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Abstract
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Determinant of Successful Technology Sector

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ABSTRACT: This study uses path dependence and analysis of feedback structures to identify the determinants for developing a successful technology sector in Israel during the 1990s. The four determinants introduced in the study are: *Entrepreneurship, Knowledge Base* in the form of academy R&D, industry R&D and military R&D, *Financial Base* in the form of venture capital and exit market and, *Government programs* that were specifically designed to stimulate the development of entrepreneurial technology sector. We present a Causal model of the development of technology sector in Israel and discuss its generic applicability.

KEY WORDS*: Entrepreneurship, Venture capital, Path dependence, Positive feedback, Causal Loop Diagram, High-tech sector*

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CONTENTS

1. Introduction

Technology development and entrepreneurship has long been viewed as an engine that drives innovation and promotes economic development (Schumpeter 1934, 1942). Entrepreneurship was, and remains one of the fundamental forces of economic life and economic processes, and much more so in the high-tech industries (Kirchoff 1991). National and global economies are increasingly made up of fast growing entrepreneurial companies, many of which are in the technology sector (Bygrave 1998). However, scholars have only a limited understanding of the determinant that contribute to the development of an entrepreneurial based technology sector. A grater understanding of the determinants of entrepreneurial based technology sector will aid policy makers, to be entrepreneurs and investors.

Study of the factors that have lead to the development of an entrepreneurial high-tech industry is often based on the development of Silicon Valley in the United States. Given the importance of the high technology sector for economic development and the globalization of the high-tech sector, there is a need to understand the factors which contribute to the development of an entrepreneurial technology industry in other regions of the world. This study examines the phenomenal growth of the Israeli high-tech sector in recent years, growth that has resulted in a successful technology sector that is often referred to as the "New Silicon Valley". We have used path dependence and analysis of feedback structures to develop a model of the development of the technology industry in Israel. We use the model to compare the development of the Israeli high-tech industry with the development of Silicon Valley.

1.1 The Technology sector in Israel

During the 1990s there has been a phenomenal growth of the technology and in particular the ICT sector in Israel. Software export for example grew from $ 400 million in 1996 to over $ 1.5 Billion in 1998. With a growth rate of 13.2%, and revenue of $7 billion (1996), of which approximately 70% for export, the Israeli ICT industry has become an important contributor to the success and growth of the Israeli economy in the 1990s. This growth is characterized by a flood of start-ups – about 3000 startups in 2000, and a dynamic Venture Capital (VC) market with more than 115 venture capital funds (2000) with $ 3 billion under management.

The direct contribution of these startups to the economy was estimated by the Bank of Israel at about 3% of the GDP in 2000. These startups raised $3.2 billion in 2000, and many have reached the Initial Public Offering (IPO) stage. More then 150 companies are publicly traded

in the US and Europe stock exchanges. The number of Israeli ICT companies listed in NASDQ takes second place, after Canada, in terms of foreign IPO's. In 1996, for example, there were 18 Israeli IPO's raising $678 million in the US exchanges, which is the highest level for a foreign country in that year.

The professional press and leading newsmagazines have referred to the Israeli technology sector as the 'New Silicon Valley'. Some examples are: the design of the multimedia extensions to Intel's Pentium processor (the Pentium MMX) and the development of the next generation processors of Intel's by Intel's Israel design center, Internet Firewall security software pioneered by CheckPoint Technologies, voice mail technology for fixed and wireless telephony by Comverse Technologies, and the ICQ Internet chat and messaging software pioneered by Miribilis.

We will discuss in brief the history of Silicon Valley, in order to understand what 'Silicon Valley' represents, and to see if the development of the Israeli Technology industry has similarities with the Silicon Valley model. Based on our study of the growth of the Israeli technology industry, its historical background and path dependence analysis of its development, we present a generic model that describes the determinants that shaped the development of entrepreneurship and the resulting technology industry. We use this model to examine, in retrospect, the development of Silicon Valley.

2. Research Approach

The purpose of this research was to study entrepreneurship based technology sector and describe the forces that shaped its development. Drawing on research streams on entrepreneurship (Barreto 1989, Bygrave 1998, Busenitz et al 2000, Anderssen 2000, Audretsch & Thurik 2000) technology policy (Mowery 1993, Brahm 1995, Vinig et al 1998, Schoening and Souder 1998, Busenitz et al 2000, Henrekson & Rosenberg 2001), Venture capital, (Sahlman 1986, Robinson 1987, Bhide 1992, Camp & Saxton 1992, De-Clercq & Sapienza 2001,) and technology incubation and startups (Smilor 1991, Bhide 1994, Roper 1999, Kenney 2000, Shane 2001) we have identified Knowledge Base, Financial Base, Government Programs and Entrepreneurship to be the determinants of importance to the develop of the technology sector. The phenomenal growth of the Israeli technology industry,

and in particular the ICT sector between 1990 – 2000 has provided an opportunity for this a study.

