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**ISRAELS VENTURE CAPITAL (VC) INDUSTRY: EMERGENCE,
OPERATION AND IMPACT***

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LIST OF ACRONYMS

SU - Start Up, Start Up company

VC - Venture Capital, Venture Capital Company

LP - Limited Partnership

IPO - Initial Public Offering

M&A - Mergers & Acquisitions

IT - Information Technology

ICT - Information and Communications Technology

ITP - Innovation & 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

1. OBJECTIVES OF THE RESEARCH

The essay focuses on Israel's Venture Capital Industry, its emergence, and operation during the 90s, during which period the number of VC Funds increased from 2 to over 100. The context is the transformation of Israel's high tech industry as a whole 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 and the specificities of the wider high tech context under which Israeli VC companies operate.

The approach adopted is Evolutionary & Systemic approach rather than a focus on 'the operation' of a mature Venture Capital industry which has been more frequent in the literature (Gompers & 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 not only its *operation*); and because we will link these with core Evolutionary concepts such as *variation, selection and reproduction*. In fact, a lot of effort is taken to set the context, which led to the central 'emergence' events of the 90s. 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, indirectly, strongly stimulated to VC industry 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.

The analysis takes place at the meso (VC industry) level where we focus on the evolution of the new industry in quantitative and qualitative terms; and where we undertake a preliminary analysis of the *dynamics of emergence*. However, as mentioned, the approach taken leads us to strive to link variables at this level with the wider high tech cluster *and* with the micro-VC company & fund-level (which is the subject of follow up research).

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*

For the High Tech Cluster as a whole and for Venture Capital we make a distinction between Background Conditions (e.g. the Electronics Industry of the 80s, business sector R&D support, etc); a pre-emergence phase (1990-93) and an emergence phase (1993-5)-

¹This has been amply confirmed by the literature (see below).

²One 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 support (Florida 1987, 1994). This stands in contrast with the Israeli Experience .

the latter constituting Phase 1 of growth of the VC industry. Moreover, for Venture Capital we will also consider two post-emergence phases: Phase 2, 1996-8; and Phase 3, 1999-2000.

2. Analyze the role of policy in the above and arrive at policy implications.

We will consider the role of business sector oriented R&D policy (the 'Backbone' "R&D Industrial Fund") policy both in creating Israel's hi tech industry (starting in 1969) and in complementing more specific policies directed towards Venture Capital; and a detailed analysis of Targeted policies favoring VC in Israel and their impact, particularly Yozma – a Government Program and Venture Capital company implemented/operating between 1993-97. The latter is widely regarded as having been the trigger of Israel's VC industry.

Structure of the Paper

This paper consists of two main Parts: A and B. Part A provides the background to the VC industry as it emerged and operated during the 90s. The background focuses both on the evolution of R&D & of hi tech industry/business sector; and it encompasses both 'positive' as well as 'normative' or policy aspects. High tech and R&D till approximately 1990 preceded a clearly identifiable Venture Capital industry; and to some extent we might say that Venture Capital, as it emerged and developed during the 90s, was an outgrowth of these developments. In contrast to this, High tech & R&D in the 90s are largely contemporaneous and co-evolves with Venture Capital. They comprise the broader system, which both affects and is affected by it. This sets the basis for a closer look at the dynamics of emergence and co-evolution in Part B.

Part B outlines a conceptual 'model' for the emergence and development of Venture Capital, including aspects of the above-mentioned co-evolutionary processes. The emphases are two-fold: first an analysis of the *trigger* to the emergence of Venture Capital--the so-called Yozma Program whose implementation began in 1993. Second, an analysis both of the *immediate pre-emergence* phase (1990-1993) and some analysis of the *emergence & post-emergence phases (1993-2000)*. The former 'qualitative' analysis delves quite in detail into the particulars of the Yozma initiative and the Yozma Policy Process, its antecedents and reasons for success. The latter is based on data, some of it generated by the research team itself; as well as on qualitative analysis. We end up with a conceptual 'Dynamic Co-Evolutionary Sequence' whose features represent the distinctive characteristics of the Israeli case. It summarizes what can be done at the *meso-level* of analysis.

2.THEORETICAL APPROACHES

2.1 Venture Capital in the Literature.

Venture capitalists invest in new unproven, entrepreneurial companies particularly in hi tech areas, which are ignored by traditional financial institutions. These firms are characterized by a lot of asymmetric information problems, agency problems & conflicts of interests, significant intangible assets, years of negative earnings, and have uncertain prospects. As a result they are unlikely to receive bank loans or other debt financing from traditional investors. For many of these young firms, VCs are the only potential source of financing. Gompers & Lerner 1999 and other researchers pointed out 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 & 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.

More specifically Venture Capital performs two important roles: it overcomes market failure associated with equity issues of SU companies; and it provides other Value Adding functions and activities to such companies. We briefly refer to each one of these.

Overcoming Market Failure in (equity) Issues of SU Companies

Akerlof (1970) argues that asymmetric information can cause market failure in equity issues of young and risky firms. This will generally lead to IPO “underpricing” which VCs can help overcome through a mechanism called ‘third party certification’. Third party certification has value whenever securities are being issued in capital markets where insiders of the issuing firm and the outside investors have different information sets concerning the value of the offering firm. 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).

For VCs to effectively undertake such functions as well as other value adding functions they have to undertake both *scanning* and *due diligence* activities. The first step is reading & evaluating a start up company’s business plan and meeting its managers. Due diligence is performed on a subset of companies scanned who are strong candidates for subsequent investment. It involves a detailed search of references, the solicitation of outside information from potential customers, suppliers and competitors about the quality of the technology and the entrepreneurial group, and often lasts for several months. During the due diligence process VCs tend to make use of personal networking and business links. This helps them to get reliable information, which is very critical in this risky and uncertain business.

Value Added: Management Assistance & Networking

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 1994, Florida and others). Venture capital bridge between sources of finance, entrepreneurs, scientists, suppliers, and customers. According to Florida op. Cit. 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 80’s and early 90’s.

The valued added of VC companies might be an explanation for the observed lower under-pricing and lower issuing costs experienced by VC-backed startups. In order to help start-up entrepreneurs, who generally have little management experience, to manage fast growing companies' management assistance & training is required. Gorman and Sahlman (1989) found that lack of management skills is the most significant reason for startup companies failure. VCs typically try to add value to their portfolio companies through assistance to management in strategic decisions. Sapienza, Manrgart and Vermeir (1996) found that VCs believe that their strategic involvement is their most important role in adding value to their portfolio companies. Moreover, they found that VCs with experience in the portfolio companies’ industry generated more add value than VCs without such prior experience. Also VC

capitalists with technology & entrepreneurial background generate more value added than VCs with financial background.

VC's also maintain close ties with investment bankers who can assist portfolio companies going public or going through an M&A process. They also have ties with hi-tech corporations that can open doors (e.g. of clients, for product testing for example) to their portfolio companies and assist in the scanning process. According to Florida (1987 op. Cit.) VCs are involved in four overlapping networks of agents related to the innovation process: financial institutions, entrepreneurs, professional business services, and professional labor market.

