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National innovation systems creation – evidence from Israel

Key words

National innovation systems, technology transfer, technological incubators, venture capital, technology transfer companies.

Słowa kluczowe

Narodowy system innowacji, transfer technologii, inkubatory technologiczne, venture capital, firmy transferu technologii.

Summary

The concept of national innovation systems (NIS) appears to be an attractive idea on the grounds of policymaking, as it is expected to provide straightforward measures to boost a state's competitive advantage. This paper presents Israel's system of innovation with the main trends of its development, as well as key agents and linkages which shape their relationships. The study forms the basis for a question of NIS transferability and adaptability, and it demonstrates considerable limitations of the NIS emulation in different environments and economic settings, pointing to the evolutionary and country-specific characteristics of the innovation system. The unit of the analysis has been chosen due to the outstanding achievements of Israel in the field of innovation, strongly embedded in the unique attributes of the state, hence, being a particularly illustrative case for the study.

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Introduction

The national innovation system (NIS) can be described as a set of private and public organisations whose relationships and interactions at the national level contribute to the development and diffusion of new knowledge which translates into novel technologies. OECD publication (OECD, 1997) gathers the most dominant definitions of the NIS developed by the concept creators and followers. All of them point to organisations' interconnectedness and interactions as the engines for technological development, which are central for the innovativeness of the economy. The NIS concept appears as an attractive idea on the grounds of policymaking, since it seems to provide a relatively clear-cut instrumentation for boosting economic performance and competitiveness. Thus, in the search for benchmarks, innovation systems of the leading knowledge-based economies have been widely studied. However, the NIS concept takes the nation state as a unit, and as such, it indicates that innovation systems are deeply embedded in the specific conditions of a country.

Taking the innovation system of Israel as a point of reference, this paper aims to discuss the issue of NIS transferability. It illustrates how the system arose from the country-specific conditions, as well as market and economic circumstances, which, timely pinpointed and understood, enabled the design and implementation of a package of pro-innovation instruments, shape the relationships among the system actors, and induce adequate financing mechanisms. The tools employed at the government level pushed the country's economy on the innovation path through the emergence of the high-tech sectors, mainly ICT, which today accounts for 30% of Israel's total export and 16% of total business output (Samuel Neaman Institute, 2010). The country is also aiming to excel in other advanced sectors, including bio- and nanotechnology. Israel's outstanding attainments are further reflected in its venture capital market, which until the recent 2009–2010 global economic crisis raised a spectacular amount of about \$13.3B invested in Israeli start-up high-tech companies (IVC, 2009; Avnimelech & Schwartz, 2009). Taking into account venture capital investment as a percentage of GDP, as of 2008, Israel ranked second with 0.3%, outdistanced only by the United Kingdom (OECD, 2008). The country has been very dynamic in start-up firm creation, and it is in the forefront in the number of high-tech companies listed on Nasdaq, following only the United States. Moreover, despite the difficult geopolitical situation, Israel managed to attract the large investment of multinational corporations in their R&D centres, including the biggest players, such as Google, Intel, Microsoft, HP and others. The country has the highest expenditure on civilian R&D among OECD members, which reached 4.3% of GDP in 2009 with almost 80% of R&D financed by the business sector (Samuel Neaman Institute, 2010).

The following analysis of the Israel's system of innovation and its main elements is preceded by a brief presentation of a theoretical background of the

NIS concept evolution and premises. The concluding part discusses the key organisations and mechanisms which shaped the country's innovation system from the viewpoint of their transferability and adaptability to different economic contexts and environments. The paper is an empirical study, based in a large part on semi-structured individual in-depth interviews with the key figures of Israel's NIS, conducted between April and July 2011.

NIS concept development - theoretical background

The concept of national innovation systems was almost simultaneously formulated in the 1980s by Christopher Freeman (2003) and Bengt-Åke Lundvall (2010), and followed by other scholars, such as Richard Nelson (1993) and Charles Edquist (1999) among others. However, the origins of the concept can be traced even further back to the OECD's work related to a system approach within the framework of the national science policies promotion, launched in 1960s, though the term itself was not used at that time. Godin (2009) presents an overview of the OECD's policy papers that involved the system approach that underscored institutional and contextual facets of research. OECD's view on research system entailed the conviction that research is not an isolated organism, but it is conducted within a certain institutional context in which scientific inventions should be applicable to the economic and social needs. The issue of research results commercialisation by universities was then raised.

