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CAUGHT IN THE MIDDLE:
AUSTRALIA'S INFORMATION TECHNOLOGY POLICY

Jason Dedrick and Kenneth L. Kraemer

Center for Research on
Information Technology and Organizations
(CRITO)

Graduate School of Management
and
Department of Information and Computer Science

University of California, Irvine

ABSTRACT

Australia's treatment of information technology (IT) can be characterized as falling between two policy extremes--laissez faire, market-directed strategy on the one hand, and strong government interventionist, plan-directed strategy on the other. The resultant policy mix is more a collection of individual initiatives than a coherent strategy, and produces conflict between initiatives aimed at developing indigenous information industries on the one hand, and improving the productivity and competitiveness of all industry by encouraging the wider application of IT on the other. Unlike its East Asian neighbors, Australia does not have a powerful, independent economic planning agency capable of creating and implementing industrial and technology policy. Policies must be developed through the give and take of a democratic political process, a process which can lead to fragmented, uncoordinated policies based on bureaucratic inertia, the demands of special interest groups and short-term political considerations, rather than long-term strategic plans. The future of IT policy in Australia will depend upon what kinds of consensus can be achieved on the role of IT in economic development. It will also depend on the government's skill in implementing policy and on the reactions of the private sector to whatever policies emerge.

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I. INTRODUCTION

There is a heated debate among academics, policymakers and others in the U.S. and Europe over the merits of industrial and technology policies to promote the development of so-called "critical" technologies and sunrise industries. While the U.S. government publicly opposes industrial policy as antithetical to the proper functioning of the free market, it has implemented many such policies for reasons of national security or social welfare. For example, in the area of high technology, the growth of the U.S. aerospace and computer industries depended heavily on Pentagon contracts and government research. Other industries such as textiles and steel are protected by import restrictions simply to protect jobs. Still, any effort to develop a coherent industrial policy, even if limited in scope, draws cries of denunciation from those who see such policies as picking winners and losers.

The debate is less heated in Europe, which has pumped huge amounts of money into Airbus and into national champions in the computer industry to compete with Boeing and IBM. Meanwhile, in Japan and East Asia, industrial policy is pervasive in the economy, and the idea of close cooperation between government and industry is taken for granted, despite occasional quarrels over the desirable nature and extent of government intervention. These countries have taken a pragmatic approach to economic management, less concerned with the theories of Adam Smith than with catching up with the West. While some economists (Balassa, 1981; Little, 1982; Ranis, 1990) argue that East Asia's economic miracles are a function of liberal economic systems and open markets, a growing body of literature has shown the extent to which those governments have intervened strategically to direct resources into high growth industries, protect their

domestic markets, and subsidize exports (Johnson, 1982; Amsden, 1989; Wade, 1990). While a causal relationship has not been clearly established between such policies and economic success, a strong circumstantial case can certainly be made.

Australia finds itself in an interesting position in relationship to the preceding debate. While a developed country, its wealth is based largely on successful exploitation of its natural resources. It is closer to the level of a developing country in terms of industrialization, and its continued prosperity is threatened by the steady decline in prices of its primary goods exports. Australia clearly needs to develop new industries in order to maintain its standard of living in the future. Given the small size of its economy, and the fact that it lags behind the industrialized world in industial and technological capacities, Australia would seem a likely candidate for an active government industrial policy. However, government intervention in Australia has come to be associated with past policies of protectionism, state ownership, and subsidies that were responsible for creating the largely inefficient, uncompetitive industries that exist today. For the past decade, the government has been gradually dismantling those policies and trying to create a more market-oriented economy, and therefore many would consider new interventions to be backsliding.

Still, a decade of market-oriented liberalization has not created economic prosperity; in fact, unemployment is at a postwar high and economic growth has stagnated in the 1990s. There has been little evidence of dynamism in the private sector, despite the more liberal economic climate. There is now discussion about what is needed to revive the economy. Some call for further reform to free up labor markets and remove remaining subsidies, while others call for government policies to create a "clever country" with economic growth based on technology- and information-based industries. No consensus has developed, and the government has vacillated, unwilling or unable to move far in one direction or the other.

The information technology (IT) sector offers a good illustration of Australia's policy approach to high-technology industry. The Australian government’s treatment of information technology (IT)[1] can best be characterized as falling between two policy extremes—*laissez faire*,

market-directed strategy on the one hand, and strong government interventionist, plan-directed startegy on the other. Market-directed strategies are based on the idea that the operation of the free market will lead to optimum resource allocation and result in the most desirable economic outcomes. Thus, the government's role is limited mainly to regulating the private sector to achieve social goals such as pollution control or equal opportunity, and to providing public goods such as education and infrastructure. Plan-directed strategies are based on the idea that the market is a tool for achieving economically and socially desirable objectives and that government has a strong role to play in directing the market towards such objectives. While market-directed strategies treat the market as an end in itself--an alternative allocation mechanism to political/bureaucratic processes--plan-directed strategies treat the market as a means to achieving government determined ends.

The IT sector also is interesting because it is a high-technology industry in which the country is believed by many to have good potential as a producer and user. Some policymakers and analysts see IT production as the type of industry into which Australia needs to move to prosper in the next century—high technology, high value added, and one which capitalizes on the country's pool of skilled and innovative workers. Others see IT mainly as a valuable tool to use to achieve competitiveness in other industries and efficiency in government. In reality, it might be both.

Australia was an early adopter of IT. The well-developed service and financial sectors began to employ computers in the 1960s, not far behind the U.S. and Europe. With no import barriers placed on most IT products, computerization took place at a brisk pace, and growth of IT use accelerated in the 1980s with the personal computer revolution.

However, domestic IT production has not kept up with demand. The difference has been made up by imports, and a large sectoral trade deficit has developed in IT. While it is a dubious practice to worry about trade balances for every sector of the economy, the $4 billion deficit in IT (about 25% of the total current account deficit) has been hard to ignore at a time when the country faces significant balance of payments problems. Some government officials, business

people and academics also see this deficit as part of a larger trend—i.e., Australia's lack of competitiveness in the technology-based industries which will be critical to future economic growth.

These concerns led to the initiation of various policies to stimulate IT production, including the 1984 Computer Bounty and the 1987 Information Industries Strategy. The former is a direct payment to computer hardware producers of a percentage of their value-added production in Australia. The latter is a broad program aimed at increasing local IT production, exports, research and development, and professional skills. Along with these targeted programs, a number of more generic industrial policies have elements which provide support to the IT sector in areas such as export promotion, research and development, human resource development and business support.

So far, the policy mix is more a collection of individual initiatives than a coherent strategy. A fundamental question which is not addressed directly is whether IT is an industry in which Australia can achieve competitive advantage, and if so, whether it is worth the cost to do so. A careful analysis is needed as to what would be required for Australia to become competitive in IT, what strategy would be effective, what costs will be incurred, and who will pay those costs. The government so far has analyzed various parts of the problem and implemented a range of policies, but a comprehensive strategy is still lacking which outlines where Australia hopes to be in IT and how to get there. Such a strategy would take into account the benefits of IT use by other sectors as well as the benefits of developing production capabilities in hardware and software.

An example of the types of issues faced by policymakers and the need for clearly defining strategies is seen in the two goals of the 1984 Computer Bounty Act, reiterated in the 1987 Information Industries Strategy:

1. Encouraging the development of an internationally competitive manufacturing industry (in IT);

2. Improving the productivity and the competitiveness of all industry by encouraging the wider application of IT.

Accomplishing the first goal entails certain costs, at least in the short run, since it is clear that the marketplace alone currently is not achieving that objective in Australia. The question is who is going to pay and how. In countries which have promoted domestic IT production through protection and subsidy (Japan, India, Korea and Brazil, for example), the costs have been borne mainly by users, taxpayers, and foreign producers. Users pay the cost of trade barriers through higher prices and lack of availability of IT products. Taxpayers pay the costs of subsidies and incentives to industry. And foreign corporations often pay through restricted market access and restrictions on foreign investment.

In the past, Australian consumers have paid the price for supporting many domestic industries through high import tariffs and other barriers. But in IT, the consumers are mainly firms in other industries and government agencies. To put the burden on other industries would work against the second goal of improving productivity through IT application. The government can bear some of the costs itself through strong "Buy Australia" policies (which are now being implemented in some cases), but this could conflict with other goals of controlling spending and improving government efficiency.

One means of promoting domestic production which has been employed is direct subsidy, in the form of the Computer Bounty, R&D grants, tax concessions and various industry promotion schemes. However, these programs give tax money to corporations, often foreign multinationals (the Australian government has not excluded foreign firms from receiving government subsidies). This could be politically unpopular, but so far doesn't seem to have engendered much opposition.

