Japan and the World Economy 21 (2009) 325–336

Contents lists available at ScienceDirect

Japan and the World Economy

journal homepage: www.elsevier.com/locate/jwe

Does information technology raise Japan's productivity?

Takuji Fueki [a,*], Takuji Kawamoto [b]

[a] Research and Statistics Department, Bank of Japan, 2-1-1, Nihonbashi-Hongokucho, Chuo-ku, Tokyo, Japan
[b] Financial Markets Department, Bank of Japan, 2-1-1, Nihonbashi-Hongokucho, Chuo-ku, Tokyo, Japan

ARTICLE INFO

Article history:
Received 15 December 2008
Accepted 26 February 2009

JEL classification:
D24
E23
E32
O47
O53

Keywords:
Total factor productivity
Information technology
Japanese economy

ABSTRACT

A standard growth accounting exercise indicates that, after Japan's "lost decade," its overall total-factor-productivity (TFP) growth has increased notably since 2000. This productivity revival has been limited, however, to information technology (IT) *production*—has not been a broad-based productivity acceleration like that seen in the United States after the mid-1990s. This paper examines the relationship between IT and productivity gains by employing the "augmented" growth accounting framework for Japanese industry-level data from 1975 through 2005. In particular, we estimate "purified" technology change at industry level by accounting for cyclical mismeasurement of inputs. We find that the post-2000 increase in overall TFP growth does indeed appear to arise from an increase in technological change. Furthermore, the pickup in technology growth has occurred not only in the *production* of IT but also in the industries that *use* IT intensively. Our results suggest the possibility that stories of IT as a general purpose technology (GPT) could apply to Japan as well as to the United States.

1. Introduction

After the mid-1990s, labor and total factor productivity (TFP) accelerated sharply in the United States, but not in Japan. A growing body of research has explored the robustness of the U.S. productivity acceleration; it generally concludes that information technology (IT) was a key driver of the U.S. acceleration.[1] By contrast, in terms of cross-country productivity evidence, Gust and Marquez (2002), among others, document that Japan (and many European countries) did not experience such IT-driven pickup in productivity growth in the late 1990s. Why did Japan not benefit from IT, even though it had access to the same technology as the United States did? To the extent that one expects ideas – especially when embedded in easily traded physical capital – to diffuse easily across borders, the lack of productivity acceleration in Japan has puzzled many economists and policymakers.

This paper sheds lights on the relationship between IT and productivity gains by employing the "augmented" growth accounting framework for Japanese industry-level data from 1975 through 2005. In particular, we estimate "purified" technology change at industry level by controlling for non-technological cyclical factors: varying utilization of capital and labor and non-constant returns and imperfect competition.[2] We then examine the post-1995 performance of purified technology for the individual industries that either *produce* IT, *use* IT, or are relatively isolated from the IT revolution. Through this type of disaggregated analysis, we seek to understand the impact of IT from the bottom–up, rather than a top–down decomposition of aggregate data.[3]

Why do we care about the non-technological cyclical components of measured productivity? First, compared to the U.S. economy, which has shown relatively stable macroeconomic performance since the mid-1990s, Japan's economy experienced substantial business-cycle fluctuations during the 1990s and early 2000s. Following the collapse of the "asset price bubble" in the early 1990, Japanese growth rates steadily deteriorated through the first half of the decade, rebounded briefly at mid-decade, and fell again during the severe financial crisis in the last half of the

* Corresponding author.
E-mail addresses: takuji.fueki@boj.or.jp (T. Fueki), takuji.kawamoto@boj.or.jp (T. Kawamoto).

[1] See Jorgenson and Stiroh (2000), Jorgenson (2001) and Oliner and Sichel (2000) for early discussions of the role of IT in U.S. productivity acceleration.

[2] Kawamoto (2005) constructs a measure of purified technology for Japanese industries over the years 1973–1998 by using the augmented growth accounting framework *a la* Basu et al. (2001).

[3] For the United States, Stiroh (2002), Basu and Fernald (2007) and Bosworth and Triplett (2007), among others, examine the impact of IT on the post-1995 productivity acceleration by using detailed industry-level data. Oliner et al. (2007) extend the standard growth accounting at industry level to account for time-varying utilization of inputs, adjustment costs of capital, and intangibles.

0922-1425/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.japwor.2009.02.001

decade. Since the IT boom and bust cycle at the beginning of the 2000s, the Japanese economy has enjoyed a long steady expansion from early 2002 forward. Thus, in contrast with the United States, cyclical mismeasurement of inputs plays a potentially important role in variations in Japan's productivity growth, and thereby masks the structural link between IT and productivity gains.[4] The second reason, which is closely related to the first, is that cross-industry comovements in Japan have notably declined in recent years, i.e., cross-industry heterogeneity in cyclical fluctuations is becoming stronger than before.[5] Thus, in seeking a structural link between IT and productivity from the variations in industry-level data, it is desirable to purge measured productivity of *industry-specific* transitory factors.