Thus, the development of the NIS concept can be divided into two interrelated stages – the first one dating from the post-war period until the 1980s, the second one from the 1980s until present (Soon Yim & Nath, 2005). During the first phase, a direct relationship between research and innovation was held as a model, with science and technology policies involving direct governmental support of R&D. The second phase, next to the formulation of the concept as such, brought a radical change in the perception of innovation. It was at that time that the shift from the so-called linear model of innovation to a dynamic and interactive one took place. It is also important to note that the NIS framework emerged in opposition to the standard economics in that it challenged its understanding of international competitiveness, which was then attributed to national wage reduction and devaluing of national currency. As Lundvall (2007) wrote,

The intention was thus not just to give a new tool to those policy makers who were in charge of science and technology policy. ... We saw a need for a different kind of economic theory and also a need for a different perspective on economic policy where innovation and learning were seen as important processes behind economic growth and welfare.

The NIS concept was simultaneously developed in academic and policymaking circles, because its proponents were both academicians and held positions in such organisations as the OECD (Sharif, 2006). The term “national innovation system” was first used by Christopher Freeman in his 1982 paper prepared for the OECD Ad-hoc Group on Science, Technology and Competitiveness (Freeman, 2004) and then disseminated in his 1987 book on innovation in Japan (Freeman, 1987). Freeman referred NIS to Friedrich List’s concept of “national systems of production” which involves national institutions and infrastructures and focuses on production forces. Based on it, he questioned the then-mainstream perception of international competitiveness. He also linked the need for public financing of the technological infrastructure with the country’s economic performance. In the early 1980s, the NIS concept was also being developed by the IKE group at the Aalborg University with the leading role of Bengt-Åke Lundvall, whose publications used the term “innovation system” (Lundvall et al., 2002). The Freeman and Aalborg group developed a broader approach to NIS and innovation itself, which entailed diffusion, absorption and usage to the innovation process, next to the radical or incremental innovation per se. Lundvall (2010, 2) defines the system of innovation as “elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge,” which are rooted or located within a nation state. This version of the NIS concept, in which firms and their interactions with other firms and with knowledge organisations are central to the innovation process, and which highlights knowledge-flow and interactive learning, was further developed into the multi-channel interactive learning model (Caraça, Lundvall, Mendonça, 2009), built on the Kline and Rosenberg’s (1986) chain-linked model. The chain-linked model questions the linear perspective’s thought that research is the main source and starting point to innovation. While scientific knowledge may still play its traditional role of nurturing innovation, the relationship between the two may well be reversed, because innovation processes and dynamic market forces may trigger scientific activity. The multi-channel interactive learning model reassesses and complements the chain-linked model by extending institutional context in which innovation takes place. It adds micro- and macro-environments to the learning process, where the micro-environment encompasses the agents who directly influence the firm’s innovative activity, such as suppliers, distributors, partners, competitors, and the like, who operate within a wider setting of macro-structures formed by political, social and other forces, including the education and training system, information infrastructure, science and technology system, etc. The general idea behind the model is that, although science is fundamental for innovation, it is not the only source of new-knowledge creation and often does not translate easily into commercial application, whereas interactive learning and firms’ interactions with other market players seem equally crucial for their innovativeness.

A narrower approach to NIS, which identified innovation with processes that firms apply in developing novel products, focused more on the institutional facet of the system was proposed in a comparative study of innovation systems compiled by Nelson (1993). In this view the NIS is defined as “a set of institutions whose interactions determine the innovative performance ... of national firms.”

Groenewegen and van der Steen (2006) extend the institutionally-oriented approach to NIS by proposing a layered institutional model which places NIS within social settings and underscores interconnectedness of institutions (both formal and informal rules, values and norms), institutional arrangements, and dynamics of the system. Moulaert and Hamdouch (2006) in their analysis of the EU RTD Framework Programmes list those which highlight the role of cultural factors in NIS, further extending the settings in which national innovation systems are embedded.

