Public vs. Private Technological Incubator Programs:
Privatizing the Technological Incubators in Israel

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ABSTRACT

Since the year 2000, private technological incubators began operating in Israel. This development owes its activity to the rapidly growing private (venture) capital (VC) that traditionally did not fund such projects. This study examines the differences and similarities between these two types of technological incubators – public vs. private. It addresses the question whether there is still a need for the Public Technological Incubators Program (PTIP).

Based on our empirical analysis and findings, the main conclusion is that private incubators cannot fully substitute for public incubators; even after the entrance of the private sector into the area of technological incubator activity, there is still justification for the continuation of the PTIP. Private incubators tend to concentrate in selected fields while public incubators sponsor a large variety of fields. The PTIP is found to be the only answer to advance national objectives such as the promotion of peripheral regions and providing special incentives to some selected population groups (new immigrants) for whom such activities would otherwise be out of reach.

Keywords: Technological Incubators, Public vs. Private, Technology Policy, Venture Capital

1. Introduction

The Public Technological Incubator Program (PTIP) was initiated by the Office of the Chief Scientist in the Ministry of Industry and Trade in Israel in the wake of a large influx of immigrants from the former USSR, many of whom were scientists and engineers. This massive immigration of highly skilled labor bolstered the Israeli high-tech industry which in the early 1990's, blossomed in an unprecedented manner[1]. Between 1990 and 1993, 28 incubators were established and today there are 24 technological incubators still in operation. They can be found near metropolitan areas and in peripheral areas, as well. Since the 2000s, private technological incubators began operating in Israel as a result of the readily availability of private venture capital (VC) to sectors that traditionally had been funded solely by the public sector.

The objective of this study is to evaluate the PTIP from the point of view of the privatization trend. With the private sector taking a central role in financing technological initiatives, it would be important to examine the necessity of continue the public program and to examine its efficiency compared to the private incubators: first, its functioning as a tool that is supposed to encourage and develop technological innovation in the industry; second, as a tool to advance national economic and social objectives. In order to do that the study examines the differences and similarities between the two types of technological incubators – public vs. private. It addresses and discusses the key question weather there is still a need for the PTIP.

This question takes on added importance when facing the immense changes in international business climate that require new and creative thinking on Israel's technological policy. Designing effective and efficient policies to help develop the high-tech industry requires both a conceptual framework and a clear view of the reality of time and place for employing such policies. The rapid growth of Israel's high-tech industry, on the one hand, and the swift changes in the technological

[1] According to the Office of the Chief Scientist (OCS), which operates Israel's public-sector R&D incentives programs, Israel produces the second highest absolute number of technological start-up companies per year in the world after the U.S. (OCS, 1997). The electronics industry, which accounts for most of the high-tech sector, increased its sales from $2 billion in 1986 (Association of Electronics Industries, 1996) to $13.1 billion in 2003 (www.iael.org.il).

environment, on the other hand, raise the need to examine the adequacy of the technological incubator program with respect to its efficiency and suitability.

In this context, the analogy to the Venture Capital (VC) industry is quite clear and straightforward. In the early 1990s', Venture Capital funds did not take part in the seed stages of high-tech projects in Israel. The Israeli government identified the great potential of the high-tech sector for the economic growth of the country and the need to support the new, innovative industry, as well as the deficiency of supportive mechanisms for raising funds for the newly created high-tech firms. Since the growth of the high-tech sector depended largely on the firms' ability to raise money, it was clear that supportive funds for R&D should become the pillar of any government program aimed at encouraging the establishment and growth of new high-tech firms (Trajtenberg, 2000).

This kind of government intervention started in 1991 with the Government Insurance Company – Inbal which provided VC funds that are traded on the stock market, with a 70% guarantee. The government program Yozma, based on a $100 million fund, began operating in 1992. The basic idea was to promote, through government support and the involvement of foreign financial/investment institutions, the establishment of Israeli VC funds that invested in young Israeli high-tech startups. In 1997, the government sold Yozma to the private market, pointing to the end of government intervention in the VC market. During its period of operation, Yozma led to the establishment of 10 VC private funds, which raised $2.7 billion until the end of 2002, thereby triggering the emergence of Israel's VC market (Teubal & Avnimelech, 2001)[2]. This government-intervention model in a situation of market failure which ended when the market started to supply the needs efficiently, calls for an examination and a comparison with the government's Technological Incubator Program.

[2] The total investment of VC funds in Israel from 1998-2002 amount to a total of $8.1 billion. The peak was in 2000, before the high-tech market collapsed, when 62 companies operated 100 VC funds with a total capital of $5 billion, estimated to be 3% of GDP (by comparison, VC funds' share of U.S. GDP is estimated at 0.7%, Ber, 2002).

2. Background

2.1 Technological Incubators

The idea of the technological incubator program emanated from the desire to encourage and support budding new start-ups in their critical years before reaching maturity (Hoy et al, 1991). The incubator increases the chances of the small firms graduating from the incubator to survive by supplying such basic services as assistance and consultation in varying areas, thereby helping to accelerate their rate of growth (Sherrod, 1999). Enterprises that began their life in an incubator have been found to have a higher rate of success than those that did not. This is due to the increase in the number of employees, a reduction of labor and operational costs, as well as increase in gross sales, net profits, net value, and overall benefit to the entrepreneurs (Gatewood et al., 1985). Cutbill (2000) reported that firms that began their life in a supported milieu (e.g. technological incubator) had an 87% chance to succeed, in contrast to an 80% failure rate among start-ups that chose not to stay in such a supported milieu in their first five years of operation. Research in the UK found that managers of firms within incubators or firms that had graduated from incubators strongly believed that this attachment had been important to the development of their business (Hannon and Chaplin, 2003).

