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Incubators as catalysts of academic spin-offs: evidence from the Israeli case-study

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Abstract

There is already a respectable body of evidence that connect industrial innovation with knowledge spillovers from academic research, and many suggest that university research units can play a helpful role in small firm innovation, but very few take into account their role in the making of ‘innovation systems’, as promoters of innovative spin-offs. In addition, the theory does not distinguish sufficiently between different patterns that foster the spatial concentration of new activities. Dealing with the processes of knowledge generation and diffusion, this paper explores the behaviour of development agencies, i.e. of incubators, in order to increase interactions between academic research and firms, expressly Small and Medium Enterprises (SMEs).

Through a survey of Israeli Technological Incubators Programme (TIP), this paper both attempts to individuate specific behaviours and aims at identifying the interdependence of universities, firms and development agencies in stimulating innovative dynamics. Through a questionnaire and on field investigations, it put in evidence ‘formal’ and ‘informal’ interdependences between universities and incubators. In particular, it has been achieved an empirical analysis on a sample of university incubators, in order to reflect on successful experiences and limitations of their methodologies in the entrepreneurial promotion. These “enabling structures” are intended to increase the level of basic education through actions of continuous learning and to develop efficiently a process of networking.

The Israeli case-study put in evidence that: 1. information or codified knowledge, as in the collaboration between RTD institutions, but also tacit knowledge, know-how and competencies circulate in the incubators; 2. “soft” infrastructures and institutions can remove those obstacles which usually hinder the diffusion of “technology spillovers” and stimulate the opening of the local district to the external world, thus favouring its relations with research centres and technologically-advanced businesses; 3. such agencies need a necessary institutional background in order to sustain ‘knowledge and innovation networks’ at local and inter-regional level; 4. innovative projects can be supported by action tools based on a “transactive” approach that stimulate cooperation amongst the different actors and facilitate their mutual relations.

Finally, it seems to be indispensable the creation of a subject “integrating” the technological relations amongst the businesses in the different sectors thus assuring a unitary governance of the interactive process of technological development.

1. Introduction

Recent studies on entrepreneurial promotion agencies and, in particular, on technological incubators (Pace, 2000 and 2001) have highlighted that these organisations can create and develop several typologies of linkages with academic institutions. However, the resultant fluxes of resources and knowledge have been rarely analysed, and universities have generally been taken into account for their role in the making of national and regional innovation systems, with specific regard to knowledge spillovers to industrial sectors (Jaffe, 1989; Florax, 1992). Recent studies flourished on the concept of 'innovation system' assess universities as a cornerstone of the system, with the responsibility to promote, beyond their traditional role in higher education and basic research fields, the spreading of technology mainly in the entrepreneurial context that surrounds them. Nonetheless, despite the general convergence of empirical results, there are still dissenting voices in the literature on whether academic resources really matter for industry (Rosenberg and Nelson, 1994; Quintas *et al.*, 1992)[1], that point to a fundamental mismatch between the activities, objectives and needs of academic versus private research units: academics mainly want to publish papers, whereas private R&D people want to develop new products.

This uncertainty come from both a somewhat mixed evidence and a failure of best-practice econometric approaches to identify the mechanisms whereby spillovers are actually transmitted (McPherson, 1998). In the regional economic literature recurring themes are: 1. the advantages on firms' innovation in locating close to major universities (Jaffe, 1989; Krugman, 1991; Jaffe et al., 1993; Feldman, 1994, 1999; Henderson et al., 1996, 1998; Anselin et al., 1996); 2. the growing ability of small and medium enterprises (SMEs) to exploit external resources from universities (Freeman, 1991; Feldman, 1994; McPherson, 1998). On the contrary, transmission mechanisms that facilitate spillovers or the importance of 'intermediate' institutions to favour the diffusion of "technology spillovers" have rarely been assessed in a systematic way. Thus, the first section of this article briefly defines the theoretical framework and discusses the role of universities in innovation processes and in entrepreneurial promotion, especially with respect to spillovers and spin-offs.

The second section analyses, through a survey-based research on Israeli Technological Incubator Programme (TIP), academic-business-industry interactions emerging from agencies of entrepreneurial promotion activities. Even conscious of each case-study specificity, it tries to specify the ability of such organisations in order to increase fluxes from universities to local productive systems. Israeli last twenty years' growth in high-technology industry, with several governmental programmes and an exceptional number of start-up enterprises, represents an unique case and its success has roots in a favourable environment, characterised by an higher-education system, a research tradition inherited from agriculture, and the expansion of large scale, state-owned defence industries (Felsenstein, 1996). By questionnaires, interviews and statistical data, the paper intend to verify if technological incubators act as catalysts for academic spin-offs, developing a much more intimate cooperative framework between industry and university, if their development can remove those obstacles which usually hinder the diffusion of "technology spillovers" and stimulate the opening of the local productive system to research centres and technologically-advanced businesses, and if these organisations need a institutional background in order to sustain 'knowledge and innovation networks' at local and inter-regional level. An increasing understanding of the nature of these relations can provide an important empirical support for both theoretical progresses and regional economic policy-making.

2. The theoretical framework

Trends as globalisation, liberalisation, dematerialisation, and technological revolution created uncertainty and turbulence in the world economic system, changing greatly both the industrial perception and the institutions involved in innovation processes and entrepreneurship promotion. Rather, innovation and entrepreneurship have become key concepts of a new paradigm characterized by both flexible manufacturing and effects of so-called information technologies (IT) (Freeman & Perez, 1988; Piore & Sabel, 1984).

Moreover, a revitalization of interest in economic growth models, concurrently with the ineffectiveness to explain innovation of both the traditional Schumpeterian model and the linear product cycle model[2], has led new models to gain ground (Romer, 1986; Lucas, 1988). These models emphasized the endogenous character of technological processes in opposition to their exogenous origin in neoclassical model (Solow, 1956). They pointed out innovation as an evolutionary, non-linear and interactive process between the firm and its environment (Kline and Rosenberg, 1986; Dosi, 1988; Kaufmann and Tödtling, 2000), focusing on the importance of interactions and co-operations between firms and other external actors, like other firms, universities, research centres, business organisations, and public administrations. In this context, concepts as "innovation system" (Lundvall, 1992) and "learning region", besides to consider economic development directly linked to innovation, reflect out knowledge as the most critical resource for innovation growth and the most important processes those that transform knowledge into learning (Lundvall and Johnson, 1994).

By linking the generation of knowledge with the diffusion, transfer, and use of R&D results, 'innovation system' represents a significant change in the way of imagining the Science & Technology (S&T) organisation. Initially applied to the national level and defined as "…the set of organisations, institutions, and linkages for the generation, diffusion, and application of scientific and technological knowledge operating in a specific country"[3], innovation systems have seen their boundaries to become even more uncertain, up to become open systems, flowing partly upwards to supranational institutions and partly downwards to regional and local institutions (Cooke et al., 1998). The number of places and actors actively involved in the generation of knowledge has rapidly multiplied, inducing changes in existing institutions and the progressive appearance of new kinds of institutions and mechanisms as informal groups, networks and associations, consultancy firms, and venture-capital innovative businesses. Moreover, with respect a specific functional rigidity of traditional organisations, nowadays each institution tends to play increasingly various roles and functions at different levels, operating recurrently as agents of development.

An outcome of this evolution has been the concept of 'learning region', whereby the competitiveness of a region can be directly influenced by local actors' ability to generate, access, understand and transform knowledge and information by means of an interactive learning (Maillat & Kebir 1999). This interactive nature involves groups of individuals both outside and inside the personal businesses (social networks) and calls for the development of links, networks and co-operative actions among different actors even outside the existing institutions.