The above brief overview of the selected currents in the NIS concept development in the historic perspective, as well as more recent contributions to the preliminary idea appear to head in a similar direction. Although various approaches may stress different facets of the system, what stems from the re-assessment of the NIS concept by its first proponents and other scholars' work is the emphasis of a complex nature of innovation systems, the role of interactions between its various agents, interconnectedness of the system's elements and the broader environment.

Drawing upon the theoretical background of the NIS concept, what follows is an attempt to depict Israel's system of innovation, with the goal to raise the question of the NIS transferability.

Model of the national innovation system of Israel

As stated before, Israel belongs to the group of countries whose economy is based on knowledge-intensive sectors that fuel the state's competitive advantage. The country has excelled in ICT, but it also aims to dynamically develop other high-tech sectors, such as bio-, nano-, environmental and medical technologies. This part of the paper outlines the main forces that stand behind the Israel's ability to innovate, which jointly make up the country's NIS.

Figure 1 presents a model of Israel's innovation system. It involves the organisations that appear central to the system's development, as well as key processes that influence their relationships. For the sake of clarity and in order to stress its core, the model has been intentionally simplified in that it does not incorporate minor players and linkages which, in the view of the author, have not been critical to the country's innovativeness. In addition, it is a static representation, whereas it is also important to underscore the evolutionary character of the innovation system of Israel. The current state of Israel's NIS

can be traced back to the 1990s. However, its origins reach further back, to the beginning of the state, i.e. 1950s and 1960s. Teubal's (1993) analysis of the country's innovation system delineates its major characteristics and directions in the period between 1950-80s, i.e. before the turning point in the state's approach to its economic performance.

Next to the three main actors, i.e. firms, government and universities, two additional players – technological incubators and venture capital institutions have been integrated into the model, due to the substantial part they have played in the Israel's NIS. Moreover, within the group of firms four main subgroups have been distinguished, that is local start-ups, other local firms, R&D centres of foreign companies, and foreign firms located outside the Israeli market. Singling out the four kinds of enterprises appears useful to illustrate different functions they perform in the system and their distinct interactions with other agents.

It is important to note that in Israeli settings the term “start-up companies” refers specifically to newly established high-tech firms. They are one of the most important elements of the country's economy in terms of its innovative performance, and they may be recognised as a cornerstone of the Israel's innovation system, as opposed to the states where innovation is channelled mainly through large corporations. “Other local firms” represent other than start-up companies which deal in high technology sectors or perform R&D. “R&D Centres of foreign companies” have been marked out in the model, as they depict another peculiarity of the Israel's NIS in which R&D centres of multinational corporations are a particularly welcome form of foreign investments. Finally, incorporating “foreign firms” in the model is justified in that it represents extensive connections of the Israeli enterprises with external markets, including both their export orientation, as well as the quite common exit path of Israeli start-ups through foreign M&As.

The connections between the NIS agents have been divided into the two main groups. The first one embraces the processes that might be broadly referred to as knowledge transformation or technology transfer which involve both codified and tacit knowledge transfer, as well as the transfer of (innovative) products, processes and companies.

The most classic knowledge transformation avenue runs from universities (via their technology transfer companies (TTCs)) to firms through research result commercialisation. Technology transfer in this context may take a number of forms, such as licensing, creation of spin-off companies, collaborative research, and joint ventures. An additional aspect of knowledge flow encompasses human capital transfer to companies through university graduates, which is particularly significant in the case of R&D centres of foreign firms that employ a large number of Israeli university graduates. Another type of knowledge transformation is embodied in joint R&D cooperation (consortia) of

commercial enterprises and universities within the framework of a number of government programmes.

