



Concentrated growth: The role of the IT sector

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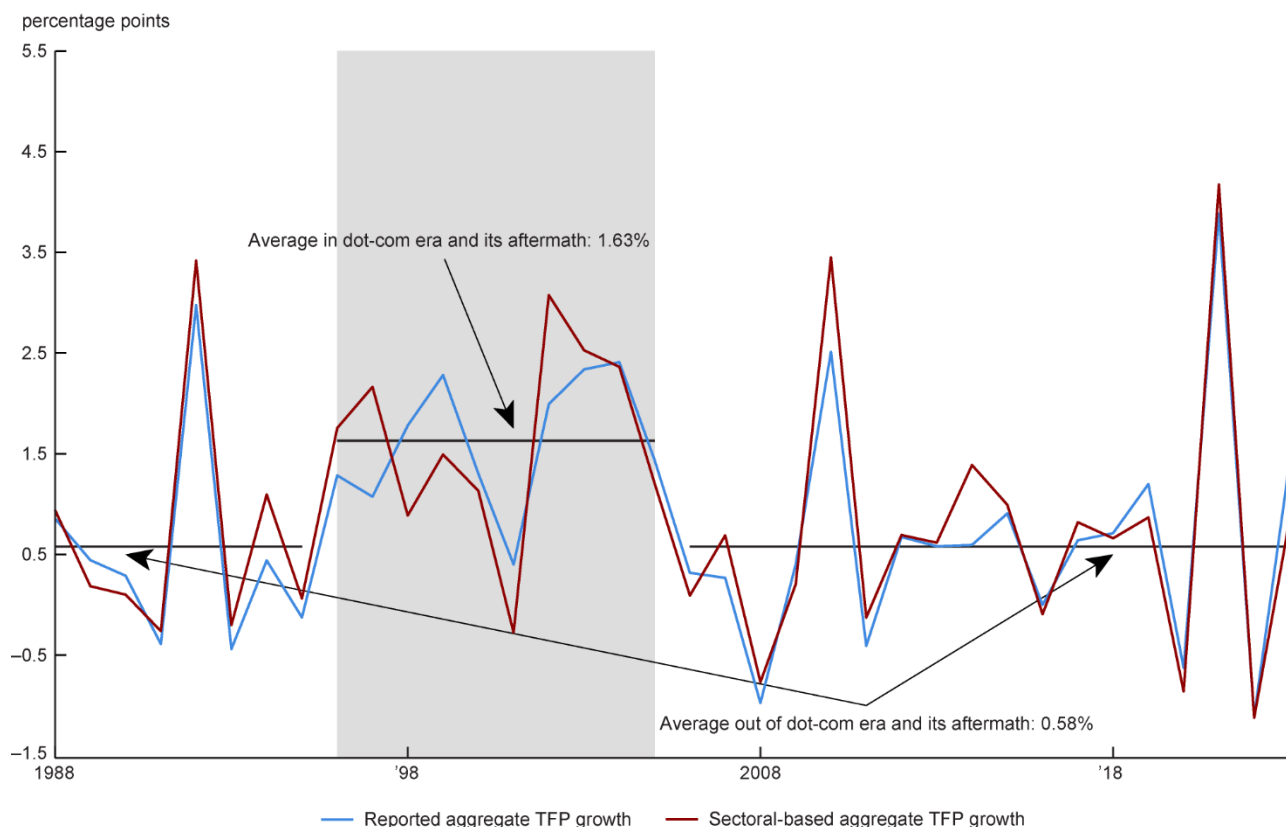
Productivity¹ is the engine of economic growth and a key factor in determining standards of living and economic well-being. In this article, we study the distribution of total factor productivity (TFP)² growth across sectors of the U.S. economy—i.e., the composition of TFP growth—and demonstrate that over approximately the past four decades, U.S. TFP growth has been highly concentrated, with the information technology (IT) sector in particular playing a large and outsized role.