The empirical material for this research was collected using archival research: articles, industry and government reports, WWW resources, newsmagazines and interviews. The study of the development of the Israeli technology industry is an interpretive case study at a country level. In a sense, this is a study of the history of the technology industry in Israel. According to the Schumpeter, the first to put the entrepreneur and technological innovations at the centre of economic development, "A study of history is necessary to provide a temporal and contextual meaning for each of the four forms of knowledge: 1) empirical data observations and facts, 2) theories and paradigms, 3) ethics and, 4) history". Though this study was triggered by the fast growth period in the 1990s, it starts with an historical review of the industry.

This study contributes to the body of knowledge in the areas of high-tech industry development, entrepreneurship and entrepreneurial finance, and public policy. We believe that the results of this study can be of interest to public policy makers in countries interested in developing their technology industry, to technology entrepreneurs and venture capital firms.

In addition to historical, path dependence review the development of Silicon Valley, we have looked at studies of Taiwan's computer industry (Kraemer et al, 1996), the national technology policy in Asia-Pacific (Dedrick et al, 1995), and the case of the IT industry in Bangalore, India (Madon, 1997). This in order to answer the question of whether or not the model we propose is a generic model that can be applicable to other countries.

3 The Israeli technology industry – Path dependence analysis

3.1 Path dependence

Path dependence offers an alternative, to the neoclassical, analytical perspective for economics. Path dependence embraces positive feedback in the economy. The concept of path dependence and related concepts – increasing returns, positive feedback and lock-in are mainly associated with the work of Arthur Brian on the economics of the high-tech industries, but have been used by Paul Romer (new growth theory), Paul Krugman with Elhanan Helpman (new trade theory) and Paul David (historical economics). These ideas are now acceptable in economics, in fact

they have become fashionable. But this was not always so. Until the mid-1980's many economists regarded them with skepticism. According to Brian these ideas "have always been part of economic literature….were difficult to bring under mathematical control….and they tended to have disturbing implications….as a results many have chose to disregard them".

Path dependence refers to the relationship between process dynamics and its outcome. It is a pattern of behavior of a system in which small random events early in the history of a system determine the ultimate end state, even when all end states are equally likely at the beginning. Path dependence arises in systems with locally unstable equilibrium whose dynamics are dominated by positive feedback processes which increase the impact of small events. Path dependence is a property of a stochastic process. Path dependence process has multiple possible equilibrium but can lock a systems into a particular (local) equilibrium. Path dependence in economic processes results in different possible allocation of economic resources and therefore may result in various efficiency outcomes. In the literature on path dependence the cases of the QWERTY vs. Dvorak keyboard layout, and the VCR recording standards Beta vs. VHS are often used to illustrate and discuss path dependence (David, 1985, Brian 1990, Leowietz & Margolis 1995).

Increasing returns and Positive feedback are mechanisms that operate within markets and industries that reinforce that which gain success or aggravate that which suffer losses. Increasing returns and positive feedback disturb equilibrium and generate instability. Once technology or products, one of many competing in the market, gets adopted by more users by chance (by 'small historical events') or by strategy, positive feedback loops can magnify this advantage and the technology or product can go on to lock-in the market. In technology markets such mechanisms ensure that a product that gain advantage in the market, the market gets unstable and therefore subject to lock-in when it further increases its market advantage.

Arthur (1996) uses the example of personal computer operating systems DOS and CP/M for the PC and Apple's Macintosh as an illustration of increasing returns: If one system gets ahead, it attracts further software and hardware developers to adopt it, which results a positive feedback loop and therefore further adoption in the market. CP/M was first in the market, Mac OS arrived later and was an easy to use operating system. The DOS operating system came following the agreement that Microsoft will supply the operating system for IBM PC's. The growing user base of DOS/IBM platform caused software and hardware developers developed

more products for the DOS/IBM which got further market share and eventually came to dominate the market.

4. Causal model of the technology sector

A causal model of the development of the Israeli high-tech sector represent causal relations between the determinants needed to generate explanations of the fast growth of the sector in the 1990s. Our use of path dependence review and study of the feedback structures among the determinants contributed the parameters of the model. The four determinants in the model comprise of *Entrepreneurship*, *Knowledge Base* in the form of academy R&D, industry R&D and military R&D, *Financial Base* in the form of venture capital and exit market and, *Government Programs.* The interactions between these determinants have created a number of positive feedback loops that have increased the impact of events, and stimulated the development and growth of the high-tech sector in Israel during the 1990s. We have used Causal Loop Diagrams[3] to model the dynamics and the feedback structures between these four determinants (Figure 1). For clarity purposes, the model describes the main causal links and feedback loops at a generic level.

In the following sections we discuss the model, the interactions and feedback structures that led to the development and fast growth of the high tech industry in Israel in the 1990s.