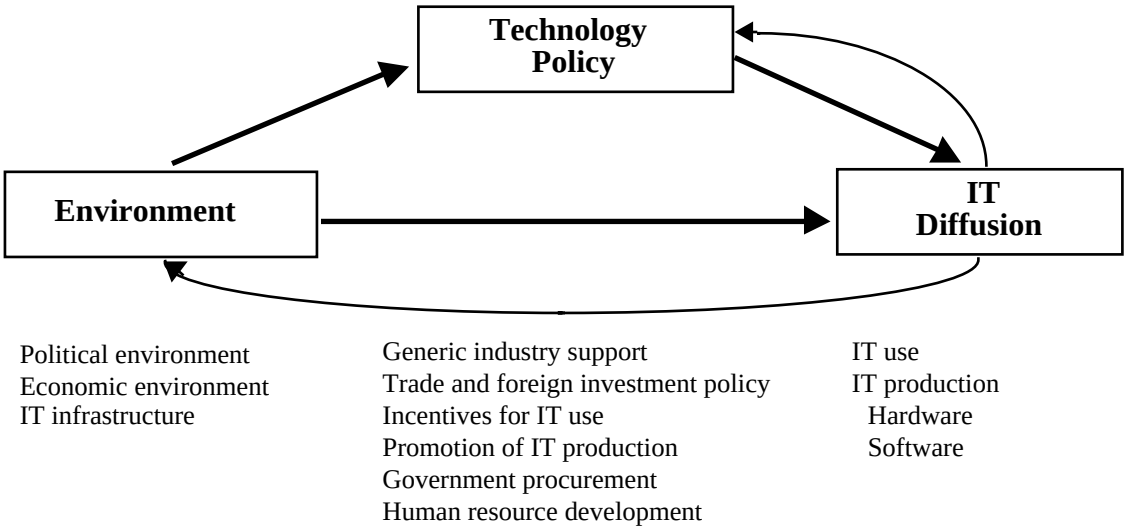
As will be seen later, the most important policy approach employed to promote domestic production has been the use of incentives to influence multinational corporations (MNCs) to expand their productive activities within the country. The Australian Civil Offsets policy and the Partnerships for Development program are examples of this strategy. While the MNCs

undoubtedly would prefer fewer restrictions on their activities, the requirements are not terribly onerous. And, given the size of the Australian IT market (over US$6 billion per year, with government comprising 40% of the market), it is not surprising that the MNCs have been quite cooperative.

Australia's ongoing debate over IT policy reflects a more general ambivalence about the proper role of the government in relation to the economy. The policies pursued so far reflect the lack of a clear vision on the proper direction in which the economy should be moving and what role IT should play. Unlike the East Asian countries, Australia does not have a powerful, independent economic planning agency capable of creating and implementing industrial policy. Policies must be developed through the give and take of a democratic political process, a process which can lead to fragmented, uncoordinated policies based on bureaucratic inertia, the demands of special interest groups and short-term political considerations, rather than long-term strategic plans. The future of IT policy in Australia will depend on what kinds of consensus can be achieved on the role of IT in economic development. It will also depend on the government's skill in implementing policy and on the reactions of the private sector to whatever policies emerge.

The framework for the analysis in this paper is outlined in Figure 1. Broadly, it examines Australia's *technology policies* and the *diffusion of IT* in the context of the country's broader *economic and political environment*.

Figure 1. Framework for Analysis



Section II discusses the Australian *environment,* analyzing the political and economic factors affecting the development of technology policy and the conditions for IT production and use. In particular, it examines the quality of infrastructure available to support the IT sector. This includes human resources, research and development capacity, capital availability, telecommunications networks, and the presence of complementary industries. Section III recounts the history of *technology policies* related to the production and use of IT, considering the reasons why particular policy choices were made and the effects of those policies. Section IV looks at *IT use and production* in Australia over time and compares the level of use and production to selected other countries. Finally, Section V draws conclusions about the Australian case and its relevance to the broader issues of industrial and technology policy. It provides insight into the reasons for Australia's lack of overall strategy, the types of policies which emerge from such an ad hoc approach to industrial policy, and the outcomes these policies in terms of production and application of information technology. It ends with insights for other countries from the Australian experience.

II. ENVIRONMENT

A number of aspects of the Australian political and economic environment have had important effects on the country's industrialization, and the development of the IT sector in particular. These include the decentralized political system which makes it difficult to develop

and implement industrial policy; the economic environment characterized by primary goods production and services rather than manufacturing for export; and an infrastructure of mixed capability for supporting IT use and production.

A. Political System

The Commonwealth of Australia is a democratic federal state within the British Commonwealth. The central government has specifically defined powers and all other powers are retained by the six states. A decentralized federal system is probably the only one which can hold together a widely dispersed population, but it can serve as an obstacle to the development of unified national economic policies.

Australia has a generous welfare state, with free health services, family allowances, pensions and unemployment benefits, and has a history of government intervention in the economy. However, in the 1980s, the government was influenced by the Thatcher/Reagan ideology of free market economics and less government intervention. Now one finds a debate between those in government who believe in the need for an industrial policy implemented by the government, and those who believe in a *laissez-faire* approach to the economy. The lines in this debate are often drawn between departments and agencies of the government. For example, the Department of Industry, Technology and Commerce (DITAC) favors more government intervention, while the Department of Finance tends to favor a more limited government role.

The government of Robert Hawke (1983-1991) had a strong market orientation and implemented a number of liberal economic reforms, as will be discussed below. The present government of Paul Keating, Hawke's former finance minister appears to be of a similar bent, although the lingering recession has led to various pro-growth measures. No clear tendency to favor or reject stronger industrial policy has been seen.

B. Economic environment

The British originally established a penal colony in Australia in 1788, and during the 19th century established control over the Australian continent. A continuing flow of European immigrants in the 19th century was paralleled by inflows of European capital being invested in

Australia to exploit its vast agricultural and mineral resources. The inflows of capital, labor and technology were applied successfully to develop productive capacity in agricultural and mineral products which were sold to the markets of the industrializing countries of Europe and North America. By the late 19th century, Australia had developed a vertical trade relationship with Great Britain in which it exported primary products and imported British manufactured goods (Maddock and McLean, 1987).

Manufacturing in Australia began to develop in the 1860s,with local production concentrated in food processing, clothing and textiles. Government took a large role in economic life in the late 19th century, borrowing overseas to invest in transportation and other infrastructure and encouraging immigration. This established a role for government which continued through the 20th century.

In 1901, the Australian Federal Government was formally established, joining the states of New South Wales, Victoria, Queensland, Tasmania, South Australia and Western Australia into a political federation. By the time of federation, Australia was becoming a modern urban society. It was also a wealthy country, with per capita income estimated by some to be the highest in the world. Primary products remained the engines of growth and accounted for the bulk of exports. The manufacturing sector developed slowly, consisting mainly of simple processing of primary products. However, a substantial service economy developed early in the 20th century in construction, transport, retailing, and financial services. The highly profitable primary goods exports paid for imports of manufactured goods, while the high incomes generated by those exports supported the service sector. It is notable that in Australia, the service sector had matured before the industrial sector moved beyond its infancy, a reversal of the standard model of economic development (Maddock and McLean, 1987, p. 19). The strength of the service sector was eventually a factor in Australia's early and extensive adoption of IT, since the heaviest users of IT are service sectors such as banking, finance and insurance.

The situation in Australia was not conducive to the development of an internationally competitive manufacturing sector. Wage rates were relatively high and a strong currency was

supported by primary goods exports. Australia is also far from the major markets of Europe and the U.S. and transportation costs were substantial. Still, the government wanted to develop manufacturing, which was seen as more conducive than primary goods production to long-term economic growth. Over time a broad assortment of policies were employed to assist industry, including tariffs, quotas, and direct support to manufacturers.

The strategy of import-substituting industrialization (ISI) supported by primary goods exports succeeded reasonably well until the 1970s, with Australia experiencing sustained solid economic growth. However, forces were at work which would undermine this success. First, the prices of the country's primary goods exports began to fall while its import prices rose. Also, as often happens under ISI regimes, much of the manufacturing sector was inefficient and not internationally competitive. Given the country's distance from the major markets and the existence of a protected market at home, Australia's manufacturers made little effort to export. Capital-intensive industries were unable to achieve economies of scale and labor intensive industries faced high wage costs. The manufacturing sector was too broadly based for local economic conditions and in many cases was technically obsolescent (Gagg, 1991).

From the early 1970s, several changes in the international economy began to erode Australia's economic position. Over the years 1955-85, Australia's terms of trade (the ratio of export prices to import prices) declined by 43% (Higgott, 1987, p. 12). Another change was the rapid industrialization of the East Asian countries, which put pressure on the Australian manufacturing sector. This pressure was exacerbated by large wage increases in Australia; in 1974 alone, wage rates grew in real terms by 19% for males and 27% for females (Anderson, 1987, p. 173). Such increases raised the production costs of Australian companies at a time when they were faced by competition from countries with very cheap labor rates.

Due to the effects of these developments, as well as the global economic crises of the 1970s, the period of 1974-1983 was one of sustained economic stagflation. By the time the Labor government of Robert Hawke took power in 1983, the economy was in a severe recession, with -1.7% growth, unemployment at 10.3% and inflation running at 8.2% (Mitchell, 1984, p.

147). The longer term trends illustrated in Table 1 show that these conditions were part of a continuing decline in economic performance.

