

Economic Research Note

US: is I.T. over?

- Prices for IT equipment are declining at the slowest pace in over a generation
- This implies a slowing in the pace of technological advance in this type of equipment
- Growth accounting exercises generally ascribe a huge role for IT in the 1995-2005 growth spurt
- Slowing in tech advance may imply slower potential growth, but could have ameliorative social benefits

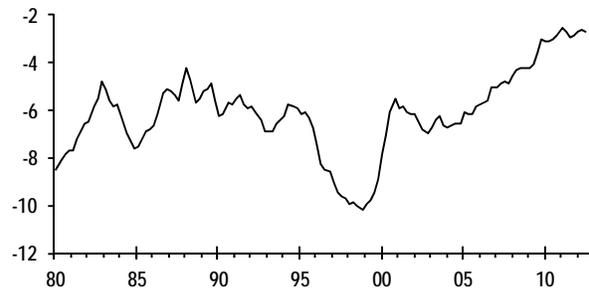
Over the past few years the real price of information processing equipment and software has declined at the slowest pace in over a generation. At first, this may seem to be a relatively mundane observation. However, the change in the real, quality-adjusted price of equipment should be inversely related to the degree of technological advancement embodied in that equipment. In other words, the slower decline in information technology (I.T.) equipment prices indicates a slower increase in the level of technology incorporated in that equipment. Gains in information technology are routinely credited with the strong growth in the supply side of the US economy in the 1995-2005 period. If that technological growth is slowing—as indicated by the earlier observation on tech prices—then this could have quite significant implications for the US economy’s potential growth rate.

Note that this is not an exercise in futurology. Northwestern University economist Robert Gordon’s recent claim that US economic growth is over has attracted a fair bit of attention. This note, however, does not speculate on whether growth in information technology has reached some natural limit, or whether further revolutionary advances are coming. Instead, by looking at tech prices—and incorporating some economic reasoning—we can infer what is currently occurring on the tech frontier. While we are not qualified to speculate on the future of technological change, we do observe that the growth in tech prices is positively serially correlated, which is another way of saying the pace of innovation growth in the near future is likely to resemble that in the recent past.

The slowing growth in the pace of technological advance does have some cautionary implications for trend growth in the US economy. It also explains why tech capital spending has been slower in this cycle than the last cycle, and much slower than the 1990s business cycle. Even so, the slowdown in the advance of technology may not be an unalloyed negative. A temporarily slower patch of growth on the supply side will allow the economy to more quickly absorb and re-employ the vast number of underutilized workers. Moreover, there is a

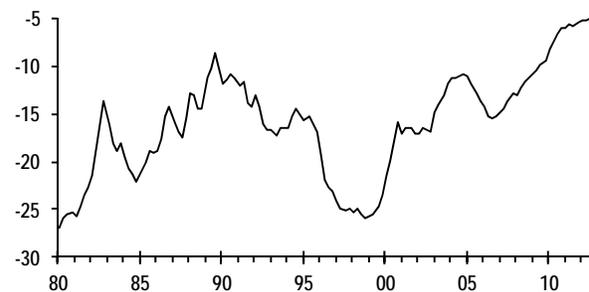
Information processing equipment and software prices

%ch over 8 qtrs, ar, relative to GDP prices



Computer prices

%ch over 8 qtrs, ar, relative to GDP prices



growing consensus that the rapid pace of technological growth in the recent past was an important contributor to the widening of income inequality. A slower pace of tech advances may allow the skill and education level of the workforce to catch up with the level of technology.

Embodied technical change

Technological change is the driving force behind modern economic development. This technological change is most often visible in the form of better capital goods—computers with faster processing times, more powerful two-stroke diesel engines, more efficient turbfans, etc. This way of seeing how technology begets economic growth is sometimes known as embodied, or investment-specific, technical change. If the market for capital goods is competitive—which seems a very reasonable assumption—then the pace of technological advance embodied in new equipment should be inversely related to the change in the price of this equipment. In other words, more rapid increases in the capability of computing equipment should imply more rapid declines in the price of a computer with a given, fixed capability.

It is important to keep in mind that the prices we are focusing on are quality-adjusted, or constant-quality, prices. The example most often given for what this means is a standard desktop computer. An average computer may retail for around \$1,000 now, roughly similar to what it sold for 10 or 15 years ago. However, the power of that computer has increased

dramatically. While it may be difficult or impossible to buy a new computer today of the quality available 10 or 15 years ago, presumably the price would have declined sharply. By employing what are known as hedonic methods, statisticians are able to estimate price changes for capital goods of a given, fixed quality.

