Financing of Innovation - A Survey of Various Institutional Mechanisms in Malaysia and Singapore

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Summary

Production of goods and services always necessarily depends on the use of knowledge. The knowledge intensity of production, however, has increased manifold in the last two decades or so. This is clearly indicated by the rise in the share of knowledge intensive products, which are traded. The production and export of these advanced products are not confined to developed countries alone, but also among developing countries. But in the latter there is considerable concentration of it in a handful of countries primarily in the Asian region. Knowledge underlying production, whether industrial or non-industrial, embodies two types of knowledge: formal and non-formal.

In this paper we are entirely concerned with the financing of the creation of formalized knowledge in the context of two similar Asian developing countries, namely Singapore and Malaysia. Three broad types of financial instruments are considered: research grants, tax incentives and venture capital. Both the countries are shown to be having very similar financial instruments for promoting innovation. Thetiming of these instruments is quite similar too. But one country has performed much better than the other. The main argument of the paper is that while financial instruments are a necessary input for innovation, the sufficient condition lies in the supply of a sufficient quantity of scientists and engineers.

Key words : innovation, research grants, tax incentives, venture capital, Singapore, Malaysia

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1. Introduction

Production of goods and services always necessarily depends on the use of knowledge. The knowledge intensity of production, however, has increased manifold in the last two decades or so. This is clearly indicated by the rise in the share of knowledge intensive products which are traded (Mani, 2004). The production and export of these advanced products are not confined to developed countries alone, but occur also among developing countries. But, in the latter there is considerable concentration of it in a handful of countries primarily in the Asian region.

Knowledge underlying production, whether industrial or non-industrial, embodies two types of knowledge: formal and non-formal. In this paper we are entirely concerned with the creation of formalized knowledge. It is also a very widely held view that there are a number of disincentives to create formalized knowledge even in a freely competitive market. There are both theoretical and empirical reasons as to why the creation of formalized knowledge especially within industrial enterprises needs to be supported by the state. While the theoretical reasons for intervention in knowledge development is applicable to both developed and developing country situations, the empirical reasons apply more to developing countries rather than to the developed ones.

Though the issue of the role of state intervention in the generation of knowledge is very important, it has hardly received any serious attention in the literature. The only major attempt has been by World Bank (1998). While this study has sought to emphasis the role of the state in the creation of knowledge (of the type that we are talking about in this case), it has interpreted government's role narrowly in terms of freeing up the trade and investment regimes of developing countries through international trade in commodities and in capital.

But, there is very little empirical evidence from anywhere in the developing world that formalized industrial knowledge, especially of disembodied variety, can be obtained through free trade. This type of knowledge is also very location specific and will have to be created locally by applying the right types of institutions and incentive systems. Given the well-known market failures in this process it will have to be achieved through state intervention. In the context, the basic objective of this case is to survey the main theoretical and empirical reasons for knowledge creation.

This paper is organized as follows. The second section marshals the theoretical arguments for government support for innovative activity. The third section provides an overview of alternative innovation funding sources such as tax incentives, research grants and venture capital. In Section 4, I provide a survey of the instruments used for financing innovation in two seemingly successful Asian economies, which can be easily compared with each other. Section 5 concludes.

2. Theoretical Rationale for Interventions in Financing of Innovation

The theoretical rationale for this line of reasoning can be found in the widely cited pieces of Nelson (1959) and Arrow (1962). In this specialised literature it is assumed that formalised knowledge is created through the R&D efforts of firms and research institutes while of course there is no denying of the fact that knowledge is indeed created through a variety of non-R&D routes as well. Private sector agents can identify two types of failures in the financing of R&D.

The first one has been very well articulated in the so-called appropriability argument. This argument runs as follows: R&D investments result in the production of new knowledge and this is non-rival in its use. Despite the existence of intellectual property right (IPR) mechanisms, given its non rival nature, it can be copied or imitated by competitors at costs which are less than the cost of creating it from scratch. Economists have attempted to capture this by computing the spillover gap or the gap between private and social rates of returns for samples of innovation. The existence of this gap justified various public policy measures to combat for possible underinvestment in R&D by private sector agents. These public policy measures range from various fiscal incentives for R&D, research grants, strengthening of the IPR regime, financing of research partnerships and so on. The major assumption in this line of argument is that the firm or the agent who performs the R&D is also its financier.

