CHAPTER 4

A HOTBED FOR ENTREPRENEURSHIP AND INNOVATION

Looking for success factors in Israel's High-Tech Clusters

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INTRODUCTION

Innovation and entrepreneurship have become buzzwords in discussions on economic policy and they are seen as a panacea for economic growth in developed economies (e.g., the 2005 EU Lisbon strategy, the Council of Competitiveness 2004 Innovate America report). The notion that innovation, entrepreneurship and knowledge can drive economic growth is well-grounded in economic research (Acs and Audretsch 2003; Helpman 2004; Audretsch and Keilbach 2004; Trajtenberg 2006). Formulating and implementing policies that encourage innovation and entrepreneurship at the firm, regional and national level have become national priorities. However, difficulties in implementing these policies illustrate the complexity of the change process and its multilevel and multi-variable nature. Baum et al. (2001) have proposed and tested a multilevel model for venture growth, measuring its characteristics at the individual, firm and business environment level, and found significant direct effects at all levels on venture growth. The purpose of this chapter is to suggest a multilevel economic-growth model by elaborating and expanding the models developed by Audretsch (2006) and Baum et al. (2001), and to illustrate and tentatively test the model in the Israeli high-tech sector. The success of the high-tech sector in Israel makes for an interesting case study for economic growth based on innovation and entrepreneurship. Israel is comparable in size to Silicon Valley and the greater Boston area. It has a similar track record in high-tech

W. Hulsink and H. Dons (eds.), Pathways to High-tech Valleys and Research Triangles: Innovative Entrepreneurship, Knowledge Transfer and Cluster Formation in Europe and the United States, 79-97.

growth, but in many other aspects it is different from the U.S. Moreover, the small size of the country makes analysis at both the firm and national levels feasible.

Ever since the research conducted by Solow (1957), economists have known that it is the technical change concealed within the Total Factor Productivity (TFP) 'black box' rather than the capital and labour factors that explains most of economic growth. With the advent of the endogenous-growth theory in the late 1980s, economists came to accept the view that innovation and knowledge spillovers were indeed the key factors driving long-term economic growth, and that these factors were generated from within the economic system, making them self-sustained and programmable through proper economic policies (Trajtenberg 2006). However, Baumol (2002) has argued that entrepreneurial activity can also explain a significant part of the TFP 'black-box.'

When Audretsch (1995) introduced the Knowledge Spillover Theory of Entrepreneurship, he argued that economic agents (entrepreneurs) outside existing firms seek out and apply knowledge spillovers to generate innovative outputs by creating new firms. He called presence of entrepreneurial activity and agents in economic systems 'entrepreneurial capital', and declared it to be an additional factor in the economic-growth function. Audretsch and Keilbach (2004) tested the hypothesis that entrepreneurial capital augments the Cobb-Douglas-type production function across 327 German regions. They measured the impact of financial capital, human capital (labour), knowledge capital and entrepreneurial capital on economic growth, and the results showed that all four types of capital contribute significantly to economic growth and that the impact of entrepreneurial capital is stronger than that of knowledge capital. The best way to appropriate knowledge capital is through entrepreneurial agents leveraging knowledge spillovers.

Social-capital theory refers to the ability on the part of actors to extract benefits from their social structures, networks and memberships (Portes 1998). Putnam (2000) has argued that, in addition to physical and human capital, social capital is also important in generating economic growth. Although Audretsch (2005) has argued that entrepreneurial capital and social capital are distinct concepts, he has also suggested that entrepreneurial capital constitutes a particular subset of social capital. We suggest that entrepreneurial capital is indeed distinct from both human and social capital. We argue that the economic term 'capital' applies not only to financial and knowledge resources but to human, social and entrepreneurial resources as well. They all need investment and are productive; unbalanced investment and over-investment may result in declining yields.

Human capital is a well-established concept in economic literature concerning entrepreneurship. Human-capital theory states that knowledge increases an individual's cognitive capabilities, leading to more a productive and efficient potential activity (Davidsson and Honig 2003). Human capital is not only the result of formal education, it also includes experience and practical learning. Human capital is a necessary condition for technological innovation, both at the individual and at the conglomeration level. Research has shown that an increase in human capital in the areas of schooling and training also has a positive effect on

entrepreneurial performance (Van Praag 2005). Rauch et al. (2005), Davidsson and Honig (2003) and Colombo and Grilli (2005) have found that the tacit knowledge acquired through a previous start-up and working experience in same industry plays a major role in people's decision to start a new venture as well as in the growth of a new venture.

During the 1990s, a new concept of capital gained general currency: *social capital*. Bourdieu (1986) has argued that social capital is an individual-related resource: "the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition". Coleman (1990) is of the opinion that social capital is a public good and that it refers to features of social organization that facilitate co-operation, such as networks, values and trust. We agree with Westlund and Bolton (2003), who see social capital as a multilevel concept. The distinction made by Granovetter (1973) between weak and strong ties in social networks (weak ties are loose relationships between individuals and strong ties are those found in the networks of family and friends) is highly relevant in entrepreneurship. Davidsson and Honig (2003) have found that individuals with strong-tied networks and business experience are more likely to start a new venture, but that a weak-tied business network is a strong predictor that a new venture will achieve first sales and be profitable for a new venture. Social capital can be a main contributor to economic growth in the early, entrepreneurial phase of new economic activity, complementing human capital in the areas of information and experience and providing access to resources and markets. During the discovery process, social capital helps entrepreneurs by exposing them to new ideas and providing them with a wider frame of reference. Sivan et al. (2005) have found that networks increase the competitive knowledge of nascent entrepreneurs.

Entrepreneurial capital is distinct from the human and social capital of entrepreneurs. The human capital of entrepreneurs is the endowment at the individual and conglomeration levels with experience, skills and education in entrepreneurship. Repeat entrepreneurs typically perform better than their first-time counterparts. The social capital of entrepreneurs consists of access to networks, organizations and individuals with relevant information, influence and resources. By contrast, we suggest that entrepreneurial capital is the endowment of individuals with entrepreneurial traits. At the conglomeration level of an organization or region, entrepreneurial capital is the accumulation of individual entrepreneurial capital and a legitimization of entrepreneurship and entrepreneurial culture. Audretsch and Keilbach (2004) have described various aspects of entrepreneurial capital at the regional level without actually defining entrepreneurial capital. In their study on the economic growth of German regions they operationalized entrepreneurial capital as its manifestation: the number of start-ups in a region relative to its population.

