1. ICT in the Knowledge-Based Economy

1.1 The Knowledge-Based Economy

Many of the recent transformations in national economic policies around the world have been in the context of a drive towards the *knowledge-based economy* (OECD 1996, 2001) (APEC 2000, 2001, 2002) (ESA 2002) (Houghton 2002b) (ACG 2002) (ABS 2002b). This type of economy is also commonly referred to as the *information economy*, *digital economy* or *new economy*. The term 'knowledge-based economy', or KBE, was coined by the OECD. They defined the term as an economy "*directly based on the production, distribution and use of knowledge and information*" (OECD, 1996). This relentless drive is based on the belief in the benefits of an economy fundamentally different from the ones that existed prior to the mid-1990s[2]. This belief has support in strong quarters, none more so than the chairman of the U.S. Federal Reserve, Alan Greenspan. He described in 1998 that the U.S. economy is going through,

> *"… what can be best described as another industrial revolution. The rapid acceleration of computer and teleCommunication technologies is a major reason for the appreciable increase in our productivity in this expansion, and is likely to continue to be a significant force for expanding standards of living into the twenty-first century."*
>
> (quoted on page 6, DoC 1999)

There have been widespread efforts in quantifying the factors and dimensions of this KBE. A significant development in this is the OECD's two-year project called the *Growth Project*. The project concluded in 2001 with a final report *The New Economy: Beyond the Hype* (OECD, 2001a). That report identifies the following as key aspects to the new economy:

- Information and Communication Technology as an enabling technology
- An innovative environment
- Human capital
- Entrepreneurial climate
- Economic and social fundamentals

APEC also ran a parallel project from mid-1999 called *Towards Knowledge-Based Economy in APEC*. The project culminated in a report in November 2000 (APEC 2000). The report identified similar dimensions to the KBE as OECD's Growth Project. They are:

- Innovation System
- Human Resource Development
- ICT Infrastructure
- Business Environment

In the Australian context, the Australian Bureau of Statistics (ABS) is currently consulting on a new framework for dimensions and indicators for KBE (ABS 2002b). Since the ABS framework is built on OECD and APEC's work, it therefore lists similar dimensions to those concluded by OECD and APEC. The dimensions are diagrammed in Figure 1.1. Details of framework are found in Appendix B.

[2] Associated with this change to the economy is what is believed to be an equivalent, less understood, change to society in general. Terms like *the Knowledge-Based Society* and *Information Society* are used to characterise this. Readers are referred to Lee (2002) for further discussions.

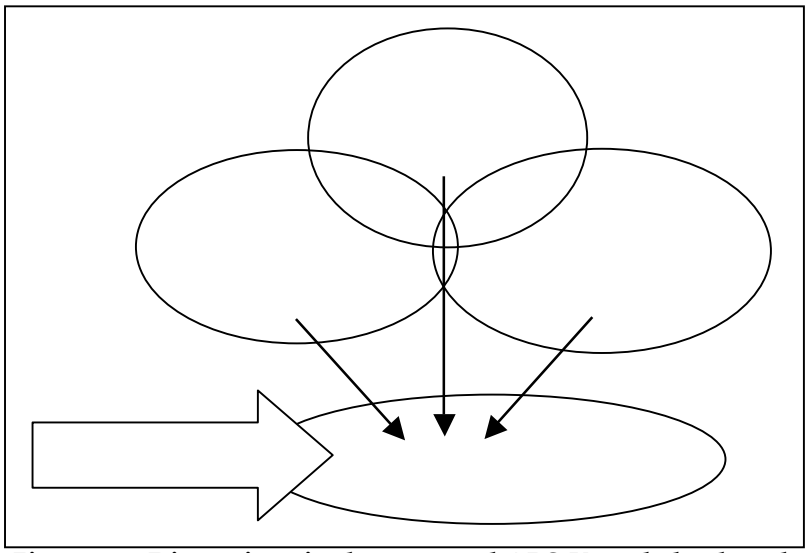

Figure 1.1: Dimensions in the proposed ABS Knowledge-based Economy/Society Framework. Source: ABS (2002b) page 15.

