WHY ARE THE PRICES SO D*MN HIGH?

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Health, Education, and the Baumol Effect

Eric Helland and Alexander Tabarrok

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Printed in the United States of America

ISBN-13: 978-1-942951-55-1 paperback
ISBN-13: 978-1-942951-56-8 ebook

Mercatus Center at George Mason University
3434 Washington Blvd., 4th Floor
Arlington, VA 22201
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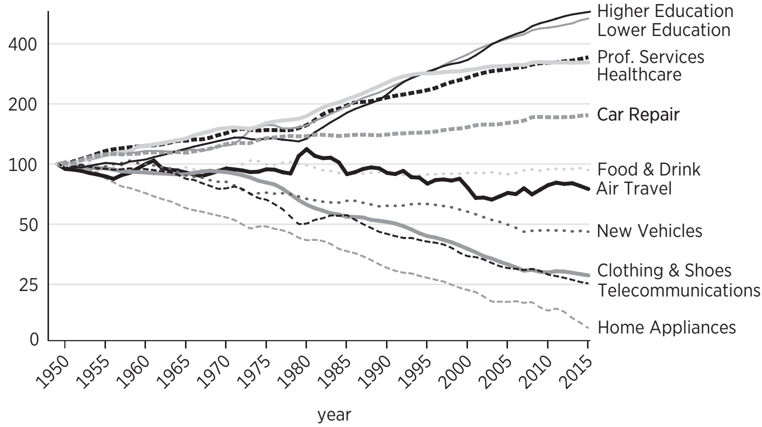
Why are prices in some sectors increasing dramatically even as economy-wide technology and productivity improve? Education and healthcare are notable examples of sectors seemingly stricken by constantly rising prices. At the same time, home appliances and telecommunications have become much cheaper. Why? Is there a common factor that unites sectors afflicted by rising prices and sectors blessed by falling prices, or are we simply seeing idiosyncratic price increases driven by random ebbs and flows in technology and demand?

Figure 1 shows the real price of a wide range of consumer goods and services from 1950 to 2016. All prices have been normalized to 100 in 1950. The goods and services shown were selected to span the range of price increases and decreases. At the top of the graph, higher education has increased in price by a factor of nearly six since 1950 (from 100 to 586). The price of lower education, meaning elementary and secondary schools, has increased in lockstep with that of higher education (from 100 to 534).[1]

Also seeing large increases in prices are professional services, such as legal, accounting, and other business services, and healthcare. In each case, these services have increased in price by a factor of more than three since 1950.

1. For higher education, the price given is the amount of average tuition and fees per student, which is less than the actual cost per student, as discussed later in this study.

Figure 1. The Real Price of Selected Goods and Services, 1950–2016



Note: Prices normalized to 100 in 1950. Ratio scale.
Source: Bureau of Economic Analysis (BEA), "National Income and Product Accounts."

At the bottom of figure 1, goods and services have fallen in price. Home appliance prices have fallen by a factor of about seven since 1950. The first microwave, for example, was produced in 1947. It weighed about 750 pounds, stood nearly six feet tall, and needed to be cooled by running water. Only eight years later, a large domestic version that didn't require plumbing was available for $1,295.[2] In today's (2016) dollars, $1,295 is about $11,600. A superior microwave can be bought on Amazon today and delivered for $129—a fall in price of about 10 times.

New vehicles are half the price they were in 1950. Vehicles are an interesting product because, while the price of purchasing a vehicle has halved, the price of maintaining that vehicle has nearly doubled (from 100 to 175).[3] These nominally similar industries have very different price trends. As we will illustrate later, the distinction between producing goods (auto manufacturing)

2. Suzanne Deffree, "1st Domestic Microwave Is Sold, October 25, 1955," *EDN Moments* (EDN Network), October 25, 2018.

3. Note, however, that fewer repairs are needed because car quality has also increased.

and services (auto repair) is an important clue to explaining divergent price trends.

Air travel has fallen modestly in price, especially after deregulation in the late 1970s. The modest fall in price is perhaps understandable. Note that the Boeing 707 introduced jet travel to the commercial market in the 1960s and 1970s, but growth in air transport speed and capacity declined after that time with arguable retrogression in airport delays and comfort.[4]

These are the basic facts motivating our exploration of the causes of rising prices. We turn now to three case studies: lower education, higher education, and healthcare. We first examine a host of proposed explanations for rising prices in these sectors. After finding many of the explanations lacking, we turn to a broader explanation proposed by William Baumol[5]—namely, that price increases in labor-intensive sectors are a consequence of greater productivity growth in goods-producing sectors. A proper understanding of the Baumol effect implies that some price increases are a sign not of failure but of success.

After exploring the Baumol effect and what it predicts, we supplement our case studies with a statistical analysis of 139 industries. We conclude with a discussion on how to overcome the Baumol effect.

EDUCATION

We begin our detailed case study of the education sector, both lower and higher education, with the facts about price and cost increases. Only then can we turn to an examination of theories, such as the bloat theory, that try to explain rising prices.

4. Robert J. Gordon, *The Rise and Fall of American Growth: The U.S. Standard of Living since the Civil War* (Princeton, NJ: Princeton University Press, 2017). Airplane safety, however, increased markedly over the 1950 to 2016 period.

5. William J. Baumol, "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis," *American Economic Review* 57, no. 3 (1967): 415–26.

Cost Increases in Elementary and Secondary Schools

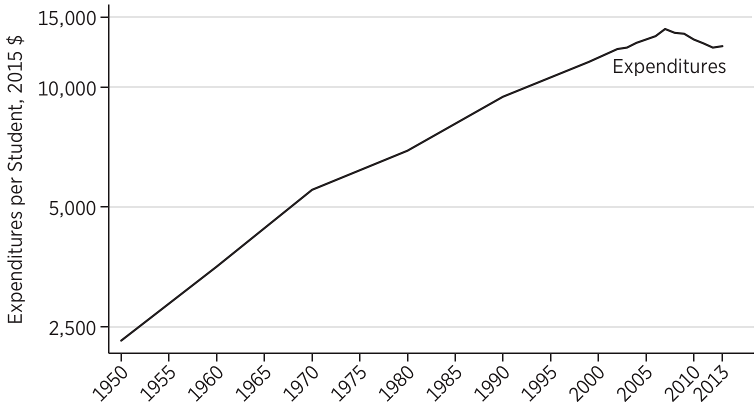
The cost of elementary and secondary education has been increasing steadily and almost without pause since the 1950s. Figure 2 shows the real (inflation-corrected to 2015 dollars) expenditure per student from 1950 to 2013. In 1950 the United States spent $2,311 per student compared with $12,673 in 2013, over five times more. The graph is on a ratio scale, so slopes can be interpreted as growth rates. Note that since 1950, costs per student have increased almost continually, but the growth in costs was highest in the 1950 to 1970 period. Growth slowed somewhat between 1970 and 2008, and then, unusually, expenditures fell with the financial crisis and recession that began in 2008.

One simple explanation for higher costs per student could be that quality has increased. Has education quality improved by a factor of more than five since 1950? Simply put, no. We do not have standardized test data from the 1950s and 1960s, but we have standardized test data going back to 1978. Figure 3 shows math scores for 17-year-olds normalized to 100 in 1978 and real expenditures normalized to 100 in 1980. It is clear that costs have been increasing without any concomitant increase in scores. Test scores in other subjects for students of different ages sometimes show small improvements, but no metric of school quality shows any improvement that would appear to justify a cost increase of more than five times. Improvements in quality do not appear to explain increases in cost.

Price and Cost Increases in Higher Education

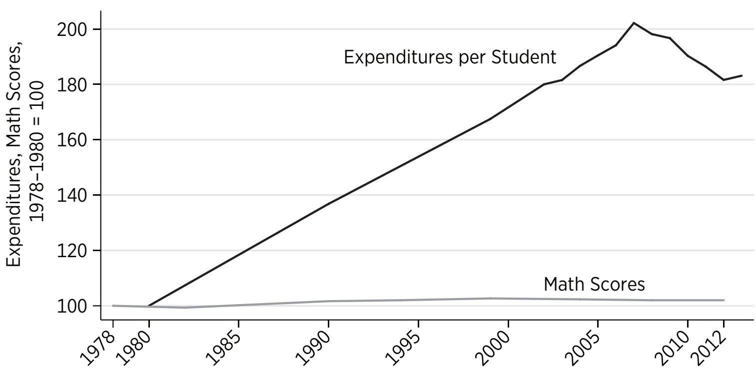
The costs of lower education are mostly paid by taxpayers. Students and their parents, however, pay a significant share of the costs of a college education, and as a result, college costs are a subject of perennial concern. College costs are "out of control," say headlines found in recent years at the *Washington Post*,

Figure 2. Real Expenditures per Student, US Elementary and Secondary Public Schools, 1950–2013



Note: The Y axis uses a ratio scale.
Source: National Center for Education Statistics (NCES).

Figure 3. Relative Growth in Expenditures and Math Scores, United States, 1978–2015



Notes: Expenditures are real expenditures for US public elementary and secondary schools. Math scores are for 17-year-olds on the National Assessment of Educational Progress (NAEP). Math scores and real expenditures are normalized to 100 in 1978 and 1980, respectively.
Source: NCES.

Forbes, and *USA Today,* among many other periodicals.[6] Sam Becker offers a representative observation:

> College costs are out of control, there's no denying it. Over the past 30 to 40 years, the price has skyrocketed 1,120%, to the point where higher education is simply unaffordable for many people, and those that do take on the financial burden are now saddled with an average of $35,000 in debt.[7]

Thirty years earlier the *New York Times* also referred to "out-of-control" college costs,[8] and 50 years earlier William G. Bowen warned of "increasingly severe cost pressures," noting that between 1905 and 1966, an index of educational cost had risen twentyfold while economy-wide costs had increased less than fourfold.[9]

The data do support the standard narrative. Figure 4 shows the average tuition plus room and board at public and private institutions of higher learning (essentially, two- and four-year colleges) from 1980 to 2015. All prices are corrected for inflation and presented in 2015 dollars. Prices are much lower at public than at private institutions. The vertical scale is a ratio scale, so equal slopes mean equal rates of growth. Thus, although prices are lower at public institutions, the rate of growth in prices has been similar at private and public institutions. Between 1980 and 2015, real prices more than doubled.

Tuition and fees do not pay all the costs of education, so we need to distinguish between tuition and costs. Figure 5 compares real

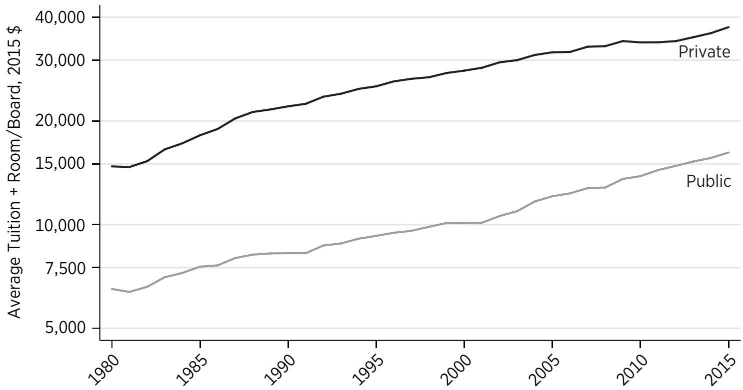
6. A Google search for "college costs out of control" will find many more examples.

7. Sam Becker, "The Simple Reason College Tuition Costs Have Exploded," *Cheat Sheet*, January 1, 2017.

8. Bruce M. Carnes, "Slowing Down Out-of-Control College Costs," letter to the editor, *New York Times*, February 21, 1987, 26.

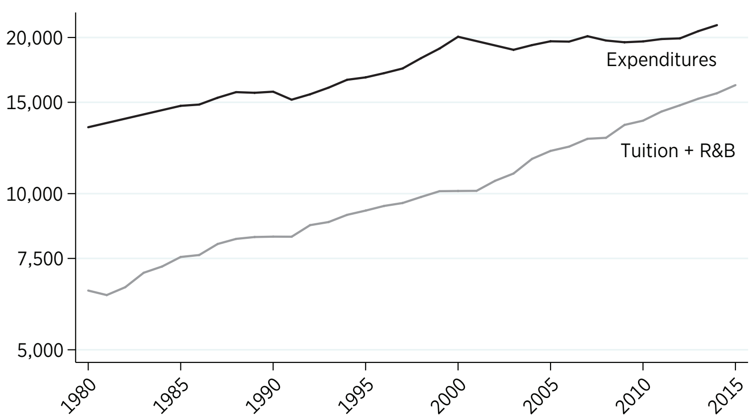
9. William G. Bowen, *The Economics of the Major Private Universities* (Berkeley, CA: Carnegie Commission on Higher Education, 1968).

Figure 4. Average Tuition Plus Room and Board, Public and Private Institutions of Higher Learning, 1980–2015



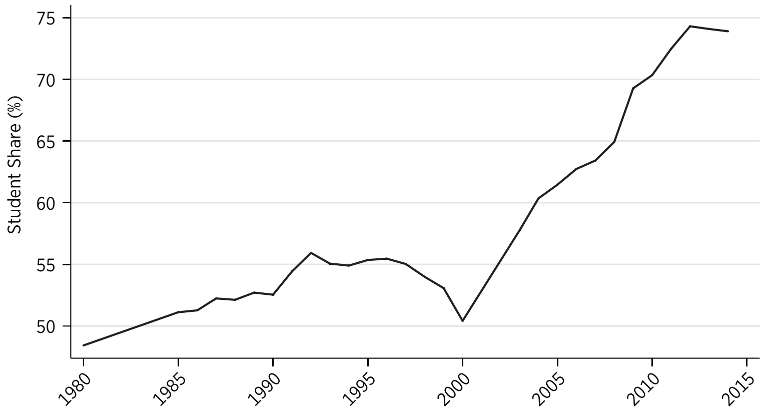
Notes: Prices are in 2015 dollars. The Y axis uses a ratio scale.
Source: NCES.

Figure 5. Expenditures Compared with Tuition Plus Room and Board (Average per Student), Public Institutions of Higher Learning, 1980–2015



Notes: Prices are in 2015 dollars. The Y axis uses a ratio scale. R&B = room and board.
Source: NCES.

Figure 6. Student Share of Costs,
Public Institutions of Higher Learning, 1980–2015



Source: NCES.

expenditures per college student with tuition plus room and board at public institutions (the public line in figure 4). We focus on public institutions because they are the dominant players. Enrollment in public institutions (14.7 million in 2014) is about three times as high as enrollment in private institutions (4 million in private nonprofits and 5.5 million in private institutions of all types).

Expenditures per student are considerably higher than prices per student, and both have been increasing. As before, we use a ratio scale on the vertical axis so that slopes indicate rates of growth. The rate of growth in tuition has been faster than in expenditures, so students have been paying a larger share of costs over time. We can see this directly in figure 6, which looks at the average student's share of costs by year. The rate of growth in the student share of costs was especially large between 2000 and 2015, when the student share increased from approximately 50 percent to nearly 75 percent. Most public universities today receive the majority of their funding from students rather than from taxpayers.

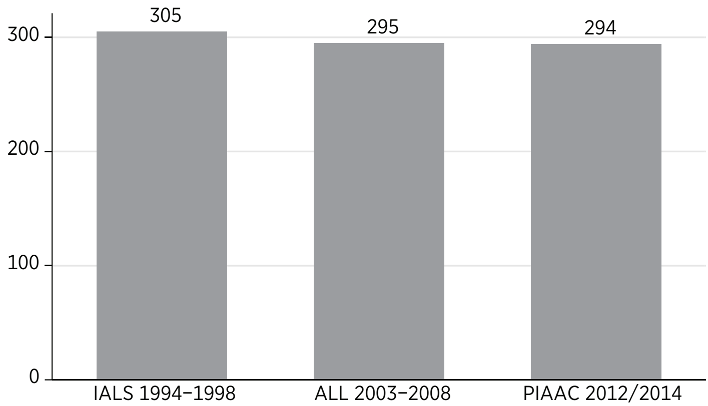
Students and their parents are worried about the price of education because they have been paying an increasing share of the increasing cost of higher education. In addition, the sticker price of education has been rising even faster than the net price (shown here). Even though the average student is paying around $16,000, including room and board, it is easy to find sticker prices of $35,000, $50,000, or higher, even at state universities. Increased inequality has encouraged universities to raise sticker prices and then offer financial aid to students on the basis of income. Higher-income students pay full price while lower-income students are offered significant discounts.

The rise in the sticker price relative to the net price makes it seem as if college is even more expensive than it is. Nevertheless, the cost of education has increased steadily over the 20th century and is continuing to increase in the 21st century.

As with elementary and secondary school education, one might ask whether quality changes account for the increasing cost of education. Unfortunately, we do not have standardized test data for college students as we do for elementary and secondary school students. Nevertheless, the idea that quality has increased seems a stretch. College classrooms have changed very little in hundreds of years, let alone since 1980. "Chalk and talk"—now sometimes elevated to "PowerPoint and talk"—remains the predominant method of teaching, and there is no evidence that students today learn more or faster than in the past.

The data that we do have on college quality do not suggest large improvements. For example, figure 7 shows data on literacy (on a 500-point scale) from three surveys of adults with more than a high school education that were completed in the 1994–1998, 2003–2008, and 2012–2014 periods. There is no evidence of an upward trend, and indeed the trend is slightly downward. The evidence is hardly dispositive that college quality is declining, but we likewise find no evidence that college quality is rapidly increasing.

