



Total factor productivity growth in information technology services industries: A multi-theoretical perspective



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ARTICLE INFO

Article history:

Received 26 June 2013

Received in revised form 27 December 2013

Accepted 25 March 2014

Available online 2 April 2014

Keywords:

Information technology services industry

Productivity and competitiveness

Innovation

Efficiency

Malmquist index

Data envelopment analysis

ABSTRACT

Information technology (IT) services refer to the delivery and support of IT operations and activities in order to satisfy business requirements and to manage IT infrastructure for organizations. Considered part of knowledge-intensive business services, IT services provide an output used by other sectors and play an increasingly important role in the services-based economy. Based on the theories of production, innovation and competition, we study total factor productivity growth of IT services industries in 25 Organization of Economic Cooperation and Development (OECD) countries over the period of 1995 to 2007 using Malmquist productivity index (MPI) as the performance metric and data envelopment analysis (DEA) as the measurement methodology. We then further decompose MPI into three components that provide a full analysis: technical change (for innovation), efficiency change (for catch-up), and scale change (for demand fluctuation). These IT services industries are found to show notable productivity growth when compared with other services industries, the services sector as a whole, and the economy at large. Through a multi-theoretical lens, our breakdown analysis reveals that the IT services industry is an innovator adept at making technological progress that becomes the key driver behind observed productivity growth; efficiency change exerts a relatively small negative impact; and scale change being mainly decided by client demands impairs productivity. Implications for IT services at both country and industry levels are drawn from our findings to provide suggestions for policymaking and strategy formulation.

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1. Introduction

Over the past several decades, developed countries have transformed themselves from a manufacturing-based economy to a services-based economy. In the U.S., the output of the services sector accounts for more than 75% of gross domestic product (GDP) and services industries employ a comparable proportion of the total workforce [56, 92]. Organization for Economic Cooperation and Development (OECD) countries exhibit a similar pattern with more than 70% of total value added coming from services [86]. Meanwhile, many developing countries are following the footsteps of their developed counterparts. As their economies grow, they witness an increasing share of output being contributed by the services sector. In China and India, 35% of their labor performs services-related work and the ratio continues to rise every year [78]. These figures and the trends they represent suggest that services industries are playing an increasingly important role in the world economy.

However, “services industries have long been disparaged as sources of low-skills, low-wage jobs, and they often are characterized as part of

a stagnant sector marked by low productivity growth and only limited opportunities for innovation” [92]. Baumol [9] contends that the long-term trend of having a greater share of employment tied to services would hurt the rate of aggregate economic growth. While this concern appears valid for many services industries, there are ones that may suggest otherwise (e.g., banking and finance, healthcare, and education). In this paper, we study the total factor productivity (TFP) growth of the information technology (IT) services industry and examine how this knowledge- and skill-intensive business services industry fares along various performance dimensions. We argue that the IT services industry is different from many other services industries, as it provides value-added business services, it is technology-enabled and innovation-driven, and its output is used by other industries, hence rendering an amplifying ripple effect throughout the economy.

IT services refer to the delivery and support of IT operations and activities in order to satisfy business requirements and to manage IT infrastructure for organizations. Organizations can make or buy IT services [75]. The internal IT department is charged with the provision of IT services if a firm decides to make them internally. The buy decision, instead, leads to sourcing IT services from outside vendors. The IT services industry is made up of IT services providers that offer the support of infrastructure, network and desktop help as well as the delivery of

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software development, applications, data, and component objects. Our study focuses on the IT services industry and looks at related issues of IT services from the standpoint of producers instead of customers.

Both technological innovations and economic factors have stimulated the IT services industry [96]. For instance, utility computing provides a cost efficient way to execute business applications, and software-as-a-service (SaaS) becomes a popular means to source IT functions [12]. Application service providers (ASP) rely on the service-oriented architecture (SOA) and reuse software objects to provide IT services more quickly [90]. Outsourcing also contributes to the growth of the IT services industry [21,85]. The worldwide revenue for IT services in 2009 was estimated at \$800 billion [4], which was higher than the global spending of \$447 billion on IT capital goods [69].

Despite its critical nature, the IT services industry has received surprisingly little attention in the literature. Extant related studies mainly focus on the adoption of various IT systems and business value of associated investments at the firm level [1,46], the industry level [26,63], and the country level [34,53]. Provider-oriented studies also mostly look at IT capital goods [31], instead of IT services. Our research intends to fill the gap in the literature by examining the productivity performance of the IT services industry in a cross-country context. In so doing, our effort also answers the call for more research on critical economic and socio-technical issues of IT services [79].

