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VENTURE CAPITAL START-UP CO-EVOLUTION AND THE EMERGENCE & DEVELOPMENT OF ISRAEL'S NEW HIGH TECH CLUSTER

Part 1: Macro-Background and Industry Analysis*

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This paper provides an account of the emergence and development of a Venture Capital Industry in Israel, and the role it played in the recent successful growth of Israel's high tech cluster.

The paper focuses on Israel's Venture Capital Industry, its emergence and operation during the 90s, in which period the number of VC Funds increased from 2 to over 100. The context is the transformation of Israel's high tech industry from the Defense-dominated Electronics industry of the 70s/80s to the 'Silicon Valley' model of the 90s characterized by large numbers of SU companies. During this period the share of high tech in manufacturing industry; and ICT's share in the Business Sector increased considerably attaining one of the highest levels worldwide. Given the importance of Venture Capital an analysis of the waves of new SU companies should be done jointly with an analysis of the emergence and development of Venture Capital (and vice-versa).

The approach adopted is Evolutionary & Systemic rather than a focus on 'the operation' of a mature Venture Capital industry, which has been more frequent in the VC literature. We focus on the Dynamics of Venture Capital particularly of the *emergence* and of *subsequent development* of the industry. We link these with core Evolutionary concepts such as *variation*, *selection and reproduction* (Nelson 1995).

The paper discusses the co-evolutionary and dynamic process involving the business sector, technology policies, venture-capitalists, individuals & Startup companies, and foreign linkages. We attempt to show that VC emergence is part & parcel of the *reconfiguration* of a pre-existing Electronics Industry one involving large amounts of SU and new and powerful links with global *capital* markets. The main conclusions and policy lessons of the paper are that specific technology policies targeted to the Venture Capital sector can be effective only to the extent that favorable background conditions exist or are created.

The main groups of factors, events or sub-processes influencing the emergence process which started in 1993, and subsequent development, are: (1) *favorable background conditions*; (2) *features of the immediate pre-emergence period* (1989–92); (3) *Targeted Policies which directly triggered VC Emergence* (1993–98); (4) *Strong VC-SU co-evolution*; (5) *Global Capital Market Links*.

Keywords: Venture capital; Start-up; High-tech cluster; Emergence; Evolutionary

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LIST OF ACRONYMS

SU	Start-Up, Start-Up Company
VC	Venture Capital, Venture Capital Company
SI	System of Innovation
LP	Limited Partnership
IPO	Initial Public Offering
M&A	Mergers & Acquisitions
IT	Information Technology
ICT	Information and Communications Technology
ITP	Innovation & Technology Policy
HTP	Horizontal Technology Policy
R&D	Research and Development
BIRD	Bi-national Industrial R&D Fund
CBS	Central Bureau of Statistics
IVA	Israel Venture Capital Association
OCS	Office of the Chief Scientist, Ministry of Industry and Trade, Israel
DIC	Discount Investment Corporation
ROR	Rate of Return

SECTION A: OBJECTIVES AND BACKGROUND TO THE ISRAELI HI-TECH INDUSTRY & TO POLICIES DIRECTED TO VENTURE CAPITAL

A1 OBJECTIVES OF THE RESEARCH

The essay focuses on Israel's Venture Capital Industry, its emergence and operation during the 90s, in which period the number of VC Funds increased from 2 to over 100. The context is the transformation of Israel's high tech industry from the Defense-dominated Electronics industry of the 70s/80s to the 'Silicon Valley' model of the 90s characterized by large numbers of SU companies. During this period the share of high tech in manufacturing industry; and ICT's share in the Business Sector increased considerably attaining one of the highest levels worldwide. Given the importance of Venture Capital[1] an analysis of the waves of new SU companies should be done jointly with an analysis of the emergence & development of Venture Capital (and vice-versa). The present paper cannot and does not undertake a full co-evolutionary analysis; it does, however, makes a serious attempt to understand the dynamics of emergence of the new industry and the specificities of the wider high tech context under which Israeli VC companies operate.

The approach adopted is Evolutionary & Systemic rather than a focus on 'the operation' of a mature Venture Capital industry, which has been more frequent in the literature (Gompers and Lerner, 1999).[2] Evolutionary since we focus on the Dynamics of Venture Capital particularly an analysis of *emergence* and of *subsequent development* of the industry; and because we will link these with core Evolutionary concepts such as *variation, selection* and *reproduction* (Nelson, 1995). In fact, a lot of effort is taken to set the context, which led to the central

[1]This has been confirmed by the Venture Capital literature (see below).

[2]One notable exception is R. Florida's work which, without being explicitly Evolutionary, has dealt with aspects of the dynamics of VC industries in the US. One of his main points is that the VC industry emerged by the workings of the market without explicit Government supports (Florida and Kenney, 1988; Florida and Smith, 1993). We will see that this stands in contrast with the Israeli Experience

'emergence' events of the 90s which, in this paper, could be defined as "*a new industry & market (VC) and a new web of external connections between domestic SU & Invention on the one hand and global capital markets on the other*".[3] This includes an understanding of the prior phase in the development of high tech (The R&D penetration phase); and its links with Innovation & Technology Policy. A major factor here was the operation of a background R&D support program since 1969/70, which not only contributed to the 'old' Electronics Industry but also indirectly, strongly stimulated VC emergence. This program was strongly complementary to the specific policies implemented during 1991–95, which were more directly related to Venture Capital and to high tech growth. Finally the approach is also Systemic since our analysis of VC takes place in the context of a new multi-component "System of Innovation" & "Cluster" perspective of High Tech development. Thus VC development has influenced other System of Innovation components as well as having been influenced by them; and these effects are important when analyzing the dynamics of Emergence.

A1.1 Specific Objectives

1. Analyze the emergence and development of Israel's Venture Capital Industry during the 90s, following an Evolutionary and Systems perspective; and within the wider context of emergence of the new High Tech Cluster of the 90s.
2. Analyze the role of policy in the above and arrive at policy implications.

A1.2 The Structure of the Paper

This paper consists of two main Sections A and B. Section A provides the background to the VC industry which evolved from Civilian R&D and High Tech as they developed during the 70s and 80s. Section B outlines a conceptual 'model' for the emergence and development of Venture Capital during the 90s, including aspects of SU-VC & High Tech-ITP co-evolution.

This paper (Part 1) mostly deals with the Industry (Meso) level of analysis; it will set the stage for the micro-analysis of Part 2 which will appear in a separate paper.

A2 THEORETICAL BACKGROUND

Our research links with two strands of literature-that on Venture Capital and the literature on the Systems of Innovation Perspective. There seems to be no prior analyses on Venture Capital, which follows a Systems perspective; while most of the specific literature on Venture Capital is non-evolutionary & non-systemic in its approach.

A2.1 Specific Venture Capital Literature

We have divided it into several themes, which are relevant to our understanding of how VCs contributed to high tech growth in Israel during the 90s.

[3]The notion of 'emergence' is intimately linked to the complexity literature where it can be illustrated by the often mentioned example "simple atoms, must somehow, in large numbers, give rise to complex *collective* behaviour" (Bar-Yam, 1997, p. 10). Our emergent property is "global" rather than 'local' like the emergence of associative memory in the Hopfield neural network (Bar Yam op cit), where VCs would correspond to the synapses of such a network. The emergent phenomenon is thus a property of the whole system and not of any individual part. See also Kauffman (1995), p.24 and Hodgson (1999) pp. 139–54.

A2.1.1 The Role of SU in Technological Innovation and the Inadequacy of Traditional Sources (e.g. Banks) of Finance

Schumpeter (1950) argued that corporations can do better then small firms in innovation because they are able to provide internal financing a view that has been reinforced indirectly by the analysis of Arrow (1962). Due to 'structural features' facing large companies the facts seem however to show the opposite. Thus even large corporations frequently (and increasingly) outsource R&D projects (Huang and Xu, 1998) or shift them to spin-off companies one possible reason being the difficulty of extending 'high powered incentives' to inventors within such corporations (Chesbrough, 1999).[4] SU do not face these constraints; moreover, VC-backed high quality start-ups have a good chance of providing such incentives through their links to capital markets.[5]

Gompers and Lerner[6] mention four reasons why the financing of high tech SU by Banks is difficult. These are *Uncertainty, High Sensitivity to Capital & Product Market Conditions*, the fact that *Most SU Assets are Intangible*, and – last but not least- *Asymmetric Information*. For a number of reasons Banks are not in general suited to overcome or minimize the above problems e.g. due to *Regulation* (in the US and in some other countries there are limitations to the ability of banks to hold shares); and *Specialization* (they specialize in loans with tangible collateral; they have no skills such as those of VCs to evaluate projects when such a collateral is not available). Moreover, *Risk Compensation would entail Banks Charging SU with very high Interest Rates;* and there are *Limitations on the Possibility of providing High Powered Incentives* to decision makers within the organization. VCs by taking an equity position in SU, which gives then a return in the upside, can overcome the first problem; and the Limited Partnership form of VC organization can overcome the second one. The unique style of VC operation and the types of contracts VCs use enable them to deal with 'opportunism' and 'asymmetric information' problems.

A2.1.2 Nature, Role and Operation of VC and VC Companies

Venture Capital has been characterized as a 'private' business enterprise support mechanism (Cooke, 2001).Venture capitalists invest in new unproven, entrepreneurial enterprises ignored by traditional financial institutions; and due to the problems mentioned above, for many SU companies, VC are the only potential source of finance. Gompers and Lerner, 1999 and other researchers pointed out to some of the mechanisms that VC companies use to reduce or to manage such problems. These include equity finance, convertible, or preferred securities; and staged and syndicated investing. The role of VC's can be seen as taking an enterprise to a stage (*e.g.* an IPO or post-IPO stage) where other forms of financial intermediation and corporate ownership and control are appropriate. VC structure and operation thus creates a way to overcome financial and organizational barriers that held back both innovation in large corporations and R&D project investment by traditional financial institutions.[7]

[4]Chesbrough's work in fact belongs to the Systems tradition rather than to the specific VC literature.