Table 1. Australian economic performance, 1960-1988

	1960-73*	1973-82*	1982-88
Avg. annual GDP growth	5.1%	1.7%	1.4 ('80-87)**
Avg. annual inflation	3.5	11.5	7.8 (80-87)**
Avg. unemployment	1.9	5.4	
Annual growth of non-farm productivity	3.6	1.9	1.16***
Annual increase in labor costs	9.7	15.1	

* R. Dornbusch, S. Fischer, 1984
** UNDP (1990)
*** IMD International (1990)

Australia has also faced continuing balance of payment problems, with a current account balance deteriorating steadily from a surplus of A$716 million in 1972-73 to a deficit of A$17,426 million in 1988-89. This deficit has largely been financed by foreign debt to the extent that the country's gross external debt rose from A$15 billion in 1981 to A$115 billion in 1988.

Faced with this situation, the Hawke government embarked on an economic liberalization program which included the devaluation of the Australian dollar, deregulation of industry, lowering of trade barriers, and "rationalization" of government operations.
Other government policies included deregulation of financial and banking sectors, a reduction in income tax rates, and strict spending limits. The budget balance moved from a deficit of A$6.7 billion in 1984-85 to a surplus of A$5.5bn in 1988-89. However, fiscal restraint failed to prevent an import binge which resulted from the reduction of tariffs, and current account deficits continued to increase (Economist Intelligence Unit, 1989, p. 9-10).

The apparent slowness of structural change in the economy in general and in manufacturing in particular has led to some recent arguments for a shift to a more positive interventionist "strategic" trade policy along the lines of export-led development practiced by the newly industrializing countries of East Asia. This recent challenge to the prevailing orthodoxy of the last ten years has gained advocates in government, but has yet to bring about any significant changes in policy. Australia presently stands between primary production and industrialization,

the free market and intervention, and the corporatism and individualism that currently divides the economic attitudes of Japan on the one hand and the United States on the other (Gagg, 1991).

The debate over the government's role in the Australian economy is clearly reflected in the policy debate over the information technology industry. There is strong concern over Australia's lack of competitiveness in high technology-based industries such as IT. However, the present economic climate creates a dilemma for policymakers. Since government intervention has been a contributor to the existing economic problems, should the government now get more involved in industrial policies to promote specific sectors such as IT? On the other hand, can Australia afford to be technologically dependent on foreign sources in a sector as critical as IT, especially in an international environment where other governments provide large-scale assistance to the IT industry?

There is currently no clear solution to this dilemma. This dilemma is behind some of the weakness in Australian IT infrastructure (discussed below). And, as will be seen later, this dilemma is also responsible for some the lack of cohesion in Australian IT policy. It may also explain why the government has fallen back on old patterns of industry assistance with policies like the Computer Bounty, but has also moved in some new directions such as the 1987 Information Industries Strategy.

C. IT Infrastructure

The production and use of information technologies typically requires a supporting infrastructure consisting of several key elements. For IT use, these include *human resources*, especially skilled workers capable of operating computer systems and adapting those systems to local needs, and dependable *telecommunications and power networks*. The production of IT products and services requires those factors, plus several others. One is specialized human resources: IT professionals such as computer engineers, programmers, systems analysts and electronics engineers; manufacturing professionals such as production engineers and quality control specialists; and marketing, finance, distribution, and other management experts. Another requirement is the *reseach and development* capabilities to design new products and production

processes and to apply existing technologies to new applications. Still another is an existing capacity in *complementary industries* such as consumer electronics and electronic components to supply products and relevant expertise. Finally, both production and use require *capital markets* capable of supporting investment in IT.

1. Human resources

Australia has a generally well-educated, English-speaking work force with an adult literacy rate of 99% (UNDP, 1990). However, as of 1984, only 45% of all students who entered Grade 7 were making it through Grade 12. This low retention rate seriously reduces the number of workers who would have the ability to enter IT-related fields, even at the technician level. Some indicators of Australia's human resource situation in comparison to other Pacific Rim countries are presented in Table 2.

Table 2. Human resource indicators for selected Pacific Rim nations

	Adult Literacy*	Secondary Enrollment*	Education Exp. as % of GNP*	Number of Scientists and Engineers**	Scientists and Engineers per 10,000 population**
Australia	*99%*	*96%*	*5.1*	*38,568*	*23.4*
New Zealand	99	84	4.8	4,091	13.6
U.S.A.	96	99	5.3	949,200	39.5
Japan	99	97	5.0	416,850	33.8
Korea	99	95	4.9	63,115	14.9
Taiwan	90***	87***	n.a.	25,612	18.0
Singapore	86	71	5.2	5,876	23.0
Hong Kong	88	69	n.a.	n.a.	n.a.
Malaysia	74	54	7.9	5,537	3.0

*UNDP (1990).
**Pacific Economic Cooperation Conference (1991).
*** Republic of China (1984), from James, Naya and Meier (1989).

Australia ranks high in adult literacy and secondary school enrollment with figures comparable to the U.S. and Japan, and its expenditures on education as a percentage of GNP compare favorably to the other developed countries. However, Australia's pool of scientists and engineers is more comparable to the East Asian NICs than to the developed countries in both number and percentage of total population.

The Australian economy has been shifting from agriculture and manufacturing towards service and information industries for some time and the country has fallen behind other developed countries in training people in the skills needed to work in those industries. As a result, the Hawke government decided that the education system needed to be reformed to better meet the needs of the labor market. One result was the creation of the Department of Education, Employment and Training (DEET), whose portfolio explicitly links education to the needs of the economy.

A major area of reform has been in higher education and university research. Policies have been implemented to make universities more responsive to the needs of the economy, both in terms of research and education. No longer can higher education operate in an "ivory tower," isolated from economic forces. This is a significant change for a country whose educational system is based on the British system and whose universities have historically been oriented towards providing a "liberal education" rather than vocational training. These changes have been

highly controversial, especially in the universities who feared the power of DEET in controlling higher education policy and their own loss of autonomy in setting academic priorities.[2] Consequently, DEET has nudged rather than pushed strongly for production of graduates in professional specialties needed for the IT industry.

2. Telecommunications networks

Telecommunications is an important part of any country's IT infrastructure. This is especially true in a large, sparsely populated country like Australia where long-distance communications are vital for linking computers and developing data networks.

Telecommunications in Australia is primarily the responsibility of the state owned Telecom, which has a monopoly over telecommunication transmission services within Australia. Another government business entity called OTC provides Australia's telecommunications links with other countries. A third entity, AUSSAT, was formed in 1981 to own and operate Australia's communication satellite system. It currently operates three satellites (Bureau of Transport and Communications, 1990).

Substantial reform of the telecommunications industry was carried out in 1989, with the government liberalizing some services and transferring Telecom's regulatory powers to an independent body, the Australian Telecommunications Authority (AUSTEL). Telecom and OTC were merged into a new organization called AOTC, and remain publicly owned. A second license was sold to a private consortium called Optus, which will compete with AOTC (K. Cranswick, personal communication). Unlike neighboring New Zealand, which sold its Telecom to a foreign consortium, Australia has kept AOTC in public hands, but tried to spur efficiency through the merger (linking domestic and international components) and the introduction of a second competitor.

Australia's telephone penetration rate is 436 main lines per 1000 inhabitants, a level lower than most industrialized countries, but ahead of Japan and the East Asian NICs, as seen in Table 3.

Table 3. Number of telephones per 1,000 population

Australia	436
New Zealand	419
U.S.A.	520
Japan	403
Korea	209
Taiwan	262
Singapore	340
Hong Kong	360
Malaysia	68

Source: Siemens (1989).

The quality of Australia's telephone services measures up well in terms of some common indicators, such as waiting time for service connection, call failure rate and fault clearance rate. According to OECD (1989, in Bureau of Transport and Communications Economics, 1990, p. 145), the basket of national telephone charges in Australia is slightly above the OECD average for both business and residential services.

Overall, Australia's telecommunications infrastructure seems adequate to meet the needs of the IT sector. The government hopes that increased competition will mean lower prices and that the deregulation of Telecom will enable it to develop value-added networks which are important to IT use.

3. Research and development

Australia's total spending on R&D is relatively low for a developed country, and is more comparable to the East Asian NICs, as Table 4 illustrates. Corporate spending on R&D also accounts for a smaller percentage of overall R&D than in most other countries as well, showing a greater distance between research and the marketplace.

Table 4. R&D expenditures for selected Pacific Rim countries

	R&D Expenditure as % of GNP	Company spending as % of R&D exp.
Australia	*1.24 ('88-89)*	*42%*
New Zealand	0.94 ('89-90)	25
U.S.A.	2.70 ('90)	72
Japan	2.91 ('89)	70
S. Korea	1.92 ('89)	74
Taiwan	1.22 ('88)	48
Singapore	0.90 ('88)	60
India	0.91 ('88)	n.a.

Source: Pacific Economic Cooperation Conference (1991). For India, IMD International (1990).

Total R&D spending as a percentage of GNP decreased from 1.3% in 1968 to 1.0% in 1981, but has since returned to 1.24%, at least partly due to government incentives to increase R&D spending in the private sector.