In all of these analyses, we see that Information and Communication Technology (ICT)[3] plays a very prominent role in this new economy. Many hold the belief that the main reason for the changes to the economy was the widespread diffusion of ICT within various industries[4]. This new ICT sector has the properties of many fundamental enabling technologies in the past: they are general-purpose, applicable to many areas, and capable of changing the basic processes of work and recreation.

In spite of ICT's importance, it is widely accepted that considerations for the KBE should not be concentrated only on the technology sectors. As noted in the *Towards Knowledge-Based Economy in APEC* report:

> *… being a KBE means more than simply having a thriving "new economy" or "information economy" that is somehow separate from a stagnant "old economy". In a truly knowledge-based economy, all sectors have become knowledge-intensive, not just those usually called "high technology".* (APEC 2000, page vii)

1.2 Definitions and Measurements of ICT

There are many ways to view ICT in the context of our economy and society. The term can cover the basic production through manufacture and services, through to distribution, usage, diffusion, content development, and so on. With the prevalence of these various aspects of ICT, there have been many international efforts[5] in defining and measuring the various aspects of ICT. In this section, we summarise the major efforts.

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[3] In this report, we will refer to ICT as "*Information and Communication Technology*". However, note that there isn't total agreement in the literature on the expansion for this acronym. Some refer to "*Information and Communication**s** Technology*", as well as "*Information and Communication**s** Technolog**ies***". There are also other commonly used terms to refer to the same field, such as "*Information Technology and Telecommunications*" (IT&T), and "*Networking and Information Technology*".

[4] See references already listed in this section. There are, of course, opposing views as well. For example Gordon (2000) challenges the claim that ICT can match the technology revolutions of the past, like electricity and internal combustion engine, or even movies, radio and indoor plumbing.

[5] Example see reviews in Jeskanen-Sundström (2001) and ABS (2002b)

The most active international body in developing definitions and measurements of ICT is the OECD, with heavy influences by the Voorburg Group from the United Nations Department of Economic and Social Affairs Statistics Division. It has extensive work in defining the ICT sector, the outputs of this sector, and their application to various other sectors[6].

Industrial Definition of the ICT

In the late 1990s, as ICT activities became prevalent, OECD countries started to recognise the importance of measuring ICT as an industrial sector. This led to the formation of an ad-hoc statistical experts group under the Information, Computer and Communication Policy (ICCP) Division in 1997. In 1998, this group became the Working Party on Indicators for the Information Society (WPIIS). WPIIS began working on drafts of a definition using the International Standard Industrial Classification of All Economic Activities (ISIC Rev.3). The principles underlying the definition were (Roberts 2001):

- For manufacturing industries, the products of a candidate industry must be intended to fulfil the function of information processing and communication including transmission and display or must use electronic processing to detect, measure and/or record physical phenomena or to control a physical process.
- For services industries, the products of a candidate industry must be intended to enable the function of information processing and communication by electronic means.

As an indication of prevailing thoughts at the time, the following diagram was used in a 1997 draft[7] to indicate what ICT production and distribution activities consisted of:

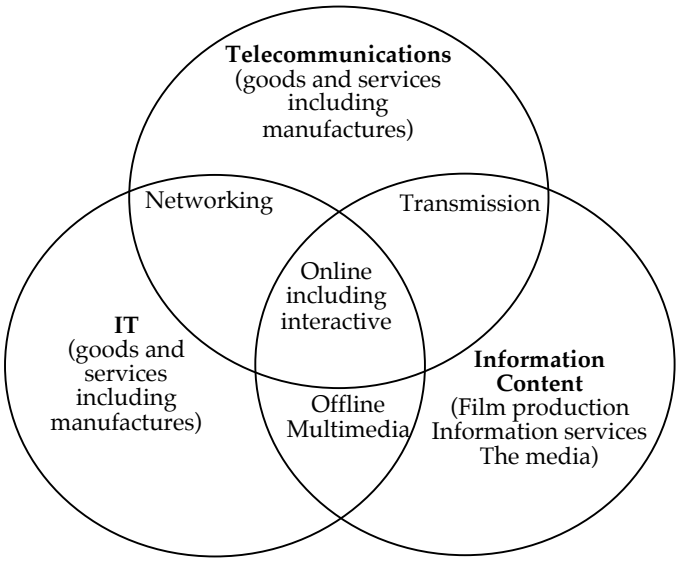

Figure 1.2: ICT Production and Distribution activities. Source: http://www2.dst.dk/internet/voorburg/pdf/3_3.pdf.

[6] For elaborations, see review in Roberts (2001) and Pattinson (2000).
[7] Full draft available at http://www2.dst.dk/internet/voorburg/pdf/3_3.pdf. This draft was produced by the Statistical Panel of OECD's ICCP Division as a discussion paper at the September 1997 Voorburg meeting.

In 1998, the WPIIS reached a consensus on a basic definition (OECD 2001). This definition of the "ICT sector" included the following ISIC Rev 3 industry classes:

- Manufacturing:
    - 3000 – Office, accounting and computing machinery;
    - 3130 – Insulated wire and cable;
    - 3210 – Electronic valves and tubes and other electronic components;
    - 3220 – Television and radio transmitters and apparatus for line telephony and line telegraphy;
    - 3230 – Television and radio receivers, sound or video recording or reproducing apparatus and associated goods;
    - 3312 – Instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process equipment;
    - 3313 – Industrial process equipment.
- Services:
    - 5150 – Wholesaling of machinery, equipment and supplies (if possible only the wholesaling of ICT goods should be included);
    - 7123 – Renting of office machinery and equipment (including computers);
    - 6420 – Telecommunications;
    - 72 – Computer and related activities.

OECD uses the ISIC Rev 3 classification system even through it recognises that ISIC Rev 3 does not cover all (potentially) ICT-related activities. Unfortunately, no better alternative existed. For this reason, individual countries have combined other data sources with their own versions of industrial classifications[8] to derive ICT aggregates in national accounts and other statistical collections. Even when using ISIC Rev 3, the classes were not uniformly applied by the different countries. For these reasons, data published from different countries needs to be constantly modified when used for comparative purposes, to adjust for the methodologies of the times.

The OECD definition is not static, and undergoes reviews due to changes in ICT activities. The latest review in April 2002 concluded that the 1998 definition was still adequate and decided against making any changes at that stage. One of the predominant review questions in an industry-based definition such as this is whether a certain industry class contains sufficient ICT activities to be included in the definition[9]. OECD expects that as prevailing industrial activities relating to the technologies change, classes will be included and/or removed accordingly.

Commodity-Based Definition of the ICT

Having defined the ICT sector based on industrial activities, the OECD is moving towards defining the sector based on ICT commodity products. Similar to the principals underlying the industry-based definition, the commodity-based definition aims to define a set of products that are

[8] Major ISIC related classification systems in different countries include the *Australian and New Zealand Industrial Classification* (ANZSIC) in Australia, *North American Industry Classification System* (NAICS-USA) in the United States, and *General Industrial Classification of Economic Activities* (NACE) within European Communities. See http://unstats.un.org/unsd/class/family/famlist1.htm for details of these systems. See Appendix 1 Table A.1 in OECD (2002b) for chart comparing the different systems.

[9] Example, see the Sept 2001 review at a meeting in Örebro, Sweden <http://www.voorburg.scb.se/ICTsector_voorburg.doc>.

- intended to fulfil ICT-related functions by electronic means, including transmission and display, or
- use electronic processing to detect, measure and/or record physical phenomena, or control a process.