[5]Thus the expectation that a startup company may undertake an IPO in the future enables it to offer share options to leading R&D engineers, even those working in large corporations. Chesbrough has documented this fact from an analysis of the Disk Drive industry.

[6]Many other researchers have also dealt with such issues.

[7]In what follows we assume a LP form of VC organization. LP form enjoys taxation advantages and its operation is governed by a rather simple set of rules (the entity of an LP is a 'management company' rather than the shareholders/investors); the possibility of making decisions without the cumbersome controls and boards of public companies; and (apparently), the possibility of rapidly exploiting reputations made through successful exits to raise capital for a follow-up fund.

The operation of VC companies takes the form of a *VC cycle* since the VC management companies don't raise funds continuously but periodically (every 2–5 years). Each fund is a Limited Partnership and runs for 7–10 years. A complete VC cycle involves the following steps: raising funds, screening and due diligence, investment, monitoring and value added, and exit (generally either an IPO or a M&A). Moreover, before a cycle is completed, a new one begins. Thus frequently VC (management) companies are simultaneously involved in more than one fund.

The final function is *Exiting*. Typically VCs seek to take public (IPO) the most successful firms in their portfolio, and this generates the bulk of their returns. Also frequently a small number of these are the source of most of their returns. The second most important method is selling the company to a corporation (M&A). Also, some companies 'remain operational at low levels of activity'. In Israel VCs *learned* how to bring companies up to an IPO; frequently, preparing a company for a M&A is simpler.

A2.2.3 VC Mechanisms to Overcome Market Failure Associated with (equity) Issues of Startup Companies

Akerlof (1970) analysis of the market for 'lemons' suggests that asymmetric information can cause market failure in equity issues of young and risky firms. Subsequent research suggested mechanisms to overcome this failure through costly signaling by means of IPO under-pricing (Allen and Faulhaber, 1989; Grinblatt and Huang, 1989; Welch, 1989). VCs can also help startup companies to overcome the costly signaling through third party certification. More specifically, the presence of VCs, as investors in a firm going public, reduces the under-pricing of an issue, reduces the underwriter spread charged by the investment banker handling the issue and increase the IPO valuation (Megginson and Weiss, 1991).

A2.3.4 VC Added Value: Management Assistance, Networking, and Impact

Some argue that Venture Capital plays a critical rule in the innovation process, not only as a source of finance to innovation but through *other functions* that lie at the core of high tech Development (Saxenian, 1998; Florida; and Smith; 1993 and others). Venture Capital bridge between sources of finance, entrepreneurs, scientists, suppliers, and customers. According to Florida and Smith (1993) the US venture capital industry played a critical rule in the innovation process in the US and is one of the reasons why US hi-tech has become the world leader during the late 80s and early 90s.

The valued added of VC companies may be an additional explanation for the lower under-pricing and other issuing costs experienced by VC-backed startups. Startup entrepreneurs (who frequently are devoid of management experience) may require management assistance & training to help them manage fast growing companies. According to Gompers (1995) and compared to startups not linked to VCs, VC backed startups on average go public younger; have less under-pricing, cheaper underwriter costs and higher valuation at the IPO; and perform better after the IPO. The superior performances of such companies are due to VCs' good scanning, monitoring activities, reputational added value, networking added value and management added value.[8]

[8]There are at least two caveats to the interpretation that higher measured VC-backed SU performance reflects value added of VC companies. The first, is confusion between actual value added given to portfolio companies and the fact that on average better companies are being selected by VCs. The second, point is that the higher SU performance or the distinct characteristics of those SU selected by VC companies are related to 'fitness' between the VC mechanism and specific types of SU. For example, VC will prefer Non-niche Company even if niche companies would have high returns.

A2.2 Systems of Innovation Perspective

This perspective emphasizes the importance of a multi-actor, interactive framework to analyze innovation at regional, national and even global levels- rather than considering individual innovations as resulting exclusively from the efforts and inputs of one firm.[9] It should be mentioned that a 'Systems Perspective' includes an Evolutionary view of Economic Processes (Saviotti, 1997; Hodgson, 2002). In a recent paper one of us has summarized this Perspective by identifying the set of System Components found in the literature and by distinguishing a set of 'Positive' from a set of 'Normative' General Principles (Teubal, 2002). These can be directly applicable to 'high tech clusters' which are Regional High Tech Sector Systems of Innovation (Saxenian, 1998). Having said this we are aware that existing knowledge provides only an overarching conceptual framework for approaching the subject rather than a clearly specified methodology. This means that there are numerous possible variants in the application of a Systems Perspective one of which has been chosen here. Rather than focusing explicitly and systematically on the social background of actors and on the social rules that govern their interaction (one possible variant), this paper focuses extensively and systematically on the: (a) background conditions and processes which '*facilitated emergence*' of the Venture Capital Industry; (b) dynamic processes & interactions between SU and VC; and (c) dynamics of policy making & of the policy process.[10] Thus applying this perspective to the contribution of Venture Capital to high tech growth (a major focus of the specific VC literature) the analysis would emphasize aspects such as: the stage of development of the VC industry; cumulative processes ('*Reproduction*' in the literature on Evolution); and other features of the broader system or high tech cluster. Needless to say an explicit and systematic analysis of micro-macro links cannot be undertaken here since this report focuses almost exclusively at the industry/macro level of analysis.

The analysis focuses on the transition from a high tech sector without Venture Capital to a high tech cluster with Venture capital; and how this is linked to the process of Globalization of the world economy, particularly of financial/capital markets. More specifically we focus on *VC-SU co-evolution*[11] and on its links with the successful emergence of a Silicon Valley-type high tech cluster.[12] While a full, formal analysis of co-evolution is not possible in this paper, we do provide some elementary analysis of the cumulative process of growth of both types of organizations after 1993.

A3 R&D, HIGH TECH AND INNOVATION & TECHNOLOGY POLICY (ITP) IN ISRAEL[13]

In analyzing the background to the emergence of Venture Capital in the 90s we should: (a) understand the evolution of high tech; (b) analyze the dynamics of policy, particularly

[9]See Nelson 1993; Lundvall, 1992; Edquist, 1997 and others; and its explicit extension to cover Innovation & Technology Policy—in Teubal, 2002

[10]Thus, although we briefly mention the roles of Culture, Universities and other specific institutions like the Army-these factors will not be systematically analyzed.

[11]This is one more instance of research on user-producer links and user producer co-evolution, which is quite common in the Evolutionary/Systems perspective. See Teubal, 1979, Lundvall, 1985, Pike *et al.*, 1990, and some authors contributing to the SI volumes mentioned above.

[12]For example, Cooke's analysis of Biotechnology in Europe and the US (Cooke op.cit) explores links among three mechanisms: exploitation of basic science, venture capital, and cluster formation.

[13]Lack of space does not enable us to systematically cover important topics such as company 'learning about R&D/Innovation'-a major phenomenon in the early years of Israeli high tech. For a more extensive version of this Section or parts of it see Teubal, 1993 1999 2002; Avnimelech and Teubal, 2002; and Trachtenberg, 2000.

Innovation & Technology Policy (ITP). Israeli High tech has undergone at least two distinct periods since its emergence after the Six Days War in 1967. The first corresponds to the 'process of introduction and diffusion of R&D throughout a prevailing R&D-less Business Sector overwhelmingly dominated by traditional and mid-tech industries; the second involves the transformation of high-tech into a 'Silicon Valley' model with Venture Capital. Similarly we may distinguish two main periods in Israel's Innovation & Technology Policy (ITP). The first phase beginning in 1969/70 with the establishment of the Office of the Chief Scientist (OCS) at the Ministry of Industry and Trade and running till about 1990. The second phase during the decade of the 90s till 2000/2001 when new sets of incentives' programs were implemented.

A3.1 The R&D Penetration Period (1970–89)

A3.1.1 High Tech Industry and R&D

The Six-day war and the subsequent French embargo generated new priorities for Israel with implications for R&D and Hi-Tech industries. Self-sufficiency (or partial self-sufficiency) in the supply of sophisticated armament systems became one of the objectives of policy, with implications for the growth of Military Industries (some of them of a 'high tech' nature) and Military R&D. Simultaneously, a Government Committee created to review policy recommended the stimulation of applied R&D and creation of a specific institution for implementing this objective in the various Ministries: Ministerial Offices of the Chief Scientist. Israel's R&D policy directed to the Business Sector resulted from the activity (and budget) of the most important of these bureaus-the Office of the Chief Scientist of the Ministry of Industry and Trade (OCS). This office became the almost exclusive agency in charge of Innovation/technology policy especially that connected to R&D; and it was a significant factor in the development of a Civilian R&D performance sector and to a Civilian High Tech industry.[14]

During the first 'R&D Penetration' period, which runs till about 1990, the basic R&D/Innovation Capabilities' of Israel's Business Sector were generated. A Civilian oriented R&D intensive, high tech sector developed in parallel to, albeit with a lag, the development of the Military Industries and Defense-oriented high tech. The share of this new High Tech Sector in total product & exports of Manufacturing increased from 6% to 24%; and from 5% to 28% respectively between 1968 and 1983.[15] During the 1968–87 period the pool of Skills employed in Manufacturing grew from 3400 in 1968 to almost 20,000, and average industrial skill-intensity from 1.3% to 5.8%. Civilian R&D performed in industry increased considerably in real terms–from 26 M (constant 1984–85) dollars in 1969–70 to 347 million, a twelve-fold increase. Despite this enormous growth, Military R&D overshadowed Civilian R&D performed in the Business Sector. Military R&D during the early 80s amounted to more than half of total R&D which, beyond Military R&D, includes both Civilian R&D performed in the Business

[14]Creation of the Office of the Chief Scientist at the Ministry of Industry and Trade was probably the most momentous policy decision of the Government of Israel, as far as Innovation & Technology Policy is concerned. It became a specialized agency involved in promoting innovation by and for the Business Sector as a whole, with a focus from day 1 on *direct support of the business sector*. This became the central feature of the Israeli strategy for promoting Innovation in the Business Sector.