According to Gompers (1995, 1997) and compared to start ups not linked to VCs, VC backed startups on average go public younger; have less under-pricing, cheaper underwriter costs & higher valuation at the IPO; and perform better after the IPO. The superior performances of such companies is due to VCs' good scanning, monitoring activities, reputational added value, networking added value and management added value.

The Limited Partnership (LP) VC company: Characteristics and monitoring mechanisms to reduce conflict of interests

Venture Capital in the 'Silicon Valley' model of hi tech largely takes the form of Limited Partnerships (LP), although Corporate Venture Capital companies and publicly traded companies co-exist with this form of organization. This is also the case in Israel. In the LP form of organization the VC company is a Management Company which manages one or more VC Funds and which shares in their profits. The owners of the Management Company are termed General Partners. Each VC fund has investors (called *Limited Partners*) and *Portfolio Companies* –that is companies where VCs have made investments in exchange of a share in their ownership. After raising the capital for a new VC Fund, the fund is closed and the VC (management) company begins activities connected to investment. It starts by scanning, undertaking due diligence, investing and undertaking an active role in management & decision making of portfolio companies. Since a VC fund operates typically for a period of 7 years and since it has an obligation to re-imbrues investors in cash, a major activity of the VC is 'exiting' that is selling the VC funds' ownership shares in its portfolio companies. In the US and in Israel, the typical modes of exit are two: IPO (initial public offering) in the stock market or selling the companies through M&A (mergers and acquisitions) deals³. The IPO exits are typically in Nasdaq (but increasingly in Europe), which is a *public* capital market where typically about 20-30% of ownership is eventually floated (after one issue or more). The selling exits are includes selling 100% (acquisition) or selling less then 100% (Merger) of the company to another company, typically a large corporation whose technologies/ products are complementary to those developed in the company concerned. The latter *private* capital market transaction is part of the activity 'Merger & Acquisition' (M&A)⁴.

Limited Partnership contracts address obvious areas of conflict of interests between general partners & limited partners; and between the VC Company & its portfolio companies. Both involve agency problems. Moreover, VC's have means to reduce conflicts of interests between principals (limited partners, VC companies) and agents (general partners, portfolio companies). To deal with the latter group of

³ These are only the two *main* exiting mechanisms. Each one comprises a number of specific variants related to timing and purpose of exits e.g. selling of technology in early phase compared with M&A of companies' technologies and operations at a later stage.

⁴A. Schwiabacher 2001 states that in the last 5 years in Europe the ratio 'trade sales' to IPO exceeds 2.5. The ratio in the US varied between 1.1 and 1.7. Our partial figures for Israel show an M&A/IPO ratio of *less than 1*.

conflicts VC investments involve equity finance, the use of convertible securities, syndication & staging of investments, the use of the ratchet mechanism; and many other mechanisms.

2.2 Systems of Innovation Perspective & Literature

The basic set of papers on the System of Innovation or Systems/Evolutionary perspective can be found in the writings of Nelson, Lundvall, Edquist and others⁵. 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 2001). This framework is directly applicable to 'high tech clusters' which are Regional High Tech Sector Systems of Innovation (Saxenian op.Cit) . The main objective of research following this perspective concerns not system 'operation' but rather system dynamics; and more specifically the transformation of a System of Innovation e.g. from a high tech cluster without VC to one including VC.

There are five System Components: the Business Sector; the Supporting Structure; Links & Interactions, Institutions & Markets; and Culture & Social Structure. In such systems the Business Sector would include SU firms; non-SU firms involved in downstream production and marketing (as well as in R&D); VC companies; and an assortment of market agents involved in providing specialized services to high tech. The Supporting Structure would involve Universities, Government Laboratories, the segment of the VC industry which is either Government owned or linked to Government (Yozma Funds in Israel), Industry Associations, Policy Institutions (like the OCS), and other non-market organizations of relevance for hi-tech (e.g. the Computer Division of the Israeli Army). The perspective emphasizes the importance of both market and non-market links; and as applied to high tech, the importance of international, cross border links e.g. with Global Capital Markets. Finally, under systems perspective the role of institutions & culture is emphasized e.g. the importance of personal links & the culture of openness in Silicon Valley (Saxenian 1998). In what follows we briefly describe General Principles, which are illustrated with examples pertinent to VC-emergence in Israel. We then proceed to identify what research questions are asked by this perspective and link them with those asked in the specific VC literature.

'Positive' General Principles include the importance of *Learning* (such as interactive learning between VCs & SU companies), of *New System Components* (a distinct VC industry), of *Cumulativeness*⁶ & *VC-SU Co-evolution* which could lead to a self-sustained process of high tech growth; of *Emergence of New Demands* e.g. For the services provided by the new VC s; *Fundamental Uncertainty*; *Possibility of Lock In*; and others.

'Normative' General Principles include: *Adaptive Policy Maker* (Metcalf 1992); *Policy as Judgement & An Explicit Strategy*: rather than Neoclassical Optimizing Policy Maker where priorities are obvious and policies can be determined with certainty). That is the Systems perspective recognizes the importance of identifying strategic priorities such as 'creation of a VC industry' or 'creation of a

⁵See Nelson & Winter 1982, Nelson 1993, 1995, 1999; Lundval 1992 and Edquist 1997.

⁶ Krugman 1991 when referring to high tech clusters states that 'small historical events start a cumulative process in which the presence of a large number of firms and workers acts as incentive for still more firms and workers to congregate at a particular location'. This corresponds to the post variation/selection phase of evolutionary processes (*reproduction*) in which *imitation, learning, exploitation of scale economies & system effects* (the latter could be appearance of a new component of the Supporting Structure which considerably facilitates SU creation and development) increase the proportion of the selected variant in the total population. See also Teubal 2002.

modern high tech cluster' more generally speaking. Other 'Normative' General Principles include *Policy is Context Specific* e.g. Cluster creating policies for one context need not be effective in another; *A Portfolio of Coordinated Policies*- rather than simple support of R&D; a *Policy Mix* involving both incentives and institutional changes as well as *Horizontal & Targeted Programs* etc.

Both sets of principles will be applied in this paper. We start by pointing out how an analysis of Venture Capital following this perspective would differ from the type of analysis (and the questions) usually followed (asked) in the specific VC literature surveyed above. To start with the systems/evolutionary perspective would try to differentiate between high tech clusters with Venture Capital (a 'private' business enterprise support mechanism, see Cooke 2001) and those without Venture Capital. This will help to understand the differential success of both at different phases in the process of Globalization of the world economy, particularly of financial/capital markets. Moreover, the questions asked include the *emergence of Venture Capital* and more generally the *transition from VC-less systems of innovation to VC-based, SU-intensive systems*. One issue is whether *VC-SU co-evolution* is necessary for successful emergence of a Silicon-type high tech cluster⁷. More generally a discussion of VC dynamics and its impact cannot be conducted in isolation from the broader discussion of transition to the new system of innovation.⁸

A major aspect of the above is the role of Venture Capital a) in the creation of SU companies; and b) in their growth and evolution,⁹ that is the co-evolution question could be considered a central aspect of the approach as applied to high tech clusters. For several reasons, this goes beyond the measurement of differences between VC-backed and non VC-backed companies as is common in the specific VC literature (see Gompers 1995,7 op. Cit and Lukomet 2000). Once we talk about co-evolution we cannot avoid dealing with: the *substance* of VC value added and exits; with *learning and other dynamic processes*; and with *externalities & social impact*. Thus, measured 'impact' may depend on learning and on other factors; and for this to be useful and indicative of future potential impact it is important to know what has been learned and what constitutes relevant learning (see Part B Section 3). Analyzing these issues requires delving into the substance of the relevant activities, and about how they evolved through time e.g. how less sophisticated activities set the basis for more sophisticated and higher value activities; and the context under which successful learning has in fact taken place.

