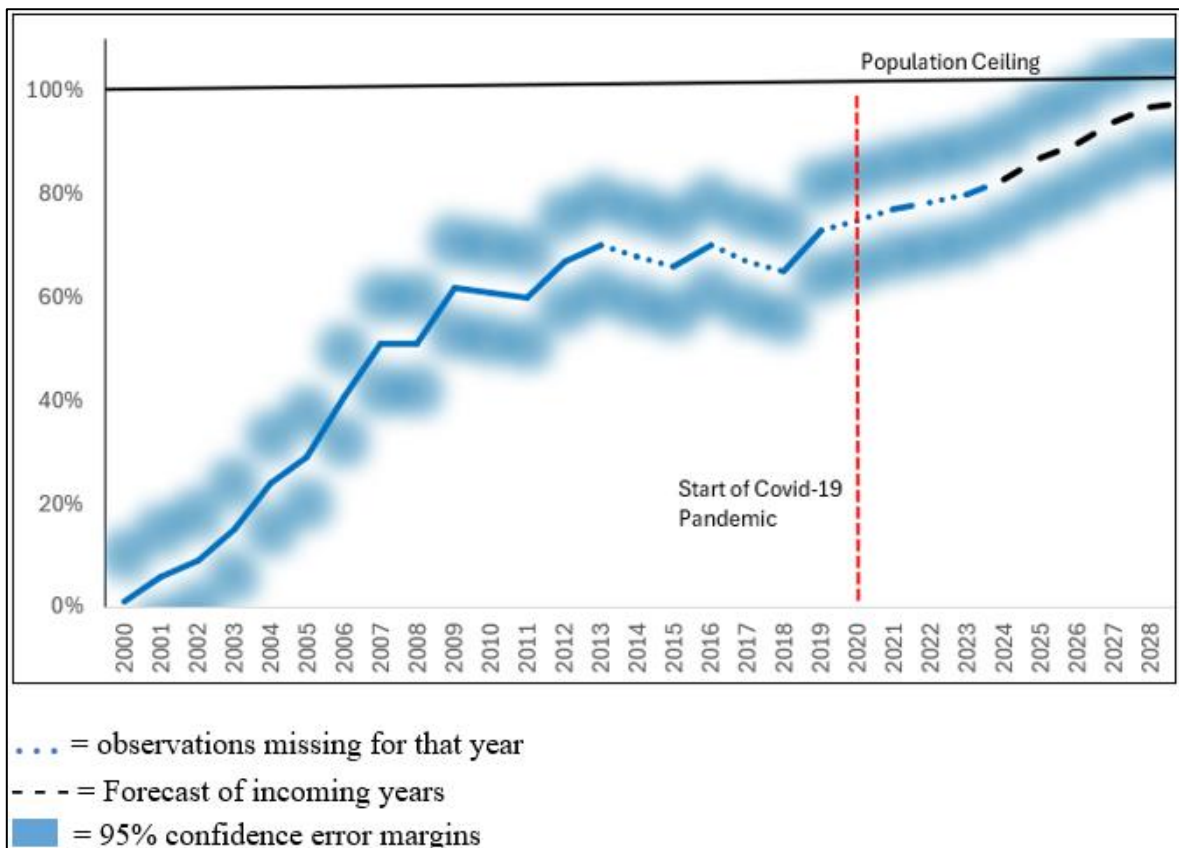

Figure 6. Constant Average Trend Model & Forecast: Time series of the Percentage of US Households with Broadband Internet Access (US Adult Survey 2000/23)

Year	Forecasted Mean	Lower Bound (80%)	Lower Bound (95%)	Upper Bound (80%)	Upper Bound (95%)
2024	0.8343478	0.7707955	0.737153	0.8979001	0.9315427
2025	0.8686957	0.7788192	0.7312414	0.9585721	1.000000
2026	0.9030435	0.7929677	0.7346971	1.000000	1.000000
2027	0.9373913	0.8102867	0.7430017	1.000000	1.000000
2028	0.9717391	0.8296319	0.7544049	1.000000	1.000000

Figure 7. Forecast of broadband internet access up to 2028 (US Adult Survey 2000/23)

Given this estimation, the model predicts that, assuming that the adoption trend of internet broadband access remains constant, by 2029, the expected broadband internet adoption in the

country will be of around 97%. When looking into the lower and uppers bounds of the prediction, internet adoption could be as low as 75% by that year, or it could already be at 100% by as soon as 2025. Even assuming the lower bound, a longer-term forecast assuming the same drift amount shows that, by 2040 at the latest, broadband internet access is expected to be ubiquitous.

