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Service Sector Role in the ICT Contribution to Economic and Productivity Growth

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Abstract

Title: Service sector role in the ICT contribution to economic and productivity growth.

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Category of paper: Conceptual paper.

Purpose of the research: The contribution of information and communications technology (ICT) to economic and productivity growth has traditionally been difficult to calculate because of the complex relationship between them, but this relationship is now better understood with ICT now accepted as a transforming and revolutionary 'general purpose technology' (GPT). This paper describes the transformation of ICT from backroom cost centre to bottom line contributor of significant economic and productivity growth and suggests that the rise of the services industry has had, and will continue to have, a significant role in the continued payoff for ICT.

Findings: Acceptance of ICT as a GPT means that the contribution of ICT to economic and productivity growth is better understood and is measurable. However, the substantial contribution to productivity gains that ICT is now understood to make is not fully explained by this change in measurement. The transformation from productivity paradox to productivity payoff has coincided with the rise of the services industry that has then been, and will continue to be, a significant contributor to the ICT productivity payoff.

Value of the paper: The paper will be of interest to academics and government policy makers.

Number of pages: 12

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Section headings: Abstract, Introduction, Background and context, ICT as a general purpose technology (GPT), ICT's contribution to economic and productivity growth, The role of the service sector, Conclusion.

Introduction

The contribution of information and communications technology (ICT) to economic and productivity growth has traditionally been difficult to calculate because of the complex relationship between them. Traditional standard total factor productivity (TFP) measures do not adequately capture the ‘information revolution’ characteristics of ICT (Diewart and Lawrence 2004) but this is now addressed with ICT being recognised as a ‘general purpose technology’ (GPT) (David and Wright 1999; Helpman 1998; Bresnahan and Trajtenburg 1995). As a result, the contribution of ICT to economic and productivity growth as a transforming and revolutionary GPT is now accepted (Gordon 2003a, 2003b).

Acceptance of ICT as a GPT means that the contribution of ICT, when combined with the complementary investment in skills, organisational change and innovation (Lipsey, Bekar and Carlaw 2005), is better understood and is measurable. However, the substantial contribution to economic and productivity growth that ICT is now understood to make has coincided, not only with the recognition of ICT as a GPT, but also with the rise of the services industry. This prompts the research question: is the substantial contribution to productivity gains that ICT is now understood to make fully explained by the acceptance of ICT as a GPT, or is the transformation from productivity paradox to productivity payoff related to the rise of the services industry.

This paper describes the transformation of ICT from backroom cost centre to bottom line contributor of significant economic and productivity growth and suggests that the rise of the services industry has had, and will continue to have, a significant role in the continued payoff for ICT. The paper presents the background and context to the ICT productivity debate before explaining the acceptance of ICT as a ‘general purpose technology’ (GPT). Australian, US and UK perspectives on the current contribution of ICT to economic and productivity growth are presented before the significant role of the services industry is discussed.

Background and context

In 1987, Robert Solow famously observed: ‘You can see the computer age everywhere but in the productivity statistics’ (Solow 1987, p36). Similar frustration is evident in statements such as ‘No, computers do not boost productivity, at least not most of the time’ (*Economist* 1990, p17) and ‘Computer Data Overload Limits Productivity Gains’ (Zachary 1991, pB1). These pithy quotes aptly sum up what had become popularly known as the ‘Productivity Paradox’, the apparent fall in white-collar productivity figures despite a massive investment in ICT through the 1970s and 1980s. In the US, the annual growth rate slowed from over 3% in the 1960s to roughly 1% in the 1990s (Dewan and Kraemer 1998). Whilst much of the productivity paradox debate has centred on the US, a similar slowdown in productivity growth has been evident in other developed countries, with their average annual growth rate slowing to 1 to 2% in the 1990s from somewhat higher levels in earlier time periods for the G-5 countries, the five largest economies in the world (Dewan and Kraemer 1998).

This outcome was counter to the perceived wisdom of the expected relationship between ICT investment and productivity increases, and led to much soul searching and many US-based research studies on the economic effects of ICT. The paradox is now considered to be largely explained and is regarded as being due to a combination of (Brynjolfsson 1993):

- (i) measurement errors in both ICT capital and outputs;
- (ii) significant time lags between investment and productivity gains;

International Technology Management Review, December 2007, v1, n1.

- (iii) management practices, and their importance in realising the full potential of technology opportunities; and
- (iv) redistribution of productivity, in that some firms gain higher productivity returns than their competitors.