The IT sector alone has been responsible for roughly 45% of TFP growth over the past 40 or so years, though its share of the U.S. economy's total production of goods and services in the private business sector (measured as either gross output or value added) averaged only about 8% during this period, according to our calculations using U.S. Bureau of Economic Analysis (BEA) data. Our results suggest that 1) understanding U.S. economic growth since the 1980s requires understanding the factors driving and promoting growth of the IT sector; 2) the medium-term outlook for U.S. economic growth may well hinge on the fortunes of the IT sector in particular; and 3) the current pace of U.S. economic growth may be more fragile than at other times when the sources of growth were more widespread and hence less concentrated.

Productivity growth was high during the dot-com era

The blue line in figure 1 plots annual percentage changes in aggregate TFP of the private business sector from 1988 through 2023 as reported by the U.S. Bureau of Labor Statistics (BLS). The BLS calculates aggregate TFP growth as the percentage change in private business sector value added (defined by the BLS as the dollar value of gross output adjusted for the removal of intermediate inputs) minus the appropriately weighted percentage changes in capital services and labor inputs.³ The average annual TFP growth rate over the period 1988–2023 was 0.87%; tellingly, growth was particularly high during—and immediately subsequent to—the dot-com era (which we date as beginning in 1995 and ending in 2000), with an average growth rate of 1.63% over the period 1995–2005. In contrast, the average growth rate in our sample period *excluding those years* was a more muted 0.58%. The red line in the figure plots a second measure of annual aggregate TFP growth that we calculate from disaggregated sector-level data, which we describe next.

1. Annual aggregate total factor productivity (TFP) growth, 1988–2023



Notes: This figure displays reported aggregate TFP growth and sectoral-based aggregate TFP growth. Reported aggregate TFP growth is directly from the U.S. Bureau of Labor Statistics (BLS), while sectoral-based aggregate TFP growth is based on our calculations using data from the BLS and U.S. Bureau of Economic Analysis. The gray bar represents the dot-com era and the five-year aftermath (1995–2005). See the text for further details.

Sources: Authors' calculations based on data from the U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

Sectoral decomposition of productivity growth

To decompose aggregate TFP growth into sectoral contributions, we use the fact that in an efficient economy, the impact of a set of sector-level TFP shocks, $\{\% \Delta TFP_i\}$ (where $\% \Delta$ refers to a percentage change), on aggregate TFP growth, $\% \Delta TFP$, can be approximated by a simple formula:⁴

$$1) \quad \% \Delta TFP = \sum_i \lambda_i \times \% \Delta TFP_i, \text{ where } \lambda_i = \frac{P_i \times GO_i}{P \times VA}.$$

Equation 1 states that for a given percentage change in any particular sector i 's TFP, the effect on aggregate TFP is equal to the sector-level change multiplied by a weight (λ_i) equal to the ratio of that sector's nominal gross output to the total nominal value added of the entire private business sector. The total change in aggregate TFP is the sum of the weighted changes in sector-level TFPs.

This formula is commonly referred to as “Hulten’s theorem.”⁵ Note that the “shares,” which are known as “Domar weights,” sum to more than one, since the numerator includes sales of intermediate goods instead of only value added.⁶ Intuitively, the Domar weights incorporate the effects of sectoral linkages—when sector i becomes more productive, the sectors that use the output of sector i become more efficient and expand production, as do the sectors that use the output of those sectors as inputs (including possibly

sector i), and so on. The elegance of the formula is that all of these input–output linkages can, at least approximately, be captured by a single simple statistic, namely, the Domar weight.⁷

Equation 1 implies that a sectoral-based measure of aggregate TFP growth can be calculated by summing the contributions from all sectors. We implement this calculation using sector-level TFP growth rates obtained from the BLS and data on sector-level nominal gross output and value added from the BEA.⁸ Figure 1 plots the resulting series. The figure shows that the sectoral-based series tracks the BLS-reported aggregate series closely: The correlation between the two is 0.93, and the levels are roughly on par; the average annual growth in the aggregate series is about 0.87%, compared with 0.95% for the sectoral-based series. To ensure exact decompositions, we work exclusively with the sectoral-based series for the remainder of this article.