For the commodity-based definition, OECD uses the international Central Product Classification (CPS) for goods and services production, and the Harmonised System for data on international trade. However, these systems have to be modified since they specifically identify ICT products, and they are relatively old and hence do not include recent goods and services coming from ICT.

Definition of Electronic Content

The WPIIS is also working on defining an *Electronic Content* sector, as the sector that produces the information content. This is a rapidly growing sector. The definition is meant to be used in contrast and in conjunction with the definition of the ICT sector above, which only deals with the infrastructure that stores, displays, transmits and processes the information. Progress in this regard has been slow and has not been a priority.

ICT Diffusion

Another important category of measurement in ICT is how and to what extent ICT outputs are diffused across the economy. In this aspect of ICT measurement, there is less need for a "definition". Work has concentrated on developing model surveys of the use of ICT goods and services across all sectors of the economy, including the Business sector, the Government sector and the Household sector. Australia has also taken a lead role internationally in measuring ICT diffusion in the Farming sector.

E-Commerce

The OECD and the European Union have focussed very heavily on defining electronic business processes carried out using ICT technologies and applications. The impetus for this work comes from the OECD *E-Commerce Action Plan* endorsed by Ministers at the 1998 Ottawa Conference on Electronic Commerce. In line with this, the WPIIS created an Expert Group on Defining and Measuring E-Commerce in 1999.

The Expert Group categorised three initial sets of indicators required for policy purposes:

- **E-Readiness**: measuring the infrastructure in place to allow for e-commerce activities to occur,
- **E-Intensity**: measuring the extent to which users are utilising e-commerce to undertake their normal business and social processes, and
- **E-Impacts**: measuring the impact of e-commerce on the economy and society

In 2000, the Expert Group also provided a broad and a narrow definition of E-Commerce Transactions:

- Broad Definition: *An **electronic transaction** is the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over **computer-mediated networks**. The goods and services are ordered over those networks, but the payment and the ultimate delivery of the good or service may be conducted on or off-line.*

- Narrow Definition: *An **Internet transaction** is the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over **the Internet**. The goods and services are ordered over the Internet, but the payment and the ultimate delivery of the goods and servicse may be conducted on or off-line.*

Refer to Pattinson (2000), and chapter 4: *E-Commerce Intensity* in OECD (2002b) for further details of work in defining E-Commerce.

Australian Bureau of Statistics

The Australian Bureau of Statistics (ABS) collects data on indicators of the ICT industrial sector (or more commonly called IT&T in past ABS terminology) in Australia for national accounts purposes. The ABS data uses the Australian and New Zealand Standard Industrial Classification (ANZSIC) to classify IT&T activities. ABS uses the following ANZSIC industries for IT&T surveys:

- Manufacturing
  - 2430 Recorded Media Manufacturing and Publishing (from 1998-99)
  - 2841 Computer and Business Machine Manufacturing
  - 2842 Telecommunication, Broadcasting and Transceiving Equipment Manufacturing
  - 2849 Electronic Equipment Manufacturing nec
  - 2852 Electric Cable and Wire Manufacturing
- Wholesale Trade
  - 4613 Computer Wholesaling
  - 4614 Business Machine Wholesaling nec
  - 4615 Electrical and Electronic Equipment Wholesaling nec
- Telecommunications
  - 7120 Telecommunication Services
- Computer Services
  - 7831 Data Processing Services
  - 7832 Information Storage and Retrieval Services
  - 7833 Computer Maintenance Services
  - 7834 Computer Consultancy

ABS deliberately leaves out a few of the equivalent categories covered under the OECD ICT industrial definition. ABS determined that in Australia, a few of the minor sub-categories do not involve significant amount of ICT activities to warrant inclusion.

Besides the manufacturing and service production activities covered under the ICT sector, ABS also collects a significant amount of data on the diffusion and usage of ICT in other sectors. Refer to the links for ABS in Appendix A for the full set of statistics.