[3] *See appendix A for definitions*

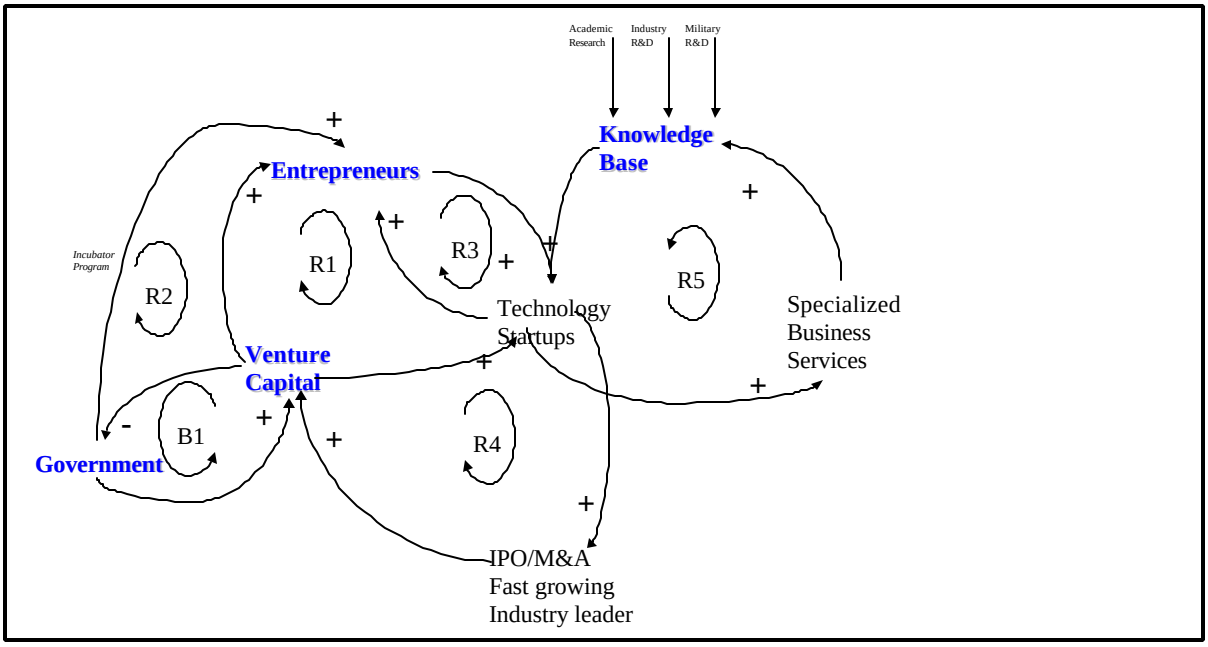

Figure 1: Causal model of the development of the Israeli technology sector

4.1 Initial conditions and events

Path dependence logic defines that initial conditions and events have an impact on the outcome of a process. Lack of natural resources and small home market, in particularly for technology products, were two initial conditions against which we need to analyze the development of the technology sector. These two conditions have influenced developments towards knowledge based industries which targeted export market from the beginning. The semiconductors industry for example, produces almost exclusively for export.

Though the technology industry in Israel has its roots in the 1950s, it reached its current state of development ('second Silicon Valley') in the 1990s. The two events that marked the start of the development of a successful high tech industry were the result of the Six-Day war in 1967. The French - the main supplier of the Israeli army, announced an embargo on military equipment, while western companies complying with the Arab boycott put Israel on their 'black list' as business partners. The response to the embargo and the Arab boycott was the development of a defense and electronic industries which became the source of the technology sector as we know it now. The defense industry became an important sources of spin-offs, new technologies and entrepreneurs during the 80s and 90s.

The fastest development of the technology industry and gaining a recognized position in the global value chain of the high-tech industry took place in the 1990s. The most significant events during that period were 1/ the establishment of venture capital fund supported by the government and, 2/ the national incubator program and , 3/ successful IPO's and M&A of Israeli technology firms that have created a role-model for future entrepreneurs.

In table 2 we present an overview of the major events that had influenced the development of the Israeli technology industry.

Year	Events
1950s	• Government initiated technology companies mainly for military application
1967	• Six days war – French embargo and Arab Boycott lead to the beginning of the Israel Military Industry
1970s	• Spin-offs from established companies lead to a wave of new start-ups
1980s	Foreign ICT companies start co-operation and R&D activities: Intel, IBM, Motorola, National Semiconductors. Veterans of the defense industry start commercially oriented ICT companies[4] • First IPO's of Israeli companies in NASDAQ • Established technology companies set up the first venture capital fund
1990s	• Large scale operation of foreign technology companies, mainly R&D centers, and entry of new companies (Microsoft, SUN Microsystems,

[4] Like in the early days of Silicon Valley, semiconductors were the first wave of technology ventures.