The IT sector has been the main driver of productivity growth

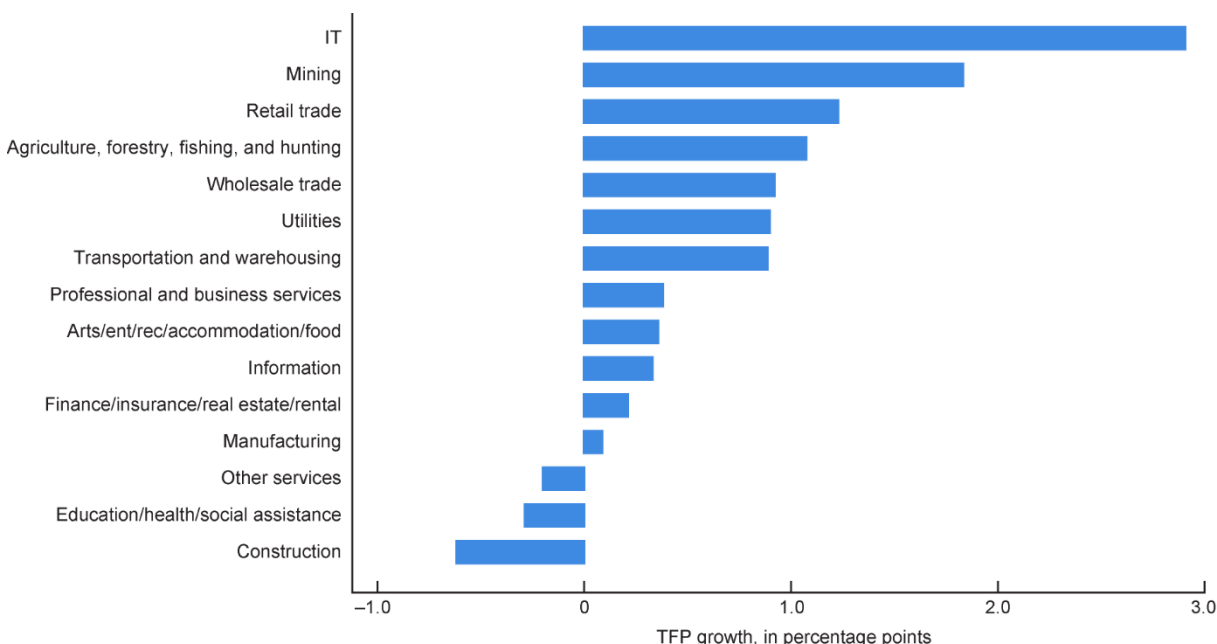
Turning to the sectoral composition of aggregate TFP growth, we display in panel A of figure 2 the average annual TFP growth rates of the 15 major sectors of the U.S. economy from 1988 through 2023.⁹ We depart from the classification system used by the BEA by separating out the IT sector as the aggregate of five subsectors: 1) computer and electronic product manufacturing; 2) publishing industries (except internet), with software included in this subsector; 3) broadcasting and telecommunications; 4) data processing, internet publishing, and other information services; and 5) computer systems design and related services.¹⁰

Panel A of figure 2 shows that average TFP growth rates have differed widely across sectors over the 1988–2023 period, ranging from about –0.6 in construction to close to 3% in IT. The IT sector has had far and away the fastest TFP growth over this period, averaging 2.9% per year. In contrast, average annual TFP growth in all the non-IT sectors combined (i.e., weighted using the gross output weights described in note 9) has averaged only 0.31%. Thus, average TFP growth in the IT sector has been roughly tenfold that in all the non-IT sectors combined. Panel B of figure 2 displays the average annual contribution of each sector to aggregate TFP growth (calculated using equation 1). The IT sector has clearly played a critical role in driving aggregate growth: Its average contribution to annual TFP growth is about 0.43 percentage points relative to a contribution of about 0.52 percentage points from all the non-IT sectors combined. Thus, IT has accounted for about 45% of total aggregate TFP growth since the late 1980s (calculated as $\frac{0.43}{0.43 + 0.52}$).