The technological incubator program integrates financial, counseling, and infrastructure services. The incubators provide the initiator with location, financial assistance, business and marketing advise, professional guidance, and administrative support - all of which help the initiator to turn his initial idea into a new product, while reviewing its economic visibility, its uniqueness, advantages, and the expected market demand for the product. As such, the incubators constitute a source of new innovation and growth for an industry, encouraging the emergence of new technologies, supporting the creation of new jobs, and as a by-product preventing brain drain (Pleschak, 1997; Reynolds, 2000). At a national level, the technological incubator program may be seen as a tool for filtering and developing new ideas and for providing seed-capital. At a local level, the incubator may be viewed as a means of local economic development, since it can induce the creation and development of new firms in a specific location (Shefer & Frenkel, 2003). Recently, Hannon and Chaplin (2003) reported, on the basis of a literature survey, that evidence from the USA and the UK strongly suggested that most incubator tenants came from the

immediate locality and that most of the firms that graduated from an incubator stayed within the same locality.

Technological and business incubators are a worldwide phenomenon. In the U.S., the number of incubators exceeds 800, and more than 20,000 companies have graduated from them and are still in operation (Applegate, 2000). Structural changes and globalization smoothed the ground for the establishment of technological and business incubators in Europe in the early 1980s, in particular in England, France, Germany, and Italy (Bird, 1989). The objectives of these incubators vary from place to place. In Spain and Belgium, the first incubators were established in order to attract branches of international companies; in Germany, to promote the creation of new jobs and to encourage potential entrepreneurships. In France, the first incubator was erected in proximity to a university in order to transfer technology from the academia to industry and to commercialize university research outputs. In Italy, the incubator is considered a regional economic development tool and in England it is a tool for the creation of new jobs (OECD, 1997).

Technological incubators also exist in the Far East. For example, in Japan they operate within innovation centers and science parks. They were established for the first time in 1989 as part of the research cores which meant to serve primarily as incubators for small and medium-size high-tech firms (Kawashima and Stöhr, 1988), and by 1994 there were 45 technological incubators in operation. The incubators in Japan, in contrast to those in the U.S. and Europe, do not limit the time that projects are allowed to operate in the incubator. Japanese incubators act more as a real-estate business, renting areas and supplying technical and administrative services. Their main weakness is the absence of access to sources of funding, including VC funds, and the lack of their connection to business and financial firms (OECD, 1997).

Technological incubators are not limited only to the industrialized world. They now can be found in such countries as China, Turkey, Brazil, South Korea, and Indonesia, where the economy has been passing through structural changes. Among the undeveloped countries, the largest technological incubator program exists in China, encompassing 85 incubators and more than 2,000 projects. Thanks to generous and intensive government support, the program has proved successful and contributes to the development of the country's economy (OECD, 1997).

It is estimated that there are today some 3,000 incubators spread all around the world, more than half of them established during the 1990s (Reynolds, 2000). Most of the incubators are affiliated with and activated by such public or private bodies, as government agencies, universities, research centers, and large technological firms (Culp, 1990). The growing number of technological incubators internationally points to the importance ascribed by governments to the development of business as a basis for the creation of economic activities and as a tool for promoting innovation and creating new jobs.

2.2 The Public Israeli Technological Incubator Program

The Public Israeli Technological Incubator Program was initiated by the Chief Scientist's Office (CSO) in the Ministry of Industry and Trade and assigned, among other things, to help with the absorption of the new immigrants and with the assimilation of the vast technological knowledge and experience that they brought along with them (Shefer & Frenkel, 2003). At the beginning of its operation, the program set a goal that at least 50% of the employees in an incubator should be new immigrants in order to improve their access to the Israeli business world (Ministry of Industry and Trade, 1998).

The aim of the technological incubator program, as a development program "from below", is to foster entrepreneurial activities from the very beginning of a project's initiation. Therefore, the incubator has the advantages and drawbacks typical of this kind of program. It can help to create a healthy entrepreneurial culture by empowering local people and encouraging them to develop their own firms locally. A technological incubator located in a remote region may be able to provide a number of functions that are seldom found in peripheral areas, such as venture capital supply, business and legal consultation, and the filtering of valuable ideas. Obviously, however, it cannot help in increasing the supply of skilled labor.

The State of Israel, through the CSO, has actively encouraged the establishment of technological incubators and continues to support their development. Significant financial support is given to the incubator's management, as well as to its projects: grants of up to $175,000 per annum to each incubator and of up to $150,000 per year to each project for a maximum of two years. The level of the grant can reach 85% of the approved budget of a project (Office of the Chief Scientist, 2001). The additional

15%, “complementary financing," is to be supplied by the entrepreneur or by a partner in exchange for equity in the project.

From a small annual budget of $2 million at the beginning in 1991, the technological incubator program increased its annual budget to $32 million in 2002. As of 2003, total government grants to the program amounted to $285 million (see: www.incubators.org.il.). At the end of 2003, more than 200 projects were in operation in incubators, which employed more than 2,000 workers. One third of the initiatives were based on ideas brought by new immigrants, all of whom had an academic education (most with a Master’s or Ph.D. degree) [3].

Recently, Shefer and Frenkel (2003) evaluated the Israeli Technological Incubator Program ten years after its establishment. They found that, in general, the program has fulfilled its purpose; 86.4% of the projects in 1999-2001 graduated from the program, and 78% of these were able to secure financial support after graduation, which is regarded as an indication of success. In this context, the incubators located in the periphery presented lower rates of success, compared with those in the central regions of Israel.