Figure 7. Three Surveys of Adult Literacy, Adults with More Than a High School Education

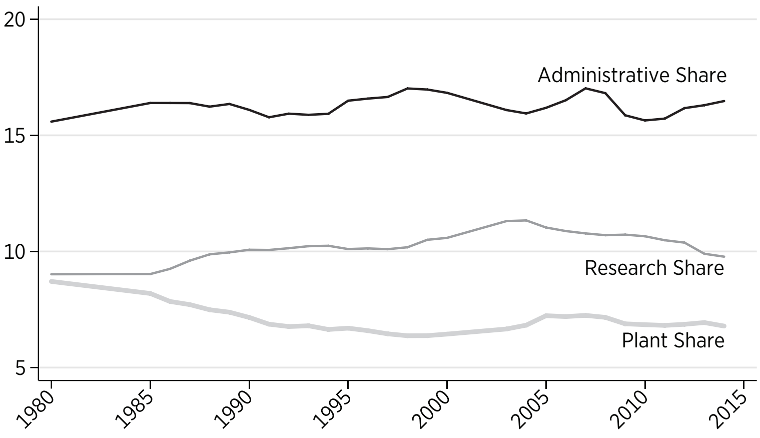


Note: The Y axis uses a 500-point scale.
Sources: NCES, "International Adult Literacy Survey [IALS]," "Adult Literacy and Lifeskills [ALL]," and "Programme for the International Assessment of Adult Competencies [PIAAC]."

It is sometimes argued that how we teach has not changed but that what we teach has improved in quality. It is questionable whether studies of Shakespeare have improved, but there have been advances in biology, computer science, and physics that are taught today but were not in the past. However, these kinds of improvements cannot explain increases in cost. It is no more expensive to teach new theories than old. In a few fields, one might argue that lab equipment has improved, which it certainly has, but we know from figure 1 that goods in general have decreased in price. It is much cheaper today, for example, to equip a classroom with a computer than it was in the past. Moreover, the research share of higher education spending has not changed much since 1980 (as shown in figure 8).

Increases in productivity usually imply more or faster output, but students are not learning more; and rather than learning faster, they are learning more slowly than in the past, at least as judged by the time to college completion. In the 1970s more than

Figure 8. Spending Shares,
Public Institutions of Higher Learning, 1980–2014



Source: NCES.

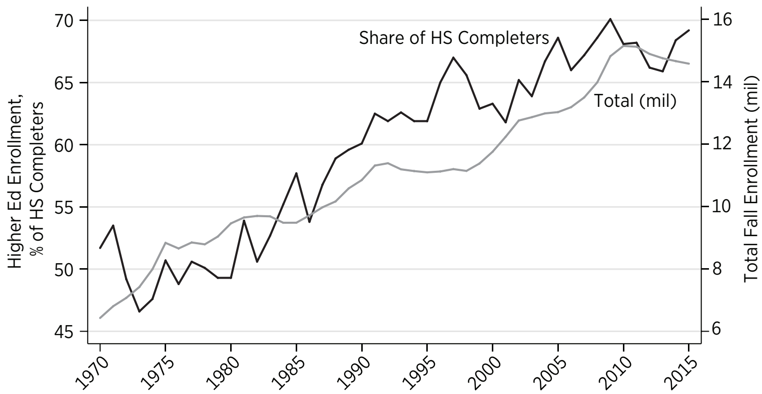
50 percent of students finished a "four-year" degree in four years, but today only 30–40 percent do so.[10]

Yet the data do contain a puzzle. Year after year pundits bemoan that college is becoming increasingly unaffordable, yet year after year more and more people go to college. Even as costs have increased, enrollment has been increasing both in total and as a share of recent high school completers, as shown in figure 9. We will return to the puzzle of increasing costs and increasing enrollment when we evaluate explanations for why college costs have increased.

The bottom line in this context is not whether the quality of lower or higher education has increased, decreased, or remained

10. John Bound, Michael F. Lovenheim, and Sarah Turner, "Increasing Time to Baccalaureate Degree in the United States," *Education Finance and Policy* 7 (2012): 375–424; Doug Shapiro et al., "Time to Degree: A National View of the Time Enrolled and Elapsed for Associate and Bachelor's Degree Earners" (Signature report, National Student Clearinghouse Research Center, Herndon, VA, September 2016), 11.

Figure 9. Enrollment in Higher Education, Percentage of High School Completers and Total in Millions



Note: The percentage of high school completers is indicated on the left axis. The total fall enrollment in millions is indicated on the right axis.
Source: NCES.

constant; the bottom line is that changes in quality are not anywhere near large or sustained enough to explain the large and sustained increases in the costs of producing education. We turn now to other explanations for increases in the cost of education.

Is Bloat to Blame?

Many authors blame bloat and waste for the increasing cost of both higher and lower education. Different authors point to different sources of bloat, with amenities for students and salaries for administrators being the two most common categories. Jonathan Swartz asks rhetorically, "Is college tuition paying for essentials, or lavish amenities?" and points to Cornell University's four fitness centers, indoor swimming pool, bowling alley, ice-skating rink, football arena, golf course, tennis courts, and movie theater.[11] Similarly, in a rare feat of intellectual

11. Jonathan Swartz, "Is College Tuition Paying for Essentials, or Lavish Amenities?," *USA Today College*, May 19, 2014.

consensus, Senator Elizabeth Warren (D-MA) and former New Jersey governor Chris Christie have both blamed climbing walls and lazy rivers for higher tuition costs.[12]

Anthropologist David Graeber summarizes the views of many when he calls academic administrators one of "the 7 biggest BS jobs in America."[13] He writes,

> Over the last several decades, university administration has ballooned insanely—even while the number of teachers and students remain pretty much the same. There are hosts of new provosts, vice chancellors, deans and deanlets and even more, who all now have to be provided with tiny armies of assistants to make them feel important. First they hire them, then they decide what they're going to do—which is mostly, make up new paperwork to give to teachers and students.

Similarly, Paul Campos writes in a *New York Times* op-ed that the real reason college tuition costs so much is "the constant expansion of university administration."[14] Mark Perry offers some specific examples:

> The University of Michigan currently employs a diversity staff of nearly 100 (93) full-time diversity administrators, officers, directors, vice-provosts, deans, consultants, specialists, investigators, managers, executive assistants, administrative assistants, analysts, and coordinators. . . . The total employee compensation for

12. Kellie Woodhouse, "Are Lazy Rivers and Climbing Walls Driving Up the Cost of College?," *Inside Higher Ed*, June 15, 2015.

13. David Graeber, "The 7 Biggest BS Jobs in America," *New York Post*, May 19, 2018.

14. Paul F. Campos, "The Real Reason College Tuition Costs So Much," *New York Times*, Opinion, April 4, 2015.

this group tops $11 million per year . . . [an amount that] could support 765 in-state students per year with full tuition scholarships![15]

Similar claims are made about elementary and secondary schools. Ted Dabrowski, for example, writes,

> Administrators have taken over education.
>
> . . . Many district administrations—over and above what already exists at the school level—are simply unnecessary. They are redundant, and don't add educational value to the people who are often considered last in school funding, the students.
>
> . . . It's no wonder classroom funding has stayed flat, despite the billions more pumped into Illinois education over the past several decades.[16]

A common refrain is that administrators have grown in number much faster than teachers and sometimes at the expense of teachers. Thus Lindsey Burke and Benjamin Scafidi argue, "Since 1950, public schools all across America have added staff at a rapid rate—much faster than their increases in students."[17]

Problems with the Bloat Theory

The bloat theory is superficially plausible—university campuses are often beautiful, and the amenities available to students,

15. Mark J. Perry, "More on My Efforts to Advance Diversity, Equity, and Inclusion and End Gender Discrimination in Michigan," *Carpe Diem*, American Enterprise Institute, May 17, 2018.

16. Ted Dabrowski, "Education Burdened by Unnecessary Administration Costs," *Daily Herald* (Illinois), Opinion, May 16, 2017.

17. Lindsey Burke and Benjamin Scafidi, "Behind the Rise of Public School Costs: The Growing Number of Non-Teachers," *Daily Signal*, July 20, 2016.

from fitness centers to art galleries and movie houses, put even Google's "campus" to shame[18]—but deeper reflection demonstrates problems with this analysis. The reason education is expensive is not that costs are "out of control." To the contrary, education is expensive because over the past century, costs have increased slowly but steadily. There is no period in the past century that one can point to and say, "*That* is when bloat set in and costs ran out of control." Cost increases in education are more like rising sea levels than hurricanes.

Even if costs are not "out of control," perhaps bloat is something that increases slowly—like the extra pound that accumulates year by year until the scales can no longer be ignored. Cost increases, however, are not just consistent over time; they are consistent across education sectors. The costs of higher education and K–12 education, for example, both have increased over time and have increased at comparable rates. But higher education and K–12 education are produced under very different industrial structures. Higher education is produced in a competitive market with substantial competition and market pricing. K–12 education is produced by government monopolies with little competition or market pricing. It is difficult for the same theory to explain why both higher education and K–12 education should bloat. Indeed, one of the signs that bloat is not a productive theory is that bloat in higher education is often blamed on competition—a common term is the "amenities arms race"—while in K–12 education, bloat is often blamed on lack of competition.[19]

18. Google's campus, however, has better food than any university campus that the authors are familiar with.

19. In higher education, Cara Newlon titles her piece on bloat "The College Amenities Arms Race." For K–12, Mark J. Perry writes, "The administrative bloat in US public schools . . . illustrates a good reason to distrust government and publicly funded organizations. To paraphrase Milton Friedman, government organizations like public schools replace progress and greater efficiency with stagnation and higher costs." Many other examples could be given. See Cara Newlon, "The College Amenities Arms Race," *Forbes*, July 31, 2014; and Mark J. Perry, "Chart of the Day: Administrative Bloat in US Public Schools," *Carpe Diem*, American Enterprise Institute, March 9, 2013.

Similarly, despite the schools' very different industrial structures, education costs have also increased consistently in public nonprofit, private nonprofit, and private for-profit schools. It is very difficult for a bloat theory to explain common increases in costs across uncommon industrial structures.

The bloat theory is questionable as a theory, but we need not theorize without data. The data also reject the bloat theory. Figure 8, for example, shows spending shares for public institutions of higher learning from 1980 to 2014. Contrary to the bloat theory, the administrative share of higher education spending has hovered around 16.0 percent (15.7 percent and 17.0 percent are the minimum and maximum) with no obvious increases over more than three decades. The research share has been only slightly more volatile, averaging 10 percent (9 percent minimum, 11 percent maximum).

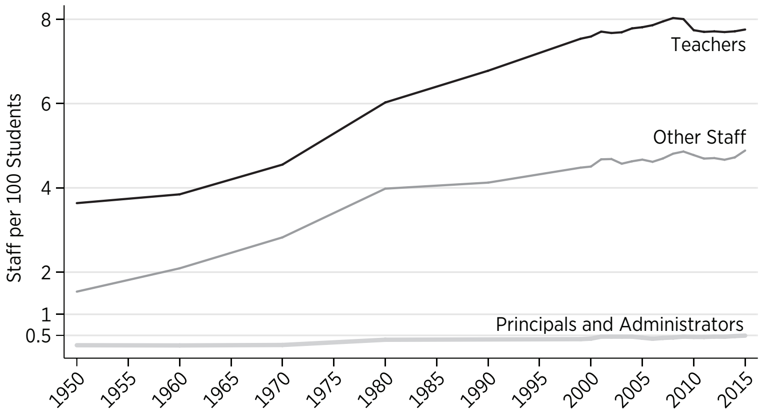
The share of spending that supports operations and maintenance of plant and equipment, called plant share, has actually declined from 9 percent in 1980 to approximately 7 percent in 2014. Plant share is where we would expect to see the long-run cost of "climbing walls," "lazy rivers," and other "edifices." Thus, the data on plant share provide no support for the bloat theory.

The bloat theory is popular because it is easy enough to find examples of bloat in higher education. The lazy rivers do exist. But to explain increasing costs, the bloat theory requires longer and lazier rivers every year, and the data do not fit that story. Bloat and complaints about bloat are probably as old as the university itself.[20]

The bloat theory fares no better when applied to K–12 education. Figure 10 shows the number of teachers, other staff, and principals and administrators from 1950 to 2015, each per 100 students. Contrary to the usual story, the number of teachers per 100 students has increased since 1950 (with only a slight drop

20. For examples, see "The University of Oxford" in *A History of the County of Oxford*, ed. H. E. Salter and Mary D. Lobel, vol. 3, *The University of Oxford* (London: Victoria County History, 1954), 1–38. Reprinted by British History Online.

Figure 10. Teachers and Other Staff per 100 Students, US Elementary and Secondary Public Schools, 1950–2015



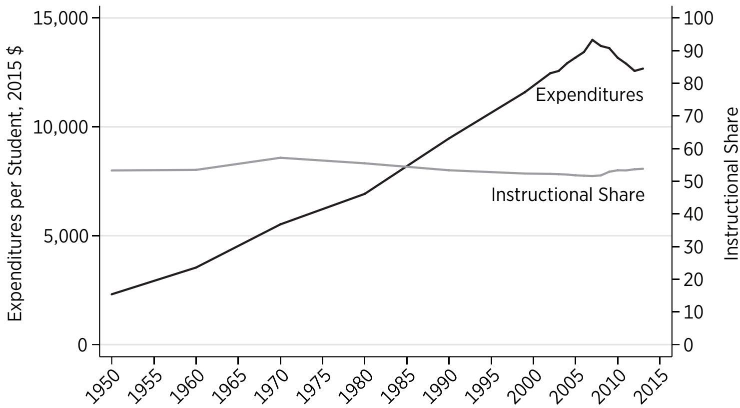
Note: "Teachers" includes instructional aides. "Other" refers to any staff not included in the other two categories.
Source: NCES.

with the recession and financial crisis in 2008–2009). The number of other staff per 100 students also has increased, but at least since 1980 the increase has, if anything, been at a slower rate than the increase in teachers per student.

Compared with teachers and other staff, the number of principals and administrators is vanishingly small, only 0.4 per 100 students over the 1950–2015 period. It is true, if one looks closely, that the number of principals and administrators doubled between 1970 and 1980. It is unclear whether this is a real increase or a data artifact (we only have data for 1970 and 1980, not the years in between during this period). But because the base numbers are small, even a doubling cannot explain much. A bloated little toe cannot explain a 20-pound weight gain. Moreover, the increase in administrators was over by 1980, but expenditures kept growing.

Similarly, figure 11 shows that although expenditures in K–12 education have increased, the share of expenditures devoted to instructional staff has been flat, averaging 53 percent with only modest variation (52–57 percent) over 65 years.

Figure 11. Real Expenditures per Student and Instructional Share, US Elementary and Secondary Public Schools, 1950–2015



Source: NCES.

Labor Costs and the Rising Costs of Education

If bloat does not explain rising costs in lower or higher education, what does? We offer a two-part answer. In this part we show that the increase in costs can be explained simply by the increasing cost of labor. Later, we draw on Baumol's theory of cost disease to explain why the cost of labor has risen and why this drives up costs in education much more than in other fields.

We already showed in figure 10 that the number of teachers has increased. The cost of teachers has also increased. In figure 12 we show instructional expenditures per teacher (in 2015 dollars) from 1950 to 2013. Real expenditures on instruction have increased during this period by a factor of 2.6, from $33,875 to $88,626. Instructional expenditures are the costs of having a teacher in a classroom and include salary and benefits but also textbooks and supplies. However, 90 percent of instructional expenditures are for teacher salary and benefits.[21] Thus, the mea-

21. Noelle Ellerson, "School Budgets 101" (White paper, American Association of School Administrators, Alexandria, VA, May 18, 2010).

Figure 12. Expenditures per Instructor, US Elementary and Secondary Public Schools, 1950–2013

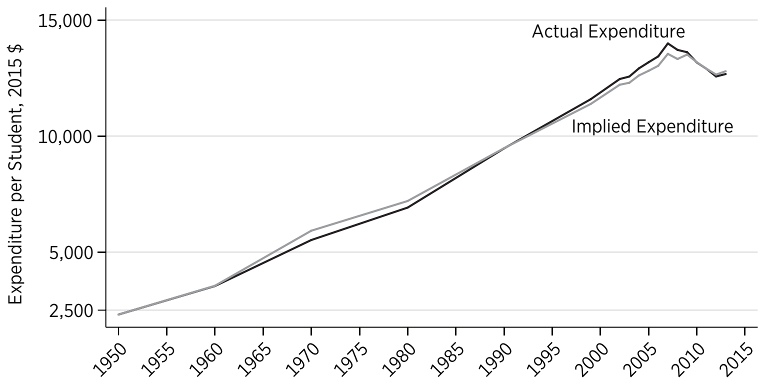
Note: The Y axis uses a ratio scale.
Source: NCES.

sure of instructional expenditures per teacher is not quite the same as teacher salary and benefits, but it is close. Moreover, any large increases in instructional expenditures per teacher must be owing primarily to increases in salary and benefits.[22] Note also that by far the fastest growth in expenditures per instructor occurred between 1950 and 1970, and since that time growth has slowed down considerably.

In figure 13 we perform the following scenario analysis: what would have happened to expenditures per student if they had simply risen in proportion to expenditures on teachers (thus including both the increase in the number of teachers and the increase in their salaries and benefits)? The result of this scenario is shown by the "implied expenditure" line in figure 13.

22. Since textbooks and supplies and other non-teacher compensation account for only about 10 percent of instructional expenditures circa 2013, a doubling, for example, of these expenditures since 1950 could have increased total expenditures by at most approximately 5 percent.