	Oracle) • Absorption of 700,000 emigrants from the former Soviet Union, most of which are with college/university education • Nationwide technology incubator program • Government supported venture fund (the Yozma fund) established • Successful IPO's of Israeli companies on NASDAQ, and large M&O of Israeli technology firms • Foreign VC funds establish operation in Israel • Emergence of 'Role model' for technology entrepreneurship (CheckPoint, ICQ, DSP)

Table 1: The Israeli ICT industry – path dependence perspective

4.2 Government Stimulation (loop identifiers B1 and R2)

Governments have supported developmental financial institutions, based on national development priorities, to increase entrepreneurship and, as part of privatization programs (George & Prabhu 2000). By targeting and designing national development priority areas, governments are better able to focus their resources in sectors and industries which are likely to maximize economic benefits (Brahm 1995). For example, Schoening et al (1998) found evidence that the South Korea and the Taiwanese governments have played an important role in increasing their countries product innovation through tax incentives and subsidies.

The Israeli government placed the support of the technology industry high on its priority list and played an active role in stimulating the growth. In the 90s the government played an essential role in initiating the financial base, and in particular the establishment of venture capital market. By recognizing that a lack of financial base is an inhibitor for creating technology ventures, it initiated programs that eventually led to the establishment the financial base for entrepreneurial technology ventures. In a relatively short time period, between 1985 and 1993, a financial base in the form of an active, internationally oriented venture capital market was established. Once in place and operational, the government executed its 'exit' strategy as part of its privatization program.

The first step in stimulating the creation of a venture capital market was taken by the government with the setting up of the YOZMA[5] venture capital fund. The government provided up to 40%, amounting to a maximum of $20 million, as well as offering co-investment in any venture capital fund with the possibility for private investors to take the government part over after few years at a convenient price. The Yozma program has been established with clear a objective focused on creating an internationally oriented venture capital market for the support of new technology ventures. The program attracted foreign investors, facilitated the creation of an international network of venture capital and ICT firms, and provided support for start-ups in capital and in finding strategic partners.

The government had initially allocated $100 million. This amount was used to set up 10 venture capital funds. In four of these, the major investors are US venture capital firms and in one the major investor is a Dutch venture capital firm. In addition to setting up venture capital funds, the Yozma fund has directly invested in ICT start-up.

This fund become operational in 1993, and was the beginning of the successful venture capital market in Israel. The Yozma fund had become so successful, that there was market interest in taking it over, which the government did as part of its privatization program. Today there are more than 115 venture capital funds with total $3 billion under management.

In is interesting to note that in the 80s, the ICT industry took the initiative in setting up a venture capital fund to support start-ups in the form of spin-off companies. The fund – the Athena fund, was established in 1985, but it soon became clear that there was a lack of venture capital expertise to support ICT start-ups and therefore no VC funds followed. This emphasizes the role on the government in creating the an active VC industry.

This is depicted in our model, in the B1 loop which is a balancing, or negative feedback loop. The Yozma venture fund and the related co-investment program have contributed to the creation and increase in the number of VC funds. The increase in the number of the VC funds reduced the importance of the government involvement up to the point the market forces take over and the government exits this activity.

The second program depicted in the model in R2 loop has created reinforcing or, positive feedback loop is the national technology incubator program. The Incubator program set up by the government is aimed at supporting seed/early stage technology start-ups. An incubator is a financial and administrative environment in which an entrepreneur can work on an idea up to

[5] *Yozma – entrepreneurship in Hebrew*

the prototype stage. At the prototype stage he/she is brought in contact with venture capital investors and is taken through the usual screening process. This program was in particular popular amongst the Soviet emigrants at that time. At present there are about 26 incubators located in high-tech parks through out Israel with about 600 projects. Increase in the number of incubators and projects within the incubator increased the number of potential entrepreneurs who indeed decided to become entrepreneurs (the R2 loop identifier).

In addition, the government initiated tax incentives programs to support R&D centers, stimulation programs to support start-ups, and legislation to attract foreign investors and world leading ICT companies. The example of Intel Corp. illustrates this: Intel began operating in Israel in the 80s out of a small design center. Based on their positive experience, Intel has decided to build a fabrication facility (FAB-8)[6]. The success of FAB-8, and the need for additional production capability resulted in building the second fabrication facility in Israel with an investment of $1.2 billion. This effort was supported by special legislation that allowed special government subsidy for the new facility.

Our model demonstrates that an effective government program is one that create balancing feedback loops in which a positive outcome of the government initiative will lead to reduced role of the government and eventually lead to exit of the government. The creation of venture capital market in the case of the high-tech industry in Israel is such an example. The strategy of the government has been to stimulate and support the initialization phases of the various programs and then exit, leaving market forces to take over.

4.3 Financial Base (Loop identifier R4)

The importance of availability of external financing for stimulating entrepreneurial activities and new venture creation has been shown both theoretically and empirically (Evans and Jovanovic 1989, Evans and Leighton, 1989, Vinig et al 1998). The added value of venture capital firms has been shown by Dorsey (1979) and Sahlman (1990) who found that the failure rate of VC-funded entrepreneurial ventures is substantially lower compared with non-VC funded ventures. Only 18 percent of VC-funded companies failed within seven years compared to 75 percent of non-VC funded firms. Kaplan and Stromberg (2000) have found that if VC's

[6] Intel's first fabrication facility outside the US

take an active role in improving the venture's management team the venture is more likely to be successful.