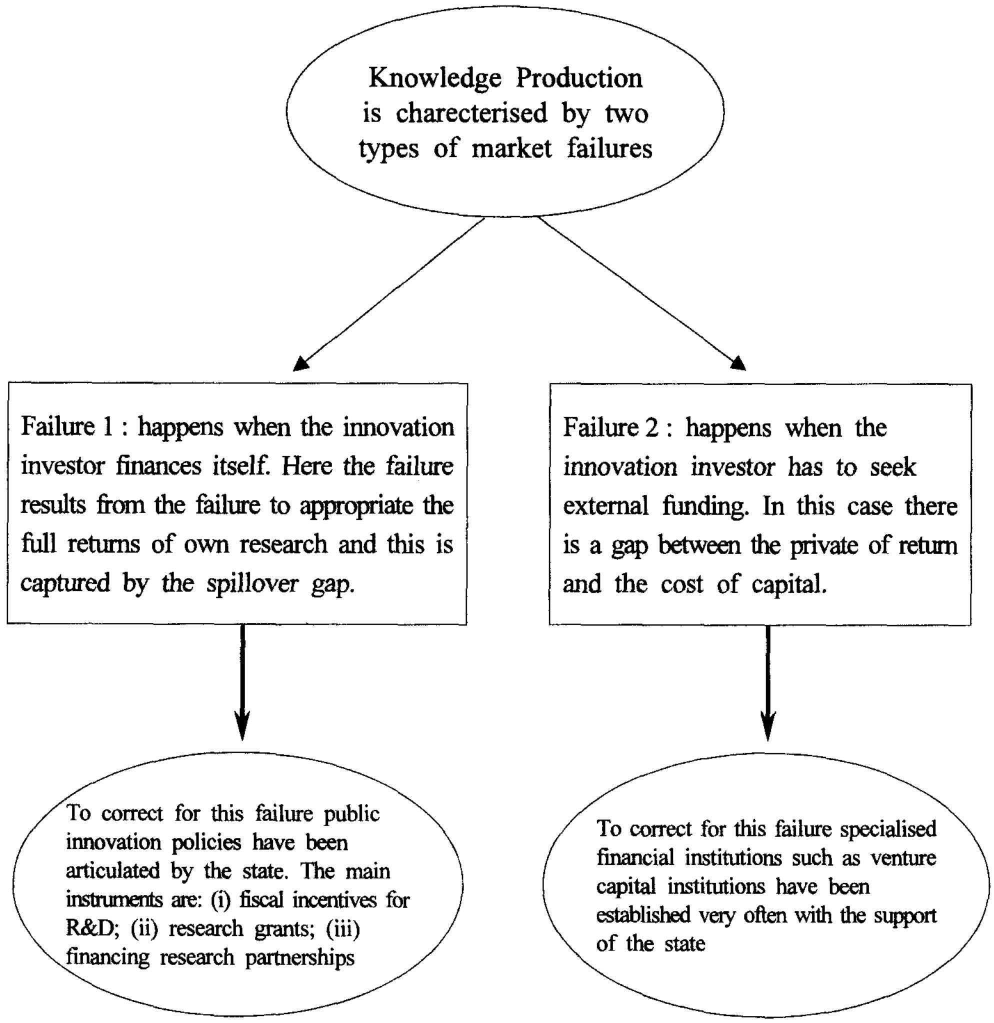
The second type of failure exists when the innovation investor and the financier are two different entities. Under such circumstances a second gap exists between the private rate of return and the cost of capital. This implies that the conventional capital market, whether based on debt or equity, would eschew projects that result in innovations as the output of these projects are uncertain or the projects are such that one cannot even attach probabilities to their potential outcomes. Hall (2002) has identified three main types of reasons to the existence of a gap between external and internal costs of capital:

(1) Asymmetric information between inventor and investor;

(2) Moral hazard on the part of the investor or arising from the separation of ownership and management; and

(3) Tax considerations that drive a wedge between external finance and finance by retained earnings.

The response to this has come from the private sector itself but very often supported by state funds, namely the establishment of specialized financial agencies such as venture capital institutions. In short, knowledge production is characterized by two types of market failures and state intervention is required to offset the consequent shortfalls in investment. Figure 1 summarizes this point.



Source: Mani and Bartzokas (2004).

Fig. 1 : Rationale for State Intervention in Knowledge Generation

My analysis thus far brings to the fore the following propositions with respect to knowledge creation in developing countries. First, globalization of technology has affected developing countries only in an insignificant manner. This process does not affect the majority of the developing countries at all. Second, the markets for technology are shrinking and appear not to be very competitive. Increasingly much technology is getting transferred to the developing countries through non-market forms like FDI. The evidence on positive technology spillovers from FDI to local firms was very limited. But some countries have been successful in engineering it through ingenious policies. This raises some questions about the continued relevance of innovation policies by national governments designed to give their national firms an advantage. Given this stateof affairs, LDCs need to have their own public innovation policies to strengthen their R&D regimes. The same argument holds good even for developed countries. The important task is to design those instruments and institutions, which can encourage the process of knowledge creation at the firm level. Most developing country governments are far from clear on this issue of definition.

The form of state intervention in the creation of formalized industrial knowledge depends very much on the potential to create such knowledge by enterprises in an economy. This potential can be measured, objectively, by using an indicator such as the number of U.S. patents issued to inventors from a particular country. Though quite restrictive, when this objective definition is applied to all the developing countries (defined in the UN sense of the term[1]), there are only eleven countries that have this potential. I denote these countries as Type 1 and all the rest, which do not have this potential as Type 2. Needless to add, it can be argued that the precise definition of the scope of state intervention will vary significantly across the two types of countries.

In Type 1 countries, the main medium for the creation of knowledge is through the route of formalized R&D activities either located within industrial enterprises or in research institutes, while in Type 2 countries firms and institutes do not usually generate knowledge through the formal R&D route but through a variety of non-R&D channels such as through the installation of new vintages of capital goods and the consequent information provided by suppliers etc. In the former case, state intervention can manifest itself in the form of a variety of financial incentives such as tax credits and research grants targeted at raising R&D investments especially at the firm level. In the latter case, it manifests itself in the form of grants and concessional loans to acquire new technologies from other firms and institutions and also to make some incremental changes in it to suit local conditions. However, our argument is that a common

1) There is no established convention for the designation of "developed" and "developing" countries or areas in the United Nations system. In common practice, Japan in Asia, Canada and the United States in northern America, Australia and New Zealand in Oceania and Europe are considered "developed" regions or areas. In international trade statistics, the Southern African Customs Union is also treated as developed region and Israel as a developed country; countries emerging from the former Yugoslavia are treated as developing countries; and countries of eastern Europe and the former USSR countries in Europe are not included under either developed or developing regions.

requirement for both types of countries is the availability of a critical mass of scientists and engineers. Otherwise mere state intervention in the form of providing financial incentives is unlikely to bear fruit. While there have been some attempts (Mani, 2002) to verify this hypothesis in the context of Type 1 countries, there have been no attempts in the context of Type 2 countries: the majority of the developing countries is of this type. Therefore, this is a fertile area for further empirical scrutiny

3. Alternative Innovation Funding Sources

Innovation can be the result of both formal and informal technology generating activities which takes place in both firms and institutions (government research institutes, universities etc.). As seen earlier, the formal innovation generating activities take place through the medium of in-house R&D centers attached to firms and in public laboratories. In firms, across both the developed and developing world, they largely finance this activity through their own funds. However, innovation policy instruments such as research grants, tax incentives and various types of concessional loans have sought to supplement it or some times even jump started own funding. Some times innovative ideas originate among individuals or among what is usually referred to as entrepreneurial firms. One of the most important issues facing these firms is their ability to access capital (Denis, 2004).