Entrepreneurial characteristics at the individual level and their effect on entrepreneurship performance have been studied extensively. There is evidence that the need for achievement and autonomy, a propensity for risk-taking, internal locus of control and self-efficacy are predictors of new venture success (Shane 2003).

Frese et al. (1997) have developed the concept of personal initiative and shown that entrepreneurs score higher on measures of personal initiative. Baum et al. (2001) measured the tenacity, pro-activity, and passion of CEOs and failed to find a direct relationship with venture growth, confirming previous research that failed to find a significant relationship between the personal traits of entrepreneurs and performance, but found a strong indirect relationship between personal traits and venture growth mediated by competences and goal-setting.

Knowledge capital consists of R&D, innovation and their spillovers. At the individual level it is individual general knowledge and specific domain knowledge that provide the ability to recognize valuable knowledge spillovers. *Financial capital* consists of financial resources at the individual and conglomeration levels, and of the mechanisms required for distributing these resources. In sum, we argue that economic growth requires financial, knowledge, human, social and entrepreneurial capital, all of them multilevel properties operating at the firm, industry and regional/national levels. We further argue that these forms of capital are partially correlated and at the same time independent of each other, each caused by different underlying factors. When they are all present, the five growth factors produce economic growth at the conglomeration level (regional, national and industry) as well as at the level of the individual, team and firm.

Because entrepreneurship involves individuals, the economic growth it produces can only be initiated by individual entrepreneurs. The entrepreneurial individual, endowed with human and social capital, recognizes valuable knowledge spillovers and organizes financial resources to exploit opportunities. We argue that entrepreneurship-based growth and the interaction between the multiple levels of the economic system (individual/firm–industry–region–nation) is driven by *a goal-setting–performance feedback loop*. Economic growth is thus a chain reaction of successful performance by individual firms, which increases capital endowment at regional/industry/national levels, enabling and initiating the establishment of new ventures and thereby creating a sustainable ecosystem. The relationship between the five capital endowment factors and performance is mediated by goal setting.

Extensive empirical research into goal-setting theory has shown that specific and difficult goals consistently lead to higher performance than urging people to do their best (Locke and Latham 2002). Baum and Locke (2004) have shown that the entrepreneurial traits of passion for work and tenacity indirectly cause higher performance through the setting of higher goal. Baum et al. (2001) found higher venture growth with CEOs who formulated ambitious visions and goals. Goal setting is dependent on reference points set by competition and growth opportunities. Fiegenbaum et al. (1996) have shown that strategic choices depend on strategic reference points (SRPs). When performance is above SRP, strategic choice behaviour is risk-averse; when performance is below SRP, choices and goal setting are risky.

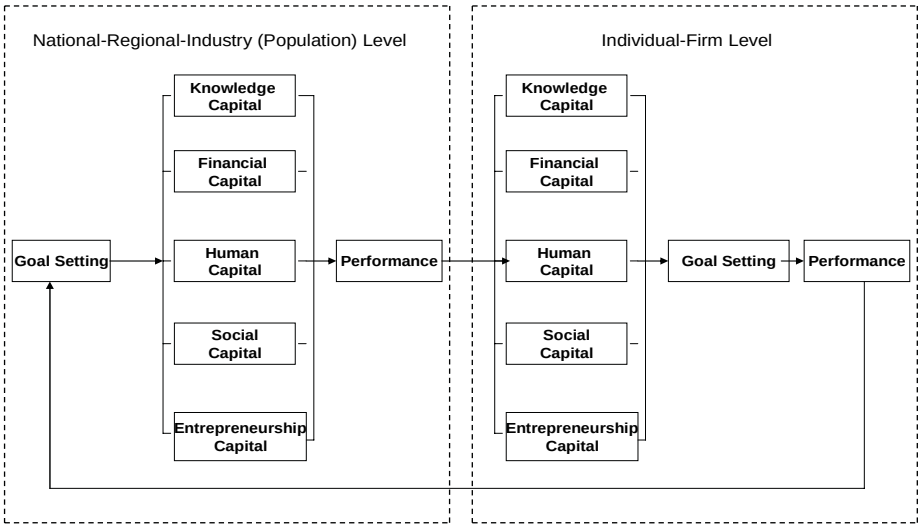


Figure 1. *A multilevel model of economic growth in knowledge-intensive economies*

In the initial phases of their life cycle, firms and industries always perform below actual or perceived SRP and entrepreneurial managers set higher, more risky goals.

Moreover, entrepreneurs with high self-efficacy and a propensity for taking risk set higher goals than managers in incumbent companies, and providers of financial capital for new ventures set specific return-on-investment goals for their capital. The strategic choices and growth strategies of new ventures are expressed in the goals they set and the knowledge, social, human, financial and entrepreneurial capital they build. This account of strategy follows the resource-based-view theory in strategy management research. Figure 1 summarizes the multilevel dynamic model of economic growth. Below, we illustrate and test the model in the case of the Israel high-tech industry.

DEVELOPMENT OF THE ISRAELI ECONOMY

During its first decades the Israeli economy grew rapidly through targeted, export-oriented sectors. Export orientation included agriculture, which benefited from applied agricultural research. A dominant element in developing the industrial sector was the defence need. A well-developed higher education system that had already been founded before the establishment of the State in 1948 produced the skilled labour necessary for a local military industry. The French arms embargo imposed after the Six Day War in 1967 accelerated the development of the local defence industry because France had been Israel's major arms supplier. As a result, the nation's military industry grew into a technologically sophisticated military industrial complex, involved largely in electronics, communication equipment and aeronautics. Israel's defence expenditures grew as a percentage of GNP from 10.4%

in 1966 to 25.2% in 1980. At its height, around 1984, the military industrial sector employed 65,000 individuals, including 25,000 scientists, engineers and technicians. Its output amounted to 50% of the electronics and aeronautics industry (Gradus et al. 1993). During the 1970s, the defence sector started spawning civilian high-technology companies like Elbit, Elscint and Scitex, supported by a strategic decision by the Israeli government to create a 'science-based' sector.