The financial base, namely venture capital market for startups had been established in a relatively short time period. In 2000 for example, this marker was responsible for supporting startups that raised $3.2 B, many of which reach the Initial Public Offering (IPO) stage – more that 150 companies are publicly traded in the US and Europe. The number of Israeli companies listed in NASDQ takes second place, after Canada, in terms of foreign IPO's. In 1996, for example, there were 18 Israeli IPO's worth $678 million in the US, which is the highest level for a foreign country in that year. This growth had established a dynamic Venture Capital (VC) market with more than 115 venture capital funds (2000) with $ 3 billion under management. More than half of the funds are foreign, mainly US based funds.

This is depicted in R4 loop in the model. It is reinforcing, or positive feedback loop in which increase in number of startups, increases the number of IPO's and acquisition by large international firms and creation of fast growing market leaders. These exits provide high level return on investments and therefore increase the number of VC's entering this market which in turn increases the capital available for investment in startups which increases the number of startups.

The success of establishing a venture capital market in Israel is supported by a market research by VentureOne (Globes, 1997), covering 600 venture capital firms in the US managing more than $25 billion. Venture capital firms from the US show more interest in investing in Israel than any other country (outside the US) in the world. Of all funds 19% of the largest US venture firms show an interest in foreign corporations:. Of them 7.7% selected Israel as a primary interest while the UK was a secondary interest mentioned by 4.5%. One out of five US venture capital firms is interested in investing in Israeli technology ventures, one out of seven has already invested in Israeli venture.

4.4 Knowledge base (Loop identifier R5)

Government stimulation alone could not lead to a successful technology industry. There had to be a mature knowledge base on which technology industry could be established. In the case of Israel, the knowledge base has been created since the 50s, in universities and research centers

and for the support of military technology, later using that technology for commercial products and eventually leading to a commercially oriented technology industry. Initially academic research, military R&D and industry R&D have created this knowledge base.

Knowledge intensity in Israel is high - about 135 per 10,000 workers are involved in R&D, compared to 70 per 10,000 in the US, and 65 per 10,000 in Japan. A review by Scientific

American (1994) of 3300 leading science and engineering journals by country of the authors, ranked Israel in the 16th place. When adjusted to its GDP, ($90 billion GDP, vs. $7 trillion US or $300 billion Netherlands) Israel emerge and the world's most productive producer of scientific and engineering knowledge (Figure 2).

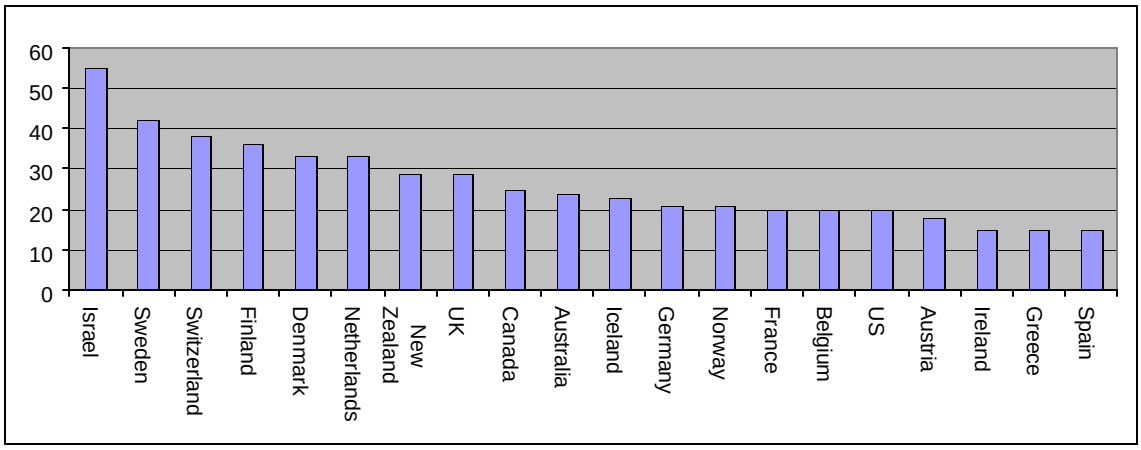

Figure 2: Scientific output in 20 countries, per billion US $ of national GDP in 1995. (Science & Engineering Indicators – 1998).

The combination of high knowledge intensity and relative low income level could explain the large number of technology companies from the US, Europe and Japan that have established R&D centers in Israel, or that work in cooperation with Israeli companies.

These joint ventures provided Israeli ICT industry access to state-of-the-art technology and have created a positive feedback loop that played an important role in extending the knowledge base in recent years. The existence of a knowledge base was one of the arguments used by the government to attract foreign investors and technology companies to Israel, thus having an indirect role in creating the financial base.

