The Commercialisation of Science and Technology:  
Government Strategies in Australia and China

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1. BACKGROUND

In assessing their role in relation to science and technology, governments find themselves torn between two opposing considerations. On the one hand, they are the custodians of public money, with an obligation to make sure that it is used wisely, minimising waste and risk. On the other hand, they want to encourage the development of new approaches and new initiatives, yet in doing so they face the high levels of risk and failure that these approaches can entail.

Given this, it is not surprising that much government activity is focussed on policy, rather than participation in the development and delivery of products and services. Through the stimulus provided by taxation packages, incentives, and seed funding – often provided on a matching basis – a government can support new initiatives and approaches without being directly involved in them.

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This balancing act has become more challenging in recent years, as the imperative to support innovation and entrepreneurial approaches has become stronger. This imperative is a function of an increasingly competitive environment, itself changing in the face of globalisation, allied with the successful results of government support for research and development leading to unprecedented levels of technological change and enhancement.

Despite this, the situation in Australia and China is likely to be different, of course. Australia is a relatively advanced country, with small proportions of the workforce devoted to primary production and manufacturing, and with a sophisticated and extensive service industry. Like many Western countries, Australia has been an enthusiastic participant in the capitalist market economy. In more recent years, this has also led to a government philosophy of increasing privatisation and commercialisation, and a significant drop in the number of government services. At the same time, it has a small population, and has sought to concentrate efforts in a limited number of areas.

On the other side, China is still developing its manufacturing and agricultural industries, and is working hard to meet the needs of its huge population as it becomes more affluent. For many years China has been an example of a centrally controlled economy, and even now, as it opens up more to the market economy model, it has retained a degree of direct government control and focus, preferring to describe it approach as a ‘socialist market economy’.

Despite these differences, both countries see involvement in science and technology, and in the effective commercialisation of science, as important. For both, systems to influence the priorities in research, to shape and influence development, and to encourage commercial exploitation of ideas are important. It is this element that is the focus of this paper.
2. AUSTRALIA

Introduction

As already noted, Australia has been seeking to balance the competing needs of either playing a key role through coordinating the science and technology effort, or creating an environment in which science and technology can flourish. Several measures in recent years have sought to influence the direction and focus of research and development, but in other regards the focus has been more on letting market forces determine the paths of development, and merely supporting and enabling the area generally.

This approach has begged the question as to what are market forces, of course. In the world of research, there is both the external market of companies seeking to exploit research, especially applied research, and there is also the internal market of researchers, who themselves make judgements about the value of research initiatives proposed by their peers.

This is particularly well illustrated by the case of the Australian Research Council (ARC), which allocates funds for research to universities. A long-standing element of the ARC approach has been peer review, with proposals for funding going out to experts in universities to rank them. A recent initiative by the government to have some full time staff appointed by the ARC to assess projects has received a great deal of concern – diminishing as it does the role of peer review, but also leaving open the possibility that the ARC might favour some areas of research, or researchers. However, even the traditional peer review model has challenges, not least of which is the allocation of funds between disciplines, which itself is a form of ‘direction’.

As will be the case with our examination of the situation in China, our focus will be on the role of the Commonwealth Government in Australia in recent years, concentrating on policies and programs in relation to science and technology, and its commercialisation. It will not include the activities at the other levels of government, state and local.
Overall, there are a number of elements of the Australian central government approach – both through the recently announced set of initiatives concerned with promoting a national innovation strategy, and through those policies concerned to develop the commercialisation of innovative technologies – which are aimed at improving Australia’s international competitive capacity by using new ideas, concepts and methods. To this end, priority has been given to the formulation of the governmental initiatives for the scientific and technological development from the point of view of the national development strategy, focusing on the reinforcement of both planning and guidance. Those initiatives include plans and policies for cooperation research centres (CRCs), tax reduction and exemptions for R&D, support for R&D and innovation, a national plan for key research facilities, developing the risk capital market and the identification of the national priority areas of research.

In addition, specific technological plans have been actively implemented to give a push to technological transformation, dissemination and commercialisation. In this connection, an information and communication technology centre, an intellectual property research centre and a biotechnology centre are being set up. The Australian government and the state governments, enterprises, and research institutes, all are committed to and involved in the whole process of technological transformation. In Australia, almost every state has the independent and different plans to support industrial innovation, with a view to creating an environment and providing the service for the small- and medium-sized enterprises to commercialise their technological innovations, and to meet their needs. Research institutes and the universities attach great importance to their cooperation with the enterprises, as well as spinning off their own research achievements out into the market, and collaboration has become well-established practice.
Key agencies

At the level of the federal government, there are two key coordinating agencies that play a central role in government policy on science and technology. They reflect the coordination strategies of the government – one agency is based in the Department of Prime Minister and Cabinet, and the other is an inter-departmental and agency committee.

