REPORT

CENTRE FOR INTERNATIONAL ECONOMICS

Breaking the skills barrier

Demonstrating the benefits of investment in ICT higher education in Australia

Prepared for

Australian Information Industry Association Ltd

Centre for International Economics
Canberra & Sydney

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Summary

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) industries now have a pervasive role in the Australian economy. All industries have benefited from growth and improvements in ICT, not least traditional industries. ICT is important because it has the capacity to facilitate complementary innovation such as new business processes and work practices. By reducing business costs, these technologies have led to productivity increases, the development of new products, and improvements in qualitative factors like timeliness, convenience, quality, and variety.

The Centre for International Economics (CIE) was commissioned by the Australian Information Industry Association (AIIA) to examine the benefits of investment in ICT higher education in Australia. In brief, the study was commissioned by the Association to:

- identify the level of direct investment (expenditure) on ICT higher education by government;
- identify the enhancement of the nation's human capital through its ICT education of university graduates; and
- identify the broader economic benefits to the national economy through the 'spillover' effects to government and industry of ICT related productivity gains, research and development activities.

Opportunities from a strong domestic ICT sector

Both directly and indirectly, the ICT industries have made a valuable contribution to Australia's prosperity. The ICT sector now contributes 4.1 per cent of total business sector value added, and has contributed 1.3 percentage points of the 4.1 per cent growth in labour productivity between 1996 and 1999 (Gruen 2001). Total income for the sector was close to $63 billion in 1998–99 and ICT employs between 200 000 and 300 000 people, depending on how the sector is defined (ABS 2000a, SA CES 2001).

In addition, the sector makes a significant *indirect* contribution, which, while more difficult to measure, is arguably far more important. The ICT revolution is changing the nature of business itself. The ICT sector's output is so widely used by other industries in the Australian economy that it has an effect on their efficiency and output. As the real cost of computers, software and communications and information fall, the benefits flow to all using industries.

ICT skills shortage is holding Australia back

This expansion in the ICT sector, both in Australia and across the globe, has driven a large increase in demand for skilled IT workers, both in terms of total numbers, and across various specialisations. However, the rapid growth of the sector has led to a shortage of skilled people to work in the industry. This shortage is constraining the contribution that the ICT sector can make to the Australian economy.

It is very difficult to obtain accurate numbers on the size of the ICT skills shortage and there is no consensus on the extent of the shortfall. However, there are widely reported estimates of a skills shortage of 45 000 ICT professionals with a university degree over the next five years, above and beyond the number of people already expected to join the industry over that period. This study has adopted a more conservative estimate of the size of the shortfall, because of various changes in the labour market and government policy in recent times. However, the skills gap is believed to be large, in the order of 27 500 ICT graduates over five years.

There are many reasons behind the skilled ICT labour shortage. These are analysed in an economywide framework, which assesses the extent to which they are associated with 'failures' or 'frictions' in the labour market. There are both demand and supply side drivers of the skills shortage.

- Australian higher education institutions face capacity constraints in providing the quantity, and in some instances, quality of graduates demanded by industry — constraints which are principally related to:
  - the public funding system to which universities are bound;
  - trends in the level of public funding; and
  - shortages in the availability of IT teaching staff.
- Industry training is inhibited by the failures and frictions in the ICT labour market, which results in firms being unable to capture and retain the benefit of their investment in training. The 'mission critical' nature of work in the industry also creates a lack of training resources,

particularly for small and medium sized businesses, which dominate the Australian ICT sector. The result is a desire to buy 'off the shelf' IT skills, evidenced by claims of an IT 'experience' shortage.

- The nature of ICT skills demand compounds these problems. Desired skill sets demanded by industry are dynamic and trends are unpredictable because they depend, in large part, on technological change and the workplace changes they precipitate.

However large, the skills shortage has led to a series of self-reinforcing problems. Rising demand for ICT professionals has led to an increase in salaries, which has drawn teaching resources out of the education sector, and tempted graduates (and those yet to graduate) into employment rather than further education. This has resulted in a lack of teaching resources, a lack of post graduate students, and less advanced academic research in the IT field. The labour shortage constrains the size of the domestic ICT sector, and with it, the direct and indirect benefits that would flow through the economy.

Assessing the impact of closing the skills gap

In assessing the impact of the shortage, this study examines what would be the *additional* impact on the output and productivity of the ICT sector and the wider economy if the skills shortage was overcome. This study simulates the effect of closing the skills gap, and traces through the direct and indirect benefits that accrue to the Australian economy — benefits currently foregone, while the gap remains.

The economywide effects of the combination of an extra 27 500 skilled workers being trained in ICT plus the small additional incremental productivity boost to other sectors are as follows.

- A rise in GDP of 0.9 per cent over and above what might otherwise be the case, amounting to an extra $5 310 million annually once the effects of the extra skilled workers and small productivity boost work through. The net present value (NPV) of the additional increase in annual GDP is estimated to be $32 350 million over fifteen years, or over 40 times the net present value of the cost of funding the additional tertiary places.
- The extra GDP and extra returns to capital available as a result of a more productive economy encourages additional investment in the economy which is 1.3 per cent higher than would otherwise be the case.

- Aggregate exports rise with Australia becoming slightly more competitive as a result of the extra productivity boost from an expanded ICT sector. Exports are $1460 million higher than otherwise.
- Aggregate employment rises with the increase in GDP and activity in the economy. Overall, there is a 3.2 per cent increase in ICT personnel which is a direct result of the extra training of 27 500 personnel, as simulated.
- For the government accounts, there is an initial cost from the extra training of students, but as the economy grows, there is extra revenue collected. Extra *net* revenue of $990 million a year is possible, over and above the additional expenditure to train the ICT people. The NPV of the additional revenue from growth is $6010 million, that is over seven times the NPV of the cost of training the extra 27 500 skilled workers.

There are three critical variables affecting these results. First, there is the size of the skills shortage in ICT. Second, there is the extra productivity boost that could be expected throughout the rest of the economy. A third factor is that the results also crucially depend on what is the baseline or counter-factual — that is, what would happen in the absence of addressing the skills shortage through policy.

The assumption implicit in these results is that the ICT sector and the economy will grow at the same rate as has been the case over the last five years. But, as highlighted in the Victorian study (Multimedia Victoria and Trinitas Pty Ltd 2000), if the ICT sector continues to be constrained by a lack of suitably trained people, the correct baseline may be one where Australia's economy does not grow or even declines. Some ICT firms are relocating part of their work offshore. Assuming a steady, rather than declining baseline, and using a modest estimate of the size of the skills shortfall, our representation of the gains from addressing the shortfall are on the conservative side.

Policy implications

While the investment in higher education for IT skills gives rise to public (community-wide) and private (individual) benefits, there are good reasons to believe that the number of IT graduates will only increase if the number of places subsidised under the Higher Education Contributions Scheme are increased. However, this alone will not deliver the results from this modelling work. The constraints facing universities and TAFE extend beyond funding for places, and include severe teacher shortages, and the inadequacy of the current process of allocating funds among faculties.

There is also a role for government to facilitate industry investment in training and the movement of people (by career transitioning and retraining) into IT through changes to the taxation system. For those looking to move into the IT field, the inability to offset the costs of retraining through the tax system is a disincentive to moving into IT. Retraining costs are not insignificant (between $8000 and $41 000), but the rules for self-education expense deductions clearly state that expenses can only be claimed when they relate to *current* not potential work activities.

There may be scope to facilitate the requisite change in industry mindset through the provision of tax credits for training. In some way, government policy could be just the catalyst needed to engender a training culture into the ICT industry.

In addressing the size of the potential pool of ICT labour, there may also be a role for government, working with industry, to improve the image of ICT professionals through programs delivered to primary and high school age children. Increasing the pool of students interested in entering the ICT profession is an important component of addressing the ICT skills shortfall.

The range of issues that need to be confronted to address the ICT skills shortfall fall into three categories with obvious areas of overlap:

- changes within the tertiary institutions;
- changes in the industry itself; and
- changes in government funding incentives and stimulus, and policy.

All need to be confronted if the Australian community is going to benefit in the way it should from the further development of the ICT industry in Australia.

1 Background

ICT NOW PLAYS a pervasive role throughout the Australian economy. Spurred by the growth of the Internet and e-commerce, ICT has changed the nature of work, and in many cases, leisure. The direct and indirect benefits of the ICT sector to the economy are significant, stimulating economic activity and improving the population's quality of life.

ICT labour is a critical input to the ICT sector. Globally, IT skills are becoming short in supply. Competition for staff has led to rising salaries and the development of software industries in countries with low labour costs. The emergence of e-commerce exacerbates shortages, particularly since the integration of business and technology demands workers who are able to combine both disciplines. Education — both quantity and quality — is a key determinant of IT labour supply.

This research by the Centre for International Economics (CIE) was commissioned by the Australian Information Industry Association (AIIA) to examine the benefits of investment in ICT higher education in Australia. In brief, this research was commissioned by the Association to:

- identify the level of direct investment (expenditure) on ICT higher education by Government;
- identify the enhancement of the nation's human capital through its ICT education of university graduates; and
- identify the broader economic benefits to the national economy through the 'spillover' effects to government and industry of ICT related productivity gains, research and development activities.

The ultimate aim of the study is to provide a measure of the impact of stemming the skills shortage in IT. The terms of reference for the study are outlined in appendix A. In meeting these goals, this study examines the importance of the ICT sector to the economy, and focuses on some key issues relevant to the addressing the ICT skills shortage, including the following.

- Why has a skilled labour shortage emerged, and what is the role of the market and of government in the IT labour market?
- How can the skilled labour shortage be measured and what is its size and scope?
- What are the effects of the current skills shortfall on the IT industry and on economic growth?
- What are the direct and indirect benefits from an economywide perspective of addressing the shortfall?
- What is the capacity of higher education institutions to alleviate this shortfall, both under current funding arrangements and more broadly?
- What are the key principles for achieving a policy framework that best improves ICT competencies, and what funding is required?

The AIIA is the peak national body representing suppliers of information and communications technology goods and services. AIIA has over 370 member companies that generate combined revenues of more than $40 billion, employ over 100 000 Australians and have exports of over $2 billion. The Association believes that Australia requires a world class national education system to enable the Australian industry to be internationally competitive.

Economic, social and community structures, particularly in developed countries, are being transformed by the innovations of the world's ICT industries. These innovations now play a major role in the strong growth, productivity and competitiveness of the Australian economy. As businesses and governments increasingly embrace ICT, the prosperity of nations is increasingly determined by the effective use and regulation of ICT products and services. Indeed, virtually all industry sectors are achieving higher growth and productivity through the enabling property of the technological innovations of the ICT industry. Nations should ensure the development of the information industries, and ensure they are innovative, competitive and capable of delivering national productivity and growth.

One way of getting more innovation is through skilled people. Skilled people are the most important component of the ICT industry as they provide the genesis, implementation, and support for the technology. However, Australia lacks sufficient numbers of people with ICT skills. The capacity of Australian education and training systems to supply skilled people to the ICT industry and to its customers is crucial to the ongoing economic and social development of Australia. The danger is that Australia will not it perform to its full potential with an ICT industry hampered by a constrained higher education system.

As the peak body for the ICT industry, the Association is working with federal and state governments on achieving a skilled workforce needed by the ICT industry through continued emphasis on ICT knowledge and skills, development at all levels of the education system — secondary, tertiary, vocational, and the workplace.

A recent survey of ICT industry associations around the world confirmed that the skilled labour shortage is a major problem, and acts as a brake on company's ability to develop e-commerce markets. Twenty-five per cent of the associations indicated that the shortage of skilled workers, regardless of levels of compensation, is the single most significant workforce barrier to future growth. Forty-two per cent believe that the state of the workforce will 'strongly' affect growth of e-commerce (WITSA 2000, p. 21).

The framework for this study

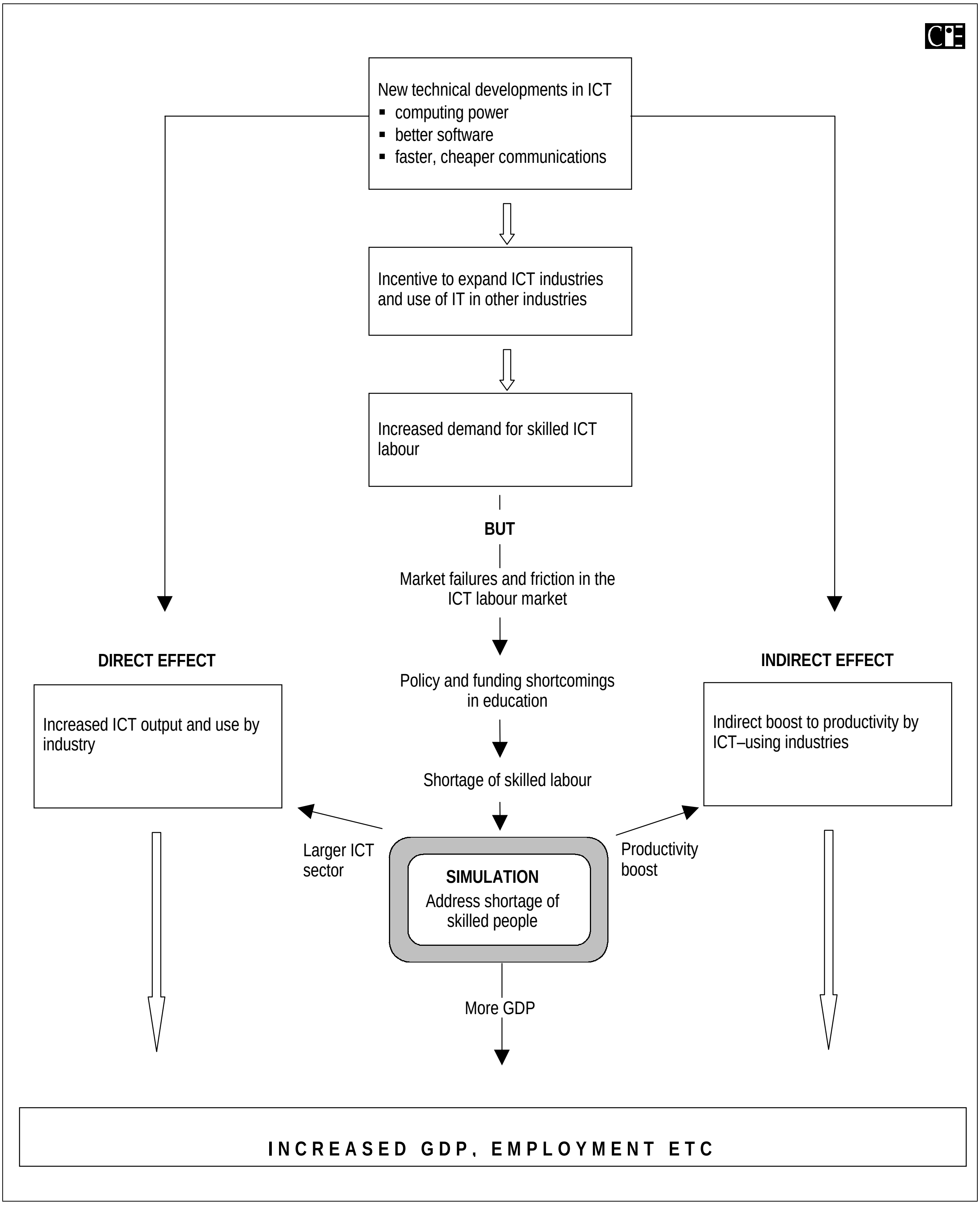
The ICT sector has expanded enormously, both in Australia and across the world. This expansion has driven a large increase in demand for skilled IT workers, both in quantity, and across various specialisations. There are currently important obstacles which prevent the demand signals from the ICT industry translating into additional supply of skilled workers. Obstacles include labour supply constraints and/or reflect the dynamic nature of labour demand in the ICT industry.

The question for this study is, if the skilled labour shortage in IT graduates is eased, what would be the *additional* impact on the output and productivity of the ICT sector and the wider economy? For modelling purposes, this study focuses on the university sector. This study is not a statistical exercise principally about estimating the *size* of the skilled labour shortfall. Rather it is a modelling exercise which seeks to measure the impact of expanding the IT skills base. The framework for this study is illustrated in chart 1.1.

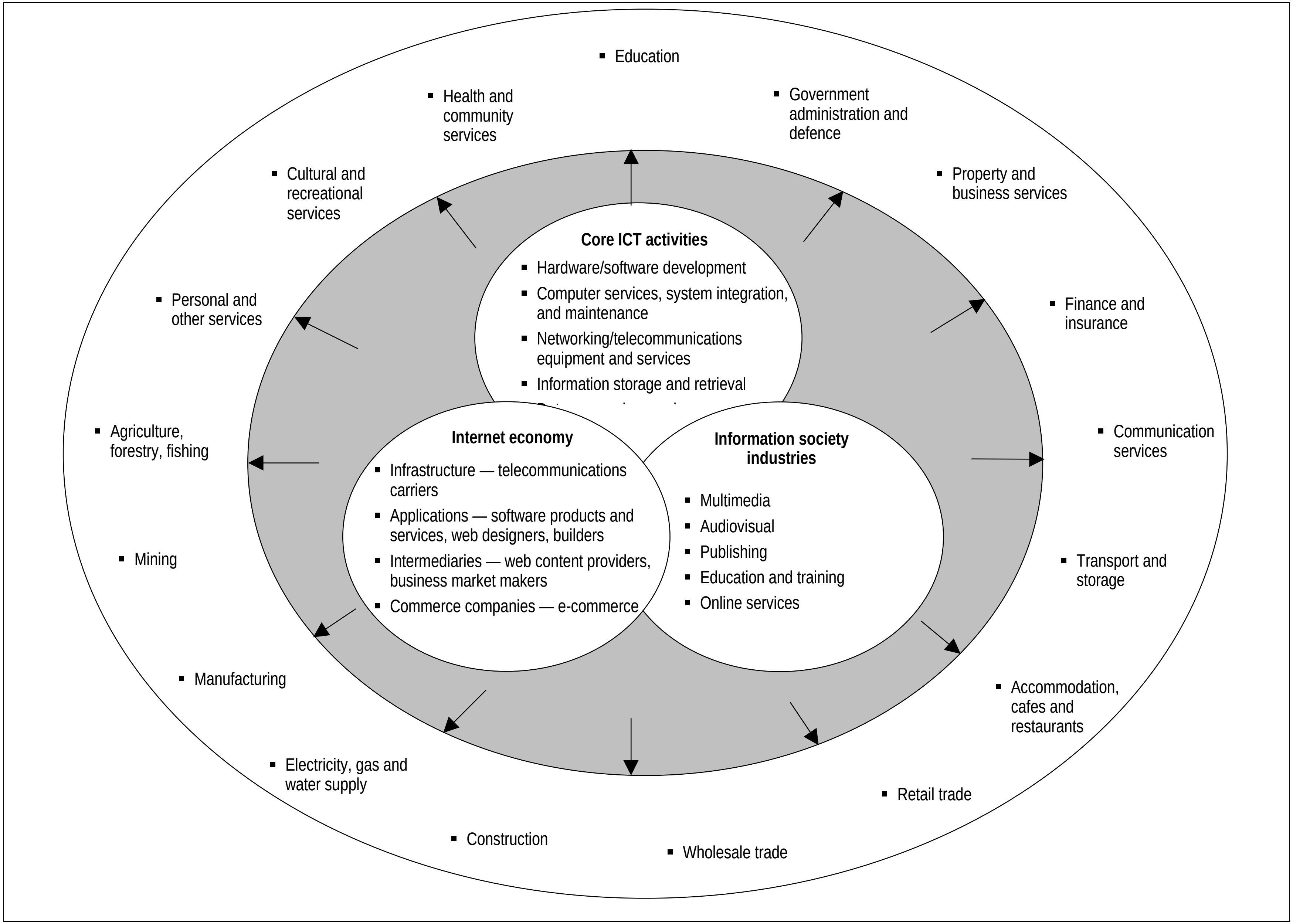
What is the ICT sector?