[15]See Teubal, 1993 (p.480). This is based on a three way classification of Industry: High Tech, Other Sophisticated (equivalent to Mid-Tech, and including a Metal working subgroup and a Chemicals sub-group) and Conventional (Low Tech). The classification used then was based on skill intensity as measured by share of scientists & engineers in total employment. Under this measure the average skill intensity of high tech in 1984 was 16% compared to 6% and 2% for the other two categories respectively. The three industries comprising high tech were 'Electro-optics & Fine Machinery', Aircraft & Ships and 'Electronics & Communications Equipment'. The first two areas were the most important ones during the 80s. During the 90s the most important group shifted to Software & Communications Equipment (note that there was no separately identifiable software industry during the 80s).

Sector and Civilian R&D performed at Universities & Government Laboratories. Its share in total national R&D was about 40% in the seventies and rose to 65% in 1981.

The scope of R&D in the Army enabled exploitation of economies of scale and the generation of research teams with strong networking among individual researchers. These effects could not have developed elsewhere, due to limited resources (Galil, 2001).[16] In addition, military R&D cooperation with the US, Germany and France presumable set the stage for the transfer of technologies from those countries to Israel (Avnimelech and Margalit, 1999). Moreover, the Army became an efficient incubator of young researchers in many technological fields. Starting in 1985 a deep process of restructuring of the military industries took place. Lay-offs and Spin-offs from the Army/Army-R&D seemed to have played an important contributory role to the emergence of the Second '*Silicon Valley*' (*or Silicon Wadi*) *Period* of Israel's high tech development. Numerous entrepreneurs and engineers of this Second Period had worked previously in the Military Industries or performed Military R&D. Moreover, the reduction in Military Expenditures also led to enhanced flows of engineers, technicians and scientists to civilian rather than military R&D activities.[17]

A3.1.2 The 'Backbone' "Industrial R&D Fund'

The beginning of the Israeli Government's Innovation/Technology Policy towards the Business Sector coincided with the creation of the "R&D Industrial Fund"in 1969 at the recently created OCS. This program was, and to some extend continues to be, the backbone of the country's R&D/Innovation/Technology Strategy as far as the Business Sector is concerned.[18] It supports the R&D of individual companies whose objective is the creation of new or improved products (or processes) directed to the export market. This type of R&D[19] could be termed 'regular' or 'classical' R&D to differentiate it from generic, cooperative R&D which is a more infrastructural type of R&D. The latter's objective is to generate knowledge, capabilities and components rather than directly marketable outputs. Its output would facilitate (or become inputs to) a subsequent 'regular' R&D activity directed to new products or processes.

The 1984 R&D Law further consolidated Israel's support of business sector R&D. The objective was to support knowledge intensive industries, through expansion of the science and technology infrastructure and exploitation of existing human resources; creation of employment including absorption of immigrant scientists and engineers; etc. The outcome was significant increases in R&D Grants to Industry.[20]

[16]See Breznitz (2002) for an interesting analysis of the role of the Army in the development of Israel's Software Industry.

[17]During the 70s and the 80s the first foreign multinationals were also established in Israel starting with Motorola in 1964 and followed by IBM, Intel, Digital Equipment. These companies also became incubators of engineers and managers, the impact of which will be seen later on during the 90s.

[18]Till the early 90s more than 90% of Government disbursements to Civilian R&D came out of this program.

[19]It is well known that Horizontal Programs embody an element of 'selectivity' by virtue of the particular activity being chosen *e.g.* regular R&D, generic-cooperative R&S, or technology transfer/adsorption. Thus Israel's "Industrial R&D Fund", while formally 'neutral' in the allocation of its incentives, and given its dominance over other programs for long periods of time, embodies strong selectivity of 'regular R&D' relative to other possible technological activities. See Lall and Teubal, 1998.

[20]The "Industrial R&D Fund" is an example of a *Horizontal Technology Policy Program* that is a program directed to the Business Sector as a whole and open in principle to all firms in that sector (rather than, as with a *Targeted Program*, applicable to a specific industry/technology). These programs embody an important component of 'neutrality in incentives'. In Israel this expressed itself as a 50% subsidy to every R&D project submitted to the OCS, whatever the firms' industrial branch, whatever the product class towards which the proposed R&D was oriented, and whatever the technology underlying such a product class (see Teubal, 1983, 96). From $2.5M in the late sixties, the program involved disbursements, which almost reached $300M in 1996.

A3.2 Silicon Valley Period (1990–2000)

A3.2.1 The New High Tech Cluster

The second period runs from 1990 till 2000 approximately and corresponds to the emergence and development of a distinct high tech cluster largely modeled on Silicon Valley lines (1990–98). This essay will focus on this period since it is then that Israel's VC industry emerged and developed. The basic characteristics of this period (and some comparison with previous periods) are summarized in the following Table I.

The high tech cluster that emerged during the 90s was very different from the military industries dominated cluster of the 80s. Its basic feature was being "SU intensive" closely following the Silicon Valley model of High Tech where both SU and VC increasingly play important roles (Teubal, 1999 op.cit.). It is also much more integrated and linked with the US and its high tech clusters. Thus, the number of SU companies was estimated at 3,000 for 1999/00 although another estimates show that this number was already reached in 1997 (Gelvan and Teubal, 1997). The number of VC funds increased from *two* in 1991 to over a *hundred* towards the end of the decade (IVA 1997–2001). In parallel to the high tech biased structural change, initiated in the 70s, continued but in an accelerated mode (Justman, 2000). Within manufacturing (and also Services) we observe a sharp increase in the weight of high tech industry (Avnimelech and Teubal, 2002a). There was a four-fold increase in the Sales from over 3 billion to slightly over $12 billion and a five-fold increase in exports (from $2.2 B to $11 B). The share of these industries in manufacturing employment increased from 14% in 1980 to 19.5% in 1998 – a higher share of all or most OECD countries.[21] The share of IT high tech in total manufacturing exports has increased even more dramatically than the share of employment reaching 45% in 1999. A similar picture emerges from recent data on Israel's Information & Communications Technology (ICT) sector (OECD definition) where output increased 4 1/2 fold during the 90s (CBS 2001). Moreover, the share of ICT growth in Israel's Business Sector *growth* was extremely high – 74% in the year 2000 and 39% for the decade of the 90s. Finally, a comparison between the share of ICT in Israel's Business Sector compared to the OECD's average (for 1997) shows that Israel's share (13.3%) was slightly less than double that of the OECD average (7.7%).

TABLE I Israel's High Tech Cluster of the 90s- Selected Data and Inter-Temporal Comparisons.*

Year	*99/00*	*90*	*80*
Number of SU:	∼3000	∼300	∼150
Number of VC companies:	∼100	2	0
Funds raised by VCs: *M*$	3400	∼49	0
Capital invested by VCs: *M*$	1270	∼45	0
Accumulated No of IPOs (high tech):	∼150	9	1
Accumulated VC-backed IPOs:	∼80	3	1
Share of foreign sources in total SU funding:	67%	NA	NA
Share of IT exports in total manufacturing exports:	45.7%	∼33%	∼20%
Capital raised in US capital markets during preceding decade: B$	∼10	NA	NA
Mergers and acquisitions(M&A): *B*$**	∼10	NA	NA

Source: SU numbers come from three sources: CBS, OCS and IVA.

*Frequently the figures in the box are approximations due to gaps in data, multiples sources of information, and fragmentary information from non-official sources.

**1 According to 'Value of the Exit or of the Transaction'.

[21]The OECD average was 9.9% in 1996; and that for the US was 11.8% (Avnimelech *et al.*, 1999)

BOX I New ITP Programs—Silicon Valley Period

(1) **Inbal** (1992) – a Government owned Insurance company which provided a (70%) guarantee to publicly traded VC funds. Four VC companies were established under Inbal regulations. This program had only a limited impact and has been discontinued.

(2) **Yozma** (1993–97) – a $100 M Government owned Venture Capital company, which invested in 10 privately owned Funds which operated in Israel ($8 M per fund). 9 of these were Limited Partnerships. Yozma triggered Emergence of Israel's VC industry. It was fully privatized by 1997(see below).

(3) **Magnet Program** (1992–) – a 60/70 M $ a year Horizontal Program supporting cooperative, generic R&D involving two or more firms and at least one University. This program still operates today and is widely regarded as being successful.

(4) **Technological Incubator' Program** (1992–) – a $30 M per year program supporting entrepreneurial firms during their Seed Phase, for a period of two years. The incubators are privately owned and managed. Both they and the projects approved get financial support from the Government. The program, which still operates today, contributed to the transformation of Israel's high tech cluster during the 90s, particularly in the early years.

A3.2.2 New Programs and Expansion of OCS Support

Successful implementation of the core or backbone program, *through an evolutionary/dynamic process*, led to the emergence and implementation of a set of other programs in the early 90s (see Teubal, 2002). Simultaneously with this, we see an expansion of the 'regular' R&D support program throughout the 90s.

An important fact is that the Backbone R&D Grants Scheme not only was not phased out during the 90s with the growth of Venture Capital; disbursements actually increased peaking at $334M during 2000. So were Total Grants of all programs (excluding Yozma which was one shot $100M disbursement) which also peaked at $440M during the same year.[22] During this period the Backbone R&D Grants Scheme continued to be the dominant program throughout the 90s, followed after 1995 by Magnet and Technological Incubators Programs–with 31 (66) and 15.3 (32) million dollars respectively in 1995 (2000).

SECTION B: BACKGROUND FACTORS & TRIGGERS OF THE ISRAELI VC INDUSTRY; STAGES IN ITS EVOLUTION AND IMPACT

B1 THE EMERGENCE OF VENTURE CAPITAL (1993–98)

B1.1 Explanatory Factors and Pre-Emergence Conditions

Our understanding of the Israeli case is still patchy, but it is clear that there were a number of factors which explain Emergence and Development of the new form of IT high tech involving large numbers of SU companies and Venture Capital (Gelvan and Teubal, 1997 list some of these). These are classified into three groups (See Box 2): Background Structural Conditions (2a), Pre-emergence Conditions & Triggers (2b); and Conditions Assuring Cumulativeness during VC Emergence and beyond (2c).

We now briefly explain how some of these factors operated.