Further research (Brynjolfsson and Hitt 1995; Lichtenberg 1995) has developed these lines of argument with increasing recognition that the impact of ICT use on organisational productivity is realised through the changes that occur over time in organisational systems and structures and not only directly from the implementation of ICT itself (a phenomenon known as organisational transformation (Gregor et al. 2006)). The value realisation from relatively large and time-consuming investments in ICT depends upon the extent to which organisations leverage complementary organisational investments such as organisational redesign, business process and work practice improvement, and other managerial decisions (Brynjolfsson and Hitt 2000; Murnane, Levy and Autor 1999). These complementary organisational investments lead to productivity increases by reducing costs and, more importantly, by allowing organisations to increase output quality, along with offering new products and improved customer service (Brynjolfsson and Hitt 2000).

The ICT productivity debate from the beginning of the productivity paradox through to claims of the ‘productivity surge’ (Mandel 1994) and the ‘technology payoff’ (Magnet 1994) are summarised by Brynjolfsson and Yang (1996). Whilst the later studies tend to explain the productivity paradox and demonstrate the expected relationship between ICT investment and productivity increases, in the mid 1990s the productivity payoff was by no means proven and the ‘understanding of how information technology affects productivity either at the level of the firm or for the economy as a whole is extremely limited’ (Wilson 1995).

ICT as a general purpose technology (GPT)

Traditional standard total factor productivity (TFP) measures do not adequately capture the ‘information revolution’ characteristics of ICT (Diewart and Lawrence 2004). ICT is then best measured not as a traditional capital investment, but as a ‘general purpose technology’ (GPT) (David and Wright 1999; Helpman 1998; Bresnahan and Trajtenburg 1995).

GPTs contribute substantially more than would be predicted by simple TFP economic and productivity measures because they facilitate complementary innovations (Brynjolfsson and Hitt 2000). Some twenty GPTs have been identified as contributing to periods of dramatic innovation and change since the Industrial Revolution, spread across the fields of communication, power, transport, material and organisation (Diewart and Lawrence 2004). ICT is now recognised as having similar characteristics to such past transforming GPTs and has a transformative impact on business, government and society (Gregor et al. 2006). ICT value is leveraged through upgrading not only the technology itself (Anh 2003) but also the complementary employee skills, management systems, organisational structures, and business strategies (Lipsey, Bekar and Carlaw 1998, 2005). ICT is ‘labour augmenting’ in that the productivity of workers undertaking clerical, accounting, and organisational tasks has been enormously augmented through the use of ICT (Tuomi 2004).

Transforming GPTs interact with the existing economic structure and, if the complementary redesigns of physical capital, re-skilling of human resources, and changes in management systems, organisational structures, and business strategies cause sufficient friction with that existing economic structure, then a real productivity slow down can occur (Lipsey, Bekar and Carlaw 2005). The resource costs in adopting the new GPT initially slow TFP growth (the

International Technology Management Review, December 2007, v1, n1.

ICT productivity paradox) but, as the GPT matures, its diffusion slows and TFP growth increases and there is a long-term productivity benefit (the paradox is now considered to be largely explained).

ICT's sustained contribution to economic and productivity growth as a transforming and revolutionary GPT is now accepted (Gordon 2003a, 2003b). The relationship between ICT and macro-level organisational/management innovation (including institutional and economic reform) is also recognised (OECD 2001, 2004; IMF 2001).

ICT's contribution to economic and productivity growth

Australian perspective

There were about 353,000 ICT professionals and specialists employed across all industry sectors of the Australian economy in November 2005 (DCITA 2006). The ICT industry generated incomes of \$79.9 billion in 2002/03 and exports totalling \$4.3 billion in 2004/05 (DCITA 2006). In addition, around \$2.5 billion was spent on ICT research and development in 2002/03, about 20% of total Australian research and development expenditure (DCITA 2006). In January 2006, the unemployment rate for ICT personnel was 2.4%, significantly below the national unemployment rate of 4.7% (DCITA 2006).

A recent study undertaken by the Australian Federal Government (Diewart and Lawrence 2005) has confirmed that ICT contributes more to output than its cost to producers (of other goods and services) and estimates that ICT inputs are worth around 40% more to producers in terms of marginal product than they pay for them. The study also finds that the majority (around 85 to 90%) of TFP growth (the report estimates an average of 1.85% annual growth in the expanded market of the Australian economy over the past decade) is accounted for by technical progress rather than increasing returns to scale. The report notes that a significant proportion of business research and development carried out in Australia is ICT related and that the productivity return for investment in ICT tends to be higher because of the learning-by-doing process associated with investment in modern equipment (DeLong and Summers 1991, 1992). These results are consistent with the emerging consensus among international economic organisations regarding the significant contribution of ICT to overall productivity growth of industrialised countries in recent times (DCITA 2005).