These are fundamental questions whose answer would shape both how we measure; how we interpret the results we get; and what policy implications follow.¹⁰ This would represent a first stage in the transition from an analysis of the operation of an existing (usually mature) VC sector to an analysis of emergence and post-emergence evolution of such industries. A second reason for underpinning measurement with significant "pre-measurement" research concerns identifying the nature of externalities and other aspects pertaining to the *social impact* (in contrast to the Private Performance) of VC companies, particularly the links between VC and

⁷This 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 Lundvall 1985, Pike et al 1990, and other authors contributing to the major works mentioned above.

⁸For 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.

⁹This has been emphasized by Saxenian in her study of IT high tech in the US and by other researchers like Cooke for biotech.

¹⁰A Systems/Evolutionary perspective would indicate that such a dynamic viewpoint should also be considered in the analysis of the mechanisms used to reduce the effects of asymmetric information, conflicts of interest and agency problems—some of the major issues considered in the specific Venture Capital literature

high tech growth more generally. It requires considering activities such as knowledge spillovers, collective learning, specific firm reputation & networking effects which 'spill-over' or are made available to the emerging high tech cluster as a whole; and novel types of backward and forward linkages (such as how more VC stimulates more SU and vice-versa).

The Systems/Evolutionary perspective can consider such a rich set of interrelationships and dynamic, co-evolutionary processes precisely because it provides a broad interpretative framework for the quantitative links established in the VC-specific literature. Thus the contribution of Venture Capital to high tech growth will very much depend on three elements. a) The stage of development of the VC industry and its capabilities; b) the types of VC companies populating the industry (e.g. a Limited Partnership form versus other forms of VC organization; the distribution of experience & skills; etc); c) on other features of the broader system or high tech cluster (e.g. Universities--who may determine the pool of skills that may populate new SU companies- or culture e.g. endogenous trends in entrepreneurship, to mention a few). These other features help to understand the processes of evolution from a small VC sector to a large one, particularly through positive feedback effects, collective learning and new industry entrants (VC-SU co-evolution may lie at the heart of this). It may also show that in some contexts, early successes in VC and in SU might be followed by strong growth of the new industry; and that this will not be the case in other contexts.

We conclude that following a system or cluster perspective might, in some instances, enrich our interpretation of the results obtained from traditional VC analysis; while in other cases it may suggest a significantly different set of relationships for empirical testing.

3. R&D, HIGH TECH AND INNOVATION/TECHNOLOGY POLICY (ITP) IN ISRAEL

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 Innovation & Technology Policy (ITP). Israeli Hi 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 (IPT). 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 2000/1 when new sets of incentives' programs were implemented.

3.1 The R&D Penetration Period (1970-89)

3.1.1 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 projects. Simultaneously, a Government Committee created to review policy recommended the stimulation of applied R&D and creation of a particular 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 (& budget) of the most important of these bureaus-that located in 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 industry¹¹.

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, hi 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%; & from 5% to 28% respectively between 1968 and 1983.¹² During the 1968-87 period the pool of Skills employed in Manufacturing grew from 3400 in 1968 to almost 20000, 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 1984-5) 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 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 (U. Galil, 28/3/01)¹³. 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. Moreover, the Army became an efficient incubator of young researchers in many technological fields. During this period 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 in 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,

¹¹Creation 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.

¹²See 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 are not the strongest product groups in the new high tech cluster of the 90s. Looking at the Business Sector as a whole (and not only at Manufacturing) the most important groups are Software & Communications Equipment (note that there was no separately identifiable software industry during the 80s).

¹³Lecture at the Hebrew University

the reduction in Military Expenditures also led to enhanced flows of engineers, technicians and scientists to civilian rather than military R&D activities¹⁴.

3.1.2 The 'Backbone' "Industrial R&D Fund"

The Israeli Government's Innovation/Technology Policy towards the Business Sector began in 1969 with the creation of the "R&D Industrial Fund" at the recently created OCS. This program was, and to some extent continues to be, the backbone of that country's R&D/Innovation/Technology Strategy as far as the Business Sector is concerned¹⁵. 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 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.

The "Industrial R&D Fund" is an example of an *Horizontal Technology Policy (HTP) 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 a *Targeted Program* applicable to a specific industry or 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 1982,93). From \$2.5M in the late sixties, the program involved disbursements, which almost reached \$300M in 1996/7¹⁶.

Due to the central role-played by "The Industrial R&D Fund" Israel's explicit R&D strategy or Innovation/Technology Policy (directed to the Business Sector) in the last 30 years can be termed an HTP-led Strategy. That program was the first of the set of programs comprising Israel's Program Portfolio; and, it was and still remains the dominant program in terms of Government disbursements and probably (at least till the 90s) in terms of impact¹⁷. Moreover, the dynamic processes unleashed by its successful implementation led to the other programs comprising Israel's Innovation & Technology Policy of the last 10 years.

¹⁴During 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.

¹⁵ Till the early 90s more than 90% of Government disbursements to Civilian R&D came out of this program.

¹⁶ 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 e.g. Lall & Teubal 1998.

¹⁷ Another smaller program-BIRD-began operating towards the end of the 70s. It was also successful and highly complementary to the main, backbone horizontal program.

A framework for understanding the impact of the “Industrial R&D Fund” is to adopt an evolutionary perspective to the implementation of the program. The objective of the program would then be *penetration and diffusion of ‘regular R&D’ throughout the Business Sector*¹⁸. While a neoclassical perspective would focus on the need to provide incentives due to market failure (caused by knowledge spillovers by firms undertaking R&D) an evolutionary perspective would focus first and foremost on the absence of R&D/Innovation capabilities as a major obstacle to diffuse R&D. Initially, when first implemented, such capabilities are non-existent or only existent in small ‘islands’ within the Business Sector. Therefore according to this perspective we should distinguish between two phases in program implementation-the first where such capabilities are absent (Infant Phase); the second when they have already achieved significant diffusion throughout the business sector (Mature Phase)

BIRD

In 1977, The Israel-United States Binational Industrial R&D foundation (BIRD-F) was established. BIRD endowment, which was contributed equally by the governments of Israel and US in the amount of \$60 million. The goal of the fund was to promote and support joint, non-defense, industrial R&D activities of companies from Israel and US. The idea was to enable young Israeli companies with pioneer technologies to calibrate with mature US companies with strong appearance in global markets. Since its establishment BIRD funds supported more than 400 joint projects. BIRD had a significant effect on the of the Israeli global hi tech industry due to the opportunity to learn managerial skills from US companies and to build Israel's hi tech reputation in the US.