Since such firms are not yet well known or profitable and since they lack collateral, debt financing is not really an option. Consequently, entrepreneurs tend to rely on three primary sources of external equity financing: venture capital funds, angel investors, and corporate investors. There are no precise estimates of the amount of capital coming from each of the three funding sources especially in the context of developing countries. Denis (2004) provides some estimate of the three sources of entrepreneurial finance in the context of just the U.S[2]. Although angel investor is an important source, data on angel investors, especially in the context of developing countries are very hard to come by.

2) According to the data from National Venture Capital Association of the U.S, cited by Denis (2004), the size of the angel investor and the organized venture capital markets are estimated to be about US 100 billion and US $ 48 billion respectively (as of January 2000). No precise statistical data on corporate venture markets.

4. The Singapore and Malaysian Cases

The specific purpose of the paper is to survey the technology financing instruments employed by two Asian economies of the Type 1 variety, namely Singapore and Malaysia. Although they differ in their physical size, the manufacturing sector of these two countries has at least four features that are common and which makes them eminently suitable for a detailed comparative study (Table 1). They are: (i) the manufacturing sector in both the countries is dominated by the electronics industry; (ii) the manufacturing sector is highly export-oriented; (iii) over half of the exports of sector are in technology-intensive products; and (iv) although the manufacturing value added and exports are dominated by affiliates of MNCs, the share of local enterprises is increasing.

Table 1 : Profile of the Two Cases, Singapore and Malaysia

Indicator	Year	Unit	Malaysia	Singapore
1. Population	2001	Million	24	4
2. Per capita GDP	2001	PPP current international $	8750	22680
3. Share of electronics in the manufacturing value added	2002	Percent	-	31.4
4. Size of high tech exports	2001	Millions of US $	40939 (57)	62572 (60)*

Note : * figures in parentheses indicate high tech exports as a percent of manufactured exports.
Sources : World Bank (2003); Economic Development Board (2002).

Both countries have improved their record with respect to their innovation as measured by the number of patents issued to inventors from these countries in the U.S (Table 2 and 3), although Singapore's record is, relatively speaking, significantly better.

I argue in the paper that this better innovative performance of Singapore is not due to the fact that it has better schemes for financing innovation, but could rather be attributed to its earlier policy on human resource development through which the country made substantial improvements in both the quality and quantity of its scientific population. I propose to demonstrate this line of reasoning by first examining the specific schemes for financing innovation and then go on to analysing the critical factors that explain the relatively better performance of Singapore. In proposing to do so, first a survey of the various schemes for financing in innovation in both the countries is presented. This is followed by an examination of the critical factors in explaining the superior performance of Singapore.

Table 2 : Innovation Indicators : Singapore, 1990-2002

	R&D		Patents			High technology exports	
	Intensity (%)	Sales revenue from commercialized products/ processes attributed to R&D performed in Singapore (millions of US $)	Granted within Singapore	Granted in the US	Licensing revenue from patents and new technologies developed in Singapore (millions of U.S $)	In millions of US $	As a per cent of manufactured exports
1990	0.86	-	-	16	-	6,051	36
1991	1.02	-	-	25	-	7,952	36.9
1992	1.19	-	20	35	22.23	10,221	37.6
1993	1.07	-	52	44	25.29	13,497	40
1994	1.10	-	58	59	32.59	19,175	43.1
1995	1.16		51	61	72.82	25,416	44.9
1996	1.39	4,525.56	91	97	19.25	26,335	43.3
1997	1.50	6,518.42	132	100	18.87	29,502	47.8
1998	1.80	8,005.94	136	136	34.44	31,663	53.5
1999	1.87	6,310.02	161	152	402.33*	39,996	57.5
2000	1.89	9,056.89	239	242	44.16	47,029	58.2
2001	2.11	9,306.99	410	304	32.08	40,939	56.9
2002	2.19	5,722.80	451	-	48.88	-	-

Note : * It is not clear as to why the licensing revenue shot up during 1999.
Sources : Agency for Science and Technology Research (2003), USPTO (2003), World Bank (2003).

Table 3 : Innovation Indicators : Malaysia, 1990-2002

	R&D	Patents		High technology exports	
	Intensity (%)	Granted to residents within Malaysia	Granted in the U.S	Value in millions US $	As a per cent of manufactured exports
1990			6	15,115	39
1991			13	17,302	39
1992	0.37		11	21,774	43
1993			19	27,094	46
1994	0.31		16	40,316	49
1995			8	53,639	52
1996	0.22	221	24	58,001	54
1997		179	29	59,757	55
1998	0.40	193	36	54,885	58
1999		218	34	60,032	59
2000	0.49	206	47	73,922	62
2001			56	62,572	60

Sources : Ministry of Science, *Technology and the Environment* (2003), USPTO (2003), World Bank (2003).

4.1 Financial Schemes for Innovation

I first provide a survey of the schemes that are available in Singapore. This followed by the Malaysian ones.

4.1.1 Singapore

First of all in Singapore over two thirds of the R&D expenditure is contributed by the private sector (Table 4). And the private sector largely funds its own R&D. However the share of government funding of R&D has increased significantly over time and for the last five years or so has averaged around 9 per cent of total private sector R&D. The major increase in government funding of private sector R&D occurred around the mid 1990s and the period coincides neatly with the initiation of a number of research grants by the government.

There are three types of financing schemes in Singapore: research grants, tax incentives, and venture capital. Before I proceed on to analyzing the details of these schemes, it is important to bear in mind one point. The above data on governmental funding of private sector R&D, in all probability, refers only to research grants. The contribution of tax incentives are usually not factored into the computations of government share as in the case of tax incentive there are no direct flow of financial resources from the government to the private sector. Therefore, it is very likely that the government share of private sector R&D is underestimated to the extent of non-inclusion of some of these components.