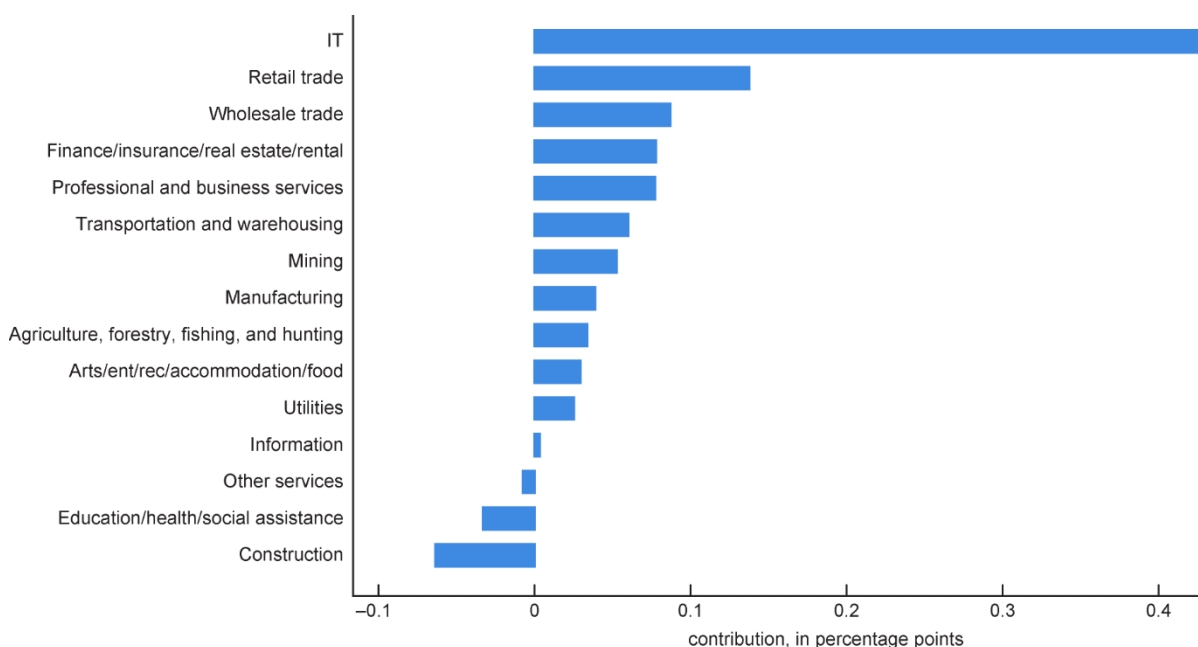
To underscore the key role of the IT sector in driving aggregate TFP growth over the past few decades, we plot in panel A of figure 3 cumulative TFP growth in the IT sector and in non-IT sectors, as well as in the aggregate. As the figure shows, aggregate TFP has increased by a factor of 1.4, or 40%, in the 36 years since the start of 1988, while the IT sector’s TFP has increased by a factor of about 2.78, or 178%. In contrast, TFP in all the non-IT sectors combined has increased by a factor of only about 1.12, or 12%. In panel B of figure 3, we similarly plot the cumulative contributions of TFP growth in the IT and non-IT sectors to aggregate TFP growth. The IT sector has contributed approximately 17 percentage points to cumulative TFP growth since 1988, and the non-IT sectors about 20 percentage points. Thus, in cumulative terms, the IT sector again accounts for roughly 45% of aggregate productivity growth (calculated as $\frac{0.17}{0.17 + 0.2}$).¹¹