The Prime Minister’s Science, Engineering and Innovation Council (PMSEIC) is the body to be found within the Department of Prime Minister and Cabinet, comprising Ministers whose portfolios encompass science and technology issues, and a number of external members, distinguished scientists and experts. Its Executive Officer is the Chief Scientist, who chairs the Standing Committee of the Council (which comprises the non-Ministerial members of the Council). The Chief Scientist is also a member of the Australian Research Council, and a member of the Victorian Government’s Innovation Economy Advisory Body.

The role of PMSEIC is fivefold:

- To provide advice to the Government on science and technology issues, particularly “as they relate to economic growth, employment creation, the development of new industries and the sustainable development of new resources”;
- To assess the role of science, engineering and innovation in contributing to the ‘innnovative capacity of Australia’ and to broader social and economic development of Australia;
- To enhance community understanding of the contribution made by science, engineering and technology;
- To provide an overview of resources for science, technology and engineering, and the effectiveness of their utilisation; and
- To look at the infrastructure to support the needs of the science, engineering and innovation areas, and ensure their contribution to broader social and economic goals.
Key to the role of PMSEIC is a desire to ensure that there is a close integration of science and technology into the broader national agendas, and for this reason, in 2002, the Government announced four national research priorities:

1. An environmentally sustainable Australia
2. Promoting and marketing good health
3. Frontier technologies for building and transforming Australian industries
4. Safeguarding Australia.

As a central coordinating body, PMSEIC is not directly involved in the assessment of research proposals or the allocation of research funds. Rather its role is agenda setting, with Ministerial members of PMSEIC taking priorities and agreements back to their portfolios for action.

The second key agency is the Coordinating Committee on Science and Technology (CCST), which is an interdepartmental committee of public servants, whose role is to complement the activities of PMSEIC. Its members comprise the heads or deputy heads of Government Departments, and heads of Government research agencies, and its functions are to:

- Provide a whole of government view of science and technology issues, particularly as an input to the deliberations of PMSEIC;
- Bring together agencies and departments;
- Exchange information; and
- Promote consistency, coherence and effectiveness of science and technology policy and programs.

In particular, CCST plays an important role in giving prior consideration of issues that are to be addressed by PMSEIC. It is a useful point for exploring issues that run across government departments and agencies, and since the Chief Scientist is a member of CCST, he also acts as a key conduit for ideas and issues.
Given this, topics on the agenda for CCST can be both specific – it recently examined a paper on the ‘Flagship Programs’ of the Commonwealth Scientific, Industrial and Research Organisation (CSIRO), a statutory authority of the federal government; and general – other papers have looked at bridging disciplines, and at risk management in relation to science and technology.

In summary, these two agencies play a key role in developing government policy in relation to science and technology, but the execution of policy is left to individual government departments and statutory agencies. That execution of policy is through a large number of programs, which between them either fund (or support the funding) of research activities (largely through universities and the various government research agencies), or support commercialisation.

**The innovation agenda**

An interesting example of the relationship between policy and implementation is provided by recent exploration of issues to do with innovation.

In 2000, the government took part in a national ‘Innovation Summit’, itself an initiative of the Business Council of Australia, a membership body representing large companies. The Business Council and the Department of Industry, Science and Technology jointly hosted the innovation summit. The summit brought together people from the private sector, government departments and agencies, scientists, research, innovators and entrepreneurs. In establishing the importance of innovation as a key tool in economic development and business competition, the Summit proposed a number of recommendations.

Following the Summit, an Innovation Summit Implementation Group was established, still as an independent initiative, and again with the support of the Business Council and the Department of Industry, Science and Technology. The Implementation Group made a more detailed set of recommendations, and these were assessed by the
Government in 2001, following review by PMSEIC. This led to a major statement by the Prime Minister on innovation in that year, *Backing Australia’s Ability*.

In practice, *Backing Australia’s Ability* brought together a number of initiatives that had already been developed by the Government over a number of years, consolidating these into an overall framework, and adding some additional funding. Key initiatives brought together under the statement included:

- The *Investing in Growth* program, which combined government funds with approved venture capital companies to fund innovation, commercialisation and the exploitation of research, a program initiated in 1997;
- A revised and enlarged program for funding research in universities, as had been announced in 1999; and
- Several smaller programs concerned with developing research areas, and supporting commercialisation.