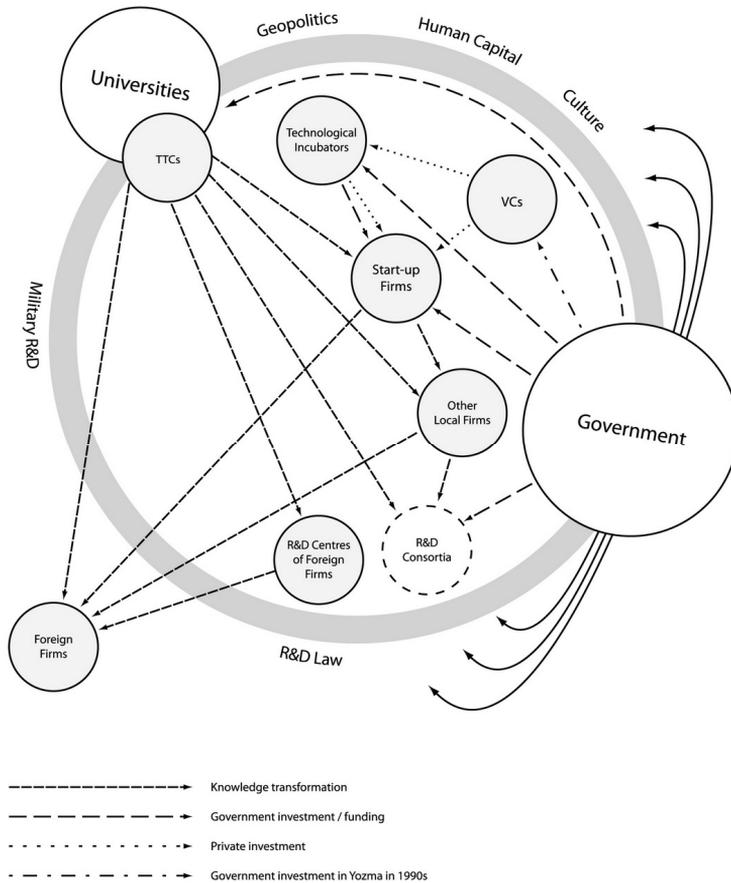


Fig. 1. Model of Israel's innovation system

Rys. 1. Model systemu innowacji w Izraelu

Source: Author

The model also depicts technology transfer processes in the inter-firm linkages. They take various forms of collaboration, as well as, especially in the relationships between start-up and existing local or foreign companies, acquiring the former by the latter.

The second type of relationships between the NIS agents refers to the resource flows, involving government funding of university research, as well as commercial and government investment, the latter taking the form of support interventions and incentives. Commercial investment involves VCs' co-investment in start-up companies through technological incubators, as well as VC direct investment in start-ups.

As shown in the Figure 1, Israel's innovation system demonstrates a significant degree of interconnectedness between its main agents with a considerable role of the government in shaping the system. Moreover, it has been strongly embedded in social, geopolitical, cultural and legal settings that form a wider environment and a very significant background for the innovation-oriented development of the country.

Israel's NIS creation – a deliberate process

Taking a look at Israel's innovation system in a historic perspective, it becomes clear that the system developed as a conscious decision in response to the variants of settings the state has been operating in, as well as the identification of its strengths and timely reaction to opportunities, with Israel's government as a driving force behind the process. Understanding the circumstances from which certain mechanisms of the Israel's NIS arose is critical to discuss their adaptability.

National innovation systems do not develop as isolated, independent units, but they are strongly embedded in state's characteristics and broader social, political, cultural, financial, legal, education and market ambience. Thus, to quote Nelson (1993, 518): "nationhood matters and has a persuasive influence" on NIS creation. The case of Israel is particularly interesting in this realm due to the specific conditions that have influenced the country's overall performance, including its economy. Among the elements of a wider environment the following appear to have had a considerable impact on the state's innovation: the country's geopolitical situation, social and cultural characteristics related to entrepreneurship and human capital, military R&D, and R&D law.

Israel has no significant natural resources and it is located in a predominantly arid area, surrounded by mostly hostile states. Paradoxically, Israel's impressive achievements in innovation may be linked to its highly adverse geopolitical situation dated back to the 1960s. It was at that time that country's military R&D emerged as a result of the French embargo on the arms supply at the time of the 1967 Six-Day War. In consequence, Israel's government undertook to develop an independent defence sector, which led to the accumulation of technical knowledge within defence companies. Military R&D soon became perceived as the potential that could fuel the whole economy, and it gave rise to the civilian R&D (Vekstein, 1999).

A small domestic market and the lack of export opportunities to neighbouring countries played part in the global orientation of Israeli companies. The necessity of international competition called for innovation of Israeli products marketed abroad (Avnimelech, 2006).