Australian R&D efforts are dominated by the Commonwealth Government, which in 1988/89 provided$A1,888 million (45%) of the country's total R&D expenditure of A$4,187 million. State agencies account for another A$453 million in research funds. In all, 60% of R&D expenditures were financed by the public sector, compared to 44% in the U.S., 18% in Japan and 17% in Korea (Pacific Economic Cooperation Conference, 1991).

Despite a strong science and technology base, Australia has been weak in the development side of R&D, and even more so in the commercialization of new products and processes by domestic industry. The government has recognized this problem and implemented several policies and schemes to improve the links between public sector researchers and industry, as well as to encourage increased R&D efforts by industry.

During the 1980s, there was a restructuring of institutional authority over R&D policymaking, partly to enable government to direct funds into economically strategic areas.

Australian industry has not yet been successful in translating the country's scientific capabilities into commercial success in technology-based industries. Its exports of technology-based products ranked 21st out of 24 OECD countries in 1985.[3] There are many examples of Australian innovativeness, such as the winged keel which enabled the Aussies to end the Americans' 132-year control of the America's Cup in 1983. However, Australian innovations rarely seem to be commercialized by Australian companies. For example, Australian discoveries in transistors, computers, and "black box" flight recorder technologies were rejected or ignored by domestic industry in the 1950s (Jones, 1989).

4. Complementary industries

In order to compete in domestic and international IT markets, a nation must have more than a good infrastructure and good policies. It must also have companies capable of designing,

producing and exporting products and services which are competitive in both quality and price terms. These firms must have the knowledge, financial underpinning, physical capacity and technological capability to make products to international quality standards and at competitive prices. However, few Australian manufacturers have those capabilities.

The likelihood of success in IT is especially enhanced by the existence of strong capacity in complementary industries such as consumer electronics, communications equipment and electronic components (Kraemer and Dedrick, 1992). The relationship of electronics to IT is best seen in Japan and Korea, where giant firms can establish computer hardware production using technology, capital and marketing and management knowledge transferred from successful consumer electronics and electronics components operations. Also, the existence of a viable components industry means that IT producers are not as dependent on imported components which may be produced by competitors in the IT market. It also means that there is more value added and more technology development within the country.

The consumer electronics and electronic components industries are almost non-existent in Australia. In 1990-91, Australia imported A$4,644 million worth of electrical and electronic equipment and parts[4] while exporting only A$306 million. Imports of electronic components were A$621 million while exports were only A$66 million (Australian Information Industries Association, 1989).

Australia has had some success in developing local production of telecommunications equipment. Telecom has historically tended to buy Australian products, even though there was no written requirement that they do so. Telecom was attempting to avoid dependence on overseas suppliers and spur the local development of technology (interview with Department of Transport and Communications officials). The industry is currently dominated by Australian subsidiaries of multinationals such as Alcatel, Fujitsu, GPT, Nortel, Ericsson, Philips, Siemens and NEC, which produce locally, primarily for sale to Telecom, which accounts for 60% of the industry's sales. Exports were A$59 million in 1985, growing to about A$195 million in 1990, while imports were A$874 million (Allen Consulting Group, 1991, p. 50).

In 1987 AUSTRADE identified the communications equipment industry as a priority for export development activities. It pointed to several strengths of the local industry, including access to technology through MNC subsidiaries, Australia's high level of expertise in rural and remote communications equipment, its positions at the leading edge of satellite technology applications and the development of submarine optical fibre systems. In 1989, an Industry Development Arrangement (IDA) for customer premises equipment (CPE) went into effect. CPE producers are required to achieve targets for local production, exports and R&D in return for being permitted to connect their equipment to the telecommunications network.

The telecommunications equipment industry is important because it may provide a model that could be used to foster local industry in the IT sector through a strong “Buy Australia” policy. Just as Telecom's favoring of local suppliers led to the growth of the communications equipment industry, a similar procurement policy towards IT products on the part of the government and public sector companies such as Telecom could spur the growth of the local IT industry. This was very much the case in Japan, where NTT's procurement from local sources was a major factor in the survival and success of the Japanese computer manufacturers.

5. Capital markets

The development of a vibrant IT production sector requires the availability of patient risk capital. Investors in IT face a high degree of uncertainty as to both the size and the timing of their return on investment. IT companies usually have few assets to serve as collateral on a loan, especially those in the software industry where a company's chief assets are the minds of its programmers.

To deal with these unusual characteristics of the IT industry, various types of financing arrangements have been employed. In the U.S., the venture capital industry provided a good deal of the initial capital for start-ups in the IT sector. More established companies are able to obtain financing from traditional sources (banks and stock markets) or use profits from other activities. In Japan, most computer production is done by large electronics firms who can tap the resources

of other parts of their company or business group to provide capital. The Japanese government also provided loans under favorable terms in the industry's early years.

Australia's capital markets have neither the size nor the experience to deal with the investment needs of the IT industry (Australian Information Industry Association, 1991). There is a venture capital industry, but it is not sufficiently developed to provide the capital needed to support a growing IT industry. The government attempted to intervene by direct investment in some ventures and through the Management Investment Company (MIC) Scheme, but these efforts led to losses in the 1987 financial market crash, and the government has since been hesitant to get involved. A major source of investment in IT has been foreign investment by MNCs. Many of the major vendors have production capacity in Australia, and the government has made efforts to attract more foreign investment.

Along with the deficiencies of the financial markets, another obstacle to investment was the high interest rates which prevailed through the 1980s as Australia tried to control inflation. This made capital expensive and inhibited IT growth on both the supply and demand side. The 1990s have seen a lowering of interest rates, which are now at their lowest level in 20 years, but this has coincided with a deep recession which has reduced demand for IT products and services in Australia.

D. Comments

The environment for IT use in Australia is very good. Australia is a wealthy country with the resources to invest in IT products and services. High wage rates encourage the substitution of labor with technology, and the large service sector provides a strong demand, as service industries are normally the heaviest users of IT (Kraemer et al., 1992). Australia has a long history of IT use, and computers are a familiar tool in business and government. The lack of tariffs on IT imports has also encouraged use. The infrastructure for IT use is very good, with a high literacy rate and advanced telecommunications and power networks.

The picture is different for IT production, however. Australia's manufacturing sector is generally inefficient, having developed behind protective barriers which only started to come down in the 1980s. The country has little experience competing in international markets for manufactured goods and depends mainly on primary goods exports. There are a number of key infrastructural weaknesses also. While literacy is high, the educational system does not produce enough technical professionals. R&D has traditionally leaned toward basic research rather than development of commercial technologies, and links between research institutions and business are weak. Capital markets tend to be conservative and have little experience with financing high technology industries. There is also a lack of complementary industries which could serve as sources of technology, entrepreneurial energy, capital and products needed in IT production.

It is not surprising that Australia has become heavily dependent on imported IT, and runs a large trade deficit in that sector. Faced with this situation, the government has attempted to boost IT production through a number of direct and indirect measures. Policies have been implemented to deal with many of the problems noted above, but as the following section will show, these efforts often seem to be halfway measures that are insufficient to create the type of infrastructure needed to support a strong IT industry.

III. TECHNOLOGY POLICY

Technology policies which affect the IT sector may take a number of forms. They include general industrial promotion policies, trade and foreign investment policy, specific measures to promote local IT production, support for R&D, incentives for IT use, government procurement policies, human resource development, and export promotion. Australia has policies in all of these areas. Unlike other countries, Australia has no policies to promote private sector IT use. It also has no industry coordination through an agency such as Singapore's National Computer Board or Japan's Ministry of International Trade and Industry (MITI). There have been two major policy initiatives which specifically targeted the IT industry. These are the Computer Bounty Act and the Information Industries Strategy. In addition, there have been a

number of individual policies and programs which have either directly or indirectly supported IT production and use.

A. Generic Industry Support

In order to enhance the capabilities of Australian industry, the government has established several programs (outlined in Figure 2) which are generic, rather than industry specific. However, IT is a targeted industry in measures such as IBD and ITES.

Figure 2. Industry support initiatives

Measure	Details	1989-90 Cost
Business Development		
National Industry Extension Service (NIES)	Helps business develop business and export strategies	A$18.8 million
Vendor Qualification Scheme	Helps firms achieve the quality standards necessary to be certified as vendors to MNCs.	A$ 2.1 million
Offsets		
Australian Civil Offsets Program	Requires overseas suppliers to government projects to direct work or transfer technology to Australian firms.	n.a.
Export Promotion		
Export Market Development Grants	Grants up to 70% of export marketing costs paid directly to company	A$162 million
International Business Development Scheme (IBD) and International Trade Enhancement Scheme (ITES)	Grants and loans to specific targeted industries (including IT) to fund export marketing costs	IBD: not available ITES A$15.9 million
Export Finance and Insurance Group	Finance and insurance facilities for exporters	A$ 21.5 million
AUSTRADE	Overseas trade offices, publications, investment assistance, trade fairs, business planning services. Also implements above programs.	A$62 million operating costs

Sources: Industry Commission (1990). DITAC (1990).