With the growth in the number of new technology ventures there has been a need for a support business services – legal, financial, accounting, management, specialized in helping young ventures. A mature business services industry for the support of new ventures has been established. The knowledge created by these activities contributed to the knowledge base and reduces the uncertainty and ambiguity associated with new venture creation and therefore contributed to establishing more new venture. This is depicted in the model in the R5 positive feedback loop.

4.5 Entrepreneurship (Loop identifiers R1, R2, R3)

Evidence of entrepreneurship's contribution to the economy has been provided in literature (Schumpeter 1934, Kirchif 1991, Reynolds 1999). Schmitz (1989) has developed a formal model in which endogenous entrepreneurial activity is a key determinant of economic growth.

The Global Entrepreneurial Monitor (GEM) study (Reynolds et al 1999), found that the level of entrepreneurship is positively correlated with GDP gains and that variation in the rate of entrepreneurship may account for as much as one-third of the variation in economic growth. According to Bygrave (1998) US's most significant strategic advantage is entrepreneurship. Busenitz et al (2000) provide an analysis of three dimensional country institutional profiles for entrepreneurship. They consists of regulatory dimension (law, regulations, government policy), cognitive (knowledge and skills) and normative (socio economic acceptance of entrepreneurship). These dimensions are captured in three out of four determinants in our model.

According to the Global Entrepreneurial Monitor report Israel together with the US and Canada has been identified as high level entrepreneurship country. They studied the level of entrepreneurship and entrepreneurship's contribution to the economy the G7 countries (US, Canada, France, Germany, Japan, Italy, UK), and Finland, Denmark and Israel. They have identified the US, Canada and Israel as high-level entrepreneurship countries. In the high level entrepreneurship countries entrepreneurship is an integral and accepted part of the economy and personal life.

In the model there are two reinforcing loops that increase level of entrepreneurship and the number of entrepreneurs. The first loop R1 - increase in the available capital for new venture increases the number of entrepreneurs who are setting new ventures. The increase in the number of new venture also increase the number of entrepreneurs as depicted in R3 loop in the model. This positive feedback loop is also supported by research of Minniti (2000). Minniti uses path dependence to develop a model[7] for understanding why individuals choose to become entrepreneurs and why communities with initially similar conditions may end up with different level of entrepreneurial activity. According to Minniti entrepreneurship exhibits positive feedback and increasing returns with respect to adoption. In high entrepreneurship areas the large concentration of entrepreneurs reduces the ambiguity attached to entrepreneurship and increases its choice as a viable career path. Entrepreneurs are required to cope with uncertainty and ambiguity in the process of new venture creation. In high entrepreneurship area entrepreneur leverages social cues and information provided by other entrepreneurs to reduce ambiguity and uncertainty. The active social networks in high entrepreneurship areas are part of the process of coping with ambiguity. Entrepreneurship creates the economic and social environment, and culture that influence individual behavior in favor towards entrepreneurship.

In agreement with the dynamics of path dependence processes, under certain conditions entrepreneurship process is shown to be unpredictable which accounts for the differences in rate entrepreneurial activities across otherwise similar communities.

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5. Silicon Valley – a path dependence history

The phrase Silicon Valley first appeared in 1971 in a series of articles that journalist Don C. Hoefler wrote for Electronic News, a weekly industry paper. Hoefler was choosing a name for an article about the semiconductor industry that he was writing for Electronic News. Ralph Vaerst, then president of Ion Equipment, suggested Silicon Valley. Hoefler named his article, ``Silicon Valley USA"[8]. The roots however of the technology sector established in Silicon Valley can be traced back to the 50s.

[7] The model is based on using a simple non-linear path dependence stochastic process based on the work of Arthur, Ermoliev and Kaniovski on the dynamics of path dependence Polya processes.

[8] www-forum.stanford.edu/history/history.html

About 40 years ago Stanford University had leased part of the university's land to high-tech companies for 99 years, to solve financial problems they had at the time. In terms of path dependence this initially insignificant event has marked the start of Silicon Valley. With the establishment of the Stanford Industrial Park in the mid 50's, the very character of Silicon Valley as a conglomeration of inter-related, interbred technology companies took hold. A quarter of century later this decision was called Silicon Valley's starting point. From a path dependence perspective this is a good example of an 'insignificant' event that have had a major influence on the creation of Silicon Valley as we know it today.

At the same time it was Stanford's University professor of electrical engineering, Frederick Terman who encouraged his students to work for local companies and to start businesses of their own, rather than being lured back east to the dead end attraction of safe, "establishment" companies there[9]. Again from a path dependence perspective an event that have impact on the development of Silicon Valley as an entrepreneurial region.