Looking at the result from traditional growth accounting, we first show that after the "lost decade" of sluggish growth, Japan's overall TFP growth shows a pickup since 2000. Furthermore, we find that the post-2000 acceleration in measured TFP was narrowly concentrated in IT *production*—not broad-based as in the U.S. productivity acceleration after the mid-1990s. This result is broadly consistent with recent studies on Japan's productivity. For example, based on the EU-KLEMS industry-level data for 1980–2004, Fukao and Miyagawa (2007) report that Japan had a similar TFP acceleration as the U.S. in IT *producing* sectors, but failed to achieve such a pickup in the sectors that *use* IT intensively. Jorgenson and Motohashi (2005), using Japanese aggregate data from 1975 through 2003 (which is adjusted to conform to U.S. definitions), found that TFP for IT-goods sector substantially increased after 1995, while TFP for Non-IT-goods sector lagged far behind the United States.[6]

A somewhat different picture emerges, however, if we undertake the "augmented" growth accounting to account for cyclical mismeasurement of inputs. We first confirm that the post-2000 increase in overall TFP growth does appear to arise from an increase in technological change, making it unlikely that business cycle considerations hold down measured productivity. Even more importantly, our measure of "purified" technology indicates that the resurgence in Japan's technology growth in the 2000s has gone beyond the *production* of IT and has been based, at least in part, on increases in technology growth for the IT-*using* industries. Even when we focus on arguably "well-measured" industries (Nordhaus, 2002; Basu and Fernald, 2007), we still find a notable technology acceleration in IT-*using* industries.[7] Our results from augmented growth accounting thus suggest that information technology has been a key driver of the pickup in productivity growth in the 2000s.

Why do the two growth accountings yield different sectoral patterns in productivity or technology? The key to this difference is that the IT-using sector – comprised mainly of non-manufacturing industries – has shown weaker growth on the whole since 2000 than has the IT-*producing* sector, which consists of several process-manufacturing industries. Fig. 1 presents annual growth rates of real value added for IT-producing and IT-using sectors in Japan. Clearly, the IT-using sector has relatively slow growth in the 2000s

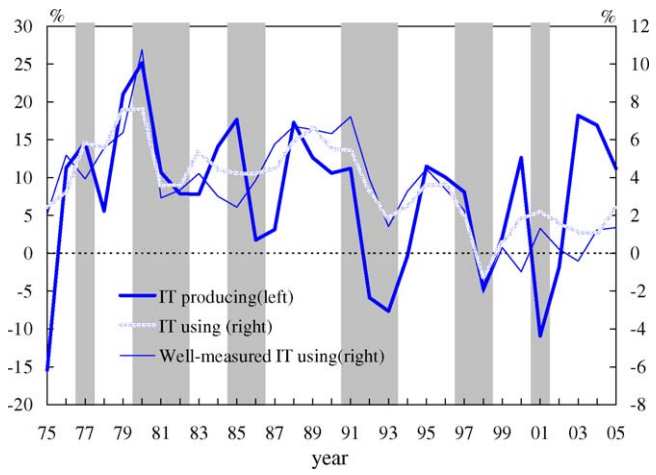

Fig. 1. Sectoral real GDP Growth (annual percent change). *Notes*: Real GDP growth is measured as real value-added growth. IT-producing sector includes machinery; electrical machinery; and precision instruments. IT-using sector is composed of six industries: chemicals; wholesale and retail trade; finance and insurance; utilities; transportation and communication; and service. Well-measured IT-using sector is composed of four industries: chemicals; wholesale and retail trade; utilities; and transportation and communication. Shaded regions show ESRI recession dates.

compared to the IT producing sector, because the recent cyclical expansions have been mainly driven not by an increase in domestic demand but by an increase in exports abroad. As a result, ignoring cyclical variations that differ substantially across the sectors tends to produce an underestimation of the contribution of the IT-using sector to overall productivity growth.

Our finding—the pickup in technology occurred in industries that used, not merely in industries that produced, IT—has important implications for the role of information technology, because it suggests the possibility that stories of IT as a general purpose technology (GPT) could apply to Japan as well as to the United States.[8] GPT stories emphasize that reaping the full benefit of IT requires firms to accumulate a stock of intangible complementary capital through learning, reorganization, and the like.[9] Since intangible capital accumulation is a slow process, the benefits of the IT revolution show up in the IT-using sector with significant lags. Indeed, our sectoral results seem to be broadly consistent with this GPT view: Technology growth in Japan's IT-using sector has picked up with long lags of 5–10 years, following the post-1995 IT investment boom that was boosted by the advent of "Windows 95." Although much more work remains to be done to assess the plausibility of GPT hypothesis in Japan – for example, measuring intangible capital directly based on Japanese data (see Fukao et al., 2007) – we believe that our results have taken a modest step toward deeper understanding of the role of information technology on productivity growth.

The organization of the paper is as follows. We present industry-level results from standard growth accounting in Section 2, and show that the post-2000 pickup in Japan's TFP has been narrowly located in the IT production sector. We then discuss our framework for purifying measured productivity in Section 3, and describe our estimation methods in Section 4. Empirical results from our augmented growth accounting are presented in Section 5. Conclusions with caveats are offered in Section 6.

[4] See Basu and Fernald (2001) for reasons why measured productivity is procyclical over the business cycle.

[5] See Nishimura (2007) and Osada and Kawamoto (2007) for a variety of empirical evidence on the recent decline in output comovements across Japanese industries. For example, Osada and Kawamoto (2007) report that the average cross-industry correlation coefficient for manufacturing production used to be around 0.5 until the late 1990s, but has currently dropped to 0.1.

[6] Jorgenson and Nomura (2005) also document that IT-manufacturing industries show much stronger TFP growth than IT-using industries do over the years 1995–2000, using the KEO data by disaggregated industries.

[7] Our industry-level results are consistent with firm-level evidence for an important role of the use of IT to affect measured productivity in Japan. For example, Motohashi (2007) finds the positive impact of information network use on productivity growth, using firm-level data for Japanese manufacturing and distribution sectors.

[8] Basu et al. (2003) and their subsequent work (Basu and Fernald, 2007) provide a simple model of IT as a general purpose technology, along with the U.S. industry-level evidence in support of the GPT view.

[9] See, for example, Bresnahan et al. (2002) and Brynjolfsson and Hitt (2003) for firm-level evidence on the importance of complementary investment to reap the benefit of IT.