3.1.3 Learning in the HTP Infant Phase

*The major objective during the Infant Phase is to promote learning about R&D/Innovation*¹⁹. Much of this learning is ‘collective learning’ that is R&D performing firms mutually learn from each other; and a lot of this learning relates not directly to technology or R&D proper but to organizational and managerial factors. The first box below proposes a certain categorization of intra-firm learning processes); while the second box, some specific aspects of ‘collective learning’ during 1969-90 in Israel²⁰.

<i>INTRA Firm Learning 'about R&D/Innovation'- Infant Phase of an HTP</i>
1. Learning how to search for Market and Technological Information.
2. Learning to identify, screen, evaluate and choose new projects
3. Learning to generate new projects, including more complex ones
4. Learn to manage the innovation process (linking Design to Production & Marketing; Selection of Personnel; Budgeting; etc)

¹⁸ Initial conditions in the ideal HTP model (see Teubal 1996,7), which reflects the conditions prevailing in Israel in 1969 are a) that R&D was practically non-existent within the Business Sector; and b) that its diffusion was a Strategic Priority of the country that is viewed as a necessary condition for growth of the business sector.

¹⁹ Learning, including experience-based learning triggered by increased R&D in the business sector is the main factor leading to enhanced R&D/Innovation capabilities.

²⁰ Both are based on studies of Israeli Hi Tech during the 70s; see Teubal et al 1976 and Spiller & Teubal 1977; (both reprinted in Teubal 1986).

Collective Learning During the Implementation of the “Industrial R&D Fund”
Firms learned about the importance of marketing (thereby overcoming the previously held view that “my invention is so good that it will sell automatically”)
Officials and experts of the OCS learned, partly through exchange of information within and informal ‘policy network’ a) to better assess the quality and potential of the projects submitted; b) how to help firms configure good projects
Firms acquired capabilities for identifying new projects, including “complex” projects which built upon prior ‘simple’ projects

3.1.4 Mature Phase Policy Restructuring

The Evolutionary Perspective to HTP states that after the infant phase of implementation of such a program (say 5-10 years depending on context) a number of developments will very likely take place: exhaustion of learning opportunities and associated externalities (in certain areas); new opportunities for complex types of R&D projects (based on capabilities generated in simpler projects); and identification of possible areas of competitive advantage. The policy implications ideally would involve a) within the HTP program- likely reductions in average R&D subsidies together with greater selectivity; b) beyond the HTP program—the implementation of a number of additional programs e.g. targeted programs for specific areas/technologies; and targeted/horizontal programs supporting generic, cooperative R&D projects. In Israel only a very limited adaptation did occur during the first phase i.e. till 1990.

3.1.5 Impact of ITP

The backbone regular R&D support program was widely regarded as having been a success in terms of stimulating R&D in the business sector. In stimulating exports resulting from R&D, and in contributing to the creation of a civilian high tech sector or cluster during the 80s (see Teubal op. Cit., Toren 1990; Justman & Zuscovitch 1999).

3.2 Silicon Valley Period (1990-2000)

3.2.1 The New High Tech Cluster

The second period runs from 1990 till 1998 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 Box.

Table 1: Israel's high Tech Cluster of the 90s- Selected Structural Elements and Comparisons

	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 (hi tech):	~130	9	1
Accumulated VC-backed IPOs:	~70	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 capital markets in the 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 the availability of data, the existence of various sources of information- including fragmentary information from non-official sources.

We can observe that the high tech cluster that emerged during the 90s was very different from the military industries dominated cluster of the 80s. Its basic feature is that of being a “SU intensive High Tech Cluster” closely following the Silicon Valley model of High Tech where both SU and VC increasingly play important roles (Teubal 1999). It is also much more integrated and linked with the US and its hi tech clusters in Silicon Valley, Boston area and elsewhere. Thus, the number of SU companies was estimated at 3000 for 1999/00 although another estimates show that this number was already reached in 1997 (Gelvan & Teubal op.cit). The number of VC funds increased from one in 1991 to over a hundred towards the end of the decade (IVA 1997,2000). In parallel to this the economy continued the hi-tech biased structural change initiated in the seventies but in an accelerated mode (Justman 2000). Within manufacturing (and also Services) we observe a sharp increase in the weight of hi-tech industry. Table 2 shows some basic data on IT high tech manufacturing industries till 2000,1. There was a fourfold increase in the Sales from over 3 billion to slightly over 12 billion dollars. 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 (Avnimelech et.al 2000)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%)²².

Table 2: IT Hi-Tech manufacturing Industry Sales, Exports and Employees

Year	Total Sales (000\$)	Exports (000\$)	Employees	Sale per Employee (000\$)
1995	5,890	4,300	40,000	147
1996	6,500	4,880	42,000	155
1997	7,200	5,700	43,000	166
1998	8,030	6,550	44,700	180
1999	8,580	7,130	45,800	187
2000	12,500	11,000	53,800	232

* Source: Israel Association of Electronic and Information Industries.

3.2.2 New Programs

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 Program Sequencing Box below). Simultaneously with this, we see an expansion of the ‘regular’ R&D support program till 1997. See data in Table and the summary of OCS activity for the year 1997

²¹The OECD average was 9.9 % in 1996; and that for the US was 11.8.%

²²Central Bureau of Statistics 2000

BOX2: NEW ITP PROGRAMS—SILICON VALLEY PERIOD

1) <i>Inbal</i> (1992) - a Government owned Insurance company, which gave partial (70%) guarantee to traded VC funds. Four VC companies were established under Inbal regulations.
2) <i>Yozma</i> (1993-97)—a 100 M\$ Government owned Venture Capital company, which invested in 10 Funds which operated in Israel (8M\$ per fund).
3) <i>Magnet Program</i> (1992-)-a 60/70 M \$ a year Horizontal Program supporting cooperative, generic R&D involving two or more firms and at least one University. Widely regarded as a successful program
4) <i>Technological Incubators' Program</i> (1992--)-a year program supporting entrepreneurs during the Seed Phase of their project, for a period of three years. The incubators are privately owned and managed. Both they and the projects approved get financial support from the Government. The program complements the "Industrial R&D Fund" (projects could be submitted to either program). It contributed to the transformation of Israel's high tech cluster during the 90s, particularly in the early years.