Figure 13. Expenditure and Implied Expenditure per Student, US Elementary and Secondary Public Schools, 1950–2013



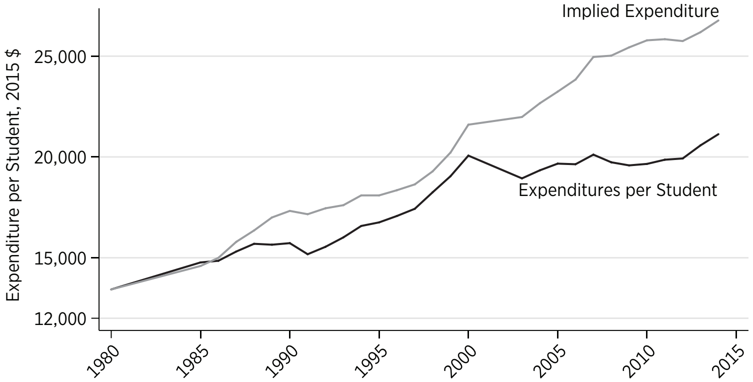
Notes: The Y axis uses a ratio scale. "Implied expenditure" is expenditure if total expenditures had risen in direct proportion to teacher expenditures.
Source: NCES

The implied expenditure line follows the actual expenditure line very closely.

It is thus fairly easy to explain why expenditures per elementary and secondary student increased by a factor of more than five between 1950 and 2013: the costs of instruction—most importantly higher teacher compensation, but also the cost of hiring more teachers—increased by a factor of more than five during this period. Instructional costs are more than 50 percent of total costs in elementary and higher education, and it is reasonable that many other costs, such as administrative costs, should rise in proportion to teacher costs. Thus, the bulk of the increase in the costs of lower education can be explained by greater expenditures on teachers—mostly more spent per teacher, but also a greater number of teachers per student.

In higher education, faculty compensation and the number of faculty per student have also increased. As we did with elementary and secondary schools, in figure 14 we compare actual expenditures with the expenditures that would have been

Figure 14. Expenditures Compared with Implied Expenditure (Average per Student), Public Institutions of Higher Learning, 1980–2014



Source: NCES.

incurred if costs had increased proportionately to instructional costs (implied expenditures). We do not match implied with actual expenditures as closely as with elementary and secondary education. That is not surprising because instructional costs are a smaller share of higher education costs than of lower education costs.

The surprise in figure 14 is that instructional costs in higher education have increased faster than expenditures per student, especially since 2000. In other words, contrary to the usual story, there have actually been savings in noninstructional costs that have allowed instructional costs to grow faster than expenditures.

The rising cost of labor inputs is the best explanation for the rising cost of education, but we are not arguing that teachers are overpaid. Indeed, it is part of our theory that teachers are earning a normal wage for their level of skill and education. The evidence that teachers earn substantially above-market wages is slim. Teachers' unions in public schools, for example, cannot explain decade-by-decade increases in teacher compensation. In fact, most estimates find that teachers' unions raise the wage level by only approximately 5 percent.[23] In other words, teachers' unions can explain why teachers earn 5 percent more than similar workers in the private sector, but unions cannot explain why teachers' wages increase over time. If the case for unions as a cause of rising teacher compensation in public schools is weak, it is nonexistent for increased compensation for college faculty, for whom wage bargaining is done worker by worker with essentially no collective bargaining whatsoever.

If increasing labor costs explain the increasing price of education but teachers are not overpaid relative to similar workers in other industries, then increasing labor costs must lead to higher prices in the education industry than in other industries. Before delving more deeply into why increasing labor costs increase prices in some industries more than others, we turn to a second case study, healthcare.

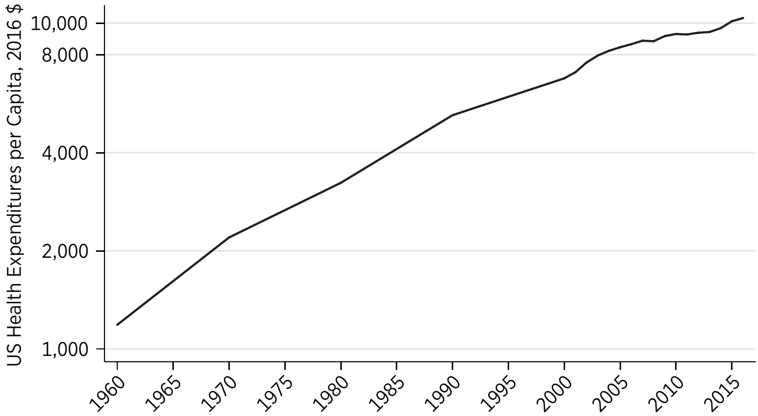
HEALTHCARE

The rising cost of healthcare is perhaps of greater concern to the public than even the rising cost of education. Consider the following:

> The health care crisis is upon us. In response to soaring costs, a jumbled patchwork of insurance programs, and critical problems in delivering medical care, some kind of national health insurance has seemed in recent years to be an idea whose time has finally come in America. For those not protected by insurance—and often for those who are partially protected—illness

23. Sylvia A. Allegretto and Ilan Tojerow, "Teacher Staffing and Pay Differences: Public and Private Schools," *Monthly Labor Review*, September 2014; Brigham R. Frandsen, "The Effects of Collective Bargaining Rights on Public Employee Compensation: Evidence from Teachers, Firefighters, and Police," *ILR Review* 69, no. 1 (2016): 84–112.

Figure 15. US Health Expenditures per Person, 1960–2016



Note: The Y axis uses a ratio scale.
Source: National Health Expenditure Accounts (NHEA).

> means financial disaster. The quality of American medical care is at issue, too. . . . We rank seventeenth in infant mortality, according to a United Nations study; thirtieth in life expectancy for males. . . .[24]

The quote appears to be contemporary, but it's from Godfrey Hodgson writing in the *Atlantic* in 1973, nearly half a century ago. Yet Hodgson wasn't wrong. Figure 15 shows US health expenditures per person between 1960 and 2016. Since 1960, real health expenditures have increased by a factor of almost nine—from $1,185 per person in 1960 to $10,363 in 2016.

Moreover, in some ways Hodgson was more correct than contemporary accounts that also point to healthcare costs that are "out of control" and "skyrocketing."[25] The graph in figure 15

24. Godfrey Hodgson, "The Politics of American Health Care: What Is It Costing You?," *Atlantic*, October 1973.

25. See, for example, Sarah Kliff and Soo Oh, "America's Health Care Prices Are Out of Control. These 11 Charts Prove It," *Vox*, May 10, 2018; and Keith Lemer,

is on a ratio scale so that slopes can be interpreted as rates of change. Note that the slope of the curve has been generally decreasing over time. Thus, contrary to conventional wisdom, the rate of growth of healthcare costs has been *declining* over time, not increasing. During the 1960s, for example, per capita healthcare costs rose at a rate of 6.2 percent per year—by far the fastest growth rate over the 1960–2016 period. In comparison, real per capita healthcare costs have been growing at less than 2 percent per year in recent years.

Monopoly Power and Medical Malpractice

We do not dismiss concerns about rising costs. Growth rates on the order of 2 percent per year are not trivial. Placing growth rates in their long-run context, however, is necessary if we are to correctly diagnose the problem. In particular, the decline in growth rates suggests that many contemporary explanations for rising healthcare costs are unlikely to be correct. Growing monopoly power, for example—a force that analysts on both the left and the right point to as an explanation for high and rising healthcare costs[26]—does not appear to be consistent with the trend toward lower growth rates in healthcare costs. Long-run trends demand long-run explanations.

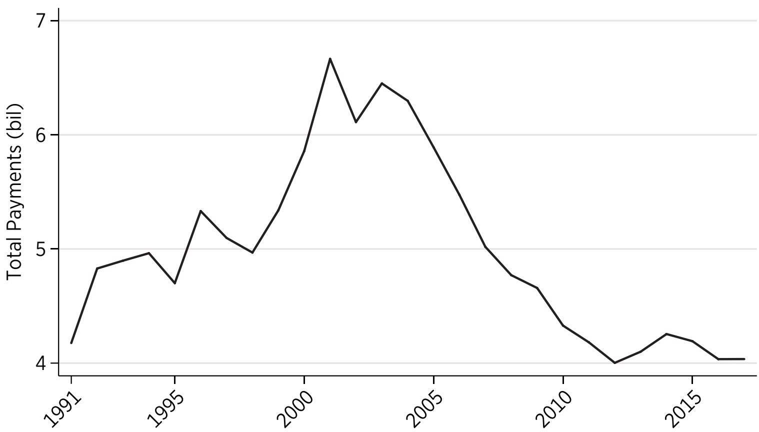
Rising healthcare costs are often blamed on the medical malpractice system.[27] The data, however, make it difficult to believe that medical malpractice is responsible for a large fraction of costs, let alone a large and *growing* fraction of costs. Figure 16

"The Hidden Reasons Your Health-Care Costs Are Skyrocketing," CNBC commentary, March 22, 2018.

26. For example, consider some recent articles in the popular press: D. Taylor, "Growing Monopoly Power of Big Hospital Systems Are Spiking Healthcare Costs," *The Hill*, April 2, 2017; Avik Roy, "Hospital Monopolies: The Biggest Driver of Health Costs That Nobody Talks About," *Forbes*, August 22, 2011; and Travis Klavohn and Laura Williams, "The Medical Cartel Is Keeping Health Care Costs High," *Foundation for Economic Freedom*, August 6, 2017.

27. Frank A. Sloan and Lindsey M. Chepke, *Medical Malpractice* (Cambridge, MA: MIT Press, 2010, paperback ed.).

Figure 16. Total Medical Malpractice Payments in 2018 Dollars, 1991–2017



Source: National Practitioner Data Bank.

shows total medical malpractice payments from 1991 to 2017 (in real 2018 dollars). Total medical malpractice payments were about $4 billion a year in 2017, down from a peak of $6.7 billion in 2001. Even ignoring the decline, however, the absolute figures are low. National healthcare costs are on the order of $3.3 trillion a year, so $4 billion in medical malpractice payments is 0.12 percent. In other words, medical malpractice payments account for about $12 of the $10,000 spent annually on healthcare per person.

Although medical malpractice payments are low, the threat of medical malpractice claims could raise healthcare costs by incentivizing physicians to order extra tests or procedures—so-called defensive medicine. After a review of studies, the Congressional Budget Office estimated that a wide-ranging tort reform package would reduce healthcare costs by 0.5 percent, or about $50 per person at current rates of spending.[28] Thus, the

28. Congressional Budget Office, "Limit Medical Malpractice Torts," Options for Reducing the Deficit series, November 13, 2013.

medical malpractice system is not a powerful lever to reduce healthcare costs. Moreover, reducing the threat of medical malpractice claims could have negative consequences.

The purpose of medical malpractice law is to incentivize physicians to take more care than they would without the threat of malpractice claims. Martin A. Makary and Michael Daniel estimate that medical error is the third-largest cause of death in the United States, accounting for some 250,000 deaths annually.[29] Few people think that the medical malpractice system is an especially effective deterrent of error, but why target for elimination the costs designed to increase the incentive for physicians to take care?[30]

Waste and Administrative Costs

The US healthcare system does have plenty of waste. David Cutler, President Obama's senior healthcare adviser, suggests that we could eliminate one-third of US healthcare spending without harming patients.[31] Robin Hanson suggests the number is closer to 50 percent.[32] The rate of spinal surgery, for example, varies by a factor of six across the United States, but only 10 percent of this variation can be explained by differences in patient populations, and there is no evidence that higher rates of surgery produce better outcomes.[33]

The US healthcare system is especially beset by administrative costs.[34] Every office-based physician in the United States requires

29. Martin A. Makary and Michael Daniel, "Medical Error—The Third Leading Cause of Death in the US," *BMJ* 353 (2016): i2139.

30. Michael Frakes and Anupam B. Jena, "Does Medical Malpractice Law Improve Health Care Quality?," *Journal of Public Economics* 143 (2016): 142–58.

31. David Cutler, *The Quality Cure: How Focusing on Health Care Quality Can Save Your Life and Lower Spending Too* (Berkeley and Los Angeles: University of California Press, 2014).

32. Robin Hanson, "Cut Medicine in Half," *Cato Unbound*, September 10, 2007.

33. Cutler, *The Quality Cure*.

34. David M. Cutler and Dan P. Ly, "The (Paper)Work of Medicine: Understanding International Medical Costs," *Journal of Economic Perspectives* 25, no. 2 (2011): 3–25.

2.2 administrative workers—more administrative workers than nurses, clinical assistants, and technical staff combined. By comparison, Canada operates with half as many administrative workers per office-based physician. Physicians in the United States also spend more time on administration than do those in Canada, an especially costly use of resources.

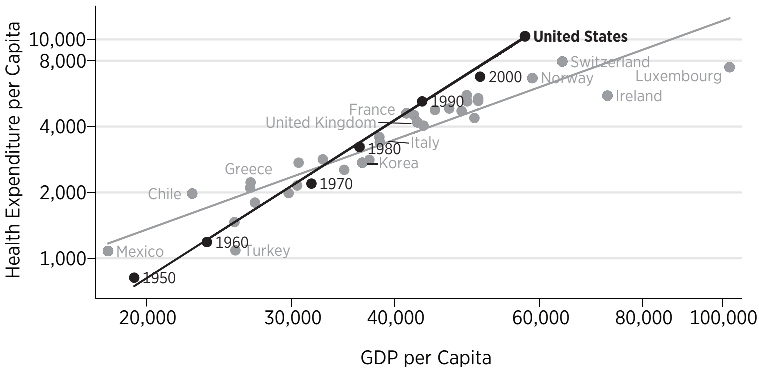
One reason administrative costs may be higher in the United States is the unusual need for coordination among producers of healthcare compared with other industries and the relatively decentralized insurance system in the United States. Producers in most industries do not need to coordinate with one another on an ongoing basis. But the primary physician must coordinate with the radiologist, the cancer specialist, and the lab technician, and the coordination is different for each patient at each point in time.[35] All producers must know what the other producers are doing and may need to adjust their own actions in response. For many people in the United States the physician, the cancer specialist, and the lab tech work at separate firms. The cost of coordination motivates uniting producers under a single umbrella, the health maintenance organization (HMO). HMOs are a minority but growing share of the healthcare market.[36]

Waste and administrative costs are plausible reasons that the US healthcare system is expensive, but they do not explain why costs have grown over time. Assume that administrative costs were 10 percent of healthcare costs in 1950, when healthcare costs were approximately $1,000 per capita. Healthcare costs today are about $10,000 per capita. If growth in administrative

35. Producers of software must coordinate with other software and hardware producers, but a great deal of effort goes into minimizing the amount of coordination required (e.g., through the use of application programming interfaces). The analogy to healthcare would be if a new round of coordination between different software programs were required every time the software was run.

36. The other sources of administrative costs in the United States are the multiple payers (private insurance, government insurance, direct payment), the complex payment systems that govern prices, and the dueling incentives of producers and payers to question spending.

Figure 17. Health Expenditures per Capita against GDP per Capita



Note: This figure uses a log-log scale. Lines of best fit indicate that a 1 percent increase in GDP per captia increases health expenditures per capita by approximately 1.4 percent outside the United States (see gray line) and by 2.4 percent in the United States (see black line). Not all countries are labeled. GDP = gross domestic product.
Source: Organisation for Economic Co-operation and Development (OECD), Health Expenditure Financing: Health Expenditure Indicators (dataset), accessed March 19, 2017, https://www.oecd-ilibrary.org/social-issues-migration-health/data/oecd-health-statistics_health-data-en; based on Kaiser Family Foundation Health System Tracker.

costs explained the growth in healthcare costs, then administrative costs would have to have grown by a phenomenal 8,100 percent and would today account for 82 percent of all healthcare costs, even assuming that base healthcare costs had doubled.[37] Those numbers are not plausible.

International comparisons also suggest that the United States might have excess costs. Figure 17 shows health expenditures per capita against gross domestic product (GDP) per capita circa 2016 for a variety of member countries of the Organisation for Economic Co-operation and Development. The United States not only spends more on healthcare than any other country, it spends more on healthcare per capita than any other country.

37. In 1950, $100 in administrative costs and $900 in base healthcare costs make for $1,000 in per capita costs. If base healthcare costs double to $1,800 but total healthcare costs increase to $10,000, then administrative costs must have grown to $8,200, or 82 percent of total healthcare costs, for a growth in administrative costs of ($8,200 − $100) / $100 × 100 = 8,100 percent.

The United States also has a higher GDP per capita than any other large country, however, and health expenditures in all countries tend to increase more than proportionately with GDP per capita.[38] Thus, comparing health expenditures per capita in the United States with those in other countries may be misleading. For this reason, figure 17 also shows health expenditures per capita in the United States in different years. In the 1980s and 1990s the United States had a GDP per capita similar to that of some of the major European economies in 2016, and even then, the United States had high health expenditures per capita. Moreover, the black line joining the US points over time indicates that health expenditures per capita have grown faster with GDP per capita in the United States than we would expect by looking at countries of different levels of GDP per capita.

The black line in figure 17 tells us something else of interest. Healthcare expenditures per capita have grown with GDP per capita in the United States reasonably consistently for well over half a century. During this period there were massive changes to the healthcare system, including the rise of third-party insurance; the introduction of Medicare, Medicaid, and the Affordable Care Act; and so forth. Yet, for the most part, these changes look like they might at best explain some deviations from trend rather than having much influence on the trend itself.