Recent studies (Lundvall and Johnson, 1994) distinguish knowledge in codified and tacit. While codified knowledge is generally more formalised, tacit is more socially embedded and raises problems in terms of transfer and measurement. In fact, beside codified knowledge, such as patents, R&D investments, qualifications, and papers, there is a large part of knowledge which is not being captured or understood. This part of knowledge is largely unrecognised by traditional development policy and analysis, however it often gives the competitive edge to regions and individual firms through creating innovative practices which are difficult to transfer in absence of face-to-face contacts (Nonaka and Takeuchi, 1995). In order to capture and codify tacit knowledge, and thus enable transfer, many studies (Nonaka and Takeuchi, 1995; Foray and Lundvall, 1996) point out on knowledge infrastructure supporting the transformation of knowledge into learning. Therefore, universities, research centres and other institutions of learning are tangible knowledge infrastructure that can be closely linked to the performance and productivity of a region's economy (Smith, 1997).

In conclusion, university-industry links and knowledge spillovers (Castells & Hall, 1994; Tödtling, 1994), together with regional policies providing support to innovation through specific institutions and agencies (Sternberg, 1995; Pace, 2000), are essential conditions to root the innovation process in regions (Aydalot & Keeble, 1988; Tödtling, 1994; Storper, 1995).

3. Universities and academic knowledge spillovers

In accordance with new approaches to competitiveness focusing on resources[4], the recognition of knowledge as the main source of competitive advantage has put in foreground intangible firm's assets based on both capabilities (or competencies) (Prahalad and Hamel, 1990) and knowledge creation dynamics (Nonaka, 1994; Nonaka and Takeuchi, 1995). On this basis - knowledge and learning as catalysts for economic development - the presence of universities, and to a lesser extend of research institutes, in a given local context has an impact that goes beyond economic indicators of employment and spending. Many universities have developed a central role within "networks of knowledge" in order to offer flexible and innovative regional responses to rapidly changing economies, and to retain an important role for the regional development policy. Therefore, in addition to their traditional role in the fields of education and research, "…universities should have a third mission, i.e. that of promoting the spreading of technology, above all in the entrepreneurial context that surrounds them", as stated by European Commission in the communication to the Council of Europe and to the European Parliament "Innovation in a knowledge-based economy" (2000).

University's goal of facilitating economic development passes through the so-called "knowledge spillovers"[5]. However universities disseminate traditionally knowledge by means of their graduates and interpersonal contacts within the community, in recent times many research-oriented institutions started a more intimate cooperation with industry, developing new mechanisms of knowledge dissemination known collectively as "technology transfer" and promoting the "commercialisation of knowledge" (Bentur, 1998). The key triggers of these changes can be of four types: 1. the academic increasingly blurred borderline between science and technology in frontier areas of research; 2. the need for interdisciplinary approach in complex problem-solving; 3. the huge size of required resources in many scientific projects; 4. the increasing competition among universities for funding and students.

Notwithstanding constraints as a traditionally narrow view of their role in the local economy, and a limited measurability of their economic impact, universities have increasingly developed technology transfer mechanisms[6].

Among them, we can identify four main ones: 1. patenting, expressly for licensing to an industrial partner; 2. patenting and ultimate commercialisation with an industrial partner of the concept/invention by the researcher either solely, or with the assistance of a third institution as innovation foundations or centres of excellence; 3. patenting followed by the formation of a spin-off company to develop specifically the idea in commercial terms; 4. non-disclosure, but commercialisation based on know-how, possibly leading to a spin-off company opportunity. The first two mechanisms deal principally with the sale of licenses for the use of patents (the sale of knowledge) in industrial production, such as knowledge spillovers, whereas the seconds deal with the establishment of subsidiary companies, the partnership with strategic and financial investors[7], and the promotion of entrepreneurship.

Sometimes universities engaged with economic development create intermediary organisations such as technology transfer and regional development office, other times they directly start up new business centres, or generate spin-offs and establish links with neighbouring firm and entrepreneurs. In order to develop and spread cutting-edge technologies into the production system, the technological transfer offices should have, as their objectives, three main missions: 1. The coordination of networks/associations and projects on the diffusion of the best practices within the process of technological transfer; 2. The promotion of research projects in collaboration with the system of businesses; 3. The promotion of the establishment of business incubators that favour both the setting up and the growth of innovative businesses.

The relevance of academic spillovers, as also argued by Turok (1993), exceeds their direct contribution to the local economy. However still a "hidden value" for the traditional market, these intangible resources has become a priority for the knowledge economy and "intellectual capital" has acquired significant economic value. The commercialisation of intellectual capital has become a predominant issue, and regarded as playing a significant role in new business starts, growth of existing businesses, and new job creation (Matkin, 1990; Parker and Zilberman, 1993; Proctor, 1993).

The increased involvement of academic faculties in industrial research and consultancy has brought many universities as primary initiators of business initiatives, identifying ideas with economic potential, and continuing to promote them on its own initiative, while relying to both business-economic and technological-scientific aspects. This new mission requires a system of evaluation and expertise beyond the academic experience. Consequently, many universities have established professional facilities whose function is to actively develop commercial applications of the university's know-how. Usually, this body is an unit for technological transfer or a "commercialisation company", that is an university subsidiary authorised to commercialise its know-how. These offices, grown to avoid an excessive exposure of the university and its members to the commercial process, give an emphasis on business aspects and the protection of intellectual property rights.

As a recognition of the importance of commercialisation of the intellectual properties at universities, several states enacted laws on intellectual rights and patents, however they let universities free to decide on division of rights between faculty and members. Moreover, there is still no universally accepted guidelines for problems such as conflicting interests in profit distribution, in the structure of start-up company ownership, and the rights to work as consultants. On the one hand, there is support, based on the appreciation of the important role that university laboratories can have for the national and regional industrial competitive advantage. On the other hand, there is hesitation, due to the fear that applied research, commercialisation of knowledge and intellectual property protection are objectives not always compatible with universities primary aims of teaching and advancing human knowledge.

This new process, evolved mainly over the last decade, is largely the result of market forces as venture capital funds, investment banks, holding companies, etc…, which operate in the high-tech field and recognised the universities' potential. Several facilities began to appear next to universities as scientific/industrial parks and technological incubators employing faculty members. In addition, a growing number of high tech start-up companies have been established at the initiative of faculty members. This has created a complementary movement of industry formed around university know-how, attracting also as potential industrial clients who previously rejected any development not discovered in their own factories. However current literature has focused mainly on academic-industry relationship, there is a growing interest in academic spillovers' capacity to encourage individuals in achieving their potential, to develop a culture of flexibility and learning, and to create employers.

Finally, universities are not always able to run an efficient technology transfer programme, for both a lack of market-experience and the absence of an adequate relational context, losing their central role in regional development. In these cases, public and private organisation are called to the task of creating the conditions for the existence of technology transfer mechanisms and academic spin-offs.

4. Academic spin-offs and entrepreneurship promotion

As previously delineate, academic spillovers can set up new forms of entrepreneurship associated with innovation process. In the last years, the debate on the university role as a source of new companies has intensified through several studies on academic spin-offs, however the complexity of spin-off process has been weakly investigated. Empirical studies still suggest a vague idea about mechanisms, processes, institutions and means that can facilitate the so-called academic spin-offs. Despite the fervour of some, there isn't evidence that universities must directly promote start-up ventures and have the necessary business know-how to enter on the marketplace.