At the same time, the 2001 statement saw some additional funding allocated, including further increases to the money available through the Australian Research Council for its nationally competitive grants programs, and additional funding for centres of excellence and cooperative research centres. The Government also committed more support to measures to try to increase the numbers of students studying science and technology at the school and tertiary levels. While much of the funding for this new policy already existed, the Government announced a progressive increase in funding over a five-year period, commencing with an additional $159m allocated in the fiscal year 2001-2.

This combination of initiatives was seen to achieve three outcomes. First, it gave focus to the importance of innovation, and since 2001, the Government has published an annual *Backing Australia’s Ability* statement. These reports give a summary of progress each year for the five-year program, together with publicising and showcasing innovation initiatives. The material from these reports on commercialisation will be further explored below.
A further element in giving focus to an innovation agenda was the establishment of a Science and Innovation Committee. This high-level committee has a membership which includes the Prime Minister, the Ministers of Science, Education, Science and Training, Finance and Administration, Industry, Tourism and Resources, and Communications, Information Technology and the Arts, together with the Chief Scientist. Its task is to give oversight to the implementation of the Backing Australia’s Ability package.

Second, this initiative allowed the Government to link together a number of priorities and policies. In doing so, it has been able to take a more directive line in the allocation of funds, strengthening the articulation of policy. For example, in increasing the allocation of funds to the ARC for competitive grants, in January 2002 the Minister for Education, Science and Training, Dr Brendan Nelson, directed the ARC to allocate at least 33% of funds in the 2003 new funding round to four areas of priority:

- 1. Nano-Materials and Bio-Materials;
- 2. Genome and Phenome Research;
- 3. Complex and Intelligent Systems; and
- 4. Photon Science and Technology.

These were “identified as fields of existing or emerging research strength in which Australia can achieve international leadership and which have the potential to deliver significant economic and social benefits to the community”.

Third, and most important, it has enabled the Government to establish a stronger link between research and the exploitation of research, by more closely tying together those programs that fund research with those concerned with commercialisation, venture capital funding and the protection of intellectual property.
Executing policy

While policy parameters are established through CCST and PMSEIC, the execution of policy is undertaken through a variety of agencies and departments. In some cases, these agencies will undertake a proactive role, and set specific actions in place; in others they provide a funding or support basis for research and development, but do not impose specific directions to be pursued.

At the present, there are a number of initiatives that are clearly intended to ensure specific Government policy initiatives are followed. These include:

- The ICT World Class Centre of Excellence, National ICT Australia (NICTA), intended to undertake research and development in information technology and communications to assist the enhancement of Australia’s competitive ability in industries such as financial services, primary industries, resources, education, entertainment and health through leading edge ICT developments
- The proposed Biotechnology Centre of Excellence, intended to enhance Australia’s capability as a leading centre for biotechnology research.

In addition to these, the Government also funds Cooperative Research Centres (CRCs), which are joint ventures between private sector companies and universities, and while these are funded on a competitive basis, the need for researchers to find industry partners means that they are likely to be established in areas of business and economic development need. This funding is balanced by the Government’s Major National Research Facilities program, through which funding is provided to support major research centres – again in areas which are seen as likely to contribute to Australia’s competitive development.

Other programs are more generally intended to support the development of research and development, especially in science and technology. In common with many other countries, Australia offers tax concessions to companies that invest in research and development (at 125%), and it recently introduced a ‘premium’ level of tax
concession (175%) for those that increase their level of research and development expenditure as part of its *Backing Australia’s Ability* policy initiative.

Finally, as already noted, the Government provides funding for the National Competitive Research Grants (and the associated Project Specific Research Infrastructure and Research and Research Training Infrastructure programs), through the Australian Research Council. While traditionally such funding has been allocated on peer review judgements of researcher excellence, recent initiatives suggest there is increasing interest in tying this more overtly to national priorities.

**Commercialisation of research**

The Australian Government has traditionally adopted a ‘hands off’ approach to the commercialisation of the outcomes of research and development, leaving this to market forces. The majority of research carried on outside of individual private sector enterprises is undertaken in universities, in cooperative research centres, or through government research agencies, especially the CSIRO. Commercialisation of that research is a matter generally left to the universities and partners concerned, and for some time the Federal Government did not provide seed funding for commercialisation. However, at the State level of government, there are various schemes to provide some seed funding for new ventures, many of which are based on the commercialisation of research.