The semiconductor industry (the Silicon) was the first technology wave in Silicon Valley. It was based on the invention of the transistor and the integrated circuit were the post-war enabling technologies for the electronic industry. According to Kenny (2000), Silicon Valley capture of the semiconductor industry is the results of 'a series of small events that could make an enormous difference' which again is an example of path dependence perspective of the development of Silicon Valley. In 1955 William Shocley, co-inventor of the transistor at Bell Lab decided to establish a company to exploit his invention for which he needed financing. He failed to raise capital in the East Coast and the founder of Beckman Instruments in LA agreed to fund him in starting up in Palo Alto. This event mark the start of the semiconductor industry in Silicon Valley. Shortly after establishing his startup, the engineers he hired left Shockly's startup to establish Fairchild Semiconductors that marked the start of a flourishing semiconductor industry in Silicon Valley. A study in 1986 has indicated that 124 semiconductor startups could trace their roots to Fairchild among them are Intel, AMD, National Semiconductors and LSI Logic.

The path dependence logic in terms of positive feedback loops created a successful semiconductor industry with role models and incentive for other to follow. One of the interesting positive feedback loop was that success of these startups was shared by the founders

[9] *Among two of the students to follow his advice were William Hewlett and David Packard the founders of Hewlet-Packard.*

and key employees who have enjoyed the capital gains and were able to invest or join new startups without any financial risks. This way Fairchild Semiconductors turned out to be a source of entrepreneurs and venture capital.

World War II saw the introduction of the U.S. government as a major supporter of emerging technology. California received almost $40 million in new plants and defense contracts.

Throughout the 1950's, electronics companies such as General Electric and Sylvania, were joined by Westinghouse Electric and Ford Philco in establishing facilities in Palo Alto and neighboring cities like Mountain View. Even as far south as San Jose, where IBM established a huge research center, companies established roots and flourished.

There are now about 4,000 ICT-related companies located in the Silicon Valley area which generate approximately $200 billions in ICT-related revenues. The venture capital market has grown to about 700 venture firms managing about $10 billion.

A mature business infrastructure for the support of entrepreneurial technology startups has emerged created in Silicon Valley in the 70s. This includes venture capital industry, business services in accounting, law, investment banking and other service specialized in supporting startups and fast growing firms.

The Causal Loop Diagram of Silicon Valley is similar to the model we have developed. By using our model we can point out both the similarities and the differences between Silicon Valley and the “New Silicon Valley”. Academic research and industry R&D established the knowledge base required for the development of the ICT industry in the Silicon Valley. This knowledge base was not initiated by military development, nor was it primarily used for military products, as was the case with the Israeli ICT. Active support for entrepreneurship from the university level and the emerging venture capital market created positive feedback loop that increased entrepreneurship and startups. The incubator programs and the high-tech parks in Israel are modeled after the Stanford industrial park, the recognized basis for Silicon Valley. The venture capital industry that was established with the success of the semiconductor industry was instrumental to the creation of startups in Silicon Valley.

Established technology companies and the traditional financial establishment initially provided the financial base for Silicon Valley as for example the case was for Fairchild Semiconductors. Following the success of the semiconductor industry an active venture capital market was created. The successful The venture capital industry in its current state emerged

and developed parallel to the growth of the technology industry in Silicon Valley. Many of the Silicon Valley venture capital firms have established operation in Israel during the 90s and brought with them the knowledge and experience that was used to establish the financial base for the Israeli technology industry. This explains to the short time span required for the establishment of the financial base for the Israeli ICT industry. The majority of the most active venture firms and ICT companies in Israel came from Silicon Valley or have 'Silicon Valley' experience.

Government support for Silicon Valley occurred at two levels: the first was early on during the initial phase, in which the government directly supported emerging technologies by means of a $40 million investment following W.W.II. The second level was legislation and regulation that created a favorable economic climate for the support start-ups. In Silicon Valley, the first wave of technology firms was in the semiconductors sector which is also the case in Israel.

6. Discussion

This paper showed that the determinants that influence the development of technology industry – *entrepreneurship*, *venture capital*, *knowledge base* created positive feedback loops that increased the effect of events during the development and growth of the technology sector and led to a mature technology industry in Israel based on entrepreneurial ventures. The fourth determinant - *government programs* created a balancing loop so that each successful implementation of a support program reduces the role of the government and eventually leads to the government exiting its supportive role leaving it to market forces. The case of the venture capital industry in our study demonstrate this.

Is the model that we present generic and, can it be used to study the development of technology industries in other countries? Can we use the framework to predict which countries / areas have the potential to develop successful technology sector and which countries / areas are unlikely to develop high-tech sector? To answer this we have used a path dependence review of the development of Silicon Valley and, examined the studies of Taiwan's computer industry (Kraemer, 1996), the national technology policy and computer and software production in

Asia-Pacific countries (Dedrick, 1995) and a study of the IT industry in Bangalore India (Madon, 1997).

Our review of the development of Silicon Valley demonstrates the usability of the framework we have presented. Knowledge base and government support were important for the establishment of Silicon Valley while financial base in form of venture capital and entrepreneurship played an important role in growing Silicon Valley into a global high-tech center.