While not all prices are hedonically adjusted, developing reliable constant-quality price indexes for information technology equipment has been a high priority for US statistical agencies. What those prices show is that in real terms—that is, relative to the overall price level in the economy—I.T. prices declined at an extremely rapid pace during the 1990s. The main driver appears to be sharply falling computer prices; prices for software and other I.T. devices fell less rapidly. Since then the pace of decline has steadily slowed, with computer prices leading the slowing. Note that this is not inconsistent with integrated circuits continuing to obey Moore’s Law, which predicts the number of transistors per circuit doubling every 18 months. Increasing transistor count does not necessarily lead to a commensurate increase in computing performance—which is what matters to users and what is measured in the prices. A number of limitational factors both inside and outside of processors can lead to divergences between transistor count and performance.

What might the above argument be missing? First, it is always possible that in spite of their efforts, the statistical agencies may be missing some aspect of quality improvement in I.T. equipment. Second, there could be, and likely are, lags between technological advance and productivity gains, so that there is still a vast amount of untapped potential in the computing advances that have already occurred. Both of these arguments have solid merit, but without further evidence they remain theoretical objections.

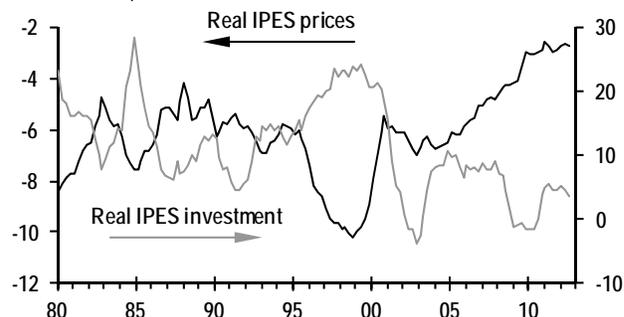
The slowing decline in tech prices can explain the slower growth in I.T. spending experienced recently, and thus in the pace of productivity growth. Fed researchers Stacey Tevlin and Karl Whelan demonstrated that the rapid decline in I.T. prices during the 1990s was central to the boom in tech spending that occurred in that decade. As such, it should come as little surprise that the less rapid pace of decline in I.T. prices seen recently should be accompanied by slower tech spending growth. Less tech investment means less capital deepening, which could help explain why productivity growth has been soft in recent years.

Always look on the bright side of life

There should be little question that a slowing in the pace of I.T. advance is not a positive development for the long-run outlook for living standards. There could, however, be some short-run benefits. First, slower gains in technology and

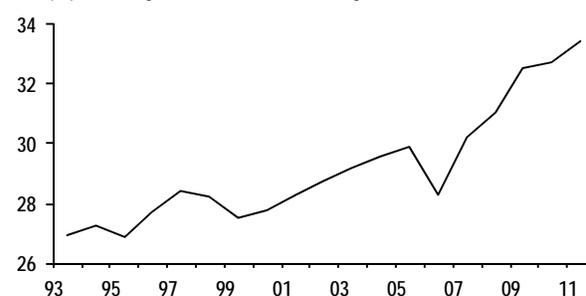
Information processing equipment and technology (IPES)

%ch over 8 qtrs, ar, both scales



College enrollment

% of population age 16 to 24 enrolled in college



productivity should make it easier for an economy that is generating only limited demand to absorb back into the labor force the large number of unemployed individuals. In the long run that could be beneficial for preserving and enhancing the human capital of the re-employed.

A slowing in the pace of technological advance may also help to reverse the inexorable rise in income inequality. The emerging consensus on the source of income inequality was summed up in the title of the work of Harvard economists Claudia Goldin and Lawrence Katz on the subject: “The race between education and technology.” Technological advances—which favor the workers with the skills to master those technologies—have advanced faster than the ability of the workforce to gain those skills through greater education. If the price data are correct and advances in I.T. are slowing, then workforce skills may be better able to catch up with the level of technology. Complementary to the slowing in the pace of technological advance is an acceleration in college enrollment in recent years. The interaction of these two forces suggests the march toward increasing income inequality could soon move in reverse.