The role of the CSIRO in relation to commercialisation has been strongly debated, however. While it has been a decision of the CSIRO units to exploit commercial opportunities, there is a growing concern that too little is done to support this element of their work. In 1997, concern over debates of this kind led the Government to develop a new initiative, the *Investing in Growth* policy, which linked government funds to venture capital funds to provide, jointly, a pool of $1.26bn over four years (with the government contribution being $400m).
Since 1997, the Government has strengthened its role in enabling commercialisation, and now has strengthened a number of initiatives. These include:

- The Investing in Growth initiative, which provides enhanced access to venture capital funding for some organisations, which provides funding under *Innovation Investment* and *Pooled Development Funds* programs;
- The *Pre-Seed Fund* which provides early funding for commercialisation, with $100m managed by private venture funding organisations (but utilising $72.7m of Commonwealth money) – an initiative to allow the Government to be a source of seed funding, but ensuring that investment decisions are at ‘arms’ length’ and made by expert investors;
- Continuing and providing extra funds for the *Commercialising Emerging Technologies Program* over a five year period – adding $40m per annum to bring the total funding available over the period to $70m per year; and
- A number of specialised innovation programs, targeted at leading edge technologies, providing funding both to researchers in universities and companies working in key areas of technology.

Finally, the Government has taken an active role in strengthening the application and use of Intellectual Property (IP), both through internal measures to promote IP protection, and through participation in international forums on Trade related Intellectual Property Rights (TRIPs).

Taken together, these various measures suggest that the pendulum has swung in Australia away from the Federal Government’s major involvement being in the promotion of research through to a much more direct role in innovation and commercialisation. It has increasingly moved to focus funding activities on areas seen to be important for long-term competitiveness. At the same time, it has also moved to enhance access to venture capital and seed funding, to enable new companies to get off the ground, and to support the commercialisation of emerging technologies in universities and existing enterprises. In doing so, it reflects a pattern to be seen across the Western world, as well as returning to a more interventionist style of government in relation to innovation and commercialisation, that had previously been evident in the latter part of the 1970s and the early 1980s.
3. CHINA

Introduction

Since the process of opening up and reform commenced, China has set up a number of new mechanisms that are intended to tailor processes to the requirements of the socialist market economy and combines technology and economy. In particular, these have included:

- the implementation of a strategy of “rejuvenating China by science and education”,
- the establishment of the national innovation system,
- the optimisation of the technological systems and structures available in the country,
- the development of an environment which is intended to bring the talented innovators and entrepreneurs in China to the fore and to encourage innovation and entrepreneurship, and
- the strengthening of the country’s innovation capability

All these efforts have laid a solid foundation for the overall construction of a society with an improved standard of living, and the promotion of the new approaches to business and industrialisation, (see Li, 2001; Sun, 2001)

In addition, the commercialisation of technological innovations has become recognised as a critical new growth point in the economic development and plays a significant role in the upgrading of the industrial structures.

The Chinese government has set up a system of national technological programs (3+2), that comprises:

- the National High Technology Research and Development Program (known as Initiative 863),
- the National Scientific and Technological Task Force Program,
- the Key Basic Research and Development Program,
- the Research and Development Facilities Construction Program, and
- the Environmental Development Program for Technological Industrialization

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This set of initiatives are linked together with a series of other smaller initiatives and programs. All of these programs have provided and created a major policy environment for the development of Chinese technology and the commercialisation of technological achievements, (see HREF 1 and HREF 6).

**Key programs**

(1) **National High Technology Research and Development Program (Initiative 863)**

Initiative 863, a strategic development plan for research and development is focussed on the development of Chinese high technology, setting priorities for high-tech research and development in 19 specific areas in 6 general areas of interest. These broader areas include information technology, biotechnology, new materials technologies, advanced manufacturing and automation technology, energy technology and marine technology, as well as other crucial programs. With the government’s guidance and enterprises’ participation, Initiative 863 is actively engaged in promoting international exchange and cooperation in high-tech research and development. So far cooperative relationships have been established with over 20 countries and substantial cooperative programs involving some 10 technologically advanced countries have been initiated. Consequently, Initiative 863 has greatly contributed to the improvement of high-tech research, the strengthening of technologically innovative capabilities and the acceleration of technological transformation in key industries, (see HREF 3).

(2) **The National scientific and technological task force program**

This program, with the task forces intended to tackle national socio-economic technological problems, is aimed at the improvement of the level of industrial technological sophistication. Critical technological breakthroughs, innovation in established technologies, the application and industrialisation of high technologies are together seen as important in providing technological support for the adjustment of industrial structures, sustainable social development and improvements in the quality of life. Science and technology are see as a source of great for change, particularly as
they often provide leading edge innovation and new business opportunities. Science and technology have become the powerful driving forces for increasing economic growth, social efficiency and promoting socio-economic development.