Ten years after the establishment of the Technological Incubator Program it was discovered that incubators are capable of enlarging their budget from non-governmental sources - mostly royalties, sale of shares and dividends, and strategic partnerships. This new sources of funding suggest that the vast government support needed in the initial stage can gradually be reduced over time, once outside private funding sources are developed and attained. Still, technological incubators located in peripheral regions require more public support, and for a longer period of time, than do those located in the central regions of the country (Shefer and Frenkel, 2003).

The Israeli Technological Incubator Program is regarded as success story and a model to be imitated worldwide. Many visitors come to Israel in order to study the program and go on to implement it abroad (Hershman, 1999). Since 1995, a joint project has existed between the Israeli program administration and Sweden in order to establish a similar program there. Shefer and Frenkel’s study of the Israeli program (see above) was part of a large EU-sponsored research project to develop a methodology for

[3] Information received from the incubator administration on 15/3/04.

creating seed and start-up capital for high-tech firms. The project follows the Israeli success story of the Technological Incubator Program and tests its applicability to EU countries, in particular Italy.

In most of the developed countries, the capital market operates in a competitive environment, based on supply and demand. A market failure, though, may prevent free competition in the capital market. The government is then forced to regulate the market and to devise policies that will direct investment to worthwhile initiatives. The VC market is a central financial resource in the new global economy in general, and for the high-tech industry in particular. Access to VC sources has a critical effect on promoting innovation initiatives, the establishment of new technological firms, and economic growth as a whole. Public intervention in the VC market is acceptable in many countries. Most of the time, it is only partial intervention focusing especially on regions where the VC market has not yet developed (Harrison & Mason, 2000). In the US and UK, for example, the VC industry tends to concentrate in the large business centers. In order to bring about geographically distribution of capital, governments intervene by adopting different strategies, such as tax remission, government guarantees, and even support of private VC funds (Doran & Bannock, 2000; Hood, 2000).

One of the greatest achievements of the Technological Incubator Program in Israel is related to its success in attracting seed money from private sources that had been unreachable until that time. Today, most VC funds and investment companies in Israel are involved in projects undertaken within the technological incubators or that graduated from the program. This development points to the beginning of privatization of this field.

The access of private capital to new type of economic activities is part of the privatization process guided by the rationale that there is no need for government intervention where the private sector operates. Privatization means a reduction in the government's role in producing goods and services, as well as limiting its control and regulation of the economy. The assumption is that the removal of government and the intensification of free competition will increase efficiency in resource allocation. It is commonly understood that government usually does not manage its resources efficiently. Therefore, public companies will be less efficient than private companies.

Thus, turning public companies to private enterprises could increase their efficiency and thereby, the efficiency of the whole economic system (Eckstein et al., 1998). Results have shown though, that privatization increases efficiency and innovation if it is done in a wise manner (Kikeri et al., 1994).

The privatization technique used in the Technological Incubator Program is to create a joint company of the public and the private sector. The incubator does not trade its shares, but increases the company's capital through the infusion of external investment, thereby reducing its shares. Alongside the privatization process, which some government technological incubators have experienced, private technological incubators have started to appear in Israel as the result of private entrepreneur initiatives.

In this context, a reexamining of the PTIP is justified in order to examine its role in the current privatization trend. One of the reasons behind the establishment of this public program was the need to relief the problem of funding during the seed stages of new initiatives. Since a large, private VC market currently operates in Israel, it is advisably therefore, to check whether the VC funds could serve as a substitute for, or as complementary to, the funds granted by the CSO. The issue is all the more pertinent at a time when a crisis in the high-tech industry in general, and in the VC market in particular, reduces the amount of available capital, thus requiring government assistance to the VC industry. The question arises as to the role of technological incubators in handling market conditions as reflected in a reduction in investments to start-ups, and in the incubators' readiness to invest in specific fields or remote peripheral regions.

3. Research Objectives and Hypotheses

The main hypothesis of this study is that basic differences in characteristics exist between public and private technological incubators. These characteristics cover, among others, range of project activities, field of activities, number of active projects, size and sources of capital investments, age and origin of the initiators and their former place of work, and areas of specialization.

We hypothesized that entrepreneurs, who came from the academic world, and had research backgrounds are more likely to join public incubators, whereas entrepreneurs

who came from industry and, thus, are more business oriented, are more likely to join private incubators. We further hypothesized that private incubators are more likely to invest in lower-risk projects, those with a potential for high profitability, and in fields with rapid growth and maximal return in the short run, such as software. In contrast, public incubators are more likely to support high-risk projects that need a longer period for maturation, such as biotechnology.

We also hypothesized that the VC industry would be a complementary rather than a substitute source for the funding granted by the public incubators. The reason is that government programs are most often supplement private investments in civilian R&D projects (Trajtenberg, 2000). Thus we assume that VC funds are more likely to invest in private incubator projects rather than in public incubator projects. This preference relates to profitability considerations, which guide VC funds that invest in start-ups so as to maximize return on their investments in a short time (Ber, 2002; Nijkamp et al., 2004).

Finally, we assume that private incubators would not endeavor to achieve non-commercial objectives; therefore, they could not be an alternative to public incubators, designed to advance social and national goals.

4. Methodology

The research hypotheses were tested by a thorough and comprehensive comparison of public and private incubators in the following subjects: organizational structure, lines of activities, characteristics of initiators and initiations, the involvement of private sector in their work, geographic location, and the level of satisfaction derived from the incubator's support. Statistical models were employed in order to test the differences between the two incubator datasets. These included χ^2 analysis, t-tests, and a-parametric statistical tests (Spearman rank order correlation coefficient and Man Whitney U-test).