Our study of the IT services industry is at the country level where the literature has found interesting results for IT economic value and the IT capital goods industries. For example, Jorgenson [53] argues that fallen prices provide strong incentives to substitute IT capital goods for other types of capital and for labor services. Colechia and Schreyer [34] find that the U.S. is not the only country that benefits from the positive effects of IT capital investment on economic growth. Other than IT capital deepening, they point out that IT diffusion and usage also play a key role. Chou et al. [31] report stronger performance of the IT capital goods industry to meet increasing demands induced by price decline. The recent observation of productivity acceleration being dominated by IT-using industries also leads to the proposition that IT's effects on output may go beyond input usage [15], and IT-leveraged innovations facilitate knowledge transfer across countries through international trade of IT capital goods [73]. Country-level studies like these offer macro insights for national policymaking but still need to be complemented by studies of other related industries like IT services or by more firm-level studies to better understand IT's impacts in different settings at different levels.

The motivation for our study on IT services is based on two observations. First, IT services are an important part of the services economy as they are inputs to other services. Second, extant literature has mainly focused on the IT capital goods but not on the services side. The research questions raised in our study are as follows: (1) Do the IT services industries in OECD countries show high productivity growth? (2) What are the sources of and the inhibitors to the observed productivity growth? (3) Are these IT services industries innovative and agile? (4) Is their productivity performance subject to the changing demands of the dynamic IT services market induced by the trend of on-demand computing? We answer these questions by analyzing panel data on the IT services industries in 25 OECD countries over the period of 1995 to 2007. The time period of the data is interesting since the Internet was decommissioned by NSFNET in 1995, which signaled the start of e-commerce [49]. Because the Internet is a disruptive innovation for many industries [32, 51] and is a key enabling technology for IT services provision [78], our study essentially looks at the performance of the IT services industry in the modern Internet-based e-commerce era.

Taking a multi-theoretical perspective, we aim to evaluate the productivity performance of 25 OECD countries' IT services industries with Malmquist productivity index (MPI) to pinpoint the contributors and inhibitors to their productivity growth. Malmquist productivity index is chosen because we can decompose it into three components that provide a full analysis with links to real-world phenomena:

technical change (for innovation), efficiency change (for catch-up), and scale change (for demand fluctuation). Technical change represents the shift in the production frontier over time; efficiency change refers to the adjustment in the relative distance of the observed output to the maximum output specified by the production frontier; and scale change relates to the movement from one scale region to another defined by the production frontier. In practice, technical change reflects the strength of innovative capacity; efficiency change reveals the capability of a unit to catch up with its leading peers; and scale change reacts to demand fluctuations in the market [2].

Our study assesses the competitiveness of a country's IT services industry on the global stage. The breakdown of Malmquist productivity index into the technical innovation of production process, catch-up effort to utilize existing capacity, and responsiveness of production scale to market dynamics provides insightful implications. Policymakers and corporate executives hence can develop and implement effective industrial policies and competitive business strategies to advance their IT services industries and firms, respectively. We employ data envelopment analysis (DEA) to calculate MPI for OECD countries' IT services industries, as DEA is considered suited for performance evaluation in the services context [87]. The application of DEA to MPI is well documented in the literature [35,39].

The rest of the paper is organized as follows. Section 2 discusses recent advances in the IT services domain. In Section 3, we review the theories of production, innovation and competition that form the underpinning for our study. Section 4 presents the DEA-based models for computing Malmquist productivity index and its three constituent factors. The data collection for our cross-country analysis is described in Section 5. Section 6 presents and discusses our empirical results. Section 7 draws implications from our results for the practice of IT services management, and finally Section 8 concludes the paper.

2. Advances in IT services

Intangible services are distinguished from tangible product goods in several ways, such as close interaction of providers and clients; simultaneity of production and consumption; nature of knowledge created and exchanged; combination of knowledge into useful systems; exchange as processes and experience points; and exploitation of information and communication technologies (ICT) [29]. ICT use is particularly relevant, as ICT is the means to produce and deliver IT services. According to ISIC Rev.3 Code 72, IT services consist of hardware consultancy, software consultancy and supply, data processing, database activities, maintenance and repair of computing machinery, and other computer-related activities. IT services are also one of six major industries that make up the ICT sector as defined by OECD (see Fig. 1), with the other five being IT equipment, telecom equipment, electronics and components, computer software, and telecom services.

IT services are used by other sectors and hence play a pivotal part in a services-based economy [16]. In the e-commerce era, they have gone through tremendous transformations and are no longer confined to a back-office function to support just data processing and applications [78]. The pace of innovations in the domain has accelerated as the Internet matured into a legitimate delivery channel and becomes a fertile ground for new IT services and providers. Bourne [17] identifies some examples of these new IT services and providers, including Web services, service-oriented architecture (SOA), software-as-a-service (SaaS), application service provider (ASP), grid computing, on-demand utility computing, cloud computing, and information technology services management (ITSM). Table 1 provides the description of and identifies key players for these new IT services.

The growth of the IT services industry also has to do with outsourcing where IT services are procured from outside vendors [96]. With outsourcing, firms enjoy cost saving and quality services as providers realize economies of scale and scope, exploit the potentials of emerging technologies, and gain access to skilled talents with specialized

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