Statistics

Table 3 summarizes OCS grants for all programs: support of regular R&D (what we termed the 'Backbone' support program or Industrial R&D Fund), Magnet, Technology Incubators and the other smaller programs which were implemented during the 90s. The rate of growth of total Grants declines considerably during the second half of the 90s compared to the first half of the decade but the yearly absolute level of grants does not decline till 2001.²³ The figure for Total Grants includes Royalties collected from the main backbone R&D support program (royalties are collected only on R&D programs leading to sales up to the real amount of the government subsidy, and at a rate of about 3 % of sales). These royalties—shown in the last column of the table-- amounted to 64 M \$ in 1995 (19 % of total) and to 154 M \$ in 2000 (35% of total), that is their share of total disbursements has risen sharply during the second half of the 90s. This means that Total Grants *net of Royalties* declined by 9% between 1995 and 2001. Concerning structure the first point is that the scope of Regular ('backbone') R&D support has not declined during the 90s despite reductions in *net* Government disbursements. The second point is that in 1995 the second and third programs in terms of disbursements were Technological Incubators and Magnet respectively (with 31 and 15.3 million dollars respectively); and that a rank reversal of these two programs occurred in 1996. Since then, the second most important program in terms of scope of grants extended is the Magnet Program with 66.6 M\$ disbursements in the year 2000 (15 % of total). The scope of the Technological Incubators program remained more or less constant (31.6 M\$ in 2000) which means a significant reduction in its share of total OCS grants. Also the number of projects in Government supported Incubators has declined between 1997 and 2000 (Table 3). We also know that there was a decline in the number of firms requesting support between 1997 and 2000—over 20%; and a slight decline in the ratio of projects whose support was requested to projects which were approved.

²³This means that Government support for R&D (actual disbursements *plus* Royalties) not only continued but increased after the first phase in the evolution of the VC industry (see Part B).

Table 3: OCS R&D Grants (NOMINAL \$ MILLION)

Year	Total Grants (Percent Change)	Regular support	R&D	MAGNET	Technology Incubators	Miscellaneous	Royalties
1995	346 (9.4)	286		15	31	13	64
1996	348 (0.5)	276		36	30	5	91
1997	397 (14.1)	303		53	30	11	121
1998	400 (0.1)	307		61	30	2	133
1999	428 (7.0)	331		59	30	8	159
2000	440 (2.8)	334		67	32	8	154
2001	432 (-1.9)	330		64	32	6	176

* Source: Office of the Chief Scientist.

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

1. THE EMERGENCE OF VENTURE CAPITAL

1.1 Explanatory Factors and 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 & Teubal 1997 list some of these). The factors affecting the early phases of the industry are classified here into three groups: Background Structural Conditions, Pre-emergence Conditions & Triggers. A fourth group of factors deals with Conditions Conducive to Learning & Cumulativeness. The Box summarizes the various categories

EMERGENCE AND DEVELOPMENT OF ISRAEL'S VC INDUSTRY & HIGH TECH CLUSTER OF THE 90s-EXPLANATORY FACTORS

<i>BACKGROUND STRUCTURAL CONDITIONS</i>
<input type="checkbox"/> Large Pool of qualified Scientists and Engineers, and Universities capable of adding to this flow
<input type="checkbox"/> The prior existence of a Civilian Hi Tech industry with experience in R&D Projects/Innovation
<input type="checkbox"/> Strong prior MNE presence in Israel (Motorola, IBM, DEC, Intel, etc)
<input type="checkbox"/> Restructuring of the Military Industries
<input type="checkbox"/> The prior existence of the Backbone, Horizontal program supporting R&D in the Business Sector
<input type="checkbox"/> Special Institutions (Army, etc)
<input type="checkbox"/> Liberalization of Capital Markets during the 80s, and of the economy more generally speaking
<input type="checkbox"/> A successful price stabilization program;
<input type="checkbox"/> The restructuring of Military Industries
<input type="checkbox"/> Existence of a number of Communications Equipment companies (Tadiran, ECI, Fibronics, PhaseCom etc) from which a number of important spinoffs of the 90s took place(e.g NiceCom subsequently sold to 3-Com)

<i>PRE-EMERGENCE CONDITIONS & TRIGGERS (late 80s-1993)</i>
<input type="checkbox"/> 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)
<input type="checkbox"/> Globalization of US Investment Banks; and their searching for opportunities in Israel;
<input type="checkbox"/> Individuals(foreign and returning Israelis) coming to Israel to search for new investment opportunities in High Tech
<input type="checkbox"/> High Rate of Start Up Formation: 1988 – 1992
<input type="checkbox"/> New Government Programs-both General and Targeted to VC: The Inbal program(1991), Magnet(1992) , Technology Incubators(199) and Yozma(1993)

CONDITIONS ASSURING LEARNING AND CUMULATIVENESS(1993-96)
<ul style="list-style-type: none"> <input type="checkbox"/> <i>The Gulf War and initiation of the Peace Process-which contributed to reduce Israel's isolation, making it more attractive for business and investments;</i> <input type="checkbox"/> <i>Continued Implementation of the R&D Support Scheme and of the Programs implemented in the early 90s</i>
<ul style="list-style-type: none"> <input type="checkbox"/> <i>Immigration from the former Soviet Union—a large number of engineers and medical doctors settled in Israel and worked in High Tech</i>
<ul style="list-style-type: none"> <input type="checkbox"/> <i>New Innovation opportunities world wide, particularly in Communications, due to the ongoing IT Revolution and to the Liberalization of Telecommunications.</i> <input type="checkbox"/> <i>Cultural Shift favoring entrepreneurship</i>

The pre-existing ‘backbone’ R&D support program affected both the supply and on the demand for VC-services: its R&D grants directly enhanced SU formation and ‘demand’ (e.g. by engineers formerly working in the Military, in MNE or in large domestic companies; and by recent graduates). They also affected VC ‘supply’ since R&D Grants were 'complementary' to VC investments since start ups could obtain such grants from the Government while at the same time receive investments from VC companies (this represented indirect incentives to VC investments). The Backbone R&D Support Program thus contributed to the creation of a 'market for VC-related services' in more than one way.

Restructuring of Military Industries in the mid 80s had the effect that significant numbers of 'incumbent' engineers and technicians began looking for alternatives in the Civilian High Tech; and so did increasing proportions of new graduates. Table 4 below provides some basic data on this matter.

Table 4: Changes in Civilian & 'Military' High Tech Employment: 1984-87 (Transportation Equipment & Electronics Sub-Branched)

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

Pre-Emergence Conditions & Triggers (late 80s-1993)

Foremost here is the beginning of a new phase in the Globalization process: foreign hi tech Start Ups 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; and three (pre-Yozma) VC companies began operating (Athena, Star and Giza) The significant SU activity which appeared in the early 90s provided *pointers towards the new model of high tech* and a *potential for learning*. The actual trigger, as far as we know was implementation of Yozma in 1993; and its operation throughout 1995-6. This provided the critical mass for the onset of a cumulative, self-reinforcing process of growth of VCs and SU s. Between 250-300 M\$ were raised during the three year period and significant amounts were invested.

Conditions Conducive to Learning and Cumulativeness (1993-6)

Strong collective learning processes took place during these three years and beyond, triggered by Yozma, who contributed to attain the critical mass which made this process effective and self-sustaining. These concerned scanning, due diligence, investment, monitoring, and exiting of the portfolio companies of the new funds. This further stimulated entry of new VC companies, and accelerated creation of second/third funds by existing Yozma VC companies. The feedback-cumulative process was also fueled by favorable changes in the *External Environment* in particular the rise of the Nasdaq Index, and deregulation of communications. Additional factors were the Oslo peace agreements, the Russian Immigration, and domestic regulatory changes²⁴.