Israel is an immigrant country, which is believed to translate into the entrepreneurial spirit of the society, risk taking capabilities, perceiving failure as

an important element of a learning process, as opposed to its stigmatisation (Ruohonen and Oy, 2007). Between 1989 and 2001, Israel experienced an influx of high-educated immigrants from the Former Soviet Union which exceeded a million people of whom 11,000 were skilled scientists and engineers (Getz and Segal, 2008). In addition, Israeli society stands out in terms of the human capital, with 44% of the population aged 25-64 holding tertiary education degree (Samuel Neaman Institute, 2010).

Finally, legal settings, embodied in the Law for the Encouragement of Industrial R&D, enacted in 1984, formed the basis for the acceleration of the high-tech sector development. Although until that time some attempts on the grounds of economic innovativeness had been made, the primary aim of the Israel's economy had been employment creation (Porath, 2006). The Law considerably extended economic goals to the development of the local knowledge-based industry and the improvement of the country's trade balance (MOITL, 2010).

All of these provisions constitute an important background for the state's innovation system.

Venture Capital market

The early 1990s marked the beginning of the era when the innovation processes in the Israel's economy speeded up significantly. It was the time when important measures were taken by the government with the goal to facilitate the development of high-tech sectors in response to the identified "market failures." One of the deficiencies spotted was the lack of the capital market that would cater to the development of a growing number of start-up companies. Thus, in 1993, an outstandingly successful programme to stimulate venture investment, Yozma, was introduced. It involved government contribution to the fund of around 40% (approximately \$80M in total) and the option for private investors to buy out government's share at the initial price plus some interest.

Several factors add up to the Yozma's success at the stage of its conception and operating. First of all, it was proposed by the then Chief Scientist at the Ministry of Industry and Trade who accurately assessed Israel's shortages in the area of capital market and proposed adequate measures to fill in the gap. Hence, the suggestion came out from the figure "within the system," which helped to ensure government approval for the programme implementation. Secondly, the programme outset coincided in time with a large immigration, among which there was a substantial number of high-educated people and specialists; thus, the government sought plans enabling to utilise this potential. At the stage of Yozma performance, one of the key factors that contributed to its effectiveness may be described as "good timing," since the programme set out right in time for the high-tech boom at the end of the 1990s. In addition, on the operational level, the fund was established as an independent government company, which allowed for its flexibility, in such areas as e.g.

employment policy, ensuring adequate human resources, outside the government structures.

The initial goal of the programme was to attract U.S. venture capital funds to Israel. It involved, among other things, personal efforts of the programme founder to convince some of the leading VCs in the U.S., such as Advent and H&Q, to invest in the country. The two major obstacles pointed to by potential investors were locality of the business, as Israel was perceived as a distant country, and the lack of experience in managing the funds in place. However, the opinion about the country itself, its human capital, and then-relatively cheap labour costs were among the arguments that managed to convince American and European VCs (Erlich, interview, July 11, 11).

Yozma triggered mechanisms that fuelled the innovativeness of the Israel's economy by matching the potential of an increasing number of start-up companies with the high-risk venture financing which had been non-existent before the programme's inception. Taking into account the excellent state of the Israel's VC market activated in the course of government intervention, it should be noted that it was considerably challenged by the 2009-2010 global economic crisis when the VC fundraising fell to almost none. This raises the question of a cyclical nature of the VC market that may significantly hinder economic growth of the countries that are predominantly based on this source of innovation funding. Thus, there is a need to search for alternative forms of capital investment which would turn out effective also during downturns (Etzkowitz, 2005).

Technological incubators

Technological incubators programme is a government initiative established in 1991 in order to counteract a market failure defined as the lack of efficient mechanisms to support early-stage high-risk innovative enterprises.

Technological incubators aim to enhance the creation of new start-up companies which otherwise would not be set up. Thus, the main idea behind the programme is the government participation in the risk of establishing innovative ventures at the seed stage of their development, where other sources of funding are usually difficult to achieve. Some secondary goals of the programme involve technology transfer from academia to industry, fostering technological entrepreneurial culture in the country, and providing deal-flow for VC industry.

