What Do We Know About Economic and Productivity Growth? A Review Article on *Measuring Economic Growth and Productivity: Foundations, KLEMS Production Models, and Extensions*

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ABSTRACT

Measuring Economic Growth and Productivity is not only a book on an essential topic, namely that of "growth and productivity", it is also a fabulous ensemble, bringing together contributions from many top specialists. But, in addition, it is a tribute to Dale W. Jorgenson, who has for decades been an exceptional contributor to gaining a better knowledge of the mechanisms of growth and productivity. The volume is dedicated to him. I was present in January 2020 at the annual IPM dinner at the AEA conference, when a preprint of the book was presented to him by the editor, Barbara Fraumeni. I openly admit that it was a very emotional moment.

Economic growth and productivity measurement are of principal concern for policy makers and economists, among others. Productivity growth is one of the main sources of economic and real income growth needed for improvements in well-being. A vast literature has been devoted to this topic over the last decades and even centuries. But there is still much to do to better understand the mechanisms of growth.

Dale W. Jorgenson, Samuel W. Morris University Professor in the Department of Economics at Harvard University, is one of the main economists to have contributed to a better understanding of these growth mechanisms. The volume under review, *Measuring Economic Growth and Productivity: Foundations, KLEMS Production Models, and Extensions* is dedicated to

him.[2] As the volume editor, Barbara Fraumeni, Special-term Professor at the China Centre for Human Capital and Labor Market Research of the Central University of Finance and Economics in Beijing, China, writes in the introduction to the volume,[3] "The chapters of this book demonstrate the significant influence of Dale W. Jorgenson on the research of many economists". No one researcher in this field can ignore the name of Dale Jorgenson and at least some of the papers from him. But his academic production has been so abundant and varied that no one (other than himself perhaps) can pretend to completely know his large and deep contribution.

This book is a compilation of 22 articles (excluding the Introduction) written by 58 authors totaling over 536 pages. Most of the articles use data from the World KLEMS database, an enlargement of EU KLEMS, and the fruit of a three-decade old project, which has been continuously supported by Jorgenson (see, for instance, Jorgenson, 2012). Numerous dimensions of economic growth and productivity measurement are treated in this compilation. We comment on different chapters of the book, grouping them into the four topics: foundations, international comparisons, country-specific analyses, and methodological issues, before concluding the review with some general remarks.

Foundations

The volume begins with three chapters on foundations. Using long-term data for the United States, Edward A. Hudson shows the essential role of demand in growth mechanisms. He emphasizes the role of innovation and the contribution of the Schumpeterian concept of "creative destruction". What might surprise the reader is that the ground-breaking contribution from Aghion and Howitt on this topic is not mentioned.[4]

J. Steven Landefeld describes the interaction between economic theory, research and the development of the US national accounts. He discusses improvements in national accounts which take into consideration this interaction, including better measurement of economic welfare, such as supplementary accounts on the distribution of income, natural resources and the environment, and the development of a set of sustainability measures.

Kun-Young Yun presents the Dynamic General Equilibrium Model that he developed with Jorgenson in 1986 on the US economy to evaluate the welfare effects of tax policy and government spending. They found with this tool that taxation of capital income is the most expensive compared to other forms of taxation in terms of the efficiency cost per dollar of tax revenue.

2 The volume was published in November 2019 by the Academic Press of Elsevier, ISBN: 9780128175965, USD$125.00. The table of contents is available at
https://www.sciencedirect.com/book/9780128175965/measuring-economic-growth-and-productivity.