1.2 VC Targeted Policies

There is wide consensus that one of the major factors triggering emergence of Israeli VCs was Yozma. As mentioned, the implementation of this program cannot be considered as obvious and automatic. It might not have happened, but it did. As mentioned above the factors responsible for this included the vision, capabilities, and 'policy learning' of Israeli Policy Makers at the time. We should not underestimate the importance of 'luck' or randomness in the process. Let us recall some of the background conditions which were operating at the time and which *transformed Yozma into an effective trigger of Israel's new High Tech Cluster*: the backbone R&D support Program; the restructuring of the Military Industries and New Innovation Opportunities, particularly in the IT area. These, together with a *cultural shift* where self employment and enterprise were increasingly being considered prestigious in Israeli Society, generated a spurt of SU activity during the early 90s (it then transformed itself into a wave). More specifically they 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 emergence and subsequent 'cumulativeness'. In addition, we should not underestimate the specifics of the design and of the implementation of Yozma.

The Policy Context

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; and there were many attempts to create startup companies, which largely failed.

One of the targets was enhancement of start up formation and their survival. Till the 90s, the percentage of successful young companies was extremely low and the accepted view was that this resulted from weak management abilities. Experts in the field and officials in the Treasury (who had good BA training in Economics) realized that despite massive Government support for R&D there still was a clear 'market failure'²⁵ which blocked the successful creation and development of Start Up companies. The head of OCS or "Chief Scientist" at the time, Ygal Erlich, pondered

²⁴A more systematic treatment of the cumulative process ensuing after 1993 would require microeconomic analysis of collective *learning, Knowledge Dissemination by Yozma & Links/Other Cluster Effects*.

²⁵In fact both a 'market' and an 'institutional/systemic' failure.

about how to make OCS support more effective. There was not then, even one real success "similar to those we see today" (interview 1/98). The basic 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 between 1-3 Venture Capital Companies but it was clear that the total capital available was inadequate for the task at hand.

1.2.1. Inbal

The Inbal program was implemented one year before the implementation of Yozma. Its central idea was to stimulate VC funds by guaranteeing the Downside of their investments. The mechanism used was creation of a Government Insurance Company ("Inbal") that provided a 70% guarantee to VC funds traded in the stock market (calculated as 70% of the value of their public issue). The program imposed certain restrictions on the investments of the 'protected' Funds. Four (4) funds were established—Mofet, Marathon, Teuza and Sdot Mop. They and the Inbal program, as a whole was not a great success. Fund valuations in the stock market were like those of Holding Companies (i.e. low-valuations). 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 succeeded in doing. Today all the (former)Inbal Funds are 'held' by one company-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 contributing to the operation of the fund; the greater difficulty in exploiting reputation earned from early exits to increase the capital invested (in LP form of organization it would be easy to rapidly raise a second fund; and absence of incentives relevant to the upside.

1.2.2 Yozma Program²⁶

The program began operating in 1992. The explicit objective was to create a solid base for the industry; to learn the business from foreign 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 idea was to promote the establishment of Israeli VC funds that invested in young Israeli high tech startups with the support of government and with the involvement of foreign financial/investment institutions. Each fund would have to get the investment of one such foreign institution together with that of a well-established Israeli financial institution. When a fund fulfilled these conditions, the Government would invest (through Yozma) around 40%(up to 8 \$million) of the funds raised. Each fund also had a call option on Government shares, at cost (plus interest) and for a period of five (5) years. This was the main incentive of Yozma beyond risk sharing with the Government. It was not a simple supply incentive as was common in other Government VC support programs; rather it was an incentive to the 'upside'. 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 &

²⁶Most 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 Pavia in February 2001; and from other sources.

Technological Incubators Programs (see above).

In total 10 private 'Yozma funds' were created but the Yozma Program also included the 20 M\$ directly invested by the Government through Yozma 1 Fund which started operating in 1993. Five were also founded in 1993: Gemini, Star, Concord, Pitango, Walden; one in 1994: JVP; two in 1995: Medica & EuroFund; one in 1996: Genesis; 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 start up companies.

Impact

The Yozma funds initiated a dynamic, cumulative process involving: learning by doing and imitation/learning from foreigners. It was a collective learning process, which also contributed to exploitation of economies of scale and specialization. As mentioned, Venture Capital co-evolved with Start Ups; with high tech more generally speaking; and with a whole range of specialized services supporting the new high tech cluster.

An indication of their success in triggering growth of the industry is their expansion, which took the form of 'follow up' funds. Each one of the Yozma funds (and some other funds as well, who indirectly learned from the Yozma experience) was followed by one or more additional funds managed by an expanding but related core of managers. *The total sums managed by this group today is approximately 5 \$billion*, a large share of total funds managed today. Another measure of the success is the rapid entry of non-Yozma related funds, something triggered by the handsome profits obtained by Yozma Funds.

2. STATISTICS AND DESCRIPTION OF THE ISRAELI VC INDUSTRY

2.1 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 the late 60's and 70's, DIC, Elron and Scitex had only few venture capital related investments. 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 1985, following previous success in venture investments in Israel Fred Adler established with Dan Tolkowsky the first formal VC company- Atena (Elron was a limited partner in the fund with 10% of equity). In the 80's, only a few Israeli companies were VC backed including Fibronics, Optrotech, Biotechnology General and Zoran.

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 3 funds raising \$37 million.

Finally, in 1991/2 & in 1993 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 Table 5).

Table 5: 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.

Total capital raised per year during 1991-1996 ranged from 58 M\$ in 1991 to 397 M\$ in 1996; and from 727 M\$ in 1997 to 3288 M\$ in the year 2000. In fact during the second half of the 90's, the Israeli VC industry becomes a significant VC industry with huge influence on Israel's hi-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. We see that prior to the establishment of Yozma Funds there already was VC activity, it did not amount to significant amounts. The big jump occurred in 1993 when Private VCs raised 162 M\$ compared to 27 million the year before (primarily Yozma Funds). Note that during 1992 non-Private VCs played a dominant role in total Capital raised—133M\$ compared to 27 M\$ capital raised by Private VCs. This in part reflects the Inbal incentives on Public VC raising of capital; but capital was also raised by the other two categories of financial institutions-Private Equity Funds, and Investment Companies.

These observations sustain our presumption (also buttressed by qualitative evidence) that a) there were already non-insignificant VC and VC-related activity prior to implementation of Yozma (160 M\$ raised in 1992)-a fact which may have been significant for Yozma's impact two- three years after; b) that Yozma's 200 + M\$ raised in 1993-95 significantly contributed to create a critical mass which triggered a cumulative process of growth in the VC industry during the second half of the 90s²⁷; and c) that the dominant form of organization was, and increasingly so, private VC companies (which means in our case Limited Partnerships)²⁸. Also d) the Inbal Program did not *directly* generate, in its wake, a cumulative process of steady growth (although it did have important *indirect effects* through increased effectiveness of the Yozma program).