Focusing on the long-run trend in figure 17 sheds light on a puzzle we noted earlier in figure 15, the decline in the growth rate of healthcare expenditures per capita. The relatively consistent trend line in figure 17 suggests a simple explanation: the growth rate of healthcare expenditures per capita has declined because the growth rate of GDP per capita has declined.

38. The countries in figure 17 with higher GDP per capita than the United States are also somewhat unusual. Ireland, for example, has high GDP per capita, but only because it exports a tremendous amount for a country of its size. GDP per capita is significantly higher in Ireland than gross national product per capita, a measure that better represents the wealth of Irish citizens. Norway also has very large oil revenues, and Luxembourg is tiny, so only Switzerland is a reasonable comparable.

Figures 15 and 17 show that costs have been increasing for a long time under a variety of institutional structures.[39] Once again, the larger lesson is that long-run trends demand long-run explanations.

As with education, one might wonder whether healthcare quality has increased. Here, the situation is much more complicated than with education because the quality of healthcare has increased in important and measurable ways.

Healthcare Quality and the High Value of Life

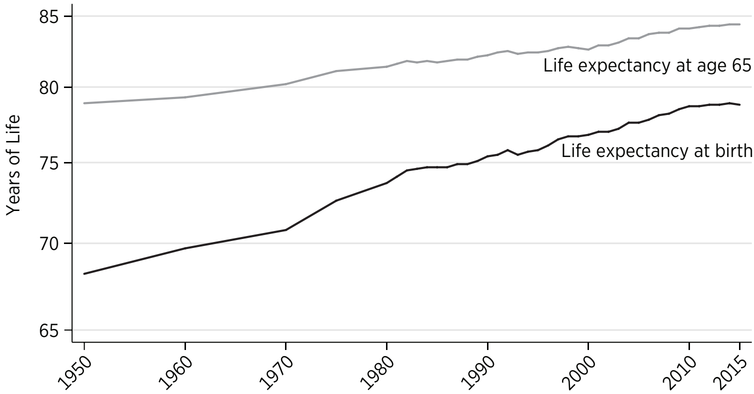
Healthcare spending has increased in the United States, but so has life expectancy, both at birth and at age 65, as shown in figure 18. Increases in life expectancy have multiple causes that go well beyond healthcare. Nevertheless, there is little doubt that healthcare is one component of increased life expectancy.[40] Thus, as measured by life expectancy, it is likely that quality has increased in US healthcare.

What value are we to place on the increase in life expectancy? Kevin M. Murphy and Robert H. Topel estimate that since 1970, gains in life expectancy added about $3.2 trillion *per year*

39. We could have ventured even further back in time. In its 1932 report, the Committee on the Costs of Medical Care concluded that the United States could not sustain spending of more than 2 percent of its GDP on healthcare. See Committee on the Cost of Medical Care, *Medical Care for the American People: The Final Report of the Committee on the Costs of Medical Care, Adopted October 31, 1932* (Chicago: University of Chicago Press, 1932); and Robert S. Woodward and Le Wang, "The Oh-So Straight and Narrow Path: Can the Health Care Expenditure Curve Be Bent?," Health Economics 21, no. 8 (2012): 1023–29.

40. Cutler, The Quality Cure; Frank R. Lichtenberg, "The Impact of New Drug Launches on Longevity: Evidence from Longitudinal, Disease-Level Data from 52 Countries, 1982–2001," *International Journal of Health Care Finance and Economics* 5, no. 1 (2005): 47–73; Frank R. Lichtenberg, "Despite Steep Costs, Payments for New Cancer Drugs Make Economic Sense," *Nature Medicine* 17, no. 3 (2011): 244; Frank R. Lichtenberg, "Contribution of Pharmaceutical Innovation to Longevity Growth in Germany and France, 2001–7," *PharmacoEconomics* 30, no. 3 (2012): 197–211; Frank R. Lichtenberg, "Pharmaceutical Innovation and Longevity Growth in 30 Developing and High-Income Countries, 2000–2009," *Health Policy and Technology* 3, no. 1 (2014): 36–58.

Figure 18. Life Expectancy at Birth and Age 65, United States, 1950–2015



Notes: The Y axis uses a ratio scale. "Life expectancy at age 65" is calculated as 65 plus life expectancy at age 65.
Source: Centers for Disease Control and Prevention, National Center for Health Statistics.

to national wealth, equal to about half of GDP.[41] If a fraction of these gains in life expectancy were due to healthcare spending, the spending would be well justified.

The same issue applies when we compare countries. The United States spends about 5 percent more of GDP on healthcare than do other developed countries. US GDP is almost $20 trillion, so 5 percent is approximately $1 trillion. The US population is 325 million, so the United States spends an extra $3,000 per person each year on healthcare. Is the expense worthwhile?

A value of a statistical life-year of around $200,000 is a midrange, widely used estimate in the United States. Thus, if the extra US spending generated an extra $3,000 per $200,000 of a life-year, it would pay for itself. In other words, for the extra US spending to be worthwhile it must generate 3,000/200,000 × 365

41. Kevin M. Murphy and Robert H. Topel, "The Value of Health and Longevity," *Journal of Political Economy* 114, no. 5 (2006).

= 5.45 extra days of statistical life, and, of course, it must do so every year. In recent years, life expectancy in the United States has increased by about 52 days a year. Thus, a little more than 10 percent of the increase in actual life expectancy must be a result of the extra US spending for that spending to be worthwhile. That hardly appears impossible. It's also not impossible that the increase in life expectancy was not caused by the extra spending.

The bottom line is that the value of life is so high that US levels of spending could be worthwhile, but the high value of life and the difficulty of measuring the effectiveness of healthcare makes the question impossible to answer with certainty.

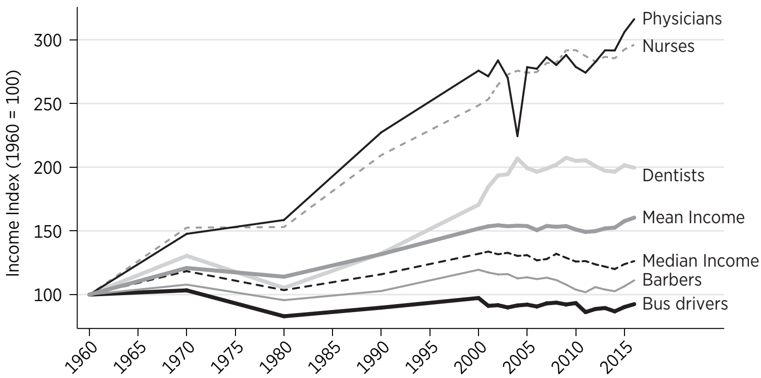
In addition, even if the spending on healthcare is well justified by the improvements in life expectancy, it does not follow that the cause of higher spending is the improvement in life expectancy. As with education, many of the increases in life expectancy come from better knowledge, which does not necessarily cost more to use. It does not cost much more to treat an infection with antibiotics than with bloodletting; perhaps it costs less. We do use more technology in healthcare than in previous years—this includes computerized tomography (CT) scanners, magnetic resonance imaging (MRI) systems, and positron emission tomography (PET). Technology, however, is falling in price. At some point one would expect that decreases in the cost of existing technologies would overwhelm increases in costs owing to the introduction of new technologies. As with education, it would be peculiar if the only place in which technology raised costs was in healthcare (but see Joseph P. Newhouse for a strong argument that healthcare costs are driven by technology[42]).

Labor Costs and the Rising Cost of Healthcare

We argue that there is a direct, obvious, and measurable cause of higher costs in healthcare—namely, the price of skilled labor. No

42. Joseph P. Newhouse, "Medical Care Costs: How Much Welfare Loss?," *Journal of Economic Perspectives* 6, no. 3 (1992): 3–21.

Figure 19. Average Annual Income, Selected Professions, 1960–2016



Notes: "Average income" refers to average income among those employed. "Physicians" inclues surgeons. "Barbers" includes beauticians and manicurists. *Source:* Integrated Public Use Microdata Series (IPUMS), 1950 occupation definitions.

profession other than physicians has seen such large increases in incomes over the past 50 years. Figure 19 shows the real income of physicians from 1960 to 2016, indexed to 100 in 1960. Since 1960 the real income of physicians has increased by a factor of three. By comparison, barbers and bus drivers have seen essentially no increase in real incomes. Median incomes are up only modestly whereas mean incomes, which are pulled up by outliers, are up by only 50 percent.

Not only are physicians making more, but there are more physicians in the workforce. Since 1960 the number of physicians per capita has more than doubled, as shown in figure 20, panel A. Thus, at three times the price and twice the number, the cost of physicians has increased by a factor of six.

When more physicians each make more, it's not surprising that the cost of medical care would increase.

As with education, one back-of-the-envelope test of our intuition is to ask what would have happened to healthcare costs if costs had increased in direct proportion to physician incomes.

Figure 21 shows that the implied costs would have increased almost as much as the actual costs.

Physician income is not the only cost of healthcare, so this is a back-of-the-envelope calculation. Furthermore, healthcare draws on numerous forms of skilled labor that have also increased in price. Figure 19, for example, shows that although nurses have lower incomes than physicians, they have also tripled their real incomes since 1960. Figure 20, panel B, shows that the number of nurses per capita has more than doubled since 1960. Thus, nursing costs have also increased by more than a factor of six. Indeed, throughout the medical field, real incomes have increased substantially. Dentists, optometrists, and pharmacists all have doubled their incomes, about on par with the rate of lawyers and judges. Veterinarians, who have skills similar to those of other medical professionals, also have doubled their incomes.[43]

Skilled labor has increased in value throughout the US economy, and the healthcare sector uses a lot of skilled labor, even aside from physicians. That reality has pushed up the price of healthcare.

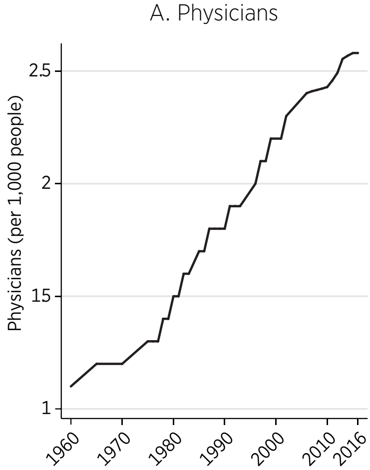
EDUCATION AND HEALTHCARE TAKEAWAY

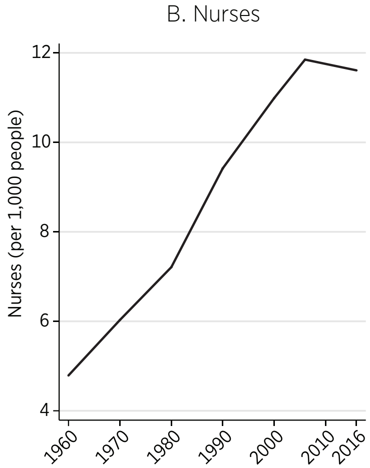
Education and health costs have been increasing more rapidly than other costs for at least a century. We have found that the best, albeit perhaps pedestrian, explanation for increasing costs is that the price of the major inputs into education and healthcare—namely, teachers, faculty, physicians, nurses, and so forth—has increased and, secondarily, that we have bought more of those inputs.

We have examined and rejected a number of idiosyncratic explanations for rising costs in education and healthcare, such

43. Rising healthcare costs are thus closely tied with rising inequality. If we think of physicians' offices and hospitals as industries, then those industries have more people in the top 1 percent of incomes than any other profession (tied with law offices). See Jonathan Rothwell, "Make Elites Compete: Why the 1% Earn So Much and What to Do about It" (Social mobility paper, Brookings Institution, Washington, DC, 2016).

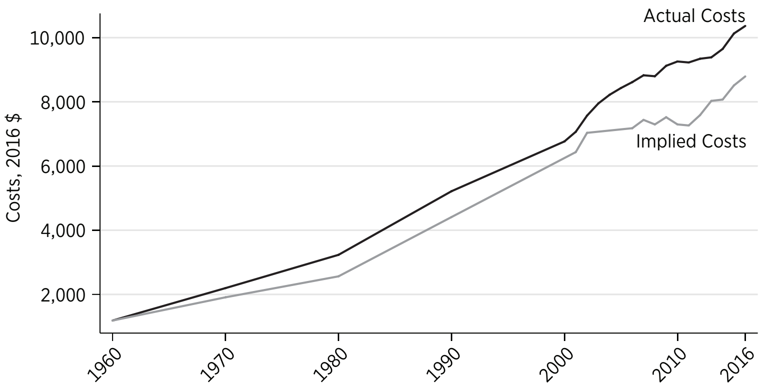
Figure 20. US Physicians and Nurses per 1,000 People, 1960–2016





Note: In panel A, data for 1995, 2000, and 2004 were inconsistent with adjoining years and were interpolated.
Sources: Panel A: World Health Organization, "WHO Global Health Workforce Statistics"; OECD. Panel B: Patricia D'Antonio and Jean C. Whelan, "Counting Nurses: The Power of Historical Census Data," *Journal of Clinical Nursing* 18, no. 19 (2009): 2717–24; US Census Bureau, "Population Data"; OECD Data, "Nurses."

Figure 21. Healthcare Costs per Capita versus Costs Proportional to Physician Incomes, 1960–2016



Sources: NHEA for health costs; IPUMS for physician incomes.

as the bloat theory and medical malpractice costs. One factor that appears to explain a substantial share of increasing costs is a higher price of labor, particularly skilled labor. Many industries, however, draw on skilled labor, including some such as the computer industry in which prices have fallen. Thus, what we have yet to explain is why increases in the price of skilled labor raises costs in some industries more than in others. This is what Baumol's cost disease, or what we prefer to call "the Baumol effect," explains.

THE BAUMOL EFFECT

The Baumol effect is easy to explain but difficult to grasp.[44] In 1826, when Beethoven's String Quartet No. 14 was first played, it took four people 40 minutes to produce a performance. In 2010, it still took four people 40 minutes to produce a performance. Stated differently, in the nearly 200 years between 1826 and 2010, there was no growth in string quartet labor productivity. In 1826 it took 2.66 labor hours to produce one unit of output, and it took 2.66 labor hours to produce one unit of output in 2010.

Fortunately, most other sectors of the economy have experienced substantial growth in labor productivity since 1826. We can measure growth in labor productivity in the economy as a whole by looking at the growth in real wages. In 1826 the average hourly wage for a production worker was $1.14. In 2010 the average hourly wage for a production worker was $26.44, approximately 23 times higher in real (inflation-adjusted) terms.

Growth in average labor productivity has a surprising implication: it makes the output of slow productivity-growth sectors (relatively) more expensive. In 1826, the average wage of $1.14 meant that the 2.66 hours needed to produce a performance of

44. William J. Baumol and William G. Bowen, *Performing Arts, the Economic Dilemma: A Study of Problems Common to Theater, Opera, Music and Dance* (New York: Twentieth Century Fund, 1966); and William J. Baumol, "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis," *American Economic Review* 57, no. 3 (1967): 415–26.

Beethoven's String Quartet No. 14 had an opportunity cost of just \$3.02.[45] At a wage of \$26.44, the 2.66 hours of labor in music production had an opportunity cost of \$70.33.[46] Thus, in 2010 it was 23 times (70.33/3.02) more expensive to produce a performance of Beethoven's String Quartet No. 14 than in 1826. In other words, one had to give up more other goods and services to produce a music performance in 2010 than one did in 1826. Why? Simply because in 2010, society was better at producing other goods and services than in 1826.

The 23 times increase in the *relative* price of the string quartet is the driving force of Baumol's cost disease. The focus on relative prices tells us that the cost disease is misnamed. The cost disease is not a disease but a blessing. To be sure, it would be better if productivity increased in all industries, but that is just to say that more is better. There is nothing negative about productivity growth, even if it is unbalanced.

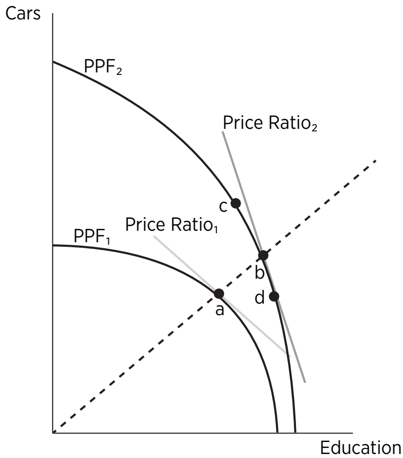
In particular, it is important to see that the increase in the relative price of the string quartet makes string quartets costlier but *not* less affordable. Society can afford just as many string quartets as in the past. Indeed, it can afford more because the increase in productivity in other sectors has made society richer. Individuals might not choose to buy more, but that is a choice, not a constraint forced upon them by circumstance. If workers' wages increase, it is costlier for them to tend to their own gardens—they must give up more in other goods and services to do so—but tending to their gardens is still within their choice set. And if tending a garden is something that a person enjoys, that person might even do more of it despite the increase in cost.

Figure 22 makes the same points using a simple two-sector economy, illustrated using what economists call a production

45. Wage data are from Lawrence H. Officer and Samuel H. Williamson, "Annual Wages in the United States, 1774–Present," *MeasuringWorth*, 2018.

46. Using wages of skilled workers such as orchestra musicians will change the absolute numbers but will have less impact on the relative change between 1826 and 2010.

Figure 22. The Baumol Effect



Note: At time 1, society can consume any combination of cars and education along the production possibilities frontier PPF_1. Suppose point (a) is chosen. At point (a) the relative price of education, the opportunity cost, is given by the slope of the light gray line. At time 2, productivity has increased for cars much more than for education. Suppose we continue to consume a similar proportion of the two goods at point (b). Even though we can and do consume more of both goods, the relative price of education, given by the slope of the dark gray line, has increased. Points (c) and (d) describe how prices change if consumers want to spend a smaller or larger share of their income on education as income increases.