ICT is no longer a discrete industry sector. There is a core set of ICT industries, comprising computer services and maintenance, software and hardware development, telecommunications, information storage and retrieval, and data processing. In concert with activities that comprise the Internet Economy and 'information society' industries, ICT has become diffused throughout all other industry sectors (see chart 1.2).

1.1 Framework for this review



1.2 Links between ICT and other activities



Growth in the Internet in particular has accelerated the wide diffusion of ICT through the development of applications such as the World Wide Web and Internet browser. These technologies link the existing capital stock of computers and communications systems in an open network that significantly increases their use.

All industries benefit from ICT

All industries benefit from growth and improvements in ICT, not least traditional industries. Scientific and technological developments have always been key drivers of economic performance around the world, and the ability to create, distribute information and exploit knowledge, is a source of competitive advantage. As a result, the ICT industry is playing a more prominent role in the economy and society. ICT is important to sectors that process information, like financial services, as well as for areas such as logistics because it makes more efficient transport possible.

ICT investments have greater flow on benefits that other investments, therefore *improvements* in ICT have a beneficial ripple effect through the economy. ICT are described as ‘general purpose technologies’ rather than a traditional capital investment. This means their economic contribution is far higher than would be predicted by multiplying the quantity of capital investment devoted to it by a normal rate of return. ICT enables productivity improvements in services, such as transport, communications, wholesale and retail trade, and finance and business services. Sectors such as communication and transport are now more technology-intensive than many manufacturing industries.

ICT is particularly valuable to the economy because it facilitates complementary innovation. It enables complementary organisational investments, such as business processes and work practices. For instance, due to problems coordinating external suppliers, large firms previously often produced required inputs in-house. Yet technologies such as electronic data exchange, Internet based procurement systems, and other inter-organisational information systems have significantly reduced the cost, time and other difficulties of interacting with suppliers. They have led to productivity increases by reducing costs, and enabled firms to increase output quality in the form of:

- new products; and/or
- improvements in intangible aspects of existing products like timeliness, convenience, quality, and variety (Brynjolfsson and Hitt 2000, p. 24).

It is no surprise that ICT is the technology area with the highest rate of innovation as measured by patents. Of the overall growth in patents granted by the US Patent and Trademark Office from 1992 to 1999, ICT accounted for 31 per cent, rising 15 per cent annually (OECD 2000b, p. 7). Brynjolfsson and Yang (1997) found that IT capital is disproportionately associated with intangible 'assets' like costs of developing new software, populating a database, implementing a new business process, acquiring more skilled staff, or undergoing a major organisational transformation (in Brynjolfsson and Hitt 2000, p. 34). The economywide benefits of ICT cannot be understated.

- ICT transforms firms, facilitating more flexible management practices and organisational structures.
- ICT changes interactions with suppliers, enabling better coordination of external suppliers and facilitating supply chain integration.
- ICT changes customer relationships, improving customer service and support, facilitating built-to-order production systems and just-in-time inventory management.
- ICT lowers transactions and other business costs, further facilitating the above relationships, and enhancing firm, and economywide, productivity.
- ICT also speeds up the innovation process, reducing cycle times, and increasing the efficiency of science (such as enabling computer simulations to provide faster test results).

Size of the ICT sector

The ICT sector is a major generator of jobs and output internationally. For the OECD group of economies alone:

- 12.8 million persons are employed in ICT (35 per cent in the US);
- the ICT sector generated US$1191 billion in value added in 1997; and
- value added per ICT worker within the OECD ranges from US$135 000 per person, down to less than US$40 000. Value added per person in Australia is just over US$70 000 (OECD 2000a, pp. 12–20).

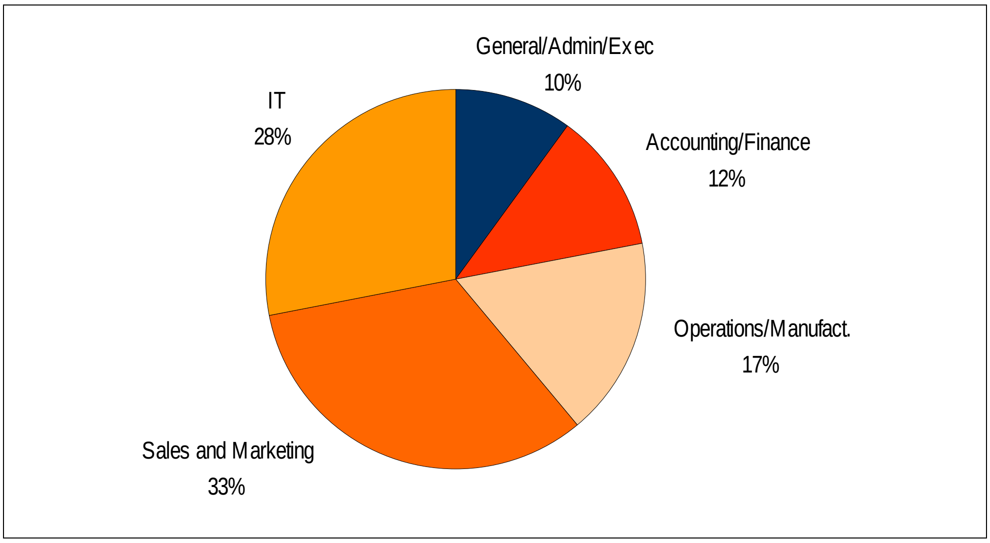
ICT goods and services are heavily traded. Global expenditure on ICT imports amounts to $1.45 trillion annually. World ICT spending was over US$2 trillion in 1999, with the global industry expected to double in size from 1992 to 2002, from US$1.3 trillion to over US$2.4 trillion. Australia remains on the top ten list of ICT spenders in 1999 (WITSA 2000, pp. 1–3).

The global Internet economy itself is said to have produced US$830 billion in revenues in 2000, a 58 per cent rise over 1999 and up from US$323 billion in 1998. The Internet economy is considerably larger than ‘dot com’ companies, whose revenue comprises just 9.3 per cent of the total Internet economy, and who employ just 12.1 per cent of Internet employees (Cisco, University of Texas 2001, pp. 3–4). Supporting the Internet economy are:

- over 932 000 people in infrastructure, with quarterly revenue per employee of up to US$80 000, generating US$142.8 billion in revenues in the first half of 2000;
- over 740 000 people in applications infrastructure with quarterly revenue per employee of $52 500, generating US$72.8 billion in revenues in the first half of 2000;
- almost 500 000 people in intermediary companies (such as web content providers), with quarterly revenue per employee of $78 300, generating US$64 billion in profits in the first half of 2000; and
- over 1 million people in Internet commerce companies, with quarterly revenue per employee of just under $65 000, generating US$127 billion in revenues in the first half of 2000.

The Internet economy is producing jobs across various fields. Seven out of every 10 jobs in the Internet economy are traditional, rather than high-tech, jobs (chart 1.3). Of all Internet-related jobs, only 28 per cent are in IT, which ranks below sales and marketing as the job function generating Internet-related employment (Cisco and University of Texas 2001, pp. 1–17).

1.3 **Composition of Internet-related jobs**



[a] Based on US-based Internet companies.

Data source: Cisco and University of Texas 2001, p. 4.

The Australian ICT sector

The Australian ICT sector is relatively small, but like others, its economic contribution is very large. Total income for the sector was close to $63 billion in 1998-99, an increase of 28 per cent over 1995-96 (ABS 2000a). There around 200 000 people employed in the ICT sector, around half of which are in ICT professions (ABS 2000a). Outside the sector, there are another 200 000 ICT professionals and para-professions employed.

By world standards, Australians are intensive ICT users. Australia ranks sixth in the world in terms of the total number of Internet users, despite its relatively small population. Over 35 per cent of the Australian population is ‘on-line’, comparable to the share of the US online population, where the number of Internet users is almost sixfold higher than in any other country in the world (CIA 2000 and ABS 2000b). In terms of e-commerce, the number of secure servers in Australia is double the OECD average and is just above average in terms of the number of Internet hosts, when weighted by the number of inhabitants. The number of on-line buyers as a per cent of working age population is 6.4, second only to the US out of all OECD countries (OECD 2000e, pp. 5 and 9). ICT comprises 4.1 per cent of total business sector value added, and its share of total employment is 2.6 per cent, compared to an OECD average of 7.4 and 3.6 per cent respectively (OECD 2000a, p. 39).

Australia is not a big ICT producer. Unlike other OECD countries, value added in the ICT sector is dominated by a few large telecommunications companies (comprising 55 per cent of value added in the sector, double that of most OECD countries) with relatively small manufacturing capacity (table 1.4). This is reflected in the large trade deficit in ICT of US$7 billion (chart 1.5), attributable to trade in *goods* only, due to the dependence on manufactured imports to meet domestic demand. Modest manufacturing capacity does not reflect the input of ICT to productivity growth. ICT investment in Australia has risen considerably, particularly in real terms, due to the fall in prices for computers and related equipment. In nominal terms, investment in IT has risen from around 1.2 per cent of GDP in 1984-85 to 3 per cent in 1999-2000. In real terms, investment has risen from around 0.1 per cent to 3.5 per cent of GDP over the period (Gruen 2001, p. 7).

Australian R&D intensity (expenditure as a percent of value added) in ICT is more than 6 times as large as for the economy as a whole. Manufacturing ICT is particularly R&D intensive, more so than telecommunications and ICT services. Almost 50 per cent of value added is spent on R&D, compared to 3 to 4 per cent for total manufacturing (OECD 2000a, p. 39).

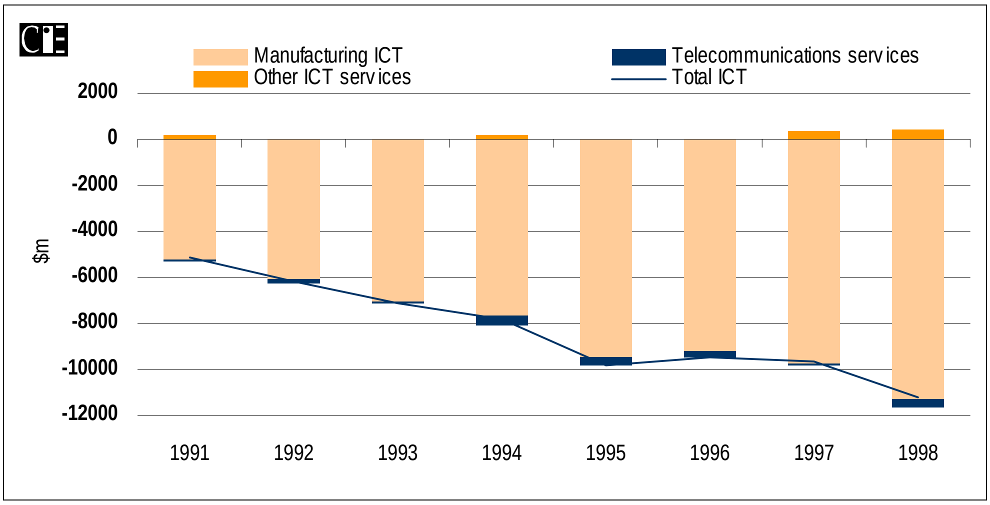
1.4 **The ICT sector in Australia** 1998–99

	Unit	*Manufac-turing ICT*	*Telecom-munications*	*Other ICT services*	*Total ICT*
Number of enterprises	No.	268	931	17 270	18 469
	%	1.5	5.0	93.5	100
Employment	No.	10 014	74 910	110 656	195 580
	%	5.1	38.3	56.6	100
Production	A$m	3 178	26 160	30 083	59 421
Value added	A$m	632	10 396	7 764	18 792
Capital expenditure[a]	A$m	-	5 412	-	-
Wages and salaries	A$m	459	3 701	5 681	9 841
R&D	A$m	330	189	417	936
Imports	A$m	14 445	1 493	388	16 326
Exports	A$m	3 193	1 291	600	5 084

[a] 1997 instead of 1998-99. [b] Using PPPs, except exchange rates for trade data. Trade data relate to the 1998 year.

Source: OECD 2000a (Measuring the ICT Sector), p. 41.

1.5 **Australian balance of trade in ICT** 1991–1998



Source: OECD 2000a (Measuring the ICT Sector), p. 41.

Recent work by the OECD ranks member countries according to their ICT ‘intensity’, which measures the relative importance of the ICT sector to the total business sector. ‘Scores’ comprise data on employment, value added, R&D and trade in ICT. Australia has been ranked in the ‘low ICT intensity’ group. West European and Scandinavian countries are typically ‘medium intensity’ countries. ‘High intensity’ countries include the US, UK, Korea, Sweden, Ireland, Hungary and Finland. Australia attracted a ‘medium’ OECD ranking for its R&D intensity in ICT (OECD 2000a, p. 31).

The ICT sector makes a large contribution to the Australian economy, but the rapid growth of the sector has led to a shortage of skilled people, constraining the contribution the ICT sector can make to the Australian economy. Why this shortage of skilled workers has arisen is discussed next.

2 Why the short fall?

THERE ARE SEVERAL REASONS behind the skilled ICT labour shortage in Australia and around the world. Most are associated, in one way or another, with 'failures' or 'frictions' in the labour market. Market failure can occur when signals, such as wages, are not adequately transmitted or are insufficient to generate adequate labour supply. Market friction can occur when signals are transmitted too slowly to be effective. If the ICT labour market functioned correctly, any skills shortage would be temporary and self-correcting. That is, an increase in demand would, in the short term, be accompanied by an increase in wages, which would attract more labour, alleviating the shortage and returning wages to their 'market rate'.

For a range of reasons, wages alone are unable to redress the imbalance between ICT labour supply and demand. The labour market is characterised by a range of supply constraints. These are worsened by the dynamic nature of ICT (changing areas of specialisation and requirements for emerging skills), creating a problem of lags in satisfying industry demand.

Defining the skills shortage problem

Commonly reported drivers of the skills shortage in ICT include:

- insufficient supply capacity at universities and TAFE, including a shortfall of student places, teaching staff and overall funding levels;
- apparent falls in public funding for education more broadly, and a relative fall in public tertiary funding per student;
- higher salaries (particularly given exchange rate effects) and more opportunities overseas those with advanced research skills;
- the expansion of ICT functions through the Internet, multi-media and e-commerce, in conjunction with more frequent use of computers and telecommunications, increasing demand for ICT professionals;
- some reluctance on the part of companies to train people internally because they are unable to capture the benefits of that training, given the skills shortage encourages a footloose culture among ICT people;

- limits on migration into Australia;
- negative perceptions of the ICT profession, acting as a deterrent to market entry for groups such as young women in particular; and
- the pace of change in ICT, and the virtuous cycle of skill demands.

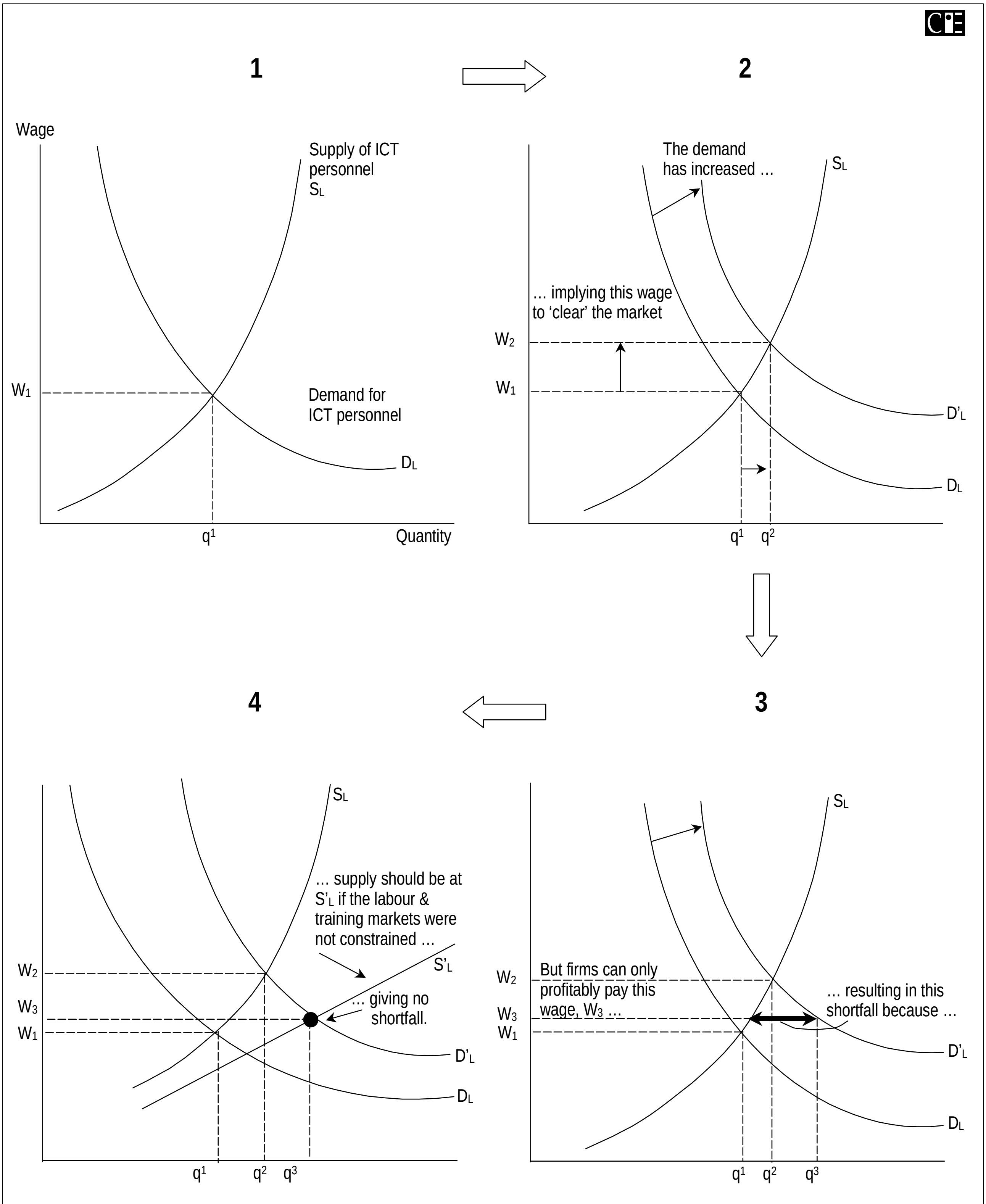
These factors can be interpreted in an economic framework to see how and why the skilled labour shortage exists in the ICT labour market. Chart 2.1 shows the supply (S_L) and demand (D_L) for skilled labour in ICT in panel 1 with a wage of W_1 and quantity of people employed of q^1. Through productivity and new technology in ICT, the demand for labour has shifted upwards to D'_L. However the labour supply curve, S_L, is quite steep, which means that the supply of labour in this industry is not particularly responsive to wages — a relatively large wage increase results in a proportionately smaller increase in labour supply.