3 The associate editors are Carol Corrado, Mun S. Ho, Hak K. Pyo, and Bart van Ark.

4 For instance, among numerous ones, Aghion and Howitt (1992, 1998, 2009).

International Comparisons

Khuong M. Vu compares the economic growth performance of the E7 economies (the 7 largest emerging countries, namely China, India, Indonesia, Brazil, Mexico, Turkey and South Korea) to that of the G7 economies over the 2000-2017 period. In 2017, the two country groups represented respectively 37 per cent and 31 per cent of world GDP, while GDP per capita was on average in the E7 countries only 26 per cent of that in the G7 countries. But the E7 countries are (except Mexico) in a fast catch-up process; due to higher capital accumulation and total factor productivity (TFP hereafter) growth, their contribution to world growth is 60 per cent compared to less than 20 per cent for the G7 countries.

Robert Inklaar, Kirsten Jäger, Mary O'Mahony and Bart van Ark analyse the supply factors of European growth compared to the United States between 1995 and 2015. They show that both in Europe and in the United States, information and communication technologies (ICT) have significantly contributed to productivity growth, but they admit not to be able to explain the general productivity slowdown. It seems to them that we are still "in the midst of the transition from the Old Digital Economy (which was characterized by the introduction of the PC in people's lives and business processes, the rise of the internet, and the beginning of the e-commerce) to the New Digital Economy (which is characterized by the change toward mobile, ubiquitous access to the internet, the storage and usage of data, and advances in artificial intelligence and robotics)".

Chi-Yuan Liang and Ruei-He Jheng com-

pare TFP changes in the ICT industry among Japan, Korea, Taiwan, China and the United States. They show that during 1981-2010, lower R&D spending, fewer and lower-quality patents have led to lower TFP growth in the ICT industry in Taiwan, Korea and China compared to that of the United States and Japan.

Kyoji Fukao, Tsutomu Miyagawa, Hak Kil Pyo, Keunhee Rhee and Miho Takizawa compare the impact of information and communication technology investment on employment in Japan and Korea. They show that in both countries, this impact depends on the skill level of the workforce.

Matilde Mas, André Hofman and Eva Benages propose an international comparison of knowledge-based human and physical capital services over the 2000-2015 period. More developed countries appear to have a higher share of knowledge-based capital services in total capital services, but the knowledge-based economy is growing faster in less developed countries, which represents a convergence process.

Country-Specific Analyses

K.L. Krishna, Bishwanath Goldar, Deb Kasum Das, Suresh Chand Aggarwal, Abdul A. Erumban and Pilu Chandra Das analyse the Indian growth performance. It appears to them that while economic reforms undertaken in India since 1991 had a positive impact on productivity performance in the manufacturing sector, there are still many reforms to implement to boost productivity growth in manufacturing and also in other sectors of the economy.

Harry Wu analyses the origins of the pro-

ductivity slowdown in China. He shows that the TFP slowdown starting in the early 2000s was a consequence of its WTO entry in 2001 because of the increase in state interventions to protect strategic industries. He points out that capital resources were increasingly directed to selected state industries and crowded out more efficient private enterprises.

Gang Liu analyses the growth factors in Norway during the period 1997-2014. The productivity slowdown in that country came from slower growth of TFP and capital deepening, and the two industries which contribute the most are finance and distribution services.

Methodological Issues

Ilya Voskoboynikov, Derek Burnell and Thai Nguyen report on the progress of the World KLEMS project in Australia and Russia. These two countries seem to be now well-covered by the World KLEMS database, which offers new research opportunities to economists.

Lucy Eldridge, Corby Garner, Thomas Howells, Brian Moyer, Matthew Russell, Jon Samuels, Erich Strassner and David Wasshausen discuss how the US Bureau of Economic Analysis (BEA) and Bureau of Labor Statistics (BLS) have developed "a complete integrated industry-level production account for the United States that combines output and intermediate inputs data from the BEA GDP by industry accounts with measures of labor and capital inputs from the BLS productivity program". The authors of this chapter are from the two institutions (BEA and BLS). Such an outstanding project in the US sta-

tistical system must of course be congratulated.

Koji Nomura, Kozo Miyagawa and Jon Samuels provide new benchmark estimates of Japan-US industry-level price differentials for 2011, based on a price accounting model.

