

World KLEMS: Productivity and Economic Growth in the World Economy: An Introduction

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This issue of the *International Productivity Monitor* contains papers presented at the Fourth World KLEMS Conference, held at the BBVA Foundation, Madrid, Spain, on May 23-24, 2016.² This is the latest in a series of international conferences devoted to research on productivity and growth in the world economy. World KLEMS is based on outputs and inputs of capital (K), labour (L), energy (E), materials (M), and services (S) for individual industries. Productivity of each industry is the ratio of output to all inputs.

The point of departure for research on economic growth and productivity is the volume edited by Dale W. Jorgenson, Kyoji Fukao, and Marcel P. Timmer (2016), *The World Economy: Growth or Stagnation?* This volume presents studies for more than forty countries by teams involving thirty-eight authors. The methodology follows Chapters 19 and 20 of the System of National Accounts 2008 (SNA 2008) produced by the United Nations Statistical Division (UN, 2009). Jorgenson and Schreyer (2013) show how to incorporate accounts for industry-level growth and productivity into the SNA 2008.

More than a dozen countries have added industry-level data on growth and productivity to their national accounts. This follows SNA

2008 and assures a higher degree of international comparability. The Madrid World KLEMS Conference included reports from three regional organizations. The first of these, European Union (EU) KLEMS, arose from a research project supported by the European Commission. This project was initiated in 2003 and completed in 2008. The Economic Commission for Latin America and the Caribbean (ECLAC) in Santiago, Chile, an agency of the United Nations, established the Latin American regional organization LA KLEMS in 2009. The third regional organization, Asia KLEMS, was organized by the Asian Development Bank Institute (ADBI) in Tokyo, Japan, in 2010.

The EU KLEMS project was led by the Groningen Growth and Development Center (GGDC) at the University of Groningen, in the Netherlands, and involved 18 participating organizations. The project applied international standards for data on growth and productivity to 25 of the (then) 27 members of the European Union. The project generated similar data for Australia, Canada, Japan, and the United States. Marcel Timmer, Robert Inklaar, Mary O'Mahony, and Bart van Ark (2010) reported the results in their monograph *Growth of the*

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2 The conference program is available on the World KLEMS website: <http://www.worldklems.net/conferences.htm>.

European Economy: A Comparative Industry Perspective.³

The main conclusion of the EU KLEMS project is that Europe's unsatisfactory economic performance preceded the downturn in the European economy following the Great Recession in the United States. This was due to underinvestment in human capital, information technology, and research and development. The volume *Industrial Productivity in Europe: Growth and Crisis*, edited by Matilde Mas and Robert Stehrer (2012), presented international comparisons of growth and productivity within Europe and between Europe and advanced economies in Asia and North America.

Updated estimates of the industry-level sources of European economic growth for the period 1999-2014 were presented by van Ark and O'Mahony (2016) in Chapter 4 of *The World Economy*. The Great Recession that began in the United States during 2007-2009 was transmitted to Europe in 2008 and 2009. This resulted in a "double dip" recession in Europe and widened the gap in growth rates between Europe and the United States. Slower growth in Europe can be attributed to demand-side factors, such as "secular stagnation", and supply-side slowdowns in the growth of employment and productivity.

In 2016, the European Commission launched a project to update the EU KLEMS database. The original EU KLEMS study included data on outputs, inputs, and productivity for 72 industrial sectors. The update is based on value added for 34 industrial sectors with inputs of capital and labour services. This employs Eurostat's (2013) European System of Accounts 2010 (ESA 2010), which is closely related to SNA 2008. The estimates are based on the International System of Industrial Classification (ISIC), Revision 4, and are consistent with the national

accounts that individual countries report to Eurostat, the European statistical agency.

The initial update of the EU KLEMS database for ten European countries by van Ark and Kirsten Jäger, "Recent Trends in Europe's Output and Productivity Growth Performance at the Sector Level, 2002-2015" is found in this volume. Results are available for manufacturing and market services, as well as the total economy. The emerging picture of the European economy reveals little evidence of a recovery from the Great Recession. The database will be updated and extended to cover the EU 28, the United States, and Japan.

Substantial differences in economic performance characterize the major European economies. In "The Role of Capital Accumulation in the Evolution of Total Factor Productivity in Spain," Francisco Pérez and Eva Benages show that relatively satisfactory economic growth in Spain is due to substantial investments in human and non-human capital with negative contributions of growth in total factor productivity. Italy has had little economic growth in per capita terms since the adoption of the Euro in 2000. Germany's more satisfactory performance can be traced to a successful program of economic reforms.

The Latin American regional organization, LA KLEMS, was originally coordinated by ECLAC and included research organizations and statistical agencies in the leading Latin American countries. Mario Cimoli, André Hofman, and Nanno Mulder (2010) summarized the results of the initial phase of the project. André Hofman, Matilde Mas, Claudio Aravena, and Juan Fernández de Guevara (2016) presented industry-level production accounts for Argentina, Brazil, Chile, Columbia, and Mexico for 1990-2010 in Chapter 5 of *The World Economy*. A striking finding is that there has been no total

3 See Timmer *et al.* (2011) for an accessible overview of the monograph.

factor productivity growth in the leading economies of Latin America during the past two decades.