Table 4: Source of Funding of Private Sector R&D Expenditure in Singapore, 1993-2002 (in Singapore Dollars)

	1993	1994	1995	1996	1997	1998	1999	2001	2002
Total R&D Expenditure	997.93	1,174.98	1,366.66	1,792.14	2,104.56	2,492.26	2,656.3	3,232.68	3,404.66
Total Private sector R&D expenditure	618.9	736.2	881.4	1,133.4	1,314.5	1,536.1	1,670.9	2,045.0	2,091.33
Source of funds									
Own Funds	507.7	629.1	688.1	922.8	1,051.3	1,263.7	1,360.6	1,629.9	1614.88
Other Internal Funds	92.1	59.8	83.7	70.0	-	-	-		
Other Companies Locally Based	3.4	1.5	20.0	31.0	34.8	26.4	22.9	77.8	46.57
Other Companies Foreign Based	2.7	28.5	44.1	36.5	108.2	90.2	99.0	202.1	232.2
Local Tertiary Institutions	0.0	-	-	1.0	0.4	0.5	3.8	1.2	9.72
Local Government	13.1	17.2	45.4	71.9	119.9	155.3	184.5	133.6	182.29
Foreign Governments	-	0.1	0.1	0.2	0.1	-	0.1	0.5	5.67
Share of private sector R&D expenditure	62.0	62.7	64.5	63.2	62.5	61.6	62.9	63.3	61.4
Share of Singaporean government in private sector R&D expenditure	2.11	2.34	5.15	6.34	9.12	10.11	11.04	6.53	8.72
Rate of growth of government funding of private sector R&D		31.70	163.78	58.47	66.77	29.55	18.79	na	36.49

Sources: National Science and Technology Board (Various issues) and Agency for Science and Technology Research (Various issues).

Research Grants in Singapore :

I could identify six different types of research grants and it finances every stage of the innovation chain from the generation of ideas to its eventual commercialization. This shows that financing of innovation has been very carefully thought through.

(i) Research Incentive Scheme for Companies (RISC)

It aims to encourage and assist companies and organizations which are registered in the country to set up R&D centers in the country and to develop in-house R&D capabilities in strategic areas of technology with the longer term objective of strengthening the company's industrial competitiveness. By using the RISC programme a company can cover a maximum of 50 per cent of its total research efforts for a period of five years. The grant is disbursed to the company on a reimbursement basis.

Companies can benefit from RISC's support only once, unless they change course and wish to build up research capacity in a different sector. There is no official maximum to the amount of subsidy, but in practice it varies according to the sector, the nature of the technology and the degree to which the company involved contributes to objectives, which Singapore has set itself in the various sectors of technology. The criteria that meet RISC are a long-term research commitment by the company, considerable research efforts by the company itself, and perceptible growth in the number of researchers within the company. Subsidisable R&D costs are salaries of research personnel, costs of laboratory equipment and necessary material, as well as costs for education and training of researchers. It is not immediately known how many companies have benefited from this scheme.

(ii) Innovation Development Scheme (IDS)

Local and foreign companies are being pushed to become more innovative through this scheme. The criteria for eligibility are: (a) project should involve product or process innovation which lead to significant improvements in value-added per worker or it must lead to tangible outcomes such as additional investments for the new products, introduction of new services or adoption of new technology; (b) project should lead to significant contribution to the relevant industry or cluster; and (c) the project must not have commenced at the time of application. The IDS typically provides assistance (on a reimbursement basis) through grants to cover a percentage of qualifying cost of the project, based on different levels of support for each component of allowable costs such as 50 per cent level of support in the case of the cost of manpower while 30 per cent each in the case of costs of equipments and materials, professional services and intellectual property rights.

In 1996, 103 projects were supported with US$80 million, and for period up to 2001, US$400 million is reserved for this purpose. According to more recent data (December 31, 1998) provided by the EDB (Economic Development Board), more than 500 innovation projects have been successfully implemented. Local companies received some 59 per cent of total IDS grants while MNCs accounted for the remaining 41 per cent. Local companies undertook more than 73 per cent of the IDS-supported projects. Distribution of the projects according to industry cluster is given in Table 5.

Table 5: Distribution of IDS Grants According to Industry Cluster (Cumulative 1995-1998)

Cluster	Number of Projects
1. National Computer Board	154
2. Promising Local Enterprises	101
3. Electronics	73
4. Services	57
5. Engineering	56
6. Chemicals and Life Sciences	23
7. Others	49
Total	513

Source: Mani (2002).

(iii) Fund for Industrial Clusters (CDF)

This special policy instrument of US$650 million was introduced prior to the IDS in 1994. Its main purpose is to help start projects which carry too many risks for industrial companies to be financed by themselves, and might thus not be realised. The instrument can also be used to create strategic alliances, which can secure strategic investment projects in Singapore, to stimulate growth of Singapore's promising young industries, and to secure cooperation between Singapore and important multinationals. Since 1994 the CDF spent US$325 million on fifteen projects, among others in the petrochemical field, the key industry in Singapore. However, there are still many other very promising projects. To this end the government intends to raise the amount of the fund to US$1.3 billion.

(iv) Promising Local Enterprises (PLE)

This grant scheme was introduced in 1995. There is a "top hundred list" of local enterprises, selected by the EDB, as possible Singaporean 'multinationals for the next century'. It strives to push each of these 100 companies to a turnover of Singapore $ 100 million each by 2005. Being on the list in itself has a stimulating effect on the innovative capacity and on the cultivating of a new generation of entrepreneurs. The companies are nourished by additional incentives. In 1999, 45 PLEs achieved sales revenues of more than $ 100 million, up from 31 in 1998 and the average revenue per PLE was $ million in 1999 (up from $ 54 million in 1998). The programme has also been successful in raising the productivity of the PLEs: on average their productivity is higher than the industry average by about 12 per cent.

(v) Patent Application Fund Plus (PAF Plus)

The grant is targeted at startups and helps defray the cost of patent application. It thus encourages the diffusion of innovations by reducing the cost of patent applications. To be eligible to receive this grant there are two conditions: commercial benefits from inventions must accrue to Singapore; the particular inventive activity must not be receiving any other governmental aid.

(vi) Technology for Enterprise Capability Upgrading (T-UP)

This research grant provides partial funding for secondment of research scientists and engineers from research institutes to local enterprises for two years and thus it helps local enterprises build in-house R&D capabilities by partially supporting salaries of seconded researchers and engineers. The scheme is open to all companies located in Singapore having at least 30 per cent of its equity held by local investors.