The reasons why the supply curve is steep (why the incremental supply of more labour is relatively expensive) include the reality that:

- higher education institutions are slow to respond to market signals which might suggest more and / or different types of labour is required;
- ICT faculties are constrained by inadequate levels of funding, largely as a result (albeit indirectly) of the commonwealth RFM;
- sufficient numbers of young people are not attracted to the industry;
- there are administrative barriers to migration, many of which are not trivial, limiting the migration of ICT (and other) professionals to Australia; and
- Australians are attracted to the US where exchange rate effects favour US-dollar based salaries, bidding wages up, and so on.

Chart 2.1 is consistent with the recent of experience of the ICT labour market in Australia. The demand for labour has increased (from D_L to D'_L in panel 2); the number of additional people which have responded to that demand is quite small (from q^1 to q^2); and the wages required to attract them is very steep at W_2. Faced with having to pay much higher wages, anecdotal evidence presented to this review suggests firms have become reluctant to offer continually higher wages to fill vacancies, partly because suitable candidates are simply not available. To attempt to pay even more would make the firm unprofitable and cause it to relocate its activity offshore. Firms make a choice to compromise total output or perhaps do not expand into new product lines, with adverse flow-on effects to the other industries which use ICT. Firms pay wages of W_3 and there is a shortfall as shown on panel 3 of chart 2.1.

2.1 Changes in the labour market for ICT professions



Source: Centre for International Economics.

The point made by the ICT sector is that the supply curve for ICT workers is unnecessarily too steep and artificially constrained in Australia. If the labour market worked ‘properly’ and constraints on training were lifted, the supply of skilled ICT workers would be more responsive to changes in demand. The supply curve for labour would be flatter — more like S'_L in panel 4 of chart 2.1. If this were the case there would be no shortfall. Just what these constraints on labour supply are is discussed next.

The role of universities in (restricting) ICT labour supply

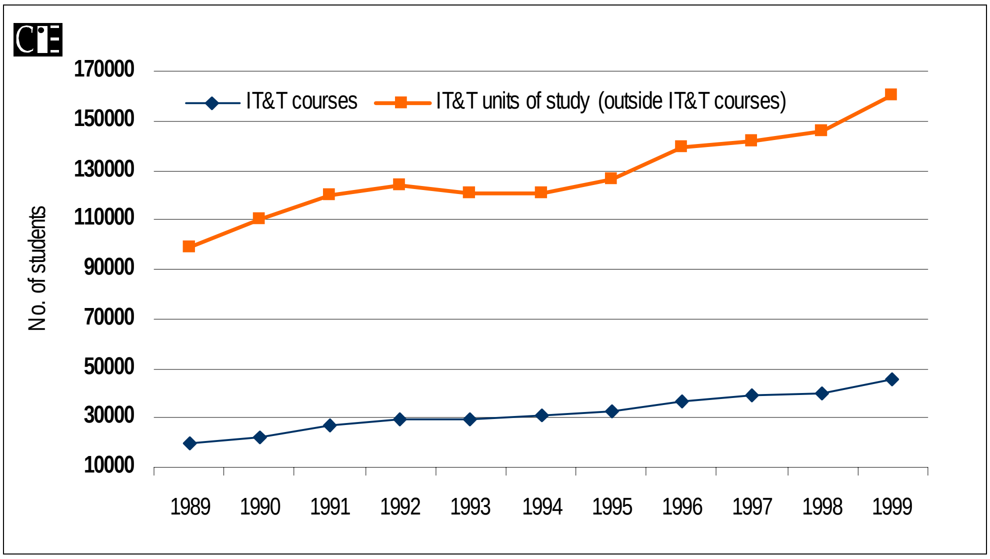
The past decade has seen strong growth in tertiary participation rates in Australia and around the world. Between 1980 and 1997, participation in Australian university, college and technical training more than tripled, from 324 000 to 1 042 000 (NCES 2000, p. 453). Enrolments in Australian universities alone rose over 20 per cent between 1992 and 1999, with per annum growth averaging just under 3 per cent (see table 2.2). The growth in enrolments in ICT has been even more dramatic, both in IT&T courses and IT&T units of study (chart 2.3). Student enrolments in ICT courses has risen 8.5 per cent per annum over the past decade, and enrolments in IT&T units of study have risen almost 5 per cent each year over the period.

2.2 **Number of students enrolled in tertiary education in Australia,** 1992–99

	1992	***1995***	***1999***	***1992–99***
				% change p.a.
Number of students	559 381	604 176	686 267	2.96

Source: DETYA 2001b.

2.3 **Enrolments in IT&T courses and units of study**



Data source: DETYA Higher Education Division, University Statistics 2000, unpublished.

However, university *completions* continue to fall well short of industry demand. Over the past 10 years, completions in higher education in IT&T courses have grown at an annual rate of 12.6 per cent, but still only reached 8700 students in 1999 — well short of industry demand, as discussed later. These completions include graduates of Computer Science, Computer Science, Information Systems (General), Computer Science, Information Systems (Other), Information Systems, and Electronic Engineering and Computer Engineering (DETYA unpublished).

Much of the growth has also been from international students, most of whom do not remain in Australia (either because they have not been permitted to stay or choose not to stay). Growth in completions by local students has been just over 9 per cent per annum (6000 students in 1999), but has averaged over 30 per cent per annum for overseas students.

Universities are a major supplier of ICT skills, with 47 per cent of computing professionals having a bachelor's degree or higher qualification (DETYA 2000b, p. 8). However, the capacity of universities to increase their output of ICT graduates is limited by current funding arrangements and resource shortages.

International comparisons of public spending on education

The adequacy of funding for educational institutions is the subject of much debate. Public funding of educational institutions is currently below the OECD average. As a proportion of total public spending, the level of funding for education is above the OECD average (table 2.4), however as a per cent of GDP, funding is certainly lower. In 1997 (latest available intern-ational data), public funding to educational institutions was 4.3 per cent of GDP, compared to an OECD average of 5.1 per cent. Public and private funding as a proportion of GDP is also below the OECD average (table 2.5).

2.4 **Public *education* expenditure as a percent of total expenditure** 1997

Countries		*Tertiary*	*Average across all education levels*
Australia	%	3.9	13.1
Canada	%	4.8	13.6
Ireland	%	3.1	13.5
Japan	%	1.2	9.8
Korea	%	1.4	17.5
United States	%	3.6	14.4
OECD average	%	2.7	12.6

Source: OECD 2000c, p. 161.

2.5 **Government and private funding for educational institutions** % of GDP

OECD country	*Source of funds*			
	Government only		Government and private	
	1990	1997	1990	1997
Australia	4.3	4.3	4.9	5.6
Canada	5.4	5.4	5.7	6.5
Japan	3.6	3.6	4.7	4.8
United Kingdom	4.3	4.6	-	-
United States	5.3	5.2	-	6.9
OECD average	4.8	5.1	5.2	6.8

Source: OECD 2000d, table B1.1a.

Tertiary spending fares better

Although public funding for all levels of education in Australia is below the OECD average, public funding for *tertiary* education — the focus of this study — is more in line with OECD trends. Direct public expenditure for tertiary education was 1 per cent of GDP, right on the average level for OECD countries. Private funding, as a proportion of GDP, was comfortably above the OECD average, but somewhat below very high private funding levels of countries such as the United States (table 2.6).

While Australia appears to be an 'average' performer in terms of public tertiary funding, relative to its own previous levels of funding, there have been changes. In absolute terms, public spending on tertiary education rose slightly from 1992/93-1997/98 and has remained relatively constant as a proportion of total outlays (table 2.7). However, these increases have not kept pace with rising tertiary participation, and funding per student has fallen, despite comparing favourably with other OECD countries (table 2.8). In recent years, the value of Commonwealth grants per student has fallen, whether we consider the grants as being paid to *all* tertiary students or only those students whose positions are government funded (ie. the non-fee paying students, table 2.9).

2.6 **Tertiary education funding** 1997

Country	*Government funding*	*Private funding*	*Total funding*[a]
	% GDP	%GDP	% GDP
Australia	1.0	0.53	1.7
Canada	1.2	0.35	2.0
France	1.0	0.14	1.2
Germany	1.0	0.08	1.1
Japan	0.5	0.58	1.1
United Kingdom	0.7	0.12	1.0
United States	1.4	1.29	2.7
OECD average	1.0	0.31	1.3

[a] Total funding includes public subsidies to households other than for student living costs.

Source: OECD 2000d, table B1.1c.

2.7 **Federal Government total outlays on tertiary education** 1992/3-1997/8

		1992–93	1993–94	1994–95	1995–96	1996–97	1997–98
Tertiary							
▪ University	$m	4 037	4 336	4 628	4 793	4 725	4 665
▪ Technical and further	$m	788	855	967	1 036	1 198	1 187
▪ Tertiary n.e.c.	$m	12	17	27	63	82	79
▪ Total tertiary	$m	4 837	5 208	5 622	5 892	6 005	5 931
Proportion of total outlays on education	%	7.7	7.9	8.0	7.7	7.7	8.0

Source: Australian Bureau of Statistics 1999.

2.8 **Total expenditure on tertiary institutions per student** 1997

Country	US$
Australia	11 572
Canada	12 217
France	6 569
Germany	9 001
Japan	9 337
United Kingdom	7 225
United States	19 965
OECD average	8 781

Source: OECD 2000c, p. 159.

2.9 **Commonwealth expenditure on higher education per student,** 1993-1998

	1993	***1994***	***1995***	***1996***	***1997***	***1998***
	$	$	$	$	$	$
Commonwealth government grants per student	6 285	7 066	7 144	7 200	6 711	6 394
Commonwealth government grants per non-fee paying student	6 929	7 993	8 137	8 571	7 989	7 788
HECS payments per HECS liable student	1 859	1 858	1 885	1 920	2 387	2 921
Total government funding per EFTSU	13 012	13 313	13 352	13 474	13 431	13 542

Source: DETYA 2001b and DETYA 1999.

Looking at Commonwealth funding per Equivalent Full Time Student Unit, measured by the Department of Employment, Training and Youth Affairs (DETYA), total funding appears to have increased slightly over the period. This is largely because this funding measure includes grants *and* HECS payments to universities. Since 1996 there has been a considerable increase in HECS payments per student in line with changes to increase the contribution of students towards the cost of higher education. The fall in direct Commonwealth grants to universities has been offset by this increase such that total funding appears relatively stable. The changing balance between private and public funding for tertiary education is shown in table 2.10.

2.10 **Source of funds for higher education**

	1993	*1995*	*1997*	*1998*
	%	%	%	%
Commonwealth government grants	56	57.2	53.8	50.8
State government income	4.3	1.4	1.1	1.1
HECS	13	12	14.7	17.2
Fee paying overseas students	5.2	5.8	7.6	8.3
Fee paying post graduate students	0.6	1.0	1.4	1.8

Source DETYA 2001b.

In 1993, public funding (commonwealth and state) accounted for 61.3 per cent of tertiary revenues compared to 51.9 per cent in 1998. Throughout this period private payments (HECS, overseas fee paying student fees and fees from local post graduate students) accounted for a noticeably growing share of revenues. All other sources of revenue remained relatively stable over the period.

Determining the level of funding for Australian universities

Current commonwealth funding for higher education is in the order of $5.7 billion (table 2.11). Institutions receive the majority of their funding in a single block operating grant from the commonwealth government, which is allocated according to ‘the Relative Funding Model (RFM)’ (box 2.12). The RFM attempts to link the level of funding to the costs incurred by each institution in the provision of higher education.

In a recent survey of universities, most were sceptical about their ability to increase HECS funded student places at all under current funding arrangements. There may be some scope to increase places for fee-paying overseas students, but not HECS students. ICT faculties report they have exhausted the potential for efficiency gains as a means of increasing student places. Transferring places from other faculties to ICT is not financially viable, partly because the funding ratio for ICT places under the RFM is too low to adequately cover the true cost of student places. More than half also reported that they have reached physical capacity limits of existing buildings, computer laboratories and teaching space, acting as a barrier to increasing university places (SA CES 2001, pp. 26 and 116–117).

2.11 **Commonwealth funding available for higher education** 1996–2002

Type of grant	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
	$m	$m	$m	$m	$m	$m	$m
Total operating grants	4 920	5 012	4 921	5 127	5 270	5 288	5 285
Total research programs	386	415	443	441	452	449	417
Total higher education	5 357	5 466	5 403	5 569	5 724	5 739	5 704

Source: DETYA 2000a and DETYA 1996.

2.12 **The relative funding model (RFM) for Australian universities**

The RFM was established in 1989 to promote consistency between the funding received by each institution. In essence, the model aims to link the level of funding to the costs incurred by each institution in the provision of higher education. Operating funding is provided to institutions to cover general teaching and research functions and is allocated on a formula-related basis. Institutions are funded for a target student load.

The original estimates were based on the costs involved in providing the variety of courses that can be found at any one higher education facility. Clusters of similar cost courses were established on the basis of the discipline and the level at which that discipline was being studied. Each cluster was given a ‘weighting’ or measure of the costs of providing such a course by comparison to the lowest cost courses available. Once weightings were allocated, costs for every course were approximated using the estimated cost of the base or least expensive course. The model established the mix of disciplines and the level at which these disciplines were studied at each institution as well as the total load target for each institution in terms of equivalent full-time student units (EFSTU).

The application of the RFM was a one-off equalisation measure to determine the relative level of funding to be received by each institution. The funding received in any year is essentially based on the grant received in the previous year with adjustments made for growth in an institution’s student numbers. The process for allocating funds *within* an institution is subject to an internal process of distribution, and is not *directly* influenced by the Commonwealth. However in practice, there are important indirect effects on the way in which universities allocate their funding among faculties.

ICT teacher scarcity as a barrier to increasing graduate supply

The shortage of ICT teachers in universities and TAFEs is a barrier to increasing the supply of ICT graduates, particularly in the short term. The teacher shortage is attributable to several factors, not least of which are the income disparities between teachers and industry practitioners (partly related to limited practical teacher training), and the reduced quality of life of the academic as work loads and class sizes increase to unsustainable levels. Australian teacher salaries, both at the entry level and at the maximum pay scale, are below the average for the OECD (table 2.13). Teachers also reach the top of the pay scale after twelve years, compared to an OECD average of twenty-five years, leaving little incentive for senior teachers to remain in the teaching profession.

The teacher shortage is evidenced by the increase in student/staff ratios at universities, which have almost doubled over past fours years for which data is available, and are around five times the average for all subject unit groups (table 2.14). The increase is a result of rising student numbers, declining staff numbers, and insufficient funding per student for ICT under the RFM. Anecdotal evidence from the TAFE sector suggests they too experience the same staffing problems as the university sector in ICT.

2.13 **Annual teachers' salaries in public institutions, upper secondary level**
US dollar equivalent 1996

OECD Countries	*Starting salary, minimum level of training*	*Salary after 15 years, minimum level of training*	*Salary at the top scale, maximum qualifications*	*Years from starting to top salary*
	US$	US$	US$	Years
Australia	19 166	34 897	34 897	12
France	22 125	28 949	39 218	32
Germany	32 992	41 081	47 503	20
Ireland	23 809	37 154	41 889	23
Korea	23 960	42 597	67 448	41
New Zealand	14 730	23 965	23 965	8
United Kingdom	19 262	29 948	29 948	8
United States	23 815	33 953	41 615	30
OECD Average	20 527	29 114	35 627	25

Source: OECD 2000c, p. 166.

2.14 **Student staff ratios in Australian universities by unit group**

Subject area	*Student numbers*		*Staff numbers*		*Student staff ratio*	
	1994	1998	1994	1998	1994	1998
Mathematics, computing	34 850	39 206	3 924.7	3 166.1	8.9	12.4
Computer science	24 679	34 586	912.1	671.8	27.1	51.5
Electrical, electronic, computer and communications engineering	10 461	11 478	1 496.3	1 006.1	7.0	11.4
Total IT&T specific courses	35 140	46 064	2 408.4	1 677.9	14.6	27.5
All academic organisational unit groups	453 309	524 091	55 508.9	48 899.5	8.2	10.7

Source: SA Centre for Economic Studies 2001, p. 121.

Unmet student demand for ICT tertiary and TAFE education

Contributing to the shortfall of graduates is the existence of unmet *student* demand for places at Australian universities and TAFE. The trend in demand for places in ICT university courses, measured by applications, has been growing at a faster rate than offers of places. A recent survey found annual unmet *student* demand is now greater than 11 000 for university and TAFE places. The survey measured unmet demand for places at university and VET institutes in IT&T specific courses from students who were considered by the faculty to be capable of taking the course. It found that:

- for tertiary places, unmet demand is 3400-3700 persons (over 30 percent of current enrolments), or assuming that all students applying for IT&T courses at 'Group 1' or large metropolitan universities found places at other institutions, *adjusted* unmet demand is between 2200 and 2300 persons; and
- for VET places, there is unmet demand of almost 9000 persons, or 10 per cent of current enrolments (SA CES 2001, pp. 100-103).