Most of these initiatives are implemented by the Department of Industry, Technology and Commerce (DITAC). DITAC lacks the authority to effect changes in areas such as finance, education, and taxes, and thus cannot develop a comprehensive industrial policy. Instead, it tends to concentrate on support for R&D in the private sector and especially on export promotion. The emphasis on exports reflects government concerns over the current account deficit.

B. Trade and Foreign Investment

The Australian government has recognized the importance of IT as an input and a capital good in other economic sectors and the need to make IT products available at world prices to those sectors. For that reason, computers and related products are allowed to be imported free of tariff. There are also no restrictions on foreign investment in IT production. These policies are atypical of Australian economic policy before the 1980s, and have had a positive impact on IT use.

C. Promotion of IT Production

However, the government also feels that the domestic IT industry had strong growth potential and should be supported as well. In order to support domestic producers (including MNCs), several schemes have been initiated. These include the Computer Bounty Scheme, the 1987 Information Industries Strategy, the Civil Offsets Progam and various policies toward government computing use.

Computer Bounty Scheme[5]

The computer bounty scheme, in existence since 1977, is aimed at helping firms produce computing equipment and software. Under the scheme, bounty is paid at 14% of the value added within the factory. The bounty is set at a level to provide assistance comparable to that received by most other industries through tariff protection. The magnitude of the bounty program has grown rapidly since 1984 with payments increasing from A$1.5 million to A$51 million in 1990/91. Bounty payments are forecast to level off from 1990 to 1993 at about A$ 50 million per year (K. Cranswick, personal communication).

From the industry's point of view, the bounty is a desirable form of assistance since it provides prompt cash payments which add to firms' profitability and does not impose onerous restrictions on their activities. In terms of achieving the government's goals of increasing exports, training, and R&D, there are no direct provisions to require expenditures in those areas. In 1990, the government's Bureau of Industry Economics concluded that the results of the program were sufficiently positive to justify continuing it and the program was extended to 1995, when the bounty will be removed and a "level playing field" established (K. Cranswick).

Offsets[6]

Offsets have been used since 1970 to utilize the government's buying power as a means to gain access for domestic firms to the internal markets and marketing facilities of large MNCs. Under offset arrangements, overseas suppliers to the government must buy local goods equal to some percentage of the value of their government contracts or perform activities in the areas of exports, R&D, technology transfer, or training. Such arrangements have been used extensively in leading technology areas such as aerospace and IT.

In 1988 the Pre-Qualified Offsets Supplier (PQOS) agreements were introduced. Under PQOS guidelines, companies who are regular suppliers to the government are encouraged to develop long-term programs for meeting offsets requirements, rather than preparing offsets plans related to each specific contract. Since 1987, all of the major IT vendors have switched from the Civil Offsets program to the Partnerships for Development program, which will be discussed below.

The 1987 Information Industries Strategy[7]

In 1987, Senator Button, Minister of Industry, Trade and Commerce, announced a comprehensive Information Industries Strategy (IIS) to promote IT production and use. The plan was based largely on the recommendations of three working parties (Market Development, Infrastructure, Problems and Prospects) set up by DITAC, who is the primary implementor of the strategy. A clear concern in the formulation of the policy was the large and growing sectoral trade deficit in IT, which stood at A$4 billion in 1986/87 and was expected to rise to A$10 billion annually in the early 1990s.

The IIS outlines goals for both Australian-owned and multinational firms. For locally-owned firms, the goal is for them to pursue niche markets and develop a greater international focus. For MNCs, the goal is to get them to expand the scope of their activities in Australia, especially in R&D, and to have them increase exports of Australian-made products. They are also encouraged to increase their use of local components and work with domestic firms to help them compete in international markets. The IIS contains initiatives in the areas of education, export promotion, R&D, and government procurement, which will be discussed later, but the key element of the strategy is the Partnerships for Development program.

The PDP was set up as an alternative to the offsets program for MNCs operating in Australia. Companies who sign partnership agreements are exempted from their offsets obligations. In order to participate, the MNC must commit to achieving the following targets within a five to seven year period (Button, 1988):

-expenditure on R&D in Australia equivalent to 5% of its local revenue

-annual exports equivalent to 50% of the company's imports into Australia

-an average across all exports of 70% local value-added content

The aim of the Partnership program is to provide incentives for the MNCs to help improve Australia's balance of trade in IT, support local firms, and as Senator Button puts it, "encourage transnationals to deepen their roots in Australia; that is, for their Australian activities to become an integral and important part of corporate global operations and growth strategy." Since the program was initiated, several large projects have been undertaken, including R&D projects by IBM and DEC. As of January 1992, partners had committed to increasing levels of R&D and exports reaching almost A$400million for R&D and A$1600 million for exports by 1995 (McAlister, 1992).

In 1991, the government announced changes in the regulations of the Partnership program. Participation was made mandatory for all companies with annual sales to the government of more than A$40 million. Companies selling between A$10 million and A$40 million must enter into a fixed term arrangement combining elements of the Pre-Qualified Offsets and Partnerships programs, while those firms with annual sales to the government of less than A$10 million are now exempt

from offsets requirements. Also, activities eligible to satisfy partnership requirements were expanded to include infrastructure development and efforts to upgrade indigenous companies to achieve world standards (Button, 1991).

Clearly, it will take more time to assess the value of the program. Early indications are that some gains have been achieved in getting MNCs to expand their operations in Australia, but it has had limited effect in spurring locally-owned industry. In the *Computing 100* (November 1990) list of 100 top IT companies, the number of Australian suppliers dropped from 39 in 1989 to 38 in 1990 and Australian companies' share of revenue dropped from 25.6% to 23.9%. Whether that is important depends on whether the country is intent on developing a competitive indigenously-owned industry, or will be satisfied with increasing employment, exports and value added by the multinationals operating in Australia.

D. Research and Development

Along with the R&D components of the IIS, the government supports R&D in a number of ways, some of which are specific to IT, and some of which are more general. Government promotion of R&D has taken several forms, including tax incentives to private industry, grants and subsidies, and direct funding through government research agencies. The major programs are outlined in Figure 2. They include the following types of efforts:

- Promotion of private sector R&D through tax concessions and discretionary grants to all industries;
- Promotion of greater industry industry-university linkages through grants for industry-based research by doctoral/graduate students;
- Direction of government research institutions towards emphasis on economic application of technologies developed and on commercialization of those technologies.

Figure 3. Major R&D programs

Program	Details	1989-90 costs
Grants for Industrial Research and Development (GIRD)	:	A$32 million
-Discretionary Grants Scheme	Grants to small startups. Not industry specific.	:
-Generic Technology Scheme	Grants to specific strategic sectors including IT, communications, biotechnology, new materials.	:
National Procurement Development Program (NPDP)	Grants to industry/government collaborative projects to develop products for government procurement.	A$5.6 million
Tax concession for R&D	150% deduction for eligible R&D costs. 125% after June 1991.	A$178 million in lost tax revenues
National Teaching Company Scheme	Supports graduate students doing company-based research.	A$2.1 million
Commonwealth Scientific and Industrial Research Organization (CSIRO)	Principal government research organization. Six institutes divided along industrial lines with emphasis on economic applications of technologies.	A$393 million

Besides supporting IT R&D by industry through the GIRD and NPDP schemes, and the Partnership and Offsets programs, the Commonwealth government also carries out IT research itself through the Institute of Information Science and Engineering at CSIRO. Supported primarily by DITAC, with some outside funding by joint venture partners, the Institute's research encompasses information and computing technologies, electronic and communications engineering, mathematics and statistics and quality improvement. The Institute encourages pre-competitive R&D, and works in conjunction with groups of companies and with other research centers and universities to develop marketable technologies. Within the Institute, IT research is specifically the domain of the Division of Information Technologies (DIT).

DIT is involved in research partnerships with three multinationals as part of the Partnerships for Development and Offsets programs. It is also collaborating with a number of university research centers and with other CSIRO divisions. DIT's research activities are organized under four major

programs, knowledge-based systems, spatial information systems (such as geographic information systems), computer communications, and parallel computation (CSIRO, 1989a).

CSIRO's stated objectives are to carry out strategic research useful to Australian industry, government and society and to collaborate with industry and other institutions to ensure the transfer and application of that technology. Many of its research projects in IT have led to useful commercial products. However, as a measure of Australia's commitment to IT, it is notable that of the six Institutes of CSIRO, the Institute of Information Science and Engineering was last in research expenditures in every year from 1986-1989 and its piece of the pie did not expand during that time, despite the existence of the 1987 IIS (CSIRO, 1989b). In contrast, the requirements of the Partnerships for Development Program should substantially increase R&D in information technologies by the private sector. In 1987, IBM alone invested A$57.1 million in R&D in Australia, with a commitment to reach A$75 million by 1993 (IBM Australia, 1990).

Recent policy changes have been aimed at better linking science and technology to commercial applications, and thereby enabling Australia to benefit economically from its scientific capabilities. The notion of conducting research primarily for the sake of advancing knowledge is being challenged by the need to reverse the economic slide of the past 20 years. While scientists and academics may resist such policies, the government holds the purse strings and is clearly determined to use at least some of its R&D funds to enhance the country's economic competitiveness.