Tax Incentives in Singapore

There are five different types of tax incentives for innovation (Table 6). This range from 200 per cent tax deduction for performing R&D, for acquiring intellectual property and for licensing advanced technology from abroad. Thus, it is seen that the country has a rather comprehensive range of tax incentives not just to create technologies through the medium of in-house R&D centers but also to acquire technologies created outside of the firm. However I do not have detailed data on the amount of tax foregone or the effectiveness of these tax incentives. But the overall data on innovation (Table 2) shows that the innovation performance measured in both input and output indicators have shown significant improvements over time.

Venture Capital in Singapore

In 1999 a scheme to stimulate and support high-tech enterprise, or technopreneurship was initiated. In 2001, 3,459 high-tech companies were registered with the Registry of Companies and Businesses (RCB) - fewer than the peak of 5,087 in the Internet boom year of 2000, but more than the 2,521 in 1998 before the technopreneurship drive was launched. Of the high-tech companies incorporated in 2001, 450 commenced operations within the year, generating about 2,970 jobs with expected revenue of S$210 million. In 2000, 659 startups commenced operations, generating 6,065 jobs and S$341 million revenue. In October 2001, the Singaporean Economic Development Board (EDB) launched the Startup Enterprise Development Scheme (SEEDS), a $50 million co-financing scheme to take dollar-for-dollar equity stakes in promising startups backed by third-party private sector investors. It aims to fill a market gap in seed-stage funding, and has attracted 110 pipeline projects. A total of $2.5 million funding was committed to the first 10 successful SEEDS applicants in December 2001.

Table 6 : Tax Incentives for Innovation in Singapore

Name of scheme	Nature of incentive	Purpose
Further deduction for R&D expenses (S14E)	Allows the company to deduct a second time qualifying expenses from its income, in addition to the automatic single deduction allowed. S14E covers both R&D done in-house, and by a third party R&D organisation.	Promotion of in-house R&D
R&D and intellectual property (IP) management hub	Provides tax exemption for a set period on all qualifying foreign-sourced royalties or foreign-sourced interest remitted to Singapore. It is open to all Singapore-based companies. The tax-exempt royalty or interest income should be used as further R&D expenditure. Resulting IP must be owned and managed by the respective companies.	Promotion of in-house R&D
Writing down allowance for cost sharing agreement (S19C)	Allows companies to write down cost-sharing payments for R&D activities, which are otherwise not deductible, over one to five years.	Promoting spin-offs from in-house R&D
Writing down allowance for acquisition of know-how (S19B)	Allows companies to write down its intellectual property (IP) acquisition costs over five years. Encourages companies to acquire IP. Automatically available to all companies through the Income Tax Act.	Encourages companies to acquire IPRs
Approved royalties incentive (ARI)	Provides full or partial exemption on withholding tax for royalty payments or technical assistance fees payable to non-residents. Includes royalties, fees and contributions to R&D costs paid for the transfer of technology and know-how to Singapore.	Encourages transfer of advanced technology to Singapore

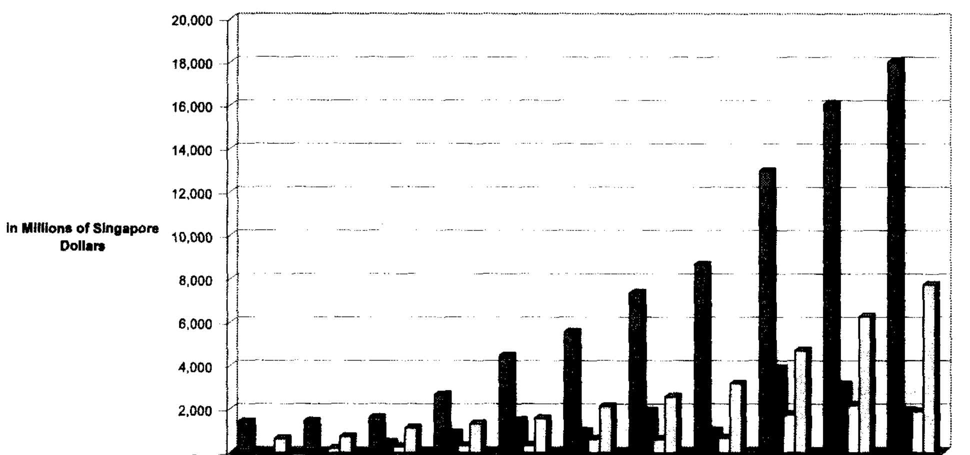
Source : Singapore Economic Development Board.

Singapore is one of the first among the developing world to have established a thriving venture capital industry. According to Wang (2004), the evolution of the VC industry can be traced to 1983 when the first VC fund was raised. He divides the history of the industry into four phases. The VC industry has over time grown into a very vibrant one. (See Figure 2). Over the years approximately 60 per cent of the total VC disbursements in the country have gone towards technology-base ventures in computer related, electronics, information technology, and biotechnology and telecommunications industries. The government has always supported the formation of a strong VC industry in the country through a host of tax incentives. The effect of this VC industry can be seen in the growth of the number of VC-backed Singapore-based companies and the number of technology start-ups incorporated in the country (Table 7).

Table 7: Effect of VC Industry in Singapore, 1998-2001

	Number of technology start-ups incorporated in Singapore	Cumulative number of VC-backed Singapore-based companies
1998	2,521	310
1999	3,669	375
2000	5,087	556
2001	3,459	635

Source: Economic Development Board, http://www.sedb.com/etc/medialib/downloads/media_releases.Par.0010. File. tmp/Charts-Innovation%20&%20Enterprise.pdf (accessed on March 10 2004).



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Venture capital pool	1,439	1,466	1,623	2,685	4,480	5,573	7,373	8,676	12,995	16,094	18,032
New funds raised	90	69	492	925	1,498	1,009	1,925	1,023	3,904	3,150	1956
Annual venture capital investment	-	196	298	345	340	645	641	699	1,768	2,221	1927
Venture capital investment portfolio	661	752	1,153	1,354	1,592	2,142	2,597	3,198	4,720	6,287	7760

Source: Asian Venture Capital Journal (2002).