United Nations and ITU

The United Nations main interest in ICT indicators is in their relation to global social progress. In September 2000, 147 heads of government and 189 nations under the United Nations banner made a *Millennium Declaration*[10]. The declaration was founded on social and economic developments targeted at freeing the human race from want. Of the 18 targets stated, target number 18 relates to ICT. The target is stated as, *"In cooperation with the private sector, make available the benefits of new*

[10] http://unstats.un.org/unsd/mi/mi_highlights.asp

technologies, especially information and communications". The two indicators used for this target are:

- Telephone lines and cellular subscribers per 100 population, and
- Personal computers in use per 100 population and Internet users per 100 population

Both these indicators are officially measured and released[11] by the International Telecommunications Union (ITU). ITU also uses and publishes a more comprehensive set of communications and network indicators[12].

Other ICT Economic Statistics Collection

Some sections of the research community have attempted to measure the ICT status by combining different indicators for form indices. Some examples of these are the *Index of Technological Progress* by Rodriguez and Wilson (Rodriguez and Wilson, 2000), InfoDev's *E-Readiness Index* (InfoDev, 2001), *Technology Achievement Index* by Desai et al (Desai et al, 2002), and *E-business Readiness Index* by the Economist Intelligence Unit (EIU 2001, 2002).

ICT Defined as Academic Body of Knowledge

See section 4.3 and Appendix D for an overview of ICT-related areas as an academic body of knowledge.

1.3 Current Statistics on ICT in Australia

Compared to the many other major economies in the world, Australia has a very minor ICT production sector (Houghton 2001, 2002, and ABS data). Table 1.1 shows some key statistics on the Australian ICT sector as of June 2001, as released by the Australian Bureau of Statistics.

Table 1.1: Australian ICT Sector - Summary of Operations (June 2001)

	Businesses	Persons Employed	IT&T income	Total income	Wages and salaries	Industry value added
	no.	no.	$m	$m	$m	$m
IT&T SPECIALISTS						
Manufacturing						
Computer and business machines	282	3,398	1,311.3	1,342.7	137.6	227.9
Telecommunication, broadcasting and transceiving equipment	188	8,373	1,914.0	2,340.5	555.8	815.3
Electronic equipment n.e.c.	-	-	-	-	-	-
Electric cable and wire	28	928	430.2	469.7	55.6	139.9
Total Manufacturing	**497**	**12,699**	**3,655.4**	**4,152.9**	**749.0**	**1,183.0**
Wholesale trade						
Computers	2,320	38,656	20,271.2	20,618.3	2,148.2	3,057.6
Business machines and electrical and electronic equipment n.e.c.	483	12,327	6,072.5	6,704.4	902.2	1,056.3
Total Wholesale trade	**2,803**	**50,983**	**26,343.7**	**27,322.7**	**3,050.4**	**4,113.9**

[11] Regular publications of the indicators can be found at http://unstats.un.org/unsd/mi/mi_goals.asp.
[12] See http://www.itu.int/ITU-D/ict/.

Telecommunication services	**814**	**77,275**	**29,827.1**	**31,504.8**	**4,651.3**	**15,478.4**
Computer services						
Data processing	485	3,718	*443.2	*477.3	154.3	*263.1
Information storage and retrieval	33	1,174	141.7	150.0	49.0	73.6
Computer maintenance	457	4,451	944.4	983.2	252.6	337.9
Computer consultancy	17,386	88,222	12,411.6	12,927.3	5,154.6	6,761.5
Total Computer services	**18,361**	**97,565**	**13,940.9**	**14,537.8**	**5,610.5**	**7,436.0**
Total	**22,475**	**238,521**	**73,767.1**	**77,518.2**	**14,061.1**	**28,211.3**
OTHER BUSINESSES						
Manufacturing						
Computer and business machines	16	808	n.p.	212.4	45.4	262.1
Telecommunication, broadcasting and transceiving equipment	-	-	-	-	-	-
Electronic equipment n.e.c.	301	8,027	31.1	1,948.4	361.1	558.1
Electric cable and wire	33	2,461	n.p.	939.2	134.9	241.8
Total Manufacturing	**351**	**11,296**	**109.5**	**3,099.9**	**541.4**	**1,062.0**
Wholesale trade						
Computers	-	-	-	-	-	-
Business machines and electrical and electronic equipment n.e.c.	1,914	26,744	634.9	9,174.2	1,088.7	1,660.4
Total Wholesale trade	**1,914**	**26,744**	**634.9**	**9,174.2**	**1,088.7**	**1,660.4**
Telecommunication services	-	-	-	-	-	-
Computer services	-	-	-	-	-	-
Total	**2,264**	**38,040**	**744.5**	**12,274.0**	**1,630.1**	**2,722.3**