Accepting the two-dimensional definition proposed by Smilor et al. (1990), spin-off is a new company formed (1) by individuals who were former employees of a parent organisation, and (2) around a core technology originated at the parent organisation and then transferred to the new company, that become independent with his own feasibility in terms of legal, technical and commercial structure. In the multi-dimensional definition of *spin-out*, proposed by Carayannis et al. (1988), is also considered the opportunity that technology may be transferred to the new company while the inventor/founder remains with the parent organisation.

Taking into account Carayannis et al. (1988) analysis, four main roles can be individuated in the spin-off company process: 1. the technology originator(s), who brings the technological innovation through the innovation development process to the point at which the transfer of this technology to the commercial sector can begin; 2. the entrepreneur(s), who attempts to create a new business venture that is centred on the technological innovation; 3. the parent organisation, in which R&D activities to create the technological innovation take place, and which may provide such functions as assistance in patenting the innovation, technology licensing, etc; 4. the venture investor(s), who provides the financial resources to establish the spin-off and may also provide for business management expertise.

In the academic spin-off[8], both the roles of originator, entrepreneur and parent organisation can be performed inside the university. Most studies on entrepreneurship and spin-off companies have defined the model of the academic entrepreneur as an individual who is the technology originator but also assumes the role of the entrepreneur. In order to encourage and guide the formation of internal spin-offs, many universities have provided to establish a framework to assist researchers to better be aware of opportunities arising from research results originating within universities. In such a way, they can use the institution facilities in order to produce goods and/or services, and if they become profitable in a appropriate time, they leave the institution as ordinary companies. These companies emerging from university clearly improve interactions and contacts between the latter and the market, helping to transform a purely academic culture into a more entrepreneurial environment focused on market and society.

But who are the academic entrepreneur? Samson and Gurdon (1990) define him an as "…an academic whose primary occupation, prior to playing a role in a venture start-up, and possibly concurrent with that process, was that of a lecturer or researcher affiliated with a higher education institute". So, differently by others, they do not consider professors and students, the firsts because their institutional role of academic leaders and the seconds because their incomplete involvement in the academic R&D. On the contrary, experience has shown an indiscriminate participation of all academic members, attributing more importance to their ability with regard to the process of application and commercialisation and focusing on other complex issues, as conflict of interest, financial support and potential exploitation of university resources and personnel including the students.

Radosevich (1995) describes, but does not test, two models of entrepreneurship associated with the formation of new spin-off companies from academic institutions: the inventor-entrepreneur or academic-entrepreneur model and the surrogate entrepreneur model. The first one is the typical academic spin-off with the originator entrepreneur "spinning off" a company from the technology source. Differently, in the surrogate entrepreneur model the technology source elects to provide the rights to the technology to an external, independent entrepreneur who will initiate a local company (Radosevich, 1995). Not only did this model develops a new kind of relationship – scientist and entrepreneur - but it also recognises the academic lack of business knowledge and experience, and a possible difficult to induce academic inventors to leave their present organisation to set up a new venture.

Nonetheless, initial technical capacity must be assured in order that surrogate entrepreneurship could increase the probability of commercial success. Empirical evidence suggests that ventures created by “outside entrepreneurs” with “faculty assistance” become somewhat larger on average than those created otherwise (Chrisman et al., 1995).

Recognising the importance of the entrepreneurial function, and thus the need to combine experienced entrepreneurs with technology development talents of university staff, spin-off institutions aim at improving the access to both the knowledge influencing business decisions and finance. Sometimes, in addition to license patents and to form alliances amongst companies, investors, strategic partners and commercially viable R&D project groups, the units for technologic transfer assist and nurtures new start-up companies by providing them with professional services and consulting.

Not always academic organisations are able or interested to develop this kind of organisational context. In that case, specific external public/private organisations, like the agencies for the promotion of entrepreneurship[9], can replace universities in stimulating spin-offs. These organisations, differently by academic technology transfer subsidiaries, are exclusively focused on promoting entrepreneurship and they must be evaluated on the basis of their capability to provide business support; to reduce costs of accessing information and advice; to develop financial initiatives, improving the access of small firms to finance; to facilitate local network development and the propagation of innovation in the local economy, with the provision of technology centres or business parks (Pace, 2001). Therefore, they take advantage to improve their linkages with universities and public authorities, or better to create inter-organisation networks (Rimmer, 1986), in order to foster academic spin-offs and/or to commercialise University or Polytechnic research (Lowe, 1984).

Amongst these agencies, incubators are facilities which support fledgling organisations by providing shared administrative services and technical and management assistance (Bauman, 1981; Allen, 1985; Gatewood, Ogden and Hoy, 1987; Lumpkin and Ireland, 1988). Many universities set up their own academic incubators, usually as part of their technology transfer subsidiaries, and inside their scientific parks. Other owners can be public bodies, research institute, non profit organisations and private for-profit corporations.

Amongst several types of incubator (Pace, 2001), universities established or developed linkages mainly with technological incubators, that are directed to the promotion of R&D, and to assist communities in the progress of targeted technological sectors and activities. In order to provide a supporting environment to an inventor during the crucial period between the conception of a new idea and its possible commercialisation, most of them are located alongside educational institutions. They can obtain not only equipment, facilities, and technical assistance for the small inventors, but also innovative ideas and skilled human resources through a continuous process of knowledge transfer.

Many studies' findings suggest that incubators are successful high risk economic development experiments which create new jobs and enterprises, reducing the business failure rate of firms, and sparking innovation and entrepreneurial development in communities. It is generally recognised that incubators are community specific and a relevant role in their development is played by local organisations, however in many cases the government bodies act as initiators, catalysts and controllers.

But, turning to the main paper issue, it is still to demonstrate if the university-based incubators act differently from the others, motivating tighter linkages with academic R&D, and if they stimulate more academic-entrepreneurs.

5. The Israeli case-study: The Technological Incubator Programme (TIP)

5.1. Historical background

Israel represent a very exemplary case of connection among university, industry and public bodies. Since the establishment of the State, Israeli government has largely subsidized education and research sectors, considered as cornerstones of national industrial development (see international comparison in Table 1). Being a small country with limited resources, Israel could not establish separate institutes for industrial R&D. Therefore, existing academic infrastructures were utilised for the benefit of applied-industrial research. Government ministries and national agencies approached firstly the

Technion (Israel Institute of Technology) departments where service units and research centres were established in order to provide professional assistance to the construction industry (Building Materials Testing Laboratory and Soil and Road Testing Laboratory), to civilian industry (Metal Institute and Chemical Testing Laboratory), and to the defence establishment (Aeronautical Research Center, Agricultural Machinery Research Center, Microelectronic Research Center, and Electro-Optics R&D Division)[10]. This example was followed in other academic institutions and all these units played an important role in national civilian projects, especially in the agriculture sector, but above all they made a significant contribution to the technology advancement of the defence sector.