Data Sources

For the purpose of the study, a sample of 12 incubators was selected: 6 public incubators (of the 24 government incubators) and 6 private incubators. At the time of the data collection the number of private incubators was limited. Since, then, more

private incubators have been established; however, they have been adversely affected by the economic recession. The criteria for selecting the incubators in the sample were related to their geographical distribution, type, and ownership, thus obtaining appropriate representation of the population being investigated.

A field survey was carried out that included a sample of projects operating in the public and private incubators. The data were collected by means of two well-constructed questionnaires (instruments). Managers of the 12 incubators selected were personally interviewed, as were 60 project initiators: 40 from the public incubators and 20 from the private incubators (which was the total number of initiatives in these incubators). The database was built to give statistical representation to various characteristics of the incubators and the projects. Accordingly, the incubators and the projects within them were divided into sub-groups: by geographical sub-location (metropolitan, intermediate, and peripheral), type of incubator (general or specialized), and type of sponsorship. The projects were also classified by major field of activity. The assumption was that these categories had a major influence on certain aspects of the incubators' operation and performance. Data analyses were performed on four main levels of characteristics: the incubators, the initiators, the projects, and the policies of the technological incubators.

The basic variables included in the questionnaires were as follows: the characteristics of the incubators (location, number of employees, type of ownership, number of projects), project filtering process, project field of activities, projects that "graduated" and projects that "dropped out", the incubator source and extent of funding, preferred location of projects after graduation, barriers and obstacles to the operation of the incubator, level of satisfaction with the incubator, characteristics of the initiators, project's source of funding.

5. Results

5.1 Characteristics of Incubators and Project Initiators

The classification of the incubators and the projects within sub-groups is presented in Tables 1 and 2. The results show that most of the incubators (7 of the 12) are centrally located (located in metropolitan regions). Only two incubators are located in the periphery, both of them public incubators. With respect to type of incubator, we classified an incubator as specialized if all the projects operating in its framework

belonged to one field of activity; otherwise the incubator was classified as general. All private incubators were found to be specialized; half of them specialized in biotechnology and half in software. Only one public incubator was found to be specialized, exclusively in biomedicine. With regard to the type of ownership, all the private incubators were in the hands of private owners. Two of the public incubators were classified as semiprivate (shared jointly between the government and private investors who bought 50% shares of the incubator), and all the others were public incubators.

Table 1: Incubators Classification by Location, Specialization and Ownership

Type	Name of the Incubator	City	Location	Type	ownership
Public Incubators	1. Rad Ramot	Ramat Gan	Central	Specialized	Semiprivate
	2. Technological High-tech Entrepreneur Center - Hotzvim Mount	Jerusalem	Central	General	Public
	3. Future Technological Center	Dimona	Periphery	General	Public
	4. Technological Entrepreneur Center in the Golan	Katzerin	Periphery	General	Public
	5. Technion Entrepreneur incubator	Haifa	Central	General	Public
	6. Nayot - Technological Center	Nazareth Illit	Intermediate	General	Semiprivate
Private Incubators	1. Eager Bio Group	Ashdod	Intermediate	Specialized	Private
	2. Keream Innovation	Herzliah	Central	Specialized	Private
	3. JBC	Jerusalem	Central	Specialized	Private
	4. Klal	Yavne	Intermediate	Specialized	Private
	5. VNC	Tel Aviv	Central	Specialized	Private
	6. Magnet	Tel Aviv	Central	Specialized	Private

Table 2: Distribution of Incubators, by Sub-group

Group		Public Incubators		Private Incubators	
		Number	%	Number	%
Location	Central	3	50.0	4	66.7
	Intermediate	1	16.7	2	33.3
	Periphery	2	33.3	0	0.0
Type	Specialized	1	16.7	6	100.0
	General	5	83.3	0	0.0
Ownership	Public	4	66.7	0	0.0
	Semiprivate	2	33.3	0	0.0
	Private	0	0.0	6	100.0

For the 60 projects included in the sample, there were 109 initiators, 67 of them in public incubators and 42 in private incubators. A t-test between the two types of incubators, with respect to the average number of initiators per project, pointed to a statistically significant difference (*t = 2.384; sig.= 0.02*), with public incubators having a lower number (1.67) than private incubators (2.1).

Most of the initiators were men (87%). Half of the incubators in the sample had no female initiator at all. The distribution is more extreme in the private incubators, where 95% of the initiators were male. The average age of an initiator in all incubators was 44 years old, a little older in public incubators (48 years old) and younger in the private incubators (38 years old). Although 24% of the initiators in the private incubators were young (21-30 years old), the proportion of this age group in the public incubators was only one percent. In the private incubators, there were no initiators age 60+ and only 7% were between 51 and 60 years old. In contrast, the proportions of these two age groups in the public incubators were 7% and 21%, respectively. The differences between the two types of incubators in regard to the average age of the initiators were found to be statistically significant (t = 4.528; sig. = 0.00).

In the public incubators, 45% of the initiators were immigrants; 25% of them came from the former USSR, mostly during the 1990s. This finding fit the initial objective of the PTIP to promote technological entrepreneurship among the immigrants who came from the former USSR. On the other hand, only 12% of the initiators in private incubators were immigrants, but all of them had come to Israel in the 1950s and 1960s. This finding is not surprising because of newcomers' lack of management knowledge, unfamiliarity with acceptable Israeli business norms and rules, and lack of access to source of funding, thus reducing the chances of these initiators to operate in private incubators. It is clear, therefore, that the private incubators are not able to substitute public incubators in advancing national goals.

In the distribution of the entrepreneurs according to education level, it was found that a high percentage held advanced degrees: 59.6% had a Ph.D. and an additional 18.3% a Master's degree. We found highly statistically significant differences between public and private incubators with respect to the initiators level of education (see Table 3).