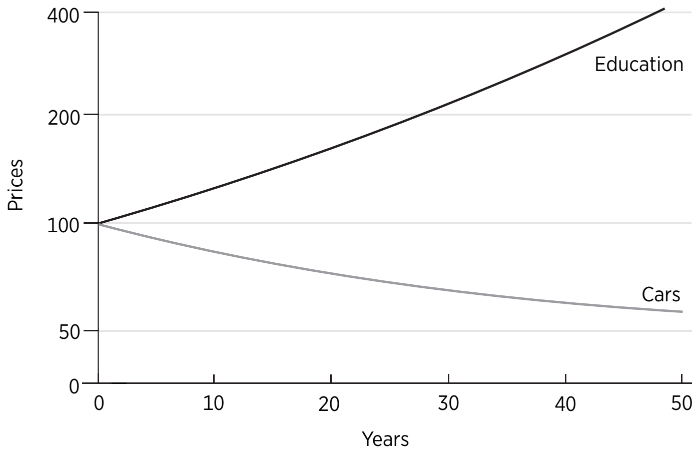
possibilities frontier (PPF). The curve PPF_1 shows all the combinations of cars and education that are available to society at time 1. More cars mean less education and vice versa. Suppose that society chooses to consume at point (a). At point (a) the tradeoff between cars and education is given by the slope of the light gray line. In other words, the slope of the light gray line shows the opportunity cost of education in terms of cars. In a market economy, the slope of the light gray line is also the relative price of education. Now imagine that productivity increases so that at time 2, society can produce more of both goods. As a result, the PPF shifts outwards. We assume, however, that productivity growth is not even. Productivity improves more for cars than for education, giving us PPF_2. Suppose that society chooses to consume the two goods in similar proportions as at time 1, so consumption is now at point (b). At point (b), the relative price of education has risen dramatically. This is the Baumol effect.

The economy depicted in figure 22 is simple, but it contains deep lessons. One lesson is that all prices cannot fall. Behind the veil of money, prices are ultimately relative prices—prices tell how much butter society must give up to get guns. But if butter becomes cheaper and society can buy more butter by giving up the same number of guns, then guns must have become more expensive—it takes more butter to buy the same number of guns.

The contrary intuition that all prices must fall with economic growth comes from thinking about prices as a measure of affordability. When a price falls, people are pleased because that good has become more affordable. Over a short period of time when incomes are fairly constant, relative price and affordability signals work in the same direction—goods that fall in price are more affordable, and goods that rise in price are less affordable. But over long periods of time, prices cannot be interpreted as measures of affordability. At point (b) in figure 22, education has risen in price and become *more* affordable.

Figure 22 has another lesson. By plotting the price ratios at (a) and (b), we have assumed that the share of spending that consumers allocate to the two goods remains constant over time. But suppose that as income increases, consumers spend a smaller share of their income on education, such as at point (c). In this case the price effect will be smaller. However, if consumers want to spend a greater share of their income on education as income increases, such as at point (d), the price effect will be larger. The expenditure-share effect is independent of the Baumol effect because it would still occur even if productivity growth were balanced. What drives the expenditure-share effect is the idea implicit in the shape of the PPF curve that some resources are better at producing cars and others are better at producing education. Naturally, we produce education using the resources that are best at producing education. As we produce more and more education, however, we must draw on resources that are less well-suited to education production, so the price of education must increase. The evidence is that as income has increased, the share of spending that consumers allocate to sectors like education and healthcare has *increased*, so the expenditure-share effect will magnify the Baumol effect.

Figure 23. The Progressive and Stagnating Sectors: Two Sides of the Same Coin



Note: The Y axis uses a ratio scale.

If we graph the prices of the two goods shown in figure 22, over time we will see a graph like that of figure 23. Looking at such graphs, our attention naturally is drawn to the rising cost of good 2, in this case education. Why are costs rising so quickly? Entranced by such graphs, we may enter into a detailed analysis of the special factors of sector 2 production—regulation, unionization, government purchases, insurance, international trade, and so forth—to try to explain the dramatic increase in costs. Yet the rising costs in the stagnant sector are simply a reflection of increased productivity in the progressive sector. Thus, another deep lesson of the Baumol effect is that to understand why costs in the stagnant sector are rising, we must look away from the stagnating sector and toward the progressive sector.

Services as the Stagnant Sector

Why productivity increases faster in some sectors than in others is a deep question with few systematic answers. In 1950 the average strawberry farm produced 3,123 pounds per acre. Today, the most advanced, vertically organized, hydroponic farm can produce 125,000 pounds of strawberries per acre.[47] Over the same time period, there has been no advance in huckleberry productivity. By all accounts, huckleberries are delicious, but they have resisted domestication, so if you want a slice of huckleberry pie someone will have to find and pick wild huckleberries.[48] Progress proceeds by fits and starts.

One of the few systematic factors that we do know is that the productivity of services tends to increase more slowly than that of goods. Indeed, in some cases, it is difficult to understand how the productivity of some services *could* be increased. How could Beethoven's String Quartet No. 14 be produced in less than 40 minutes with fewer than four performers? True, recordings can make a performance available to millions at low cost,[49] but a recording is not a perfect substitute for a live performance.[50] We can eat strawberries rather than huckleberries, but they are not the same. It is great when we can substitute a good from the progressive sector for one from the stagnating sector, but we should not confuse statements about substitution with statements about productivity growth.

A key distinction is when labor is an input into the good or service and when labor, in essence, is the service. Consumers do not care how much labor is used as an input into the production of a car, but they do care how much labor input is used in a massage, artistic performance, or doctor's visit. It is hard to increase labor

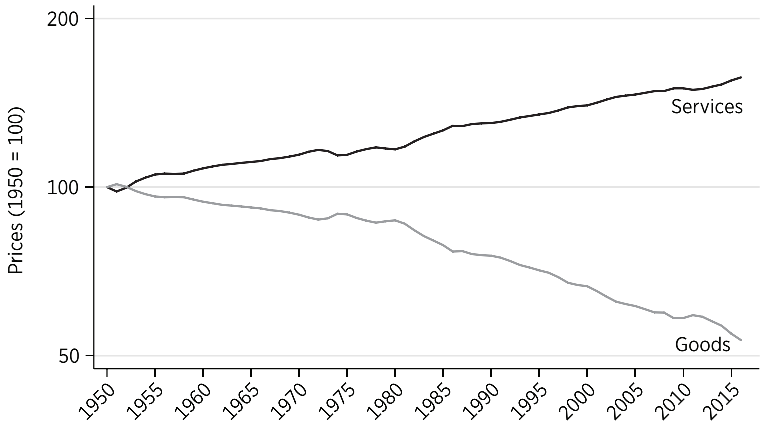
47. US Department of Agriculture, *Agricultural Statistics 1960*, 1961, Table 292; and Herman K. Trabish, "The Farm of the Future Will Grow Plants Vertically and Hydroponically," Greentech Media, March 16, 2012.

48. See Becky Kramer, "WSU Researchers Taming the Wild Huckleberry," (Spokane, WA) *Spokesman-Review*, September 21, 2016, for some hints of progress.

49. Tyler Cowen, "Why I Do Not Believe in the Cost-Disease: Comment on Baumol," *Journal of Cultural Economics* 20, no. 3 (1996): 207–14.

50. Comparing the relative price of a ticket to a live concert (about $100) to that of an MP3 ($10 to free) of the same piece suggests that these goods are not even close substitutes, at least for some people.

Figure 24. Prices of Goods versus Services, 1950–2016



Notes: Prices are normalized to 100 in 1950. The Y axis uses a ratio scale.
Source: BEA, "National Income and Product Accounts."

productivity if what is being purchased is the time and attention of the laborer.

If productivity in goods does increase faster than in services, then we ought to find that prices have increased faster for services than for goods.

The Baumol Effect Explains Price Increases in Services Relative to Goods

Healthcare and education are paradigmatic examples of services. Do these examples generalize? Let's return to figure 1. It's notable that services such as education, healthcare, legal services, and even car repair tend to be at the top of the figure, whereas goods such as new cars and home appliances are at the bottom.

Figure 24 shows the Bureau of Economic Analysis (BEA) breakdown of price increases in the goods and services sectors at the highest level of aggregation. Consumer goods in general have fallen in price by a factor of two (from 100 to 53), while services have increased in price by a factor of approximately 1.5 (from 100 to 157).

Thus, there is a definite tendency for services to increase in price relative to goods over time. But what is a service? The distinction between goods and services is not hard and fast. Services tend to be labor intensive, intangible, and produced at the moment of consumption. The BEA defines services using the last consideration—services are products that cannot be stored and are consumed at the place and time of their purchase.[51] Wikipedia, in contrast, focuses on the first consideration and defines services, somewhat loosely, as activities provided by other people.[52]

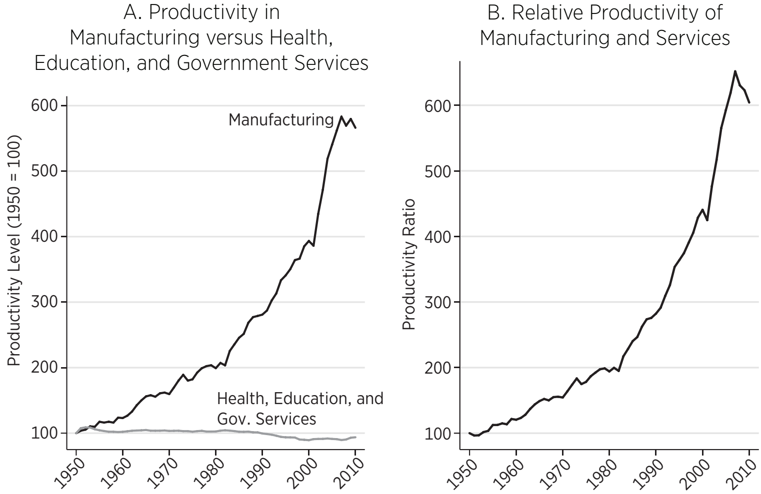
Defining services as people or labor-intensive activities is more useful for understanding price differences across sectors. On the basis of their definition, the BEA defines telecommunications, air travel, and car rental leasing as services. Unlike teaching, healthcare, or massage, none of those services require the time and attention of a laborer. Moreover, it is notable that those are the *only* services in the BEA data to see significant price declines. Thus, price increases in services in figure 24 would be even larger if we excluded the capital-intensive services—telecommunications, air travel, and rental car leasing. More generally, some services, such as movie distribution (Netflix) and music distribution (Pandora), are not labor intensive and therefore are not subject to the Baumol effect.

If the price of services is rising relative to that of goods, is this because the productivity of goods production is rising relative to that of service production? In figure 25 we show the labor productivity of the manufacturing sector against that of the health, education, and government services sector. Measuring productivity is difficult, especially in services, but the differences in productivity growth between these two measures are so striking and consistent that measurement errors are not a plausible

51. Bureau of Economic Analysis Glossary, s.v. "Services," April 14, 2018.

52. Wikipedia, s.v. "Goods and Services," last modified February 23, 2019, https://en.wikipedia.org/wiki/Goods_and_services.

Figure 25. Productivity in Manufacturing versus Services

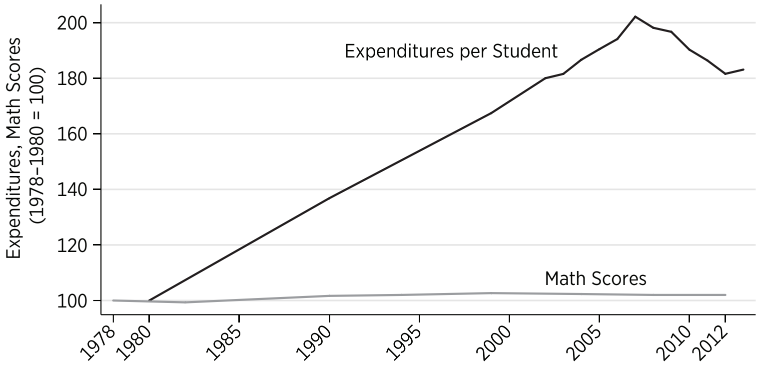


Note: Data cover labor productivity and also include government services. These data are classified using International Standard Industrial Classification codes L, M, and N.
Source: Groningen Growth and Development Centre, "10-Sector Database."

explanation for the differences.[53] Panel A of figure 25 shows productivity levels. Panel B shows the manufacturing-to-services productivity ratio. The productivity of manufacturing relative to services grew by a factor of six between 1950 and 2010. It is telling that this ratio is of the same order as the growth in relative prices. The data is consistent with the predictions of the Baumol effect.

53. For more on the data, see Marcel Timmer, Gaaitzen J. de Vries, and Klaas de Vries, "Patterns of Structural Change in Developing Countries," in *Routledge Handbook of Industry and Development*, ed. John Weiss and Michael Tribe (London: Routledge, 2015), 65–83. Ideally, we would like a measure of multifactor productivity, rather than just labor productivity, in health and education separately rather than combined with government services. Unfortunately, these data are not available for as long a time period. Government services does include significant spending on health and education services, so the overlap in that case is good, but it also includes spending on other services such as defense, which interest us less. See the subsequent discussion for a more detailed breakdown of multifactor productivity by industry that covers a shorter time period.

Figure 26. Relative Growth in Expenditures and Math Scores, United States, 1978–2015



Notes: Expenditures are real expenditures for US public elementary and secondary schools. Math scores are for 17-year-olds on the NAEP. Math scores and real expenditures are normalized to 100 in 1978 and 1980, respectively. *Source:* NCES.

The Baumol Effect Explains Rising Expenditures and Constant Quality

Discussions of the rising price of education, healthcare, or other sectors often contrast tremendous increases in expenditures with flat or relatively flat changes in quality.[54] The contrast can be striking. Figure 26, for example, repeats figure 3 in showing math scores for 17-year-olds on the National Assessment of Educational Progress (NAEP) test and real expenditures on K–12 education for public schools. Both scores are normalized to 100 at the beginning of the series (1978 for math scores and 1980 for expenditures) to show relative growth. Between 1980 and 2005, educational expenditures doubled, but over the same period, math scores were comparatively flat (between 1978 and 2012, scores fluctuated by approximately 3 percent). At first glance, it would seem that increased spending has been fruitless, perhaps

54. See, for example, Scott Alexander, "Considerations on Cost Disease," *Slate Star Codex*, February 9, 2017.

even wasteful. The Baumol effect provides a new interpretation and understanding of figures like this.

Recall that between 1826 and 2010, the price of a string quartet performance increased by a factor of 23, and yet there has been no increase in quality.[55] But who would expect otherwise? We did not spend more on string quartets in order to increase the quality of performance. We spent more because we had to spend more to pull workers and resources from *other* industries in which their productivity was increasing. The price of the string quartet increased by a factor of 23 between 1826 and 2010, but the real resource use remained four laborers. Because we did not invest more real resources in string quartet performances, we should not expect increases in quality. Thus, to the extent that the Baumol effect is the explanation for rising expenditures, we should not expect rising expenditures to be accompanied by rising quality.

Unlike with string quartet performances, society has invested more real resources in education. For example, there are more teachers per capita today than in the 1950s. Expenditures on education have increased both because input prices have increased and because society has bought more inputs. The price increases do not imply greater quality, but we would expect some output effect from greater resource use. Nevertheless, the Baumol effect makes the failure of quality to increase with greater expenditure much less mysterious than it otherwise might be because price increases have been a big factor in explaining higher expenditures.

Between 1980 and 2007, for example, staff per 100 students in K–12 public schools increased by 25 percent (from 10.0 per 100 in 1980 to 12.5 per 100 in 2007). During the same time period, real expenditures per student doubled from $6,920 to $13,992.

55. Musicians have likely increased in quality in the same way that Olympic athletes have increased in quality. But most of this is owing to learning and improvements over time rather than to greater investment. The major point is that any changes in quality have been dwarfed by changes in expenditure, and such quality changes as have occurred are not explained by changes in expenditure.

Only one-quarter of the actual increase in expenditures can be explained by the increase in staff. Because real resource use increased by only 25 percent, the "mystery" of much higher expenditures accompanied by relatively flat quality has been cut in size by three-quarters.

Indeed, focusing on real resource use rather than expenditures reveals that greater real resource use increases output, especially when output is measured in ways other than mean test scores. David Card and Alan B. Krueger, for example, find that students who are educated in classrooms with lower student-to-teacher ratios earn more later in life.[56] More recently, Raj Chetty, John N. Friedman, and Jonah E. Rockoff find that better-quality teachers, as measured by value-added scores (the change in score from the beginning to the end of the year), significantly increase future student earnings.[57] Again, our goal is not to review this literature but to emphasize that the Baumol effect tells us that to understand the true education production function, we should focus on real resources and outputs, not expenditures and outputs.[58]

Real Resource Costs versus Expenditures in Healthcare

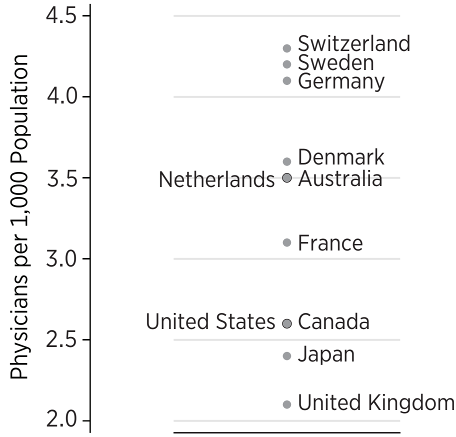
The same story illuminates healthcare expenditures. The price of guns is butter. If we want more X, we must be satisfied with less Y. The real cost of US healthcare is the opportunity cost of the resources—physician and nurse labor, capital resources, time, and so forth—that are used to produce healthcare. Healthcare in the United States looks expensive relative to the rest of the

56. David Card and Alan B. Krueger, "Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States," *Journal of Political Economy* 100, no. 1 (1992): 1–40; David Card and Alan B. Krueger, "School Quality and Black-White Relative Earnings: A Direct Assessment," *Quarterly Journal of Economics* 107, no. 1 (1992): 151–200.