2. Sector total factor productivity (TFP) growth and sector contribution to aggregate TFP growth, 1988–2023

A. Sector TFP growth



B. Sector contribution to aggregate TFP growth

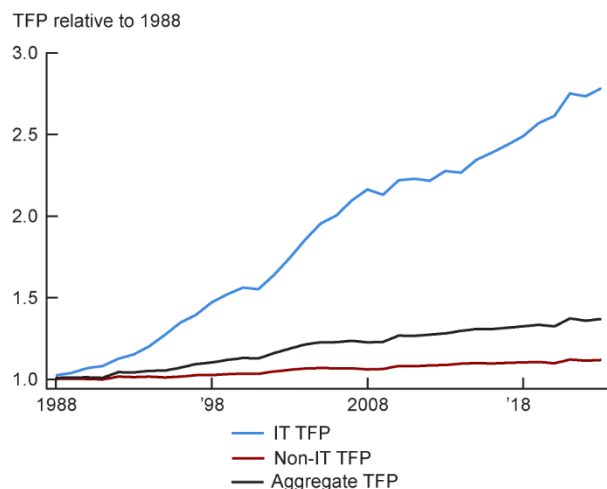


Notes: Panel A displays average TFP growth by sector over the period 1988–2023. Panel B displays each sector's average contribution to aggregate TFP growth over the same period. For further details on the information technology (IT) sector, see the text. Mining encompasses mining, quarrying, and oil and gas extraction. Information encompasses motion picture and sound recording industries. Arts/ent/rec/accommodation/food is short for arts, entertainment, and recreation and accommodation and food services. Finance/insurance/real estate/rental is short for finance and insurance and real estate and rental and leasing. Education/health/social assistance is short for educational services and health care and social assistance.

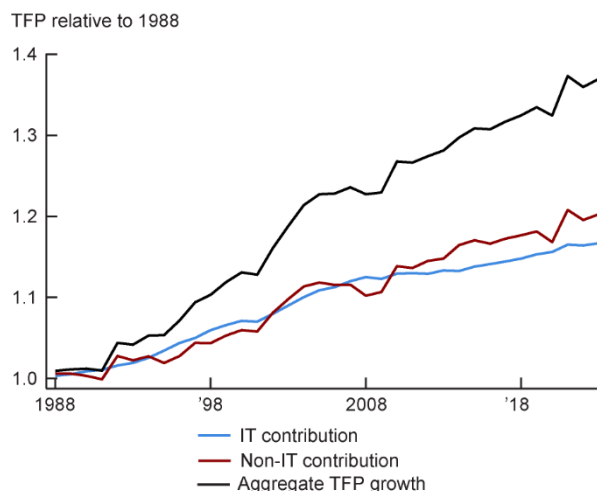
Sources: Authors' calculations based on data from the U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

3. Cumulative total factor productivity (TFP) growth in the information technology (IT) and non-IT sectors, 1988–2023

A. Cumulative TFP growth



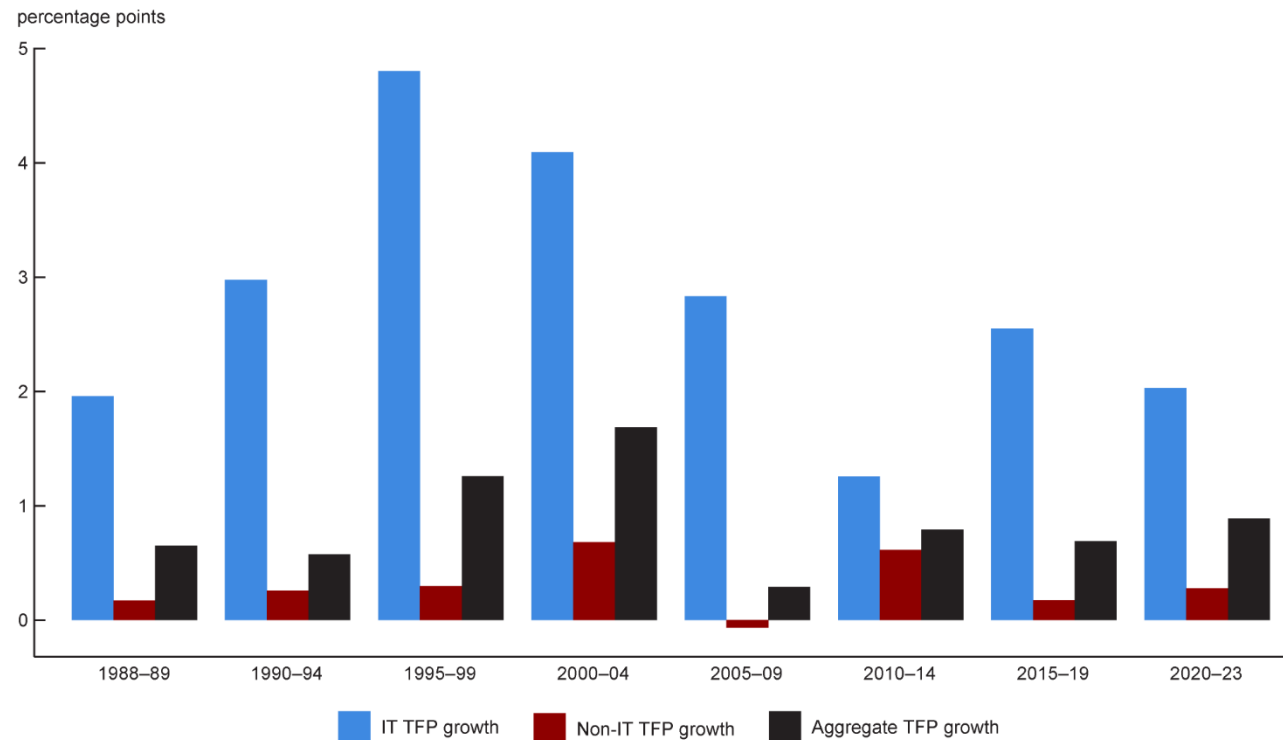
B. Cumulative contributions to TFP growth