In 1969, the Office of the Chief Scientist was established as part of the Ministry of Trade and Industry, which provided grants to civilian R&D projects with export potential. In the 1970s, the first (U.S.) multinational companies established R&D and manufacturing facilities in Israel, attracted by stable and relatively cheap top-quality scientific labour. The migration path of foreign direct investment (FDI) in Israel shows a different pattern from that in other countries, such as Ireland, Eastern Europe and Asia. In those countries FDI is attracted by a combination of low-cost labour and local market potential. In time, with the development of a local supply base and engineering education, FDI migrates towards local development and in rare cases local research. The industries in these countries developed through foreign investment, and ownership remained to a large degree with the foreign companies.

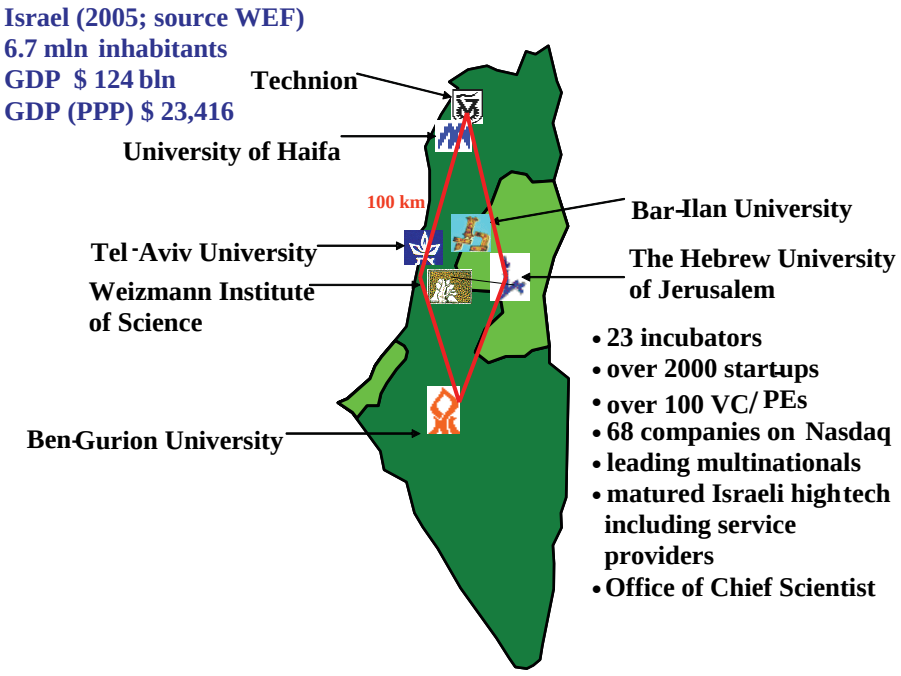


Figure 2. *The Israeli Diamond*

In Israel, the technology sector developed from indigenously initiated R&D operations for military and later civilian applications, and the resulting scientific-

engineering labour base attracted FDI. Even as late as 1998, 82% of employment in the electronics sector in Ireland was in the hands of foreign-owned companies, compared to 25% in Israel. In the same year there were only two multinational companies among the top 20 companies in the electronics sector in Israel (Roper and Frenkel 2000). The period of rapid growth ended in 1985 as result of a world-wide downturn in the electronics market and severe cuts in the defence budget following a drop of defence spending as a portion of GNP from 21.1% in 1985 to 13.8% in 1990. The military industry laid off thousands of technically skilled workers. At the same time, the lack of capital influx hampered growth in the civilian sector. Moreover, despite abundant technological opportunities and support from the Office of the Chief Scientist (OCS), there was a shortage of technological entrepreneurship and of people willing to take risks (Breznitz 2002).

The year 1991 marked the beginning of the rapid high-tech growth in Israel brought about by the concurrence and convergence of several factors. During the 1990s almost one million Jews from the former Soviet Union immigrated to Israel. Among them were many highly skilled engineers and scientists looking for employment. In 1991 the Office of the Chief Scientist created technological incubators to offer employment possibilities to immigrants and to breed entrepreneurial skills and experience in a protected environment. In 1992, the government launched Yozma, a program designed to create a vibrant venture capital (VC) industry in Israel. The Yozma investment fund with $100 million in government money initiated and invested in VC funds, with the condition that any Yozma investment in a VC fund would be matched by at least one foreign and one local financial partner (Breznitz 2002). This program, initiated at the same time that entrepreneurship and venture capital began their rapid rise in the U.S., proved to be a great success: Israel has become the most VC-intensive country in the world in terms of venture capital available per citizen. In 1993, the signing of the Oslo accords led to high expectations of a peaceful Middle East economy in which Israel could play a key role, similar to that of Singapore in Asia. The prevailing optimism in those years brought in additional investments from multinational companies.

Table 1. *Converging factors acting as tipping points for high-tech growth*

	New high-tech companies average per year	VC/PE raised in mln dollars average per year
1969 - 1992	19	7
1993 - 2005	307	1,214

The convergence of all these factors produced a critical mass that propelled the high-tech sector onto a rapid-growth track, and it managed to cope well even with the dip that followed when the Internet bubble burst in 2001. The share of the high-tech in industry grew from 26% in 1994 to 34% in 2004. In 2005, FDI (mainly in high-tech) amounted to $4.5 billion, and 68 Israeli companies were traded at the

NASDAQ, the second largest foreign presence after Canada (IEICI 2005). It is estimated that 2,600 young technology companies currently provide employment to 120,000 people (Haour 2005). Companies like Amdocs, Comverse, Orbotech and Checkpoint are world leaders in their industry. Microsoft, Oracle, SAP, Google, Cisco, Philips, Siemens and Motorola, to name a few multinational companies, have R&D operations in Israel. To date, Cisco has spent $1 billion to acquire nine Israeli companies (The stars of David 2006). On the World Economic Forum Global Competitiveness Index of 2005, Israel ranked 15 out of 125 countries, mainly thanks to its very high scores on technological readiness and innovation.