57. Raj Chetty, John N. Friedman, and Jonah E. Rockoff, "Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood," *American Economic Review* 104, no. 9 (2014): 2633–79.

58. For a review of the literature, see Michael Lovenheim and Sarah Turner, *Economics of Education* (Worth Publishers, 2018).

Figure 27. Physicians per 1,000 Population



Source: Irene Papanicolas, Liana R. Woskie, and Ashish K. Jha, "Health Care Spending in the United States and Other High-Income Countries," *JAMA* 319, no. 10 (2018): 1024–39, using data circa 2015.

world when measured in dollars, but less so when measured in real resources.

The United States, as shown in figure 27, has fewer physicians per capita than most European countries have.[59] Thus, when real resources are measured, the United States spends *less* on physicians than other countries do. Indeed, overall it can be argued that Americans give up fewer other goods to produce healthcare than people in other countries, and they get roughly similar service.[60]

The same point can be made in a slightly different way. Physicians in the United States earn more than physicians in other countries. But all highly skilled labor earns more in the United States than in other countries. The high wages of physicians, nurses, and

59. Irene Papanicolas, Liana R. Woskie, and Ashish K. Jha, "Health Care Spending in the United States and Other High-Income Countries," *JAMA* 319, no. 10 (2018): 1024–39.

60. Mark Pauly, "U.S. Health Care Costs: The Untold True Story," *Health Affairs* 12, no. 3 (1993): 152–59; Papanicolas, Woskie, and Jha, "Health Care Spending."

other skilled healthcare workers in the United States correctly represent the opportunity cost of skilled labor rather than rents.[61]

The Baumol Effect Is Consistent with Increased Purchases of More Expensive Goods

Because the Baumol effect is driven by increased income, it is consistent with declining, flat, or increasing output in the stagnant sector. But if prices in a sector are rising because of higher costs—because of increased input prices, greater regulation, increased inefficiency, or other reasons—then the *only* rational response is to substitute away from the good that is rising in price. Thus, if prices and output in a sector are *both* increasing, that is consistent with the Baumol effect but *not* with pure cost-driven explanations for increases in prices.

How the benefits of increased productivity will be spent depends on preferences, as shown in figure 22, and also on opportunities for technological substitution. At one point, lawnmowers and dishwashers were people. Today they are more likely to be capital goods. As wages rose, consumers switched to using capital goods to mow lawns and wash dishes because those methods were cheaper and often of higher quality. Similarly, we have substituted recorded for live music performances, in part because live performances have become more expensive but also because recorded performances are in many ways—although not in all ways—better. Recorded music has meant that total music consumption has increased tremendously since 1826, even though live performances have become more expensive.

More generally, higher prices in the stagnant sector encourage the search for substitutes in the progressive sector. But it is not always possible to find such substitutes. Unfortunately, massage chairs are not (yet) a good substitute for a masseuse. To date, medical care and education are two fields that have resisted

61. Cutler and Ly, "The (Paper)Work of Medicine."

substitution. Policing, legal services, and repair services also resist substitution. In each of these cases, support services from the progressive sector (better tools and information technology) have increased productivity, but not as much as in the progressive sector. When substitution is not possible, individuals may choose to spend more or less on these services. In education, medical care, and policing, people have chosen to pay the expense *and they can*.

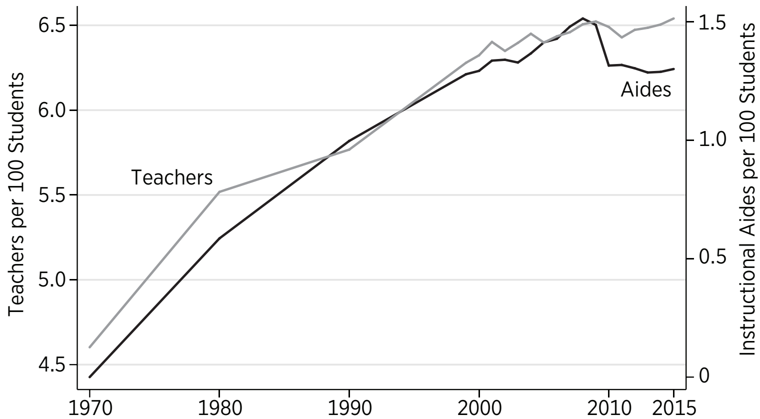
Figure 28 shows the number of teachers and instructional aides per 100 students since 1970. It is evident that Americans have chosen to consume greater output from the education sector even as costs have increased. The evidence is thus consistent with the Baumol effect but not with non-Baumol cost-based explanations for rising education prices. Notice that the number of instructional aides, a relatively cheaper substitute for teachers, has increased from nearly zero percent in 1970 to approximately 20 percent of the number of teachers in 2015, a substitution that is also consistent with the Baumol effect.

Figure 29 shows physicians per 1,000 people in the United States. As with teaching, it is evident that despite higher costs Americans have chosen to buy more healthcare output over time. Once again, this is consistent with the Baumol effect but inconsistent with a purely cost-driven explanation for rising prices.

The Baumol Effect Explains a Slowing Rate of Productivity Growth and the Reason the Baumol Effect Will Decline

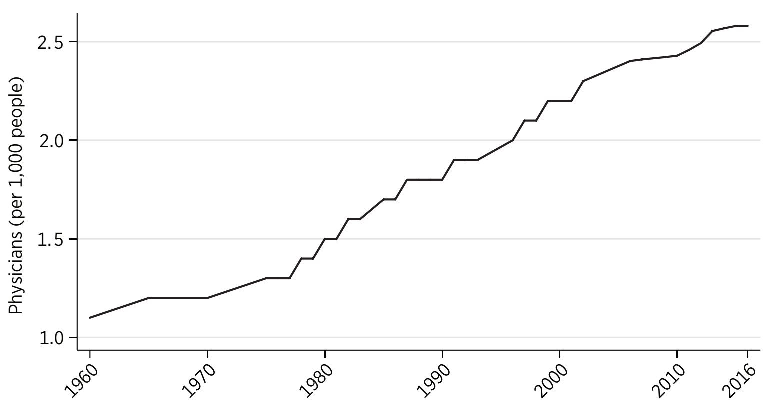
The price of services relative to goods has been rising because productivity in services has increased more slowly than productivity in goods. At the same time, the services sector has been growing as a share of the economy. In 1950, for example, services accounted for approximately 60 percent of the economy, measured as a share of either GDP or employment. In 2018, services accounted for approximately 80 percent of the economy, again measured as a share of either GDP or employment. Because society is moving more resources into lower-productivity sectors,

Figure 28. Teachers and Aides per 100 Students, US Elementary and Secondary Public Schools, 1970–2015



Source: NCES.

Figure 29. US Physicians per 1,000 People, 1960–2016



Note: Data for 1995, 2000, and 2004 were inconsistent with adjoining years and were interpolated.
Source: World Health Organization, "WHO Global Health Workforce Statistics"; OECD.

the inevitable result is slowing net productivity growth.[62] Dietz Vollrath, for example, calculates that between 2000 and 2015, the effect of shifting resources from higher-productivity-growth industries to lower-productivity-growth industries reduced net productivity growth by 20 percent (from 0.5 percent to 0.4 percent).[63]

Even though shifting resources to services is slowing down the rate of productivity growth, the shift itself is not a bad thing. Over the past 60 years, consumers have used their higher incomes to buy relatively more services than goods. It is unfortunate that productivity is not increasing faster in services, but faster productivity growth is good only if it results in greater consumer satisfaction. Shifting resources to the service sector increases consumer satisfaction even if it reduces productivity growth. There is nothing wrong with a future world in which consumers spend most of their income on live musical performances. Thus, Vollrath calls the lower rate of US productivity growth "optimal stagnation."

A slowing rate of productivity growth also means a decline in the Baumol effect. The Baumol effect is driven by increasing productivity in the progressive sector. As the progressive sector becomes a smaller share of the economy, it can no longer drive price increases elsewhere in the economy. Put simply, in the future world when most workers are musicians, wages cannot rise faster than productivity in musical performance. Recall that for both education and healthcare, the fastest growth in costs occurred in the 1950–1970 period; thus, relative costs grew fastest when productivity growth was the highest, exactly as predicted by the Baumol effect.

62. Because society is shifting more and more resources into the stagnant sector, including some resources that may be better suited to production in the progressive sector, the potential income effect from figure 22 magnifies the Baumol effect.

63. Dietz Vollrath, *Optimal Stagnation: Why Slower Economic Growth Is a Sign of Success* (Chicago: University of Chicago Press, forthcoming).

The Baumol Effect versus the Income Effect

The Baumol effect is primarily a relative price effect. But because the change in relative price is caused by rising productivity in the progressive sector, the increase in relative price is always accompanied by an increase in income. This is why Baumol effects—unlike pure cost explanations—are consistent with increasing real resource use in the stagnant sector (as explained earlier). Because Baumol effects are always accompanied by increases in income, however, an alternative explanation for rising expenditures is increasing income as the *primary* cause. This argument has been made especially for the case of healthcare.

Robert E. Hall and Charles I. Jones argue that the growth of healthcare spending is a rational response to higher income.[64] It is obvious that with greater income, people will want to spend more on healthcare, just as they will want to spend more on pizza. Hall and Jones, however, argue that as income increases, people will want to spend a greater *share* of their income on healthcare.[65] Using a quantified model, they predict that by 2050 Americans will want to spend 30 percent or more of their income on healthcare. Hall and Jones imply that increased healthcare spending is no more a concern than increased spending on tourism or cut flowers—these are luxury goods that we want more of as we get richer. Indeed, the worry from the Hall and Jones perspective is not that we will spend too much on healthcare, but that out of misplaced concerns about cost we will spend too little. Similarly, many people have noted that European countries spend a smaller share of GDP on healthcare than does the United States, but from the Hall and Jones perspective, this may be a European error rather than a US failing.

Two ideas drive the intuition behind the Hall and Jones model. First is the well-understood idea that goods and services

64. Robert E. Hall and Charles I. Jones, "The Value of Life and the Rise in Health Spending," *Quarterly Journal of Economics* 122, no. 1 (2007): 39–72.

65. In the language of economics, this means an income elasticity greater than 1, which would make healthcare a superior good.

have diminishing marginal utility. The more stuff people have, the lower the value of additional stuff. As the value of additional stuff declines, it makes more sense to spend on other goods such as additional life—this is the usual story. The second and more subtle idea is that the value of additional life increases with the *total* value of stuff. An additional year of a luxurious life is worth more than an additional year of a life of penury. Thus, we spend more on healthcare as income rises because the value of additional goods and services falls and the value of additional life *rises*. The faster the marginal utility of goods falls, and also the more effective income is at increasing lifespan, the greater the optimal share of income spent on health. Using their model, Hall and Jones estimate that current levels of healthcare spending are not unreasonable and could reasonably rise to 30–45 percent of GDP by 2050.

As income increases, both the Baumol effect and Hall and Jones's income effect are consistent with greater spending on healthcare (P × Q), but there are differences between the two models. The Baumol effect explains most of the increase in expenditures from price increases (P), whereas Hall and Jones explain the increase in real expenditures from greater real resource use (Q). In fact, in the Hall and Jones model there is no reason that healthcare prices would increase in the long run. Thus, to explain persistent price increases, Hall and Jones must either refer to exogenous factors or deny that price increases are an important part of the story. Neither approach seems plausible.

Prices in the healthcare sector have increased consistently over time, and not just in the United States but in most countries. Explaining consistent price increases requires more than a theory that says society has been unlucky.

Could prices be mismeasured? A heart operation in 2018 is not the same thing as a heart operation in 1990. Recovery from the former is quicker, for example. It is difficult to control for quality changes, but price increases are common even across healthcare goods that do not appear to have increased in quality.

Moreover, since the Boskin Commission report in 1996,[66] economists and statisticians at the Bureau of Labor Statistics and their counterparts around the world have worked to improve healthcare price indices.[67] While these efforts do tend to show that price increases have not been as large as quality-unadjusted indices suggest, no one thinks that productivity in healthcare is improving at a rate anywhere close to that in manufacturing.[68] Thus, to explain rising expenditures over time, the conclusion of Gerard F. Anderson and his co-authors seems appropriate. Namely, "It's the Prices, Stupid."[69]

We can test for differences between the Baumol effect and the income effect in other ways. The Baumol effect implies that increases in prices in the stagnant sector should be a function of productivity improvements in the progressive sector rather than of income per se. Papers by Jochen Hartwig, Laurie J. Bates and Rexford E. Santerre, and Carsten Colombier all test whether healthcare expenditures are better explained by a Baumol factor that relates specifically to productivity growth in the progressive sector or by income increases more generally. They find that the Baumol factor is always important and usually more important than income growth per se.[70] See also our analysis following.

66. Michael J. Boskin et al. (Advisory Commission to Study the Consumer Price Index), *Toward a More Accurate Measure of the Cost of Living: Final Report to the Senate Finance Committee* (Washington, DC: US Senate, 1996).

67. For example, see Jack E. Triplett and Barry P. Bosworth, *Productivity in the U.S. Services Sector: New Sources of Economic Growth* (Washington, DC: Brookings Institution Press, 2004); Ana Aizcorbe et al., eds., *Measuring and Modeling Health Care Cost*s (Chicago: University of Chicago Press, 2018).

68. Note also that "difficult to adjust" does not necessarily always imply underadjustment.

69. Anderson et al. were more concerned with explaining cross-national differences than with explaining differences over time, but the title still seems appropriate. See Gerard F. Anderson, Uwe E. Reinhardt, Peter S. Hussey, and Varduhi Petrosyan, "It's the Prices, Stupid: Why the United States Is So Different from Other Countries," *Health Affairs* 22, no. 3 (2003): 89–105.

70. Jochen Hartwig, "What Drives Health Care Expenditure?—Baumol's Model of 'Unbalanced Growth' Revisited," *Journal of Health Economics* 27, no. 3 (2008):

Another test of the Baumol effect versus the income effect occurs when income increases for reasons other than productivity. Oil price shocks, for example, create mini-booms in oil-producing regions of the United States. Daron Acemoglu, Amy Finkelstein, and Matthew J. Notowidigdo test for this effect and, contrary to the prediction of Hall and Jones, estimate that income elasticities are less than 1., This result leads them to conclude that "rising income is unlikely to be a major driver of the rising health expenditure share of GDP."[71]

In short, the Baumol effect is consistent with rising costs and rising purchases, which is what we observe in important sectors such as healthcare and education. Other theories could explain those facts using auxiliary assumptions—especially if we look over long periods of time when income is rising—but all else equal, it is better to follow the simpler explanation than the theory that requires Ptolemaic assumptions.

TESTING THE BAUMOL EFFECT IN MULTIPLE INDUSTRIES

The evidence for the Baumol effect is strong in our three "case-study" industries: lower education, higher education, and healthcare. These are large and important industries that are in the public eye. In this section we expand our analysis to a larger range of industries, but instead of case studies we present a statistical analysis. We follow closely the analyses of William D. Nordhaus and also Jochen Hartwig,[72] but we use a

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603–23; Laurie J. Bates and Rexford E. Santerre, "Does the U.S. Health Care Sector Suffer from Baumol's Cost Disease? Evidence from the 50 States," *Journal of Health Economics* 32, no. 2 (2013): 386–91; Carsten Colombier, "Drivers of Health-Care Expenditure: What Role Does Baumol's Cost Disease Play?," *Social Science Quarterly* 98, no. 5 (2017): 1603–21.

71. Daron Acemoglu, Amy Finkelstein, and Matthew J. Notowidigdo, "Income and Health Spending: Evidence from Oil Price Shocks," *Review of Economics and Statistics* 95, no. 4 (2013): 1079–95.

72. William D. Nordhaus, "Baumol's Diseases: A Macroeconomic Perspective," *B.E. Journal of Macroeconomics* 8, no. 1 (2008): 1–39; Jochen Hartwig, "Testing the Baumol–Nordhaus Model with EU KLEMS Data," *Review of Income and Wealth* 57, no. 3 (2011): 471–89

more recent and complete dataset.[73] We also include a larger range of control variables for regulation, concentration, and workforce statistics

We find that the data are consistent with the Baumol effect: industries with smaller increases in productivity exhibit larger increases in prices. Moreover, industries with smaller increases in productivity that rely on large numbers of college-educated workers see especially large price increases. In comparison, we find little evidence that price increases over our time period are driven by regulation or concentration.

Data

The KLEMS Productivity and Growth Accounts are the most detailed and sophisticated attempt by the European and US statistical agencies to measure productivity. We use KLEMS data produced by the BEA covering the period 1987–2016.[74] The data are available by industry as measured by NAICS codes at the two-digit (highly aggregated) to six-digit (least aggregated) levels.[75] We use the data at the four-digit NAICS level whenever available but include some NAICS three-digit industries when

73. Nordhaus's data cover a longer time frame (1947–2002) but fewer industries than our data. Nordhaus's data are not maintained by the BEA and use SIC industry codes that are no longer in use. We focus on the price-productivity prediction of the Baumol effect. Nordhaus also looks at the implications of cost disease on real output, employment, and compensation in the stagnant sector.