A detailed report on Mexico KLEMS was published by the Mexican statistical agency, INEGI (2013). Mexico KLEMS includes a complete industry-level database for 1990-2011, integrated with the Mexican national accounts and updated annually. Since 1990 periods of positive economic growth have been offset by the negative impacts of the Mexican sovereign debt crisis of 1995, the U.S. dot-com crash in 2000, and the U.S. financial and economic crisis of 2007-2009. Mexican total factor productivity at the economy-wide level has remained unchanged throughout two decades.

André Hofman, Claudio Aravena, and Jorge Friedman analyze industry-level data on growth and productivity for Argentina, Brazil, Chile, Columbia, and Mexico in "Sources of Productivity and Economic Growth in Latin America and the Caribbean, 1990-2013" in this volume. In addition, they report aggregate data on growth and productivity for 18 Latin American countries. In 2016, the LA KLEMS project was transferred from ECLAC to the Inter-American Development Bank (IDB) in Washington, D.C.

Ariel Coremberg summarizes a remarkable application of Argentina KLEMS in his contributions to this volume, "Argentina Was Not the Productivity and Economic Growth Champion of Latin America." In 2007, the Argentine government embarked on a program to manipulate the official statistics to exaggerate Argentina's economic performance. This policy was reversed by the current government. The Argentine statistical agency, INDEC, has reconstructed the Argentine national accounts according to internationally accepted principles. Earlier, the Argentina KLEMS research group at the University of Buenos Aires developed an unofficial system of national accounts for Argentina, largely anticipating the necessary

revisions. This was based on data sources less subject to political manipulation, including those for Argentina KLEMS.

Asia KLEMS is the third regional organization devoted to research on productivity and economic growth at the industry level. This includes the Japan Industrial Productivity database, used in analyzing the sources of Japan's lost decades since 1991 by Kyoji Fukao, Kenta Ikeuchi, Hyeogug Kwon, Younggae Kim, Tatsuji Makino, and Miho Takizawa (2016) in Chapter 3 of *The World Economy*. This database is supported by the Research Institute for Economy, Trade and Industry (RIETI), an agency of the Japanese government. RIETI also supports the China Industrial Productivity database reported by Harry X. Wu (2016) in Chapter 6 of *The World Economy*. The Korea Industrial Productivity database, supported by the Korea Productivity Center, was reported by Hak K. Pyo, Hyunbae Chun, and Kyunhee Rhee (2016).

The construction of the India KLEMS database is supported by the Reserve Bank of India. Deb Kusum Das, Abdul A. Erumban, Suresh Aggarwal, and Sreerupa Sengupta (2016) present the results in Chapter 7 of *The World Economy*. There is an extensive literature on China-India comparisons of economic growth. The first study to use industry-level data on growth and productivity for this purpose is found in this volume by Harry Wu, K. L. Krishna, Deb Kusum Das, and Pilu Chandra Das, "How Does the Productivity and Economic Growth Performance of China and India Compare in the Post-Reform Era, 1981-2011?."

Both China and India grew much more rapidly than the world economy, especially after India's economic reforms of the 1990s and China's accession to the World Trade Organization in 2001. China's aggregate output grew more than 50 per cent faster than India's. China's total factor productivity growth was adversely affected by the collapse of world trade

during the Great Recession and India's productivity growth was 25 per cent faster. Manufacturing accounted for 50.9 per cent of China's growth, but only 22.5 per cent of India's, while services contributed 56.2 per cent of India's growth, but only 29.0 per cent of China's. While India's total factor productivity performance for the two sectors reflected the positive contribution of the sectors to economic growth, China experienced negative productivity growth in services.

In the contribution, "Can Intangible Investments Ease Declining Rates of Return on Capital in Japan?," Tsutomu Miyagawa, Miho Takizawa, and Konomi Tonogi analyze the stagnation of the Japanese economy after the collapse of the "bubble economy" in 1991. Growth accounting based on the Japan Industrial Productivity database reveals a sharp decline in the rate of capital formation and an associated decline in the rate of return to capital. Detailed modeling shows that the rate of return is positively associated with intangible forms of investment, especially research and development, human capital, and information technology. The authors conclude that economic policy in Japan should stimulate investment in intangibles to revitalize capital formation and economic growth.

Investment in human capital is an important focus of research on economic growth and productivity. In Chapter 12 of *The World Economy* Gang Liu and Barbara Fraumeni provide an international survey of research on human capital investment. Michael S. Christian's article, "Net Investment and Stocks of Human Capital in the United States, 1975-2013," in this volume, provides an annual time series for the value of human capital and investment in human capital in the United States, eliminating an important gap in the literature.