Fig. 2: Growth of the Venture Capital Industry in Singapore

4.1.2 Malaysia

The share of private sector in total R&D expenditure has been fluctuating, but currently stands at about 58 per cent (Table 8). An interesting feature is that over time the share of government in financing private sector R&D has shown some impressive increases. This coincides with the government putting in place a number of financial instruments to stimulate innovations. These instruments can be broadly classified into four categories[3]: (a) R&D research grants; (b) tax incentives; (c) loans and venture capital; and (d) human resource development fund. Based on the clarification provided by MASTIC (Ahmad Din, 2004), the data on source of funds for private sector R&D are unreliable and therefor may not be used for any analytical purposes.

Table 8 : Source of Funding of Private Sector R&D Funding in Malaysia, 1992-2000

	1992	1994	1996	1998	2000
Total R&D expenditure (RM million)	550.7	611.2	549.1	1,127.0	1671.5
Total private sector R&D expenditure (RM Million)	246.3 (45)	292.6 (48)	400.1 (73)	746.1 (66)	967.9 (58)
Source of financing private sector R&D (in per cent) :					
a. Own funds		92.0		83.0	6.0
b. Government		0.0		3.0	1.0
c. Other external funds		8.0		14.0	93.0*

Notes : * For the year 2000 the source of funds reported for 'other funds' was not for the year 2000 only, but covered the project span, meaning that the figure given was not broken down to reflect the year 2000. This was due to some inadvertent omission in the instructions in the questionnaire. Therefor, it is not advisable to compare year 1998 to 2000.

Source : Malaysia Science and Technology Information Center.

Research Grants in Malaysia

There are 12 research grants. Some of them were introduced only in 2002. But in terms of their magnitude, the grants compare very favorably with their Singapore counterparts. Of the 12, I discuss four of the more important projects, which were initiated during the second half of the 1990s.

3) For a rather comprehensive listing of these incentives see Malaysian Science and Technology Information Centre (2002).

(i) The Industry Research and Development Grant

This was introduced in 1996 and became operational from 1997 onwards. The Science and Technology Division of the Ministry administer it. The main objectives of this scheme are to: encourage Malaysian companies to be more innovative in using and adapting existing technologies and in creating new technologies, products and processes that will benefit the economy; and to promote closer co-operation through joint ventures and institutional linkages between the private sector and public sector universities and research institutes.

The scheme is restricted to only Malaysian controlled companies (at least 51% local equity holding). There is no absolute maximum grant under the IGS as each project is determined according to its own merits. The main criterion is of course the technical viability of the project. The scheme can fund up to 70% of eligible project costs[4]. It can also pay for the purchase of technical information that is directly associated with the project as well as patent searches, but the cost of patenting is not covered.

The grant is payable on a reimbursable basis and the R&D under the grant must be carried out within the country itself. There is also a requirement that the grantee company needs to collaborate with one or more approved research institutions or universities within the country[5]. Generally, the IGS grant is restricted to R&D projects in biotechnology, advanced manufacturing, advanced materials, automotive, IT and multimedia, electronics, aerospace and energy industries. The grantee company generally owns the intellectual property deriving from an IGS project. The total pool of funds under the scheme (1997-2000) is RM 165 million. A total of 46 projects have been approved since 1997 and of this five firms have commercialized the products that were developed under the scheme. Detailed R&D investments of the firms, and grant receipts are not readily available.

(ii) Technology Acquisition Fund (TAF)

This scheme was introduced in 1997 and is administered by the newly created Malaysian Technology Development Corporation. The fund will provide partial grants ranging from 50% to 70% to majority Malaysian owned companies that undertake a variety of technology acquisition activities (Table 9). Distribution of approvals showed that one time approval accounted for 46%,

4) This consists of salary expenditure, administrative cost, prototypes, consumables, pilot plants, contract research as well as travel related to the R&D project.

5) There are three levels of collaboration, namely (a) a joint venture between the company and a research institute or university; (b) a contract research assignment to the research institute or a university; and (c) a technical services agreement defining manpower and equipment usage with the latter.

two times for 19%, three and five times for 2%, six times for 6% and seven times for 25% as on 21, July, 2000.

Table 9 : Technology Acquisition Activities Eligible for Partial Funding under the TAF Scheme in Malaysia

Activity	Objective	Approved Activities	Nature of Funding
Purchase of high-tech equipment and machinery	To enable qualified companies to acquire high-tech machinery and equipment to enhance the current production process and the physical development of new products	Purchase of machinery and equipment, mould and die	Partial grant of up to a maximum of 50% of the total cost of machinery and equipment to purchased
Technology licensing	Technology acquisition through licensing to enhance the design and production of new and existing products and processes.	Procurement of technology and technical assistance	Partial grant of up to a maximum of 70% of the cost involved in the initial payment of the licensing fees
Acquisition of patent rights, prototypes and design	To facilitate transfer of technology to local companies, enabling the development of new processes and products	Procurement of Manufacturing rights and registered design, prototypes and its related technology transfer to facilitate the physical development of new products.	Partial grant of up o 70% of the total cost involved in the acquisition of patent rights, prototypes and design.
Placement of Malaysians in foreign companies and foreign technology institutes	To expose Malaysians and upgrade their knowledge on technology development in foreign technology companies	Job Attachments / On-the-job Training	Partial grant of up to 50% of the total cost or RM 30,000 whichever is lower for each person subject to a maximum of 3 persons per project and the duration not exceeding 3 months. However funding is not provided for training in affiliated or subsidiary companies abroad
Expert sourcing programme	To assist firms to engage foreign technical experts and consultants in upgrading their products and processes	Sourcing for foreign experts to advise and assist in upgrading their products and processes.	The fund provides a partial grant of up to a maximum of 50% of the total cost or RM 30,000.
Information dissemination seminars/ workshops	To assist the Industry Associations and Chambers of Commerce to engage foreign experts to advise in upgrading the current technological capability of its member companies	Organizing technical workshops/seminars by Industry Associations in relevant areas of technology	Partial grant of up to a maximum of RM 50,000 TO Industry Associations or Chambers of Commerce
Software technology	To promote and enhance the use of IT to upgrade manufacturing processes	Application from manufacturing companies is restricted to acquisition and implementation of ERP Software for manufacturing through licensing only. Each application must comprise at least three manufacturing companies.	Partial grant of up to a maximum of 50% or RM 1 million whichever is lower

Source: Malaysian Technology Development Corporation.