74. The KLEMS data project is named after its primary method of deriving a measure of productivity. That measure relates gross output or value added to capital (K), labor (L), energy (E), other materials used as inputs (M), and purchased business services (S). See https://www.bls.gov/mfp/mfp_by_industry_and_measure_data_only.xlsx. For a detailed discussion of the annual industry accounts, see Erich H. Strassner, Gabriel W. Medeiros, and George M. Smith, "Annual Industry Accounts: Introducing KLEMS Input Estimates for 1997–2003," *Survey of Current Business* 85, no. 9 (2005): 31–65.

75. The NAICS classification system is an acronym for the North American Industry Classification System (NAICS). This system replaced the older SIC (Standard Industrial Code) used in Nordhaus's study. For a discussion of the conversion of BEA data from SIC to NAICS, see Robert E. Yuskavage, "Converting Historical Industry Time Series Data from SIC to NAICS" (BEA Papers 0085, Bureau of Economic Analysis, 2007).

none of the four-digit subcategorizations are available. Using this rule, our final dataset contains 139 industries at either the NAICS three- or four-digit level (see the table in appendix A, page 74).[76] The most important variables from the KLEMS data for our purposes are an estimate of multifactor productivity and the industry output-price.

We supplement KLEMS data with three other data sources. The Mercatus Center's RegData project[77] analyzes the text of the *Code of Federal Regulations* to estimate the amount of regulation by industry by year.[78] We find data on the portion of an industry's workforce with a college education from the American Community Survey (ACS).[79] The ACS is a household-level survey and not an industry survey. We use this information because, surprisingly, there does not appear to be a survey that includes information on the average level of worker education by industry.

The data on the four-firm concentration ratio are provided by the Economic Census for the years 1987, 1992, 1997, 2002, 2007, and 2012.[80] The four-firm concentration ratio (C4) measures the proportion of total sales in an industry captured by the four largest firms. Thus, a C4 of 65 percent would indicate that the top four firms in that industry constituted 65 percent of sales. The C4 is often considered an estimate of competitiveness or monopoly power.

76. The number of industries varies somewhat depending on the graph/regression because of data limitations in control variables.

77. The regulation data are available at https://quantgov.org/federal_regulation_tracker.

78. For more on REGDATA, see Omar Al-Ubaydli and Patrick A. McLaughlin, "RegData: A Numerical Database on Industry-Specific Regulations for All United States Industries and Federal Regulations, 1997–2012," *Regulation and Governance* 11, no. 1 (2017): 109–23, and Nathan Goldschlag and Alex Tabarrok, "Is Regulation to Blame for the Decline in American Entrepreneurship?," *Economic Policy* 33, no. 93 (2018): 5–44.

79. American Community Survey data, US Census Bureau, https://www.census.gov/programs-surveys/acs/.

80. See "Concentration Ratios" for the 2007, 2002, and 1997 Economic Census, https://www.census.gov/econ/concentration.html.

Defining Productivity

KLEMS stands for Capital (K), Labor, Energy, Materials, and Services, and the fundamental idea is that increases in output that cannot be explained by the KLEMS factors must be due to productivity. More generally, economists, following Solow, use the heuristic of a production function to explain how the KLEMS factors combine to determine output.[81] The total value added by an industry, Y, is given by

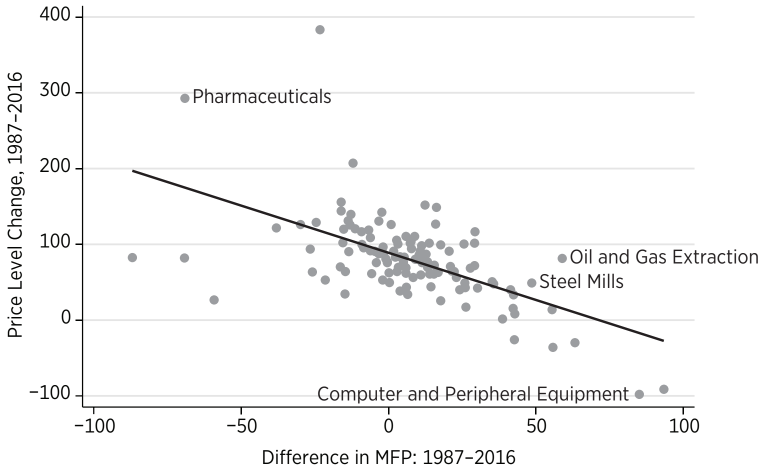
$$Y = A \times F(K, L, E, M, S),$$

where A is multifactor productivity (MFP) or total factor productivity. Solow's insight was that economic theory and assumptions such as cost minimization provide some information about the functional form F, so if one can estimate the KLEMS inputs, then it is possible to estimate A. An industry with growing productivity, say, that is due to technological change will exhibit greater output than can be explained by the inputs. An industry that is stagnant will see no more output growth than can be explained by input growth. Thus, if an industry's growth can be explained by increases in inputs, productivity is not growing. Industries could also shrink and yet still increase in productivity if output does not shrink as much as would be predicted from shrinking inputs. Because productivity can increase (or decrease) with increasing, decreasing, or constant output, a model and careful statistical analysis are needed to uncover productivity changes from data on output and inputs—that is what the KLEMS data provide.

The Solow model and the KLEMS measures require assumptions about market structure and market competition. We do not examine all the assumptions in this paper, although we will examine the assumption that markets are broadly competitive

81. Robert M. Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics* 39, no. 3 (1957): 312–20.

Figure 30. Price and Multifactor Productivity Trend (MFP), 1987–2016



Source: BEA, "Integrated Industry-Level Production Account (KLEMS)."

and test whether our price-effect results are robust to including controls for competition.

Results

Figure 30 shows the relationship between changes in MFP (horizontal axis) and changes in real prices (vertical axis). Greater MFP growth is strongly associated with lower prices. Nordhaus finds a similar relationship but uses 28 manufacturing industries over a longer time period,[82] whereas we replicate his analysis using approximately 139 industries, including less-well-measured service industries, over a shorter time period.

The lowest MFP growth industries are those with the highest price growth. Not surprisingly, computers and peripheral equipment have experienced large productivity increases and

82. Nordhaus, "Baumol's Diseases: A Macroeconomic Perspective."

falling prices. In contrast, pharmaceutical productivity has fallen and prices have risen. Overall, there is thus a clear negative relationship between growth in MFP and industry prices, consistent with the results found in Nordhaus and predicted by Baumol.

One alternative (or potentially related) hypothesis to explain price increases is an increasing regulatory burden. The idea is simple: regulation raises costs, which are passed on to consumers.[83] It could also be the case that regulation is the mechanism by which MFP growth declines. If regulation reduces MFP growth, the relationship in figure 30 might be owing to an increased regulatory burden working through MFP growth. In either of these cases, one would expect to see a clear positive relationship between the extent of regulation and the price increases.

Figure 31 shows little evidence that price increases at the industry level are caused by regulation. This is consistent with earlier findings by Nathan Goldschlag and Alex Tabarrok,[84] and it suggests that MFP growth is driven by technological change, along the lines suggested by Solow, more than by regulation. This is not to say that regulation has no impact on productivity or on prices. A more detailed examination of particular industries and particular regulations passed at particular times would likely uncover important effects. Rather, the primary factor explaining long-run trends in prices is differences in productivity growth rates rather than regulation.

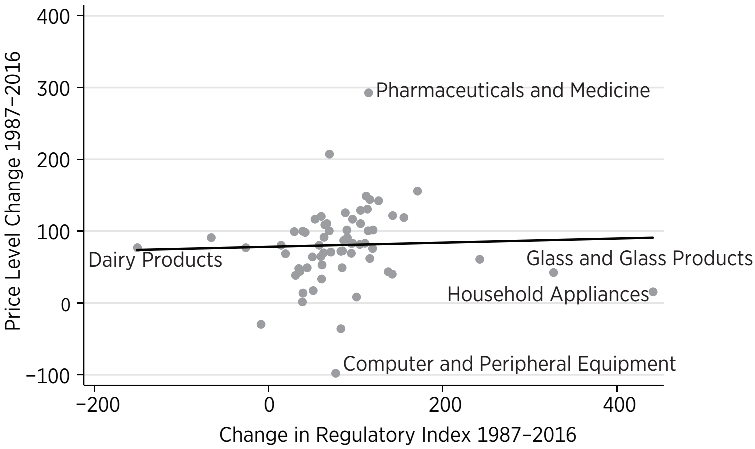
In figure 32 we explore another possible cause of increasing prices: concentration.[85] We graph the four-firm concentration

83. See, for example, Michael Greenstone, "The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures," *Journal of Political Economy* 110, no. 6 (2002): 1175–1219.

84. Goldschlag and Tabarrok, "Is Regulation to Blame for the Decline in American Entrepreneurship?"

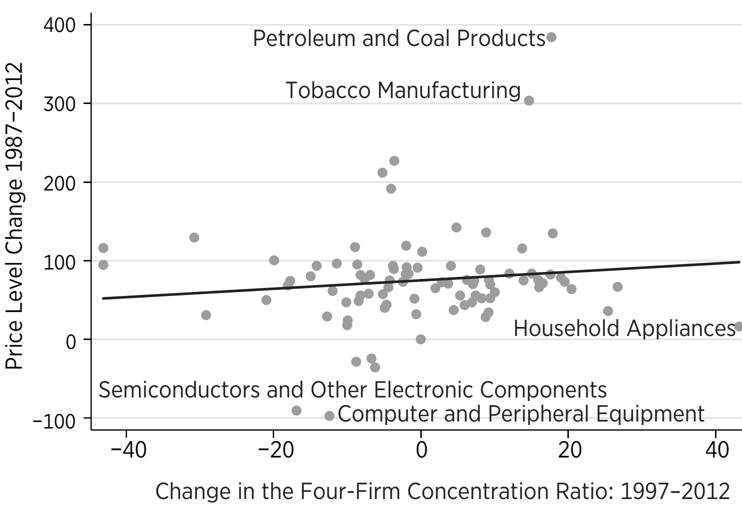
85. Our analysis is correlational. A more complete analysis would take into account that the MFP data assume that industries are competitive and that the prices reflect the marginal cost of production. However, if there is widespread market power in

Figure 31. Price and Regulation Trends, 1987–2016



Sources: Price data are from BEA, "Integrated Industry-Level Production Account (KLEMS)." Regulation data are from RegData US 3.1 Annual (dataset), QuantGov, Mercatus Center at George Mason University, https://quantgov.org/regdata-us/

Figure 32. Price and Four-Firm Concentration Ratio, 1987–2012



Sources: Price data are from BEA, "Integrated Industry-Level Production Account (KLEMS)." Concentration ratio data are from the Economic Census.

ratio on the industry-level price changes and find (weak) evidence of market power as an alternative. The effect is small, however, and it is worth noting that the entire effect is driven by petroleum and coal products and tobacco manufacturing. When we exclude those two industries, the regression line is essentially flat.

Returning to the Baumol effect, recall that a key force factor has been the rising return to education. As discussed earlier, the returns to education have risen in the American economy and driven up the wages of college-educated workers. Industries that require an educated workforce, therefore, face increases in the costs of their inputs. In industries with high productivity growth, the greater price of inputs can be absorbed, but in low-productivity industries, the rise in the price of inputs must be reflected in the price of outputs.

We collect data on education by industry using the American Community Survey (ACS) over the time period 1998–2016. Because the hypothesized effect involves the interaction between the proportion of the industry workforce that is college educated, and hence paid higher wages, and the growth in MFP, we estimate the following regression:

$$\ln(price_{it}) = \gamma_t + \delta_j \beta_k + \epsilon_{it},$$

where $\ln(price_{it})$ is the natural log of the price index for industry i, γ_t are fixed effects for each year 1987 to 2016, and $\delta_j \beta_k$ are fixed effects for the first through fourth quartiles of MFP growth and the first through fourth quartiles of the fraction of the industry workforce with a college education.

In figure 33 we plot the coefficients of the 16 interaction terms, omitting the year fixed effects. Each interaction term shows the annual average price for industries in an MFP-education quartile. The four coefficients at the bottom of the graph,

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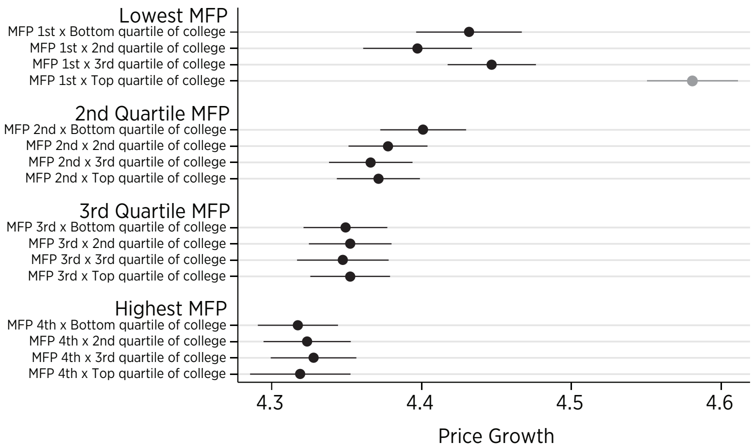
the economy and prices are above marginal cost, then the calculations will overstate MFP. A full analysis of the problem is outside the scope of this analysis.

Figure 33. Coefficient Plot of MFP and College-Educated Workforce Regressed on Price Growth, Annual Data 1998–2015



Sources: Price data are from BEA, "Integrated Industry-Level Production Account (KLEMS)." Data on the college-educated proportion of the workforce are from the American Community Survey.

for example, are the highest-growth MFP industries broken down into quartiles of the percentage of college-educated workers. In this case, all industries with high MFP growth have relatively small annual price increases, even those industries with a high percentage of college-educated workers. Working up the graph, we are moving to lower and lower MFP growth. The clear outlier is that industries in the bottom quartile of MFP growth and the top quartile of college-educated workers have seen the largest price increases. Thus, consistent with our evidence in the case studies, industries such as education and medicine that have not experienced higher productivity growth but require a highly educated workforce are most susceptible to the Baumol effect.

Overall, there is a clear negative relationship between industry-level price inflation and MFP growth over the 1987–2016 period. Low-productivity industries with a large number of college-educated workers have the highest price increases. This result is based on a broader number of industries than Nordhaus's original study and uses less well-measured industries such as services. The results do not appear to be driven by regulation or concentration.

THE BAUMOL EFFECT DOES NOT EXPLAIN PRICE INCREASES IN EVERY SECTOR

After rejecting a number of alternative explanations, we conclude that the Baumol effect is the best explanation for rising prices in education and healthcare. The Baumol effect also explains price increases in other labor-intensive, high-skill services such as law, accounting, and car repair. Similarly, our analysis of the KLEMS data finds the highest price increases in low-productivity sectors that use many high-opportunity-cost (i.e., college-educated) workers.

In short, the Baumol effect offers a compelling explanation for the dispersion of prices from 1950 to 2016 shown in figure 1. The Baumol effect, however, does not explain every incidence of rising prices. For example, it is unlikely to explain the high cost of infrastructure construction in large cities such as New York and Los Angeles. In these cities, it costs 2 to 10 times as much to build a subway line as in cities of other developed countries. The cause here appears to be much more owing to unionized labor contracts that mandate inefficient employment and methods of construction and to a legal system with many veto points than to secular increases in the price of skilled labor.[86] One indication that this is the case is that the cost of residential construction, which is much less centralized and unionized, has increased only modestly since 1950 (on the order of 40 percent).[87]

86. Brian M. Rosenthal, "The Most Expensive Mile of Subway Track on Earth," *New York Times*, December 28, 2017.

87. Robert J. Shiller, *Irrational Exuberance*, revised and expanded 3rd ed. (Princeton, NJ: Princeton University Press, 2015). Note that this is the cost of residential construction, not the price of a house, as the latter also includes the price of land.

The case of urban infrastructure is also telling for another reason. We argued earlier that a signature of the Baumol effect is that it is consistent with rising costs and rising purchases. Even as everyone complains of the rising price of education and healthcare, we are buying more of these goods in *real* terms—in other words, not just spending more but increasing the number of teachers per capita, educating more people for longer periods of time, buying the services of more physicians and nurses per capita, and so forth. In contrast, we argued that a signature of a true cost disease is that consumers would reduce their purchases of the good that increased in price. Urban infrastructure seems to fit the latter story. Although it is difficult to exactly measure quantities of infrastructure purchased, especially because these purchases occur over long periods of time, the complaint most often heard in the urban infrastructure debate is that we are relying on old, crumbling infrastructure—100-year-old subway and sewage systems—precisely because consumers and taxpayers are unwilling to pay the high prices of new infrastructure.

OVERCOMING THE COST DISEASE BY UNDERSTANDING THE BAUMOL EFFECT

Misdiagnosing a problem often leads to "solutions" that make the problem worse. The Baumol effect tells us that if we try to reduce costs by going after the "usual suspects"—unions, regulations, monopolies, capitalists, bureaucrats, capitalism, socialism—we are likely to make things worse. The Baumol effect, however, is not a call for complacency. Instead, the Baumol effect tells us that we need to look to the deeper issue of productivity.

