Chapter 6

Sequencing public interventions to support techno-entrepreneurship

Morris Teubal and Yevgeny Kuznetsov*

While the area of innovation studies is extensive and rapidly expanding, analysis of innovation policy is much less developed. A view that policy applications can be inferred linearly as an afterthought of positive analysis parallels the logic of a linear innovation model, whereby innovation is almost a straightforward outcome of either university research or company R&D. Taking as an example Israel's cluster of technology start-ups and venture capital industry, the paper develops a theory of innovation policy as an endogenous variable. A three-phase model of innovation policy evolution is introduced, as well as directions for the adaptation of the model for middle-income economies.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

---

* Morris Teubal is at the Hebrew University of Jerusalem and Yevgeny Kuznetsov is at the World Bank. The authors wish to thank B. Kosacoff, E. Kargierman, Ruth Ladenheim, D. Malkin, A. Lopez, Dirk Pilat, J. Robbio, Sarquis J. Sarquis, F. Sercovich, T. Shmukler, and G. Yoguel for help in preparing this paper.

Introduction

While the area of innovation studies is extensive and rapidly expanding, the task of extracting usable policy implications has only developed in a rudimentary way. In an extensive review of evolutionary economics, Fagerberg (2002) concludes that, based on an evolutionary perspective, "one cannot draw very firm conclusions on policy matters". A similar point is made by senior policymakers and practitioners involved in developing innovation clusters and techno-entrepreneurship, particularly in the middle-income economies of post-socialist countries, Latin America and Asia. These policymakers are very well aware of what to do in terms of the "wish list" of required actions to overcome constraints. Put another way, while the list of the constraints to be overcome might be largely understood, there is as yet no systematic knowledge about the evolutionary processes leading to (eventual) endogenous growth, *i.e.* a process by which, at any moment of time, the remaining constraints are overcome within the national system, with policy (itself already being largely endogenous) playing only minor roles in the process.

A view that policy application can be inferred linearly and in an almost "trivial" fashion as an afterthought of positive analysis parallels the logic of a linear innovation model, whereby innovation is almost a straightforward outcome of either university research or company R&D. In contrast to this view, we suggest that positive analysis is only one input in our understanding of policy issues, and policy design and implementation; other issues include those related to context, to the policy system itself and to the policy process.

In this paper, an endogenous policy process is viewed as:

- Trial-error search and experimentation by policymakers into new approaches and institutional solutions, which respond among other things to stakeholder needs, with the objective of overcoming critical market/system failures and/or government failure,

- Anticipatory thinking that links current policies and possible future policies in response to learning, and new opportunities and threats, and

- Readiness and disposition to adapt or complement and/or replace policies ("policy selection") in response to actual or expected performance (due consideration being given to possible costs to stakeholders of too frequent changes of policies).

To stay focused, the object of our analysis is limited in a number of ways. First, we confine ourselves to the process of creation of entrepreneurial

systems, including the institutional infrastructure that supports them, for example, the incubation cycle of technology start-ups (SUs) and spin-offs. While this is a narrow segment of innovation policy, which is of little relevance in low-income economies (where a broader approach to innovation is usually adopted, see for instance, World Bank, 2010), we consider some implications for mid to low-tech entrepreneurship in middle-income countries. Second, we break the policy process into evolutionary phases, rather than view it as a continuous, open-ended activity of adjustment and change (Avnimelech and Teubal, 2008a). Other approaches view policymaking as bootstrapping; as a continuous search for possibilities; and as follow-up in terms of implementation, and of detection and correction of inevitable errors and mistakes (Sabel, various years). Third, in terms of methodology, the paper relies significantly on the judgment, experience and observations of a seasoned practitioner. Thus, we cannot document every statement with a reference to the literature, as is customary in academic publications.

The argument is developed in four steps. We start with key definitions (such as institutional infrastructure for techno-entrepreneurship), the analytical framework (the three-stage evolutionary model leading to the endogenous emergence of techno-entrepreneurship in the sense of an entrepreneurial cluster/system) and the problem of critical mass of innovative, entrepreneurial companies (high-tech SUs or innovative SMEs)

We then discuss in detail the "three-phase model" as applied to Israel during 1969-2000 and extend the model to cover middle-income economies that have relatively developed R&D and human capital capabilities but a highly fragmented innovation infrastructure.