[22]These figures include Royalties collected from the Backbone R&D Grants scheme (3% of sales of past projects supported by the OCS) which are also used to finance current disbursements.

BOX II Emergence and Development of Israel's VC Industry & High Tech Cluster of the 90s-Explanatory Factors

2a Background structural conditions (2nd half of 80s)

- Large Pool of qualified Scientists and Engineers, and Universities capable of adding to this flow
- The prior existence of a Civilian High tech industry with experience in R&D Projects/Innovation
- Strong prior MNE presence in Israel (Motorola, IBM, DEC, Intel, etc)
- Existence of a number of Communications Equipment companies (Tadiran, ECI, Fibronics, PhaseCom etc) which generated spin-offs during thee 90s *e.g.* NiceCom subsequently sold to 3-Com
- Restructuring of the Military Industries
- The prior existence of the Backbone, Horizontal program supporting ('regular') R&D in the Business Sector
- Special Institutions (Army, etc)
- Liberalization of Capital Markets during the 80s, and of the economy more generally speaking
- A successful price stabilization program;

2b PRE-EMERGENCE CONDITIONS & TRIGGERS (late 80s-1992; 1993/4)

- Globalization of Capital and Asset Markets-enhanced opportunities for SU technology companies out of the US to float in NASDAQ (Israel was quick to make use of such opportunities)
- Globalization of US Investment Banks; and their searching for opportunities in Israel;
- Individuals (foreign and returning Israelis) coming to Israel to search for new investment opportunities in High Tech
- Business Experiments with the new model of High Tech
- Acceleration of Rate of Startup Formation: 1988–1992
- New Government Programs-some of which were Targeted to VC: The Inbal program (1991 & subsequently discontinued), Magnet (1992–), Technology Incubators (1991/2–) and most important- Yozma (1993–1997), which triggered Israel's VC Industry
- Adaptation of the Institutional & Tax frameworks
- Government Experimentation and Learning

2c CONDITIONS ASSURING LEARNING AND CUMULATIVENESS (1993–95/6; and beyond)

- The Gulf War and initiation of the Peace Process-which contributed to reduce Israel's isolation, making it more attractive for business and investments;
- Implementation of Yozma which created 'critical mass'
- Continued Implementation of 'backbone' R&D Support Scheme; and to some extent, impact of Technological Incubators (and Magnet Program)
- Immigration from the former Soviet Union – a large number of engineers and medical doctors settled in Israel and worked in High Tech
- New Innovation opportunities world wide, particularly in Communications, due to the ongoing IT Revolution and to the Liberalization of Telecommunications.
- Cultural Shift favoring entrepreneurship

Restructuring of the Military Industries This started in the mid 80s with the effect that significant numbers of 'incumbent' engineers and technicians began looking for alternatives in Civilian High Tech; and so did increasing proportions of new graduates. Table II below provides some basic data on this matter.

Backbone R&D Support Program The 'backbone' R&D support program was being implemented throughout the 80s and 90s. It impacted both the supply and the demand for VC-services

TABLE II Changes in Civilian and 'MILITARY' High Tech Employment: 1984–87 (Transportation Equipment & Electronics Sub-Branches).

Employment	*Military: scientists & engineers*	*Military: total employment*	*Civilian: scientists & engineers*	*Civilian: total employment*
Absolute change	−370	−5040	1560	7540
Relative change	−1.8%	−4.6%	11.4%	7.4%

Various Sources.

particularly during 'VC Emergence' but also before 1993. R&D grants directly enhanced SU formation and 'demand' since they enabled engineers formerly working in the Military, in MNE or in large domestic companies; as well as recent University graduates – to found SU companies. They also affected VC 'supply' since the existence of such grants, being 'complementary' to VC investments, stimulated such investments.[23] This was of particular important during Emergence when the VC industry was inexperienced since it meant, *ceteris paribus*, enhanced expected returns from VC investments and decreased risk. The Backbone R&D Support Program thus contributed to the creation of a 'market for VC- related services' in more than one way.

B1.1.1 Pre-Emergence Conditions (1989–1992)

Foremost here is the beginning of a new phase in the Globalization process: non-US high tech Startups could for the first time "systematically" float in NASDAQ, provided the economy had "adapted" to the new opportunities. Part of Israel's adaptation involved new Government programs which complemented the above mentioned 'Backbone' R&D support program (which also continued to be implemented). These included *Targeted* Programs supporting Venture Capital (Inbal and Yozma); and complementary programs raising the Demand for VC-services (*e.g.* Technology Incubators' Program). Simultaneously foreigners and Israelis began searching for new investment opportunities in Israel; three privately held (pre-Yozma) VC companies began operating (Athena, Star and Giza) as well as some publicly traded ones (*e.g.* Mofet) created in the wake of Inbal-the first 'targeted' program directed to VC.

The period was characterized by significant 'Variation' both by the Business Community and by Government. A significant amount of *Business Experimentation* took place. It involved aspects such as: (a) structuring of a new type of 'bi-national' SU directed both to product and to capital markets; (b) SU foundation and operation under the new external conditions; (c) Demonstration of possibility of undertaking a successful IPO of Israeli SU, and (d) VC-like investments and SU monitoring by individuals. *Government Experimentation & Learning* also took place *e.g* from the first, non-successful VC-directed program (Inbal). These experiments and the significant SU activity which appeared in the early 90s provided *pointers towards the new model of high tech & potential for learning* (*Selection*). Both the Government and the Private Sector identified a small set of market tested forms of desirable SU/VC activity, structuring and organization; and a sharper identification of the type and design of the targeted VC directed program which eventually succeeded (see Yozma in B1.3 below). The actual trigger, as far as we know was implementation of Yozma in 1993; and its operation throughout 1997–2000. This provided the critical mass for the onset of a cumulative, self-reinforcing process of growth of VCs and SUs.

Our data below (B3) shows that a non-insignificant amount of SU existed prior to Yozma. We also know that some of them were so good that they could go public in NASDAQ without the intermediation of VC. This suggests that by 1993 when Yozma was launched: (a) there was *an excess demand for VC*; and (b) Yozma funds were confronted with *very rich pickings* (investment opportunities in very good SU companies). One cannot think of more favorable conditions for the implementation of a targeted program directed to VC companies.

B1.2 Cumulativeness and VC Emergence

VC Emergence is closely related to the onset of a cumulative process where VC activity and profits led, at least till the end of the decade and through a variety of processes, to more VC

[23]The grants extended also covered the pre-seed and seed phases which even mature VC industries seldom finance (Avnimelech and Teubal, 2002b).

activity and profits. This would correspond to the Evolutionary Process *Reproduction* which comes after *Variation & Selection*. The three processes comprise what is termed 'Universal Darwinism' – an overarching theoretical perspective applicable beyond biology (Dodgson, 2002 op. cit.).

Cumulativeness involves four main component sub-processes which interact; and a fifth (*VC-SU Co-evolution*) which integrates some of these and comprises in some cases, a central part of the overall process. It is also a central feature of Israel's Emergence *Profile*. The four component sub-processes are: *Entry, Collective Learning, Exploitation of Economies of Scale, Reputation*[24] *Effects & Networking*. No research we know of has developed an empirical methodology for analyzing in an integrated way the dynamics of operation of these factors. The problem is both conceptual (*e.g.* how to define each component and how to articulate them in empirical terms) and empirical since data is generally not available at this, micro level of analysis. This is one of the major challenges of applying Universal Darwinism principles to the Social Sciences. This paper is no exception: our description of cumulativeness-emergence is quite general since the component sub-processes are not precisely defined, neither here or in the follow-up Part 2 paper. Moreover the supporting data used below (Section B3) is mostly aggregate data that is, in most cases, inherently not precise enough for describing cumulativeness in terms of the interaction of elementary sub-processes.

Having said that, we still are reasonably confident about the broad outline of some of the dynamic processes at work and their interaction. Strong *collective learning* took place during these four/five years (1993–98) and beyond, triggered by Yozma, who contributed to attain the critical mass of activity for an effective and self-sustaining process. Three phases of VC learning and evolution are identified (see B3 below). Learning pertained to screening deal flow, due diligence, selection of investments, investing in SU companies, monitoring SU, providing value added, and in the exiting process (an IPO was considered a more complex exit which required more learning compared to acquisition of a SU company). Collective learning of VCs together with some very good 'early exits' (through demonstration, networking and reputation effects) stimulated entry of new VC companies, and accelerated creation of second/third funds by the existing Yozma VC companies. Yozma, by creating a quantum jump in VC activity accelerated individual learning by VC and SU companies, collective learning[25] through inter-organizational spillovers (which supposedly increases more than proportionately than the increase in activity); and *interactive SU- VC learning*. Moreover the Learning Process involved a significant component of *learning from foreign agents* in particular from the foreign 'limited' partners of Yozma Funds.[26]

Enhanced VC and other high tech activity which ensued enabled a better *Exploitation of Economies of Scale* in the domestic generation of non-traded (or partially non-traded) inputs to high tech *e.g.* accountants, lawyers, investment bankers, consultants, providers of knowledge inputs, and independent suppliers of production & marketing inputs. This factor, together with the existence of networks of personal links, presumably contributed to reductions in *Transactions Costs* and through this, facilitated deal-making in the VC industry. Through time after 1993 Israel's high tech cluster became better integrated and increasingly

[24]A cumulative process of generating SU & VC firm reputation which eventually transforms into Industry/Country high tech reputation (Avnimelech and Teubal, 2002b).

[25]Yozma Funds were connected in a network by the fact of a common OCS board member.

[26]Yozma was instrumental in bringing to Israel important financial institutions. These included: Advent International, the Van Leer Group, Walden VC Group, Oxton, TVM, AVX, MPV, DEG, and Oxford Partners. These companies became a source of know-how, networking and reputation for the young VC industry. They presumably were instrumental in triggering new elementary dynamic processes which directly and indirectly contributed to the overall high tech momentum of the period.

capable of providing effective services to new SU, both through VC and through a gamma of other input and service suppliers.