2.2 The Growth of SU and of VC-backed SU companies

Table 6 shows *gross addition* estimates of new Start Up companies which began operating since 1991 (rows 2,3) and estimates of VC backed SU(row 1). Row 3 are new firms requesting OCS support which are SU. These are good estimates of numbers of new SU before the onset of VC towards the mid-90s (since they were no additional sources of finance till then)²⁹. Gross new SU prior for 1991,2 i.e. prior to implementation of Yozma are estimated to range between 80 (row 2) and 143 (row 3)

²⁷46% of total funds raised during 1994-6 where from Private VCs(up from 35 % from 1992-94). About half are directly from Yozma Funds; they may have indirectly influenced the others. Note however the importance of Private Equity Funds in capital raised during '93 and '94. (At least some of the)Yozma funds however emphasized Early Phase financing, in contrast to the policy of other VC s. This would have a much larger effect on new SU companies compared to the effect of later phase financing. Through this mechanism it also would have indirectly stimulated others to enter the industry.

²⁸Especially since 1996 where private VC funds raised represented 93%, with the ratio moving between 80-96% till the year 2000.

²⁹Also SU after 1995-6 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).

companies. Significant increases during 1993, 4 (at least 100 and most probably around 380) and sharp increases year by year after that (excepting 1998). This reflects the 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 (the indirect impact should also include the acceleration of SU formation itself starting in 1995-which led to a Steady Growth/Cumulative process during the post-emergence period after 1995). Thus while during 1991,2 new VC-backed SU trail below new SU, the reverse seems to occur during 1993,4-the first two years of implementation of Yozma (according to one measure of new SU); while according to the alternative measure in the third row the share of new VC backed over new SUs increased from approx. 20 % to approx. 50 % between 1992 and 1993(in general we see a sharp rise in the proportions of VC-backed SU companies whatever the series we use).The 'swarming' of SU during the second half of the 90s (excepting 1996) meant a reversal of the reversal: new VC-backed companies increasingly trail behind new Start Ups.

Table 6: 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

2.3 Growth in Exits

2.3.1 IPOs

The first Israeli Company with an IPO in NASDAQ was Elscint, a medical diagnostics company belonging to the Elron group, in 1972. This early beginning did not signal the beginning of a new era, however, 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. Today Israeli (or Israeli-related) companies traded in the U.S. (over 150) are the third largest group behind only the U.S.& 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 7: Number of Offerings of Israeli companies in NASDAQ*

YEAR	Total Offerings	Total IPOs	VC backed Offerings	Capital Raised (M\$)
Before 90	10	9	3	
1991	3	3	0	
1992	9	9	1	225
1993	17	10	4	529
1994	10	9	2	336
1995	16	8	5	608
1996	31	22	13	1,037
1997	24	19	6	1,074
1998	13	12	5	907
1999	20	12	14	3,172
2000	27	20	20	2,842
Total 90's	158	126	69	10,730

* Most if not all VC-backed offerings are first offerings (IPOs)

Table 7 shows total issues or offerings, both IPOs and subsequent company issues. Total offerings (the middle figure of Column 2) increased considerably during

the 90s- compared to the previous decades; and during 1995 and beyond-compared to 1991-94(all years except 1998 and marginally 1995³⁰). IPOs jumped in 1993 and then in 1996 with the first exits from Yozma. A related point is increase in the share of VC-backed issues from roughly 30% at or before 1997 to over 70% in 1999-2000. Moreover, most IPOs during the end of the decade must have been VC-backed. 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), a process which accompanied the increase in the Nasdaq index (which by itself would also induce an increase in IPOs).³¹ We cannot avoid noting also that prior to 1993, there was already a non-insignificant number of IPOs (12 during 1991-2 alone) all of whom excepting one being non VC-backed issues. This in part reflects the fact that very good, high quality SU began populating the scene in the early 90s.

2.3.2 M&As

The picture about the emerging hi tech cluster will not be complete without considering the phenomenon of M&A—one of the main mechanisms of exit for Venture Capital companies & for SU entrepreneurs and early investors. M&A are not an homogenous phenomenon since it comprises a variety of different types of transactions distinguished by e.g. degree of complexity; and objectives of SU acquiring companies (usually multinational corporations). Moreover the 'market' for M &A differs considerably from the 'public' capital markets epitomized by NASDAQ. The term 'private' which could be attached to such (capital) markets, is supposed to indicate the fact that the acquirors of SU are not the public at large but rather one specific company usually a competitor or a company with a technology which is complementary to that of the SU itself. There is no clear 'market place' where M&A transactions are negotiated and implemented. Markets are 'thin' and a lot of randomness exists about whether a particular transaction will take place. It follows that the conditions for an emerging cluster to enable M&A activity on a *continuous basis* differ from those required to provide access to public capital markets.

The Israeli case suggests that IPOs might play a crucial role in creating the conditions for cluster emergence; and that M&A only come in stream in increasingly large numbers later on, probably starting in 1994 (see partial data in Tables 5 and 6 among other considerations). The link could be as follows: public capital market links early in the game generate conditions for the emergence (given a suitable Government program like Yozma) of a distinctive VC industry during -1994-5 in the case of Israel. The new industry 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 strategy³². This will in part change once the strategy of many VCs shifts towards the building of large companies (in which process IPOs became extremely important).With

³⁰No exception if we consider capital raised rather than numbers of offerings(see third column of Table 3). Note that exits from Yozma first funds were supposed to take place during 1996-8.

³¹Both 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 companies 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.

³²The '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 onset of cluster maturity and with enhanced cluster reputation, MNEs start coming and this creates a very strong wave of new M&A.

The sequence of events seems to be borne by the data. Tables 7 & 5 show that during 1996-7 the number of *significant* VC backed M&A (14) was still 20 % lower than IPO numbers for the period (total of 19); but that the former exceeded the latter by about the same percentage during 1998-2000.

Table 8: Selected VC backed M&A involving Israeli companies 1994-2000

	Number of significant VC backed Deals	Total Valuation of Deals (M\$)	Average Value (M\$)	Average top 5	Biggest Deal (M\$)
1994	2	62	31	16	53
1995	5	635	127	127	350
1996	10	950	95	119	200
1997	4	788	197	181	400
1998	14	2,604	186	305	412
1999	12	3,180	265	583	1,600
2000	21	10,500	574	1,874	4,800
Total 90's	68	18,719	275	1,982	4,800

- Total Valuation of M&A Deals refers to the implicit value of 100 % of the SU sold. Thus if the VC owns 20% of a company who is acquired for \$100M, then the Valuation will be \$100M. The Value of the deal, however, will be 20 M\$

CONCLUSIONS AND MAJOR EMERGING ISSUES

This paper analyses *Background Conditions, Policies* and the processes leading to *Emergence* of Israel's Venture Capital Industry in the 90s. The approach adopted is explicitly a Systems/ Evolutionary Perspective focusing on the broader High Tech Cluster and on the links between VC and SU. We end up identifying and to some extent characterizing Israel's 'model' of Venture Capital emergence and development; and some aspects of the 'Silicon Valley' model of high tech which developed there in the 90s.