We also introduce the notion of *Framework Programmes*, which lie at the Phase II-III interface of the three-phase model. Finally, we note that every success is relative. While Israel was very successful in terms of high-tech development, it was much less so in terms of impact on inclusiveness and even on aggregate growth. We then conclude.

A key issue in the emergence of institutional infrastructure for techno-entrepreneurship: the problem of critical mass

In middle-income economies, the search for and incubation of new entrepreneurial niches often occurs in a rigid institutional environment that is full of vested interests. However, while the public sector may be dysfunctional, it can also be characterised by a large internal diversity, with pockets of excellence within individual ministries or implementation agencies. By supporting the emerging entrepreneurial segments, a virtuous

dynamic of continued entrepreneurial growth and public-private co-evolution may be ignited. Thus, public-sector talent and entrepreneurship that leads to new policy initiatives and Schumpeterian private-sector entrepreneurs are two indispensable and complementary facets of self-discovery; indeed, two sides of the same collaborative process.

One can think of such a collaborative process evolving in the following four-dimensional way, with the first dimension reflecting innovation entrepreneurship and the other three reflecting the institutional infrastructure to support it:

1. number and sectoral composition of firms,

2. specialised infrastructure - *e.g.* science parks, incubators, innovation centres, etc.,

3. professional business services firms - *e.g.* offering tailored services in accounting, tax, marketing and product design and development, and

4. venture capital firms.

A three-phase evolutionary model of emergence of entrepreneurial systems

We propose a three-phase model of evolution of entrepreneurial systems and support structures (techno-entrepreneurship). Its roots lie in an innovation and structural change-led perspective to economic growth and development with roots in Schumpeter; in the industry life cycle "model" (*e.g.* Abernathy and Utterback, 1969); in evolutionary economics (e.g. Potts, 2000); and in the context of the recent literature on venture capital and entrepreneurship (e.g. Lerner, 2008) and venture capital policy (Avnimelech *et al.*, 2010, Rosiello *et al.*, 2010).

Phase I is a set of preliminary, *background conditions,* which define whether or not countries may be able to develop an entrepreneurial system *in the medium term*, the materialisation of which would involve a number of other factors, both endogenous and exogenous. Background conditions are early, very basic, *necessary* conditions. They include both the usual "framework conditions" and others, such as the quantity and quality of Science, Technology and Higher Education (STE) institutions. Not every country could reasonably aspire to develop high-impact entrepreneurial systems. The conditions of Phase I would differentiate between those countries that could in principle do so from those which could not.

Phase II defines a set of immediate *pre-emergence conditions* for the subsequent emergence of entrepreneurial systems during Phase III. Pre-emergence conditions involve two sets of factors, one related to entrepreneurship and their support structures and another related to the broader national innovation system. The first set of factors relate to the scope, variety and mutual adaptation (jointly with entrepreneurial organisations like innovative SMEs or high-tech start-ups) of *both* venture capital and other financial institutions which provide financial services *and* "added value", as well as institutions and other agents providing technical and other services to such organisations. A critical pre-emergence condition which will be the focus of this chapter is *a critical mass of high-tech start-ups or innovative SMEs* required for the emergence of a domestic venture capital industry and/or market. Factors related to the broader national innovation system include the quality and scope of STE infrastructure; the institutional framework (*e.g.* bankruptcy laws); possibilities of creating distinctive types of financial organisations, such as Limited Partnerships; whether it is legitimate or not for the government to support or subsidise private organisations; innovation policy capabilities; etc. Pre-emergence conditions are *immediate necessary conditions* for the emergence of entrepreneurial clusters, and they include a large component of idiosyncratic factors.

In Phase III an entrepreneurial system *emerges* as a result of *dynamic increasing returns to scale*, a process that may or may not be triggered by policy. The entrepreneurial system is a Higher Level Organisation or System, which in the context of this chapter refers to a new cluster involving large numbers of innovative organisations (including an important segment of high-tech start-ups and/or innovative SMEs active in mid or low-tech branches/technologies) and associated financial and other support structures. The process of emergence could be very fast, possibly involving numerous variables, not only those representing entrepreneurial organisations and the agents/organisations directly supporting them, but other agents, organisations and institutions as well. A major issue is whether countries in Phase II will make a transition to Phase III, there being no automatic mechanism for this to happen (see *truncation* of the evolutionary process, Avnimelech and Teubal, 2006). Sometimes the triggering and sustaining factor may be completely endogenous (*e.g.* market forces and other processes set in motion during Phase II). In other cases, a trigger of the emergence process may be a favourable change in the external environment and sometimes a combination of both favourable exogenous variables (e.g. the Oslo Peace process and the massive immigration from the former Soviet Union in Israel during the first half of the 1990s) and a *framework programme*, such as Israel's government programme *Yozm*a, which targeted a domestic venture capital industry and market.