The scheme is thus very comprehensive in enabling Malaysian firms to secure foreign technology as well as assimilating it through training of technicians. However, it is seen that (Table 10) majority of the approvals are for either purchase of capital goods and software or none for training of technicians abroad. More over only 15 % of that is allocated to MTDC that is remaining. This means that the scheme is helping by and large only in the import of technology (either embodied or disembodied) and does not necessarily lead to the local development of technology. So in short the scheme has been narrowly interpreted as a conduit for subsidizing the import of capital goods thereby making the domestic industry more import-dependent.

Table 10: Progress of the TAF Scheme Since Inception (As on 21-7-2000)

Allocation (RM Million)		Total Applications (in numbers)				Total disbursements (RM million		Balance fund available (RM million)
Total	Of which allocated to MTDC	Received	Processed / Evaluated	Approved	Amount approved (in RM million)	Actual	Yet to be	
98	73	225	215	44	61.81	43.48	18.33	11.2

Source: Ministry of International Trade and Industry.

(iii) Intensification of Research in Priority Areas (IRPA)

This scheme was initially introduced in 1988 and was thoroughly revamped in the Seventh Malaysia Plan. The main purpose of the scheme is to focus R&D on areas, which have potential for "enhancing the national socioeconomic position". Grants are allocated to R&D projects initiated by universities and research institutes in collaboration with the private sector. In this way it is very similar to the IGS scheme excepting the grants disbursed to researchers in universities and other research institutes in the first instance. The rationale behind the scheme is that once the projects result in commercializable ideas, the next scheme (CDRF) should fund these.

The eligible sectors are from manufacturing services and even social science research is covered. In this way the focus of the scheme is much mare diffused than the IGS scheme. There is precious little information about the actual operation of this scheme. Under the seventh Malaysia plan a sum of RM 1 billion is allocated to the programme. It is thus the largest funded grant scheme. In fact until the end of 1999 (Table 11), the programme has been able to fund only 60% of the funds allocated to it during the first four years of the 7th Malaysia plan: a total of 3226 projects amounting to RM 0.63 billion has been funded during the period 1996-1999. In the last year, namely in 2000, another 11 per cent was funded, but finally only 70 per cent of the total funds available could be used by the terminal year. The low off take of funding once again points to the lack of availability of skilled manpower to conduct R&D in priority areas. About a quarter of the projects have gone towards the agro-industry while the manufacturing per se has received only 10%.

Table 11 : Progress of the IRPA Scheme Since Inception, 1996-2000 (Value in RM Million)

Panel / Field	1996-1999		2000		Cumulative total : 1996-2000	
	No. of Project Approved	Total allocation (RM)	No. of Project Approved	Total Allocation (RM)	No. of Project Approved	Amount of Funding (RM)
Agro-Industry	1143	163,559,131	112	14,988,904	1255	178,548,035
Construction	76	20,004,120	19	4,277,950	95	24,282,070
Energy	118	34,078,660	16	3,194,500	134	37,273,160
Environment	144	42,160,918	19	4,409,457	163	46,570,375
Health	531	102,643,759	40	4,629,289	571	107,273,048
Information technology	92	31,606,560	18	3,340,300	110	34,946,860
Manufacturing	291	64,061,792	30	7,711,180	321	71,772,972
Material and Geoscience	6	2,353,020	8	2,327,038	14	4,680,058
MIT-Biotechnology	2	5,136,000	-	-	2	5,136,000
Science Engineering	587	96,334,495	138	18,164,180	725	114,498,675
Service	48	10,977,935	18	3,986,110	66	14,964,045
Socio-Economics	167	13,141,885	45	2,935,490	212	16,077,375
Top-Down Biotechnology	14	16,089,000	19	12,925,960	33	29,014,960
Top-Down Photonics	6	23,169,960	-	-	6	23,169,960
Total	3,225	625,317,235	482	82,890,358	3,707	708,207,593

Source : Malaysian Science and Technology Information Centre (2003).

(iv) Commercialization of R&D Fund (CRDF)

This scheme too was introduced in 1997 and is administered by the MTDC and it is complimentary to the IRPA scheme. It provides partial grants ranging from 50% to 70% for three types of activities, namely (a) market survey and research (duration of this activity is limited to 6 months); (b) product/process design and development including development of designs, prototypes and pilot plant or trial production runs (duration of this activity should not exceed 18 months); (b) compliance of standards and regulations and intellectual property protection in Malaysia and in three major countries (the duration must not exceed 18 months).

The scheme is thus very restrictive in the sense that it will be rather difficult to develop a prototype within a matter of 18 months. Type-wise distribution of the actual disbursements is not available. It is also not known how many of these projects are sequel to the output of the IRPA scheme. Given the fact the IRPA scheme has not resulted in a large number of outputs it is very likely that many of the projects funded under this scheme are likely to be fresh ones. Compared to the TAF scheme, the amount of funds that are allocated to the scheme is much lower (Table 12) and only 18 per cent of the funds are still remaining.