Table 3: Projects' Initiators, by Level of Education and Incubator Type (in percent)

Education	Number of observations	Public Incubators	Private Incubators
Non-academic	9	4.5	14.3
Bachelor's degree	15	7.5	23.8
Master's degree	20	19.4	16.7
Ph.D.	65	68.7	45.2
Total	109	100.0	100.0%

$\chi^2 = 10.500$ $df = 3$ $sig. = 0.015$

The level of education of the initiators in the public incubators was higher than in the private incubators. For example 68.7% of the initiators in the public incubators held doctoral degrees, while only 45.2% of the initiators in private incubators possessed this level of education. On the other hand, only 4.5% of the initiators in the public incubators were non-academic professionals, compare to 14.3% of the initiators in the private incubators.

When we examined the major fields of formal education of the initiators, we found two major fields: life sciences (46.8%), and engineering (19.3%). In both types of incubators, almost half of the initiators' formal education had been in the life sciences (46.3% in public incubators and 47.6% in private incubators) (Table 4). This finding is surprising, in particular with respect to the private incubators but also in comparison with the rate among Israeli start-ups, which happened to be only 18.2% (Sadovski, 2001). We assume that this finding could be an early indication of a future structural change in the direction of supporting the biotechnology field, an area that many see as the leading field for significant inventions and innovation in the 21st century. Israel has an accumulated body of knowledge and research achievements in these technology areas, and therefore comparative advantage on an international scale in this field (Monitor, 2001). Thus, it is reasonable to assume that life sciences will enjoy a greater proportion of technological and business development in the future than it is today.

Statistically significant differences were found between public and private incubators in other fields (see Table 4). The salient fields among the public incubators were engineering (23.9%) and exact sciences (19.4%), compared to only 11.9% and 7.1%, respectively, among private incubators. On the other hand, the private incubators benefited from a higher percentage of initiators who came from the fields of

management/economics (21.4%) and software (11.9%), compared to only 9% and 1.5%, respectively, among initiators in the public incubators. This finding points to the advantage in economics/business/management orientation that initiators in private incubators have over initiators in public incubators.

Table 4: Projects' Initiators, by Field of Discipline and Incubator Type (in percent)

Field of Education	Number of observations	Public Incubators	Private Incubators
Engineering	21	**23.9**	11.9
Software	6	1.5	11.9
Life Science	51	**46.3**	**47.6**
Exact Science	16	19.4	7.1
Management/Economic	15	9.0	**21.4**
Total	109	100.0	100.0

$\chi^2 = 12.579$ $df = 4$ $sig. = 0.014$

Finally, the initiators were asked where their ideas had generated from and what the work environment was like (in each of the 60 projects in the sample). An analysis of the responses indicated that 87% of the ideas in the public incubators stemmed from Israel and only 13% from abroad; in the private incubators, all the ideas originated in Israel.

In regard to the previous working place, 53% of the ideas generated from academic/research institutes, 28% from high-tech industry, 8% from industrial source, and the remaining 10% from other sources. In this respect significant statistical differences were found to exist between the two types of incubators (Table 5). Most of the ideas in the public incubators came from academic/research institutes (57.5%), as against 45% in the private incubators. This tendency was significant mainly in public incubators (83%) located in proximity to universities and research institutes, thus pointing to the high linkage between incubators and academic institutes. In contrast, half of the ideas in the private incubators came from previous high-tech work, as opposed to only 17.5% in the public incubators.

These results are compatible with the previous place of work of the initiators: in 78% of the projects in which the idea came from academic/research institutes, the previous place of work of the initiator was an institute. Similarly, in 71% of the projects whose

idea came from high-tech and in 60% of the projects whose idea came from industry, the initiators' previous place of work had been in an industrial R&D laboratory.

Table 5: Projects' Initiators, by Previous Working Place
(in percent)

Precious Working Place	Number of observations	Public Incubators	Private Incubators
Academic/research institutes	32	**57.5**	**45.0**
High-tech industry	17	17.5	**50.0**
Industry	5	12.5	0.0
Others	6	12.5	5.0
Total	60	100.0	100.0

$\chi^2 = 8.611$ $df = 3$ $sig. = 0.035$

5.2 Fields of activity

When the projects in the incubators were classified according to nine fields of activity (Table 6), significant differences manifested themselves between public and private incubators. The public incubators appear to have a relatively high degree of concentration in medical equipment (33%), in contrast to private incubators (15%). In the private incubators, most of the projects (70%) are concentrated in two major fields: software (40%) and drugs (30%), whereas these two fields of activity accounted for only 6% and 12%, respectively, of the projects in the public incubators. The high percentage of pharmaceutical projects in the private incubators was not expected, since the development of a pharmaceutical product requires a long and expensive process. However, no significant differences were found in the nature of projects in this field between the private and the public incubators. Moreover, all projects in these two fields that graduated succeeded in securing financing after graduation. Apparently, software and pharmaceutical have become the most attractive fields of investment in Israel, and therefore are selected by private incubators as well.

On average, the number of projects within a public incubator (11) is three times that of a private incubator (3.3). It seems that private incubators prefer to invest heavily in a few projects, whereas public incubators prefer to invest smaller amounts in more projects (conceivably in order to minimize risk per project). This phenomenon could also be due to the fact that the private incubators did not reach yet a "steady state". Nevertheless it should be pointed out that even under these circumstances a private incubator, on average, managed a budget larger than a public incubator.