E. Incentives for IT Use

The government has done little to promote IT use in the private sector, even though organizations such as the Australian Information Industries Association have claimed that Australia is behind other developed countries in IT application. However, even the figures AIIA cites show Australia ahead of Japan, France, Canada and Germany in IT expenditures as a proportion of GDP at 2.11% (Australian Information Industry Association, 1991, p. 27). Kraemer, et al. (1992) put Australian IT spending at 2.84% of GDP in 1988, a figure surpassing even the U.S. It is difficult to argue that Australia's IT usage is lagging in terms of IT investment.

AIIA also points to a report by Pappas, Carter, Evans and Koop (1990) which shows that productivity gains in Australia from 1979-1987 averaged only 2.7%, compared to the OECD average of 3.7%. Growth in IT investment at least during the 1983-1987 period was quite rapid at about 12% annually (Kraemer et al., 1992). This may suggest that application of IT failed to produce productivity gains, an argument which has been made about IT investment in the U.S. as well.

In any case, the government has seen fit to let the market determine private sector investment in IT and to concentrate on improving its own use of IT along with promoting local production. However, the government is actually facilitating IT use throughout the economy by not charging any tariffs on most IT imports, while imports of most other products still face tariffs. By avoiding the temptation to fight the IT trade deficit by using trade barriers, the government has helped support continued investment in IT.

F. Government Procurement Policy

The use of computers in the Australian government began in the 1950s and 1960s with the introduction of mainframe computers into various departments such as the Army, the Department of Treasury and the Bureau of Census and Statistics. The 1970s saw the introduction of minicomputers and the growth of department-based communication networks. Major networks were developed by CSIRO and the departments of Social Security, Health, Customs and Veterans' Affairs. The 1980s saw the introduction and rapid spread of microcomputers, both within agencies where mainframes and minicomputers were present, and in entirely new areas as well (Whitehead, 1990).

The use of IT in government has been directed over the years through a series of policy initiatives. Until recently, these initiatives have been aimed at promoting efficiency, economy and modernization in government, rather than helping to promote the domestic IT industry. The explicit linkage of government procurement to promotion of the IT industry did not occur until 1987. The IIS called for changes in government purchasing policies to support local producers. Two programs were established to help local firms participate in the government market by linking local IT production to government procurement.

- The National Procurement Development Program (see Figure 3) supports local companies' efforts to develop products for sale to the government. A number of the projects funded through the NDPD were IT related.
- The Purchase Australian Office carries out information campaigns to encourage government agencies to buy Australian goods. The Purchase Australian Office collaborated with the NPDP in the development of the "Purchase Australian" campaign.

There seems to have been some tension between various interests within government regarding IT procurement. The government has gone to substantial lengths to make its own use of IT more efficient as seen in numerous studies, reviews, recommendations and policy initiatives to improve computing practices. At the same time it hopes to use its own purchasing power to provide a market for domestic manufacturers. These goals need not necessarily conflict, but given the relative dearth of domestic producers, they are likely to in some cases.

The conflict of interests is magnified by policy changes of the last few years which put purchasing authority into the hands of department managers and which also put a strong emphasis on cost accountability and strategic planning. It goes against the grain of this devolution of authority to then tell managers whom they should buy from. In many cases, the best value for money may be an imported product, and “buying Australian” may have a direct cost to user departments. Some department managers complain that the “buy Australian” policy is not clearly defined. In the past, there were no requirements specifically favoring local producers. In fact, a 20% pricing advantage given to Australian and New Zealand goods under the 1987 Strategy was so unpopular and apparently ineffective that it was eventually dropped (Whitehead, 1990).

Several changes in government IT procurement went into effect in 1991 which encourage outsourcing of data processing services and software development to the private sector and require that IT equipment be procured from approved suppliers meeting Partnership or offets requirements (*Contract Connection*, 1990).

G. Human resource development

The Australian government has recognized the need to increase the supply of people with IT skills in order to increase the output of the IT industry. One initiative of the IIS was the establishment of the Information Industries Education and Training Foundation (IIETF) in 1989 for the purpose of identifying human resource needs in the IT sector and developing strategies to fill those needs.[8]

IIETF (1990) projects that by 1999, higher education completions in computing specializations will have to more than triple from their 1987 level of about 3000 and that completions in electronic engineering will have to more than double from their 1987 level of 700. In order to meet the expanded needs for IT professionals, IIETF identified several strategies, including increasing the number of student places in IT programs, increasing graduate student enrollment in IT to produce future academic staff, increasing linkages between academic institutions and industry, and increasing the number of computer professionals in the country by speeding the immigration process for such professionals. Various initiatives have been developed by IIETF, DEET and industry to implement these strategies. Some specific programs are detailed in Figure 4.

Figure 4. IT education initiatives

Goals	Programs	Results
Increase university IT places	National Pilot Program in Cooperative Education: 200 extra places per year for cooperative university/industry programs Additional funding for 2885 additional places in IT from 1988-1990	
Speed up immigration of IT professionals	Fast Track Immigration Scheme: high priority handling of up to 1000 immigration applications by IT professionals	30 applications processed, 100 in pipeline
Increase technician training	Industry Training Committee Network: Local committees advise industry and government on meeting demands of IT manufacturers for technicians	
Training in manufacturing technology	Australian Electronics Development Centre (AEDC). Federal and Victorian governments, Ericsson and other corporate sponsors	

It is too early to determine the effects of most of these programs. However, it is apparent that the downturn in the economy and the worldwide slump in computing have led to severe cutbacks in new employment in the industry (*Computing*, December 12, 1990). This may be just a temporary downturn due to the recession, but it may dampen enthusiasm for putting more resources into IT education, and the lack of jobs for graduates may discourage new students from choosing IT-related courses of study.

H. Export promotion

The large trade deficit in IT products and services has led to a high priority being placed on export promotion within the sector. These efforts mainly deal with indigenous firms, since the multinationals have the capacity to reach worldwide markets and are given incentives to export under the Partnerships program. The Information Industries Strategy identifies several weaknesses of

Australian firms as exporters, including a lack of market knowledge, lack of sufficient sources of financial capital, lack of experience in international markets and lack of formal qualification as being capable of meeting international quality standards. In order to deal with these problems, the government has pursued two general strategies to promote export capabilities of indigenous IT firms.

- Overseas support for Australian exporters: In addition to its general services, AUSTRADE is involved in programs which specifically benefit the IT industry, such as exhibits of Australian IT products at international trade fairs and promotions. Another effort is the Software Marketing Consortia (SMC) (AUSTRADE, 1990). Developed with support from AUSTRADE, SMC is a consortium of software companies being established to provide export support services to its member firms. These services will be carried out by Software Export Centres (SEC) in targeted international markets, with the first Centre in Brussels to serve the European Community. The consortium plans to consolidate the efforts of these relatively small companies, establish an on-going presence of Australian companies in key markets, and establish better links between the software companies and relevant MNCs.[9]

- International accreditation of Australian vendors (DITAC, 1990): Through the Vendor Qualification Scheme, established in 1988, manufacturers are able to gain accreditation for their products and processes, allowing them to seek the Qualified Vendor Status demanded in international markets.[10]

Comments on policy initiatives

The Information Industries Strategy and other IT policies are an attempt to close the trade gap in IT and to encourage the development of a technology-intensive industry in which the government feels Australia has or can develop a competitive advantage. The strategy relies heavily on the cooperation of MNCs, and uses access to the large government market (40% of total IT spending) as an incentive to secure this cooperation. So far, this strategy seems to be working, at least in terms of the commitments made by the MNCs. The policies have been less successful in increasing production and exports by indigenous firms, which explains the 1991 expansion of the Partnership

program to recognize efforts by MNCs to assist local firms as a way of meeting their partnership commitments.

One question regarding the entire IIS is whether it goes far enough to have a significant impact on IT production. The spending figures involved are in the millions and tens of millions of dollars, which pales in comparison to the size of expenditures being made and planned by other countries (e.g. Korea, Taiwan, Singapore) on IT. The Australian strategy is for the government to act as as catalyst, rather than driver of IT production, and such a strategy must be very shrewdly targetted to be effective.

A second question is whether the IIS actually deals with the most important problems facing the IT industry, especially the lack of investment capital available to domestic firms. The Australian Information Industry Association (AIIA), points to the inexperience and lack of diversity of the Australian capital market as factors limiting the growth of the industry. It argues that past government programs such as the MIC program were too small and poorly managed to provide the venture capital necessary to support IT ventures. This deficiency is especially critical to the small indigenous firms who don't have the financial support of a large multinational behind them.

As of 1988, 30 information and computer industry ventures had been assisted through the MIC scheme, accounting for about 40% of the total capital invested under the scheme (Richeson, 1988). The venture capital market was hit hard by the October 1987 stock market crash, but then rebounded as Australia's venture capital pool tripled from US$500 million in 1988 to US$1500 million in 1989 (*Electronic Business Asia*, October 1991, p. 73).[11] One way in which firms can meet offsets requirements is through investment in venture capital funds, but there has been little interest on the part of MNCs in investing in these funds (DITAC 1990a, p. 30).