Table 12: Progress of the CRDF Scheme (As on 21-7-2000; Value in RM Million)

Allocation (RM Million)		Total Applications (in Numbers)				Actual Disbursement	Balance Available
Total	Allocated to MTDC	Received	Processed	Approved	Amount Approved (RM million)		
40	35	159	140	35	28.69	10.34	6.32

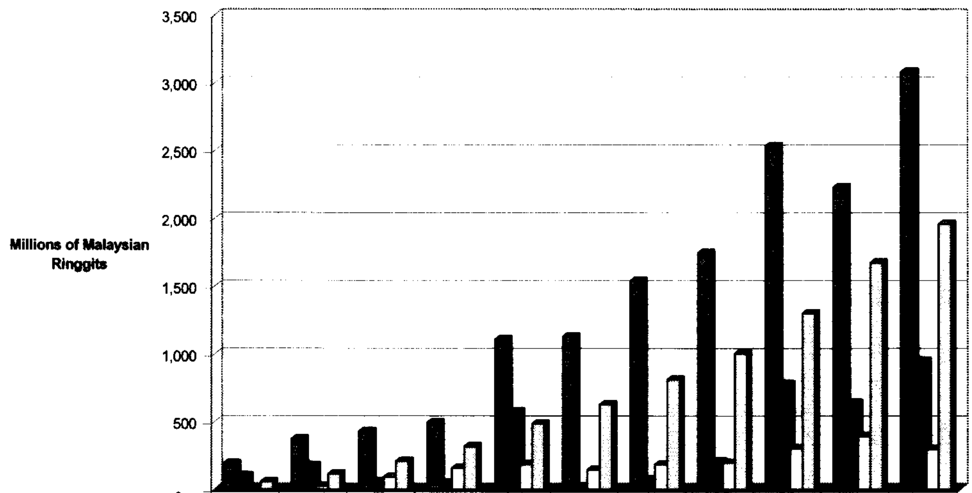
Source : Ministry of International Trade and Industry.

Tax Incentives in Malaysia

At present there are ten different types of tax incentives. Mani (2002) noted that these tax incentives are not very popular with the domestic enterprises. In fact according the 2000 National Survey of R&D, less than fifty per cent of the firms have actually used these incentives and the main reasons for their lack of popularity could be attributed to the lack of knowledge of proper procedures to be followed to obtain these incentives.

Venture Capital Industry in Malaysia

There are five different types of loans and three different types of venture capital funds sponsored by the Malaysian government. The loans are made available through financial institutions such as Credit Guarantee Corporation Malaysia Berhad, Bank Pembangunan dan Infrastruktur Malaysia Berhad and Bank Industri dan Teknologi Malaysia Berhad to enable them to obtain up to 100% loan and credit facilities to support their business endeavors. The main target of all these are the high technology sectors of information technology and biotechnology. In the present paper I consider only the VC funds. Government has been supporting the establishment of VC funds. Three large VC funds were established, namely the high-tech venture capital, MSC venture one and the Malaysian venture capital management fund. The growth of the VC industry is presented in Figure 3.



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Venture capital pool	194	374	432	496	1,110	1,130	1,542	1,748	2,535	2,231	3,082
New funds raised	102	180	61	50	578	22	75	208	779	642	951
Annual venture capital investment		27	93	160	186	146	186	200	306	396	299
Venture capital investment portfolio	57	117	211	319	486	628	812	1,006	1,302	1,675	1960

Source: Asian Venture Capital Journal (2002).

Fig. 3 : Growth of the Malaysian Venture Capital Industry, 1991-2001

Although the venture capital pool has increased significantly over the period under consideration, the annual venture capital investment has not shown much increase over the last three years. In fact the number of investee companies has actually shrunk from 194 in 1999 to just 80 in 2002 (Bank Negara, 2001 and 2002). This may indicate a shortage of fundable projects and this is in sharp contrast with the experience of Singapore.

Thus, it is obvious that although Malaysia has a number of similar financial incentive schemes (compared to Singapore), the final outcomes in terms of innovation policy are significantly different: its research intensity is much lower, and the number of patents taken by local inventors is insignificant. A possible reason for this differential performance is explored in the next section, which also concludes with the main arguments of the paper.

5. Concluding Remarks: Explaining the Differential Performance in Innovation

Both Singapore and Malaysia have put in place similar instruments for promoting innovations in their respective economies. But the outcomes have been different. Several reasons can possibly explain this differential performance. But, the most important candidate, in my view, is the number of scientists and engineers. The Singaporean innovation policy also contained a clearly articulated policy in increasing both the quantity and quality of scientists and engineers. This meant that, over time, not only just the numbers of research scientists and engineers (RSEs) have shown an increase, but also the density has shown significant increases (Table 13).

Table 13 : Trends in R&D Scientists and Engineers in Singapore and Malaysia (Headcount Basis)

	Singapore			Malaysia		
	Total RSEs	Private sector RSEs	Density of RSEs per 10,000 labor force	Total RSEs	Private sector RSEs	Density of RSEs per 10,000 labor force
1990	4,329	1,363	27.7			
1991	5,218	2,315	33.6			
1992	6,454	3,187	39.8			
1993	6,629	3,248	40.5			
1994	7,086	3,561	41.9	11,472	3,164	5.8
1995	8,340	4,163	47.7			
1996	10,153	5,085	56.3	9,233	3,270	5.1
1997	11,302	5,792	60.2			
1998	12,655	6,573	65.5	12,127	4,158	7
1999	13,817	7,502	69.9			
2000	14,483	7,997	66.1	23,262	4,246	15.6
2001	15,366	8,389	72.5			
2002	15,654	8,598	73.5			

Sources : Agency for Scientific and Technological Research (2003) and Malaysian Science and Technology Information Center (2003).

In the case of Malaysia, the increase has been noticed only in the very recent period. Moreover the increase is noticeable mainly in the government sector and not in the private sector: the ratio of private sector RSE to total RSE in Malaysia has actually declined from 0.28 in 1994 to 0.18 in 2000 while in the case of Singapore it has increased from 0.50 to 0.55. In short Malaysia has a serious shortage of scientists and engineers, especially of the type that is required for performing R&D activities. According to the Malaysia's Second National Science and Technology Policy (Ministry of Science, Technology and Environment, 2003, p. 17), "the shortage of S&T personnel is estimated at between 20 per cent to 30 per cent across all levels of scientific and engineering areas. The situation is particularly acute for small and medium scale industries". Fortunately, the Plan has a number of specific initiatives to arrive at a critical mass of scientists and engineers[6].

The main conclusion that can be drawn from this comparative exercise is the fact that financial incentives while necessary are not sufficient enough to promote innovations.

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6) For the details see Ministry of Science, Technology and Environment (2003), pp. 18-21.

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