US perspective

US labour productivity boomed to 2.5% in the 1995-2005 period, more than 1 percentage point higher than at any time in the previous 20 years (Anderson and Kliesen 2006). Anderson and Kliesen (2006) make three important points regarding this growth: first, it was a surprise; second, it was driven by corporate investment in ICT; and finally, it occurred mostly in services-providing industries rather than in the goods-producing industries.

US companies using computer networks for buying and selling, logistics, operations, and other steps in the business value chain, around half the respondents to a 1999 US Computer Network Use Survey (CNUS), were shown to have improved TFP by 5% in comparison to those that do not (Atrostic and Nguyen 2002).

US owned multinational companies in the UK show an increase in productivity of 5% on doubling their ICT investment, compared to 4% for non-US owned multinational companies

International Technology Management Review, December 2007, v1, n1.

in the UK (Bloom, Sadun and van Reenen 2005). These large returns for ICT usage are found in industries that use ICT intensively (retailing, wholesaling and publishing), the same sectors that have contributed significantly to the US productivity miracle, the surge in productivity growth since the mid-1990s UK (Bloom, Sadun and van Reenen 2005).

UK perspective

Investment in ICT improves the productivity of UK businesses and is associated with significantly higher output per worker (Bloom, Sadun and van Reenen 2005) as well as contributing very significantly to labour productivity growth in the UK economy, accounting for around 20-30 % of labour productivity growth (Bakhshi and Larsen 2000).

The UK Office for National Statistics (ONS) has commissioned a number of studies into ICT productivity in recent years:

- ICT has a positive and significant correlation with productivity, with evidence of an increase of productivity of between 2% and 4 % for companies doubling their ICT investment (Sadun 2005). This is consistent with the findings of Bloom, Sadun and van Reenen (2005), who estimated increases of productivity of between 4% and 5 % on the doubling of ICT investment of UK-based multinational companies.
- In the UK economy for 2000 to 2004, the identifiable effects of ICT use on company level productivity are large and significant (Farooqui 2005), with productivity gains of between 1.5% and 2.9% (dependent on industry sector) for every additional 10% of ICT-enabled employee investment. Farooqui (2005) suggests that ICT is critical in co-ordinating and managing complex supply chains and external links, with productivity gains of between 1% and 2% from e-procurement in the manufacturing sector. The services sector shows the strongest gains but the impact of e-business is more complex and varies within detailed sectors; for example, around 4% productivity gains for distribution services (Farooqui 2005).
- e-Business integration is becoming an established practice for UK companies of all sizes and these companies are shown to be more productive than companies that do not apply ICT in this way (Goodridge and Clayton 2004). On average, companies with business processes linked electronically have higher average labour productivity than companies without such links (Goodridge and Clayton 2004), with the highest productivity levels coming from multiple linkages that include suppliers and/or customers. The survey suggests that productivity gains may be easier to achieve for larger companies, which tend to have invested earlier in e-business processes and to have already learned from this experience links (Goodridge and Clayton 2004). Also, that there is no general 'ICT productivity effect' and productivity gains are realised by companies that 'select appropriate technology, integrate the processes most relevant to their operation and implement the organisational change necessary to make it work' (Goodridge and Clayton 2004, p6). Goodridge and Clayton (2004) conclude that, in general, e-business integration does improve productivity, particularly in areas such as operation, logistics and financial systems.
- UK manufacturing companies using e-procurement showed an overall measurable positive impact on company level productivity, through value-added productivity gains associated

with electronic buying, electronic process use and market price effects including stronger price competition (Criscuolo and Waldron 2003).

Summary

ICT is demonstrating measurable and substantial impacts on economic performance and the success of individual companies, in particular, when combined with investment in skills, organisational change and innovation (Lipsey, Bekar and Carlaw 2005). Integrated ICT that links production, distribution, procurement and sales functions together with the appropriate investments in organisational and human capital produces significant gains in labour productivity (Brynjolfsson and Yang 1999). In summary, ICT is recognised as the GPT that most drives innovation (Boklin et al. 2004; Fransman 2002) and these impacts are evident in all OECD countries.

The role of the service sector

A decade ago the ICT productivity debate had progressed to largely explaining the so-called productivity paradox, but the expected relationship between ICT investment and productivity increases was still not fully proven (Wilson 1995). Acceptance of ICT as a GPT means that the contribution of ICT, when combined with the complementary investment in skills, organisational change and innovation (Lipsey, Bekar and Carlaw 2005), is better understood and is measurable. However, does this ability to better measure fully explain the substantial contribution to productivity gains that ICT is now understood to make? The transformation from productivity paradox to productivity payoff has coincided with the rise of the services industry – is this mere coincidence?