Table 1. *National expenditure on civilian research and development (R&D)in USD at current prices,1999.*

Country	Civilian R&D final expenditure per capita (USA = 100)	Expenditure per capita	Percent of GDP
Israel	**86,8**	**673**	**3,6**
Members of OECD			
Sweden	94,5	732	3,5
Finland	90,4	701	3,1
Japan	93,2	723	3,0
Switzerland	87,2	676	2,7
Korea	44,4	344	2,4
United States	100,0	775	2,3
Germany	70,2	544	2,3
Denmark	67,2	521	2,0
Netherlands	59,5	462	2,0
France	54,7	424	2,0
Iceland	64,0	496	1,9
Belgium	53,0	411	1,8
United Kingdom	44,7	346	1,6
Norway	59,8	464	1,6
Canada	53,0	411	1,6
Australia	43,8	339	1,4
Ireland	38,2	296	1,4
Czech Republic	20,4	158	1,2
New-Zealand	25,0	194	1,1
Italy	29,2	226	1,0
Spain	20,7	160	0,9
Portugal	11,9	92	0,6
Greece	8,7	68	0,5

Source: *Central Bureau of Statistics, Israel, 2001*

This cooperation affected academic members that were involved in national R&D facilities as professional consultant and researchers. Afterwards, all the basic knowledge developed for defence industry has been converted to promoted primarily high-technology industries[11] (Gradus, Razin, and Krakover, 1993) and to forge both a culture of productive innovation and suitable human resources, making the country competitive in export market (Pace, 2000). These factors, combined with an advanced high-tech R&D, have given to Israeli high-tech industries a place in the international division of labour, however by the end of the 1970s military contracts still accounted for 90% of the Israeli electronic sector output, and close to 45% of the industrial R&D was defence related (Felsenstein, 1991). During the 1970s, high-tech products increased from 40% of all industrial exports to 66% (Teubal, Halevi, and Tsddon, 1986), thanks also to grants to civilian R&D projects with export potential developed by Israeli government since 1976 (Gradus, Razin, and Krakover, 1993). Moreover, these incentives attracted multinational electronic firms headquartered in the United States and, in particular, their R&D and skill-intensive production units, strengthening the scientific and technological primacy of Israeli educational and research systems.

Table 2. *Israeli national expenditure on civilian R&D by financing sector in percentage.*

Financing sector	*1993*	*1994*	*1996*	*1998*
Business	36,0	36,0	41,9	60,5
Government	40,0	40,0	41,9	30,4
Higher education	10,0	10,0	6,4	3,7
Private non-profit inst.	7,0	7,0	3,5	1,4
Rest of the world	7,0	7,0	6,3	4,0

Source: Central Bureau of Statistics, Israel, 2001

From the end of '70s to the middle of '80s, Israel experienced a period of economic crisis, because of a heavy inflation. The resultant efforts to stabilise the economy implied, in addition to a monetary devaluation, a substantial reduction of government expenditures for R&D and a downturn in the local high-tech sector (Gradus, Razin, and Krakover, 1993; Pace, 2000). Out of this crisis emerged a more streamlined set of industries, less dependent on government incentives and national contracts in the defence sector (Felsenstein, 1996). Therefore, government-funded academic research declined in favour of a business-funded R&D, however researchers and scientists of public and private organisations maintained contact with academic institutions and work together to advance applied research in all Israeli universities. In fact, during the 1990s, Israeli national expenditure on civilian R&D indicates a remarkable growth in the business sector financing, passed from 36% in 1993 to 60,5% in 1998, and a reduction of governmental financing, passed from 40% to 30% (Table 2). But, above all, there has been an evident growth of business operating R&D (from 53% in 1990 to 71% in 2000) compared to an academic (from 29% to 17%) and governmental (from 10% to 7%) percentage reduction (Table 3). This process, partially consequence of the international trend, finds its justification in the high-tech sectors success that, by the early 1990s, had the highest level of productivity, wages, exports and rates of return in the Israeli economy.

Table 3. *Israeli national expenditure on civilian R&D by operating sector in percentage, 1990-2000.*

Operating sector	*Private non-profit*	*Higher*	*Government*	*Business*
1990	7,46	29,24	10,56	52,74
1991	6,94	27,84	10,45	54,77
1992	6,59	27,37	10,68	55,36
1993	7,02	26,74	10,00	56,25
1994	6,36	25,84	8,97	58,83
1995	6,83	25,67	8,41	59,09
1996	5,33	23,20	10,02	61,45
1997	5,06	22,36	9,01	63,57
1998	4,70	21,73	8,12	65,45
*1999**	4,66	20,42	7,69	67,23
*2000**	4,22	17,83	7,00	70,96

Source: *Central Bureau of Statistics, Israel, 2001*

A stronger presence of R&D in industrial sector, aiming to solve specific scientific and technological problems at the various stages of product development and in the manufacturing process, both produced human resources fluxes from scientific and technical universities to the business sector (see tables 4-5) and induced most of Israeli universities to deal with the commercialisation of knowledge and to researches significantly influenced by the industrial client who provides the funding.

Before this spontaneous university-industry cooperation, Israeli government decided to improve this interaction by establishing technological-industrial complexes near universities, the Science Parks (Felsenstein, 1996). Four parks were built in the 1970s: two in the Tel Aviv Metropolitan area associated respectively with Tel Aviv University and the Weizmann Institute of Science, one in Haifa associated with the Technion and one in Jerusalem associated with the Hebrew University. However promoted as seedbeds of innovation through technology transfer, joint research, and spin-off firms, their results were unsatisfying and survey-based research did not emphasized particular advantages for science park firms in terms of innovation and linkages with universities (Felsenstein, 1996).

Table 4. *Expenditure, investments, financing, revenue and employed persons in the business sector, 1998 (NIS million, at current prices)*

	Manufacturing	*Research and development(1)*	*Computer and Related services*	*Total Business Sector*
Current expenditure on R&D	4.265,8	1.387,8	2.948,2	8.601,9
- Labour cost and other expenses(2)	3.263,5	1.098,2	2.702,4	7.064,2
- Raw materials	437,7	162,8	108,3	708,8
- Contract and commission work	559,8	126,8	137,5	824,1
Capital formation in buildings and equipment for R&D	339,3	150,0	434,9	924,3
R&D financed by government and international sources	712,6	229,0	191,5	1.133,1
TOTAL REVENUE	**166.754,0**	**5.061,0**	**11.590,0**	**183.405,0**
Revenue in R&D companies	62.705,8	3.205,6	8.489,3	74.400,6
Thereof: exports	36.733,1	1.220,4	6.267,8	44.221,3
Employed persons (thousands)	**344,8**	**13,0**	**30,7**	**388,5**
Thereof: employed persons in R&D companies	83,2	10,2	21,6	115,0
Employed persons in R&D (thousands)	13,2	5,6	12,5	31,2
Thereof:				
Academicians	9,0	4,0	9,8	22,8
Technicians	3,4	0,8	1,6	5,7
Other	0,8	0,7	1,1	2,6

Source: *Central Bureau of Statistics, Israel, 2001*

The Government achieved better results with the entrepreneurship promotion policies, for long time ignored by Israeli policy-makers. After early attempts of promoting entrepreneurship - as industrial villages initiative, the Ganei Taassiya incubator facility, and loan funds for small business initiated in two development towns by the Jewish Agency's Project Renewal (Gradus, Razin, and Krakover, 1993) – the formation of instruments for promoting entrepreneurship by the government, local authorities, and other public organisations reached the 'take-off' stage with the new wave of immigrants from the former Soviet Union. This large immigration (316.700 in 1990-1991, for a total of 748.829 until 1999) produced both new needs and new resources. The immigrants had not only increased the potential of the Israeli work-force, arriving to 17% of the total (397.800 – CBS, 2000), but they increased the high educated and skilled work-force above all (26,6% of immigrants with a university degree, and 63% academic, professionals, technical and related workers). Policy-makers did not consider the production capacity of the economy sufficient to absorb the newcomers, and they developed alternative means of employment generation (Pace, 2001). Because self employment was seen an attractive option for many immigrants, the State fostered the promotion of entrepreneurial initiative. Together central government and extra-governmental public organisations, institute of higher learning became directly involved to promote entrepreneurship in the new immigrants and made joint efforts to establish technological incubators.