The feedback-cumulative process was also fueled by favorable changes in the *External Environment* in particular the almost continued rise of the Nasdaq Index, and of communications' deregulation. Additional factors were the Oslo peace agreements, the Russian Immigration, and domestic regulatory changes. The domestic diffusion of communication and internet technologies and products created, towards the end of the 90s, new opportunities for high tech development.

B1.3 VC Targeted Policies

There is wide consensus about the importance of the Yozma Program ('Yozma') for the emergence of Israel's VC industry after 1993. Our analysis above suggests that the implementation of this program cannot be considered as obvious and automatic. It might not have happened. Two sets of factors seem to have been responsible for *Yozma to become an effective trigger of Israel's new High Tech Cluster*: (a) favorable background conditions; (b) policy and market forces' experimentation during the pre-emergence period. These assured that at the beginning of operation of Yozma (1993), there was a *clear 'excess demand' for VC 'services'*. The surfeit of SU included also some very high quality firms and entrepreneurs (Checkpoint, Memco, Galileo, and ESC among others) who made a significant direct and indirect contribution to cumulativeness and emergence.

Two additional factors must be mentioned here. First, we should not underestimate the *importance of 'luck'* in the process *e.g.* the time overlap between the learning & cumulativeness process on the one hand and the rising NASDAQ index and expanding market for Communications & Internet-related Equipment & Software on the other. This overlap was not so consistent in other countries where VC-SU co-evolution began operating after 1996/7. The second factor was Yozma's successful design. Some aspects of the program design and of the process leading to it are mentioned below.

B1.3.1 Identification of a System Failure

New National Priorities emerged with the beginnings of the massive immigration from the former Soviet Union during the early 90s. The Government of Israel began searching for means to employ the thousands of engineers that came to this country. Simultaneously the Military Industries had laid-off hundreds of engineers (Tab. II); and many startup companies were created only to subsequently fail.

A major priority of policy was enhancement of startup formation, survival & growth. During the late 80s, early 90s only a small share of SU founded succeeded, and the accepted view was that this resulted from weak management abilities. Experts in the field and officials in the Treasury (who had good undergraduate training in Economics) realized that despite massive Government support for R&D there still was a clear 'market failure'[27] which blocked the successful creation and development of Startup companies. The head of OCS or "Chief Scientist" at the time, Yigal Erlich, pondered about how to make OCS support more effective. He could not find even one real success "similar to those we see today".[28] The basic

[27]In fact a mixed 'market' & 'institutional/systemic' failure since not only incentives to 'market forces' were required to generate a domestic VC industry but *also* a measure of institutional adaptation and change in 'general taxation' and in the Business Environment.

[28]There were two interviews with Yigal Erlich (1998 and 2000). In addition we interacted intensively with him in the context of the IFISE project during the year 2000–2001.

problem was lack of capability to grow after the product development phase. He arrived at what could be seen as a Vision and Strategic Perspective for Israel's high tech: that the missing link was 'marketing/management'; and that the way to get it was to foster Venture Capital. At the time, there were only 2–3 *privately held* Venture Capital Companies; for this and the other reasons already mentioned it was also clear that the total capital available for supporting SU activity was inadequate.

B1.3.2 A First Attempt: Inbal

The Inbal Program was the first attempt at implementing a targeted ITP directed to the VC industry. It was launched in 1992 one year before the implementation of Yozma. Its central idea was to stimulate *publicly traded* VC funds by guaranteeing the Downside of their investments. The mechanism used was a Government Insurance Company ("Inbal") that guaranteed VC funds traded in the stock market up to 70% of the value of their public issue. The program imposed certain restrictions on the investments of the VC companies covered by the program ('Inbal Funds'). Four (4) funds were established, neither they nor the Inbal program, as a whole, were a great success. Inbal fund valuations in the stock market were low, similar to Holding Companies' valuations. Moreover, the funds encountered bureaucratic problems and had to go to great lengths in order to prepare regular period reports. Eventually all of them attempted to leave the program, which they eventually did. Today all the (former) Inbal Funds are 'held' by one Holding Company-Green Technology Holdings.

Policy makers and business men alike learned from Inbal's weak impact: the difficulty in publicly traded VCs of having investors contribute to the operation of the fund; greater difficulty to rapidly exploit reputation earned from early exits in order to raise new capital; limits on management decision making flexibility and on management compensation; and last but not least-absence of incentives during the "upside".

B1.3.3 Success: The Yozma Program and its Design[29]

The program began operating in 1992. The explicit objective was to create a solid base for a competitive VC industry with critical mass; to learn from foreign limited partners; and to acquire a network of international contacts. It was based on a 100 $million Government owned VC fund (with the same name) oriented to two functions: (a) investment in private VC funds ('Yozma Funds'-80 $million); and (b) direct investments in high tech companies-20$ million. The basic thrust was to promote the establishment of domestic, private LP VC funds that invested in young Israeli high tech startups ('early phase investments') with the support of government and with the involvement of reputable foreign financial/investment institutions. Each 'Yozma Fund' would have to engage one such foreign institution together with a well-established Israeli financial institution. When a fund fulfilled these conditions, the Government would invest around 40% (up to 8 $million) of the funds raised. Thus $100M of Government Funds would draw $150M of private sector funds (domestic and foreign).

Yozma did not simply provide supply, risk sharing incentives to investors – as was common in other Government VC support programs; on the contrary its main incentive was in

[29]Most of the material below was obtained from two interviews (1/98 & 5/00) with Ygal Erlich the CEO of Yozma and the (or one of the most important) architect(s) of the Program. Additional material was obtained from a lecture he gave at the University of Pavia in February 2001; and from other sources.

the 'upside' that is when VC investments where very profitable. Each Yozma fund had a call option on Government shares, at cost (plus interest) and for a period of five (5) years.[30]

The program also assured the realization of 'supply side learning' through the compulsory participation of foreign Financial Institutions. 'Demand side' support was provided not by Yozma itself but by the Backbone 'R&D support and Technological Incubators Programs' (see above).

A total of 10 private 'Yozma funds' were created by the Yozma Program. The program also directly invested $20M through a Government-owned Yozma 1 Fund which started operating in 1993 (this was privatized in 1997). Six were founded in 1993: Gemini, Star, Concord, Pitango, Walden; Invantech; one in 1994: JVP; two in 1995: Medica & EuroFund; and one in 1997: Vertex. The total capital raised by Yozma funds was about $250 million ($100 million out of it government capital) and they invested in over 200 startup companies.

Impact Our data show a quantum jump in VC activity after Yozma. This and the insights received and statements made during our interviews are the basis for our inference that Yozma triggered cumulative growth and VC emergence.

An indication of Yozma Funds' success in triggering growth of the industry is their expansion, which took the form of 'follow up' funds which were not supported by the Yozma Program. Most Yozma funds (and some other funds as well, who indirectly learned from the Yozma experience) were followed by one or more additional funds managed by an expanding but related core of managers. *The total sums managed by this group amount to about 5 $billion* during early 2001. This is a large share of total VC industry capital managed then. Another measure of the success is the rapid entry of non-Yozma related funds, something triggered by the handsome profits obtained by Yozma Funds.

B1.4 Notes on VC-SU Co-Evolution

VC-SU co-evolution is a central axes in the cumulative process leading to VC emergence and beyond. The interaction between the two types of agents of the business sector is both direct and indirect. Direct interactions parallel supply-demand effects and user-producer links in young markets *e.g.* VC & SU *entry*; and interactive learning. Indirect links also occur through the wider cluster via one or more component sub-processes of cumulativeness (see above).[31]

The data of B3 below is, broadly speaking, consistent with at least three steps in the VC-SU co-evolutionary process:

Pre-Emergence the numbers of SU companies operating then and the small share of those which were VC-backed (and the limited amount of VC capital and activity then) suggests the existence of '*unsatisfied SU demand for VC services*';

Emergence The rapid policy response (through Yozma) to such a deficit led to a quantum jump in VC capital raised and, due to the availability of a pool of skilled potential VC *entrepreneurs*, to a corresponding increase in VC activity. This in turn led to a '*temporary excess supply of VC services*'. As a result we observe not only an increased share of SU which were VC-backed but also significant increases in gross additions to SU during 1995–6.

[30]The incentives to the 'upside' also stimulated entry of professional VC firms and managers, a fact which also encouraged fast learning (Avnimelech and Teubal, 2002b).

[31]Frequently entrepreneurs from VC portfolio companies subsequently become consultants to the VC or even partners (VC interviews during the years 1999–2001).

These were either a (or a delayed) reaction to the 'excess supply of VC services' or the expectation that new SU foundations would easily find *new* VC sources of finance if required.[32]

Incrasingly Synchroneous Growth Starting in 1996 SU demand for VC services and VC 'supply' become increasingly synchroneos *i.e.* rapid mutual adjustment. During the rest of the decate, the share of SU which are VC-backed increases (up to about 70%) although there always will be a SU who are not VC backed.

B2 LEARNING & VC INDUSTRY CAPABILITIES AND STRATEGIES

The US VC industry emerged during the 60s and passed through a number of evolutionary phases in which it gradually learned the VC business *e.g.* how to screen companies, how to sell companies or to undertake an IPO; how to contribute Value to the company, how to build large companies, how to forge strategic partnerships and how to become global. According to Chemi Peres of Polaris, the Israeli VC industry underwent a similar process but within a much more compressed time frame-one rather than four decades.[33]

We can distinguish between three distinct phases in the capabilities and in the evolution of Israel's VC industry: Phase 1 (1993–95) which coincides with VC Emergence; Phase 2 (1996–98); and the onset of maturity (Phase 3, 1999–2000) where Israeli (foreign)VC funds were establishing offices abroad (in Israel) and investing more and more in non-Israeli high tech companies.