Christian employs the lifetime income approach to human capital of Jorgenson and

Fraumeni (1989). This incorporates the costs of human capital investment, as well as the impact of this investment on labour incomes over the lifetime of each individual. Christian's primary conclusion is that human capital per capita in the United States has remained relatively constant with increased educational attainment offset by aging of the population. He compares the results with a cost-based approach to human capital measurement and confirms previous findings that the lifetime income approach yields estimates of investment in human capital that are several times larger. He concludes that the characterization of investment in human capital by the cost-based approach is incomplete and can be misleading.

Investment in information technology is a second important focus of research on growth and productivity. In Chapter 9 of *The World Economy*, Carol Corrado, Jonathan Haskel, and Cecilia Jona-Lasinio analyze the impact of investment in information technology and other intangible assets on productivity growth at the industry level in Europe. In article, "ICT Prices and ICT Services: What Do They Tell Us about Productivity and Technology" in this volume, David Byrne and Carol Corrado summarize a new line of research on the prices of information technology. These include prices for hardware and software, as well as prices for services like cloud computing and computer systems design.

Byrne and Corrado show that the composition of ICT outputs in the United States has shifted from hardware and software towards services. They also show that official prices indexes for ICT products have failed to track recent changes in technology. They present new estimates of ICT prices and new estimates of the contributions of ICT investments and ICT services to economic growth. They conclude that the contribution of information technology to economic growth is much larger than suggested by the official estimates.

International trade is a third important focus of research on growth and productivity. In Chapter 15 of *The World Economy*, Marcel Timmer, Bart Los, and Gaaitzen J. de Vries summarize research on global value chains (GVCs). They decompose international production processes for deliveries to final demand — consumption, investment, government, and exports — into the stages in which value is added by industry and country. The value chain is usefully identified by the final stage of production, for example, German automobiles. The value added at each stage of production is decomposed by the factors of production, capital and labour inputs. These factors can be further disaggregated, as in the KLEMS-type data sets described in the other chapters of *The World Economy*.

Timmer, Los, and de Vries present a new conceptual framework, the World Input-Output Database (WIOD), linking KLEMS-type data sets for more than forty countries by means of bilateral trade flows. Using Wassily Leontief's (1977) World Input-Output Model, the income generated by each of hundreds of global value chains can be broken down by industry, country, and capital and labour inputs. International trade is analyzed in terms of exchanges of value added among countries. Among the trends that emerge from this new perspective is greater fragmentation of international production with a diminishing role for domestic sources of value added. There is a greater role for emerging economies as sources of value added and a diminishing role for advanced economies. More value is added by capital and less by labour.

In Timmer's contribution in this volume, "Productivity Measurement in Global Value Chains," the WIOD database is applied to the measurement of productivity. Changes in the income generated in each global value chain are separated into price and quantity components.

Taking deliveries to final demand as outputs and the contributions of factors of production by all countries and industries as inputs, productivity of the value chain is output per unit of all inputs. Timmer illustrates the new approach to productivity measurement by the international production of German automobiles. The contribution of capital input accounts for about half of output growth, labour input for another 30 per cent and total factor productivity 20 per cent. He also shows that three-quarters of the productivity growth in the German automobile industry takes place in Germany.

I conclude that the World KLEMS Initiative established by Jorgenson, Timmer, and van Ark at the First World KLEMS Conference, held at Harvard University in 2010, is flourishing.⁴ The three regional organizations in the European Union, Latin America, and Asia are generating important new research on productivity and economic growth for the leading economies of the world. The contributions of capital and labour inputs have emerged as the predominant sources of economic growth in both advanced and emerging economies. Economic growth depends primarily on investments in human and non-human capital, including investments in both tangible and intangible assets. These investments take place through markets and the central role of government policy is to assure that the markets function properly and are relatively free of distortions. This has proved to be an enormous challenge during the Great Recession and the incomplete recovery.

Productivity continues to play an important role as a source of economic growth, but this role has diminished sharply in the aftermath of the Great Recession. Total factor productivity growth disappeared for long periods of time, for example, during the last two decades in the leading economies of Latin America and in the lost

4 For an overview of the initiative see Jorgenson (2012).

decades in Japan after the collapse of the bubble economy. Governments play a key role in providing incentives for productivity improvements. An example is the creation of property rights for the accumulation of intellectual capital through patent systems. A much more important role for governments is the maintenance of orderly markets for different types of investments. This must be adapted quickly to new circumstances like the emergence of new sources of financial instability.

The success of the World KLEMS Initiative has inspired governments to provide new information on growth and productivity. This has led to important innovations, like the creation of KLEMS-type databases as part of the national accounts. However, the framework for new data development is now expanding to encompass the world economy, as in the World Input-Output Database. This will open many opportunities for research like those already underway in human capital, information technology, and global value chains. It will also create an expanded role for international organizations like the United Nations and the OECD in providing the institutional framework for new research on growth and productivity in the world economy.

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