Table 5. *Expenditure, investments, financing, revenue and employed persons in R&D in manufacturing, by division, 1998 (NIS million, at current prices)*

Aggregated division	*Employed persons dealing with R&D - total (Thousands)*	*R&D finance by government*	*Current expenditure on R&D*				*Total*
			Capital formation in buildings and equipment for R&D	*Contract and commission work*	*Materials and energy*	*Labour cost & other expenses (incl. overhead)*	
All establishments							
TOTAL	**13,2**	**712,6**	**339,3**	**559,8**	**437,7**	**3.263,5**	**4.265,8**
Refined petroleum, chemical & chemical products	1,4	48,0	32,6	173,9	27,6	323,6	525,1
Machinery and equipment, transport equipment	1,1	29,7	6,2	19,7	45,1	204,4	269,2
Electronic components	1,0	63,7	83,1	33,3	62,1	259,7	355,0
Electronic communication equipment	4,5	339,2	130,0	147,8	139,5	1.369,6	1.659,1
Industr. equipment for control and supervision, medical & scientific equipment	3,9	191,2	39,9	153,7	127,7	930,2	1.212,1
Companies receiving R&D financed by government sources							
TOTAL	**10,6**	**712,6**	**232,4**	**476,5**	**353,5**	**2.805,7**	**3.637,7**
Refined petroleum, chemical & chemical products	1,0	50,2	28,1	164,8	20,8	245,2	430,7
Machinery and equipment, transport equipment	0,9	29,7	5,1	14,1	35,2	170,9	220,2
Electronic components	0,7	63,7	19,2	19,5	27,7	171,6	218,9
Electronic communication equipment	4,0	339,2	125,8	135,4	132,8	1.279,0	1.547,1
Industr. equipment for control and supervision, medical & scientific equipment	3,2	191,2	32,8	116,7	113,4	828,4	1.058,5

Source: *Central Bureau of Statistics, Israel, 2001*

Enjoying a very high level of financing support from the government, 'Technological incubators program" (TIP) has been considered an outstanding success in this field, however this success cannot be explained without taking into account the Israeli favourable climate for the high technology, as the presence in Israel of about 2,000 high-tech companies and more than 3,000 high-tech start-ups, an established existence of venture capitalists and so-called "business angels" with a growth of total foreign investment from $537 million (1992) to $5 billion (1998).

5.2. *Israeli universities' technology transfer bodies*

In such a favourable context, most of Israeli universities had already developed facilities for the technology transfer process between the academia and society as a whole. In order to better understand technological incubators results in stimulating academic spin-offs, a survey of academic facilities has been carried out.

Huge part of Israeli university-based research draws sustenance from external sources of financing (nearly the 80%) (Table 6). Foundations, government, industry, grant agencies and funding organizations in Israel and abroad assist the universities and confer them status and prestige.

Table 6. *Expenditure on separately budgeted research in Universities by sources of financing.*

Source of financing	1997/98	1995/96	1993/94	1992/93
Internal sources – total	*20,4*	*22,3*	*20,5*	*21,6*
External sources – total	*79,6*	*77,7*	*79,5*	*78,4*
Israel – total	*54,2*	*53,3*	*50,8*	*46,6*
Public	35,2	39,0	32,0	29,5
Business	7,5	5,3	7,9	8,0
Private - non-profit institutions	2,1	2,3	4,8	2,2
Universities	0,9	1,2	0,8	1,2
Long-term national funds	6,6	4,9	4,0	4,6
Unknown	1,9	0,7	1,2	1,1
Abroad	15,2	13,6	17,8	20,3
Bi-national funds	10,2	10,8	10,9	11,3

Source: *Central Bureau of Statistics, Israel, 2001*

For a long time historical universities, as the Technion and the Hebrew University of Jerusalem, concentrate most of national funds and grants on academic R&D. Nowadays, research expenditures appear more homogenous (Table 7), however not enough in comparison with the students distribution by field of study and institution (Table 8).

Table 7. *Expenditure on separately budgeted research in Universities by institutions, 1981-1998*

Institutions	*1997/98*	*1995/96*	*1993/94*	*1992/93*	*1990/91*	*1988/89*	*1984/85*	*1981/82*
The Hebrew University	30,2	31,6	31,5	32,3	32,4	31,8	35,4	36,8
Technion R & D Foundation	12,3	14,4	13,9	14,7	15,3	14,9	19,4	20,2
Weizmann Institute of Science	20,5	20,2	21,5	22,8	22,1	31,4	23,5	18,3
Tel Aviv University	16,3	13,5	15,4	12,8	15,4	7,8	10,5	14,1
Ben Gurion University of the Negev	10,6	10,4	12,2	12,4	10,2	9,5	6,6	6,8
Bar-Ilan University	6,7	6,9	4,8	4,2	4,0	4,3	3,9	3,1
Haifa University	3,6	2,9	0,7	0,9	0,6	0,3	0,7	0,7

Source: *Central Bureau of Statistics, Israel, 2001*

Almost all Israeli universities solicit and administer funds through a Research Authority that usually is an integral part of the university and serves as contact point between departments/research units and external funding sources. These structures supervise the operate of each university's research groups, and help to maintains contacts with funding agencies and research foundations that have shown an interest in supporting academic research.

Table 8. *Students in universities, by field of study and institution, 1970-2000.*

	1998/00	1998/99	1989/90	1979/80	1969/70(1)
Field of study					
Humanities	27,9	30,3	29,0	31,7	32,9
Social sciences	24,1	24,2	27,8	24,6	32,3
Business and administration sciences	2,6	2,4	2,6	3,9	
Law	3,6	3,3	3,3	5,0	4,8
Medicine and paramedical courses	8,3	8,2	7,2	4,4	2,9
Mathematics, statistics and computer sciences	9,4	9,1	6,5	8,3	
Physical sciences	3,5	3,5	4,8	3,6	12,4
Biological sciences	5,7	4,4	4,4	3,7	
Agriculture	1,2	1,3	1,8	2,9	1,5
Engineering	13,7	13,3	12,6	12,3	13,3
Institution					
Hebrew University	18,3	18,2	25,2	21,8	33,4
Technion	10,3	10,1	11,5	11,0	12,6
Tel Aviv University	18,2	18,3	24,5	29,6	22,5
Bar Ilan University	21,1	21,4	15,4	13,6	12,5
Haifa University	12,7	12,8	13,9	12,6	12,0
Ben Gurion University	19,3	19,2	9,5	11,3	6,9

Source*: Central Bureau of Statistics, Israel, 2001*

As a consequence of their historical involvement in national research programmes, most of all Israeli universities early developed technology transfer subsidiaries. The Technion was the first, with the Research & Development Foundation Ltd. (TRDF) established in 1952. To overcome goals as the promotion of intra-mural research, technology transfer, industrial testing and services, and the commercialisation of inventions and ideas, the TRDF is organised in two divisions, the Research and Development Division and the Business Development and Financial Control Division. The first one promotes and administers the research performed at the Technion, sponsored or contracted by various industries, governmental agencies and science and technology foundations, local as well as international. The second division has been established in 1998, with the aim of promoting the commercialisation of the Technion's state-of-the-art know-how within Israel and world wide. Similarly, in the 1959 the Weizmann Institute of Science founded its commercial arm, the Yeda Research and Development Company Ltd., and in the 1964 the Hebrew University of Jerusalem established the Yissum Research Development Company, a subsidiary organization responsible for the commercial exploitation of the University's intellectual property, also playing an active role in strengthening the University's relationship with the business community.