COMPONENTS OF A KNOWLEDGE-ECONOMY GROWTH MODEL AT THE FIRM AND NATIONAL LEVELS IN THE ISRAELI CONTEXT

Knowledge capital

Knowledge capital has been defined as consisting of R&D, innovation and their spillovers. Israel spends 4.9% of its GDP (2005) on civilian R&D, the highest relative national R&D expenditure in the world, compared to 2.6% in the U.S. and 2.4% in the EU (OECD 2005). There is a strong correlation between the number of patents published in the U.S. and national expenditure on R&D (per capita), supporting the approach that considers patent registration in the U.S. a good measure of the output of the innovation process. Given the high rates of obsolescence of knowledge capital in the high-tech sector, a steady stream of innovations (as represented by patents) is required to maintain current levels. In a comparative analysis using patent data from 1968-1997, Traijtenberg (2001a) has shown that Israel ranks very high in terms of the number of patents per capita. Only the US and Japan score higher. Like most countries, Israel has four sources of knowledge creation and spillover: universities and other public research organizations (PROs), the defence establishment, multinational corporations and start-up companies.

Universities and PROs

The Technion, a science and technology research university, was established as early as 1924. It was followed in 1925 by the Hebrew University and in 1934 by the Weizmann Institute of Science. Israel now has seven research universities and many more colleges. The Israeli government recognizes that the market (the private sector) cannot be fully counted on to invest in basic research, where risks and potential spillovers (leaks) are very high and consequently the level of ownership of research results is low. Therefore, the government uses grants and programs to support university research and pre-competitive research co-operation with industry. All research universities have a Technology Transfer Office and are actively engaged in transferring research results to the private sector.

Defence establishment

During the 1980s, 65% of total national R&D expenditure was estimated to be defense-related (Peled 2001). Those percentages have been reduced drastically. Civilian R&D, consuming 4.6% of GDP, is now the major R&D investor. Nevertheless, contribution by the defence industry remains significant and spills over to the private sector in four ways. First of all, spillover takes place through the infusion into the private sector of about 1,000 highly trained engineers annually who finish their compulsory military service and enter the job market. High-potential highschool students have the opportunity to study science and engineering before their military service with financial support from the army. After graduation, they serve for an extended period in the R&D and technology-intensive support units of the military. After completing their military service, they enter the private sector equipped with non-classified tacit know-how ready to be applied to business opportunities in the private sector. MAMRAM, the computer unit of the Israel Defense Forces (IDF), is one of the main sources of software innovation diffusion to the private software sector (Breznitz 2002). Many Israeli entrepreneurs in the information and communication technology (ICT) sector have served in the MAMRAM unit. Drafting high-potential engineering graduates into the army not only resulted in knowledge spillovers but also increased human, social and entrepreneurial capital. The young engineers gained specific high-tech experience and skills, and became part of a tight-knit social network. This facilitated their entry into high-tech entrepreneurship and exposed them to teamwork, risks and an ability to operate under conditions of uncertainty, all of which enhanced their entrepreneurial capital.

Secondly, defence research contracts to universities create defence-related spillovers. In the U.S., approximately 70% of basic research funded by the Department of Defense is carried out by universities, accounting for about 40% of all R&D activities in engineering at U.S. universities. Spillovers of this research created the Internet and the Global Positioning System (Peled 2001). Although no similar data are available with regard to Israel, there are substantial spillovers, mostly indirect ones, through faculty and graduate students working on defence-contracted research and applying their know-how to civilian projects.

Thirdly, defence-related spillovers are produced through the customer relations of the military with its suppliers. The Israeli defence industry is one of the world's top-five arms suppliers. The French weapons embargo of 1967 emphasized the need for an independent military industry. Companies like Raphael, Elbit, IAI and El-Op specialize in complex electronic-based weapon systems. They are leaders in their fields because of their close co-operation with demanding customers such as the IDF. Spin-offs by the military industry are a fourth path for defence-related knowledge spillovers. A few of the many examples were Scitex (computerized print systems), Elscint (medical imaging) and Orbotech (a world leader in electric-optical inspection equipment). In sum, knowledge spillovers from defence-related research

and industry have been and remain a major source of knowledge input to the civilian high-tech sector, as is the case in other countries with a large defence outlay.

Multinationals

Through FDI and joint ventures, multinational companies are major contributors to national innovation systems and reinforce other trends in the internationalization of science and technology. However, there are considerable differences in the impact of multinational companies on national innovation systems (Nelson 1993). Unlike Japan and Korea, Israel has always been open to FDI. As early as the 1970s, Israel succeeded in attracting R&D and manufacturing investment from U.S.-based companies like Intel and Motorola. However, until the 1990s the influx of multinationals remained limited because of the political situation and because of the strong dominance of local (mostly defence-related) companies that generated a strong demand for scientific labour. Since the 1990s, many multinational companies acquired Israeli start-ups as their local bridgehead. Of the 566 companies registered in the Israel Venture Capital data base between 1995 and 2005, 63% were acquired or merged and 37% exited through an IPO (Israel Venture Capital Research Center). Most of the acquisitions involved foreign firms.

Although the integration of these acquisitions by the acquiring multinational companies into their R&D function may have tended to lead to an outbound technology spillover rather than an inbound one, Israel high tech has benefited greatly from the management know-how spillover from the multinational companies. Multinational companies trained the human capital necessary to complement the entrepreneurial capital in order to start and grow new companies.

National innovation systems need the exploration skills of both innovators and entrepreneurs and of start-up companies to create new business opportunities, and the skills of managers and incumbent companies to exploit and grow these opportunities.

Start-up companies

The turnover of scientists and engineers at start-up companies is one of the main mechanisms of knowledge spillover in clusters of knowledge-intensive industries.