The demand for student places casts doubt on the capacity of universities and TAFE to respond to the skills shortage in ICT. The study found that the principal barrier to entry to ICT education for those interested is the availability of places. Because of demand for places and pressures on teaching staff, several universities specifically commented that they had reduced school visits and more general publicity exercises for ICT courses because 'why increase demand when you cannot satisfy it' (SA CES 2001, p. 56).

Failures in 'benefit capture' for industry-based upskilling

The scope for an industry solution to the skills shortage is limited to some extent by the 'non excludability' nature of training. This means when a firm invests in training/upskilling of their employees, they are limited in the extent to which they can capture the benefits of their investment because of the mobility of labour. This acts as a disincentive to invest in training.

Anecdotal evidence suggests firms are concerned about other firms 'free riding' on their training investment, particularly by the small and medium sized enterprises who are more reluctant to pay for the up-skilling of staff. And there are few remaining tax incentives that offset these problems. Larger firms such as IBM and Unisys *do run* extensive in-house training programs to upskill employees. In terms of private sponsorship of ICT research and development outside any one firm, there are selected examples of larger firms assuming responsibility for improving competencies across the market. For instance, Ericsson Australia spends around $3 million per annum on its sponsorship of post-graduate research.

The free rider problem with regard to training and staff development is widespread, and not limited to the ICT sector. It is part of the reason why governments, through their funding of universities, become involved in the up-skilling of the population in the first instance. However, it is likely that this type of 'market failure' is accentuated by other factors that limit the supply of ICT skills, increasing difficulties in retaining staff. Industry interviews suggest that the average tenure for an IT person in a single firm is 18 months to 2 years. There are several reasons for such a high turnover rate, such as the ability to earn a wage premium during the transition to another position, and perceptions within the industry that short stints are the norm and staying too long with the one company reduces employability.

At the end of the day, the skills shortage issue is about increasing the stock of skilled labour. Constraints on companies' ability to buy in additional skills is an obstacle to growth in employment and output in the ICT sector. How big this shortfall is in the stock of labour is discussed next.

3 How big and how urgent a shortfall?

AN IMPORTANT TASK for this study is to measure the impact on the economy of overcoming the shortage in ICT labour supply, which requires some estimation of the size of the supply gap. For modelling purposes, the size of the tertiary *graduate* skills gap has been examined.

The pace of industry growth drives ICT labour demand

Some studies have looked to indicators such as strong employment and salaries growth, and low vacancy rates as *indicative* of the shortage. The ICT industry in Australia has seen impressive jobs growth for some time. Jobs for ICT managers, computing professionals and support technicians (the bulk of ICT employment) has increased by over an average of 8 per cent a year since the late 1980s. A breakdown of growth for various professions is shown in table 3.1. Looking forward, even stronger growth is expected, around 9 per cent a year up to 2004 (chart 3.2). As mentioned previously, the growth in ICT graduates falls well short of expected growth in ICT jobs.

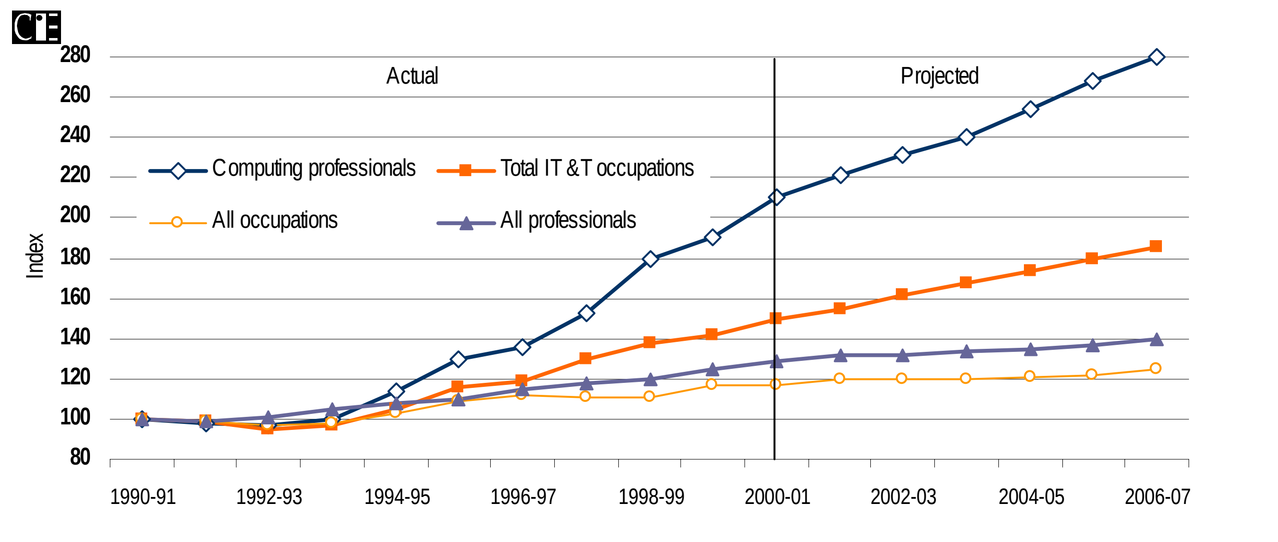
There has also been rapid salary growth, reflecting labour scarcity. Graduate starting salaries for ICT fields ranked fourth highest out of 23 fields in 2000, estimated at $37 000 by the Graduate Careers Council of Australia survey (GCCA 2000). And all universities experience higher attrition rates of students as they are lured into employment prior to graduation.

3.1 **Recent growth in ICT employment in Australia**

	Average annual employment growth		
ICT profession	1987–1990	1991–1995	1996–2000
Information Technology Managers	3.8	-1.8	11.8
Computing Professionals	15.4	5.3	8.4
Computing Support Technicians	8.2	5.8	3.1
Total	13.0	4.9	7.9

Source: Trended data from the ABS Labour Force Survey.

3.2 **Real and projected employment growth for computing, IT and other professionals**



Data source: Centre for Policy Studies, Monash University, in DETYA 2000b, p. 4.

Migration accommodates part of the surge in labour demand

Migration is an important source of skilled ICT workers. A significant benefit of migration, compared to education, is that workers arriving from overseas will already have the necessary skills to begin productive work. And these skills are the result of some other country having had to devote their resources to training skilled people. The current net gain from migration is approximately 1500 computer professionals per annum (BCA 2001, p. 27). Over the next five years, net migration could have amounted to a net inflow of 7500 ICT employees. However, recent initiatives by the commonwealth government specifically aimed at attracting more ICT workers to Australia (box 3.3) suggest this figure can be revised upwards.

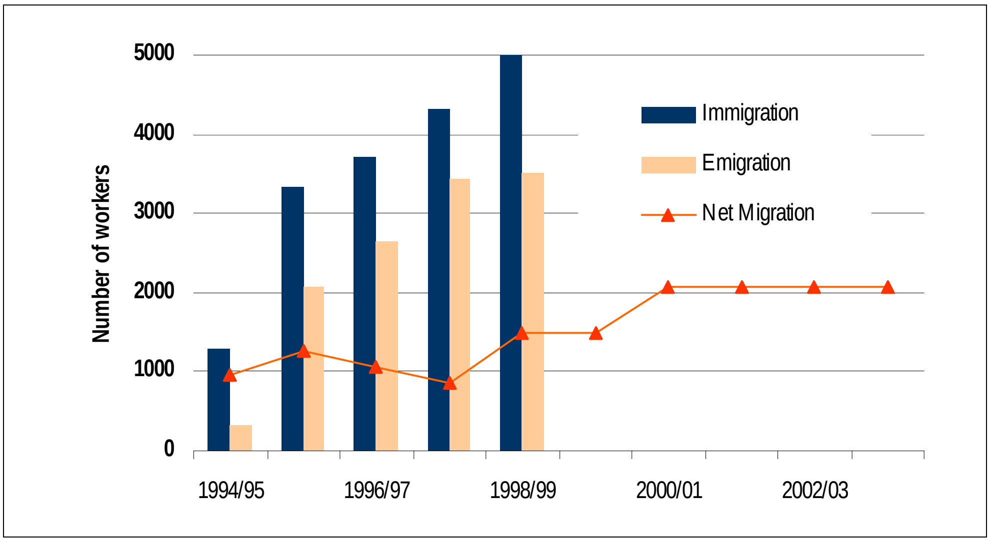
3.3 **Backing Australia's Ability: Summary of new migration initiatives**

There will be at least 2 500 places over and above the 76 000 places announced in the Migration Program for 2000/01 to be allocated to ICT professionals who have been trained in Australia. From July 2001, overseas students who have received their ICT degree from an Australian university can apply for a permanent visa without leaving Australia. All immigration decision-makers are to give processing priority to ICT professionals who apply under the Temporary Business (Long Stay) visa and the Skilled Stream of the Migration Program. ICT jobs will be recognised as 'key' positions, removing the need for employers to test the market before nominating overseas workers for long-term temporary entry.

Source: Commonwealth Government 2001, Backing Australia's Ability Fact Sheet 2001

One estimate suggests that of a projected 21 000 completions by ICT students from abroad over the period 2000 to 2004, the new measures will encourage 15 per cent to apply for residency (SA CES 2001, p. 26). The federal government has indicated that the initiative will result in at least 2500 extra places for ICT professionals. An average of the two suggests the new migration program will attract 2825 ICT workers or 565 employees per annum. Adding this to the existing level of net migration, expected gains from migration are 2065 workers per annum, as shown in chart 3.4.

3.4 **Actual and forecast net migration of ICT professionals**



Data source: SA CES 2001 and Commonwealth Government 2001.

Estimates on the size of the ICT labour shortfall

There are a range of studies which try to estimate the *size* of the ICT skills shortage in Australia and worldwide:

- estimates for the United States suggest there are currently between 200 000 to 722 000 unfilled jobs in the ICT industry, expected to climb to between 850 000 and 1 million jobs over the next few years (SA CES 2001, p. 10; ITAA 1999, p. 5);
- in Germany, there are 75 000 unfilled ICT jobs, and plans are in place to implement a US entry visa system for up to 30 000 foreign ICT workers (SA CES 2001, p. 10); and
- in Australia, estimates vary, with upper bound estimates for the current shortfall of around 60 000 people (Cisco and University of Texas 2001), potentially rising to up to 200 000 (Wilson 1999 in SA CES 2001).

There is no doubt that an ICT skills shortage exists. How large it is in Australia depends on definitional issues.

- Is the shortage the amount of skilled people demanded at the market wage, or a lower wage?
- Do estimates subtract *all* sources of supply including migration?
- Are estimates 'recent' in that they take into account recent policy changes that might affect various sources of labour supply?
- Were estimates of the shortage inflated by the world-wide boom in the ICT sector over the late 1990s?

Deriving a relevant measure of the ICT skilled labour shortage in Australia

Various estimates on the size of the skills gap in Australia are summarised in table 3.5. Most recent available estimate of the size of the *graduate* shortage was undertaken by the IT&T Skills Task Force in 1999, reiterated in the Business Council of Australia (BCA) study in 2001. This research suggests that the current level of unfilled demand is for 31 500 people, of which 45 per cent require a university degree or equivalent (over 14 000). Over five years, the number of required tertiary graduates is expected to rise to 90 000. In addition to this, the study estimated that another 90 000 TAFE qualified graduates would be required over five years, however the modelling exercise at hand has been confined to the university sector.

The sources of supply of ICT graduates include graduates from ICT courses or from other fields entering ICT, migration, and graduates from private

3.5 **Indicators of the size of the skills shortage in Australia**

Indicator	*Source*	*Current*	*Expected*
Vacancies in IT in Australia	Cisco Systems Australia (reported in AFR 12/01/01))	30 000–60 000	N/a
Shortfall in skilled IT employees	Wilson Consulting (1999) in SA Centre for Economic Studies, 2001	N/a	200 000 in 2002
Industry demand for those with university qualifications	IT&T Industry Task Force, 1999 in DETYA 2000, p. 8	14 200	89 000 in 2004
Industry demand for those with VET or equivalent qualifications	IT&T Industry Task Force, 1999 in DETYA 2000, p. 8	9 800	56 600
Industry demand for those with no formal IT qualifications	IT&T Industry Task Force, 1999 in DETYA 2000, p. 8	7 500	34 600
Shortfall in industry requirements for tertiary IT graduates	BCA 2001, p. 25		45 000 in 5 years
	DETYA[a] 2000, p. 9	4 000 per annum	2 000 per annum in 2003–2004

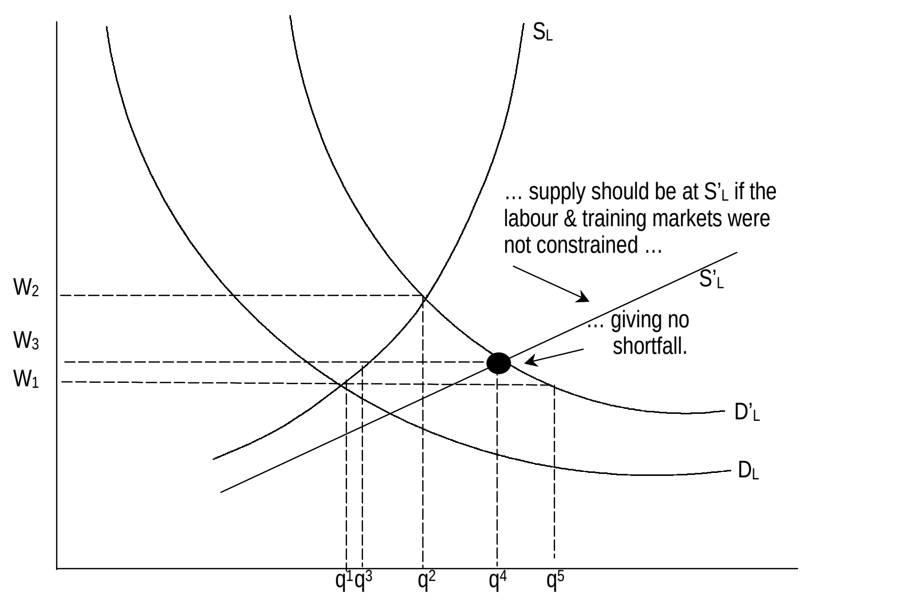
[a] Assumes industry demand in first year is the same as demand in outer years.

courses. DETYA estimate that taken together, these sources supply around 10 000 professionals a year (DETYA 2000b, p. 9). This is comparable to BCA estimates, which suggest Australia will produce 40 000 ICT graduates over the next five years, based on current enrolment projections. On this basis, the shortfall in graduate numbers appears to be 40 000 to 50 000. To address the 'gap', the BCA have called for 45 000 additional tertiary places to be created over five years (Boston Consulting Group for the BCA 2001, p. 25).

To assess the appropriateness of this estimate, it is useful to return to our economic framework of the ICT labour market developed in chapter 2. We have seen that the demand for ICT labour has increased from D_L to D'_L, as shown again in chart 3.6. Without an increase in the supply of ICT labour, the only available labour is at the higher wage W_2, which may be prohibitive to firm profitability. If the labour supply is like S_L, paying wages of W_2 only secures the amount of labour shown at q^2.

But what is the size of the labour shortfall? The perception among industry is that the size of the gap is the amount of people that are not available at the wage they have become accustomed to paying, which is shown as W_1 on chart 3.6. The gap is perceived as the quantity between q^1 and q^5, which would also include those people who cannot be employed even at a higher wage because they simply cannot be found. This might be as a result of migration restrictions or other supply constraints in the market.

3.6 **The 'true' size of the ICT labour shortfall**



However, this is likely to overstate the gap. Some firms *are* able to secure labour at a higher price, and are willing to do so. And it is unrealistic to expect that the supply of ICT labour will ever be unresponsive to wages (perfectly elastic or horizontal at an historical wage), which is implied by the larger supply gap mentioned above. For many reasons there will always be some limits to labour supply, either because of migration restrictions, secular upward movements in wages in *other* sectors, physical limits to the expansion of graduates, and so on.

But labour supply can rise, and the supply curve can become more responsive to changes in wages as frictions and constraints in the labour market (such as migration policy) and the training system (such as limits on tertiary places) are removed. This is shown by the new supply curve, shown as S'_L in chart 3.6. A closer estimate of the size of the labour supply gap is then between the quantities of labour shown as q^3 and q^4 on chart 3.6. Moving the supply curve to S'_L would close this gap, giving no shortfall.

Demand for ICT labour is expected to keep rising as e-commerce becomes more pervasive, and the diffusion of technology through society continues. The size of this anticipated supply gap is probably around 27 500 people over five years, less than the original estimate of 45 000 due to:

- anecdotal evidence that demand has softened in the aftermath of the bursting of the ‘dotcom bubble’, and as the business cycle in Australia and the US starts to turn (box 3.7);
- recent migration trends, and the prospect of additional migration as a result of recent changes to migration regulations, which when combined result in a net inflow of over 10 000 IT professionals over the next 5 years; and
- recent announcements by the federal government to fund additional ICT tertiary student places (estimated to be around 1000 places each year, for five years). In total, the initiative announced an additional 2000 university places a year over five years, rising to nearly 5500 a year as students continue through the system (or 21 000 equivalent full time student places), with priority given to ICT, mathematics and science.

Table 3.8 shows the derivation of the 27 500 skills gap from the base case of 45 000.

3.7 The Nasdaq Boom and Bust

The skills shortage in ICT industries is a worldwide phenomenon, As the ICT sector has boomed, so too has the demand for jobs. But the Nasdaq — the US tech stock index — has tumbled to 60 per cent of its peak a year ago. And it looks like this fall in stockmarket value is badly affecting economic growth. Observers speculate whether the US and the Australian economies are in recession and the extent to which this is related to the scaling back of growth expectations for the Internet economy.

How has the fall in the Nasdaq and economic slowdown affected the skills shortage and the likely productivity affect from the ICT sector? A slowing economy does reduce the demand for new investment and hence skilled ICT workers. This has been allowed for in our more modest estimate of the ICT skilled shortage — for the reasons discussed in the text we use 27 500 as opposed to the widely quoted 45 000 shortage. And yes, the Nasdaq downturn has affected equity raisings and investment in new technology. But there are two important qualifications here. The new technology economy is real, and firms are still pushing ahead with e-commerce and redesigning workplaces. Also, the projection period we use is 5 years — a period well in excess of any short-term downturn. As stated in responses from participants in this study, the skills shortage and productivity effect from the ICT industry are a long-term phenomenon, notwithstanding the Nasdaq boom and bust.

