Will History Repeat Itself? Comments on "Is the Information Technology Revolution Over?"

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ABSTRACT

In this article I comment on three aspects of Byrne, Oliner and Sichel's analyses. First, I show that the patterns in labour productivity growth during the IT era echo those observed during electrification. This includes a slowdown of roughly analogous timing to that observed in 2004-2012 — a slowdown that in the electrification era was followed by a productivity growth acceleration. Second, I discuss the implications of continued divergence in mean and median incomes for the analysis of productivity growth in the long run. Third, I explore further the issue of whether technological progress in semiconductor manufacturing is yielding concomitant increases in semiconductor performance.

RÉSUMÉ

Je commenterai trois aspects des analyses de Byrne, Oliner et Sichel. Premièrement, je vais démontrer que les tendances en matière de croissance de la productivité du travail en cette ère de la T.I. reflètent la situation en vigueur au moment de l'électrification. Cela inclut un ralentissement à peu près au même moment que celui qu'on a pu observer entre 2004 et 2012 — un ralentissement qui, lors de l'ère de l'électrification, a été suivi d'une accélération de la croissance de la productivité. Deuxièmement, j'aborderai les répercussions de la divergence continuelle en ce qui a trait aux revenus moyen et médian aux fins de l'analyse de la croissance de la productivité à long terme. Troisièmement, j'examinerai de plus près la question de savoir si les innovations technologiques dans le secteur de la fabrication de semi-conducteurs donnent lieu à des augmentations simultanées du rendement des semi-conducteurs.

THE ARTICLE "Is the Information Technology Revolution Over?" by David M. Byrne, Stephen D. Oliner, and Daniel E. Sichel represents a thought-provoking work which updates and extends the authors' earlier research. It addresses an important question, namely: does the recent slowdown in aggregate productivity growth reflect a petering out of the information technology (IT) revolution?

The article's analysis has three main parts. The first decomposes aggregate labour productivity growth into IT-related factors for three separate periods: 1974-1995, 1995-2004, and 2004-2012, paying particular attention to the

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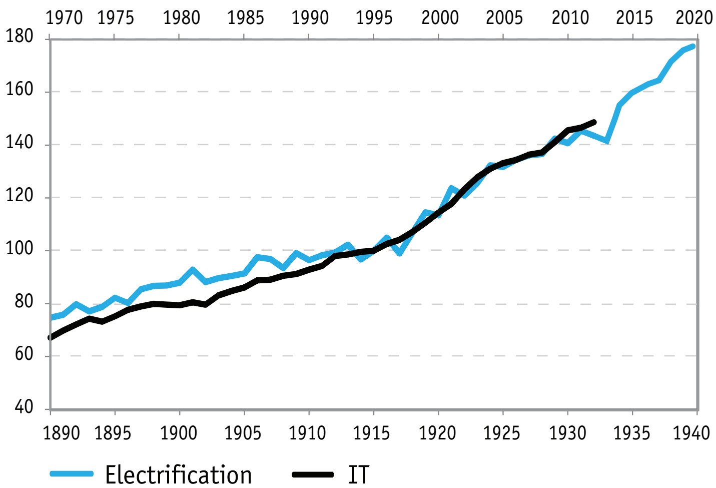
Chart 1
Labour Productivity Growth During the Electrification Era (1890-1940) and the IT Era (1970-2012) in the United States
(1915 = 100 and 1995 = 100)



Source: Kendrick (1961); Byrne, Oliner, and Sichel (2013).

sources of the productivity growth slowdown between the second and third periods. The second computes a projection of average annual labour productivity growth over the foreseeable future. The third assesses the potential for future productivity growth in semiconductor manufacturing, with a focus on the pessimistic case raised by recent patterns in microprocessor price indices. I have one comment on each of these three parts.

Productivity Growth Decomposition

The decomposition starts by pointing out that measured labour productivity growth over 2004-2012 slowed to an average annual rate of 1.6 per cent from the significantly higher 3.1 per cent rate sustained over 1995-2004. This earlier period of accelerated productivity growth followed on the heels of a well-documented period of slow productivity growth extending from the mid-1970s to the mid-1990s. The authors' decomposition indicates that a substantial part of the post-2004 slowdown is accounted for by IT-based sources, but that IT still accounts for a considerable portion — about 40 per cent — of the productivity growth that remains.

While one could quibble with the specific assumptions made by this decomposition, I have no special concerns. Instead, the overall patterns they document raised a question in my mind: are such patterns new? Did labour productivity have similar speed-up and slowdown periods during the diffusion of earlier general purpose technologies? History can offer a guide; electrification was the last general purpose technology to diffuse through the economy prior to IT. Happily, there are data on labour productivity growth during the electrification period that can be compared to the IT experience.

To make this comparison, I use the data originally constructed by Kendrick (1961) for 1890-1947, which the authors themselves use to compute historical average annual labour productivity growth rates in the United States.[2]

It turns out that labour productivity during electrification shared remarkably common patterns with the IT era. This can be seen in Chart 1, which overlays U.S. labour productivity in the IT era from 1970 to 2012 with the Kendrick series for the 1890-1940 period (the IT series years are labeled on the upper horizontal axis, and the series is indexed to a value of 100 in 1995. The electrification series years are on the lower horizontal axis, and the series is indexed to 100 in 1915). During the electrification era, there was an initial period (roughly a quarter century) of relatively slow labour productivity growth, just as was the case in the IT era from 1970-1995. Then both eras saw decade-long accelerations in productivity growth, spanning 1915-1924 during electrification and 1995-2004 in the IT era. Furthermore, analogous to the 2004-2012 slowdown that is the focus of the

2 The data are from Kendrick (1961:Table A-XXII). I use the series "Output per Unit of Labor Input."

article, labour productivity growth slowed in 1924-1932.