Notes: Panel A displays cumulative TFP growth in the IT sector and in the non-IT sectors combined, as well as in the aggregate, over the 1988–2023 period. Panel B displays the cumulative contributions of the IT and non-IT sectors to aggregate TFP growth over the same period.

Sources: Authors' calculations based on data from the U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

4. Average total factor productivity (TFP) growth in information technology (IT) and non-IT sectors, by half decade, 1988–2023



Note: This figure displays average TFP growth by half decade (with the exceptions of the briefer subperiods of 1988–89 and 2020–23) in the IT sector and in the non-IT sectors combined, as well as in the aggregate.

Sources: Authors' calculations based on data from the U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

The disproportionately rapid TFP growth in the IT sector is not limited to the dot-com period. In figure 4, we plot average annual TFP growth rates by half decade in the IT sector and in all the non-IT sectors together (i.e., the appropriately weighted average of all non-IT sectors), as well as in the aggregate. The IT sector's TFP growth has consistently outpaced that of the non-IT sectors by a significant amount. Though the gap was indeed particularly dramatic in the period surrounding the dot-com boom (1995–99), it was large and positive in all subperiods since the late 1980s.

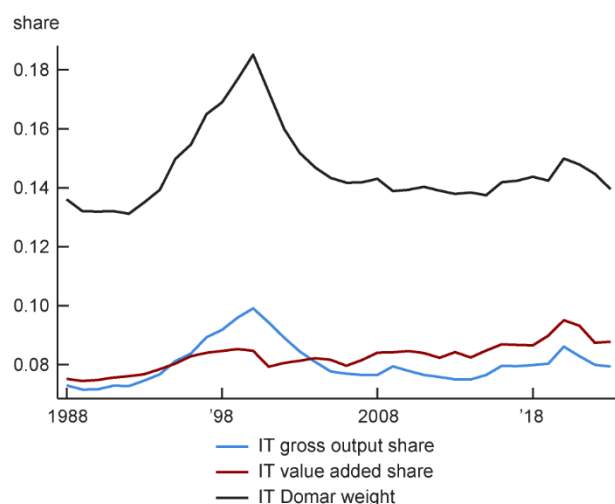
The contribution of IT to TFP growth is larger than its share of production

The contribution of the IT sector to aggregate TFP growth has been disproportionately large relative to its share of the economy's production of goods and services. For example, during the 1988–2023 period, the IT sector accounted for about 45% of TFP growth but made up only about 8% of the value added of the private business sector, meaning that its TFP growth contribution was over five times larger than its value added share—this is the largest such proportion across all sectors. In contrast, the non-IT sectors combined accounted for about 55% of TFP growth and 92% of value added, meaning that their TFP growth contribution was only about 60% of their value added share.