3.8 Estimation of the likely size of the ICT labour shortfall

Indicator	***People affected***	***Remaining shortage***
Published industry estimate of ICT labour supply shortfall	45 000	45 000
Softening in demand as a result of the bursting of the dot.com bubble and slowdown in wider economic activity @ 5 per cent of base-case	2 250	42 750
Expected net migration without recent policy change	7 500	35 250
Additional net migration as a result of initiatives announced in Backing Australia's Ability (estimated)	2 750	32 500
Additional undergraduate places funded as a result of initiatives announced in Backing Australia's Ability (estimated)	5 000	27 500

Source: CIE estimates.

4 Direct and indirect benefits of meeting the skills shortfall

Direct benefits

The ICT industry makes a valuable contribution to Australia's prosperity. It does so in two ways. First, the ICT industry makes a direct contribution through its own production, employment and productivity growth. The ICT sector now contributes 4.1 per cent of total business sector value added, and the sector has contributed 1.3 percentage points of the 4.1 per cent growth in labour productivity between 1996 and 1999 (Gruen 2001).

Indirect benefits

The second contribution the ICT sector makes to the Australian economy is far more important. It comes from the indirect effects the sector has on the economy. The ICT sector's output is so widely used by other industries in the Australian economy that it has an effect on their efficiency and output. As the real cost of computers, software and communications fall, there is a beneficial flow-on effect to using industries.

In addition, the nature of ICT output has an even more powerful indirect influence but one that is more subtle to see. The ICT revolution is changing the nature of business itself. Computers, e-commerce, and the internet are all transforming the way business is conducted. Business management and customer relationships are all being changed to more efficient methods in much the same way that the introduction of electric motors allowed workflows in manufacturing plants to be redesigned, giving dramatic gains to productivity (David 1990).

The size of this indirect effect of the ICT sector on economywide growth outside the sector has been the subject of extensive investigation. Initially, the advent of the computer age in the late 1980s led to the information technology 'productivity paradox' summed up in well known remark by Robert Solow in 1987: 'You can see the computer age everywhere except in the productivity statistics' (Solow 1987). Since then, substantial work has shown why this paradox arose. Problems with measuring prices and quality improvements that are not captured in outputs plus lags between investment and effect all explain the apparent absence in the early data of the real impact of the ICT revolution.

The debate about measuring the impact of the ICT industry on the economy more broadly can be technical and will not be joined here. What matters is that both macroeconomic studies and firm level studies confirm the finding that the ICT industry has had a large impact on economic growth, and this impact is likely to grow further in coming years (Brynjolfsson and Hitt 2000). Case studies and econometric work lead to the conclusion that 'computers have made a much larger real contribution to the economy than previously believed' (Brynjolfsson and Hitt 2000).

The line of logic is as follows. The ICT industries make a large direct and indirect contribution to the performance of the Australian economy. The larger the skills base in the ICT industry, the higher the uptake of information technology, the faster will be the growth of the economy. But the lack of skilled workers is limiting the size of the sector and therefore constraining the growth of the economy. The comprehensive economywide model discussed in the next chapter captures many of the direct and indirect effects of expanding the ICT sector by addressing the skills shortage (see chart 4.1). But one of the indirect effects — namely the economywide productivity boosting effects of ICT are not automatically captured by the 'off-the-shelf' model used in this study.

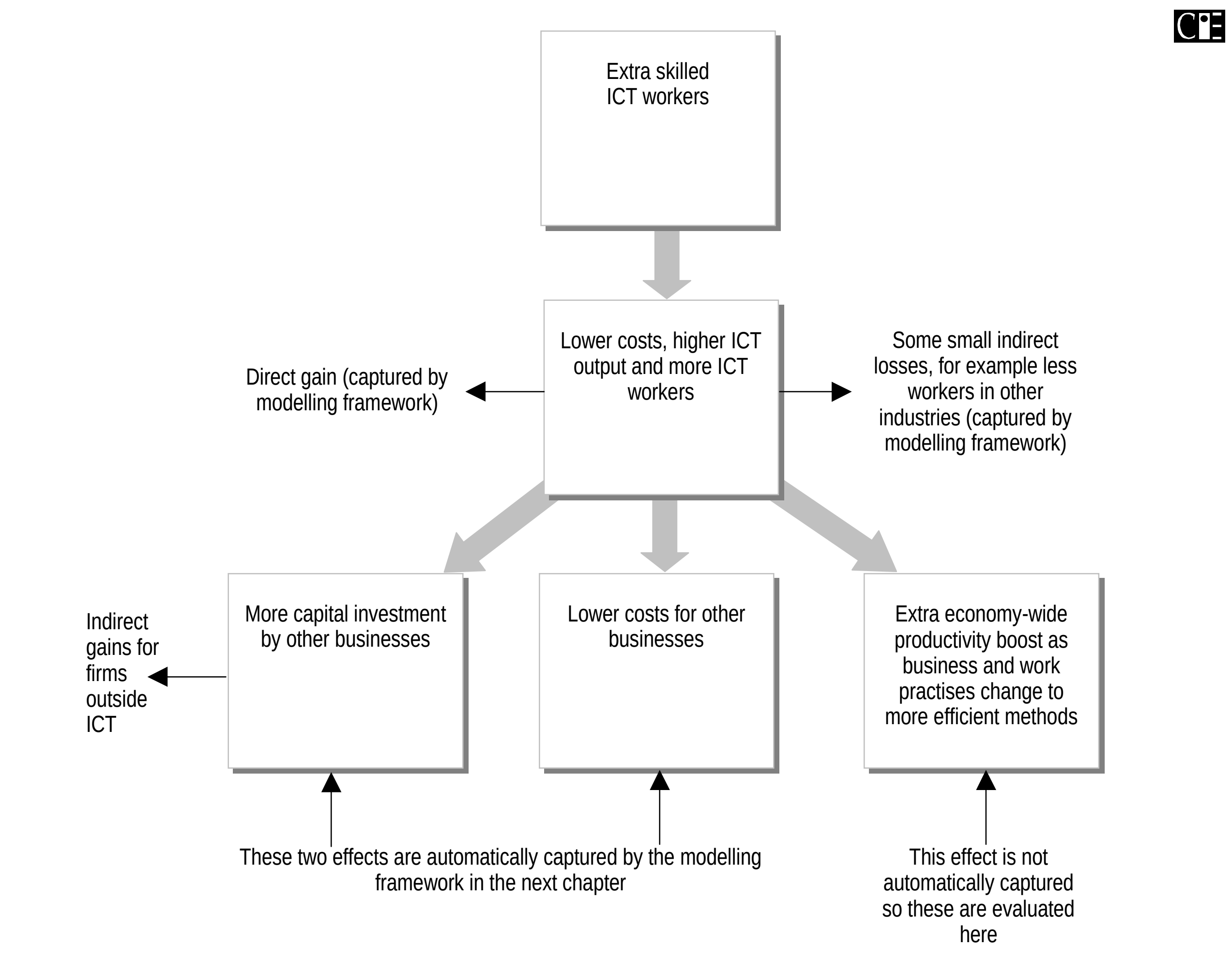
In this section we turn to measuring just how big a boost to productivity in the economy more generally might result from policies and actions to ease the skills shortage identified in the previous section.

Productivity growth due to the US 'new economy'

Most of the work on the productivity boosting effect of ICT has been undertaken in the United States. The United States, like Australia, has witnessed a major boost in productivity since 1996. This major productivity boost has had major implications for the two economies. It has led to a high growth, low inflationary environment where unemployment has fallen — so much so the Chairman of the Federal Reserve, Allan Greenspan, popularised the phrase 'new economy'.

The increase in labour productivity since 1996 in both the United States and Australia is shown in chart 4.2.

4.1 **Direct and indirect affects of addressing the skilled worker shortage**



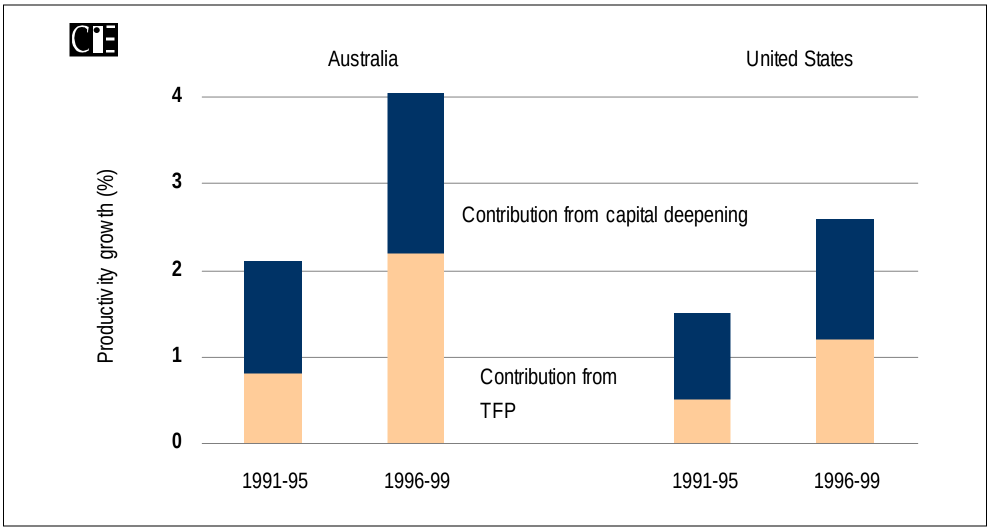
Source: CIE.

Labour productivity growth in Australia has been much higher than in the United States since 1996. It has grown over 4 per cent per annum in Australia compared to nearly 2.7 per cent in the United States.

The productivity spurt can be broken down into the contribution from capital deepening and that from total factor productivity growth (TFP). Capital deepening arises from more investment in equipment, which lifts labour productivity because each worker has more equipment to work with. TFP arises from 'working smarter' — producing more output with a given amount of equipment. In technical terms:

Growth in labour productivity = Share of capital in income x Capital deepening growth + TFP growth

4.2 **Labour productivity growth**



Data source: Wilson 2000.

As Wilson (2000) notes, 'Since continued investment without improvements in efficiency sooner or later leads to falling marginal returns, TFP growth is critical to long-run growth in labour productivity — and so in living standards'.

We now know that a lot of this productivity spurt can be accounted for by the ICT revolution. The micro studies cited by Brynjolfsson and Hitt (2000) in particular support the line of causality that information technology causes substantial increases in output and productivity. Indeed, Brynjolfsson and Hitt note that ICT may be disproportionately associated with intangible assets like new software. They note that it could be that for every $1 of ICT capital, the typical firm has accumulated $9 of additional intangible assets.

The breakdown in labour productivity growth for the US and Australia is shown in table 4.3. The enormous investments in hardware and software can be seen and ICT investments in Australia are growing at rates comparable to the United States. The interesting figure in table 4.3 is that 2.2 percentage points of the 4.1 per cent growth in annual labour productivity since 1996 has come from total factor productivity.

Measuring labour productivity and estimating the contribution from ICT has not been without it critics. Most notable is Robert Gordon (2000) who finds that the 'new economy' has created an explosion of productivity growth but confined to the manufacturing durables sector. The difference between Gordon's estimates and those of Oliner and Sichel (the latter of which are shown in table 4.3) is that Gordon focuses on *trend* productivity growth while Oliner and Sichel explain developments in *actual* productivity growth (Oliner and Sichel 2000).

4.3 **Contribution of IT to labour productivity growth**

	Australia		*United States*	
	1991-95	1996-99	1991-95	1996-99
	%	%	%	%
Annual labour productivity growth	2.1	4.1	1.5	2.6
Contributions from				
▪ Information technology (capital deepening)	0.9	1.3	0.5	1.0
▪ Other capital (capital deepening)	0.4	0.6	0.1	0.1
▪ Labour quality	na	na	0.4	0.3
▪ Total productivity growth	0.8	2.2	0.5	1.2
Annual growth rates of inputs				
▪ Hardware	21.2	32.6	17.5	35.9
▪ Software	20.4	17.0	13.1	13.0
▪ Communication	na	na	3.6	7.2
▪ Other capital	1.1	2.5	1.6	2.8
▪ Labour hours	-0.1	0.7	1.2	2.2

Source: Oliner and Sichel (2000) and the Gruen (2001).

More recent work by Nordhaus (2001) finds that 'productivity growth in new economy sectors has made a significant contribution to economywide productivity growth'. He finds that 0.54 percentage points of growth can be attributed to the indirect effect of the new economy since 1996. Nordhaus' work 'definitely rejects the Gordon hypothesis' (Nordhaus 2001, p.18).

How much of the increase in TFP over recent times can be attributed to the indirect effect of ICT sectors? The analysis of productivity performance by Goldman Sachs shows most of the productivity boost has come in sectors like financial services (annual labour productivity growth of 5.9 per cent between 1986 and 1994), utilities (6.2 per cent), wholesale trade (6.2 per cent) and communications (6.7 per cent) (Wilson 2000).

This boost to TFP has come from many sources, not just the uptake of ICT. Microeconomic reform has been a major contributor, as has the upturn in the economy. In Wilson's study for Goldman Sachs on Australia's future long-term productivity performance the findings are that integration of ICT leading to greater e-commerce especially B2B (but also B2C) will generate further cost savings across the economy — in effect a further economywide productivity boost of 0.25–0.3 per cent. The total effect of ICT related developments could be 0.55–0.8 per cent broken down as shown in table 4.4.

4.4 **The overall impact of the 'new economy' on growth**

	%
Average labour productivity growth, 1964–89	2.20
Plus annual labour productivity gains from:	
▪ Increased IT investment	0.20–0.40
▪ Cost savings from B2B	0.25–0.30
▪ Flow on from US improvements	0.10
▪ Total new economy gains	0.55–0.80
▪ Implied labour productivity growth, 2000–10	2.75–3.00

Source: Goldman Sachs (Wilson 2000).

The Goldman Sachs findings in table 4.4 imply that there will be a lift in annual labour productivity over the next decade of 0.55 to 0.8 per cent, with up to 0.3 percentage points coming from cost savings stemming from the introduction B2B. These gains are the expected result of lower costs due to B2B e-commerce in key sectors across the economy. But implicitly these cost savings — akin to a gain in TFP — could be even greater because the ICT industry is currently constrained from expanding as fast as it could because of the shortage of skilled workers.

Without any additional stimulus to ICT labour supply, ICT employment is expected to expand by 19.8 per cent over the next five years, based on recent trend growth. That continued expansion of the ICT industry is expected to lead to an extra 0.3 per cent of annual productivity gain across the economy. The 'experiment' conducted in the next chapter is to suppose the skilled worker shortage is addressed whereby the ICT industry will now expand at a faster rate —an additional 27 500 workers or an additional 7.5 per cent growth in skilled workers in ICT. This additional expansion of 7.5 per cent will lead to additional economywide productivity gain of above the 0.3 per cent already expected.

Would the additional productivity gain be proportioned to the extra expansion of the ICT sector to what is already foreshadowed? Probably yes, given the assessment in the Goldman Sachs study that the ICT gains are about to get going in Australia since we lag the United States by a couple of years. It could even be argued that flow on from US improvements of 0.1 per cent (line 3 in table 4.4) may not materialise if the skills shortage is not addressed or could even be higher if the ICT industry here realised its full potential. However, to remain on the conservative side we confine ourselves to an extra proportion of the 0.3 per cent economywide productivity boost from the possible extra expansion of the ICT sector if the skills shortage is addressed.

To calculate the extra gain to be added to the 0.3 per cent productivity growth that is expected to occur anyway, we scale the 0.3 per cent according to the additional workers and the recognition of the fact that the 0.3 per cent expected under the baseline is the result of both more labour and more capital being employed in the industry.

Since labour's share of value added in ICT is 60 per cent, the TFP productivity attributable to extra ICT workers would be 0.18 per cent (= 0.3 x 0.6). Also, dynamics are important since the first of the 5500 extra ICT workers per year will not be employed until the year 2004, since it takes three years to train a graduate. The extra 5500 workers in 2004 (column 4 of table 4.5) is 11.5 per cent higher than the expected increase of 47 750 workers that will occur even if the skills shortage is not addressed (column 2, table 4.5). That is, the extra productivity in 2004 will be an additional 11.5 per cent above the base 0.18 per cent, giving an increase of 0.2 per cent (column 7). The result is an extra 0.02 per cent productivity, shown in column 8.

The cumulative effect of these additional skilled workers amounts to a modest 0.19 per cent extra productivity boost per year by the year 2008 when all of the additional 27 500 skilled ICT workers are fully employed. Even so, these small effects have significant implications for the economy as seen in the next chapter.

4.5 **Calculation of ICT model shocks**

	ICT persons	*Increase from 2000 base*	*Projected annual increase in ICT trained*	*Cumulative addition of trained persons*	*Projected cumulative increase in ICT trained*	*Baseline productivity contribution from total ICT sector*	*Baseline plus additional productivity from higher ICT training*	*Additional productivity from higher ICT training*
	Persons	Persons	Persons	Persons	% addition to increase from 2000 base	% annual growth	% annual growth	% annual growth
1996	258 000							
1997	294 400							
1998	284 400							
1999	294 400							
2000	305 290	0						
2001	316 590	11 300	5 500	0	0.0	0.18	0.18	0.00
2002	328 300	23 010	5 500	0	0.0	0.18	0.18	0.00
2003	340 450	35 160	5 500	0	0.0	0.18	0.18	0.00
2004	353 050	47 750	5 500	5500	11.5	0.18	0.20	0.02
2005	366 110	60 820	5 500	11 000	18.1	0.18	0.21	0.03
2006	379 660	74 360		16 500	22.2	0.18	0.22	0.04
2007	393 700	88 410		22 000	24.9	0.18	0.23	0.05
2008	408 270	103 000		27 500	26.7	0.18	0.23	0.05
Total growth 2000–08 (cumulative)	33.7					1.45	1.64	0.19

Source: Centre for International Economics

5 *Modelling analysis and results*

THIS SECTION ANALYSES THE RESULTS of a simulation study, which captures the effects on the economy of bridging the skills gap in ICT. It combines previous analysis on the shortage of skilled ICT workers with the productivity boosting effect of ICT output on the Australian economy.

ORANI economywide framework

The framework used to assess the quantitative impact of changes to the ICT sector is an economywide model called ORANI. ORANI is a multi-sector model of the Australian economy and is currently used by the Productivity Commission and other government departments as well as research groups and private industry. Important to the performance of the model is its theoretical structure and database (see box 5.1). The key conceptual points for this analysis are as follows.