During the four five-year plans since 1982, 539 programs have been launched, with almost 100,000 projects accomplished and, by the end of 1999, 15.34 billion yuan (RMB) worth of economic result had been yielded.

(3) The national key basic research program (Initiative 973)

Initiative 973 is concerned with important basic research projects of global significance, with considerable potential for national development and technological progress. They are projects that are only viable with the government’s vigorous involvement in their organisation and execution. Multidisciplinary and comprehensive researches have been carried out in the fields of agriculture, energy, information, natural resources, environment, population and health, and materials (see HREF 4).

From 1998 to 2002, 132 initiatives were launched and the government expenditure on them during the period of the ninth five-year plan was 2.5 billion yuan (RMB). Most of the projects under the auspices of Initiative 973 have entered into various forms of cooperation with other countries.

(4) The spark program

The spark program is the first government authorised program to promote economic development in rural areas by means of science and technology. The program supports, by using rural resources, large numbers of projects, which are characterised by having small investment, quick economic return, yet using advanced and broadly applicable technologies. With the support of the program, technology intensive areas and regional pillar industries have been established. Agriculture characterised by high yields, high quality and high efficiency has been developed. Socialized service systems in the country and rural scale-economy have been promoted.
The end of 1995 had seen the launching of a total of 66,736 projects under the aegis of the program, covering over 85 percent of all the counties. Of these projects, 35,254 had been completed. With the total financial input of the program at 93.76 billion yuan (RMB), an output value of 268.27 billion yuan (RMB) has been realized, generating the profit tax of 47.39 billion yuan (RMB) and the foreign currency of US$ 8.89 billion. 127 national technology intensive areas, 217 regional pillar industries and 40 national training centers have been established (HREF 5).

(5) The torch program

The National Commission of Science and Technology executed the torch program, a guiding program approved by the State Council in August 1988, to develop high-tech industries. The market-driven program undertakes to promote the commercialisation of high-tech achievements, the industrialization of high-tech commodities, and the internationalisation of high-tech industries. Development priority of the program is given to the fields of new materials, biotechnology, electronics and information, the integration of optico-machinery-electricity, new energies, high efficiency and power saving, and environmental protection. Under the guidance of the program, the construction of the high-tech areas, the service centres for the launching of the high-tech businesses, the management of the projects under the auspices of the program, the internationalisation of high-tech industries and the construction of software bases have all been brought up to a new level (HREF 2).

It is especially noteworthy that great progress has been made in the work on the innovation fund for the small- and medium-sized technology-intensive enterprises. In 1999, the number of the service centers nationwide reached 110 and, with nine more national centers authorized by the government, there were a total of 38 such centers. In addition, 30 national university science parks were set up, 15 of them validated by the Ministry of Science and Technology and the Ministry of Education as pilot parks. Also in operation were over 30 ‘business-launching parks’ for those professionals with foreign academic degrees and over 20 software science parks. A variety of business incubators came into existence, including those concerned with special technical know-how, international enterprises, state-owned enterprises, and
those especially for professionals with doctorates. The torch program has given a strong impetus to the commercialisation and the industrialisation of technological innovations, greatly enhancing the globally oriented development of high-tech industries.

**Technological development and commercialisation**

In order to popularise the industrialization of technological achievements, the government has adopted a series of scientific and technological policies to continue implementing, in various forms, a series of guiding programs such as “the technological achievement popularising program” and the “new product program”, (together with the spark and torch programs noted above), resulting in prompt technical transformation, and bringing into existence a group of high-tech enterprises.

1. **The funding policy concerning the technological innovation of the small- and medium-sized technology-intensive enterprises**

The fund, an earmarked fund sanctioned by the State Council, is an important governmental supportive instrument intended for the technological innovation of small- and medium-sized technology-intensive enterprises. The fund, operationalised in the form of loan and discount, interest free financial support and capital input, and by means of technological innovation and transformation, has provided great support for the development of these enterprises. Among the beneficiaries enterprises in seeking government seed funding support in view of their early phase of industrialisation, with priority given to those with high technological content, good market prospects (but high risk), and insufficient conditions for the inflow of business capital. The fund also paves the way for and guides the expansion of the industrialisation and the introduction of business capital.