Co-evolutionary processes could be critical. The Israeli experience strongly suggests that *innovation-innovation policy co-evolution* may be important for ramping up innovation and growth of innovative, entrepreneurial organisations in phases I and II, thereby mitigating the problem of critical mass. Moreover, co-evolution between *innovative organisations* (high-tech start-ups) and *private finance organisations* (venture capital) represented a key element in the country's Phase III emergence of a domestic venture capital market and industry and its embeddedness into a broader high-tech entrepreneurial cluster (Avnimelech and Teubal, 2009; Teubal, 2011).

The three-phase model is a framework for generating an *endogenous process*; namely a set of favourable pre-emergence conditions (Phase II) which could trigger, with or without the help of government, the successful emergence of fully fledged techno-entrepreneurship (Phase III). *Endogeneity* refers both to the process - which, once triggered, is largely independent of government policy - and its consequences; namely, that the entrepreneurial system or cluster that emerged will transform a start-up-oriented innovation process from government-led to private sector-led. The key role of co-evolution is illustrated by the Israeli experience starting in 1969 with implementation, by the OCS (Office of the Chief Scientist), of its initial and main programme, the *Grants to company R&D* programme. This programme generated a chronic "excess demand" for grants, continued expansion of budgets, new BERD (Business Expenditure on R&D) support programmes and the search for new private sources of finance for company R&D. These efforts led to the launch of the "Projects of National Importance" *programme* which was implemented in the second half of the 1970s; the BIRD-F (Israel-US Binational Industrial R&D Foundation) programme, which started in the early 1980s; and the US-oriented "angel investor" support of individual projects or companies (an early form of venture capital) in the early 1980s. The outcome of all of these changes in policy was a further surge in innovation. Subsequent co-evolution involving the original *Grants to company R&D* and other programmes were instrumental in generating a critical mass and the launch of the Yozma programme in 1992 directed to domestic venture capital and the eventual emergence of Israel's entrepreneurial cluster in the 1990s.

Key challenge: incubating the incubation cycle

The incubation cycle of a technology start-up can be conceived as consisting of four stages (Figure 6.1):

- Pre-incubation (tiers 0 and 1): this consists of tier 0, which is the proof-of-concept stage and is usually funded by grants, and tier 1, which

is the first informal but external funding stage from the three Fs (friends, family and fools) or, more appropriately named, business angels,

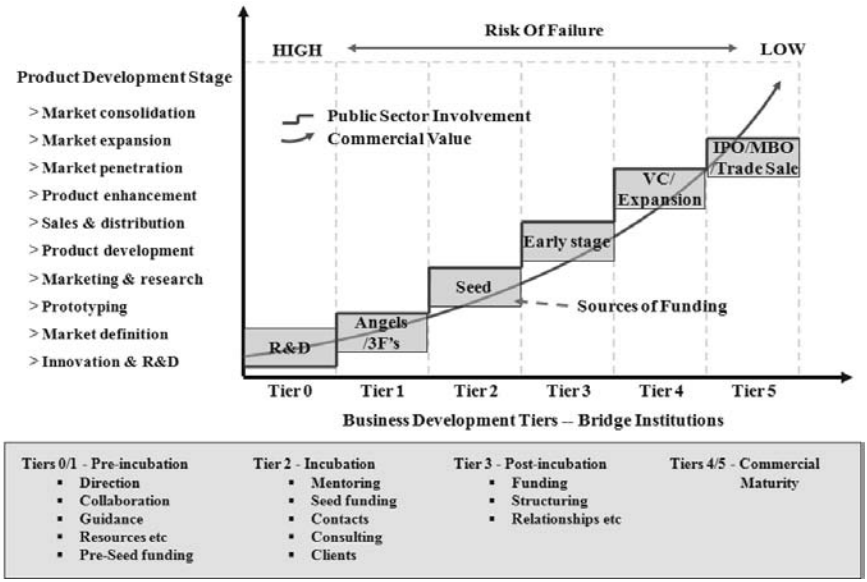
- Incubation (tier 2): the company develops a prototype and grows to establish a client base and receive seed money from institutional seed venture capital, represented mainly by large companies and other commercial sponsors. Funding is small (seed funds' investments usually do not exceed half a million dollars), whereas hand-holding of management is intensive and very time consuming,

- Post-incubation (tier 3): this is where early stage venture capital begins to play its role for those businesses that have already introduced their product to the market and have achieved a positive trading position that, through an injection of new capital, can be taken quickly to a higher level of success, and

- Commercial maturity (tiers 4 and 5): this is where larger development capital investments are made to accelerate the company growth and realise its full potential (tier 4) and its initial public offering (IPO) on a formal stock exchange, so enabling the company to raise capital in line with its expansion needs (tier 5).