Background Conditions and Horizontal R&D incentives

Israel's Venture Capital industry and high tech cluster of the 90s is an outgrowth of high tech as it developed during the seventies and eighties and which involved a significant Military-oriented component including a significant share of Defense R&D in aggregate National R&D. Civilian high tech industry grew in parallel to the Military oriented component, although initially at a slower rate. Both components of high tech reinforced each other till the mid eighties (when severe resource constraints dampened further development of the military component, a fact which led to a successful shift of resources to 'civilian' high tech). During this period a large technological infrastructure was established; and a significant process of Learning in connection with Civilian R&D & Innovation took place. It was a period were Civilian oriented R&D/Innovation activities and R&D/Innovation Capabilities *penetrated* and *were diffused* throughout the Business Sector. Hundreds of companies, large and small, were performing R&D on a routine basis towards the end of the 80s. They had learned how to search for good R&D projects, search for market information, link Marketing & Production to R&D, shift from 'simple' to 'complex' R&D projects as well as learning how to manage the innovation process as a whole. All of this led to an R&D- performing segment of the Business sector; and also to a clearly identifiable Civilian oriented, and 'Electronics'-oriented, High Tech industry. This practical 'collective' knowledge about R&D and innovation within the Business Sector was the basis upon which the future Venture

Capital industry grew. A dominant share of VC company founders' (and also an important share of SU of the 90s) were individuals who had prior experience with the Electronics Industry of the 80s.

Targeted Cluster-Creating Policies

Despite the above successes and the increased numbers of SU created during the late 80s and early 90s, serious problems concerning their survival and growth emerged. The rate of failure of SU companies did not increase during this period.; and it gradually began to dawn to policy makers (particularly to the Chief Scientist at the time) that the 20 year old R&D support scheme while necessary was not any more a sufficient condition for further development of High Tech. The real problem was successful transition to the post SU phase of new company growth; and the crux of the problem was identified as non-existence (with some exception) of a special financial institution developed in the US during the preceding two decades--Venture Capital. Venture Capital not only provided resources through the purchase of equity of SU companies; it also provided important value adding functions & activities such as management, head hunting, R&D & Strategy focus, links with clients and Strategic Investors, and last but not least a channel for linking both to public (i.e. stock market) and private (M&A deals , particularly with MNE) capital markets. While Capital Markets were becoming global not every country could exploit the new opportunities; and at that time the creation of a domestic Venture Capital industry was an essential pre-condition which Israel (in anticipation of other peripheral economies with a technology & skills orientation) readily generated.

Given the above-mentioned favorable background and new challenges, the mechanism for triggering a domestic Venture Capital industry was a *Targeted VC support program entitled 'The Yozma Program'* where a \$100M Government VC company was set up early in 1993. Of these funds 80 M\$ were invested in 10 private funds of approximately \$20M each and the remaining 20 M\$ was invested directly by a Government Fund ('Yozma'). The program was a Targeted program that is its incentives were directed to a particular sector--Venture Capital--rather than to the Business Sector as a whole. A condition for being part of the program was the involvement of a reputable foreign Financial Institution together with a reputable local Financial Institution. The incentive, beyond Government's risk sharing with private investors, derived from the possibility of purchasing the Government share approximately at cost. Yozma directly generated \$250M which were invested in over 200 portfolio companies. The high and rapid returns obtained by these funds (the result of some very successful 'exits' both IPO and M&A) stimulated a Schumpeterian 'swarming' process where both follow up funds to existing VC companies and completely new VC companies entered the market. These, the earning of the first round of new companies, and the enhanced reputation of Israel's new high tech cluster increased considerably the rate of SU creation, and the numbers of successful 'exits'. Thus a self sustained growth process, of cumulative nature, set in. This would correspond to the *'Reproduction' phase* of Evolutionary Processes. It is important to point out that the policy process leading to Yozma began in the early 90s; that several alternatives were probed including another Targeted Government Program (Inbal) with only very limited success (*Variation*); and that a lot of search and even policy relevant research took place before *'Selection'* of the Yozma policy alternative took place.

Towards a Co-Evolutionary Dynamic Process

The data reported in this paper and other evidence shows an interesting dynamic sequence involving co-evolution. It involves three 'phases' and looks as follows:

- *Significance Pre-emergence activity*(prior to 1993): existing or new SU – we estimate that between 80 and 143 were founded in 1991-2 only; preliminary successes with IPO s in Nasdaq -about 12; some VC activity (Athena/Veritas, Star, Giza) & VC-related activity by other institutions and key individuals (Adi Shalev, Jay Morrison, etc)—all of this generated conditions for the implementation of Yozma
- *Policy-Induced Creation of Critical Mass*: Yozma generated a discontinuous jump in VC and VC & SU–related activity during 1993-6: large increases in VC capital raised, and about 250 new VC-backed companies compared to about 30 VC-backed SU during 1991-2;
- *Cumulativeness & Steady Growth*: the above contributed to sharp increases in exits particularly IPOs in Nasdaq: in 1996 these amounted to 22 against between 8-10 during 1993-95. These in turn generated a self-sustained process of steady growth characterized by: a further increase in the number of start ups and in VC-backed SU; increases in the number of SU which grew beyond the SU phase; further entry into the VC industry; sharp increases in public offerings and also on M&A deals, etc.³³
- *Mergers and Acquisitions*: They play some role during emergence but probably not (or much less so) in the pre-emergence period. On the other hand, they become an important mechanism of cumulativeness & steady growth *after* emergence of VC industry and once the high tech cluster acquires an international reputation.

The above is the core of Israel's model of VC (and modern high tech cluster) emergence. In the above process, special attention should be given to the pre-emergence period, 1991-3. Star, one of the three VCs operating then, *was already making profits* in the new activities characterizing the new model of high tech. So were Giza and Mofet (an Inbal publicly quoted VC), and to a lower extent Athena/Veritas There must have been significant numbers of *very good* SU companies around- created by returning Israelis, spun-off from MNE s, founded by former employees of domestic Electronics companies and from the Defense Industries, etc. These represented *very rich pickings* for the small numbers of Schumpeterian investors and VCs active during 1991-3.

This observation is consistent with a very rapid growth of VC and high tech *after* Yozma. Yozma funds were extremely profitable- the Success Ratios were extremely high(work in progress) and all except two of the 10 Yozma funds exercised their right to buy back the 40 % Government share--some of them after only one or two years of operation when Exits and realized profits were still scarce(this would not have happened in the absence of strong expectations of profitability: the purchase meant that the companies were renouncing their right of having the Government share in any future losses) High private profitability must have led, through entry/imitation and expansion of existing companies, to the early onset of Cumulativeness/Take Off in the VC industry as a whole.

³³ A previous study of the Data Security industry suggests that undertaking an IPO is a necessary but not sufficient condition for a SU to grow and become an indigenous company undertaking downstream production and marketing.

The whole process took about six years: three years where favorable ‘immediate pre-Yozma conditions’ were created; and three additional years for VC (and SU-intensive hi tech) cluster emergence. Yozma was implemented at the mid-point, and triggered the process.

Further work will buttress these findings with microeconomic data. This will set the stage for cross –country comparative work on VC emergence and development.

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