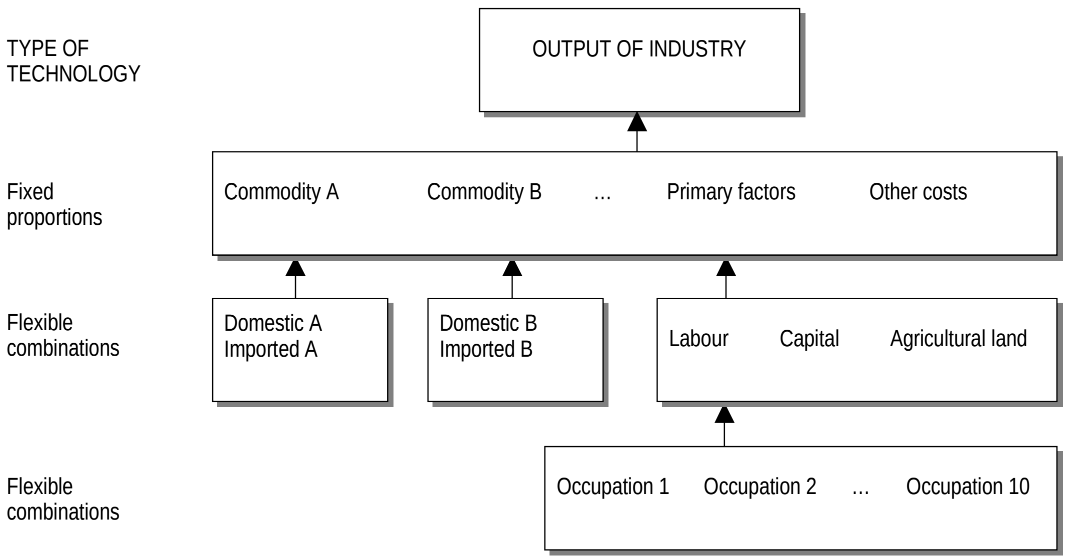
- All industries are linked one to the other so a change in one industry affects other industries to varying degrees. For example, banks use computers and ICT industries use banking services.
- There is competition between industries, exports and consumers for the output from producers.
- Industries employ workers of varying occupations and skills and workers can switch occupations based on the extra wage they can earn relative to other occupations.
- Changes in macroeconomic outcomes (like GDP or total employment) are the sum of all the micro changes in value added by firms and the number of workers.
- The *type* of technology used in an industry does not change in direct response to changing prices. The *amount* of 'technology' (capital equipment) will change as a result of changing prices but the way goods and services are combined will not change as prices change. Clearly the type of technology changes as new things are produced and new technology permits new business systems to be adopted.

5.1 **ORANI model**

To assess the impact of addressing the ICT skilled worker shortage, an economywide framework is used. The framework that is used here is the ORANI model. This framework is used because it is widely used now by government and industry in Australia. It has been used for many years, it is fully transparent, and over the years has received wide peer review and scrutiny.

An economywide model is used because an industry sector, such as ICT has linkages both upstream and downstream to all other industries. Output from the ICT sector is used downstream as input in farming, mining, manufacturing and other service industries and the ICT sector uses other sector outputs as inputs. ORANI captures the linkages within an economy by modelling the economic behaviour and interactions of producers, consumers and governments. The in-built behaviour in the model is that consumers are assumed to maximise utility and producers to maximise profits. Markets are assumed to be competitive and there are constant returns to scale. The economy is composed of consumers and producers. Producers can purchase their inputs from any other industry in Australia as well as imports from overseas. Producers supply goods and services to consumers who have a choice about whether they purchase imports based on price and tastes. Producers also supply the export market. Producers have a degree of flexibility in how they combine inputs, using that combination which minimises costs. Technological change is exogenous.

The model reflects a combination of two key components: its database and the theoretical structure embodied in the system of equations of the model. The database uses data as at 1997–98 and the version used in this study uses an updated input/output structure for the Australian economy. This is as recent as available in Australia today. A schematic representation of the production technology used in the ORANI framework is shown below.



Of key importance in this model is that workers can make choices between the occupations they engage in according to the wage they can earn in a particular industry. This labour can be used in varying proportions with capital and land. Also, producers can make flexible choices between the use of imported or domestic inputs from industries, such as motor vehicles. However, different inputs and the use of primary factors plus other costs are used in fixed proportions as given by the input/output structure.

The ORANI model is very similar in structure and theory to the Monash model which was used in the NOIE analysis (NOIE 2000) of e-commerce. The ORANI model is used here since, at the moment, it is more up-to-date and is based on update 1997–98 input/output tables.

Source: IAC 1987

This last point explains the lengthy treatment of this extra productivity boost from ICT discussed in the previous chapter. It suggests the need to allow for broader technological change in the model explicitly when simulating the effects of addressing the skills shortage in ICT.

The simulations and the questions they answer

The simulations are designed to track the combined economywide effects of two related changes:

- an increase by 2008 of 27 500 extra skilled workers in the ICT sector, distributed over five years (a phasing in of workers is required because physical constraints negate the possibility of increasing the stock of workers too quickly); and
- an increase in annual productivity in other industries, differing according to each other industry's use of ICT in their production process, and amounting to 0.19 per cent per year in 2008. The derivation of the 0.19 per cent productivity was described fully in chapter 4.

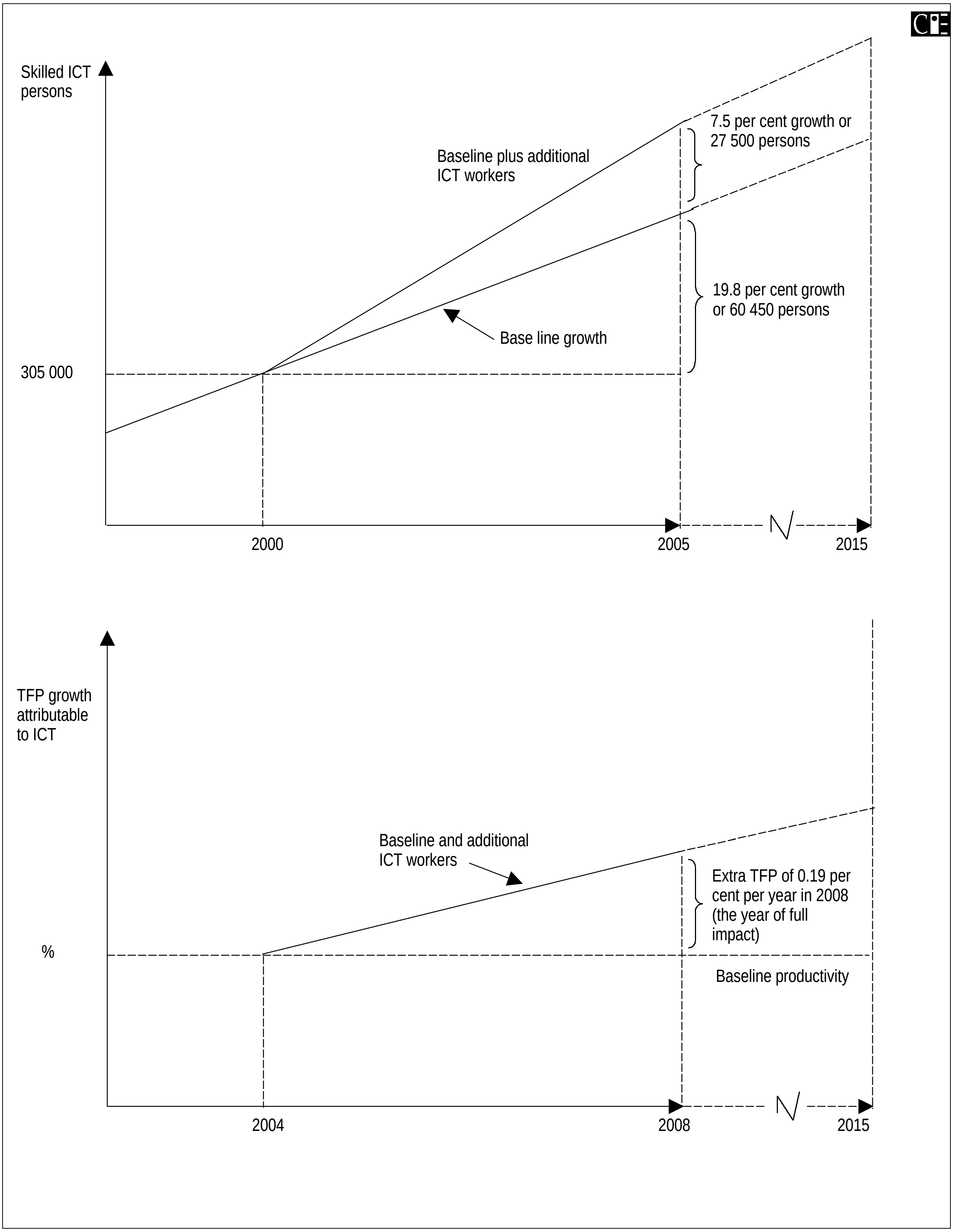
The model of the economy is used to calculate the combined effects of these changes on gross domestic product (GDP), aggregate investment, Australia's exports, employment, and government revenue. It also shows the differing effects on individual industries. These differences are in part due to the different reliance on ICT across industries.

The approach used is to assume that, without the gains from these beneficial changes, the economy (in terms of GDP etc) and the ICT sector itself will continue to grow at a slower 'baseline' rate. The issue then becomes 'what are the *extra* gains above baseline that will result from the progressive removal of the skills gap in ICT and the associated cumulative gains in productivity?' These are the basic questions the modelling is designed to answer.

Allowing for the fact that gains are not instantaneous

The extra 27 500 skilled workers is less than the 45 000–50 000 shortage commonly cited in the media for the reasons explained earlier. The possibility of extra immigrants, the shortage of teachers and the lower wages available in ICT if such a large increase in skilled workers became available, means 27 500 is a more conservative and realistic number to use.

5.2 **Simulation: extra skilled workers plus economywide productivity growth**



Data source: Centre for International Economics

The two inputs to the model simulation are shown graphically in chart 5.2. Note that the extra productivity boost does not start until 2004 when the first of the extra 5500 graduates per year finish their three-year degree.

Also, the full effects of the productivity boost of 0.19 per cent per year does not occur until all of the 27 500 skilled people are trained and employed in 2008. Before then, the extra productivity boost is phased in over the eight years in proportion to the extra numbers of skilled workers being trained and culminating at 27 500 in 2008.

Results in detail

Economywide effects

The economywide effects of the combination of an extra 27 500 skilled workers being trained in ICT plus the small additional incremental productivity boost to other sectors are shown in table 5.3, 5.4 and 5.5. Results are expressed as deviations from baseline. The baseline is what would have happened in the absence of the extra skilled workers being trained. Even without the extra training, the ICT industry will still grow and employ more people. The baseline was shown earlier in table 4.5.

Table 5.3 shows the macroeconomic impacts of addressing the ICT shortage. The model simulates the responses of the macro economy to these beneficial shocks by adding up the output responses in individual industries. The increase in GDP is the combined effect. GDP rises by 0.9 per cent over and above what it might otherwise be. The biggest contributor to this overall increase is the economywide productivity boost from extra ICT made possible by removing the constraint of the unavailability of skilled workers. Although a small percentage, this extra GDP amounts to an extra $5310 million annually once the effects of the extra skilled workers and small productivity boost work through, which takes until 2008 assuming it takes three years to train an ICT person. The extra GDP and extra returns to capital available as a result of a more productive economy encourages additional investment in the economy which is 1.3 per cent above baseline.

Aggregate exports rise with Australia becoming slightly more competitive as a result of the extra productivity boost from an expanded ICT sector. Exports are $1460 million higher than otherwise. Imports also rise with the extra economic growth and lift in household consumption, some of which will be met by imports. Also, some investment goods required to realise the

5.3 Economywide effects of addressing the ICT skills shortfall

Macro aggregates	*Deviation from base*	
	%	$ million
Gross domestic product	0.9	5 310
Household consumption	0.8	2 950
Aggregate investment	1.3	1 890
Aggregate exports	1.2	1 460
Aggregate imports	0.7	760
Consumer price index	0.2	
Aggregate employment	0.1	
ICT personnel	3.2	
Other managers, professional and tradespersons	-0.2	
Other occupations	0.1	
Average real wages[a]	0.9	
ICT personnel	-7.2	
Other managers, professional and tradespersons	1.6	
Other occupations	0.1	
Government position		
Government revenues	0.7	1 440
Government expenditures	0.2	450
Net government position		**987**

a Deflated by the consumer price index.

Source: CIE economywide model of Australia and CIE calculations.

opportunities created by easing the constraint on the ICT sector would contribute to the $760 million rise in imports.

As expected, aggregate employment rises with the increase in GDP and activity in the economy. There is a 3.2 per cent increase in ICT personnel which is a direct result of the extra training of 27 500 personnel as simulated. These extra 27 500 people have to come from somewhere. One area they come from is other sectors. If there are more Australians working in ICT there are less working in other professions such as management, architecture, and so forth. The decline in employment in these management and professional categories is 0.2 per cent.

The effect of people switching from other professional work to the ICT sector causes a slight increase of 1.6 per cent in the average real wage of these other professional people. In the ICT sector however, real wages are 7.6 per cent lower than otherwise would be the case. This does not mean that ICT wages would fall. Rather, they would not rise as much as they would otherwise. There are more skilled workers available for ICT firms to hire and they do not have to bid up wages as much to attract key staff. Remember that these results are deviations from base or what otherwise would occur, and ICT wages will grow more slowly than if the extra persons had not been trained. Wages in ICT have been rising strongly, up to 20 or 30 per cent above levels of five years ago. The results mean that the rise in real wages in the ICT sector would therefore be of the order of 13 or 23 per cent.

Industry wide effects from change

The industry wide effects on output are shown in table 5.4. There are differing industry effects on outputs because of several factors. First, as can be expected, the number of people employed in the ICT sector rises with the additional training and so the communications industry and the sector comprising scientific research, technical and computer services rises by around 1 per cent over and above the rise that would be experienced had this change not occurred.

A second factor behind the different results across industries is that the productivity boost has been apportioned across the different industries according to their intensity of ICT use. Therefore, it is assumed that banking, for example, would receive a higher productivity boost from having an expanded ICT sector than would say restaurants. Banks are far more intensive in their use of ICT. The reason there is a small decline of 0.8 per cent below what otherwise would occur in agriculture is that the agriculture industry is a small user of ICT relative to other sectors. Instead, agriculture has a large input of land into the production process. Again, the impact on agriculture does not mean that agriculture actually declines, it simply grows at 0.8 per cent lower than what would otherwise be the case.

5.4 **Industrywide effects of addressing the ICT skills shortfall**

Macro aggregates	***Deviation from base***
	%
Industry wide effects — output levels	
Agriculture, forestry and fishing	-0.8
Mining	1.8
Manufacturing	0.5
Electricity, water and gas	0.5
Construction	0.2
Wholesale and retail trade and repairs	0.3
Accommodation, cafes and restaurants	0.5
Transport and storage	0.1
Communication services	0.2
Banking	0.5
Other finance and insurance	0.4
Ownership of dwellings	1.2
Scientific research, technical and computer services	1.0
Legal, accounting, marketing and business management	0.2
Other property and business services	0.2
Government administration and defence	0.0
Education	0.0
Health and community services	0.1
Cultural and recreational services	0.4
Personal and other services	0.2

[a] Deflated by the consumer price index.

Source: CIE economywide model of Australia and CIE calculations.

It could be argued, however, that the decentralised and remote nature of agriculture could mean that ICT could have a much larger impact on reducing costs for agriculture than for other sectors even though their expenditure on ICT is relatively low. Were this the case, it could be that the agriculture sector actually expands. Evaluating the actual effect of ICT on individual industries is complex. Our proxy of impact according to the importance of ICT in the production process of another industry is a simplification.

Another explanation of the results is that workers have to come from somewhere and if more people are engaged in ICT then there are less workers in some other industries. These other industries use ICT and would benefit from the productivity boost that will occur if the ICT sector is less constrained. However, many of the people who will be trained and work in the ICT sector will come from these other industries and that has a negative impact. The zero simply means that two effects are cancelling each other out. The fact that there is net zero change for some industries as a result of the ICT change does not mean that there are no effects.

Government position

The change in government accounts is interesting since training extra skilled people has a cost initially but later leads to extra revenue as the tax-take is higher with a growing economy. Extra net revenue of $990 million a year is possible (table 5.3) over and above the additional expenditure to train the ICT people. More important is the time profile of government expenditure and revenues since the expenditure is up front but the last of the extra workers are not hired until 2008 under the scenario we have chosen of five years of an additional 5500 workers (making 27 500 overall) and taking three years to train these skilled people (table 5.5). The net present value to government of this extra cost is $800 million as set out in table 5.5. The net present value of the additional revenue is however $6010 million. That is over seven times the NPV of the cost of training the extra 27 500. The net present value of the additional increase in annual GDP is estimated to be $32 350 million or over 40 times the net present value of the cost. That demonstrates a well-known fact that additional productivity — even very small amounts — confers substantial benefits over time.

5.5 **Benefit and cost profile**

	Additional ICT places each year	*Total ICT places each year*	*Cost per person per year*	*NPV of additional cost of ICT places*	*Additional ICT employment each year*	*Increase in GDP*	*Additional government revenue over outlays*
	Persons	Persons	$	$ million	$ million	$ million	$ million
NPV 2000–15[a]				800		32 350	6 010
2001	5 500	5 500	11 800	65		0	0
2002	5 500	11 000	11 800	130		0	0
2003	5 500	16 500	11 800	195		0	0
2004	5 500	16 500	11 800	195	5 500	1 060	200
2005	5 500	16 500	11 800	195	11 000	2 130	400
2006		11 000	11 800	130	16 500	3 190	590
2007		5 500	11 800	65	22 000	4 250	780
2008					27 500	5 310	990
2009						5 310	990
2010						5 310	990
2011						5 310	990
2012						5 310	990
2013						5 310	990
2014						5 310	990
2015						5 310	990

a Real discount rate of 5 per cent.

Source: Centre for International Economics.

How robust are these results?

There are three critical variables affecting these results. First there is the size of the skills shortage in ICT. Second there is the extra productivity boost that could be expected throughout the rest of the economy as a less constrained ICT sector permeates all other industries and changes the way commerce is conducted and businesses managed.

A third factor is that the results also crucially depend on what is the baseline or counter-factual — that is, what would happen in the absence of addressing the skills shortage through policy. The assumption implicit in these results is that the ICT sector and the economy will grow at the same rate over the last five years. But, as highlighted in the Victorian study (Multimedia Victoria and Trinitas Pty Ltd 2000), if the ICT sector continues to be constrained by a lack of suitably trained people, the correct baseline may be one where Australia doesn't grow or even declines.