The IT share of production has changed little

Strikingly, despite its high TFP growth, the IT sector's share of the economy has changed only modestly since the late 1980s. Figure 5 plots the IT sector's share of the nominal gross output of the private business sector, its share of nominal value added, and its Domar weight over time. Following brief increases in the dot-com period, the IT sector's share of gross output increased only about 1 percentage point over almost four decades—from 7.3% in 1988 to 7.9% in 2023; the IT sector's share of value added changed similarly from 7.6% to 8.8% over the same span (the IT sector's shares of gross output and value added

5. Information technology (IT) sector shares of production, 1988–2023



Notes: This figure displays the IT sector's share of nominal gross output, share of nominal value added, and Domar weight. For further details on the Domar weight, see the text.

Sources: Authors' calculations based on data from the U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

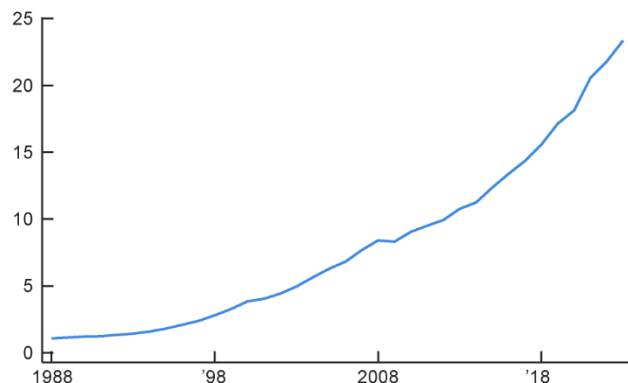
are expressed as proportions within figure 5 itself). Domar weights also changed little: The Domar weight of the IT sector increased from 0.136 in 1988 to 0.139 in 2023; the Domar weight of the combined non-IT sectors (not shown in figure 5) declined somewhat, from 1.73 to 1.62, over the same period.¹²

Figure 6 shows why this approximate constancy over the longer run holds. In panel A, we plot the cumulative growth in real value added for the IT sector: In real terms, value added of the IT sector increased by over 2,300% between 1988 and 2023. In panel B, we plot the cumulative growth rate of the price of a unit of value added of the IT sector: This price declined by almost 70% over the 1988–2023 period.¹³ Putting these results together, along with the fact that aggregate nominal value added of the entire private business sector grew about 500% over the same period,¹⁴ leaves the share of the IT sector only slightly higher in 2023 than in the late 1980s.

6. Information technology (IT) sector cumulative real value added and price growth, 1988–2023

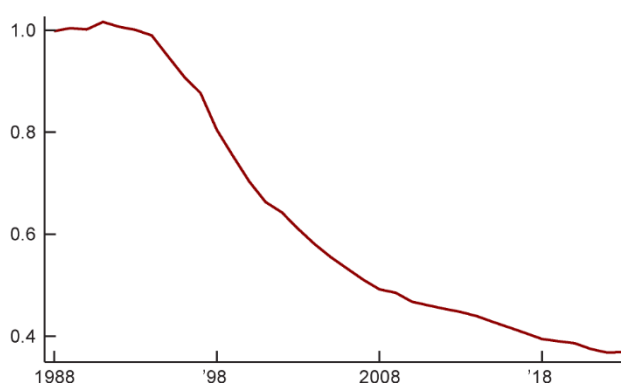
A. IT sector's real value added

real value added relative to 1988



B. IT sector's price of a unit of value added

price relative to 1988



Notes: Panel A displays the IT sector's cumulative real value added growth over the 1988–2023 period. Panel B displays the IT sector's cumulative growth in the price of a unit of value added over the same period. For further details on both measures, see the text (in particular note 13).

Sources: Authors' calculations based on data from the U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis.

Conclusion

The results from our study of U.S. TFP growth and the IT sector have several implications. First, understanding the growth experience of the U.S. economy over the past few decades necessitates an understanding of the factors fostering IT sector growth. Second, if similar trends continue, e.g., because of the introduction and rollout of AI (artificial intelligence) technologies, the medium-term outlook for U.S. economic growth may well hinge on developments in the IT sector. And third, given the concentration of growth in a single sector, maintaining a steady pace of aggregate economic growth may be more fragile than at times when the sources of growth were more widespread. Will the rapid TFP growth in the IT sector stall out, or will it accelerate based on new innovations in AI and other cutting-edge computing technologies? Given the key role of IT in driving aggregate TFP growth over the past few decades, the answer may have profound implications for future advances in economic conditions.