The collective group and community culture in Israel makes company and team loyalty stronger than in other countries with strong high-tech industries. However, many founders and engineers leave their company after it exits and join another start-up. The preference to work in a small, entrepreneurial company, the technical challenge and high demand (and remuneration) make moving on to the next start-up after exit a common phenomenon.

Financial capital

After two decades of rapid growth, the Israeli economy reached an impasse in the early 1970s. The economy had outgrown the centralist mould that had worked well

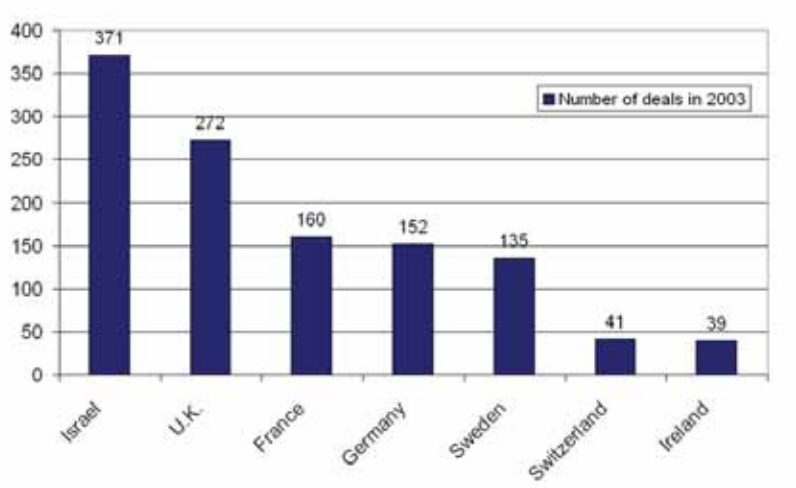
initially. Israel has few natural resources but plenty of highly skilled labour, as well as scientific capital. The question was how to mobilize these assets for economic growth. The Israeli government made a crucial decision to breed a science-based sector by providing broad financial support for commercial R&D and making up for market failures (Trajtenberg 2006). Infant industries may need temporary protection and support because of the hazards of two types of market failure: (1) positive externalities, such as external economies of scale and knowledge spillovers, and (2) inefficient markets in which young firms find it difficult to borrow against potential future earnings because of information asymmetries between inventors and external agents (Avnimelech and Teubal 2006).

Although the Office of the Chief Scientist (OCS) was established in 1968, it began its work in earnest in 1973 by launching a program to subsidize 50% of the costs of R&D projects aimed at exportable products. Successful projects were required to repay the grant by paying 3% royalties on annual sales. In 1975, a bi-national industrial R&D foundation (BIRD) was established. The BIRD foundation funds projects for which the R&D is carried out in Israel and which target the U.S. market (Breznitz 2002). BIRD has been successful in helping Israeli companies enter the U.S. market and attracting U.S. multinationals to invest in Israel. In 1985, the Law for the Encouragement of Industrial R&D was passed by the Knesset; implementation was assigned to the OCS. The stated goals of this legislation were to develop science-based, export-oriented industries. Between 1969 and 1987 industrial R&D expenditures grew by 14% per year, and high-tech exports grew from $422 million in 1969 (in 1987 dollars) to $3,316 million in 1987 (Trajtenberg 2001b). This was a reconstruction period of the institutional base of Israel's political economy. The old centralized socialist economy, with state- and union-owned industries and an ideology of full employment had lost ground.

With the decline of the defence industry and the influx of a large wave of well-educated immigrants, new initiatives were needed. In the early 1990s, new programs were introduced by the OCS, the most important of which were MAGNET, the incubators and Yozma. MAGNET, which was founded in 1993, supports the formation of consortia consisting of industrial firms and research universities in order to develop generic, pre-competitive technologies. Grants constitute up to two thirds of the approved R&D budget, with no repayment requirement.

Incubators are designed to supply the basic needs of fledgling new ventures to help them develop their innovative ideas and set up new businesses. Incubators provide financial support, plug-and-play facilities and advisory services. The main difference between Israeli incubator programs and those in the U.S. and EU is the high level of up-front grant support that Israeli incubators receive (two thirds of the budget, with a maximum of $500,000 for the two-year incubator period to be paid back through royalties on actual sales). Twenty-eight incubators were established in Israel between 1990-1993. Twenty-three are still operating. In the last years most incubators have been privatized, with VCs acquiring shares in the incubators and using them as a vehicle for subsidized, high-risk, very early-stage investment. To date, approximately 1,000 Israeli companies have started their life in an incubator and 45% have managed to raise follow-up financing. From the 369 incubator projects that completed their two-year incubator stay between 2001 and 2005,

according to the OCS 65% are still operating. Questions have been raised about the impact of the incubator program on the employment of scientists, in particular immigrants, and about its cost-effectiveness (Roper 1999). However, the effect of the well-funded and designed incubator program has not been only economic. The program has also served to legitimate early-stage technology entrepreneurship and it has lowered the psychological entry barrier for fledgling entrepreneurs by providing the funds and expert managerial support needed to overcome market failures.



Source: IVC 2005

Per-capita VC funds raised (2000)
Israel: $600 per capita
Europe: $30 per capita (20x)

Figure 3*. Israel is the most active VC-fund-raising country*

Yozma jump-started the venture capital sector in the early 1990s. Because of its great success, Yozma has led to path-dependence in the financial-capital component of the high-tech growth model in Israel, which has since been domineered by the VC investment model. With a government investment fund of $100 million, Yozma established 10 VC funds and raised $200 million by attracting foreign and local investors and offering them options to buy out government shares five years later at a predetermined price. Because of its success, the investment portfolio was privatized in 1997 and Yozma's mission came to an end. In the course of its operation it brought in not only financial resources of Venture Capital funds, but also the management expertise of experienced VC managers who served as board member in start-ups. This program seems to have triggered the take-off of the high-tech sector. Between 1993 and 2000 close to $10 billion was raised by about 80 VCs, and between 2001 and 2005 another $3.2 billion. A consolidation is currently

under way in the VC market, with 23 VCs managing about 94% of the total capital raised (source Israel Venture Association Yearbook 2006). In absolute terms, high-

