

5 Conclusions

This paper has brought together aggregate and sectoral growth accounting and econometric analysis of a firm-level longitudinal dataset. The main objectives have been to explore the factors affecting the uptake of ICTs in Australia and to assess the effects of ICTs on output and productivity performance at the aggregate, sectoral and firm levels. The focus has been on ICT products — chiefly, computer hardware and software. ICT services have not been included.

5.1 Main findings

The aggregate, sectoral and firm level evidence examined in this paper presents a picture of strong ICT uptake in Australia in the 1990s which, in concert with restructuring of firms and production, has brought performance gains.

Uptake of ICTs

ICT investment has been growing strongly for decades, but initially from a low base. Real IT investment grew from around 3 per cent of total market sector investment in 1989-90 to around 19 per cent in 2000-01.

Services industries featured very prominently in the uptake of ICTs, absorbing at least three-quarters of total market sector IT investment (about 10 percentage points more than their share of market sector output). The Finance & insurance sector stands out as the main area of uptake, with a 25 per cent share of investment — more than double its output share. Manufacturing has also been a major user. These two sectors were major contributors to the acceleration in market sector IT use in the 1990s (table 5.1).

The uplift in ICT use has not just been a post-1995 phenomenon. Some sectors (Finance & insurance, Communication services and Cultural & recreational services) raised their use of ICTs strongly from the second half of the 1980s. Some cyclical and one-off factors may have also contributed to the perception of a post-1995 ‘boom’. Nevertheless, there were some genuine post-1995 developments, including more rapid technological advances and price declines.

There was rapid diffusion of ICTs among firms in the 1990s to match the rapid growth in investment and use. In 1993-94, around 50 per cent of firms in a wide range of sectors used computers and around 30 per cent had Internet access. By 2000-01, these proportions had grown to nearly 85 and 70 per cent respectively. But the penetration still varies across industries (table 5.1).

The firm-level analysis in this paper has pointed to the ‘march of time’ as a significant explainer of ICT uptake and Internet access. This covers time-related factors and could include the continual decline in ICT prices, lower adjustment costs (learning) and network effects (advantages from more users joining computer networks).

The influence of other factors on ICT and Internet use varied across industry sectors. But positive relationships with firm size and skill were commonly found. The earliest and most intensive users of ICTs and the Internet tended to be large firms with skilled managers and workers. Computer use was also commonly associated with use of advanced business practices, company incorporation and firm reorganisation. There also appears to have been a link between openness to trade and the use of the Internet.

Table 5.1 **Summary statistics of ICT use, MFP growth and effects of ICT use on productivity growth**

	National accounts (1993-94 to 1990-00)			Business Use of IT (2000-01)				Effect of ICT use ^c (1994-95 to 1997-98)		
	IT growth ^a		MFP growth	Proportion of firms using				ICT alone		With complements
	Sector	Contribution to Mkt sect acceleration ^b	Sector	Computers	Internet	Web	Sector	Contribution to total	Sector	Contribution to total
	%pa	pp	%pa	%	%	%	pp	pp	pp	pp
Agriculture	27.4	0.1	3.4	-	-	-				
Mining	25.0	0.1	2.2	88	79	30				
Manufacturing	29.0	1.2	0.9	81	66	28	0.14	0.04	0.14	0.04
Electricity, gas & water	28.8	0.8	1.6	95	89	44				
Construction	23.1	0.1	1.1	80	64	10	0.04	0.00	0.18	0.02
Wholesale trade	22.2	0.0	5.2	89	77	33	0.14	0.02	0.07	0.01
Retail trade	26.2	0.2	0.4	78	57	22	0.14	0.02	0.12	0.01
Accom., etc	28.6	0.1	0.3	71	53	26	0.09	0.00	0.13	0.01
Transport & storage	19.5	-0.3	1.8	76	60	19	0.09	0.01	0.09	0.01
Communications	22.5	0.0	4.0	78	58	20				
Finance & insurance	26.8	1.7	1.2	90	81	22				
Cult. & rec. services.	26.2	0.1	-3.7	87	74	30	0.29	0.01	0.28	0.01
MARKET SECTOR	25.6	4.1	1.8	-	-	-	-	-	-	-
Prop. & bus. services				93	85	25	0.06	0.01	0.17	0.03
Health & comm.				89	72	14				
Personal services				72	52	22				
TOTAL				84	69	22	0.11	0.11	0.14	0.14

^a Annual average rates of growth in IT capital services. ^b Sector contribution to acceleration in market sector growth between the last two productivity cycles. ^c Effect on annual MFP growth from ICT use and complementary factors, evaluated at mean values.