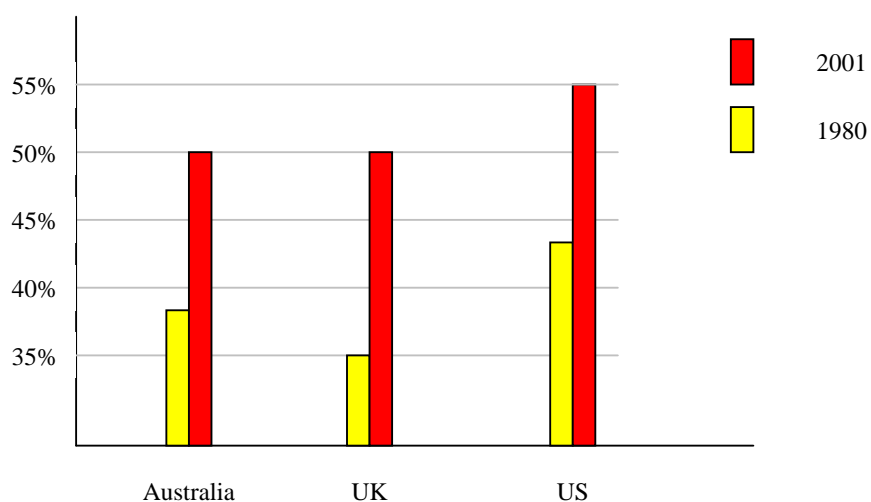
The services sector plays a significant role in all developed economies and has exhibited remarkable growth in recent decades to account for 70% to 80% of economic activity in most developed economies (Chesbrough and Spohrer 2006; Sheehan 2006). Business services such as health care, government, banking, finance and insurance, and information technology now generate more than half of all employment growth in developed countries based on share of market services in total value added (Sheehan 2006). This growth is shown graphically in Figure 1. The US Bureau of Labor Statistics (<http://www.bls.gov/opub/ooq/2005/winter/art03.pdf>) estimates that services providing jobs will grow from 110.4 million in 2004 to 129.1 million in 2014, in contrast to an estimated fall from 23.0 million to 22.9 million jobs in the goods producing industries. ICT services are significant in their own right, but ICT has also revolutionised the service sectors in general by transforming the way in which services are conducted and delivered (Bitner and Brown 2006; Rust and Mui 2006; Zysman 2006). These services are now heavily reliant on ICT for innovation and operational efficiency and ICT underpins some 75% of this sector (Lebihan 2006). The services sector is ICT savvy, ICT dependent and ICT hungry. In the services sector, increased productivity can be realised by deploying ICT at the point of customer contact to enhance the capability to meet individual customer needs (Goodridge and Clayton 2004). ICT-enabled service delivery has allowed service organisations 'to improve both profits and financial accountability by providing high quality, personalised service more easily and affordably than ever before' (Rust and Mui 2006, p49). Farooqui (2005) finds that ICT investment is used to create client and service provision knowledge bases and that productivity gains are markedly higher for the services sector than the manufacturing sector. ICT decreases the cost of service delivery and customisation as well as creating opportunities for service innovation through customer self-service (online reservations, online banking etc.) (Bitner and Brown 2006; Rust and Mui 2006). ICT has also

International Technology Management Review, December 2007, v1, n1.

enabled the developing economies such as China and India to rapidly close the gap on the developed economies (Rouse and Baba 2006), more quickly in the services industry than in manufacturing.

From the mid 1990s, productivity in the US services sector has increased sharply, while productivity in manufacturing has continued at about the same level as earlier (Anderson and Kliesen 2006). Three-quarters of the US private sector gross national product comes from companies in the services sector meaning it has a large effect on productivity for the economy as a whole (Anderson and Kliesen 2006). Service sector investment in ICT has led to increased productivity both in services and in the entire US economy (Anderson and Kliesen 2006).

Figure 1: Share and growth of market services industries



Source : extracted from Sheehan (2006, p 44)

Conclusion

Acceptance of ICT as a GPT means that the contribution of ICT to economic and productivity growth is better understood and is measurable. However, the substantial contribution to productivity gains that ICT is now understood to make is not fully explained by this change in measurement. The transformation from productivity paradox to productivity payoff has coincided with the rise of the services industry that is now heavily reliant on ICT for innovation and operational efficiency. The services sector is ICT savvy, ICT dependent and ICT hungry. The services sector has then been, and will continue to be, a significant contributor to the ICT productivity payoff – this contribution needs to be understood and factored into any assessment of the contribution that ICT makes to economic and productivity growth and should influence government thinking on ICT policy.

Also, the better understanding of ICT productivity payoff at a macro-economic level provides insights into assessing the benefits and payoff of ICT investment at an individual organisation level. Future work needs to translate the understanding of ICT as a GPT to the organisational level.

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