Year	Forecasted Mean	Lower Bound (80%)	Lower Bound (95%)	Upper Bound (80%)	Upper Bound (95%)
2024	0.8343478	0.7707955	0.737153	0.8979001	0.9315427
2025	0.8686957	0.7788192	0.7312414	0.9585721	1.000000
2026	0.9030435	0.7929677	0.7346971	1.000000	1.000000
2027	0.9373913	0.8102867	0.7430017	1.000000	1.000000
2028	0.9717391	0.8296319	0.7544049	1.000000	1.000000
2029	1.000000	0.8504163	0.7680092	1.000000	1.000000
2030	1.000000	0.8722913	0.7832814	1.000000	1.000000
2031	1.000000	0.8950296	0.7998741	1.000000	1.000000
2032	1.000000	0.9184736	0.817546	1.000000	1.000000
2033	1.000000	0.9425083	0.8361212	1.000000	1.000000
2034	1.000000	0.967047	0.8554673	1.000000	1.000000
2035	1.000000	0.9920224	0.8754812	1.000000	1.000000
2036	1.000000	1.000000	0.8960808	1.000000	1.000000
2037	1.000000	1.000000	0.9171998	1.000000	1.000000
2038	1.000000	1.000000	0.9387835	1.000000	1.000000
2039	1.000000	1.000000	0.9607859	1.000000	1.000000
2040	1.000000	1.000000	0.9831685	1.000000	1.000000

Figure 7a. Forecast of broadband internet access up to 2040 (US Adult Survey 2000/23)

Limitations

Despite the findings from the exercise, it is important to highlight some of its limitations. The first is a reduction in accuracy with some of the measurements. The survey item used to measure "negative influence from professors" was only directed to students interested in teaching and was ambiguous of what that influence implied (i.e. bad example). Since the measurement didn't exactly correspond to the definitions from the literature, there could have been a gap between the instrument used and the desired measurement. Additionally, the analysis used Adjusted Gross Income to estimate student's economic situation and a graduate's reported income in 2019 as an objective measurement of their investment in education. Although these metrics make sense for the purposes of testing the hypotheses, the former doesn't measure as precisely the exact economic status of the student´s household and the later assumes that a graduates' income some years after

graduating is a generalizable predictor for personal success, which could not be the case. In the same way, the timeseries data only covered the relatively brief period of time in which broadband internet has existed using yearly measurements, and even then was missing some of the years. As a consequence, the model's forecasts might not be as precise.

A second problem is that the exercise didn't cover all of the drawbacks outlined in the literature. The text could not conceive of a strong theoretical argument about how online higher education could standardize career outcomes for different majors (Zhang et al. 2024). The restricted nature of the dataset also did not allow for the introduction of more interactions to the model, like variables that measure differences between majors and online and in-person college. Therefore, there are various areas of opportunity to continue expanding this research.

Findings and Discussion

Based on the results, it seems that channeling digital technologies via online higher education could be a feasible option to expand postsecondary education in the United States, but it might not be able to mitigate all of the drawbacks related to the acquisition of this good. On one hand, the exercise found evidence that African American and Female students had more access to online education, and this type of education was more economically accessible compared to in person education. In the same way, the results showed that it seems to be associated with a noticeably higher yearly income for its users; even when controlling for their age, student loans and majors. Finally, current trends in broadband internet adoption make it seem increasingly likely that, in less than a generation, the number of households without broadband internet access will be negligible. Therefore, employing this strategy, from a digital infrastructure perspective, seems feasible.