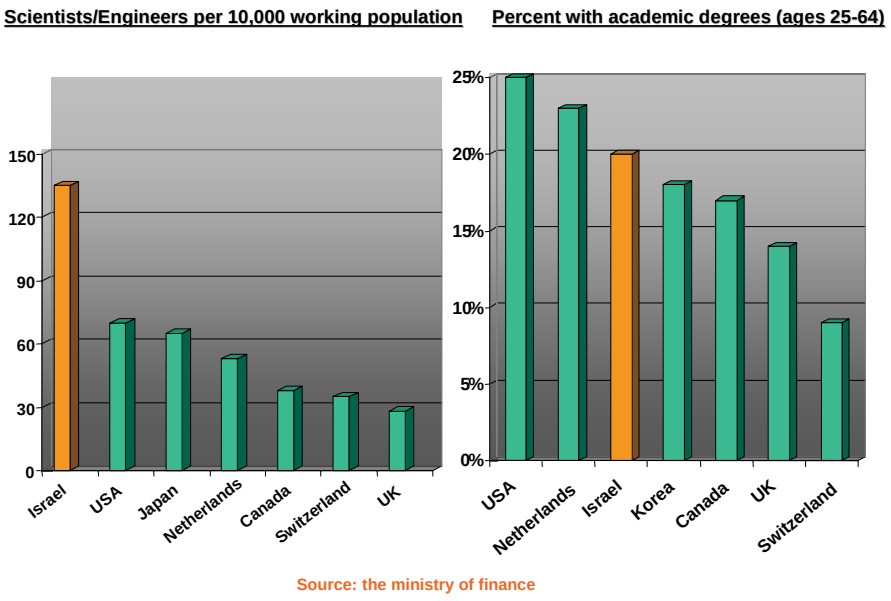


Figure 4. *Human capital: Israel's biggest asset*

tech VC investments in Israel are higher than in any EU country. Israel has the highest VC capital investment as a percentage of GDP in the world (source: Israel Venture Association, OECD VC database 2002). Ernst & Young recently reported that in 2006 VC investments were highest in California ($12.4 billion), Massachusetts ($2.8 billion), and Israel in third place ($1.4 billion) (Ha'aretz 23/1/2007).

The success of VCs in Israel has led to path-dependence and lock-in in the financing of the high-tech growth. As a result, other financial-capital sources, such as business angels and private investors, are not well represented. The success of VC-backed funding made it possible for the government to confine itself to bridging the gap between social and private rates of return covering for market failures in the very early stage of new ventures. The defining character of government policy has been its neutrality (refraining from picking winners) and its dynamism in creating new and varied programs responsive to the needs of the 'market' (Trajtenberg 2006).

Human capital

The abundance of scientists and engineers in Israel prompted the government's decision to create a science-based sector. Led mostly by defence-related high-tech industries, the number of scientists and engineers in industry grew by 460% between 1968 and 1984. At the same time, the overall number of employees in the industry grew by only 50% (Gradus et al. 1993). The experience part of human capital is self-reinforcing through the growth and failure of new ventures and the re-entry of entrepreneurs and engineers into the system. However, the formal education part of human capital with respect to science and engineering education is not self-generated by the system, but must be provided at the national policy level. To keep up with demands from the high-tech sector, new colleges were established and existing engineering and science faculties expanded. The number of science and engineering graduates from universities grew from 3,963 in 1994 to 9,458 in 2004, accounting for 26% of all university graduates (Neaman Institute 2006). A technically educated human-resource base remains the main competitive advantage needed to create a high-tech sector. Israel employs 1.68% of all employees in the business sector in R&D functions, compared to 0.89% in Japan and 0.59% in the EU.

Social capital

The Israeli culture and reality facilitates building social capital and consequently networking. In Hofstede's study (1984) on national cultures, in which he measured cultures on five factors, he found that Israel scored 54 on the scale of individualism vs. collectivism, whereas the U.S. scored 91 and France 71. Moreover, the Israeli culture is informal and non-hierarchical, which makes personal access easy. During the three-year military service extensive networking evolves that carries over into professional careers. Honig et al. (2006) have shown that social capital accrued in the military leads to greater investment and better performance of new ventures. There is relatively easy and institutionalized availability of expertise and access to advisory boards in incubators. The same is true for events organized by the Israeli Venture Association and by professional service providers to the high-tech sector.

VC investment in companies and board membership by VCs provides companies with access to extensive VC networks, locally and abroad. VC investment in the social capital of a firm is as important as the financial capital, and it is this that differentiates VCs from one another when firms select them. The phenomenon of repeat entrepreneurs and engineers who remain in the start-up sector also leads to an increase in social capital. A common way of recruiting in Israel is by encouraging employees to bring in their friends.

Entrepreneurship capital

Entrepreneurial capital at the individual level is the endowment with entrepreneurial traits such as a need for achievement, risk-taking, over-confidence, self-efficacy and personal initiative. We are not aware of research data on individual entrepreneurial capital in Israel or of comparisons with other countries. Anecdotal evidence describes typical Israelis as improvisers, self-confident, assertive and energetic, which implies the presence of a positive stock of entrepreneurial capital. At the organizational or regional level entrepreneurial capital is the accumulation of individual capital and the legitimacy and social desirability of entrepreneurship. Aldrich and Fiol (1994) have argued that from an institutional perspective founders of high-risk new ventures appear to be fools, unless entrepreneurship acquires cognitive and socio-political legitimacy and becomes part of the accepted norms and even of the culture.

The legitimacy of entrepreneurship and personal wealth creation took longer to develop in Israel than in many Western countries. The Israeli political-economic system was not receptive to entrepreneurs due to a historical labour-socialist tradition that was deeply antagonistic with regard to the self-employed sector, making Israel one of the few non-Communist countries where Jews did not gravitate to small businesses (Gradus et al. 1993). There was a long incubation period from the establishment of the Chief Scientist Office in 1973 to the take-off of the high-tech sector in the 1990s. Establishing the legitimacy of free capitalism and entrepreneurship took time. However, the presence of individual entrepreneurial traits among the population caused a rapid shift after the legitimacy was accepted and entrepreneurs became role models. Zilber (2006) conducted a longitudinal analysis of newspaper articles and want-ads for high-tech personnel and showed the development of collective meanings and myths that institutionalized the acceptance of social practices in the high-tech sector.