n.p. = not published; n.e.c. = not elsewhere classified;
Source: ABS AusStats 2001.

However, Australia is one of the heaviest consumers and adopters of ICT in the world (examples see Table 1.2). The Economist Intelligence Unit/Pyramid Research in evaluating the E-business Readiness of over 60 countries ranks Australia 6th and 2nd in 2002 and 2001 respectively (EIU 2001, 2002). The readiness ranking is based on 6 categories of factors: connectivity; business environment; e-commerce consumer and business adoption; legal and regulatory environment; supporting e-service; social and cultural infrastructure. The index used by the Australia's own National Office for Information Economy (NOIE) places Australia 3rd behind the US and Sweden[13].

Table 1.2: Summary of Australia's status in ICT penetration and usage relative to other countries.

	Aust ranks	Highest Ranked
% of households with a fixed telephone line	7th	Norway , Sweden
% of households with more than one fixed telephone line	6th	US
% of persons 16 years and over with use of a mobile phone	8th	Hong Kong
% of households which own / lease a PC	2nd	South Korea
% of households connected to the Internet	7th	Hong Kong, Sweden
Internet connection speeds	9th	South Korea

[13] http://www.noie.gov.au/projects/framework/Progress/ie_stats/CSOP_April2002/index.htm

% of persons 2 years and over with Internet access via a home PC	8th	Sweden
% of persons 16 years and over with Internet access from any location	5th	Sweden
% of persons 16 years and over with Internet access at home	8th	Sweden
% of persons 16 years and over with Internet access at work	4th	Sweden
% of persons 16 years and over with Internet access actually using the Internet	6th	Sweden
Equity of access (lowest difference) between males and females for persons 16 years and over	1st	Australia
Equity of access (lowest difference) between age groups for persons 16 years and over	1st	Australia
Number of persons 16 years and over with Internet access per ISP	1st	Australia
Number of secure servers per 100,000 persons 16 years and over with Internet access	2nd	US
Price of 40 hours of Internet use at peak times	3rd	US
Charges for a basket of national leased lines of 2 megabits per second	10th	Sweden
Average number of Internet sessions	9th	South Korea
Average hours online per month	7th	South Korea
% of persons (people with Internet access and browsers) 16 years and over purchasing online	5th & 8th	US
B2C as a % of GDP	6th	US
B2B as % of GDP	4th	US
Peak penetration of online government services	3rd	US

Source: NOIE's State of Play – April 2002 (NOIE 2002).

Many other key statistics on ICT usage and diffusion released by the Australian Bureau of Statistics supports the view that ICT is widely adopted and diffused in Australia. Some of these statistics include:

- Businesses using ICT:
    - 84% were using computers (up from 76% in June 2000)
    - 69% had Internet access (up from 56%)
    - 22% had a web presence (up from 16%)
    - 20% were purchasing via the Internet (up from 10% in 1999-2000)
    - 9% were selling via the Internet (up from 6% in 1999-2000)
- ICT in Government (in 2001):
    - Total IT&T expenditure were $4.3 billion (5% of total government operating expenditure).
    - 47% of the IT&T expenditure were from federal government, 45% from state/territories, and 8% from local governments.
    - IT employees accounted for 2% of government employment.
- Farm use of ICT (in 2001):
    - Total IT&T expenditure were $4.3 billion (5% of total government operating expenditure).
    - 47% of the IT&T expenditure were from federal government, 45% from state/territories, and 8% from local governments.
    - IT employees accounted for 2% of government employment.
- ICT R&D
    - The business sector is the biggest contributor to ICT R&D expenditure.
    - In 1999-2000, total business sector R&D expenditure on ICT were $1.4 billion, mostly in *Computer Software* and *Communications Technologies*.