2. **The mechanism of risk investment**

Under the principle of “enacting the policy, creating the environment, reinforcing the supervision and controlling the risk”, local governments, enterprises, financial
institutions, individuals, foreign businessmen and other investors are encouraged to promote and participate in the development of risk investment industry. The investment can be made through risk investment companies, share floatations, the founding of loan guarantee companies for high-tech industries, the establishment of appropriate progressive income tax and the newly increased profit of the enterprises, the issuance of enterprise bonds, and investment in the stock-right and transferable securities. In the light of the national industrial and technological policies, and the strategic objectives in the adjustment of the industrial and product structures, the State Council regularly sets down and issues the guide for risk investment items (areas) to channel the direction of the business-launching investment and legislates a series of laws and regulations governing risk investment.

(3) The law “promoting the transformation of technological achievements”

Following the promulgation of “The law on promoting the transformation of the technological achievements” by the 19th Plenary Session of the Standing Committee of the 8th National People’s Congress on 15 May 1996, local governments have also rolled out “The rules governing the promotion of the transformation of the technological achievements”. This document encourages the combination of research and development organizations, higher education institutions and other institutions with industrial enterprises in joint efforts to carry out the transformation. The national financial expenditure for technological transformation is utilised mainly through such mechanisms as seed capital, the discounting of loans, a subsidy fund, a fund for risk investment and other funds.

The government has also adopted a policy to provide preferential treatment in taxation for technological research and development and has gradually increased the amount of loans. The government encourages the set-up of technological transformation funds and risk funds. The fund resources are from the central and local governments, enterprises, institutions or individuals. The funds are used to support the development and commercialisation of technological achievements requiring large investments, high risk and high output and the funds are used to speed up the industrialisation of the important technological achievements. In addition, the government has also
formulated the “The administrative measures for the national technological innovation program”, “The administrative measures for bid inviting and tendering for national technological innovation projects”, “The law on the promotion of the small- and medium-sized enterprises” and others with a view to supporting the development of the technology-intensive enterprises by virtue of the policies.

Research and development and the industrialization of technology

The Chinese government pays great attention to the construction of research and development conditions and the industrialization of technology, supplying good environmental support for the development of high-tech industries and the technological transformation.

(1) The National Engineering Technology Research Centers

National Engineering Technology Research Centers have been established as the key link between technological achievements and their productive transformation, with the intention to shorten the latter’s cycling time. Based on the research strengths of the key research institutes, technology intensive enterprises and universities in a certain field, the centers keep a close touch with the relevant enterprises and have become research and development entities with a healthy self-cycling development mechanism. At present, China has a total of 103 such centers distributed in over 20 provinces, municipalities and autonomous regions.

(2) High-tech industrial areas

These areas are an important component of the torch program. Depending on the intellectual concentration, the opening environment and conditions and the technological and economic capacity, and through the local optimisation of the hard and soft environments, these centres have been established to maximize the transformation of technological achievements into the real productive economy. As important bases for the development of innovative technologies and their industrialization, these high-tech industry concentrated areas are market-oriented,
internationally and domestically. They have leading roles to play in the regional economic development, acting as a beacon for others.

Since 1991, the State Council has sanctioned 53 national high-tech industrial development areas, APEC science parks, university science parks, service centres for launching high-tech technological business, software industrial bases and national export bases of high-tech products. They have already become important constituent parts of the incubation system of technological innovation and the support and service system for the high-tech industries, greatly pushing forward the commercialisation of the high-tech achievements and the industrial development.

(3) The technological transaction market and technological intermediary service agencies

The central and local governments have established a group of technological intermediary service agencies such as the national center for the promotion of productive forces, the national technological evaluation center, the north technological market, the north scientific and technological facilities market, the center for the promotion of the productive force of machinery industry, the center for the promotion of technological innovation and the productive force in Beijing, the center for the transformation of high-tech achievements in Tianjin, etc., thus constructing an open channel for the transformation of the high-tech achievements. The north technological transaction market, jointly constructed by the Ministry of Science and Technology, and Tianjin municipal government, is also an important distributing center of information about technological achievements in north China. In Shanghai and Shenzhen, similar markets have also been set up, providing a favourable environment for the protection of the intellectual property in the course of the technological transformation.
Discussion

The Australian government’s total spending on scientific research in 2001 increased by 15 percent. The government also encourages and attracts the enterprises to invest in scientific researches. Generally speaking, for those programs that are mainly financed by the government, the government’s input amounts to 70 percent and the enterprises 30 percent. However, while in China, the spending on R&D in 2001 constituted only 1 percent of the GDP of the same year, in Australia in the same year it was on 0.67%. There has been considerable interest paid to Australian developments in China, nonetheless, (see Luo, 2003; Tang, 2001; and Zhang and Wang, 2003). These have suggested a number of areas for further development, and similarly we have identified a number of initiatives that could be taken to raise the scientific and technological awareness of the enterprises so as to increase the spending on R&D through different channels involving government, enterprises and society at large. At the same time, in our analysis, we have identified a number of challenges facing China at present:

Possible future considerations

(1) Weak awareness by enterprises of the importance of innovation, and inadequate protection of the intellectual property

After joining WTO, China has been confronted with the challenge of large numbers of patent applications by transnational corporations, which want to exercise technological control. In this case, something must be done to redress the inadequacies in protecting the intellectual property, to increase the number of Chinese self-determined intellectual property and to strengthen the technological competitive ability.
(2) An inchoate technological market and an underdeveloped transformational function of the technological centers

As an intermediary between science and technology and the economy, technological markets need to be more standardised in terms of their operating systems, to overcome their present lack of structure and coordination, the weak macro-regulatory capability of national administrative departments and the lack of well-established policies and regulations concerning the technological market.

(3) The inflexibility of enterprise incubators and the need to strengthen the technological intermediary service system

With a view to promoting the transition towards knowledge economy and developing science parks and enterprise incubators in Australia, some 24 science parks, more than 60 enterprise incubators, have been established, all operating in a flexible way. By contrast, the role of the incubators has not yet been brought into full play in China. Correspondingly, the intermediary service system needs to be strengthened to meet the demands of enterprise establishment with regard to R and D, information, investment and fund raising, trading, law, guarantee, financing, evaluation, human resources, international exchange and training, intellectual property and technological transaction.

(4) Imperfect systems for risk investment and the construction of the quitting mechanism

Specific programs have been initiated in Australia, such as the “Innovation Investment Foundation Program”, which has successfully nurtured and developed the risk investment market. But there are few institutions especially engaged in risk investment and few fully functioning intermediary services in China. Funding shortage, lack of an unimpeded channel for capital circulation, non-standardised investment operations, and lack of favourable legal environment and investment mechanism, all these combine to bring about the result that the average conversion rate is around just 20% for the 30,000 technological achievements identified at the
ministerial and provincial level, and the 70,000 patents that have been registered. Such a low rate is obviously indicative of enormous waste of labour, hindering the development of high-tech industries.

(5) Incongruous combinations of enterprises, universities and research institutions blocking the integration of science and technology, and economy

A good mechanism for establishing effective combinations between enterprises, universities and research institutions has been set up in Australia. The joint research centre is a case in point. With the participation of relevant government departments, the centre is principally made up of universities, research institutes and enterprises. In so doing, not only is the management of government budget for scientific research strengthened, but also the rate of scientific and technological conversion is accelerated. Clearly China needs to develop a similar approach, given the fact that the overall strengths of universities and research institutes have not yet brought into full play for lack of effective financial inputs, leading to dispersed approach to the conversion and commercialisation of technological developments and a low degree of technological integration.

Developing commercialisation in China

Our research suggests there are a number of fundamental approaches to the promotion of commercialisation and the industrialisation of technological developments, and their applicability to China.

(1) Strengthening the macro-regulating capability and giving full play to the coordinating and guiding function of the government so as to create a favourable environment for technological transformation

To this end, the Ministry of Science and Technology, on the one hand, takes charge of the nationwide arrangement of the technological activity, paying special attention to the local technological R&D and creating greater working space for local technological management departments. On the other hand, the Ministry optimises the
contact system of ministerial leaders respectively in charge of different areas, thus keeping close contact with the local government. They have also formulated rules which stipulate that local opinions and suggestions must be solicited before any important technological decision-making and the local governments must be notified of the decision immediately after it is made.

We suggest that, in addition, provincial and regional participation in the national macro technological decision-making should be enhanced and regular meetings are held with the attendance of the provincial heads in charge of science and technology. At these meetings, regional and provincial technological activity can be reviewed, discussed and future work planned.

(2) *Enlarging the technological investment by the central government, and the establishment of an optimised socialised fund-raising system*

Measures should be taken to carry out basic research and at the same time to strengthen applied research so as to support the national technological programs. Enterprises should be encouraged to increase research and development funding, and to act as the major investor in technological innovation. Funding to support the key role played by small- and medium-sized technology-intensive enterprises in innovation should be brought into full play. New investment and fund-raising mechanisms and seed funding mechanisms should be established and improved, particularly those suitable for the development of high-tech industries in areas such as risk investment, insurance, technological credit and credit evaluation. In so doing, the capital market will become a strong source of support for technological development. Given the increased importance of financial allocations and bank loan, investment should be sought from enterprises, civil institutions and foreign businessmen so as to construct a multi-channel technological investment system, optimise the fund-raising mechanism, and increasing the range of potential sources. With a diversified set of major investors, a socialised investment pattern will eventually emerge.
(3) **Speeding up the industrialisation of high technology achievements, and the construction of the high-tech development areas**

With the support of the favourable policies, the construction of technology-based enterprise incubators, better management of the high-tech industrial development areas, the high-tech industrial parks and the duty-free zones will attract both international and domestic R&D institutes and the transnational corporations to set up their research and development institutes in China. Research and development organizations can also be jointly established using various forms of cooperation to build up technological strengths for the support of industrial development and the acceleration of technological transformation and high-tech dissemination in traditional industries. The high-tech transformation of the traditional industries will enable them to act as the catalyst for the commercialisation and industrialization of high-tech achievements.