The incubators intend to provide full support for start-up companies, including financing, facilities and infrastructure for their R&D performance, professional counselling, and connectivity to potential customers (Smoler, 2011). The government's share in the funding amounts to 85%, the remaining 15% is matched by the incubator, i.e. private investors.

The projects applying to the programme undergo a strict selection process, based on such criteria as *inter alia*: innovativeness and uniqueness, early-stage, high-risk venture, and market and management potential. The assessment of the

projects is two-fold – due diligence is conducted by the incubator which recommends selected ventures to the programme authority within the Office of Chief Scientist of the Ministry of Industry, Trade and Labour, where the second stage of evaluation is done. The applying companies are required to present a market analysis of the project, patent search, business plan, as well as demonstrate management potential, etc.

Until 2002, technological incubators were non-profit entities, whose shareholders were various private entities, such as municipalities, since one of the main tasks of the incubators was the development of the regions in which they operated. In 2002, however, all technological incubators were privatised as a result of the identification of certain shortages in technical and business skills of current shareholders, which were believed to hold back the efficiency of the incubators and success rate of the incubated companies. The introduction of the new incubator model also involved a change in their financing and allocation of larger resources into incubated projects and not into the incubator itself, which, for example, has been reflected in cutting government coverage of the incubators' operational costs, with the only exception referring to some peripheral incubators. Another significant change was proposed in 2011, with reference to the extension of the incubator's (franchisee) term from 3 to 8 years, in order to adjust the ownership period to a more realistic return-on-investment time (Smoler, interview, June 30, 11).

Although technological incubators are believed to be crucial vehicles for start-ups creation, two major issues require further consideration. The first one refers to the incubator's effectiveness evaluation, which has not been clearly defined yet. There appears a question whether the evaluation should be done at a company, incubator, or programme level and what criteria should be employed. The second problematic area relates to the tendency among shareholders to lower the incubators' investment risk, and thus, allocating more resources to the ICT projects, which are expected to generate revenues in a shorter time-span, which does not fit the economic objectives of the government.

Academia-industry technology transfer

The emergence of the knowledge-based economy around 30 years ago induced a change in the role of universities in society and economy. Since knowledge became an asset of its own, and a tool for innovation-driven economic development, there appeared growing expectations towards university market-oriented research performance. These processes were accompanied by the decrease in public funding of university research, which forced them to seek additional research funding through the cooperation with industry. As a result, academia-industry relationships became more institutionalised which has been reflected *inter alia* in establishing separate technology transfer units within universities (Bonaccorsi, Daraio and Geuna, 2010; Geuna and Muscio, 2009).

Universities and other research institutions play a role of the knowledge infrastructure that in the linear model was believed to be the primary source of technologies adapted by companies. With the development of the NIS concept, it became clear that the relationship between science and economy innovativeness is not necessarily straightforward, and in many cases, a high level of government funds allocated to university research does not bring expected results on the grounds of technology commercialisation. Although university research is still one of the critical bases for novel economically useful inventions, it has been argued that innovation takes various forms and numerous manifestations of interactive learning, leading it to take place outside the academia, as well as that there is a mutual flow of new-knowledge between research institutions and other market players (Caraça, Lundvall, Mendonça, 2009).

In Israel's innovation system universities as technology providers have been ranked high. The appreciation of their role as sources of innovative developments has been embodied in both government programmes supporting academia-companies collaboration, as well as universities entrepreneurial culture and technology transfer companies (TTC), created to commercialise research results. TTCs, which are fully university-owned but independent units, exist in all seven public research universities.¹ They differ as to the tradition, size, business model, as well as profitability, but they share the same goal – bring research outcomes to the market in order to generate revenues for the university.