The other Universities, as Tel Aviv University (TAU), Ben-Gurion University of the Negev (BGU), and Bar-Ilan University, established only later a subsidiary company for the technology transfer. The TAU established the Ramot University Authority for Applied Research & Industrial Development Ltd. in the 1973 as a private company commercially oriented in order to support research with the potential for significant industrial development and market success. The B-G Negev Inc., responsible for the BGU to assist the relationships between faculty members and commercial companies or industries, and to coordinate budget and terms for know-how transfer (service contract, sale of know-how, commercialisation of know-how, etc.), has a function mainly of control and regulation.

This trend appear common to all scientific and technical-based universities, whereas humanistic and social-oriented universities, like the Haifa University, have only a Research Authority mostly involved to initiate and sustain relationships and affiliations with partner institutions in Israel and abroad, and to maintain contact with funding agencies and research foundations interested in supporting academic research (Table 9).

Table 9. *Academic infrastructures for technology transfer and spin-offs*

Institutions	*Research Authority*	*Subsidiary for technology-transfer*	*University-industry consortia*	*Spin-off programme*	*Start-up companies*	*Incubator*
The Hebrew University		X	X		X	X
Technion	X	X	X		X	X
Weizmann Institute of Science		X	X		X	X
Tel Aviv University	X	X	X		X	X
Ben Gurion University of the Negev	X	X	X		X	X
Bar-Ilan University		X	X		X	
Haifa University	X					

Source: *IREM, 2002*

Table 9 put in evidence the recognition of these technology transfer companies as essential for encouraging fruitful collaboration between industrial companies and academic research institutes, establishing spin-off companies, joint ventures and "incubator" firms, and nurturing these ventures in their early stages through ongoing managerial assistance. All of them have promoted university-industry consortia and created start-ups, and four of them established own technological incubators. Until the incubators appearance, their large variety of objectives and the limited size of their organisation did not allow to promote directly academic spin-offs. Moreover, too many constraints as Patent Committees and Liaison Offices discouraged scientists and researchers, lacking of business experience, to try the entrepreneurial option.

5.3. *The Technological incubator programme (TIP)*

Initiated in the 1991 under the guidance of the Office of the Chief Scientist (OCS), the TIP was set by a Steering Committee of Technological Incubators, appointed by the general director of Ministry of Industry and Trade and composed of representatives from Ministry, high-tech industries, universities and the incubators themselves. The official objectives were: 1. to support the initiation of high-tech industry by sustaining fledgling entrepreneurs at the earliest stages of technological entrepreneurship; 2. to encourage new export oriented industry; 3. to create new employment opportunities for technologically skilled persons. Modelling the incubators on American and English experiences, the OCS meant to provide a supportive and protective environment to individual inventors and entrepreneurs, for the development of innovative technological ideas into business ventures, but the complexity and the relative size of Israeli technological incubators have exceeded other experiences (Pace, 2001). They have exposed a continue aptitude to enhance their organisations and linkages, to attract projects and to direct resources, apart from the initial goal to integrate the immigrants from the former Soviet Union. The committed government investment increased from 1,8 mil. to 30 mil. USD between 1991-2000, with a total investment of 223,1 mil. USD (Table 6).

Today, 23 technological incubators are operative of the initial 28, with four incubators directly owned by Israeli universities, and further five linked to educational colleges or research centres. However the government transfers support funds to the incubator, for both the incubator's management and the projects, the initial capital costs of establishing the incubator were provided the owners – for example two-thirds of the initial capital costs (around 1 mil. USD) of the Technion incubator were provided by a US business consortium and by the Technion itself (Roper, 1999).

Table 6 – '*Technological Incubators Program' OCS budget*

Year	*US Dollars*
1991	1.800.000
1992	10.200.000
1993	18.800.000
1994	23.200.000
1995	25.800.000
1996	25.500.000
1997	27.800.000
1998	30.000.000
1999	30.000.000
2000	30.000.000
Total	***223.100.000***

Source: Office of the Chief Scientist, 2000

Recent survey-based research has identified three different 'incubator-types', on the basis of their central, intermediary and peripheral location (Pace, 2001). Universities are strongly linked to the so-called 'central region incubator-type', a private for-profit organisation, sited in a Science Park, with a mixed partnership of public organisation, universities, large firms and private investors. Its aims are mainly product development, business creation, university research commercialisation and venture capitals' expansion. In fact, central region's incubators are mainly linked to an university (60%) (Table 10), within their facilities (20%) or outside, in a Science park or in a Technology park (40%). Similarly, in peripheral regions a large part of the incubators is linked to universities or research centres (56%) - with an higher percentage (33%) sited inside - and to industrial zones (33%). This phenomenon can be explained, noting that in the peripheral areas many initiatives have found place in 'frontier' colleges (Lithwick, Gradus & Lithwick, 1996) – i.e. Ben Gurion College at Sde-Boker and College of Judea and Samaria at Ariel; Leshem Institute of Rafael in the Misgav; Tel Hai Community College at Kiryat Shmona – that is institutions promoted and/or established by government and/or philanthropic organisations for the development of border regions.

Evidence suggests that State grants encouraged an increase of the academic involvement to the TIP, producing a development of relationships between university and high-tech industry. These academic spin-offs constitute 'interaction-intensive' elements of innovative systems, concurring to create a favourable milieu for high-tech production. Besides promoting academic 'technology transfer', the State assistance acts mainly as a business accelerator. For this reason, behaviours and strategies inside technological incubators are substantially different from those inspiring technology transfer subsidiaries.

Table 10. *Technological incubators – university and industrial links by region, 2000.*

	Central regions	*Intermediary Regions*	*Peripheral Regions*	*Total*
Physical university links	2	0	4	6
Non-physical university links	4	0	1	5
Industrial zone	3	1	2	6
Regional development bodies	0	3	1	4
None	1	1	1	3
Total	10	5	9	24

Source: *IREM, 2001*

Finally, the TIP offers to the academic members operating as fledgling entrepreneurs within incubators, academic or not, to discontinue their regular activity, obliging them to choice their future only at the end of their start-up period.

5.4. *Analysis of linkages between universities and technological incubators*

Keeping this context in mind, we have distilled two separated (also in time) questionnaires and organised a data-set on Israeli technological incubators. The first questionnaire, more general, was directed to incubators' management in order to investigate their organisation, property, sponsors, regulations, partnership, and results (Pace, 2001). The second has been dispensed to entrepreneurs inside or passed through incubators. Through them, formalized relations between Israeli universities and incubators operating inside the TIP has been analysed, in order to identify also their interdependence in stimulating innovative dynamics, and possible 'informal' interdependences, i.e. university degree, post-lauream training courses, professional training courses, up-to-date courses. Moreover, on a sample of university incubators and university facilities for technological transfer, the survey investigates differences between private incubators and academic-based one, and the diffusion of surrogate entrepreneurs.