Table 6: Projects Fields of Activity in Incubators
(in percent)

Project type	Public Incubators	Private Incubators
Drugs	12.1	30.0
Medical equipment	33.3	15.0
Chemicals and raw materials	7.6	0.0
Mechanical engineering	6.1	0.0
Hardware, communication and electronic components	4.5	5.0
Optical and precision equipment	7.6	0.0
Biotechnology	10.6	10.0
Energy and ecology	6.1	0.0
software	6.1	40.0
Others	6.1	0.0
Total	100.0	100.0
Average number of projects per incubator	11.0	3.3

Within regions (Table 7), we can observe that public incubators in the center attracted mainly biomedical projects: pharmaceutical-drugs (63%), biotechnology (57%) and medical equipment (55%). Significant fields of activity in peripheral region incubators were hardware, communication and electronic components, and energy and ecology (100% each), mechanical engineering (75%), and chemical and raw materials and optical and precision equipment (60% each).

Table 7: Project Fields of Activity, by Location and Type
(in percent)

Incubator type	Public Incubators			Private Incubators	
Location	Central	Intermediate	Peripheral	Central	Intermediate
Project type					
Drugs	**62.5**	25.0	12.5	16.7	**83.3**
Medical equipment	**54.5**	9.1	36.4	**66.7**	33.3
Chemicals and raw materials	40.0	0.0	60.0	0.0	0.0
Mechanical engineering	25.0	0.0	75.0	0.0	0.0
Hardware, communication and electronic components	0.0	0.0	**100.0**	**100.0**	0.0
Optical and precision equip.	20.0	20.0	**60.0**	0.0	0.0
Biotechnology	**57.1**	42.9	0.0	**50.0**	**50.0**
Energy and ecology	0.0	0.0	**100.0**	0.0	0.0
software	0.0	**75.0**	25.0	**100.0**	0.0
Others	25.0	25.0	50.0	0.0	0.0
Total	39.4	18.2	42.4	65.0	35.0
Number of incubators	3	1	2	4	2

The private incubators in the center attracted projects mainly in the fields of software and hardware, communication and electronic components (100% each), and medical

equipment (67%). In contrast, drugs projects were predominant in private incubators located in the intermediate region (83%). These findings attest to the variance in the attractiveness of location and activity field, which are apparently affected by proximity to knowledge and research centers, large pools of highly skilled labor in the relevant fields, and specialized services, such as laboratories, etc.

5.3 Project Funding

The average annual budget per project in a private incubator ($1,137,500) was found to be 4.5 times higher than in a public incubator ($255,375), and the differences are statistically significant (at the 1% level) (Table 8). The total annual budget of the 40 projects within the public incubators amounted to $10.2 million, while the total annual budget of the 20 projects within the private incubators came to $22.8 million.

Table 8: Projects' Average Annual Budget, by Location, Specialization and Sponsorship

		Public Incubators		Private Incubators	
Group	Sub-group	Number of projects	Average annual budget ($)	Number of projects	Average annual budget ($)
Total Incubators		40	255,375	20	1,137,500
Location	Central	18	284,167	13	665,385
	Intermediate	5	382,000	7	2,014,286
	Periphery	17	187,647	0	0
Specialization	Specialized	6	259,167	20	1,185,417
	General	34	254,706	0	0
Ownership	Public	29	232,759	0	0
	Semiprivate	11	315,000	0	0
	Private	0	0	20	1,137,500

t-test between public and private incubators: *t = 5.311 sig. = 0.000*
t-test between public central and intermediate incubators: *t = -0.875 sig. = 0.391*
t-test between public central and peripheral incubators: *t = 1.994 sig. = 0.054*
t-test between public intermediate and peripheral incubators: *t = 2.756 sig. = 0.012*
t-test between private central and intermediate incubators: *t = -3.548 sig. = 0.002*
t-test between public specialized and general incubators: *t = 0.056 sig. = 0.955*
t-test between public and semiprivate incubators: *t = -1.328 sig. = 0.192*
t-test between public and private incubators: *t = -4.672 sig. = 0.000*
t-test between private and semiprivate incubators: *t = -2.603 sig. = 0.014*

Looking at the differences among the projects with respect to location, we found that the highest annual budget per project was in the intermediate zone. In the private incubators, the differences in location were statistically significant and related to the fact that these incubators specialized in the biomedical field, which requires a much larger budget than do other fields of activity. In the public incubators, semi-private

incubator, who benefit from better access to sources of funding, preferred to locate in the intermediate region.

As expected, the annual budget per project in peripherally located public incubator was found to be the lowest, conceivably because of the remoteness of the projects from investment sources. The results, with respect to the budget variable, show that statistically significant differences exist between projects located in the peripheral incubators and the central and intermediate incubators in the public sector (Table 8).

No statistical difference was observed in regard to the level of specialization of an incubator. This finding does not support the assumption that specialization contributes to the success of projects in securing more funds.

As for the effect of incubator-ownership type on project budgets, no statistical difference was found between the semi-private and the public incubators (both are public incubators). In contrast, highly significant differences (at the 1% level) exist between these two sub-groups and the private incubators. Being a private incubator increases the ability of its projects to secure funding and to increase the investment in projects.

5.4 Source of Funding

We can see from the distribution of the projects' sources of funding (Table 9) that the Chief Scientist's Office in the Ministry of Industry and Trade is the main source, contributing 59% of the funding of projects in public incubators. The main source of funding of projects within the private incubators is the incubator itself and/or the owner/sponsor of the incubator (46.7%). A salient result is the importance of the CSO, which also serves as a secondary source of funding for projects in private incubators (19.3%). In fact, 90% of the projects in the private incubators are partly financed by the CSO, which on average provide even higher funding per project ($244,400) than it does to projects in public incubators ($150,700); the difference is statistically significant (at the 1% level). This means that projects in private incubators, and not just those in public incubators, rely to a great extent on government funding. This finding is compatible with that reported by Sadovski (2002) who found that more than 50% of Israeli start-ups had been supported by government funding.