(4) **Nurturing and developing the technology market, lowering the risk in the enterprise’s technological introduction, realising the commercialisation of the technology achievements and their scale production**

Governments at all levels should set up a group of intermediate experimental bases and engineering centers, normalize risk investment companies and train the relevant management and operating personnel. Technological transaction markets, productive force promoting centers and technological transformation centers of all descriptions specially engaged in technological achievements and promoting their commercialisation should be optimised so as to act as an exchange for the supply and demand of technological achievements, and to formulate a technological transaction network of multi-dimension, multi-channel and multi-form.

(5) **International technological cooperation and exchange and enlarging the opening up of research and development**

Through international cooperation in technological programs, efforts should be made to introduce advanced technologies, management experiences and highly qualified
manpower. Support should be given to a number of strong international technological cooperation bases and joint research and development organizations, both international and domestic. The absorption, digestion and innovation of the achievements brought about by the above undertakings will produce a ‘nuclear fusion’ effect, which will enhance the development of the high-tech industries.

(6) **Strengthening the cooperative relationship between research institutes and enterprises to create a standardized mechanism for technological innovation**

The construction of the scientific research system, the technological development system and the technological service system should be further strengthened. At the same time, there should be support for the combination of enterprises, universities and research institutes to form a pattern of technological innovation and operating mechanism with the enterprise as the major player, and the research institute, university, intermediary service agency and government department relating to one another in an interactive way. Under the support of the technological research and development policies and the initial research funds, scientific researches and business launching undertakings of universities and research institutes are encouraged, together with the enterprise’s technological innovations, as a result of the close cooperation between enterprises, universities and research institutes.

(7) **Intensifying the management of the technological transformation**

Firstly, program management should be strengthened and technological programs optimised. Program evaluation, process management and technology commercialisation should be intensified. Secondly, attention should be paid to the work on patents. The marketisation of patents should be promoted, using the policy and fund as the leverage so that the instantiation and the application of patents constitute a key link in the transformation of the technological achievements. Thirdly, in accordance with the principle that human beings should be treated as the most essential factor, an enterprise environment should be constructed, in which knowledge and talented manpower should be respected. Prominence should be given to the training of personnel with all-round capabilities, and the human resources
development system should be diversified so as to give full expression to the innovative value of science and technology, and operating and managerial personnel. Fourthly, importance should be attached to the research and development of the technology with self-determined intellectual property. The protection of the intellectual property should be strengthened and original (radical) innovation encouraged. Special recognition should be given for innovations distinguished by originality, outstanding personnel and unique intellectual property.

4. CONCLUSION

In reviewing the systems in Australia and China, we have noted an interesting policy convergence between the two countries. It was our initial expectation that the two countries would differ in terms of where they would fall along the continuum between being concerned with setting policy or actively participating in control over the use of resources. As we noted earlier, Australia is a relatively advanced, an enthusiastic participant in the capitalist market economy, with a government philosophy of increasing privatisation and commercialisation, and a significant in reducing the number of directly delivered government services. On the other hand, China has been an example of a centrally controlled economy, and has retained a degree of direct government control and focus, preferring to describe it approach as a ‘socialist market economy’.

Despite this, it seems that at present Australia is moving towards a more directive role than has been normal, and China is coming from a traditionally strong government policy direction role to one where it sees importance in creating an environment in which innovation and commercialisation can flourish. As a result, the two countries seem to demonstrate comparable levels of government intervention – while coming to the same point from different directions: as a result, they share a common approach to policy and regulatory structures. Indeed, in a number of respects programs and government mechanisms are remarkably similar.
In part, this may reflect the increasing importance of innovation and effective commercialisation for the broader economic and social development of all countries. Both China and Australia depend on effective business activity, and both need to ensure they will be able to promote effective enterprises at a time of change, and global competition. This extrinsic demand may have played a larger role than political or ideological differences, an outcome indicative of the importance of globalisation in contemporary government policy.
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