In some cases, local firms can hook up with MNCs in joint ventures or long-term production agreements and gain access to capital from the MNCs. But some kind of government-sponsored finance facility is probably needed if indigenous firms are going to succeed in the IT industry. For example, in Korea, the Ministry of Trade and Industry manages 53 venture capital funds focused on early stage investments in technology industries, while in Taiwan, some of the largest funds are

managed by government agencies, and in Singapore the Economic Development Board created a US$60 million fund. The Australian government must decide whether it needs to play a more direct role, as in the East Asian countries, or whether it should limit its role to providing tax incentives.

Given the government's reluctance to provide large-scale subsidies to strategic industries, it may be worth asking whether it makes sense to provide any support at all. Another alternative is to follow a truly *laissez-faire* approach, as New Zealand is doing, and let the market direct resources without interference. Some economists might argue that if Australia really has the advantages in IT that Senator Button and others claim it does, then the government shouldn't have to subsidize the industry at all. The counterargument is that no country, including the United States, has developed a successful IT industry without significant government involvement, especially in the early stages.[12]

The goals and strategies of the IIS clearly reflect the nature of economic problems facing the country. Australia's balance of payments situation is serious, and the heavy emphasis on exports in the IIS shows a desire to deal directly with the deficit in IT. Also, as Australia watches the state-directed economies of East Asia pass it by in IT production, there is strong pressure to take action. Promoting IT production fits well with the government's plans to make Australia into a "clever country" whose economic competitiveness is based on intellectual resources rather than natural resources. Whether the policy initiatives taken so far are adequate to make Australia into an internationally competitive IT producer is uncertain.

IV. POLICY OUTCOMES: THE AUSTRALIAN IT SECTOR

A. IT Use

Despite the lack of explicit government policy promoting IT use, Australia's IT market is the second largest in the Asia-Pacific region after Japan, and its investment in IT ranked first at 2.84% of GDP in 1988 (Kraemer, et al., 1992). Growth in IT expenditures from 1983-1988 grew faster than any country in the region except New Zealand. Table 5 compares Australia's level of IT expenditures with other countries in the area.

Table 5. IT investment in Asia-Pacific countries

Country	IT investment as % of GDP (1988)	Growth in IT investment 1983-88, in constant US$
Australia	*2.84*	*11.9*
New Zealand	2.34	19.4
Singapore	1.31	3.8
Hong Kong	1.11	7.8
South Korea	0.63	10.8
Taiwan	0.60	10.8
United States	2.22	n.a.

Source: Kraemer, et al. (1992).

The high levels of IT use in Australia can be related to the lack of tariffs on IT products, to high wage rates—an average wage in manufacturing of US$13.05 (Electronics Business Asia, September 1991, p. 9), and to the predominance of the service sector in the economy. The lack of tariffs lowers the cost of IT for all sectors of the economy and indirectly encourages use. The high wage rates increases the returns for substituting capital for labor, especially in the service sector, which is generally the heaviest user of IT.[13] Market growth slowed to just 2% in 1991, as the effects of economic recession were felt. The Australian IT market (including communications equipment) in 1991 was estimated to be A$11.5 billion, up from 10.8 billion in 1989 (McAlister, 1991).

B. IT Production

The IT industry in Australia is dominated by a few large firms. The top 14 IT companies comprised about 60% of the market in 1990. Table 7 shows the revenues and market shares of the

top 14 countries for 1990 (including sales of computers, peripherals, data communications, software, maintenance and services, but not communications equipment).

Table 7. Revenues and market share of top IT vendors in Australia

Company	Revenues (A$ million)	% of IT market
IBM	1260	15.4%
DEC	415	5.1
Unisys	400	4.8
Telecom	*330*	*4.0*
NEC	308	3.7
Fujitsu	244	3.0
Hewlett-Packard	233	2.8
Apple	215	2.6
Wang	215	2.6
Computer Power	*202*	*2.4*
Bull	189	2.3
Ferntree	*182*	*2.3*
Compaq	168	2.0
Amdahl	160	2.0
Total	**A$4521**	**59.7%**

Source: *Computing* (December 1990).

Of the top 15 companies, only Telecom, Computer Power and Ferntree are Australian-owned. The dearth of Australian companies is especially apparent in the hardware sector, where the are no Australian manufacturers in *The Computing 100*. The top 15 hardware companies are all multinational subsidiaries and account for about 90% of the market (Rob Durie, AIIA, interview).

The Australian IT market is relatively large, but domestic IT production is still very limited. For example, hardware exports equal only about 18% of imports (McAlister, 1991). And the hardware production and exports that exist are dominated by multinationals. IBM's exports from Australia in 1991 were A$428 million, mostly from the Wangaratta Manufacturing Facility, which produces PS/2 PCs, planar boards and Japanese Kanji Character controller cards. Local companies have had little success in the hardware or packaged software areas. Companies such as Dulmont, Time Office and President have failed despite having innovative hardware products (The Computing 100, December 1990, p. 24).

The only area where Australian-owned companies have had much success has been in software and services. Here, their closeness to the market and familiarity with local conditions give them an advantage in the domestic market. However, they have had only moderate success as exporters, achieving A$640 million in software and services exports in 1990/91 out of a total production of A$2.5 billion (McAlister, 1991). The top companies are generally Australian firms, such as Computer Power, Ferntree and Paxus. The industry consists of about 50 relatively large companies and 1200 very small, locally-owned companies.

Production by the Australian IT industry grew at a fairly slow 5.16% annual rate from 1987/88 to 1989/90 in terms of domestic value added. However, exports grew at 20.05%. This suggests that the 1987 strategy may have had an impact on exports, but little effect on production for domestic use. This is not surprising since the strategy is heavily oriented toward export promotion. The claims that investment capital is in short supply is supported by the fact that investment by members of the Australian Information Industry Association (AIIA), which includes all the major IT vendors, grew by less than A$3 million over those two years, and was actually estimated to drop significantly in 1990/91 (AIIA, 1990).

Another sign of industry weakness is in R&D, which grew from A$102 million in 1987/88 to A$181 million in 1989/90, but was estimated to drop to just A$129 million in 1990/91 for AIIA members. These negative trends undoubtedly are an effect of the economic recession, but they cast into doubt the effectiveness of the Information Industries Strategy in promoting investment and R&D in IT. The trends are especially serious when it is considered that the major multinationals have increased R&D as part of their Partnership requirements, suggesting that investment by non-Partnership companies has dropped substantially.

V. CONCLUSIONS

Australia became an affluent country in the late 19th century as a primary goods producer. It initiated and was able to sustain a protectionist industrial policy because of the high profitability of

the primary goods sector until the economic crises of the 1970s and 1980s made that strategy too costly. By the early 1980s, the Australian economy was mired in a long period of inflation and slow growth. The government has since gradually moved to liberalize trade by reducing tariffs, in an effort to increase economic efficiency and force Australian industry to compete internationally. However, the immediate effect has been an import boom, which combined with lower prices for Australia's commodities exports, has caused large trade deficits and a rapid increase in foreign debt.

The Hawke government took a course of gradual liberalization toward a market-directed economy, opening the economy to international competition and dismantling the uncompetitive industrial structure which had evolved over several decades of protectionism. However, opening up the economy is a risky proposition if Australia's only competitive products are agricultural and mining goods. Unless the country can increase productivity in areas beyond the primary goods sectors, wages eventually will have to fall to maintain competitiveness, meaning a decreased standard of living for Australia's workers. The need to revitalize the economy has led the government to develop policies to promote information technology, which is seen as a means of increasing productivity in other sectors and as a high value added industry in which Australia can compete in world markets.

By keeping most IT imports free of tariffs, the government is allowing the market to determine the course of IT use in the economy. IT use is heavy already in international terms. However, it is unclear whether Australia's substantial investment in IT is paying off in the expected productivity gains. This situation parallels the so-called "productivity paradox" in the U.S., where huge expenditures in IT and rapid advances in the technology appears not to be accompanied by measurable improvements in productivity (Roach, 1987; Attewell, 1990).[14]

On the other hand, world IT production is dominated by the US and Japan, and it is very difficult for other countries to compete, especially in computer hardware. So with demand growing rapidly and domestic production limited, Australia has run up a sizable trade deficit in IT. This has led the government to develop a series of policies to support local IT production and exports. The policies chosen to support IT production have been broad-based, dealing with

everything from IT skills to export promotion. However, the level of government support is low compared to East Asian countries. Support to IT education is limited, compared with a country such as Singapore, which trained 10,000 new IT professionals in eight years. R&D support has grown through grants and incentives to multinationals, but is still relatively small, considering the large sums spent by industry and government in the U.S. and Japan, and even in countries such as Taiwan and Korea.

The most important and successful component of Australia's IT policy has been negotiation with multinational corporations, offering incentives to increase levels of hardware production, exports, R&D and local sourcing in Australia. This is probably the best hope in the mid-term for Australia in achieving success as a hardware producer and exporter.

In software, Australia may have a good chance at competing in world markets. Its programmers are world class, as evidenced by Fujitsu's contracting with the Australian National University for supercomputer software. One hurdle to overcome may be the lack of exporting experience among the smaller producers and the lack of emphasis on developing commercial software packages. While they are mainly niche marketers, the Australian software producers have the potential to become important competitors in those niches worldwide.