Marshall Reinsdorf and Paul Schreyer address the question of measuring consumer inflation in a digital economy. They deal with three problems: incomplete adjustments for quality change in products or distribution channels; neglected welfare gains or costs savings from truly novel digital products; and neglected welfare gains from free digital products. They calibrate their evaluation at the upper bound and find that in OECD countries, the products concerned accounted for about 35 per cent of household expenditure in 2005, declining to 32 per cent in 2015. In the new measurement they propose, the consumption deflator would be lowered by 0.6-0.7 percentage points. This gives "a more optimistic picture of growth and productivity changes but would not overturn the conclusion that productivity has slowed substantially".

Carol Corrado, Jonathan Haskel, Massimiliano Iommi and Cecilia Jona-Lasinio develop a theoretical framework to analyse the relationship among intangibles, innovation, and productivity by building a Jorgenson-like model of economic growth. They also provide empirical evidence for the United States and selected European countries. They show that the growth of intangible capital recovered faster after the Great Recession than did tangible capital, and that there is a positive relationship between intangible capital growth and TFP growth, whereby the decline in intangible

Chart 1: Total Labour Productivity Growth in the United States, the Euro Area, the United Kingdom, and Japan, 1891-2018
Smoothed indicator (HP filter, $\lambda = 500$) − average annual growth rate in output per hour
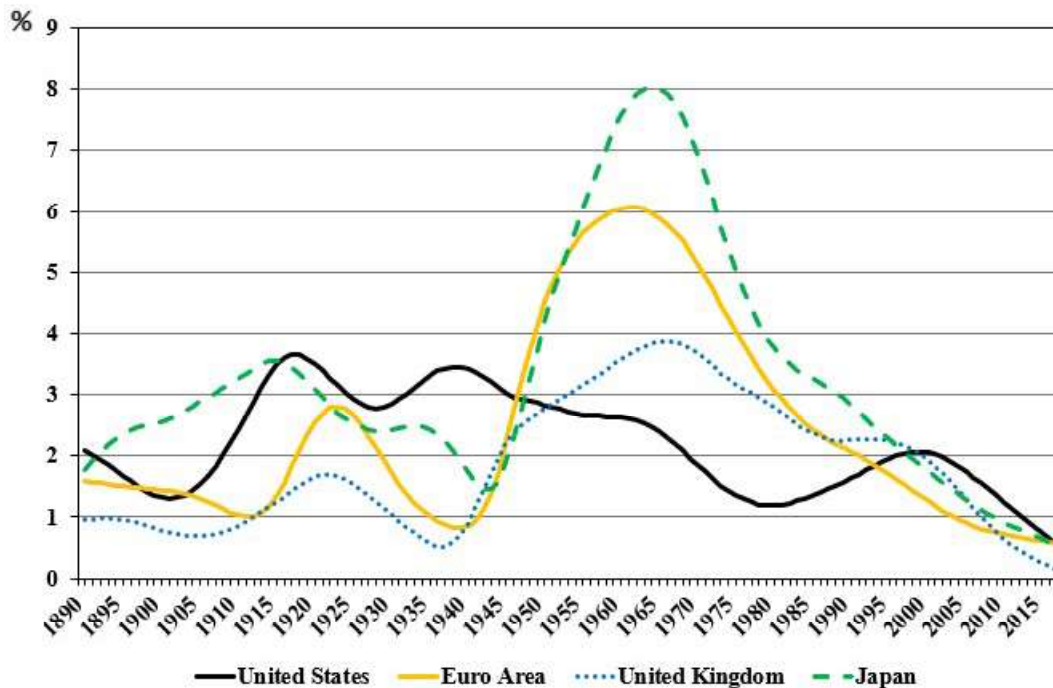
Source: Bergeaud, Cette and Lecat (2016) - See: www.longtermproductivity.com

capital growth explains more of the decline of TFP growth in the United States than in Europe.