Looking at formal relationships between incubator and university, the most formal is represented by the university ownership – total or partial – of the incubator. Both the Technion, the Tel Aviv University, the Hebrew University and the Weizmann Institute have founded their own incubator, together with business consortia, bank, and development agencies. These incubators are nominally non-profit organisation under the control of technology transfer subsidiary of each university. A particular case is constituted by the HITEC incubator which is operated by the Hebrew University and other 22 partners, such as industrial companies, financial institutions, public and philanthropic organisations. Other incubators are linked to research centres, and sometimes they operate directly inside their research facilities. Such a co-ownership between university and business or public bodies seems to reduce academic linkages in favour of scientist, experts and professional from industry.

Table 11. *Qualification of entrepreneurs by incubator and locality*

Incubator	*Locality*	*Qualification*					*Total*
		Professor	*PhD*	*Professional*	*Expert*	*Other*	
1. ADVANCED TECHNOLOGIES CENTER ASSOCIATION – Arava	Periphery	0	5	10	7	5	27
3. ITEK – Ness Ziona	Centre	0	25	5	5	3	38
4. TEIC – Haifa	Centre	9	27	2	1	31	70
6. THE INITIATIVE CENTER OF THE NEGEV – ICN – Beersheva	Periphery	3	19	11	8	12	53
8. MISGAV KARMIEL TECHNOLOGY INCUBATOR – Karmiel	Intermediary	1	10	5	3	6	25
15. ASHKELON TECHNOLOGICAL INDUSTRIES – Ashkelon	Centre	12	11	4	2	4	33
20. BIOMEDICAL INCUBATOR RAD-RAMOT LTD – Ramat Gan	Centre	5	12	8	4	3	32
23. HITEC HAR HOTZVIM T.E.C. – Jerusalem	Centre	6	12	10	12	16	56
28. TARGET TECHNOLOGY CENTER – Netanya	Centre	4	3	8	5	5	25
TOTAL		40	124	63	47	85	359

Source: *IREM, 2002*

A new kind of linkage could be represented by the Ashkelon Technological Industries where in 1998 a new team took over the management and administration of the incubator. In order to reduce the local knowledge weakness, they specialised the field of activity on biotechnology in agreement with the OCS and subscribed key partnerships with the major Israeli universities and research institutes, creating a form of academic sponsorship.

Analysing incubators management, almost all of professionals come from business and industry, and only one from academic, demonstrating once more the importance that TIP has given to the business experience. On the contrary, boards of directors, that set policy, approve the admission of selected entrepreneurs and assist in locating strategic partners, show a relevant academics participation (they are present in the 70% of incubators).

Table 12. *Academic linkages of entrepreneurs by incubator*

Incubator	*Hebrew*	*Tel Aviv*	*Technion*	*Beer Sheva*	*Bar Ilan*	*Weizmann*	*Unknown*
1. ADVANCED TECHNOLOGIES CENTER ASSOCIATION – Arava	0	0	0	0	0	0	5
3. ITEK – Ness Ziona	0	0		0	0	2	23
4. TEIC – Haifa	0	0	9	0	0	0	27
6. THE INITIATIVE CENTER OF THE NEGEV – ICN – Beersheva	0	3	1	5	0	0	13
8. MISGAV KARMIEL TECHNOLOGY INCUBATOR – Karmiel	0	1	2	0	0	0	8
15. ASHKELON TECHNOLOGICAL INDUSTRIES – Ashkelon	11	0	1	2	0	0	9
20. BIOMEDICAL INCUBATOR RAD-RAMOT LTD – Ramat Gan	2	10	0	2	0	1	2
23. HITEC HAR HOTZVIM T.E.C. – Jerusalem	5	0	0	0	2	4	7
28. TARGET TECHNOLOGY CENTER – Netanya	0	3	1	0	1	0	2
TOTAL	18	17	14	9	3	7	96

Source: *IREM, 2002*

Obviously, the most relevant mechanism of knowledge spillover is represented by entrepreneurs. Our analysis, on about 25% of enterprises, in the aggregate has shown that about 46% are academics, with a relevant percentage of entrepreneurs with PhD (35%), and a limited number of professors (11%), and this result seems to confirm Samson and Gurdon definition of academic entrepreneur. No palpable differences can be recognized between academic-based and private incubators, with exception of Ashkelon with about 36% of professors. From the analysis of academic entrepreneurs' origin (Table 12) emerges that university-owned incubators effectively have influence on their members' choices, with the highest percentage of local academic entrepreneurs, however highly effective appear the formal/informal linkage between Ashkelon and the Hebrew University with almost 50% academic-entrepreneurs coming from there.

However the fragmentarily of questionnaires answers, as proved by the high number of unknown sources – partially explainable with the high involvement of Russian professors, scientists and doctors, and some Dutch and French academics - these initial results seem to strengthen the idea of incubator as catalysts of academic spin-offs.

Attempting to explore informal relationships, the survey has investigate the existence of surrogate entrepreneurship in the Israeli incubators. The results (Table 13) has been very interesting. University-related incubators, as TEIC, ICN and HITEC, have shown the highest level of surrogate entrepreneurship, corroborating both a business-oriented strategy and a weak entrepreneurial vocation in academic staff; on the contrary, research-related incubators, as ITEK and MISGAV, offer high levels of academic entrepreneurship due their mostly applied research field. The Ashkelon and Rad-Ramot incubators show a weak presence of surrogate entrepreneurship, due mainly to their extremely specialised target (respectively bio-tech and bio-med), but in the first also to the need to raise their knowledge status and prestige, and in the second case to the co-ownership of RAD Data Communications, who provide complementary expertise in applied research, business development and general management.

Table 13. *Academic and surrogate entrepreneurs by incubator*

Incubator	*Academic*	*Surrogate*
1. ADVANCED TECHNOLOGIES CENTER ASSOCIATION – Arava	13	5
3. ITEK – Ness Ziona	27	2
4. TEIC – Haifa	27	16
6. THE INITIATIVE CENTER OF THE NEGEV – ICN – Beersheva	10	11
8. MISGAV KARMIEL TECHNOLOGY INCUBATOR – Karmiel	14	3
15. ASHKELON TECHNOLOGICAL INDUSTRIES – Ashkelon	20	3
20. BIOMEDICAL INCUBATOR RAD-RAMOT LTD – Ramat Gan	8	2
23. HITEC HAR HOTZVIM T.E.C. – Jerusalem	11	16
28. TARGET TECHNOLOGY CENTER – Netanya	13	4
TOTAL	143	62

Source: *IREM, 2002*

Comparing this table with the Table 11, we can observe that the relevant number of non-academic entrepreneurs in university incubators found its explanation in an university attitude and strategy for an high performance in spin-off company generation. The lack of commercial experience of professors, scientists and inventors, together a weak entrepreneurial interest in academics, suggested them to develop relationships with expert entrepreneurs. Moreover, academic scientists consider their entrepreneurial activity as temporary and sometimes as a part-time activity, as consultants. On the contrary, in the other incubator, less linked to universities, the inventors come mainly from industrial and professional sectors, with a certain market experience.

6. Conclusions

However results are not conclusive and the Israeli case study appears to be special, the analysis has confirmed the incubator role of academic spin-offs catalyst. As promoter of technology transfers from universities to industry, the TIP has been clearly successful, even though changes in Israeli economy and society in the 1990s make unmatched any kind of comparison. Besides traditional formal relationships between universities and public bodies, incubators stimulate formal and tacit linkages among universities, industry, business organisation, and other private actors. The growing complexity of the knowledge spillover mechanisms is reported by the emergence of the surrogate entrepreneur model that has taken root mainly in the university-related incubators, as an answer to those conflicting interests between applied research and universities primary aims of teaching and advancing human knowledge.