Perhaps the critical questions are whether the Australian government has a clear vision of what it hopes to accomplish in the IT sector and whether the policy mix it has chosen can accomplish the general goals it has set. One problem stems from the nature of Australia's pluralistic federal government system. The competition of interests in the political arena makes it more difficult to pursue an industrial policy which creates clear winners. Also, the domination of politicians over the bureaucracy means that there is no economic development agency with the independence to set and implement industrial policies free from the demands of the political system.

This is illustrated in the IT sector by the lack of an industry coordinator with the authority to develop a broad, coherent strategy covering most aspects of IT production and use. This is in sharp contrast to the situation in Japan, Korea, Taiwan and Singapore, where IT policy is guided

by one, or at most two key agencies.[15] In Australia, DITAC, DEET, AUSTRADE, the Department of Finance, the Department of Administrative Services and others, all have a role in IT policy in the Commonwealth government. On top of that, most of the states have their own IT policies. This is not to suggest that Australians would trade their democratic political system for a more centrally controlled government, but it points out the difficulty in pursuing an East Asian-style national IT plan in the Australian context. Still, policy coordination is possible even in a decentralized system if political leaders push hard enough. The support of Senator Button and other politicians made the IIS possible, and it appears that some progress is being made as a result. What is needed now is to go further with efforts to spur the development of indigenous companies in the industry, and to deal with the problems not well addressed by the original plan, especially the lack of capital available to the industry and the lack of export marketing experience on the part of local firms. But more importantly, it may be necessary for government and industry to come to an agreement over a set of clear, realistic objectives for the future of IT in Australia. And if this vision includes Australia becoming a significant producer of IT products and services, it may require a bureaucratic restructuring to put one or two agencies clearly in charge of coordinating policy for IT production and use.

The underlying question for Australia is whether to move further toward a free market economy or to implement industrial policies aimed at developing specific sectors such as IT. In general terms, it is a debate between a US-style market-directed economy and an East Asian-style plan-directed model. The choices being made may determine the ability of Australia to revitalize its economy and develop an economic base for the 21st century.

Australia's experience with IT provides several insights for developed countries as well as for developing countries. *First, there are two broad goals that might be pursued with respect to the role of IT in the economy: (1) to use IT to create competitive activities in other economic sectors, and (2) to develop IT as an important productive sector.* The two goals need not be in conflict with one another, but they can be. For example, Australia's policy for government use and procurement of computing emphasized efficiency and gave individual department managers

control over procurement, which was seriously at odds with a "buy Australia" policy aimed at helping domestic computer firms. Although such conflicts might be irresolvable, the key to resolving them generally is recognition that they exist and explicit attention to dealing with them. The Australian government recognized the conflict and dealt with it over time by strongly encouraging multinational firms, which were the preferred providers of computing hardware among government mangers, to use Australian firms as component suppliers, partners in joint ventures, or niche marketers.

Second, the policy approach for promoting IT use might be very different from that for promoting IT production. Australia has largely, and successfully, followed a market-directed stategy towards IT use. But there has also been strategically significant government involvement--not in targeting use towards any particular economic sector, but towards making the technology widely available at low cost. Australia promoted IT use by keeping tariffs on IT products low (or nonexistent) and products available to all economic sectors. This is in marked contrast to countries such as India and Brazil where tariffs on imports exceeded 100% except for export-oriented firms in the IT sector itself. On the other hand, Australia followed a weak plan-directed strategy towards IT production. The government sought to develop a domestic hardware and software industry through a series of policy initiatives (e.g., the Computer Bounty and the Information Industries Strategy), but the level of support provided was generally too low to have a major effect, and paled in comparison to its East-Asian competitors to say nothing of the United States and Japan.

Third, the most efficient and effective production strategy for many countries will be a multifaceted one, and one focused on niche markets. Given the large investments (capital, R&D, human resources, IT infrastructure, complementary industries) required for IT *hardware production*, most countries cannot be major players except in niche markets and/or involving cooperation with multinational corporations. On the other hand, the Australian experience (as well as that of India and New Zealand) indicates that many countries can expect to become significant players in *software production* for domestic and world markets directly or through

multinationals, and in domestic computing services in the areas of outsourcing, systems integration, and local adaptation of user applications.

Fourth, strategy to promote hardware production differs from promotion of software production. Hardware production depends heavily on technology controlled by large multinational corporations, and other countries must gain access to those technologies either through licensing or direct investment. This generally requires government to negotiate on behalf of the country as a whole, using factors such as market access as bargaining chips. The Partnership for Development Program is a good example of such as strategy. On the other hand, promotion of software requires a strong emphasis on infrastructure, especially education, training and telecommunications. Software exports can be supported through programs such as overseas marketing assistance and export financing facilities. If a country has the necessary endowments to support software production (human resources, telecommunications, capital), a more market-oriented strategy is likely to be effective.

Finally, plan-directed strategies require strong central coordination, especially if multiple independent agencies are required for implementation. Australia's DITAC, which developed the Information Industries Strategy, did not have control over trade, education, government procurement or other policies that would make the strategy effective. Each agency that did have control viewed IT as only one concern among many, and responded from its traditional perspective, rather than seeing its role as part of a coordinated effort to establish information industries in Australia. What is needed in such situations is an interagency structure to bring about the needed coordination, or strong, sustained political leadership to achieve coordinated action, or both. Direct realignment of functions and resources from existing agencies to a central coordinator is another option, but generally very difficult to achieve.

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Center for Research on
Information Technology and Organizations
(CRITO)
Suite 320, Berkeley Place North
University of California, Irvine
Irvine, CA 92717-4650

Tel 714/856-5246
Fax 714/856-8091
E-mail crito@uci.edu

(Australia:World Dev-Aust-double spc:7-27-92)
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[1] For the purposes of this paper, information technology, or IT, refers to a package of technologies which includes computer hardware, software, and services, as well as digital data communications. Information technology is often defined more broadly to include telecommunications, broadcast communications and office technologies such as photocopiers and telefax machines. We treat those as elements of the IT infrastructure, supporting and complementing IT production and use.

[2] In the words of Sydney University Chancellor Sir Hermann Black, "...it is not our function to turn out spick and span graduates who can spray paint on export products." A counterargument made is that the universities are supported by public funds and should contribute to national economic welfare.

[3] $72 per person, compared to figures for other small countries of $2426 for Switzerland, $1313 for the Netherlands, and $1060 for Sweden.

[4] ASIC codes 3352 - Manufacturing communication broadcasting or other electronic equipment or parts, and 3355 - electric and telephone cable and wiring

[5] Background from *The Computer Bounty Scheme, Program Evaluation Report 8*, Bureau of Industry Economics, Canberra, 1990

[6] Background from Department of Industry, Technology and Commerce (DITAC), 1989

[7] Background from DITAC, 1987

[8] The Foundation is governed by a Board of Directors, with members from the private sector, government and academia. The Commonwealth committed $300,000 per year for three years to the Foundation, which is to be matched by industry contributions of at least $100,000. The key objectives of the Foundation are:
-to establish itself as the primary source of information and advice on information industries' education, training and skills requirements and report on these matters;
-to assess and facilitate improvements in the relevance of education and training for the information industries through liaison with government, industry and educational institutions;
-to promote education activities which are responsive to industry needs and ensure maximum industry contributions to curriculum and course development processes.

[9] The SMC/SEC will be funded originally by AUSTRADE through the ITES with further funding to come from member company subscriptions and royalties from member companies' exports. SMC will be owned by member companies, with at least 51% control by Australian-owned and operated software companies. AUSTRADE projects that SMC/SEC will break even by the end of its third year and have funds available for reinvestment, repayment of ITES funding and dividends to members.

[10] The Vendor Qualification Scheme is administered by DITAC under the National Industry Extension Service (NIES). A$2.073 million was spent in 1989-90 and A$1.25 million has been allocated to the scheme in 1990/91.

[11] Electronic Business Asia, "More cash than opportunities," October 1991, p. 73

[12] For examples of how government's role has been critical in the development of a domestic computer industry in the U.S., Japan and Europe, see Flamm 1987 and 1988; Anchordoguy, 1989.

[13] See Kraemer et al., 1992, for discussion of relationship between wage rates, service orientation of the economy and IT investment

[14] There is considerable controversy over the Roach and Attewell analyses on both technical and substantive grounds. However, few analysts disagree with the general idea that productivity gains from IT are not apparent. Some say that gains have been achieved in manufacturing, and that they are just around the corner in services now that IT infrastructure has reached sufficient critical mass and the economic slowdown has forced staff reductions previously resisted by managers until forced to make cuts (Pinnsoneault and Kraemer, 1992). Still others feel that the real gains in productivity from IT await the re-engineering of business and government to take advantage of the potential offered by the technology.

[15] In Singapore, IT policy is dominated by the National Computer Board, in Taiwan by ITRI, in Japan by the Ministry of International Trade and Industry and the Ministry of Posts and Telecommunications, and in Korea by the Ministry of Trade and Industry and the Ministry of Communications.