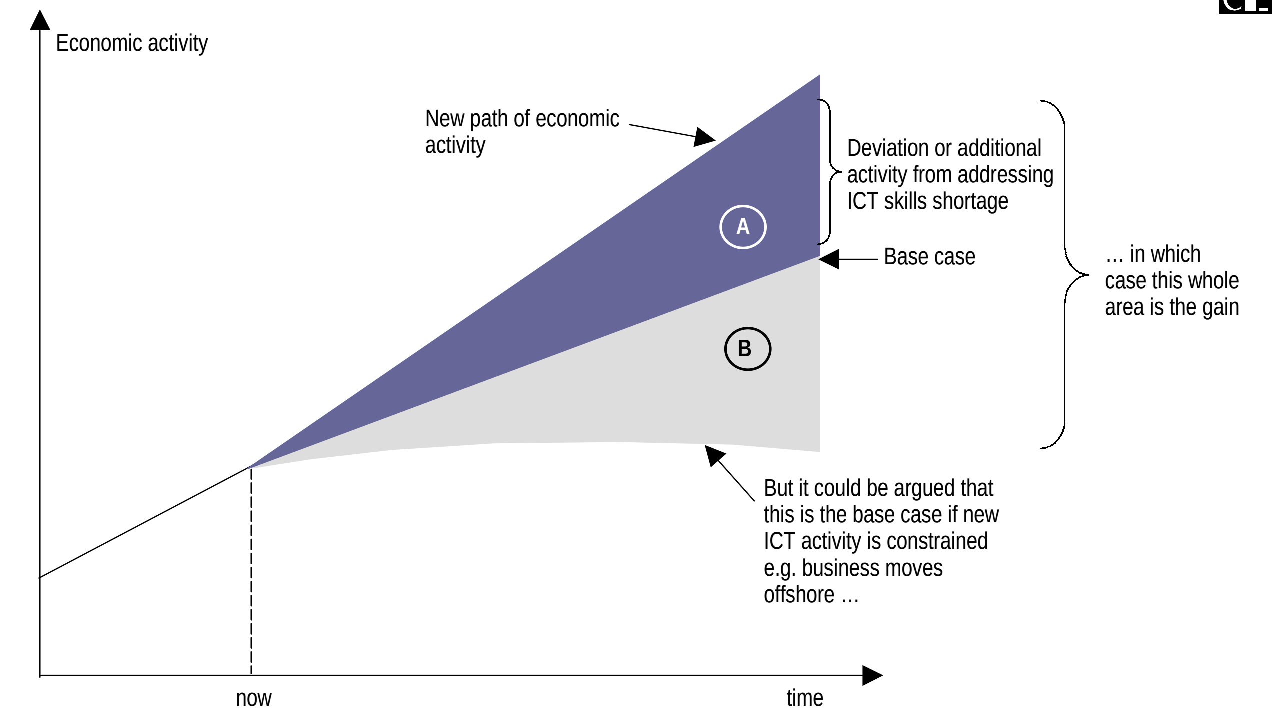
The reason is that some firms finding it difficult to hire skilled people move offshore to where there is a greater supply of trained ICT personnel so they can expand their business. For instance, our discussions with Ericcson Australia suggest that the skills shortage has already contributed to the firm transferring research arms into Brazil and India. While other factors have influenced these decisions, up to half the people currently employed in Brazil and 10 per cent of those employed in India, could be employed in

Australia if it were not for the unavailability of skilled IT labour domestically. An increase in firm behaviour of this type could see more activity move offshore where there is a greater supply of skilled IT professionals. That is, business activity and investment could leave Australia and relocate elsewhere.

If business were to relocate offshore, and it is a big if, then the real baseline would be as depicted in chart 5.6 as the bottom line instead of the baseline in the middle that we have assumed. The gain from addressing the ICT sector skills shortage is shown in chart 5.6 as the shaded area 'A'. But if the real baseline is the bottom line of chart 5.6, that is, Australia fails to realise its potential and firms locate offshore and the economy declines, then the real gain from addressing the ICT shortfall would be represented by the areas 'A' plus 'B'.

We do not believe the real baseline is the bottom line but anecdotal stories and the Victorian study suggest there is a real possibility there could be come truth to this issue. As such it highlights that our representation of the gains from addressing the shortfall are on the conservative side. On top of that we have used a skill shortage of 27 500 as opposed to the widely

5.6 **Impact of new ICT on economic activity**



Data source: Centre for International Economics quoted 45 000 shortfall. Also the productivity boosting effect of ICT is 0.19 per cent at its maximum in 2008 when the full complement of extra workers has come into the workforce. It was highlighted in chapter 4 that some micro studies of the impact of ICT have shown that for every $1 of expenditure of ICT there is another $9 of investment in workplace redesign and reconfiguring of business to the most efficient means. Not all of this extra $9 of investment would be a net gain since investment costs money and there are adjustment costs of change. But there is potentially a larger gain that is not recorded. For these reasons our results could be on the conservative side.

6 Conclusion: moving forward

THE ICT LABOUR MARKET is in a constant state of change. Desired skill sets *demanded* by industry are dynamic and trends are unpredictable because they depend on technological change and the workplace changes they precipitate. There are several supply side constraints limiting the ability of firms and the training sector to respond rapidly and produce the number and quality of people required to enable the ICT sector to function effectively.

- Providers of public education are bound to a funding system, which is not supplying sufficient resources to expand graduate output. Some private course providers have been in the market for some time and new providers continue to emerge. While private courses are valuable in terms of re-skilling and upskilling computer professionals across various sectors, courses are typically tailored to those seeking career changes, and are not designed to substitute for tertiary education.
- For industry, ICT work can often be 'mission critical', making in-house training difficult (scarcity of training resources), particularly for small and medium sized companies, which dominate the Australian ICT sector. Difficulties in retaining staff can also discourage industry training because the investment in education is not often 'captured' for long. The result is a desire to buy 'off the shelf' ICT skills, evidenced by claims of an ICT 'experience' shortage.

The result is a shortage of ICT skills in the community, modelled in this study as being around 27 500 people with tertiary qualifications over five years. This estimate already discounts for the short-term impact of the bursting of the 'dot.com bubble' and suggests that an ICT skills shortfall still exists. Certainly over the medium to longer term, growth in demand for ICT skills is expected be strong, and any temporary easing should be used to strength Australia's capacities in the supply of ICT skills.

However large, the skills shortage has led to a series of self-reinforcing problems. Rising demand for ICT professionals has led to an increase in salaries, which has drawn teaching resources out of the university and TAFE sector, and tempted graduates (and those yet to graduate) into employment rather than further education. This has resulted is a lack of teaching resources, a lack of post graduate students, and less advanced academic research in the ICT field.

The task now is to develop a framework for moving forward, and to identify the types of changes, both in government policy and industry practice, that would work towards improving the pool of ICT competencies within the Australian community.

Changing the scale and scope of tertiary education

Universities play a key role in improving the competency of the Australian workforce in ICT. They are the single largest source of ICT workers in Australia, and a university qualification is an important signal of quality to potential employers, helping to overcome the inherent information asymmetry in the employment decision. Universities face two major obstacles to increasing the quantity and quality of ICT graduates: limits on government-funded HECS undergraduate places; and ICT staff shortages. The TAFE sector also faces equivalent constraints.

Several institutions have taken steps to try and overcome these obstacles. Some have developed links with industry to share some of their training load. Most have increased student/staff ratios to accommodate more students. And there are signs of some minor reallocation of places from other faculties. While opinions differ on how universities can change to better accommodate the need for more (and likely different) ICT graduates, there is little doubt some change is justified. Change might involve an increase in the number of funded HECS places, and changes to how public funds are *allocated* and *used* within universities.

Funding for undergraduate ICT places

Higher education today is a mix of public and private investment. How to get ‘the right mix’ between public and private financial contributions will always be a contentious issue, and is not the subject of this study. The concern at hand is to increase the supply of skilled ICT workers, and what is required to achieve that cost effectively, given the broad parameter settings of public and private sector funding burdens.

Universities were recently permitted to increase student places by 25 per cent for *full-fee paying* undergraduate places. The vast majority elected not to exercise this option on equity grounds. The experience of those that have is that quotas are difficult to reach given that, at a cost of $12 500 a year without a loans scheme, demand is not significant. Potential graduates are not seeing expected wage differentials in ICT that are sufficient to cause them to make the investment. These factors combined suggest that an increase in the number of university places in ICT will require those places to be subsidised HECS places.

There is a legitimate role for government in providing higher education, stemming from the positive spillovers to the community and the economy associated with higher education. Commonly reported benefits are outlined in box 6.1. The role for government is enhanced by the presence of market failures, which inhibit industry investment in education.

The Industry Commission previously noted that the level of a government subsidy should depend on the magnitude of spillovers, and the sensitivity of student demand to changes in prices charged for courses. The less responsive demand is to price, the less effective is each dollar of subsidy in promoting additional spillovers (IC 1997, p. 70). However the Commission acknowledged that the size of spillovers cannot be properly measured, making this an impractical way for determining optimal public funding.

There are also demonstrable private benefits of ICT education. Ideally these would reduce the need for a government subsidy to encourage students into ICT education — public benefits would accrue without the subsidy. Modelling by the Industry Commission shows computer professionals have the highest private rate of return for tertiary investment compared to other selected occupations (box 6.2).

6.1 **Positive spillovers commonly attributed to higher education**

Positive spillovers of higher education include:

- general advances in the stock of knowledge, its application and dissemination;
- improvements in the quality and character of society through improved voting behaviour and increased political and social awareness (eg higher voter participation and appreciation of issues), the emergence of social, cultural, political, economic and moral leaders, reduced crime and anti-social behaviour;
- better information transmission (facilitating competition, among other things),
- more favourable attitudes to growth, innovation, new technology and risk, improved adaptability to changes in technology and the organisation of work, and graduate contributions to the skills and productivity of co-workers;
- higher tax-take from graduates and lower welfare payments associated with improved employability; and
- intergenerational or family effects (eg learned skills passed on to offspring).

Source: Industry Commission 1997, with CIE additions.

6.2 Estimating the private rate of return on higher ICT education

Modelling work by the Industry Commission (1997) showed that computer professionals have the highest private (internal) rate of return (IRR) for their investment in higher education. Other occupations modelled were architects, teachers, engineers, lawyers, nurses and scientists.

The purpose of the modelling was to examine how the private rate of return for various occupations might be effected by various charging systems for a university education. Median age and income profiles of computer professionals were supplied by the Association of Professional Engineers and Managers, Australia (APESMA) as at 1997.

- The private rate of return for investment in an ICT education was found to be the highest of any occupational category modelled under various funding scenarios. The return was between 23.3 per cent under a 'no fees' scenario, down to 12.8 per cent under a 'full fee' regime with a total course cost of $39 990.
- Under the current differential HECS scheme, where fees are influenced by course cost, graduate return, and student demand considerations, the IRR for computer professionals is 20.8 per cent, and is only fractionally higher (21 per cent) under a model where fees are based on cost recovery only.

Source: Industry Commission 1997 pp. 97-104.

Looking at the enhanced taxation benefits alone, recent analysis by the Business Higher Education Round Table (BHERT) suggests that the direct social cost recovery rate (net present value of the income tax payable on the gross income differential of a degree vis-a-vis the taxpayer supplement per degree) is 1.100. For the individual, the direct private cost recovery rate is almost double, at 2.017 (net present value of the income differential after costs and tax vis-a-vis the private costs per degree) (BHERT 2000, p. 22).

This assumes an internal rate of return to education of 10 per cent to establish the expected income differential between those with and without a degree. However, the internal rate of return for ICT degrees higher, at around 20 per cent. This suggests that:

- the social cost recovery rate for ICT higher education is 2.200; and
- the private cost recovery rate for ICT higher education is 5.033.

However, the fact that full fee paying students are not responding to the high private rate of return suggests market signals are not clear to individuals, or that other issues outweigh them. These factors notwithstanding, under current funding arrangements, universities are *not* able to satisfy:

- current student demand for subsidised ICT education;
- any increase in student demand, which needs to occur as the image of the industry changes and students become more IT literate; or

- industry demand for quantity and quality (although at times, industry demand is poorly articulated, being based on unrealistic expectations).

The SA CES study cited previously suggests there is no scope for efficiency gains to increase the number of places under current funding arrangements, and the scope to transfer places from other facilities is negligible. In its view, any expansion in student numbers 'would need to be funded by a specific purpose allocation of funds from the commonwealth' (SA CES 2001, p. 26).

This study modelled the impact of increasing graduate numbers by 5500 a year for five years, at an approximate cost of $972 million, less the private contribution component. The number of additional places that might be funded would depend on several factors, elaborated below. This is because the effectiveness of increasing student places will be limited without simultaneously addressing other causes of the skills shortage in ICT.

The allocation and use of public funds within universities

Tertiary studies in ICT are relatively new compared to other well-established disciplines, with most universities still without a dedicated ICT faculty. This is changing and ICT is gaining increasing prominence within universities, being one of the highest growth areas in terms of student demand and university revenue generation. However, there is a general frustration among ICT faculties that ICT is not receiving the internal funding allocation it requires. The internal allocation of funding within universities is somewhat of a 'black box' to those outside the system, leading to a perception that

> 'for universities it is a case of a little bit of funding going nowhere, and a lot of funding going a little way' (an industry response to this review).

As we have seen, the level of government funding of universities today is largely based on the 1989 Relative Funding Model, which funded ICT places at a ratio of 1.6, compared to 1 for Arts places and 2.2 for Science and Engineering. The *internal* allocation of funds within universities is the outcome of a negotiation process, which typically follows this ratio pattern, whether or not this was the intention of government at the time. Some commentators claim that the ratio allocated to ICT is 'too low', and as a consequence, the level of funding for ICT faculties does not reflect the true cost of a students' education. This has led to a greater reliance on (and thereby encouragement of) international and post graduate students, who are likely paying above the full cost of education and cross subsidising existing undergraduate places.

A further difficulty is that there is no indication that the mechanism for determining the level of internal funding for ICT faculties is responsive to market signals calling for an increase in ICT graduates. Universities are not required to respond to market signals in order to receive their operating and capital funding from the commonwealth government. A recent review of the commonwealth funding framework for public universities was highly critical of the block grant approach to funding, and the incentives that are, and are not, instilled onto the university system. The 1998 West Review found that the tertiary funding system:

- is predominantly centrally planned, with the number of publicly funded domestic students constrained by centrally set student load targets, as is the distribution of activity between levels of award, and to a lesser extent, between disciplines — targets which cushion institutions from the need to adapt to any change in demand;
- does not require universities to assess student needs, and therefore does not provide for the primacy of student needs;
- does not encourage diversity, or provide institutions with incentives to understand their costs and minimise them for a given level of quality;
- is administratively complex, with funding anomalies increased by the mix of Commonwealth and State involvement; and
- has funding incentives which encourage research activity at the expense of teaching (West 1998, pp. 77–88).

> Current funding arrangements exacerbate the inflexibility of the system by virtually guaranteeing institutions that each year they will receive the operating funds they received in the previous year. Once operating resources are allocated institutions they are effectively 'locked in' indefinitely owing to the absence of any suitable, widely accepted method to reallocate resources (West 1998, p. 81).

The West Report recommended one alternative to the block funding approach, that being student centred funding, which was said to:

- give institutions strong incentives to respond to student needs, redressing the skewing of incentives in favour of research;
- allow student preferences to determine the allocation of public funding among institutions, courses and regions; and
- provide institutions with incentives to diversify the services they offer, and how, when, where, and at what price they offer them — to reflect the diverse needs and preferences of students (West 1998, p. 100).

Under the present system, the allocation of resources *within* universities is independent from government. However, it is clearly strongly influenced by the model of federal funding. Moreover, governments do spend considerable amounts of public money on higher education, and therefore have a responsibility to ensure funds are allocated in a way that is consistent with broad community goals. As stated by the then Industry Commission,

> ‘At a minimum, there is a need [for the Government] to ensure subsidy programs and other areas of public expenditure are providing value for money and, in addition, to monitor the impact of competition on course offerings and quality standards’. (IC 1997, p. 85)

The current block funding approach does not ensure that the allocation of public funds reflects market forces to any degree, nor does it encourage it to do so. Market signals need arguably to have *some* role, along with other social and cultural considerations, in the allocation of scarce, subsidised university places among disciplines.

The West Report suggested one other approach to distributing public funds. No doubt there are others, each with their implicit incentive regimes (both positive and negative) for various stakeholders. The major point to the made is that, so long as significant public funds are channelled into universities, government has a responsibility to ensure that funds are appropriately spent, and the block funding approach does not ensure that. The claims of ICT faculties on universities will invariably be countered by the claims of other disciplines. The point is that, without mechanisms in place for universities to respond in some degree to market signals, the appropriate allocation of places across disciplines may never be known.

Links between universities and industry

Experience across Australia and around the world shows that the strength of the links between ICT faculties and industry is an important component of improving the quality of TAFE and university graduates. These links are important in terms of ensuring that the syllabus taught is up to date, given that the bulk of technology research is undertaken by private industry, and that graduates are as ‘employment ready’ as possible, having been exposed to the application of their teachings in the ICT sector.

TAFE-industry links have been growing for some time, and university–industry links have become more pronounced in recent years. Universities are increasingly entrepreneurial, with many developing, or seeking to develop, outsourcing companies of their own that can generate funds for the university and provide work experience for students. Many also have direct industry links such as through:

- industry sponsored scholarship programs, where students are paid around $10–$12 000 per annum to undertake specialised degree programs at selected universities;
- industry advisory committees, with representation from major graduate employers, overseeing syllabus design and approval;
- qualifications with industry placement and industry internships as a compulsory component of degrees and diplomas; and
- particularly for regional universities, partnerships with TAFE, which themselves have direct links with industry in terms of subject selection and syllabus development.

Graduates from ICT programs with some industry involvement are highly sought after by the market, and such programs reflect positively on those institutions able to offer them. However it is already apparent that the links between educators and industry can be improved.

For universities, comments to this review suggested that the lack of vendor training is one important omission from the university syllabus. Universities should be encouraged to develop industry advisory boards, able to have an effective input to subject selection, as one mechanism for improving the pace of curriculum development.

For industry, it is clear that difficulties experienced in finding industry placements for students is an impediment to delivering more work ready graduates. Industry needs to become more willing to accept such placements if tertiary programs are to improve their contribution to overcoming the skills / experience shortfall.