Although owned by the universities, the Israeli TTC model involves their autonomy. They are for-profit companies that operate outside the university structure. They are independent in human resources policies, and they must sustain their operations from their own revenues. Most of them employ typical commercialisation strategies, including licensing, creating spin-off companies, collaborative research, as well as hybrids of the above. It is worth noting that the Israeli mechanisms of technology transfer through university spin-off companies are distinctive in that, in most cases, technology is licensed to a new start-up firm set up by an external entrepreneur whose role is to develop a company and draw private investment. Thus, researchers are not directly involved in the operation of the company, and usually their role comes down to providing consulting services or holding other non-managerial positions in a limited time range, which is strictly regulated by the university law. In addition, on very rare occasions do Israeli universities invest in their spin-off companies. In addition, they are usually more in favour of the royalty-based commercialisation strategies than equity. However, in general, the Israeli TTCs' approach to the

¹ These are: Bar-Ilan R&D at Bar-Ilan University, BGN Technologies at Ben-Gurion University of the Negev, Yissum Technology Transfer at the Hebrew University of Jerusalem, T3 at Technion Israel Institute of Technology, Ramot at Tel Aviv University, Carmel Haifa University Economic Corporation at University of Haifa, and Yeda R&D at Weizmann Institute of Science.

cooperation with business partners and commercialisation agreements shows a large degree of flexibility.

TTCs provide a full range of services to the university researchers who wish to market their research results. They evaluate the invention in terms of its commercial potential, perform patentability checking, manage patenting process, select commercialisation path, and negotiate and execute commercialisation agreements. The policies of all universities involve an incentive scheme to encourage invention disclosure, whose basic form is inventor's participation in royalty payments ranging from 30% to 60% (Kenan, Soffer, Canetti, Naiberg, Oren, interviews).

Government industrial R&D and high-tech sectors support programmes

Apart from the above, government interventions aiming to foster high-tech sectors development, including technology transfer from academia to industry, are embodied in a number of support and incentive programmes. They have been implemented under the Law for the encouragement of industrial R&D with the goal to leverage the state's science and technological entrepreneurship. In most cases, the support mechanisms assume partial government contribution to the projects, which takes forms of grants or soft loans. Just to list a few, the interventions involve pre-seed and seed programmes addressed to high-tech start-ups and provide support at the preparatory stage of the business (Tnufa programme), help to develop the project to the stage where it will be capable to attract private investment (Technological Incubators), and mobilise private investment by providing matching funds to innovative enterprises (Heznek programme).

An important measure in government direct support of economic innovation is the Magnet programme that fosters industrial R&D and technological cooperation between the business sector and academia. It promotes technology transfer from science to industry (Magnet track), aims to fill in the gap between basic and applied research in biotechnology and nanotechnology (Nofar track) and fosters new water technologies (Katamon track) (MOITL, 2011).

Another path in enhancing the country's technology base are incentives for high-tech R&D centres of foreign companies under the Law for the Encouragement of Capital Investment, involving tax benefits and employment grants, the latter in specific peripheral parts of the country. Besides that, foreign companies' subsidiaries established in Israel are entitled to the support within various government-co-funded programmes. There are however, limitations in the subsidiary company's IP transfer abroad, which requires approval of the Research Committee of the Office of Chief Scientist and compensation for the obtained grant.

It should be noted that the majority of government incentives are addressed to high-tech sectors. Only recently has the Israel's government introduced a

programme directed to the enhancement of R&D and innovation in traditional industries.

National innovation systems transferability – discussion

The refutation of the standard economics' approach to international competitiveness and the emergence of knowledge-based economy elicited the drive for establishing innovation systems within nation states with the objective to boost the countries' economic performance and effectively compete on foreign markets. On the grounds of policymaking, the NIS concept has been a particularly attractive measure, however, often used in a simplistic way.

The following are the main characteristics of Israel's NIS arise from the preceding outline. Firstly, Israel's innovation system has been a result of deliberate actions intended to build the country's economic strength in specific high-tech sectors. Moreover, it entails outstandingly high expenditure on civilian R&D, because it is believed to be the main factor of economic innovation. Secondly, the role of the government has been central in shaping the system. The government has triggered a number of market mechanisms, but it is important to note that it withdrew from its interventions upon the successful adaptation of the proposed measures by private players. Thirdly, Israel's NIS constitutes a complex ecosystem of densely interconnected agents. None of the elements implemented solely would evoke an effective NIS. And last but not least, Israel's system of innovation is strongly embedded in the wider environment and country-specific conditions, and it evolved over time as a response to the particular circumstances which shaped the situation of the state.