B2.1 Phase 1 (1993–95)

Yozma Funds were sponsored jointly by domestic and by foreign financial institutions. VC fund size was small—about $20 million; did not have experience and invested largely on the basis of intuition with relatively little knowledge about specific segments/areas of industry; and they invariably co-invested with other funds (in order to spread risks). The foreign organizations helped manage the funds and promoted a learning process. Israeli VCs learned how to undertake VC transactions, how to undertake 'due diligence', acquisition of markets' knowledge, etc. ***Co-investment*** enabled Funds without foreign partners to learn from those with foreign partners (one form of "Collective Learning"). During this process, Startup companies themselves also learned how to work with VCs and also learned what VCs could offer them in addition to finance. Fund objectives in the first phase was to exit through M&A *i.e.* generally sale of the Israeli Startup to a (usually foreign) large company. Large numbers of such transactions took place at low values (between $10–70 million). This is the easiest way of "exiting" and therefore the standard one adopted during this period.

[32]The rapid VC supply response would seem at first sight to contradict the assertion that there are supply inelasticities in the industry (Gompers and Lerner op. cit Chapter 1) the real bottleneck to expansion not being capital but experienced VC entrepreneurs/managers. This inelasticity was not present in Israel during VC emergence, however. The pool of readily available skills came from experience in the pre-existing Electronics Industry, from the high tech Diaspora in Silicon Valley and elsewhere; and from the experience accumulated during the pre-emergence period. Thus Yozma's addition to capital translated immediately into sharp increases in *bona fide* VC activity-although a strong process of individual and collective learning was still required for the VC industry to become efficient and to reach, among its top tier companies, international (US) standards. Note however, that post emergence expansions, having involved reductions in VC and SU "quality", do in fact reflect VC skills 'inelasticities'. This aspect will be explored in Part 2.

[33]Interview in September 2000.

B2.2 Phase 2 (1996–98)

During the second phase some VC funds were larger (around 100 $million) and investors in Funds (*i.e.* limited partners) began to include Pension Funds and other institutional investors; and sometimes- "Strategic Partners" (although most Strategic Partners were still accessed indirectly by Israeli VCs at the time). Effort was devoted to develop links with Investment Banks & top Analysts since the objective of the best funds shifted to 'exiting' through IPO whenever possible-rather than through M&A. VC fund managers became more experienced and they better understood the business. They succeeded in generating 'value added' over and beyond the equity they purchased; and they realized that it was not enough to identify good companies. More time was spent with each individual company; sometimes they discovered that there could be problems with Startup managers so they devoted more time to build up the company's Management Team. Finally, they realized that selling a company is not the wisest move; that the challenge is to help companies grow. This meant also attempts at achieving a better understanding of the markets for innovative products. During this period we also see a process of liaising and generating links with US Venture Capital companies, particularly those located near potential customers.[34] This would enable utilization of those companies' strategic links with clients and other organizations. At this stage we see the beginnings of investments not only in Israeli Start-Ups but also in Israeli-related companies *e.g.* US companies founded by Israelis.

B2.3 Phase 3 (1999–2000)

In this phase VC funds were larger—over 200 $million; had more limited partners especially American; and leading funds established offices abroad. There is an increased emphasis in linking directly with Strategic Partners like Nortel, Cisco, AOL, Yahoo, etc (who frequently are also investors); and continued efforts were undertaken to understanding the market. Correspondingly, there ware less links with Investment Banks (also by then Investment Banks by themselves would offer their underwriting services directly to good Israeli Companies). Also we observe a significant growth of foreign VC investing directly in Israeli SU.[35] This reflects the fact the Israeli companies by then already acquired an international reputation. In those circumstances any inquiry from a good Israeli VC concerning IPO of one of its portfolio companies would lead the Investment Bank to check the company.

An objective in this phase is not only IPOs or 'exits' but also growing large indigenous companies. This means carefully nurturing and building companies from the SU phase up to, and even beyond, the IPO.

In this phase, competition is Global Competition, and good Israeli companies knew how to 'reach' or 'access' US VCs alone. Among the advantages of US VCs relative to Israeli VCs in this phase are their capacity to search for good managers in the US; their better links with Strategic Partners; and better knowledge of the market. In this last phase, the leading Israeli VC companies were not so different than US VCs. They also start investing in Israel-related companies (*e.g.* in the US) and not only in Israeli companies.

Comment The above description suggests that considerable learning took place in Israel's VC industry, including 'collective learning', interactive VC-SU learning, and 'learning from

[34]For example, by inviting US VCs to participate in the next round of finance of selected portfolio companies poised for 'penetrating' US markets (IVA 2001).

[35]Foreign VC investment increased from an average of 30% of total VC investment in 1998 to an average of 45% in 1999.

others'. Beyond increased proficiency in their contracting with SU and investors designed to avoid conflicts of interest and agency problems (not surveyed here), VCs increasingly learned how to provide value added to portfolio companies; how to 'exit' and how to stimulate company growth. VC efficiency and Strategy also benefited from the appearance of ancillary service & input suppliers; from economies of scale & specialization; and from increased networking (including with outside agents).[36]

3 QUANTITATIVE DESCRIPTION OF THE EVOLUTION OF ISRAEL'S VC INDUSTRY

B3.1 Milestones and Capital Raised

In 1966, Discount Investment Corp. (DIC) and the Rockefeller venture fund invested in Elron Electronic Industries- the first Israeli venture capital related investment. Latter on when Elbit and Elscint were spinned-off from Elron, DIC and Rockefeller realized an impressive return on their investment. In 1971, Fred Adler an East Coast Venture Capitalist invested in Elscint which subsequently become the first Israeli Company traded on NASDAQ in 1972.

In the late 60s and 70s, there were only a few 'venture capital -related' investments in high tech companies (another important one was Scitex). In 1985, following previous success in venture investments in Israel Fred Adler established with Dan Tolkowsky the first formal VC company- Athena (a privately held VC where Elron was a limited partner with a 10% share). In the 80s, only a few Israeli companies were VC backed; these included Fibronics, Optrotech, Biotechnology General and Zoran. During these years we also see an increase in the activity of Angel investors in SU and in R&D activities.

In 1989, Meir Barel an Israeli engineer working in a private equity fund in Germany (TVM) established Star Ventures, a VC company devoted to investments in Israeli, Israeli-related and German startups. In the following 3 years, before it became a Yozma fund, Star founded 2 funds raising $17 million.

Finally, in 1991/2 and in 1993 respectively the Government launched the Inbal & Yozma programs (see above). During 1993 and thereafter, there was a rapid growth of the Israeli VC industry both in terms of capital raised and in terms of number of funds active in the industry (see Tab. III).

TABLE III Capital Raised by the Israeli VC Industry in the 90's.

	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*Total*
Private VCs	49	27	162	112	145	264	609	468	1575	3155	6566
Public VCs	0	54	42	0	0	0	27	8	44	35	210
Private equity funds	0	45	128	242	6	110	66	74	40	26	737
Investment companies	9	34	40	20	5	23	25	125	93	72	446
Total capital raised	58	160	372	374	156	397	727	675	1752	3288	7959

*Source IVA.

[36]This paper (Part 1) has only scratched the surface of these matters. In Part 2 (Micro-analysis) we deepen the analysis by focusing on individual companies and funds: ascertaining private performance and social impact; and characterizing founders & managers, capabilities & strategies.

Total capital raised per year during 1991–96 ranged from $58M in 1991 to $397M in 1996; and from $727M in 1997 to $3288M in 2000. In fact during the second half of the 90s, the Israeli VC industry becomes a significant VC industry with huge influence on Israel's high tech industry. It was then that the first foreign VC companies began to invest directly in Israeli startups. Later on, a few of them (*e.g.* Benchmark, Sequoia) established Israeli offices.

It is clear that VC activity already existed prior to the establishment of Yozma Funds, although non-Private VCs played a dominant role in total Capital raised – $133M compared to $27M capital raised by Private VCs in 1992. This in part reflects the Inbal incentives to Public VCs; but capital was also raised by the other two categories of financial institutions-Private Equity Funds, and Investment Companies. A big jump in Private VC & Total VC Capital raised occurred in 1993. In that year Private VCs raised $162M compared to $27M the year before (primarily Yozma Funds). Also the dominant form of organization increasingly becomes private (in fact LP).[37] Note that the Inbal Program did not seem to generate, in its wake, a cumulative process of steady growth; although as mentioned, its implementation led to a better design of Yozma.

B3.2 The Growth of SU and of VC-backed SU Companies

Table IV shows estimates of *gross additions* to new Startup companies which began operating since 1991 (rows 2, 3); and estimates of VC backed SU (row 1). Row 3 are SU requesting OCS support for the first time which means that such companies were founded some time before the stated year. Since they were no additional sources of finance till then these are good estimates of flows of new SU before the implementation of Yozma towards the mid-90s (although there still are problems of dating of SU founding).[38] During the pre-emergence period 1991–92, gross additions to SU are estimated to range between 80 (row 2) and 143 (row 3) companies.

Significant increases in Gross Additions to SU occurred during VC emergence: between 100 (row 2) and 380 (row 3) during 1993–94 and much more after that throughout the 90s (excepting 1998 where the number 350 equals that of 1997). This reflects the predicted impact of implementation of the Yozma Program and the increased availability of VC.

The *direct* impact of Yozma as reflected in numbers of new VC-backed SU companies is shown in the first row of the table: VC-backed SU increased (gross) from 80 in 1993 to 513

TABLE IV Gross Additions to SU Companies and to VC Backed SU Companies.

	1991	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*Total*
VC backed SUs	10	20	80	90	80	200	219	252	338	513	1802
All SU	40	40	50	50	100	200	350	350	550	850	2605
First time OCS SU	34	109	165	218	146	200	170	165	138	126	1471

*Source IVA, OCS and Newspapers.

[37]46% of total funds raised during 1994–96 where from Private VCs (up from 35% from 1992–94). About half are Yozma Funds; and these indirectly influenced the others. Yozma funds emphasized Early Phase financing, in contrast to the policy of other VCs. This would have a much larger effect on new SU companies.[37]Especially since 1996 where private VC funds raised represented 93%, with the ratio ranging between 80–96% till the year 2000.