Solving the scarcity of ICT teaching staff

ICT faculties in Australian universities and TAFE describe themselves as constantly in recruitment mode. Advertising two or three times for an academic position in ICT is not uncommon, nor is receiving *no* applications for an advertised position. However the staff shortage issue goes beyond the available pool of interested teachers. Anecdotal evidence suggests that the rigidity of recruitment and promotion practices within universities in particular is shrinking the size of that pool. It is certainly the case that, the higher the level of the position, the more difficult and slower it is to secure an appointment. This is at least partly due to the composition of selection panels, which become larger and more varied across faculties in line with the seniority of the appointment.

The selection process within universities is guided by the traditional profile of a university academic, which does not necessarily sit comfortably with ICT. University staff are required to have a significant level of publications and a number of years experience. A PhD qualification is also typical, and industry experience is highly sought after. Not only is this a difficult profile to find in ICT, but the typical starting salary for a university lecturer of around $50 000 makes such positions unattractive compared to private sector positions. Some universities offer 'loadings', or performance bonuses for staff. However loadings do not bring salaries up to levels experienced by private industry. The use and scale of loadings is university-specific, and applies mainly to larger metropolitan universities. Overall, salaries remain capped by the broader framework of salary determination for the university system, as they do for the TAFE system.

Private providers also experience some difficulties in hiring teaching staff, but they are at least able to offer working conditions and salaries that are considerably more flexible. Private teacher salaries of over $100 000 per annum are purportedly not uncommon.

While it is important to maintain a high standard in the quality of academic staff, consideration must be given to making recruitment and promotion practices more flexible to accommodate potential entrants from private industry, and structured in a way that will attract them. Turning around the teacher shortage will be difficult, if not impossible without changes to salary determination and promotion protocols. As was stated to this review, 'there is no use getting a solution to patch up a system that doesn't work'. Commenting on academic salaries, the Prime Minister has stated,

> 'one way of rectifying it [low academic salaries] is for the universities… to adopt a far more deregulated approach to how they remunerate their staff… the universities have got to do something about deregulating their salary structures… we have offered the universities more money if they restructure their industrial relations arrangements. Some of the universities are taking that up, others are not'. (The Hon PM John Howard 30/01/01)

The salary issue is not independent from the model of university funding and the level of funding allocated to ICT, which see many ICT faculties without the resources to offer higher salaries or loadings.

The shortage of ICT teaching staff inevitably affects the *quality* of teaching, be it as a result of higher staff work loads and stress, the lack of time available for keeping knowledge up to date, or just as a result of the limited size of the teaching pool. The effect on the quality of the teaching pool then adversely effects the capacity of ICT faculties to bid for research funding.

Without addressing the staff shortage issue, increasing student places may not lead to those places being filled. As was stated to this review,

> 'You cannot just increase the number of university or TAFE places and solve the skills shortage issue. Increase funding to education providers, increase the number of teachers, increase the number of computers, and then increase the number of students' (Stakeholder from the TAFE sector).

Overcoming impediments to student uptake of undergraduate places

This report has already cited estimates on the extent of unmet student demand for ICT places at Australian universities and TAFE (SA CES 2001). However the problem of student demand goes beyond the *current* level of unmet demand for undergraduate places. Anecdotal evidence from industry, universities and TAFEs suggests that there are insufficient numbers of students wanting to enter ICT higher education.

> The funnel, which spreads from school to higher education and to industry, is simply not being filled in terms of putting people into the system…there is simply not enough natural interest in ICT. (MD, Fujitsu Australia 2001)

In regional areas, there is even a decline in students wanting to study ICT. While considerable resources have been channelled into ICT in schools in recent years, it is clear that problems remain in generating student interest in pursing ICT upon leaving school. Several stakeholders commented that the ICT industry has an 'image problem', which discourages potential graduates from entering into ICT, particularly women. The image of the industry is described as one of 'nerds eating pizza and drinking Coke' working 'in the back room'. Such perceptions are counter-productive to increasing the pool of ICT professionals in the Australian community.

A recent report into student perceptions of an ICT career commissioned by the Victorian Government titled 'Reality Bytes' found that:

- students are aware of the opportunities and money in ICT but they by and large don't care, and are motivated by a desire to pursue careers that link with their personal interests;
- students see jobs involving technology as technical, not creative, solitary not team oriented;
- ICT can be seen as limiting their future options — a direct route to spending work time glued to a monitor and keyboard;
- ICT as undertaken at secondary school level is criticised by most students and contributes to their view that ICT is 'boring'; and

- students are aware that technology skills are important across all industry sectors, but not how or why, reflecting a general lack of awareness about the world of work (Multimedia Victoria 2001, p. 4).

This suggests that more needs to be done to raise the profile of ICT at the primary and secondary school level. There is a need to increase the level of interest, among high school students at least, in a career in ICT in order for any rise in undergraduate places to translate into a bigger and better ICT graduate skills base.

Compounding the problem, many school teachers have not received proper training in ICT, often resulting in students knowing more about ICT than their teachers. While these problems are somewhat outside the scope of this study, they are part of the problem in generating student demand to enter a career in ICT and help overcome the community shortage in ICT skills.

> We know this [lack of school teacher training] first hand because we are asked by vendors such as Microsoft to train many computer illiterate teachers in four or five days before they are returned to be designated 'experts' in these new areas. (Douglas O'Hara, Manager, Education Services, Aspect Computing)

A role for industry

Changes to various aspects of ICT education alone will not in themselves solve the ICT skills shortfall. One commentator suggested that 'universities can help with about 10 per cent of the problem but that's it — rest of it up to industry, TAFE, and private colleges' (IBM Australia, 2001). The ICT industry itself must become an *active* part of the solution to the ICT skills shortfall. Several commentators suggested that 'industry needs to have a close look at itself' when it comes to the development of ICT skills, and re-evaluate its approach to training, hiring, staff development, and its conception of what is required to grow the ICT industry in Australia.

The need to adopt a greater willingness to work with education providers in ICT

ICT education is distinguished from many other tertiary courses by its dependence on rapidly changing technology. One of the constraints to creating job-ready graduates, is the (un)willingness of segments of industry to take responsibility for part of graduate training. This is particularly the case for small and medium sized companies. Major users of ICT labour, such as government, might also take a more active interest in providing workplace training for students prior to graduation.

There is some evidence that, particularly larger companies, are accepting a wider role in ICT education. For instance, industry has committed $32 million to the planned establishment of the Advanced Technology High School, recently announced by the NSW Government. Large private companies will provide funding for regional network academies, and provide training laboratories, computers and teacher training (Humphries 2001).

The need to adopt a training mentality

It has been suggested that industry needs to 'make its own people'. This is likely to be difficult, given that there are market failures present, which inhibit industry's willingness to invest in training staff. And all work seems to be 'mission critical' leaving little time for staff development. However, one must always compare the outcomes of market failure with what can realistically be achieved either through regulation, or under the status quo, which is not delivering the scale and scope of ICT labour demanded.

There are inherent lags in ICT labour supply and demand, because skill sets are based on a changing platform (technology). It is also apparent that a career in ICT is one where specialists have several employers, and where contract work is common as businesses respond to sporadic requirements for changes in information systems. The movement of ICT labour may be endemic to the profession and, almost despite the fact that market failures exist, industry needs to be committed to investing in ICT training.

Other fast growing industries such as hospitality have faced similar labour shortages and have factored entry-level training programs into their core business development, including small and medium sized enterprises. Taking labour from other industries and developing skills in-house is likely to be part of the process required to 'grow the pool' of ICT labour.

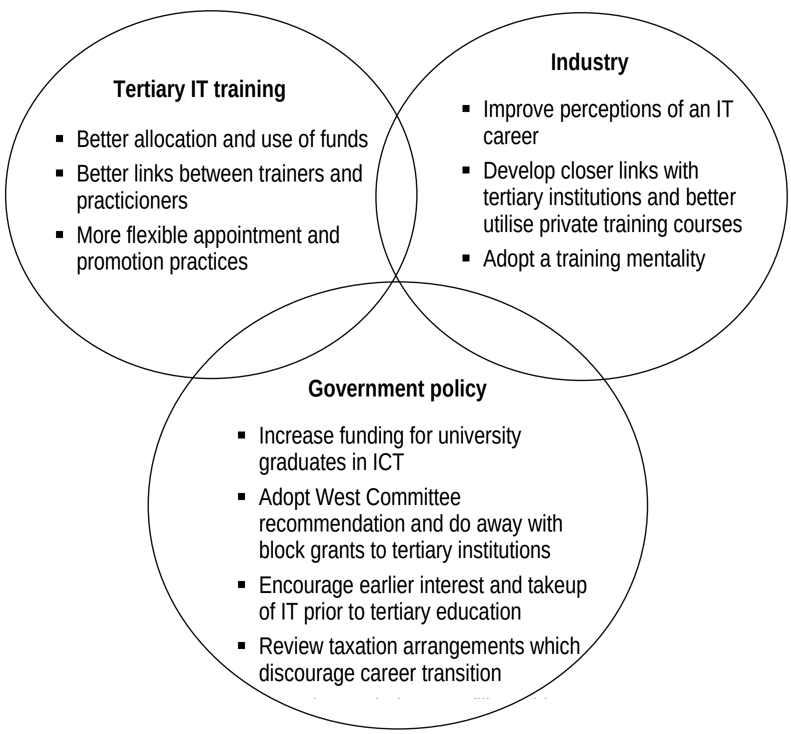
A role for government

In addition to desirable funding changes for universities, there is also a role for government to facilitate industry investment in training and the movement of people into ICT through changes to the taxation system. There is a large economywide benefit from more ICT training and some increase in funding is warranted. But the issue is not just one of funding. It is also about policies. The government has yet to adopt the key recommendation of the West Committee report and abolish block funding of universities. Funding the student and not the institution is one mechanism that would cause tertiary institutions to be more responsive to market demands, whether for ICT or some other sector where demand could change quickly. Other models may also warrant exploration. Ultimately some change is required.

For those looking to move into ICT, the inability to offset retraining costs through the tax system is a disincentive to moving into ICT. Retraining costs are not insignificant ($8000 to $41 000), but the rules for self-education expense deductions clearly state that expenses can only be claimed when they relate to *current* work activities. Also, there may be scope to facilitate the requisite change in industry mindset through the provision of tax credits for training. Tax credits for an industry levy might be one option. In addressing the size of the labour pool, there may also be scope, working with industry, to improve the image of an ICT career through programs delivered to school age children. In some way, government policy could be just the catalyst needed to engender a change in culture in the ICT industry.

Chart 6.3 summarises the issues that need to be confronted to address the ICT skills shortfall. They fall into three categories with obvious areas of overlap, those being: changes within the tertiary institutions; changes in the industry itself; and changes in government funding and policy.

6.3 **Issues to be targeted in overcoming the IT skills shortfall**



A Terms of reference

Economic study specifications

Objectives of the study

The Study should seek to identify three distinct economic impacts of Government investment in ICT higher education:

- the level of direct investment (expenditure) on ICT higher education by Government;
- the enhancement of the nation's human capital through its ICT education of university graduates; and
- the broader economic benefits to the national economy through the 'spillover' effects to government and industry of ICT related productivity gains, research and development activities.

The *primary emphasis* for the Study should be to assess and quantify the broader economic benefits to the national economy of ICT higher education expenditure. This in turn should test the proposition that ICT higher education expenditure provides a 'multiplier effect' in terms of economic benefits eg. a net $4 in economic benefit for every $1 of direct expenditure on ICT higher education.

Prescription

The Study should *not* be a statistical analysis of comparative data of public spending on higher education.

Instead, the Study must evaluate data and information using economic modelling techniques based on known economic principles. By using economic arguments, this Study can demonstrate the economic benefit of increased government funding of ICT education at universities, and therefore, be a more persuasive argument to cause a change of attitude.

It is intended that the modelling methodology developed should also be capable of being adapted to undertake comparative economic analysis for the Vocational Education and Training (VET) sector.

Focus of the economic analysis

While not seeking to impose restrictions, it is considered that the economic analysis conducted should focus on these three major areas:

1. Comparative analysis

The Study should present a comparative examination of cost patterns in OECD countries, focusing on three aspects of ICT higher education spending:

- the resources that each country invest in ICT higher education, relative to national wealth, the number of students, and the size of the public purse;
- the ways in which higher education systems are funded, and the sources from which the funds originate; and
- the apportionment of resources between different budget allocations to identify how much is spent on ICT higher education.

2. Economic performance indicators

The Study should consider the implications of an increase of government spending on ICT higher education against common economic performance indicators such as:

Contribution to economic growth and trade

- productivity gains: impact on output of GDP, especially contribution to real GDP increases, and on consumption;
- aggregate employment and wages;
- investment;
- changes in price and inflation; and
- external competitiveness for Australia eg. exchange rate impact, export and import volumes, terms of trade and change in exports.

Economic and business simulation

- realisation of opportunity costs;

- opportunity for investment growth;
- proofing of trade cycles; and
- effect on speed to market.

Productivity

- Opportunities for national and industry productivity

Return on investment

- for government;
- for business and industry;
- for tax revenue as a return on government investment; and
- difference between the 'social' and the 'private' rate of return to educational investment.

Costs of investment

- alternative costs.

3. Drivers for more effective and efficient use of investments in education

The Study should provide descriptive opinions about the economic drivers available for Australia to achieve more effective and efficient use of government investment in education on such points as:

What alternative methods exist to the financing of education?

Why costs are increasing and how governments could maintain access and possibly mitigate future cost increases?

What economic incentives exist to induce students, teachers and education institutions to adopt more productive behaviours?

How to make more effective and efficient use of current government investment in education, education facilities and structures?

Scope and Boundary of the study

The following parameters set the scope and boundary to ensure that the Study will meet to the Association's foremost needs:

1. The study should focus on **public spending** *on education*

Australian governments contribute well over 50 per cent of the funding of the public and private education systems despite the shift in the balance between public and private spending on education over the last five years. This is particularly so for pre university education.

Governments have a strong and certain influence education systems, markets and infrastructures; student and institution market behaviour; and resource allocation to and by education institutions.

In terms of undertaking the Study, useful data on public spending is more readily available and accessible. International benchmarking of private spending will be more difficult given the considerable variance in different national systems and industry education.

2. The study should focus on higher education

Overall, the Study should be limited to the higher education system, particularly university undergraduate and postgraduate education.

The industry mainly recruits employees with tertiary qualifications, although it does not restrict itself to employees with computing science and similar qualifications.

Data on university undergraduate and postgraduate education is probably more readily available, and research findings can be extrapolated to other levels of education.

3. The study should focus on ICT education

ICT education is of specific interest to the Association, particularly public higher education spending on ICT education programs, resources and courses.

An assumption is made that ICT higher education has a greater multiplier effect and ROI than other education in other disciplines. Accordingly, research that has been undertaken at more general levels may not be useful when looking directly at the investment by governments in computing and communications higher education.

Nevertheless, it is acknowledged that data directly associated with ICT higher education program may be difficult to compare, let alone obtain.

ICT higher education programs and curricula should be interpreted broadly given the wide variance in these types of courses delivered by universities, but should focus on 'higher order' ICT skills rather than generic ICT skills provision.

4. The study should look at outcomes for the National economy

The Study should look at the economic outcomes of investment in public higher education in the ICT area for the Australian national economy, and not solely for the economy returns to the ICT industry.

For example, the Study should look at identifying and quantifying the economic impacts of ICT education expenditure in terms of:

- productivity gains: impact on output or GDP, especially contribution to real GDP increases, and on consumption;
- aggregate employment and wages;
- investment;
- changes in prices and inflation; and
- external competitiveness for Australia eg. exchange rate impact, export and import volumes, terms of trade and change in exports.

This is similar to the type of economicwide assessment that NOIE commissioned for the impacts of e-commerce on the Australian economy in the report *E-commerce beyond 2000: Final report*.

5. The study should use available data and information

The Study should examine current available data, particularly government sources. Assumptions, based on economic principles, are permissible to overcome gaps in data or information.

6. The study should look at the costs at well as the benefits of investments in ICT higher education

The Study should not restrict itself to detailing the benefits of government investment in public ICT higher education. The Study should also examine the costs of investment, as well as identifying possible market inhibitors and impediments through distortions created by government investment in ICT higher education.

7. The study should look at wider economic drivers

The Study should encompass considerations of labour market; private sector investments; commercialisation benefits and costs; student and institutional barriers; population and participation rates, distribution of the financial burden of educational support among levels of government and private sources etc.

8. The study should produce an economic model capable of wider applications

The Study must provide an economic model which would be readily adapted to assess the economic impacts for other education sectors, eg. VET sector, expenditure on ICT education / training.

B Stakeholder consultations

B.1 Steering committee members

Name	*Title*	*Organisation*
Doug O'Hara	Manager, Education Services	Aspect Computing
Iain Morrison	Deputy Head Department of Information Systems	University of Melbourne
John Price	Managing Principal	JSP Associates
John Rosenberg	Dean Faculty of Information Technology	Monash University
Lucio Krbavac	Senior Advisor Skills Analysis and Data management	Department of Education, Training and Youth Affairs
Michel Hedley	Education and Training	Australian Information Industry Association
Phil Kerrigan	Managing Director	Fujitsu Australia
Peter Scope	National Education Manger	CISCO
Ann Lawn	Managing Consultant	Tier Technologies
Phil Malone	General Manager, E-Commerce	National Office for the Information Economy
Robyn Fleming	Manager, Education Strategies	National Office for the Information Economy
Peter Huta	Assistant Director, Education Strategies	National Office for the Information Economy
Helen Woollett	Public Affairs Manager	IBM Australia
Steve Braim	Manager, Government Programs	IBM Australia

B.2 List of additional consultations

Name	***Title***	***Organisation***
Alex Gosman	Manager	Ericsson Australia
Andrew Skewes		Multimedia Victoria
Helen Woolett	Public Affairs Manager	IBM Australia
Jane Aisbett	Head, School of Management	University of Newcastle
Julie-Anne Tooth	Human Resources Manager	Unisys
Marea Phillips	Managing Director	Terasys Australia
Michael Clugston	Managing Director, Education	Spherion
Michael Fry	Dean, Faculty of Information Technology	University of Technology, Sydney
Paul Stubing	Director of Information Technology Policy	Australian Vice Chancellor's Committee
Peter Johns	Executive Director, Recruitment Solutions	Spherion
Phil Kerrigan	Managing Director	Fujitsu Australia
Rebecca Power	Director	P&O
Rick Clark	Managing Director	Ericsson Asia Pacific Labs
Robert Whitechurch	P&O Graduates	Ericsson Austra;oa
Roy Hill	Head of Studies, Computing	Hunter Institute of Technology
Steve Ross	General Manager	ComTech Education Services

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