The study of Taiwan's computer industry attributes its success to a coordinated government strategy to support private entrepreneurship by a large number of small companies. Taiwan's computer industry success is despite little previous experience in high-tech industry – lack of knowledge base. A strategy of 'fast follower' rather than a strategy of developing innovative products compensate the lack of knowledge base. The study of the effect of a national technology policy in promoting the production of computers and software in Asia-Pacific countries attributes the level of production to 1) human capital – scientists and engineers 2) the presence of complementary industries, particularly electronics, and 3) expenditures on R&D. The first two relate to a knowledge base and the third to government support. A recent development in Bangalore is the move from being 'off-shore' software factory for foreign ICT firms to becoming a center for innovative software development 'made in India'. The main obstacle to this development is a lack of venture capital to support local start-ups during the early stage.

All other conditions being the same, lack or a low level of entrepreneurship can be an inhibitor for the development of a technology sector in which fast growing startups form the basis for a mature technology sector as the case is in Silicon Valley and Israel. Henkerson and Rosenberg (2001) conclude in their study of the Swedish science based entrepreneurship that a lack of favorable institutions and incentive structures that promote entrepreneurship is the main reason for the modest role of academic entrepreneurship in Sweden. All of the West European countries and some Asian countries (including Japan) have announced initiatives to promote entrepreneurship (OECD, 1999) as part of the development of a technology sector. In some

cases like the IFISE[10] program in Italy in which a study (funded by the EU 5th Framework program) of financing programs of technology innovation in Israel is used to draft policy recommendations for the Lombardy region in Italy. In a later phase this will be used in other regions in Europe. A report on the development of technology sector in Ireland used Israel as an example for an effective implementation of support policy. In recent years countries across Europe have initiated programs aimed at creating a local version of Silicon Valley. Some are more successful then others but all have yet to become the source of a mature technology sector based on fast growing startups that become major players in the technology sector global value chain.

Countries desiring to establish a growing technology industry as part of their economic development policy, can use the model presented in this article as a framework for analyzing the as-is situation as well as for policy development. In particular, we believe that this model can be used to support creation of technology industry in developing countries in which a strong knowledge base exists like the former Soviet Union, East European countries and to some extent China. Indeed initial research (George and Prabhu 2000,) starts to appear in that area and initial evidence from former east-block countries like Hungary and the Czech Republic supports the framework we present here.

The application of this model in those countries stipulates that government stimulation initiatives, in particular towards stimulation of entrepreneurship and the creation the financial base for the support of technology startups, should be developed and tailored specific for the economic and political situation, as well as to the cultural dimensions of a country.

The technology industry is a truly global industry that can attract foreign venture, and that could ally with foreign IPO markets. In countries with a strong knowledge base, entrepreneurship and venture capital market are particularly important in helping make the transition from an internal technology focus to a commercial, market focus industry, and from the managed economy of the 20th century to the entrepreneurial economy in the 21st century (Audretsch & Thurik, 2000).

[10] *www.ifise.unipv.it*

In the event that the government cannot take an active role in creating the financial base, the role of the government could be assumed by international organizations (i.e. World Bank) given that the economic and political situation permits such involvement. A successful technology industry in these countries can contribute to economic growth and stability.

This study has limitations in that we did not examine the impact of cultural dimensions of, and differences between countries and region on entrepreneurship. Research of country's cultural dimensions can assist public policy makers design effective programs for the support of entrepreneurship.

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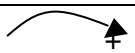
Appendix A – Causal Loop Diagrams

Causal Loop Diagrams are long used in academic work and increasingly common in business.

Causal loop diagrams are used to create a model, a flow diagram which enables the mathematical analysis of the characteristics of systems and processes. It consists of variables connected by arrows - casual links, denoting the causal influence among the dependent and independent variables. Each link is assigned polarity, either positive (+) or negative (-) to indicate how dependent variable changes when the independent variable changes. The important loops are highlighted by loop identifier which shows whether the loop is reinforcing (positive feedback loop), or balancing (negative feedback loop). Positive feedback produces exponential growth, negative feedback illustrated a balancing loop and stability.

Definitions:

Symbol	**Interpretation**	**Mathematics**
X  Y	All else equal, if X increases (decreases), then Y increases (decreases) above (below) what it would have been). In case of accumulation, X adds to Y.	dY/dX > 0 $Y = ? (X+ \ldots.) ds + Y_{t0}$ (t to t_0)
X  Y	All else equal, if X increases (increases), then Y decreases (increases) below (above) what it would have been. In case of accumulation, X adds to Y.	dY/dX < 0 $Y = ? (-X+ \ldots.) ds + Y_{t0}$ (t to t_0)

Polarity of the loop (positive / negative feedback)	The sign of the open loop X1, …, Xn	Polarity = SGN($dx_i/dx_{(i-1)}$)

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