[38]SU after 1995–96 did not always go for OCS grants since this could create difficulties in a future M&A deals (an M&A would presumably involve an element of R&D implementation out of Israel, and correspondingly, a penalty on the company according to OCS rules at the time). Thus the numbers of Row 2 would be the relevant ones after VC Emergence (1993–98).

in 2000. While during 1991–92 new VC-backed SU trail behind new SU the reverse seems to occur during 1993–94-the first two years of implementation of Yozma: gross additions to VC-backed SU exceed gross additions to SU (row 2 estimate). After 1995, the acceleration of gross SU creation is such that gross additions to VC-backed SU trail behind gross additions to SU.[39] This suggests an *indirect* impact of VC expansion namely an acceleration of SU formation. All in all we observe a sharp rise during the 90s in the proportions of VC-backed SU companies whatever the new SU series we use. For the pre-Yozma years where row 3 data for gross additions to SU is of relevance; and assuming that the pre-1991 stock of both types of companies was small – the share of gross additional VC backed over gross additional SUs increased from approx. 20% to approx. 50% between 1992 and 1993. Moreover, the 'marginal ratio' for the years 1999 and 2000 (using Row1 & Row 3 data) was approximately 60%. These figures on the direct and indirect impact of VCs support the VC-SU co-evolution thesis presented in B1.4 above.[40]

B3.3 Growth in IPOs[41]

Elscint's 1972 IPO did not signal the beginning of a new era as far as links with the US capital market is concerned. Only small numbers of Israeli companies undertook an IPO in NASDAQ (or in other markets) till the late 80s. By 2000 Israeli (or Israeli-related) high tech companies traded in the U.S. (over 150) are the third largest group only behind the U.S. itself and Canada. Moreover, the numbers of Israeli (or Israeli-related) companies, which are traded in the London-based AIM stock market, are the second largest after UK companies. Most of these companies are technology startups.

Table V shows total issues or offerings, both IPOs and subsequent company issues in both US & EU (with some exceptions) capital markets, including data on Capital Raised. The issues pertain both to hi-tech and to non-high tech companies; and the last three columns show the data on VC-backed companies only. Concerning 'All Public Offerings' there are two instances of significant increases in issues' numbers: during the decade of the 90s compared to the previous decades; and after 1995 compared to yearly data for 1991–94.[42] This is related to a second point namely an increase in the share of VC-backed issues from roughly 30% at or before 1997 to over 70% in 1999–2000. The picture, which emerges, is one of increasing maturity of Israel's high tech industry on the one hand (due to learning and other cluster effects such as the creation of the VC industry itself); and increase in the Nasdaq index (which by itself would also induce an increase in IPOs) on the other.[43] We cannot avoid noting also that during 1991–92 there were 12–15 IPOs most of which were non VC-backed issues. This in part reflects the fact that very good, high quality SU began populating the scene in the early 90s.

From the above analysis of IPOs and from a similar analysis of M&A activity not reported here we conclude *that in the Israeli case IPOs played a crucial role in creating the conditions for cluster emergence; and that M&A only come in stream in increasingly large numbers later on* (starting in 1994 in the case of Israel). The link could be as follows: public capital

[39]According to the alternative measure in the third row of Table IV the share of new VC backed over new SUs increased from approx. 20% to approx. 50% between 1992 and 1993.

[40]The 'swarming' of SU during the second half of the 90s (excepting 1996) meant however, that there may be decreases in some years in the 'marginal' VC-backed\SU ratio.

[41]For an analysis of the growth of M&A see Avnimelech and Teubal, 2002a.

[42]The years with reductions in numbers of offerings involved only marginal reductions (if at all) in Capital Raised. Note that exits from Yozma first funds were supposed to take place during 1996–98.

[43]Both factors were certainly at work here. Note that the sharp increases in the NASDAQ index did not induce other high tech clusters to float more company's *e.g.* India till 1999. Thus the fast response of Israeli firms to the growth of NASDAQ reflects *also* mounting capabilities and the effects of learning.

TABLE V Number of Public Offerings of Israeli Companies in US and EU Capital Markets*.

	All public offerings			*VC backed public offerings*		
	*Number of offerings**	*Capital raised (M$)***	*Number of IPOs*	*Number of offerings*	*Capital raised (M$)*	*Number of IPOs*
Before 93	~30	~1000	~25	4	~60	3
1993	18	529	16	7	103	6
1994	10	336	8	5	35	4
1995	16	608	12	7	210	5
1996	31	1037	24	13	535	12
1997	24	1074	16	8	175	5
1998	14	907	14	5	144	5
1999	20	3172	20	16	1073	14
2000	36	2842	31	29	1530	24
2001	3	143	2	2	83	2
Total 90's	~202	~11200	~168	96	3950	80

Sources: website of Nasdaq, NASE, EU capital markets, Yahoo finance, and Globes Newspaper.

*Including IPOs, secondary and debt offering of all Israeli and Israeli related companies (high tech and none high tech) that are traded or were traded in Nasdaq.

**US capital markets only.

***According to Bar 2001, underwriter's fees decline monotonically from 8.7% in 1991 to 7% (the standard US rate) in 1999.

market links early in the game generate conditions for the emergence (given a suitable Government program like Yozma) of a distinctive VC industry since: (a) most profits of VCs are made from IPOs of a small number of companies (Gompers and Lerner, 1999); (b) the possibility of floating SU companies raises both the valuation of M&A and at least some of the benefits to acquiring companies.The new industry then develops a capability for M&A and in fact, many VCs become oriented – during Phase 1 of the industry – towards the M&A form of exiting rather than to the IPO strategy.[44] This will in part change once the strategy and capabilities of many VCs shifts towards the building of large companies (in which process IPOs became extremely important). On the other hand with the onset of cluster maturity and with enhanced cluster reputation, MNEs start coming on; and this creates a very strong wave of new M&A.

B4 NOTES ON THE IMPACT OF VC

The motivation for analyzing the impact of VC is clear. Gompers and Lerner (1998, op. cit. p 137) state "A key motivation por policy makers abroad, seeking to emulate the US model, is the perception that VC organizations are a key factor in the rising leadership of US firms in high technology industries . . . Demonstrating a casual relationship between innovation and job growth on the one hand and the presence of Venture Capital investments on the other, is however, a challenging empirical problem". We cannot agree more with this statement if not only because of the complexity of the links coming to and flowing from Venture Capital, and the concomitant need (illustrated we hope from our analysis of the Israeli case) of adopting a broad Evolutionary/Systemic perspective. Such a perspective emphasizes

[44]The 'simple' types of M&A seem to be easier to learn during Phase 1 of the VC industry (see next subsection) compared to 'preparing a company for IPO'. The latter requires paying attention to management, financial and marketing capabilities since, for floating, a company needs a selling product (although it need not be profitable). In contrast, most M&A are based on the technology and technological excellence of SU and of its staff.

the need of pre-measurement work to identify the critical dynamic subprocesses and sequences involved. Even the extensive quantitative work by Gompers and Lerner in Chapter 14 of their book, which does not purport to follow such a perspective, has been characterized by them as being only "... preliminary evidence in support of this (*the strong impact of VC*-our addition) claim ..."

Explicit efforts to demonstrate quantitatively the positive impact of VC in Israel of the 90s are not exemptions to what has been said abroad. They will nevertheless be mentioned below since they do provide additional support to other more general evidence & reasoning which strongly suggests the existence of such an impact. Before surveying the more specific studies let us note three more general indicators of a positive VC impact in Israel. *First*, the positive association between growth of Venture Capital and 'conventional' export and valued added growth of IT high tech (reported in Section A of this paper); and between these two and overall economic growth during the 90s. *Second*, the strong positive 'accounting' contribution of "SU-output" to GNP *growth* in 1999 and 2000 (Teubal and Avnimelech, 2002) when many if not most SU were VC-backed – a fact that emphasizes the significance of a 'non-conventional' form of VC-impact.[45] *Third*, the strong VC-SU correlation suggested both by our data and by qualitative insights garnered from the industry (B1.4 above). This last point emphasizes a 'dynamic aspect' of VCs impact not covered by the quantitative studies comparing VC-backed with non VC-backed SU: the direct and indirect contribution of VC to the *founding or creation* of SU – a distinct VC impact which goes beyond their contribution to *existing* SU.

The first two quantitative analysis we report on belong to Lukomet (2001) and Ber (2002). Both build a set of VC-back SU companies and compares them with other SU – either non-VC-backed companies (Lukomet) or in the case of Ber, SU supported by Investment Banks (a non-VC financial institution also involved in financing SU). Lukomet's analysis focuses on two sorts of impacts: ROR from investing in SU which had an IPO abroad; and rate of growth of sales. He concludes that the ROR three years after issue of VC-backed companies (37 companies) was on average three times higher than the return on non-VC companies (46 companies). Also, two years after IPO, the rate of growth of sales of VC-companies was 36% compared to 23.5% for non-VC companies (this difference is significant, and the gap in rates of growth of sales increased during the second year – rate of growth of 29% for VC backed against 4% for the others).

While Lukomet considers a large sample of companies during the 1991–99 period, Ber's analysis considers *all SU in VC portfolios* between the years 1997–2000 (a total of approx 500 on her estimate) plus a control group of 200 SU involving Investment Banks *without* VC investments. She compares various measures of performance in both samples, and also undertakes probit analyses of her data. Her first result concerns the probability of having an exit (whether IPO or M&A)-this is higher if a SU is VC-backed, a result which supposedly is consistent with the view that VC companies generate value added beyond what the alternative financial arrangement ('investment banks') would provide. A second point concerns the *pre-value of a SU*-before receiving a VC or an Investment Bank investment: a higher

[45] For example the biggest acquisition of an Israeli high tech SU company ever was Lucent's acquisition of Chromatis during the year 2000 for 4.5 *billion* $. The company, who developed optical switching equipment, was a portfolio company of Jerusalem Venture Partners, an important VC who was the lead investor. Our data from B3 above and elsewhere shows quite clearly that VC played important roles both in IPOs in Nasdaq and in M&A; and we also know that most M&A involved SU acquisitions by *foreign* companies. These considerations point out to the importance of a non-conventional exports nemely the sale of 'technological assets' (or shares in such assets) to foreign private agents or to the 'public at large'. Such sales (or value added from such sales) stand side by side with valued added from sales or exports in product markets. Their share in 'total' high tech valued added increased consistently during the 90s (we estimate it at around 50% in 2000). For a discussion of the macroeconomic aspects of this phenomenon see Teubal and Avnimelech, 2002 and Teubal *et al.*, 2002.

probability of a higher pre-value when the SU is VC-backed. This could mean that VC funds perform an important *screening function*. However given that the probability of exit is not significantly related to pre-SU value (as defined above), the higher probability of exit for a VC-backed SU must mean that VCs provide important value added functions as well (misleadingly termed '*monitoring*'). Finally, among VC-backed SU, two factors increase the probability of a SU having an exit: first, the higher the number of repeated VC investments in the company; and VC reputation (as measured by accumulated exits of the VC company). Her conclusion is that the VC industry has had a significant impact on Israel's high tech industry.