Table 9: Projects' Source of Funding, by Incubator Type

	Public Incubators				Private Incubators				
Source of Funding	Total investmnt ($000)	%	Number of Projects	Average Investment Per Project ($000)	Total investmnt ($000)	%	Number of Projects	Average Investment Per Project ($000)	*t value*
Chif Scientist's Office	6,027.7	59.0	40	150.7	4,400.0	19.3	18	244.4	-3.964*
Incubator/Sponser	508.1	5.0	15	33.9	10,620.0	46.7	12	885.0	-3.949*
Venture Capital/ Investment Company	985.8	9.7	6	164.3	3,521.5	15.5	9	391.3	-2.177**
Strategic Partner/ "Angels"	2,224.7	21.8	25	89.0	3,862.5	17.0	12	321.9	-2.830*
Family/ Others	468.8	4.6	5	93.8	355.0	1.6	6	59.2	0.553
Total	10,215.0	100.0	40	255.4	22,759.0	100.0	20	1138.0	-5.310*

* Significant at the 1% level ** Significant at the 5% level

In general, we can see that strategic partner and "angels," venture capital funds and investment companies, are the main sources of funding of projects in technological incubators. Strategic partners and "angels" contribute relatively a little more to the funding of projects in public incubators (21.8%) than in private incubators (17.0%); yet, they are involved in more than 60% of the projects in both types of incubators. In absolute term, however, they invested more (3.5 times more) on average, per project in the private incubators ($321,900) than in government incubators ($89,000), and the difference is statistically significant (at the 1% level). VC funds and investment companies supply a higher rate of funding to projects in private incubators (15.5%) than in public incubators (9.7%). Accordingly, they are involved relatively more in projects in private incubators than in public incubators (45% versus 15%, respectively). The difference in the average investment per project is statistically significant (at the 1% level), being more than twice as high in the private incubators ($391,300) as compared to the public incubators ($164,300).

With respect to location, we find that the highest annual average budget per project (Table 10) is in the intermediate region ($382,000 in the public incubators, and $2,015,571 in the private incubators), and the lowest in the peripheral regions ($187,647). It can be observed that the government's share in a project's budget decreases with the increase in the average budget of a project. Therefore, the government's share (through the CSO) in the peripheral regions reaches 80.9%, while it drops to 41.4% in the public incubators and to 16.3% in the private incubators in the intermediate regions.

When we compared the source of funding with respect to the level of specialization, we found that except for the high contribution of the CSO to public incubators and

that of the owner/sponsor to private incubators, no other significant differences existed. Among the private incubators (all of which are specialized), there are differences between the biotechnology incubators, which have a high share of owner/sponsor (44%), and incubators that specialize in software, which have a significant share of "angels" (26%) and VC funds (20%). We assume that this phenomenon is associated with the degree of risk to the investment in projects in different fields, with software regarded as having less risk than the biotechnology field.

Table 10: Projects' Source of Funding, by Incubator Type and Location

	Public Incubators			Private Incubators	
Source of Funding	Central	Intermediate	Periphery	Central	Intermediate
Chief Scientist's Office	52.0%	41.4%	80.9%	24.3%	16.3%
Incubator/Sponsor	6.3%	8.7%	0.6%	23.4%	61.0%
Venture Capital/ Investment Company	12.5%	13.0%	3.1%	23.0%	10.9%
Strategic Partner/ "Angels"	28.7%	17.6%	13.2%	25.3%	11.9%
Interior/Family/ Others	0.5%	19.3%	2.3%	4.1%	0.0%
Total Budget US $	5,115,000	1,910,000	3,190,000	8,650,000	14,109,000
Number of Projects	18	5	17	13	7
Average Budget per Project US $	284,167	382,000	187,647	665,385	2,015,571

5.5 Factors Contributing to Successful Projects

Finally, the interviews with the project initiators also posed questions concerning the relative importance of variables that we hypothesized to be detrimental to the successful operation of a project after "graduation". Eighteen such variables were presented to the project initiators, who were asked to give a score on a scale of 1 to 5 (1 = very unimportant; 5 = very important), indicating the relative level of importance of each variable to the successful operation of a project. The results are presented in Table 11.

The results show a very high and statistically significant Spearman rank order correlation coefficient between government and private incubators in the scoring given by project initiators. The most important factor is financial support, which received the highest score (4.83 in the public incubators and 5.0 in the private incubators). The next seven factors had an identical ranking in both types of

incubators, with slight changes in the internal order. These factors include links to financial sources, marketing, networking with strategic partners, international collaborations, protection of Intellectual Property Right (IPR), legal counseling, and strategic counseling. Most of these factors, in both types of incubator, received a high score of 4.0 or above, thus pointing to a high degree of unanimity that exists among projects initiators regardless whether they are located in public or private incubators. Accordingly, no statistical significant differences were found in most of the factors examined between the scores given by the two groups of initiators by employing the Mann-Whitney U-test. The exception among the high ranked factors were networking with the strategic partner and the protection of IPR; both were valued more highly by initiators in the private incubators; nevertheless the average score given by initiators in public incubators was also high, above 4.0.