- IN 1999-2000, the section of the ICT industry investing most in R&D is the *Computer Consultancy Services* ($489 million of the $1.2 billion by all specialist ICT industry sections).

Further statistics on R&D by higher education, government and businesses can be found in Chapter 5.

Refer to links in Appendix A for further details of key measurements of the ICT in Australia, including those from the ABS.

1.4 ICT, Growth and Productivity

ICT as a production sector internationally is still relatively small. In spite of that, its impact has been substantial. It is well established that ICT can be a strong driver for economic growth - for example see McKinsey (2001) and Roeger (2001) for the U.S.; Daveri (2000) and Van Ark (2000) for Europe; Productivity Commission (PC 1999), Parham (2002a, 2002b), Simon and Walrdrop (2002) for Australia. ICT can contribute either directly through investment increase in the technologies themselves, or by contributing to growth in other measured outputs. One of the most important, and most studied, aspects of economic growth due to ICT is *productivity* (and *labour productivity* in particular). In the last half decade going into 2000, Australia and the US[14] experienced a significant surge in productivity[15] (0.5% of GDP in the US, and 1% of GDP in Australia). This productivity surge was also found in countries like Ireland and Finland, but not in other major economies like Japan and Europe in general (Schreyer 2000). The most visible candidate for the driver of this productivity surge was ICT. Studies show that IT and ICT spending are strongly linked to that productivity gain in US (USCEA 2001, Oliner and Sichel 2000) and in Australia (PC, 1999). However, these links between ICT and productivity above are mostly correlational, rather than causal in nature. Most studies found productivity gains in industries with high ICT-adoption, like Finance and distributions channels in wholesale and retail trade, etc (Johnson et al 2000, Pilat and Lee 2001, Parham, Roberts and Sun 2001, Parham 2002a). However, the exact cause-effect relationship is not as obvious.

In analysing what aspects of productivity ICT contributes to, we look at the two components of productivity: capital deepening and multi-factor productivity (MFP). For capital deepening, analysis suggests that the capital increases in ICT have merely replaced other forms of capital, resulting in minimal net capital deepening. In Australia during the last half of the 1990s, the net capital deepening overall have actually decreased by 0.1% of GDP in spite of a massive 0.4% increase in ICT capital (Parham 2001, 2002a, 2002b). The conclusion from this is that ICT's role in capital deepening does not contribute significantly to overall growth.

As for MFP, some commentators (eg. Oliner and Sichel 2000) attribute approximately 0.3% of GDP in MFP acceleration in the US in the second half of the 1990s to manufacturing and production of ICT. However, since Australia has a very minor ICT production sector, it leaves a big question about where its 1.1 percentage point MFP acceleration comes from. A common answer is that ICT adoption has transformed the activities of individuals and businesses, and across multiple

[14] Due to the US's leadership in ICT and its link to their productivity, data from the US is commonly used around the world as a benchmark for productivity gains resulting from ICT.

[15] Although the existence of a productivity surge in Australia in the 1990's is widely accepted, there are commentators who question the positive interpretation commonly used to explain this surge. Eg Quiggin (2001) argues among many things that this surge is only a temporary statistical artefact due to unsustainable factors like increased work intensity.

industries (PC 1999, Parham et al 2001). These effects have been found in other countries as well (Bresnahan et al 2002, Jorgenson and Stiroh 2000, Dumagan and Gill 2002). Many believe it is these transformations that will bring the most benefits to economies (APEC 2001, Simon and Wardrop 2002, Parham 2002a). But for these transformations to happen, it will take time for the technologies to be diffused and for firms to undergo organisational change and worker up-skilling to adjust to them. Some commentators believe that the real economic effects of ICT are to emerge in the near future (eg. Gruen 2001).