A major issue when comparing VC-backed and other SU is self-selection: it may be that the higher 'performance' of the former group derives from the fact that the SU companies in their portfolio are of higher quality. Both Lukomet and Ber present some general characteristics of the two groups of SU in their respective analyses, and show significant similarity *e.g.* with respect to SU age. Our opinion is that these and other similarities do not conclusively do away with the problem: a VC company may be of higher quality than another one who looks similar in terms of observable, quantifiable characteristics. It may be impossible in the actual state of knowledge about 'SU quality' to systematically solve this issue empirically. However, part of the problem may be solved if 'SU quality' is endogenous *i.e.* if VCs generate good companies rather than simply choosing them. This is probably true to some extent. In such a case, however, it is crucial to make a distinction between very good VC and others since only very good VCs could transform a promising SU with small value into one of high value and performance. Our interviews have revealed conclusively that the VC industry is heterogeneous in terms of its capabilities; and that many companies entering the field during Phases 2 and 3 may have been of lower quality compared to the Yozma Funds of Phase 1 (this links with the low 'supply elasticity' of VC activity, see footnote 27 above). Thus *a priori* we cannot assume that VCs, simply because they are VCs, will contribute added value to SU. The VC set itself should be divided into "high quality" and low quality segments (a classification which should be done independently of VC performance, on both theoretical and empirical grounds); and it must be shown that the performance measures of SU supported by high quality VCs are significantly higher than those of the other groups.

In Avnimelech 2002 we find an interesting attempt at comparing the impact of *Top Tier VC companies* with the set of VC backed SU and with non-VC backed companies. In-depth interviewing of about 20 VC companies (for details see Avnimelech and Teubal 2002b) helped identify the factors which may explain VC success: (a) VC managers with a strong Science/Technology Education plus SU or other high tech experience; (b) a main investor of the VC is a Global Investment Bank; (c) VCs with Strategic Investors. Top tier VCs were defined as VCs having at least: (a) and either (b) or (c) of the above characteristics. Of the 128 financial institutions investing in high tech in Israel, 16 were classified as 'Top Tier' according to this definition. Avnimelech's work is based on simple comparisons of SU companies in terms of: average valuations of IPOs; idem with respect to M&A deals; and in VC 'success ratios' (exits/investments).[46] Top Tier VCs were involved during the 90s in 40% of the M&A deals of Israeli SU and in 35% of company IPOs – much higher shares than their percentage in the VC company population. Moreover, very little difference was found between *non-top-tier VC* backed companies on the one hand and *non-VC* backed companies on the other. We get the startling result that most of the value added of the VC industry seems to be originating in the top tier VC segment almost exclusively.

[46]A high percentage of the 'Top Tier VC's have operated as part of the Yozma Program.

Still, Avnimelch's analysis seems to confirm, albeit in a different way, the result of the previous two analyses: the VC industry of this country seems to have contributed to the growth of high tech if not the economy as a whole. Since these more technical results are coherent with our macroeconomic and systems/evolutionary insights, it is reasonable to assume that the VC industry indeed had a significant economic impact.

SUMMARY AND CONCLUSIONS: POLICY AND WHAT IS DISTINCTIVE OF THE ISRAELI CASE

This paper provides an account of the emergence and development of a Venture Capital Industry in Israel, and the role it played in the recent successful growth of Israel's high tech cluster. Taking an Evolutionary & Systemic perspective, the paper discusses the co-evolutionary and dynamic process involving the business sector, technology policies, vanture capitalists, individuals & Startup companies, and foreign linkages. We attempt to show that VC emergence is part & parcel of the *reconfiguration* (Teubal and Andersen, 2001) of a pre-existing Electronics Industry one involving large amounts of SU and new and powerful links with global *capital* markets. The main conclusions and policy lessons of the paper are that specific technology policies targeted to the Venture Capital sector can be effective only to the extent that favourable background conditions exist or are created.

The main groups of factors, events or sub-processes influencing the emergence process which started in 1993, and subsequent development, are: (1) *favorable background conditions*; (2) *events in or features of the immediate pre-emergence period* (1990–92); (3) *Targeted Policies which directly triggered VC Emergence* (1993–96/7) & *Cumulativeness*; (4) *Strong VC-SU co-evolution*; (5)*Global Capital Market Links* (*IPOs* and *M&A*). The pre-existing Military-dominated Electronics industry which also underwent significant restructuring during the second half of the 80s, a coherent and important Horizontal Program supporting company R&D, domestic stabilization policies & capital market liberalization, and globalization of technology capital markets(Nasdaq) – are all, although not the only, important background conditions which facilitated VC emergence 5–10 years later. New SU creation, operation and experimentation in the early 90s by individuals and organizations; a situation of 'unsatisfied demand' for VC services; identification of VC as a 'systemic failure' and policy experiments leading to selection of the Limited Partnership form of VC organization- all of these generated particularly favourable pre-emergence circumstances. They enabled an appropiate design of *Targeted* VC policies (Yozma Program) and the onset of a cumulative process of VC emergence & development. VC-SU co-evolution, which parallells supply-demand and user-producer links and interactions in young markets, represented one important axis and probably a distinctive characteristic of the cumulative process taking place in Israel. Another distinctive aspect of the process that took place there is the large numbers of IPOs in global markets; and the large scope of M&A activity which took place.

Grosso Modo the Israeli high tech experience of the 90s is seemingly quite similar to that of Silicon Valley (both during emergence and during the 'reconfiguration' of the 80s/growth in the 90s, see Saxenian op. cit, Chapter 5); and also similar to that experienced by Ireland, and in some respects, Korea during the 90s. With Silicon Valley the main difference concerns policy: no Horizontal R&D Support program there nor was there a *targeted* policy directed to create a Venture Capital industry. But both in terms of degree of success, and in terms of the importance of SU, VC, their co-evolution and links with Nasdaq—Israel seemed to have followed quite closely the previously tested Silicon Valley model.

Like in Israel, in both Ireland and Korea critical roles were played by pre-existing industry -MNEs in Ireland and Chaebol in the case of Korea during their restructuring after 1997 – and by policy. Although a deeper analysis would be required to ascertain cluster dynamics in both of these countries, it seems to us that policies adopted in those countries bear similarities to those adopted in Israel both in terms of their impact and in terms of their nature and structure. Moreover, in Israel (Teubal and Avnimelech, 2002) and in other high tech clusters (Breshnahan *et al.*, 2002), existing industry also provided the SU segment with entrepreneurs and with significant management spillovers. This also has been the case of Ireland and is undoubtedly taking place now in Korea.

The Israeli pattern of VC emergence and high tech cluster reconfiguration seems to be very different from that experienced in other recent high tech and software clusters. We focus here on Cambridge and Bangalore. Cambridge was probably less successful than Israel (Breshnahan *et al.* op. cit) and this may be related to significant differences in policy (both innovation support in general and targeted support of VC), in the 'intensity' of SU & VC, in the extent of their co-evolution, and on the strength of its links with Nasdaq. This makes for a very significant difference, similarly with Bangalore. While the degree of success is at least comparable to that of Israel (in many respects it may be higher) we observe the following differences: the emergence of a Software industry rather than re-configuration of prior IT high tech industry, focus on 'services' rather than 'products' and R&D as is the case in Israel, led by large companies rather than by SU & VC, and few linkages with Nasdaq. This is a long list of differences: it shows that what happened in India differed considerably with what happened in Israel A strong potential similarity is expected, however for the future (see Teubal, 2002a): a new phase in Indian IT/Software will emerge, based on the Software 'services' industry which developed in the 90s. This may very well involve many features of Silicon Valley and Israel: returning nationals, product software and hardware, large numbers of SU & VC; and strong links with global capital markets.

Finally a number of issues emerge from the Israeli experience which pertains both to policy and to the possibility of applying the Israeli model elsewhere. The first is that the *VC industry does not arise in a vacuum*, that is targeted VC support probably should not represent the central thrust of policy directed *to create* a high tech sector (Gelvan and Teubal, 1997). VC should be regarded-at least in the beginning- as a domestic, relatively non traded 'service' which might be stimulated or triggered once a high tech sector exists and attained a certain size. Second, the Israeli case suggests the *importance of a Mix of Policies* (Teubal and Andersen op. cit) *e.g.* an horizontal policy which helps create favourable background conditions in terms of innovation in the business sector in general; and a subsequent targeted policy directed to the 'private support infrastructure' for such an R&D performing and high tech sector (P. Cooke's term for VC). *ITP-Business Sector co-evolution* lies at the root of this process. The initial program's impact on the business sector helped identify the economy's comparative advantage in innovation & high tech; and indirectly, the specific 'needs' or priorities which a subsequent targeted program (*e.g.* Yoama) could address. This process fits the SI perspective to ITP quite well (Teubal, 2002) with it's emphasize on the *portfolio* of coordinated programs (and policies) rather than the piecemeal analysis of the impact of each program individually. Building a portfolio of policies is not simple; it requires policy makers to adopt an evolutionary/systemic perspective involving varying degrees and forms of Government intervention depending on context; while simultaneously paying attention not only to incentives but also to institutions and organizational forms. This relates to the last point: in the Israeli experience, *the timing and design of Yozma* (*the* '*targeted policy*') *seemed to be crucial*. A necessary step was Policy Experimentation prior to selection of an appropiate design; and Policy Learning based on closely following a series of Business Experiments about the new model of high tech which seemed to be emerging from fundamentally changed conditions in the external environment of the country.

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