On the other hand, the study didn't offer evidence that online higher education could solve all of the challenges outlined in the literature. First, no evidence was found that online education could reduce the negative influence of professors on students. Additionally, there was not robust evidence that online education could increase graduates' personal satisfaction with investing in higher education. Finally, although the exercise found indices of the technological feasibility of online higher education, the study did not provide quantitative evidence to support the feasibility of online education from the market's interest: given the

novelty of this type of education, it is still uncertain if education providers will find compatible business models to produce this technology and satisfy student demand.

In the same way, when looking into the nuances of the results, there might be additional reasons to believe in some of the benefits of online college. First, although enrolling in online college was not associated to student´s being more satisfied with their education, there was also no indication that graduates considered it less satisfactory than in-person alternatives. Additionally, although a theoretical case on why online programs could standardize the pay-off students get from studying non-high paying majors (Zhang et al. 2024) was not explored, since the exercise offered evidence that online college is more economically accessible (lower investment) and is associated with a resulting higher income than in-person college (higher returns), this could contribute to graduates feeling that acquiring higher education online, in whatever field they choose, is a more worthwhile endeavor.

Finally, there are additional reasons to think that, despite its drawbacks, the use of digital technologies in favor of expanding higher education still seems like a sound prospect. According to the literature on policy implementation (Lipsey and Lancaster 1956), a relevant view for electing a strategy is not so much guaranteeing that it is flawless. Rather, what matters is that it retains the qualities of a "Second Best" option: although a solution might not be able to solve all the issues involved in a public problem and might bring additional hurdles, its value lies in it providing the best outcome that can actually be achieved, given all the constraints faced when tackling a problem. Under this perspective, assuming the findings related to the accessibility, higher expected value and feasibility of online education from this exercise can be consistently replicated, the potential benefits of expanding online higher education could enough to make it among the best solutions for parties interested in bolstering development in communities in a sustainable manner.

Future Research

The introduction of digital technologies into contemporary societies has sparked the literature of public interest technologies (McGuinness and Schank 2021; Sun 2022), which has been focused in finding ways in which technology can be used to bolster social welfare (Wolfe 2021). Following this approach, the text argues that introducing digital technologies

in the realm of education in the form of online higher education could be a successful strategy to increase a population's individual and aggregate welfare, from a lens of equality and social justice. Based on a review of the literature concerning the advantages and drawbacks of acquiring higher education, the text uses data from the Baccalaureate and Beyond Longitudinal Study (US Department of Education 2022) and the Pew Research Center's US Adult Surveys (2023) to observe if online college was able to reduce the unwanted influence students could experience from their instructors, facilitate the access to education among vulnerable sociodemographic groups, and make the investment more attractive and worthwhile to students; as well as observe if this approach would be feasible to implement given the current digital infrastructure. The results support the arguments that propose online education as more accessible to historically vulnerable demographic groups and individuals in less privileged economic situations, that this education modality has the potential of offering higher returns than in-person education, and that the US's current digital environment makes it a feasible alternative.

Although this study strives to explore the potential advantages of online education, it seems evident that further research is invaluable. Based on these findings, and to further understand the potential of using online education to improve development and equality, studies and experiments employing mixed-methods approaches, combining qualitative and quantitative methodologies, could offer more robust evidence and accurate findings. It is likely that future work that seeks to gain more evidence of the effectiveness and feasibility of online education should incorporate a qualitative component that includes in-depth information from the main stakeholders: students, educators and administrators enrolled or in charge of online education programs. Specifically, obtaining the perception of these populations regarding additional trade-offs and dynamics involved with the provision of online higher education, could shed light into additional variable and confounders that haven't been considered by this analysis or an important portion of the literature.

With regards to additional research venues, it could be valuable to verify if the societal advantages of higher education also apply to online higher education. In this sense, there's always a possibility that in-person and online education generate different societal outcomes; it would be valuable to know if the fact that online higher education reduces in-person interactions among students weakens their adoption of additional knowledge, like critical

thinking skills or support for democracy. There's also a chance that the effect of online higher education could also be affected by other variables, as the selectivity of the institution that offer it, the size of the cohorts, etc. Finally, more research differentiating both the academic level and modality of the program students coursed would be useful to understand if there are additional variables involved in producing the individual and societal level benefits of higher education.

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