The question relevant to this article is whether the 2004-2012 slowdown is likely to persist. We have the benefit in the electrification era data of knowing what happened after the 1924-1932 slowdown. As can be seen in Chart 1, labour productivity growth sped up again, averaging 2.7 per cent per year over 1932-1940.[3]

To be clear, I do not interpret this as predicting that labour productivity growth must again accelerate in 2013. I am not proposing a Jevons-type sunspot theory of labour productivity growth. Rather, I simply make the point that we have been here before: sluggish labour productivity growth at the beginning of the diffusion of a general purpose technology (if one believes, as I do, that the 1890-1915 period for electrification is a reasonable analog to the 1970-1995 period for IT), a decade-long acceleration, and then another multi-year slowdown. In the electrification era, this was followed by another acceleration. Whether this will also occur for IT remains to be seen, but we know it has happened before. History shows that productivity growth driven by general purpose technologies can arrive in multiple waves; it need not simply arrive, give what it has, and fade away forever thereafter.

Predicting Future Productivity Growth

The discussion of potential labour productivity growth after 2012 leads naturally to the second section, a projection of future long-run labour productivity growth.

Forecasting is hard. As with their decomposition exercise, one could argue about some of the specific assumptions they make in their projection. However, everything they do is some form of standard practice in the literature, and I do not find their midpoint estimate of 1.85 per cent per year implausible (this is not far off from the average 2 per cent rate over the prior 120 years, if history is any guide). Furthermore, the authors are admirably candid about the tenuous nature of the exercise.

My comments in this area are on a broader level. Thinking about the future trajectory of productivity growth spurred consideration of what I think is becoming, as it has revealed itself in the data over the past few decades, one of the most consequential features of long-run growth: namely, the divergence between average income (and productivity) growth and median income growth. About 30-40 years ago, the growth of median income started to slow relative to average income growth (and its labour productivity analog), and this divergence has continued since then. While future labour productivity growth is obviously important, I see this divergence as a call to investigate the implications of future labour productivity growth not just for average income, but its distribution as well.

There are normative implications of a continued divergence, of course. Economists will differ in their views of such implications depending on their preferred social welfare functions, and such differences will spur considerable debate. This aside, however, even the non-subjective implications of continued divergence are potentially very far reaching. These range from large shifts in the patterns of human capital investment, to a restructuring of the labour market, and to numerous aspects of political economy, among many others.

I do not suggest that the authors tackle these issues here, as they are far beyond the scope of the work. Instead, I see the divergence of the past few decades as a call to action to all those

3 While the Kendrick data extend to 1947, I stop with the U.S. entry into World War II to avoid any unusual productivity effects of wartime production. If these years are included, the average annual labour productivity growth rate from 1932-1947 is still substantially higher than 1924-1932, at 2.4 per cent.

working in this literature. While it is not certain that this divergence will continue, it should be a priority to find out if it will. And if it does, we need to have more to say about its economic implications.

Potential Future Productivity Growth in Semiconductor Manufacturing

In the final section, the authors take a more optimistic note for the future of IT-driven productivity growth based on their assessment of technological progress in semiconductor manufacturing. One of the most important determinants of semiconductor manufacturing productivity growth is the size of the transistors etched on microchips. As the machines that make semiconductors become able to etch smaller and smaller transistors, manufacturers can place more transistors on a given chip. A higher transistor density translates into more operations per unit time—that is, higher performance. The faster the arrival of new vintages of semiconductor manufacturing capital, the faster the growth of semiconductor performance (this is a key force behind Moore's Law).

The authors point out that recent data indicates that new vintage adoption has continued at the relatively high rate of the past two decades, and there are no indications this will slow in the near future. They further bolster their case for optimism by arguing that the Bureau of Labor Statistics producer price index for microprocessors — which has recently shown only small price declines, suggesting a technological slowdown in the industry — suffers from measurement problems. When the authors apply their corrections to the series, implied prices instead continue to fall at a fast rate.

I would just like to sound a small note of pessimism in this case. My concern is based on recent work by Pillai (2013), who has closely studied the economics of semiconductor manufacturing and its relation to technological progress in the industry.

Pillai's analysis actually agrees with the authors' contention that transistor density growth has not slowed. However, he marshals evidence that semiconductor performance has nevertheless decelerated since about 2001 because, while chip designers have had more and more transistors to work with on a given chip, they have been unable to extract as many operations per transistor as before. The industry trade press reports power consumption problems as a primary reason for this slowdown in calculation efficiency. Essentially, transistor density has led to chips that produce too much heat in too little area. This causes overheating and defects unless transistors' clock rates are slowed.

To the extent the authors' hedonic corrections to the Bureau of Labor Statistics microprocessor price index account for this broader measure of performance, their analysis will account for this additional influence on microprocessor performance. It is not apparent from what is reported in the description of their analysis whether such accounting is made, however. In any case, Pillai's study sounds a note of caution regarding any analysis that focuses only on changes in transistor size or density.

References

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