At the same time, analysis demonstrate the importance of the Israeli government to promote and sustain the programme, technically and financially, and if necessary changing rules.

Finally, the multi-ownership of the incubators suggests that they can be considered as means based on a "transactive" approach that stimulate: 1. cooperation amongst different actors and facilitate their mutual relations; 2. the opening of the local district to the external world, thus favouring its relations with research centres and technologically-advanced businesses outside the area and abroad. They can be explained as "enabling structures" of networking mechanisms at both national and local level.

Main References

AYDALOT P., KEEBLE D. (eds.) (1988), *High Technology Industry and Innovative Environments: The European Experience*, London, Routledge.

BENTUR A., LOWENSTEIN A. (1998), *Technology transfer and commercialization of knowledge in universities*, in High-Technion Magazine, June.

BOUNFOUR A. (2000), "Intangible resources and competitiveness: toward a dynamic view of corporate performance", in BUIGUES P., JACQUEMIN A., MARCHIPONT J-F. (eds.), *Competitiveness and the Value of Intangible Assets*, Cheltenham, UK, Edward Elgar.

CASTELLS M., HALL P. (1994), *Technopoles of the World: The Making of Twenty-first Century Industrial Complexes*, London, Routledge.

COOKE P. (1997), "Regional innovation system – an evolutionary approach", in BRACZYK H., COOKE P., HEIDENREICH R. (eds.), *Regional Innovation Systems*, London, UCL Press.

COOKE P., BOEKHOLT P., TÖDTLING F. (1998), *Regional Innovation Systems: Designing for the Future*, Cardiff, CASS.

DAVENPORT T.H., PRUSAK L. (2000), *Working knowledge*, Harvard Business School.

FREEMAN C. (1987), *Technology policy and economic performance. Lessons from Japan*, London, Pinter.

FREEMAN C., AND PEREZ (1988), "Structural crisis of adjustment: business cycles and investment behaviour", in DOSI G., FREEMAN C., NELSON R., SILVERBERG G., AND SOETE L. (eds), *Technical change and economic theory*, London, Pinter.

FREEMAN C., SOETE L. (1997), *The economics of industrial innovation*, London, Pinter.

GILL J.H. (2000), *The tacit mode*, New York, State University of New York Press.

JAFFE A. (1989), *Real effects of academic research*, in American Economic Review, n. 79.

KAUFMANN A., TÖDTLING F. (2000), *Systems of Innovation in Traditional Industrial Regions: The Case of Styria in a Comparative Perspective*, in Regional Studies, vol. 34, n. 1.

LUCAS R.E. JR. (1988), *On the Mechanics of Economic Development*, in Journal of Monetary Economics, vol. 22, n. 1.

LUNDVALL B. A. (ed) (1992), *National systems of innovation*, London, Pinter.

MONCK C. S.P., PORTER R.B., QUINTAS P., STOREY D.J. AND WYNARCZYK P. (1988) *Science Parks and the growth of high-technology firms*, London, Croom Helm.

NELSON R.R. (ed) (1993), *National innovation systems. A comparative analysis*, New York, Oxford University Press.

PACE G. (2000), *Policies for Industrial Districts Location in Italy and Israel: a Comparative Perspective*, Naples, IREM.

PACE G. (2001), *The role of development agencies for the entrepreneurial promotion: Israeli case studies*, Naples, IREM.

PIORE M., SABEL C. (1984), *The second industrial divide*, New York, Basic Book.

PORTER M (1990) *The competitive advantage of Nations*, London, MacMillan.

ROMER P.M. (1986), *Increasing Returns and Long-Run Growth*, in Journal of Political Economy, vol. 94, n. 5.

ROSENBERG N. (1982), *Inside the Black Box: Technology and Economics*, Cambridge, Cambridge University Press.
ROSENBERG N. (1994), *Exploring the Black Box*, Cambridge, Cambridge University Press.
SCHUMPETER J.A. (1934), *The Theory of Economic Development*, Cambridge, MA, Harvard University Press.
SMILOR R.W. (1987), "Incubators: A method for growing new businesses", in KOZMETSKY G., SMILOR R.W. AND CHAMBERLAIN E. (eds), *Economic Development Alliances*, Austin, University of Texas Press.
SOLOW R.M. (1956), *A Contribution to the Theory of Economic Growth*, in Quarterly Journal of Economics, vol. 70.
STORPER M. (1995), *The resurgence of regional economics, ten years later: the region as nexus of untraded interdependence*, in European Urban and Regional Studies, vol. 2.
TÖDTLING F. (1994), "The uneven landscape of innovation poles: local embeddeness and global networks, in AMIN A., THRIFT N. (eds.), *Globalisation, Institutions, and Regional Development in Europe*, New York, Oxford University Press.

NOTES

[1] For example, drawing evidence from the UK, Quintas *et al.* (1992) show that academic-industry linkages are remarkably weak, even in the government-funded 'science parks', whereas in the USA Markusen *et al.* (1986) note that the relationship between innovation and academic research seems clear only with regard to the locationally concentrated defence spending of the US Federal government.
[2] Innovation is neither an exclusive internal activity of firms in order to achieve monopolistic advantages, as in the Schumpeter's thought, nor it follows a mechanistic sequence from research to production and to the market, as the linear model and product cycle theory argue. Cf. KAUFMANN A., TÖDTLING F. (2000), *Systems of Innovation in Traditional Industrial Regions: The Case of Styria in a Comparative Perspective*, in Regional Studies, vol. 34, n. 1.
[3] GALLI R., TEUBAL M., *Paradigmatic Shifts in National Innovation Systems*.
[4] In opposition to Porter's approach - based on the analysis of the dynamic of competitive forces within market structures – these new approaches consider that differences of performance are to be attributed to the type of combination of resources, mainly intangibles, developed by firms, rather than to industrial structures. Cf. BOUNFOUR A. (2000), "Intangible resources and competitiveness: toward a dynamic view of corporate performance", in BUIGUES P., JACQUEMIN A., MARCHIPONT J-F. (eds.), *Competitiveness and the Value of Intangible Assets*, Cheltenham, UK, Edward Elgar.
[5] These knowledge spillovers can be defined as formal or informal fluxes of new science-based concepts, ideas, technical procedures or information from the academic sector to private industry. Cf. JAFFE A. (1989), *Real effects of academic research*, in American Economic Review, n. 79.
[6] Technology transfer mechanisms are a category of wider Knowledge transfer mechanisms which include also: information transmission via the local personal networks of university and industrial professionals (local labour market of graduates, faculty consulting, university seminars, conferences, student internships, local professional associations, continuing education of employees), and spillovers promoted by university physical facilities (libraries, science laboratories, computer facilities).
[7] A strategic investor provides financial resources for the project, like the financial one, but his involvement has additional advantages based on his experience in business development, production and marketing. Cf. BENTUR A., LOWENSTEIN A. (1998), *Technology transfer and commercialization of knowledge in universities*, in High-Technion Magazine, June.
[8] It is a particular spin-off, representing one of the ways to exploit the applied research results by creating groups of members of universities, as professors, researchers and students.
[9] These agencies aim to reduce enterprise risks during the start-up phase, to channel new economic resources and to characterise new productions in regional contexts with a low level of entrepreneurial attitude (Pace, 2001).
[10] Cf. Bentur, 1998.
[11] Since the late 1960s, fast-growing high-tech industries have been perceived as Israel's greatest hope for economic advancement. Cf. Pace, 2000.