Goal-setting and performance feedback

We have described the five multilevel components necessary for economic growth, and their interactions, and illustrated them with examples derived from the emergence of the high-tech sector in Israel. The model is still a static one, however. Adding a feedback loop of goal-setting and performance transforms it into a dynamic model. High performance at the firm level increases the accumulated capital factors at the regional/national level, which then makes it possible to start and grow additional firms and thereby create a sustainable high-tech ecosystem. Specific and difficult goals consistently lead to higher performance than diffuse and easily attainable ones (Locke and Latham 2002). We argued that, all things being equal, entrepreneurial firms outperform incumbent ones because of the focused, ambitious and risk-taking way they set their goals. The specific character of the Israeli high-tech sector, with its limited domestic market, makes this point even

more salient. In general, the reasons for specific and high goal-setting in entrepreneurial firms are:

- *Self-efficacy and overconfidence on the part of the entrepreneurs*
- *Low initial complexity and clear business vision of the new venture*
- *Initial performance below strategic reference points (which increases high-risk choices)*
- *Specific goals for results and timing set by investors.*

Consequently, *ceteris paribus*, economic systems with high entrepreneurial capital will show superior performance. Although anecdotal evidence appears to confirm this proposition, systematic research is needed. In addition to the four factors leading to specific and difficult goal-setting by new ventures in general, in the Israeli case an additional factor in high goal-setting was the internationalization of new ventures, which was a strategic goal from their inception. The success of the Israeli high-tech sector challenges traditional theories of international competition. Porter (1990) has claimed that firms and countries need large local markets in order to grow and compete in international ones. Israel does not have significant markets for the advanced products it develops, and therefore new ventures must begin internationalization from the outset.

Sapienza et al. (2006) have argued that an early internationalization of new firms, although risky, increases their probability for growth. The earlier a firm internationalizes, the more deeply its dynamic capabilities will be imprinted for exploiting foreign markets. By exposing firms to multiple and diverse requirements, early internationalization builds capabilities and processes in organizations oriented toward continual change. Choosing an incremental path from domestic to international markets poses a lower risk and increases the chances of survival, but it also lowers the chances of growth because it allows inertia to develop, making it more difficult to refigure capabilities. Internationalization from inception of new ventures lowers the probability of their survival but increases the probability of their growth. Israeli companies must decide whether or not to internationalize at the outset, and they must attract sufficient and appropriate human and social capital to accomplish their goals in this respect. About 50% of Israel high-tech firms have offices abroad (Khavul 2001). It is mostly the marketing function that is established in their main market from a very early stage. A multilingual society, extensive overseas networks and increasingly international repeat entrepreneurs give Israeli high tech an edge in early internationalization and affects the growth of young technology firms.

CONCLUSION

In this chapter we have drawn on theories and research in economics, strategic management, organisational behaviour and entrepreneurship to propose a model of economic growth through innovation and entrepreneurship. We identified five capital factors as necessary for economic growth: knowledge capital, financial capital, human and social capital and entrepreneur capital. These factors are crucially important both at the firm level and at the regional/national/industry levels.

A goal-setting performance feedback loop makes the model dynamic and sustainable. The model was illustrated using the example of the Israeli high-tech sector. In its current form, this is an explorative framework; much research remains to be done to turn it into a predictive model. Although most of the variables have been described in different research areas, and some of the relationships we have hypothesized have been confirmed by research, the multivariable and multilevel characteristic of the model creates multiple indirect relations and embeddedness. A large body of econometric research on economic growth illustrates the complexities of conducting research in this area. (Helpman 2004; Audretsch and Keilbach 2004).

The contribution of the proposed theoretical framework is that it has the potential to bridge academic research and policy-making. Literature on high-tech growth areas, such as Silicon Valley, Route 128 in the Boston area and Israel, has been descriptive in nature and is based on historical and anecdotal evidence. The present theoretical framework attempts to contribute to research literature providing a better understanding of the underlying factors and their interactions, which are important for economic growth, and it provides policy-makers with an integrative and eclectic framework for the changes required to support economic growth. The framework also provides a bridge to academic research, as it reflects and incorporates research constructs and findings on economic growth and entrepreneurship and forms a platform for additional research.

REFERENCES

Acs, Z.J. and Audretsch, D.B., 2003. Innovation and technological change. *In:* Acs, Z.J. and Audretsch, D.B. eds. *Handbook of entrepreneurship research: an interdisciplinary survey and introduction*. Springer, New York, 55-79.

Aldrich, H.E. and Fiol, C.M., 1994. Fools rush in? The institutional context of industry creation. *The Academy of Management Review*, 19 (4), 645-670.

Audretsch, D.B., 2005. The knowledge spillover theory of entrepreneurship and economic growth. *In:* Vinig, G.T. and Van der Voort, R.C.W. eds. *The emergence of entrepreneurial economics*. Elsevier, Amsterdam, 37-54. Research on Technological Innovation, Management and Policy, vol. 9.

Audretsch, D.B., 2006. *Entrepreneurship, innovation and economic growth*. Elgar, Cheltenham.

Audretsch, D.B. , 1995. *Innovation and industry evolution*. MIT Press, Cambridge.

Audretsch, D.B. and Keilbach, M., 2004. Entrepreneurship capital and economic performance. *Regional Studies*, 38 (8), 949-959.

Avnimelech, G. and Teubal, M., 2006. Creating venture capital industries that co-evolve with high tech: insights from an extended industry life cycle perspective of the Israeli experience. *Research Policy*, 35 (10), 1477-1498.

Baum, J.R. and Locke, E.A., 2004. The relationship of entrepreneurial traits, skill, and motivation to subsequent venture growth. *Journal of Applied Psychology*, 89 (4), 587-598.