There are also other non-ICT factors that many believe contribute to the productivity surge, including education and skill (Barnes and Kennard 2002), sharper competition, trade and investment openness, and microeconomic reform (PC 1999, Pilat and Lee 2001, Parham et al 2001, Parham 2002a,b).

See sections 2.5 and 2.7 for a review on the impact of knowledge as presented in this section on national policy recommendations.

1.5 Current Downturn in the ICT Sector

The current downturn in the ICT sector has been very visible in the media. There has been extensive news coverage of declines in technology stocks, the dot-com bust and large-scale job cuts[16]. In spite of this, many still believe we are just as actively shifting towards a knowledge-based economy (Price and McKittrick 2002, section III in APEC 2001). All industries, including the ones classified as "old economy", are being transformed. The transformations are the result of networked information, greater transparency, and enhanced efficiency through business-to-business transactions. All these came about partly due to the diffusion, adoption and integration of new technologies.

However, what the current downturn shows is that conventional business cycles and inflation are still very much a part of the economy. The over-optimistic belief that the new economy can eliminate business cycles and inflation was misguided. The failures of many technology firms also demonstrate that pursuing unreasonable rates of profitability and growth can come at a huge cost.

The OECD *Information Technology Outlook 2002* report (OECD 2002, page 25) attributes the current industry slump to: firms' over-investment; correction in high-technology stocks; saturation in ICT markets; lower supply-side inventory buffers; and accelerated write-offs on the demand-side. As expected, it is cautious in predicting an upturn, but is optimistic for the near-term and noting that many of the factors causing the downturn are reaching the end of their adjustments[17]. The current consensus among global community is one of cautious optimism for a slow recovery in the general economy within the next year[18].

Another very important fact also arises out of the turmoil in the last few years: the nature of the ICT field can turn quite dramatically. Just as the rate of growth and the

[16] An informal count by this author on articles appearing in the online IT section of *The Australian* newspaper showed that headlines of job cuts appeared on average once every two days in the two months following September 11 2001. Some of the job cuts were also very substantial (eg. 20 000 at Nortel, 10 000 at Alcatel, 9400 at Motorola, etc).

[17] It is important to consider that the report analyses the environment only up to early 2002, and therefore is not able to take into account very recent developments (such as the accounting scandals and the prolonged and continued decline in stock exchange equity prices).

[18] Example, see recent summary of global economy in article "The Unfinished Recession", *The Economist*, 28th Sep 2002, and address by RBA's AssistantGovernor in "The Global Economic Scene", *Reserve Bank of Australia Bulletin*, September 2002.

ubiquitous impact of ICT in the 1990s were was unexpected, so were the timing and the extent of the downturn. The act of prediction in disruptive technologies like ICT is fraught with danger. This is especially important when most of the data we currently have on the trends in this field come from over one-half to two years ago (before 2001). This lag in trends data is common in any field. We need to take care in using such data to predict into the future.

1.6 Key Findings

1. ICT plays a critical role in the knowledge-based economy and society, but that role is multi-faceted and complex. Effective long-term planning for sustainable ICT developments requires in-depth understanding of ICT from many perspectives.

2. There are many different definitions of 'ICT', each with its unique purpose. As the use of the term is yet to reach full maturity, the definitions will likely be further modified. By keeping abreast of key national and international developments in such definitions, we can gain insight into critical components of this field.

3. The current consensus view for the sector is for a slow recovery in the near future. But the upheaval in the last decade demonstrates the need for structures and processes that are relatively adaptable to cyclic fluctuations. Such adaptable structures will be crucial as we face the uncertainties still present in this sector.

4. Most data currently available on this field are pre-2001. We need to take care in using such data to predict into the future.