Ana Aizcorbe, David Byrne and Daniel Sichel propose a new price index for smartphones which is better quality adjusted than the official index, and a methodology for disentangling the spending on phones and wireless services when the two are bundled together. Their adjusted deflator of Cellular Telephone Services fell about 4 percentage points faster per year than currently published measures over the last two decades. Their "results highlight the rapid decline in quality-adjusted prices for products related to the digital economy and, by implication, continued rapid technical advance in these products".

Marcel Timmer and Xianjia Ye propose to take into account global value chains in growth and productivity accounting.

Two chapters of the book deal with the topic of climate change. Richard Goettle, Mun Ho and Peter Wilcoxen propose an approach for taking into account emissions and carbon tax in computable general equilibrium models. Jing Cao, Mun Ho and Wenhao Hu propose an empirical application of such an approach on China.

Daniel Slesnick revisits the issue of social welfare, using US regional data provided by the BEA concerning different possible welfare components.

Conclusion

This collected volume is targeted to economists and policy makers who are interested in gaining a better understanding of questions related to growth and pro-

ductivity. It provides abundant food for thought and the impetus to carry out analyses on these topics. References to Jorgenson's publications are plentiful, which indicates the extent to which he is an unprecedented pioneer on so many questions. This book is a beautiful and well-deserved tribute to him!

One criticism of the volume is that chapters do not appear to be structured in a logical manner. To assist the reader of the review article, I have attempted to present the chapter in a more logical order.

A first remark on the content is that, after having read the volume, one is still looking for an explanation of the reasons why we see ICTs and digital technologies everywhere except in the productivity growth statistics. Productivity growth has slowed down over recent decades in all developed countries, whatever their distance to the technological frontier, their institutions, and their levels of ICT use (Chart 1). For more than a decade, labour productivity growth has been at rates never observed for at least one and a half centuries. This reminds us of the well-known words from Robert Solow (1987) "You can see the computer age everywhere, but in the productivity statistics".

As suggested in some analyses (e.g. Brynjolfsson and McAfee (2014), van Ark (2016), Branstetter and Sichel (2017), or in Inklaar, Jäger, O'Mahony and van Ark (2019)), perhaps this puzzle corresponds once again to what happened in previous technological revolutions: the profound changes were only diffused gradually, and their impact on productivity performance was not felt until decades later. Paul David has shown that between 50 and 60 years passed between the invention of a working electric dynamo in 1868 and its full exploitation in production (in the 1920s to 1930s). If we extrapolate that, it will always take a long time for the full impact of a technological revolution to be seen in productivity statistics. We have to hope that this explanation is the right one, and that we will benefit in future years or decades from a productivity revival. Otherwise, developed countries will struggle to face the numerous challenges of the future. These challenges, which Gordon refers to as headwinds (see for instance, among many papers, Gordon, 2015), are significant. They include population ageing, climate sustainability, the reduction of public debt, and expectation of purchasing power increases. Moreover, without sufficient productivity growth to oil the wheels of the economy, the political risks to our democracies would inevitably increase.

A second remark on the content concerns the TFP. Is it always a relevant indicator to evaluate technological progress? We find in the literature and in this volume many factors affecting TFP growth including institutions, education, innovations, and factor allocation. We could easily obtain the impression that all together, these factors explain more than what we have to explain! As raised by Jorgenson and Griliches (1967), notionally, if the production function is perfectly specified, if all productive factors are well measured and taken into account, TFP measurement through the Solow residual approach should be small and would mostly correspond to the impact of externalities. Knowing then that TFP growth represents a "measure of our ignorance" (Abramovitz, 1956), perhaps when

we look at productivity growth, we should merely consider simple average labour productivity indicators.

But let me repeat here once again that this book is a precious compilation, useful to anyone who is interested in gaining a better understanding of growth and productivity mechanisms, and is an honorable tribute to Dale W. Jorgenson.

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