Baum, J.R., Locke, E.A. and Smith, K.G., 2001. A multidimensional model of venture growth. *Academy of Management Journal*, 44 (2), 292-303.

Baumol, W.J., 2002. *Free market innovation machine: analyzing the growth miracle of capitalism*. Princeton University Press, Princeton.

Bourdieu, P., 1986. Forms of capital. *In:* Richardson, J. ed. *Handbook of theory and research of the sociology of education*. Greenwood Press, New York.

Breznitz, D., 2002. *Conceiving new industrial systems: the different emergence paths of the high-technology industry in Israel and Ireland*. The Samuel Neaman Institute, Technion City. Working Paper Series no. STE-WP-11-2002

Coleman, J.S., 1990. *Foundations of social theory*. Belknap Press, Cambridge.

Colombo, M.G. and Grilli, L., 2005. Founders' human capital and the growth of new technology-based firms: a competence-based view. *Research Policy,* 34 (6), 795–818.

Davidsson, P. and Honig, B., 2003. The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing,* 18 (3), 301-331.

Fiegenbaum, A., Hart, S. and Schendel, D., 1996. Strategic reference point theory. *Strategic Management Journal,* 17 (3), 219-235.

Frese, M., Fay, D., Hilburger, T., et al., 1997. The concept of personal initiative: operationalization, reliability and validity in two German samples. *Journal of Occupational and Organizational Psychology,* 70 (2), 139-161.

Gradus, Y., Razin, E. and Krakover, S., 1993. *The industrial geography of Israel*. Routledge, London.

Granovetter, M.S., 1973. The strength of weak ties. *The American Journal of Sociology,* 78 (6), 1360-1380.

Haour, G., 2005. Israel, a powerhouse for networked entrepreneurship. *International Journal of Entrepreneurship and Innovation Management,* 5 (1/2), 39-48.

Helpman, E., 2004. *The mystery of economic growth*. Belknap Press, Cambridge.

Hofstede, G., 1984. *Culture's consequences: international differences in work-related values*. Sage Publications, Beverly.

Honig, B., Lerner, M. and Raban, Y., 2006. Social capital and the linkages of high-tech companies to the military defense system: is there a signaling mechanism? *Small Business Economics,* 27 (4), 419-437.

IEICI, 2005. *Israel Export and International Cooperation Institute: your gateway to business in Israel*. Israel Export and International Cooperation Institute. Available: [http://www.export.gov.il] (2005).

IVA, 2006. *IVA yearbook 2006*. Israel Venture Association, Savyon.

Khavul, S., 2001. *Money and knowledge: sources of such capital and the performance of high-technology start-ups*. Boston University, Boston. Doctoral Dissertation

Locke, E.A. and Latham, G.P., 2002. Building a practically useful theory of goal setting and task motivation. *American Psychologist,* 57 (9), 705-717.

Nelson, R.R., 1993. *National innovation systems: a comparative analysis*. Oxford University Press, New York.

OECD, 2005. *Science, technology and industry score board 2005: towards a knowledge-based economy*. OECD, Paris. [http://caliban.sourceoecd.org/vl=3788419/cl=27/nw=1/rpsv/scoreboard/]

Peled, D., 2001. *Defense R&D and economic growth in Israel: a research agenda*. The Samuel Neaman Institute, Technion City. Working Paper Series no. STP-4. [http://econ.haifa.ac.il/~dpeled/papers/ste-wp4.pdf]

Porter, M.E., 1990. *The competitive advantage of nations*. The Free Press, New York.

Portes, A., 1998. Social capital: its origins and applications in modern sociology. *Annual Review of Sociology,* 24 (1), 1-24.

Putnam, R.D., 2000. *Bowling alone: the collapse and revival of American community*. Simon and Schuster, New York.

Rauch, A., Frese, M. and Utsch, A., 2005. Effects of human capital and long term human resources development and utilization on employment growth of small-scale businesses: a causal analysis. *Entrepreneurship Theory and Practice,* 29 (6), 681-689.

Roper, S., 1999. Israel's technology incubators: repeatable success or costly failure. *Regional Studies,* 33 (2), 175–184.

Roper, S. and Frenkel, A., 2000. Different paths to success: the growth of the electronics sector in Ireland and Israel. *Environment and Planning C: Government and Policy,* 18 (6), 651-665.

Sapienza, H.J., Autio, E., George, G., et al., 2006. A capabilities perspective on the effects of early internationalization on firm survival and growth. *The Academy of Management Review,* 31 (4), 914-933.

Shane, S., 2003. *A general theory of entrepreneurship: the individual-opportunity nexus*. Edward Elgar, Cheltenham. Met lit.opg., index

Sivan, T. and De Haan, U., 2005. Managing the co-evolution of knowledge and opportunity's discovery-evaluation to enhance expected economic value. *In:* Zahra, S.A. ed. *Frontiers of entrepreneurship research 2005: proceedings of the twenty-fifth annual entrepreneurship conference*. Babson College, Babson Park.

Solow, R.M., 1957. Technical change and the aggregate production function. *The Review of Economics and Statistics,* 39 (3), 312-320.

The stars of David, 2006. *Red Herring,* 3 (23), 34-43.

Trajtenberg, M., 2001a. Innovation in Israel 1968-1997: a comparative analysis using patent data. *Research Policy*, 30, 363-389.

Trajtenberg, M., 2006. *Innovation policy for development: an overview*. The Samuel Neaman Institute, Technion City. Working Paper Series no. STE-WP-34.

Trajtenberg, M. , 2001b. *R&D policy in Israel: an overview and re-assessment.* The Samuel Neaman Institute, Technion City. Working Paper Series no. STE-WP-2.

Van Praag, C.M., 2005. *Successful entrepreneurship: confronting economic theory with empirical practice*. Edgar Elgar, Cheltenham.

Westlund, H. and Bolton, R., 2003. Local social capital and entrepreneurship. *Small Business Economics*, 21 (2), 77-113.

Zilber, T.B., 2006. The work of the symbolic in institutional processes: translations of rational myths in Israeli high tech. *The Academy of Management Journal*, 49 (2), 281-303.