The study of the Israel's NIS shows that innovation systems transferability is markedly limited. It is obvious that neither social dispositions nor cultural features can be copied to other settings, and they appear crucial in steering Israel's innovation system. The country economy's main asset seems to be high-tech start-up companies, whose creation has been driven, among other things, by the entrepreneurial spirit of the nation. Human capital embodied in a high level of the society's education has catered to the innovative nature of the start-ups. The small size of the country and low power distance have facilitated cooperation and communication between NIS players, the facet that is not typical for many states. Technological incubators may seem quite a straightforward tool to enhance the creation of innovative companies; however, they will turn out ineffective if the capital market able to invest in risky ventures is lacking. Emulating Yozma also appears feasible, as many countries have set up public venture capital funds, as well; nevertheless, the success of the programme may be also attributed to a good timing of its inception, right before the high-tech and ICT boom in the world's economies, a situation which is very difficult if not impossible to predict. Technology transfer effectiveness of the

leading Israeli universities' TTCs is not only a result of their business models, but also remarkable inventions, recognised by the industrial partners. In turn, rich invention base results from quality research which is a resultant of many factors, including education and research policies, R&D funding, etc.

Finally, critical analysis of the Israel's NIS points to a number of deficiencies of the system. First of all, an innovation system based on the development of high-tech sectors has led to the negligence of traditional industries that employ a majority of the industrial workforce. Moreover, the VC model of funding new ventures turned out inefficient during the economic downturn, imposing a considerable threat on the high-tech-based economy. It has also inhibited the creation of large national companies, due to the nature of the exits performed by the venture funds, and evoked knowledge flow outside the country. After all, expectation towards the universities to be economic innovation drivers raises a question of the role these organisations should play within the society and the balance between basic and applied research.

Although the analysis of Israel's NIS shows the limited adaptability of its elements in distinct settings, what emerges as a useful indication in terms of the NIS creation is the general approach to fostering innovation in Israel's economy, which may be defined as a complexity of the measures employed, continuity of the innovation-oriented actions over time, and flexibility in the implementation of given interventions in a response to changing market and wider settings. It appears that successful systems of innovation, although not free from certain shortcomings, arise from the country-specific settings, constant market monitoring and timely reaction to the changes in these two elements, which enables the implementation of the accurate means.

Appendix

The information included in the empirical part of the paper has been in a larger part compiled based on the interviews with the following figures:

Canetti Elena, Yissum Technology Transfer, The Hebrew University of Jerusalem – former VP Business Development, interview held on June 6, 11.

Erlich Yigal, The Yozma Group – Founder, Chairman & Managing Partner, interview held on July 11, 11.

Kenan Gabi, Bar-Ilan R&D, Bar-Ilan University – CEO, interview held on June 5, 11.

Naiberg Amir, Yeda R&D, Weizmann Institute of Science – CEO, interview held on June 6, 11.

Oren Shlomo, Carmel Haifa University Economic Corporation, University of Haifa – CEO, interview held on June 20, 11.

Smoler Josi, Office of Chief Scientist at the Ministry of Industry, Trade and Labour – Technological Incubators Programme Director – interview held on June 30, 11.

Soffer Benjamin, T3-Technion Technology Transfer, Technion Israel Institute of Technology – CEO, interview held on July 5, 11.

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Tworzenie narodowych systemów innowacji na przykładzie izraelskiego NSI

Streszczenie

Koncepcja narodowych systemów innowacji (NSI) niejednokrotnie jawi się jako relatywnie proste do wdrożenia narzędzie służące podniesieniu konkurencyjności kraju. Artykuł prezentuje system innowacji Izraela, wraz z głównymi kierunkami jego rozwoju, kluczowymi elementami oraz występującymi pomiędzy nimi powiązaniem. Studium empiryczne izraelskiego NSI jest podstawą do zarysowania problematyki adaptowalności narodowych systemów innowacji. Przedstawiona analiza pozwala wnioskować o ograniczonym zastosowaniu rozwiązań wypracowanych w innych krajach w kreowaniu NSI i wskazuje na ich ewolucyjny, wyrastający z unikalnych uwarunkowań danego państwa charakter. Izrael, ze względu na wysoką innowacyjność gospodarki oraz specyfikę czynników kształtujących system innowacji, stanowi wyrazistą ilustrację podjętej tematyki; stąd jego wybór jako jednostki analizy.