Performance effects

The use of ICTs has contributed to Australia's growth in output and labour productivity. Growth in inputs of IT accounted for a quarter of 1990s output growth of 3.4 per cent a year and made a reasonably strong contribution of 0.4 of a percentage point to output acceleration in the 1990s. IT capital deepening accounted for a third of labour productivity growth of 3.0 per cent a year in the 1990s productivity cycle and contributed 0.4 of a percentage point to labour productivity acceleration.

However, controlling for cyclical effects, increased ICT use has not affected the overall contribution from capital inputs. Rather, the contribution of increased ICT use has been offset by slower growth in the use of other forms of capital. (This finding is a departure from other Australian and overseas studies, which have not taken account of cyclical effects and the offsetting effect of lower growth in other capital.) This also means that the rate of substitution of capital for labour has remained unchanged.

With no net effect on capital deepening, the net effect of ICT on labour productivity growth hinges on whether and to what extent it influences MFP growth. With little ICT production in Australia, there are no nationally-significant MFP gains from ICT production. Comparison with the USA suggests that the contribution to Australia's aggregate MFP growth from ICT use has been of importance, but not major — one or two tenths of a percentage point of annual average growth, up to a maximum of 0.3 of a percentage point. The firm-level analysis provides strong supporting evidence of a link between ICT use and MFP growth. Aggregation of firm-level effects across industry sectors also suggests that the aggregate MFP growth effect is around one or two tenths of a percentage point (table 5.1).

There is no simple correlation between ICT use and MFP growth across industries (table 5.1). To a large extent, this reflects the fact that non-ICT factors, including policy reform, have had independent effects on productivity performance. But it also reflects the fact that the links between ICT use and performance are complex, involving lags and the joint influence of ICTs interacting with changes in the organisation of production. Even allowing for these factors, the scope for ICT-related productivity gains may also vary across industries.

At the sectoral level, the association between ICT use and productivity growth is clearest in Finance & insurance. A somewhat weaker association appears in Wholesale trade. These findings accord with overseas evidence of links between ICT use and productivity growth in financial intermediation and distribution (and business services).

The firm-level econometric analysis in this paper has found positive links between ICT use and productivity growth in all industry sectors examined. Significant interactions between ICT use and complementary organisational variables were also found in nearly all sectors. In this study, the complementary factors for which there are data and which were found to have significant influence were: human capital, history of innovation, use of advanced business practices and intensity of organisational restructuring.

However, the strength of the links to ICTs, and the importance of complementary factors, varies across industries (table 5.1). Controlling for a range of other factors, ICTs were found to have the greatest influence on productivity growth in Cultural & recreational services. (Finance & insurance was not included in the analysis due to data limitations.) Manufacturing, Wholesale trade (without complements), Retail trade (without complements), Construction (with complements), and Property & business services (with complements) formed a middle group.

Taking relative sector size into account, ICT use in Manufacturing, Property & business services and Construction had the most effect on aggregate productivity performance (table 5.1).

The micro analysis has also highlighted dynamics and the importance of lags. Productivity growth effects in industry sectors taper over time, meaning that the ultimate productivity effect from adoption of (a type or vintage of) of ICT is a step up in levels, rather than a permanent increase in the rate of growth. Naturally, further technical developments over time can set further productivity-enhancing processes in train.

Whilst further research is needed, the finding of negative effects of complements in some industries appears consistent with there being adjustment costs in the short to medium run. In Wholesale trade, for example, there were negative interactions between ICTs and complements in the short to medium term, compared with the effects of ICTs alone. But, importantly, the interactions added to productivity growth in the longer term.

Although the aggregate evidence suggests that ICTs do not affect aggregate employment growth, the firm-level evidence suggests that the structure of employment is affected. The micro analysis has confirmed earlier research that ICT use is biased toward higher levels of skill.