Table 11: Factors Affecting the Initiators of a Project by Incubator type

	Public Incubators			Private Incubators			Mann-Whitney U-test
Factors	Rank	Score	S.D.	Rank	Score	S.D.	Z
Financial support	1	4.83	0.38	1	5.00	0.00	-1.331
Links to financial sources	2	4.55	0.71	6	4.45	0.60	-0.934
Marketing	3	4.40	1.78	5	4.60	0.60	-0.876
Networking with strategic partners	4	4.23	1.00	2	4.95	0.22	**-3.627***
International collaborators	5	4.18	0.84	4	4.65	0.49	-2.091**
IPR Protection	6	4.00	1.13	3	4.80	0.41	**-2.904***
Legal counseling	7	3.93	1.05	7	4.15	0.37	-0.520
Strategic counseling	8	3.75	1.08	7	4.15	0.49	-1.308
Market information	9	3.58	1.20	8	3.80	0.83	-0.611
Access to labor pool	10	3.15	1.12	13	3.15	0.81	-0.840
Management support	11	3.03	1.25	11	3.40	0.82	-1.154
Networking of plants	12	3.00	1.13	9	3.75	1.21	-2.187**
Source of technological information	13	2.95	1.01	14	3.10	0.97	-0.545
Professional network	14	2.88	0.94	10	3.45	0.89	-2.230**
Advanced studies and re-training	14	2.88	0.99	15	2.85	1.46	-0.439
Connections with suppliers	15	2.53	0.99	16	2.45	1.28	-0.230
Available suitable space	16	2.43	1.13	12	3.20	1.47	-2.104**
Access to inputs	17	2.05	1.22	16	2.45	1.32	-1.137
Number of projects		40			20		

* Significant at the 1% level
** Significant at the 5% level
r_s = 0.904, sig.=0.000

6. Discussion and Conclusions

Based on the empirical analysis and the findings of this study, our main conclusion is that private incubators cannot substitute fully for the role served by the public incubator program; even after the entrance of the private sector into the area of technological incubator activity, there is still justification for the continuation of the public incubator program. Private incubators tend to concentrate in selected fields while public incubators sponsor a large variety of fields. The public technological incubator program was also found to be the only answer to national objectives, such as geographical distribution, which includes rural and peripheral areas, and the special incentives given to populations for whom such activities would otherwise be out of reach (new immigrant). Therefore the basic justification for public incubators still stands: it promote not only an economic and a business interest but also a national and social interest such as helping new immigrants, increasing export and developing the periphery.

The research confirms our main hypothesis, that there are basic differences between the characteristics of public and private technological incubators, in particular among their initiators. Initiators of private incubators are characterized by an economic, business, and administrative orientation; most of them came from industry thus requiring less support in these areas. On the other hand, initiators of public incubators are characterized by a higher level of education; most of them came from academia and research institutes, and they lack business and administrative skills. However, great unanimity was found among project initiators from both private and public incubators with respect to factors contributing to the success of projects.

It was found that private incubators specialize in biotechnology products in general and in pharmaceuticals in particular. However, these private incubators are not able to substitute for their public counterparts. First, the number of projects within the private incubators is by far smaller than in the public incubators. Secondly, although the technological incubator (in both type) by definition serves as a helping framework for the initiator, particularly in order to mobilize capital resources, initiators in private biotechnology incubators must finance their initial development stages before being admitted into the incubator. Third, private biotechnology incubators also depend on

government support. Forth, it is still not clear whether private incubators are a phenomenon that will survive in the long term.

The study results indicate the role played by VC funds and private investment companies that invest in technological incubators projects. VC funds tend to invest more in projects within private incubators than in the public incubators. However, they are only of secondary in importance compared to the CSO in public incubators and to the owner/sponsor in private incubators. Therefore these sources serve as complementary rather than as substitute sources of funding for projects.

Even though there are some domains where private incubators supply better services than do public ones, it is a crystal-clear conclusion that the public incubators program is a unique program. There is no other program that is able to provide a personal, intensive support system for the projects and their initiators right from the early stages to the time when the projects mature and are ready to enter the market.

The public technological incubator program provides the opportunities for a wide range of projects in the high-tech industry, encourages initiatives, and promotes transfer of knowledge from the academy to industry. The greatest advantage of the PTIP lies in its ability to sponsor high-risk projects, those that are perceived as non-attractive projects during their initial stages. The incubators support projects during the early R&D stages, when it is almost impossible to finance an initiative without government help, and it is most likely that the private sector would not be interested in investing at these stages. The PTIP serves as a trigger for initiative, a crane for growth, and many countries around the world consider it a model for imitation because of the high rate of successful projects. In addition, the government's financial investment in the PTIP encourages the private sector to invest in places and fields in which it would not otherwise venture.

Unlike the private sector, the public sector is a source of stability and can be a reliable anchor for long-term planning. A good example of such a situation can be found in continuous world-wide crisis that has plagued the high-tech industry since 2000. The crisis has pushed the whole Israel economy into an unstable, precarious situation, and some markets have ceased to function independently. In order to fill the vacuum, government intervention was needed at different levels. More over, as a result of the

ongoing recession there has been a sharp decrease in private investment. The consequent need for government intervention created a new demand and justification for the existence of the public technological incubator program.

On the other hand, there is no doubt that in its present form the public program has many flaws that must be rectified, updated, and revised in order to improve its operation and increase its efficiency. Private incubators cannot, at this point, take over and constitute a full substitute for the public incubators, but many aspects of the economic behavior of the former can be used as an example for proper management of the latter. Thus, we recommend the creation of a model that will maximize jointly the advantages of both private and public technological incubator programs, while at the same time minimizing their disadvantages. The private sector could bring its business way of thinking and vision, something that the public sector has found difficult to assimilate. The public sector could supply a safe framework, stability, and the ability to support initiatives in places where the private sector choose not to operate. It is recommended, therefore, that the privatization process of government incubators continue, but not to a complete exit of the government. The transfer of ownership into private hands is advisable alongside the continuation of government support, i.e. to some fields and in some specific location (peripheral regions).

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