Costs increase when output productivity grows only slowly but industry inputs have rising opportunity costs. For example, the cost of education has increased because teaching productivity grows only slowly and the education industry uses skilled labor, which is increasingly valuable elsewhere in the economy.[88]

88. Note that the economy needs both of these effects to operate. The productivity of bus driving has not increased much over time, but bus driving uses an input,

It follows that to control costs, industries must increase output from the same inputs or use fewer inputs with rising opportunity costs. Labor-intensive services have so far resisted productivity growth, and we cannot solve that problem in this paper. But to illustrate the relevant concepts, we give some suggestions about the types of approaches that might improve productivity in education and healthcare.

Online education could greatly increase the productivity of teaching. At a university like Florida State, Ohio State, or Texas A&M, the average class size is between 40 and 50 students. In contrast, it is not uncommon for online classes, such as those offered by Coursera, Udacity, or MRUniversity, to have 25,000 students—with some classes having more than 100,000 students. Many people who register do not finish those classes, which are typically free and uncredited, but even so, completion rates on the order of 5–15 percent mean that teaching in those classes is two orders of magnitude more productive than teaching in a traditional classroom.[89] Although there are upfront costs to develop an online course, as there are for traditonal courses, the online course can be used repeatedly with much lower marginal costs. Thus, productivity improvements are even greater over the duration of a teaching career.

Studies of online teaching show that students learn as much as in a traditional classroom but at much lower cost.[90] Moreover, the quality of online teaching will increase over time with greater investment and improvements in complementary information technology.

The economics of online teaching makes it profitable to invest more in improving quality. It doesn't pay to invest much

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unskilled labor, with a relatively declining opportunity cost. Computer chip design uses skilled labor, but costs have fallen because productivity has risen rapidly.

89. Alex Tabarrok, "Why Online Education Works," *Cato Unbound*, November 2012; Tyler Cowen and Alex Tabarrok, "The Industrial Organization of Online Education," *American Economic Review* 104, no. 5 (2014): 519–22.

90. Cowen and Tabarrok, "The Industrial Organization of Online Education."

in a course taught to 40 students. But when a course is taught to 10,000 students, it can easily pay to invest $10 per student—$100,000—in designing the course. Producers of video games invest millions of dollars in designing games, and they hire top talent. As online education expands, millions of dollars will be invested in creating online courses with superstar teachers.

With fewer teachers teaching more students, highly skilled and educated labor will be freed to focus on research and intensive training of advanced students. Thus, online education increases the productivity of teachers and reduces the need for inputs with high and growing opportunity costs.

More generally, online technologies tie education to information technology, a progressive sector. Thus, improvements in computers, artificial intelligence (AI), and internet speed and reach will henceforth increase the productivity of education.

Productivity can also be increased in more traditional classrooms. Consider this illustration of an introductory math class at Virginia Tech (Virginia Polytechnic Institute and State University), one of Virginia's largest public universities:

> There are no professors in Virginia Tech's largest classroom, only a sea of computers and red plastic cups.
>
> In the Math Emporium, the computer is king, and instructors are reduced to roving guides. Lessons are self-paced, and help is delivered "on demand" in a vast, windowless lab that is open 24 hours a day because computers never tire. A student in need of human aid plants a red cup atop a monitor.
>
> The Emporium is the Wal-Mart of higher education, a triumph in economy of scale and a glimpse at a possible future of computer-led learning. Eight thousand students a year take introductory math in a space that once housed a discount department store. Four math instructors, none of them professors, lead seven courses with enrollments of 200 to 2,000 (Daniel de

Vise, "At Virginia Tech, Computers Help Solve a Math Class Problem," *Washington Post*, April 22, 2012).

The substitution of computers, which are falling in price, for math professors, which are increasing in price, lowers costs. But the substitution also opens up other avenues to increase productivity. The classroom is now open 24 hours a day, and students can proceed at their own pace—advantages that increase the efficiency of learning. Cost savings wouldn't be worth as much if output fell, but if anything, output has increased because students are passing the introductory math courses at higher rates than before the Math Emporium was built.

Information technology can also improve productivity in healthcare. Two routes are especially important. First, greater integration of healthcare in HMOs such as Kaiser Permanente and improvements in health records will allow greater computerized oversight of treatment. Some physicians dislike the idea of computer oversight, but in industry after industry, quality and safety improvements have come with standardization. A simple system designed by physicians to standardize the treatment of back pain around scientifically validitated treatments saved the Virginia Mason system in Seattle 55 percent per case while improving patient satisfication. A similar system applied nationally could save over $50 billion per year for back care alone.[91]

Another way of reducing the cost disease in healthcare is to automate diagnosis. Advanced AI radiologists are already more accurate than physicians for some problems.[92] As one radiologist puts it,

> What we will eventually see in radiology are diagnostic image interpretation systems that have read

91. Cutler, *The Quality Cure*.

92. Naji Khosravan and Ulas Bagci, "S4ND: Single-Shot Single-Scale Lung Nodule Detection," 21st International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI 2018).

> every textbook and journal article; know all of a patient's history, records, and laboratory reports; and have memorized millions of imaging studies. It may help to imagine these systems not as a collection of circuits in a console, but as an army of fellowship-trained radiologists with photographic memories, IQs of 500, and no need for food or sleep.[93]

Left unsaid is that this army of 500-IQ radiologists without need for food or sleep will operate on the equivalent of a cell phone and at the same cost. Radiology is one of the first areas of medical practice to widely use AI because radiology data are easy to digitize and store. IBM's Watson for Oncology, in contrast, needs data from hospital records that are often nonstandardized and sometimes still handwritten. As a result, progress has been slow.[94] But data standardization is a force multiplier for AI, and once a tipping point has been reached, the effectiveness of AI medical systems will explode. Gary Kasparov's loss to the multimillion-dollar Deep Blue computer in 1997 was the first time a reigning world chess champion had lost to a computer in tournament conditions. Today, Magnus Carlsen, the best human chess player in the *history of the world*, is easily defeated by an off-the-shelf computer program running on a cell phone.

Online education and AI in medical diagnostics both apply the key idea: to increase productivity in services, the service needs to be tied to a progressive sector. More generally, AI, robotics, and similar technologies offer the prospect of large productivity advances in services. The better capital is as a substitute for labor, the more the Baumol effect will disappear.

93. Robert Schier, "Artificial Intelligence and the Practice of Radiology: An Alternative View," *Journal of the American College of Radiology* 15, no. 7 (2018): 1004–7.

94. Casey Ross and Ike Swetlitz, "IBM Pitched Its Watson Supercomputer as a Revolution in Cancer Care. It's Nowhere Close," *STAT*, September 5, 2017.

There is one other general approach to alleviating cost pressures in the stagnant sector, and that is to expand the production of the key constraining input, educated workers. Many people have suggested that society could reduce prices in medical care by increasing the number of physicians, perhaps through immigration or creating more medical schools and residency slots.[95] These are valid policies. The perspective on the cost disease from this paper, however, suggests a more general approach. The primary cause of increasing prices of medical care is the rising price of skill in *other* sectors of the economy. Thus, *any* increase in skilled workers will tend to reduce the price of medical care. To the extent that they are ultimately in the same market, more computer programmers, chemical engineers, and statisticians will lower the price of skill and thus lower the price of medical care.

Claudia Goldin and Lawrence F. Katz explain the evolution of wages in the United States through the race between education and technology.[96] Technology increases the demand for skill. Education increases the supply of skill. Since the 1980s education has been losing the race, and that shortfall has increased the relative wages of skilled workers. Contrary to popular accounts, however, the major part of the story is not that technology has advanced more quickly since the 1980s; if anything, it has advanced more slowly post-1980 than pre-1980. Instead, the major driver is that growth in educational attainment has slowed. Goldin and Katz argue that the slowing of educational attainment post-1980 increased the college wage premium, thus increasing the relative price of any good or service that uses college-educated workers as an input. Consequently, to decrease the college wage premium and the relative price of goods and services that use college-educated

95. Brink Lindsey and Steven Teles, *The Captured Economy: How the Powerful Enrich Themselves, Slow Down Growth, and Increase Inequality* (New York: Oxford University Press, 2017).

96. Claudia Goldin and Lawrence F. Katz, *The Race between Education and Technology* (Cambridge, MA: Harvard University Press, 2008).

workers, we need to increase the educational attainment of the US workforce.[97]

CONCLUSIONS

We have tried to avoid using the term *cost disease* because a deep lesson of the Baumol effect is that, over time, goods can increase in price and also become more affordable. An even deeper lesson is that higher prices of some goods are an inevitable consequence of economic growth.[98] Changes in relative prices are an inevitable consequence of growth and not a failure of growth. We can have our healthcare and our smartphones, too.

It's natural to look at high and rising prices in sectors such as education, healthcare, and the arts and to conclude that there is something wrong with these sectors. We have taken a close look at education and healthcare, and Baumol and Bowen examined the arts, and most of the specific explanations for problems in these sectors are either untrue or cannot explain rising costs.[99] Education has not become more dominated by administrative costs or lazy rivers. Medical malpractice costs are not a large share of healthcare costs. Across a wide range of industries, neither regulation nor concentration does much to explain long-run changes in prices.

More generally, any "explanation of the day" for rising prices in education, healthcare, and the arts must come to grips with the fact that rising prices have been a prominent feature of these

97. The United States has historically been the world's most successful country at attracting high-skill immigrants. In the most recent decade, for example, just over 60 percent of US Nobel Prize winners, 50 percent of software engineers with master's degrees, and 28 percent of NBA players have been foreign born (*Moving for Prosperity: Global Migration and Labor Markets* (Washington, DC: World Bank, 2018)). Immigration can increase the fraction of workers with high skill, but even at past levels, immigration has not been enough to reduce the college wage premium, although it has likely alleviated some of the rise.

98. This consequence is inevitable because it would be virtually impossible for productivity to increase for all goods at exactly the same rate.

99. Baumol and Bowen, *Performing Arts, the Economic Dilemma*.

industries for well over 100 years and under a wide variety of regulatory, legal, and economic environments. We are not claiming that factors such as regulation never increase prices. Indeed, we suspect that regulation does raise prices, but hardly any industry is immune to regulation, and there is no evidence that regulation explains the rising price of services relative to goods. (One could say the same thing about other factors such as concentration.)

The Baumol effect is the best explanation for rising prices in education, healthcare, and other service sectors. In that sense, and only in that sense, is there something "wrong" with the service sector—namely, that it's hard to increase productivity in services. Or we could equally well say that what's right with the goods-producing sector is that it's easier to increase productivity in goods. Whatever the explanation for this difference in productivity growth, however, it's a difference, like the difficulty of domesticating huckleberries, that cannot be traced back to policy. We should neither ignore this difference nor make too much of it. For thousands of years there wasn't much improvement in goods production, either, but that changed with the Industrial Revolution. We may be on the verge of a service revolution brought on by robots and artificial intelligence. Growth is always uneven.

APPENDIX A: INDUSTRIES INCLUDED IN THE NAICS PANEL

NAICS Code	Industry
111–112	Crop & animal production (farms)
113–115	Forestry, fishing, and related activities
211	Oil and gas extraction
212	Mining, except oil and gas
213	Support activities for mining
3111	Animal food manufacturing
3112	Grain and oilseed milling
3113	Sugar and confectionery products
3114	Fruit and vegetable preserving and specialty food
3115	Dairy products
3116	Animal slaughtering and processing
3117	Seafood product preparation and packaging
3118	Bakeries and tortilla manufacturing
3119	Other food products
3121	Beverages
3122	Tobacco manufacturing
3131	Fiber, yarn, and thread mills
3132	Fabric mills
3133	Textile and fabric finishing and fabric coating mills
3141	Textile furnishings mills
3149	Other textile product mills
3151	Apparel knitting mills
3152	Cut and sew apparel
3159	Apparel accessories and other apparel manufacturing
3161	Leather and hide tanning and finishing
3162	Footwear manufacturing
3169	Other leather and allied product manufacturing
3211	Sawmills and wood preservation

NAICS Code	Industry
3212	Veneer, plywood, and engineered wood product manufacturing
3219	Other wood products
3221	Pulp, paper, and paperboard mills
3222	Converted paper products
3231	Printing and related support activities
3241	Petroleum and coal products
3251	Basic chemicals
3252	Resin, synthetic rubber, and artificial synthetic fibers and filaments
3253	Pesticides, fertilizers, and other agricultural chemicals
3254	Pharmaceuticals and medicine
3255	Paint, coatings, and adhesives
3256	Soaps, cleaning compounds, and toilet preparations
3259	Other chemical products and preparations
3261	Plastics products
3262	Rubber products
3271	Clay products and refractories
3272	Glass and glass products
3273	Cement and concrete products
3274	Lime and gypsum products
3279	Other nonmetallic mineral products
3311	Iron and steel mills and ferroalloy production
3312	Steel products from purchased steel
3313	Alumina and aluminum production and processing
3314	Nonferrous metal (except aluminum) production and processing
3315	Foundries
3321	Forging and stamping
3322	Cutlery and hand tools

NAICS Code	Industry
3323	Architectural and structural metals
3324	Boilers, tanks, and shipping containers
3325	Hardware
3326	Spring and wire products
3327	Machine shops; turned products; and screws, nuts, and bolts
3328	Coating, engraving, heat treating, and allied activities
3329	Other fabricated metal products
3331	Agriculture, construction, and mining machinery
3332	Industrial machinery
3333	Commercial and service industry machinery
3334	HVAC and commercial refrigeration equipment
3335	Metalworking machinery
3336	Engine, turbine, and power transmission equipment
3339	Other general purpose machinery
3341	Computer and peripheral equipment
3342	Communications equipment
3343	Audio and video equipment manufacturing
3344	Semiconductors and other electronic components
3345	Electronic instruments
3346	Manufacturing and reproducing magnetic and optical media
3351	Electric lighting equipment
3352	Household appliances
3353	Electrical equipment
3359	Other electrical equipment and components
3361	Motor vehicles
3362	Motor vehicle bodies and trailers
3363	Motor vehicle parts
3364	Aerospace products and parts

NAICS Code	Industry
3365	Railroad rolling stock manufacturing
3366	Ship and boat building
3369	Other transportation equipment
3371	Household and institutional furniture and kitchen cabinets
3372	Office furniture (including fixtures)
3379	Other furniture-related products
3391	Medical equipment and supplies
3399	Other miscellaneous manufacturing
481	Air transportation
482	Rail transportation
483	Water transportation
484	Truck transportation
485	Transit and ground passenger transportation
486	Pipeline transportation
487–492	Other transportation and support activities
493	Warehousing and storage
511	Publishing industries, except internet (includes software)
512	Motion picture and sound recording industries
515	Broadcasting and telecommunications
517	Broadcasting and telecommunications
518–519	Data processing, internet publishing, and other information services
521–522	Federal Reserve banks, credit intermediation, and related activities
523	Securities, commodity contracts, and investments
524	Insurance carriers and related activities
525	Funds, trusts, and other financial vehicles
531	Real estate

NAICS Code	Industry
532	Rental and leasing services and lessors of intangible assets
533	Rental and leasing services and lessors of intangible assets
5411	Legal services
5412	Miscellaneous professional, scientific, and technical services
5413	Miscellaneous professional, scientific, and technical services
5414	Miscellaneous professional, scientific, and technical services
5415	Computer systems design and related services
5416	Miscellaneous professional, scientific, and technical services
5417	Miscellaneous professional, scientific, and technical services
5418	Miscellaneous professional, scientific, and technical services
5419	Miscellaneous professional, scientific, and technical services
561	Administrative and support services
562	Waste management and remediation services
621	Ambulatory health care services
622	Hospitals and nursing and residential care facilities
623	Hospitals and nursing and residential care facilities
624	Social assistance
711-712	Performing arts, spectator sports, museums, and related activities
713	Amusements, gambling, and recreation industries
721	Accommodation
722	Food services and drinking places

APPENDIX B: NOTE ON AMERICAN COMMUNITY SURVEY DATA FOR EDUCATION

The educational attainment data used in this study are from the US Census Bureau's American Community Survey (ACS). The ACS is published yearly, as a nationally representative survey of geographic areas of 65,000 or more residents. Single-year estimates from the ACS are all nonoverlapping "period" estimates derived from a sample collected over a calendar year (i.e., 2015 ACS estimates refer to the samples taken from January 2015 through December 2015). The one-year estimates for an area reflect the most current data, but they can have larger margins of error than those from overlapping samples.

Data on educational attainment are derived from a single question that asks, "What is the highest grade of school . . . has completed, or the highest degree . . . has received?" Educational data are listed as an ordinal variable and encoded as follows: 0 represents no schooling, 1 describes someone from nursery school to the 4th grade, 2's are those who have attained some education from the 5th through the 8th grade, 3's have completed 9th grade, 4's have completed 10th grade, 5's have completed 11th grade, 6's have completed high school, 7's have one year of college, 8's have two years of college, 9's have three years of college, 10 describes those with four years of college, and 11 represents five or more years of college. This study begins with the entire yearly sample set of educational data and then collapses by year and NAICS code. Thus, educational attainment represents the yearly average number of the highest ordinal descriptor of someone's education, by industry, in the ACS. So, for example, if the collapse described steel workers in 2017 as a 7.25, then the average steel worker's highest level of schooling was somewhere between one and two years of college.

The ACS provides NAICS industry codes for the 2003-onward ACS and Puerto Rican Community Survey samples. Previous years have been defined in 2003-onward terms. That is, the ACS uses a concordance to define the earlier industry classifications according to the 2003-onward industry definitions. Our sample includes educational attainment, by industry, for the years 2000–2016.

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