5.2 Further interpretation of results

The micro analysis in this paper supports the view reached in earlier research that Australia has derived productivity gains associated with the use of ICTs. Production of ICT equipment is not necessary to access ICT-related productivity gains.

The paper also supports the general purpose technology view of ICTs — that is, that ICTs generate productivity gains by enabling restructuring, new products and new ways of producing, distributing and transacting. The firm-level analysis has found that ICTs have significant effects in their own right, but that they also have influence through their interaction with skills, restructuring and so on.

The aggregate, sectoral and firm-level perspectives give somewhat different views on the importance of ICT-related productivity effects. The aggregate view is that the effects have been reasonably modest. The sectoral view provides a plausible explanation — that ICT use and performance effects have been concentrated in a few sectors, especially Finance & insurance and Wholesale trade. The firm-level view confirms that performance effects are larger in some sectors, but also suggests that, controlling for other influences, the performance effects at the firm level are significant across the range of industry sectors.

These differences suggest that the weaker relationship at the broad level comes from aggregation — the strong positive effects in some firms and industries are counterbalanced in a given period by weaker effects in other firms and industries. The aggregate performance effects over time depend on the rate of development of ICTs, their diffusion, lags, complementary changes, adjustment costs and the productivity-enhancing potential of ICTs in different industries. In principle, the aggregate productivity effects of ICTs could increase above that found in the time periods analysed here.

There are differences in measurement and approach between the aggregate, sectoral and firm-level analyses presented in this paper. The aggregate and sectoral analysis simply accounts for growth in output and labour productivity in terms of growth in ICT use. ICT use is measured in volume terms that take account of improvements in the quality of equipment. The firm-level analysis, on the other hand, is an econometric approach that controls for the influence of many other factors on productivity growth and, in principle, can identify more precise ICT-

performance relationships. ICT use, in this case, is measured in terms of whether ICTs are used or not and the duration of use, rather than in volume terms. Even with the difference in approach, there is remarkable similarity in the aggregate productivity effects derived from both the econometric and growth accounting methods.

The firm-level analysis also helps to resolve the puzzle about the apparent lack of productivity response to ICT use in Manufacturing. Controlling for other factors, a relatively large and significant relationship between ICT use and productivity is found. In other words, the analysis suggests that the drop in Manufacturing productivity performance in the 1990s is due to factors unrelated to ICT use and associated restructuring, etc.

Whilst the analysis has supported the importance of ICTs and associated organisation and innovation variables, it has not spelt out the mechanisms through which ICTs generate productivity improvements. (The case studies undertaken for this project are intended to identify such mechanisms.) But the evidence is consistent with there being major restructuring in the economy, particularly through financial transactions and management and the distribution of goods. It is also consistent with ICTs assisting performance improvement through better coordination of production and distribution, lower transactions costs, development of new products, improved management and changes in work arrangements.

The analysis in this paper supports the view that aggregate productivity growth can be promoted by fostering the ‘smart’ use of ICTs — not just the use of ICTs but their use as part of a process of economic restructuring, organisational change and innovation in products and processes.

Use of ICTs can be fostered through ensuring access to the latest technological advances and with the full flow-through benefit of price reductions. (Australia has also enjoyed real income gains through the terms of trade effects associated with importing most of its ICT equipment requirements.) Appropriate access to reliable communications infrastructure is also likely to be important.

This paper has also pointed to the significance of management and employee skills to the uptake and use of ICTs. This has implications for education and training. The analysis suggests that decision makers require not only ICT-related skills (seeing the opportunities that ICTs provide) but the management skills to implement the necessary structural changes.

The links between ICTs and restructuring also points to the importance of flexibility. This can have wide policy implications including the reduction in unnecessary ‘process’ regulation, ensuring that product and factor markets operate as freely as possible, consistent with social and environmental objectives, and tailoring the education and training systems to meet the need for flexibility.

The main tenets of policy reforms in Australia over the past two decades are likely to have done a lot to foster the smart use of ICTs. Reforms have provided competitive incentives to take up ICTs in order to improve performance; have opened the economy to trade, investment and the transfer of technology, including access to ICTs; and have increased the flexibility of the economy to adjust. Some of these reforms will have continuing effect as they provide ongoing incentives and greater ability for businesses to review and change what they do and how they do it.