Notes

- ¹ Throughout this article, “productivity” refers to total factor productivity (rather than labor productivity).
- ² According to the [U.S. Bureau of Labor Statistics](#) (BLS), “TFP measures the efficiency of labor, capital, and other countable inputs” of an economy (or a sector, firm, etc.), and “TFP tells us how much can be produced without adding more inputs.”
- ³ In practice, the BLS uses a Tornqvist chain index method to compute the percentage change in combined capital and labor from one year to the next, with the weight of each input being its average cost share in the two years. More details on this [calculation are available online from the BLS](#).
- ⁴ An efficient economy is one where markets are perfectly competitive and factors of production (i.e., the inputs, such as labor and capital, required to produce goods and services) are paid their marginal products. (Marginal product is the change in output resulting from employing one additional unit of a specific input while keeping constant all the other inputs.) Although not literally true, these assumptions are often viewed as providing a reasonable approximation for the U.S. economy (which we later verify in our context).
- ⁵ [Hulten \(1978\)](#).
- ⁶ [Domar \(1961\)](#).

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- ⁷ Equation 1 is exact when production functions are Cobb–Douglas and households have consumption functions that lead to constant sector-level consumption shares, meaning that Domar weights are constant. [Baqae and Farhi \(2019\)](#) show that when the economy does not satisfy these assumptions, nonlinearities can matter and equation 1 does not hold exactly. For example, to the second order, a term that captures changes in Domar weights, $\Delta\lambda_i$, enters the formula. [Baqae and Farhi \(2020\)](#) show that the formula may also not hold exactly when the economy is distorted, e.g., because of price markups. But the fact that the sum of the Domar-weighted sector TFPs closely tracks aggregate TFP as illustrated in figure 1 suggests that these departures are relatively minor, at least in our context of U.S. data at the sector level.
- ⁸ At the sector level, the BLS calculates TFP growth as the percentage change in real gross output minus the appropriately weighted percentage changes in capital, labor, energy inputs, materials, and services. Again, further details on this calculation are available online from the BLS.
- ⁹ Many of the sectors in figure 2 are aggregates across more detailed subsectors. To aggregate subsectors, we weight the TFP growth of each subsector by its share of sectoral nominal gross output—i.e., for sector i composed of a set of subsectors $\{j\}$, its TFP growth is equal to $\% \Delta TFP_i = \sum_j \omega_j \times \% \Delta TFP_j$, where $\omega_j = \frac{P_j GO_j}{\sum_j P_j GO_j}$. These are the appropriate weights to ensure that the sum of the contributions across major sectors in equation 1 continue to add up to the aggregate.
- ¹⁰ The BEA does not officially distinguish the IT sector in the industry classification system it uses (the BEA, like many other U.S. federal government agencies, uses the North American Industry Classification System, or NAICS, to classify industries), but it does separately report data for an information and communications technology (ICT) sector. Our definition of the IT sector closely follows the BEA definition of the ICT sector; while the same five subsectors make up both definitions, we exclude navigational, measuring, electromedical, and control instruments manufacturing from the computer and electronic product manufacturing subsector in our IT sector definition.
- ¹¹ Because of nonlinearities, the cumulative contributions of IT and non-IT sectors do not exactly sum to aggregate cumulative TFP growth. But the sum is relatively close, i.e., 37% versus 40%, suggesting that this is a reasonable approximation.
- ¹² In this light, the fact that the sectoral-based measure of TFP calculated from the approximate formula (equation 1) closely matches the aggregate measure may not be surprising: The relative constancy of the Domar weights implies that nonlinearities, e.g., changes in Domar weights, are small.
- ¹³ We calculate real value added growth of the IT sector as the average of real value added growth of each of its subsectors weighted by their shares of IT sector nominal value added. We calculate growth in the price of a unit of value added of the IT sector as the average of growth in the value added price index of each of its subsectors weighted by their shares of IT sector nominal value added.
- ¹⁴ Authors' calculations based on data from the BEA.

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