At each stage of the injection of new capital, there are associated business service needs, which are also outlined in the diagram below. The provision of such services assists the enterprises to maintain their growth momentum and helps ensure a good return from the venture-funding activity by mitigating some of the risks that are inherent in setting up and growing a new business.

Figure 6.1. The incubation process



Source: Hodgson, 2006.

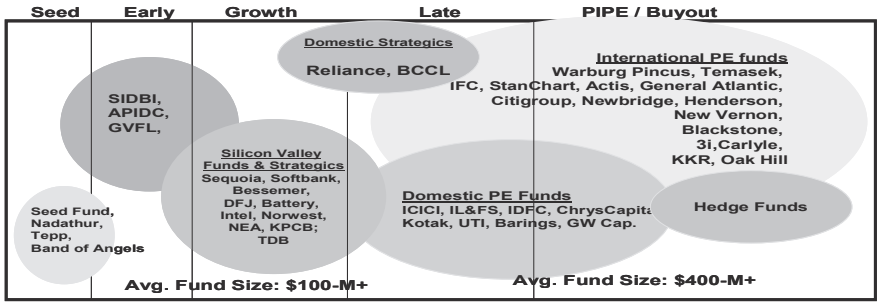
The traditional approach to supporting institutional infrastructure has involved a straightforward commercialisation function: each technology support agency focuses on and funds a specific stage of the incubation cycle. However, this approach has been facing a number of problems. *First*, the challenge of picking a winner. A SBIR grant to develop a pilot prototype can be as large as $1 million. Yet statistically, out of 1 000 ideas, early stage venture capital or a corporate sponsor will only finance 10 of them; and out of the 10 firms receiving finance, only one will be ultimately successful ("home run"), two to three will barely cover their costs ("living dead") and the rest will fail. If out of 1 000 ideas considered at the pre-incubation stage, there will only be one "home-run", then it is not surprising that everyone (*e.g.* state technology corporations, multinationals and equity investors) chases already-existing firms that may become successful in the future. So the first problem is a "doomed to choose" problem: one must make a choice (financing all promising ideas is plainly impossible), yet picking winners is plainly impossible too. Clear winners do not exist until very late: they are not picked; rather, they are generated (helped to emerge) within the incubation process. For instance, new industrial policy (Kuznetsov and Sabel, 2011) has recently emerged as a process for managing the incubation stage: a process with clearly defined cut-off points and performance benchmarks.

A second problem with the traditional approach is governance. Clearly defined accountability rules and transparent management structures exist only at the initial and final stages of the incubation; at the intermediate stages, they are quite fuzzy. To be more explicit: the logic of the initial stage is the logic of public sector grants for research and technology commercialisation. In contrast, the logic of the final stage - when a commercially successful company already exists - is decidedly private. Venture capital funds and multinational corporations would be by then the key managing agents. Yet there is no clear agent responsible for managing the commercialisation process in stages 2 and 3 (between the initial and the final stages). So-called search networks - bringing together and integrating relevant expertise of early-stage venture capital investors, researchers in universities and R&D institutes with technological expertise, consulting companies with marketing expertise, legal and investment banking specialists and the financial intermediaries - appear to be the key. Such expertise is required to identify the proposal as a promising idea and to decide what needs to be done to move it further along the commercialisation/ incubation cycle of Figure 6.1, and yet this knowledge does not reside in any one organisation. Organisations such as technology incubators, venture capital funds, national bio- or nano-technology corporations are only useful to the extent they can rely upon and tap into the increasingly globalised private-public search networks, which jointly have a capability to transform promising ideas into progressively more articulated deals.

So the policy issue is not the creation of efficient incubation organisations (incubators, science parks, innovation centres, etc.) but the creation of private-sector-led institutions that support the incubation cycle as a whole. For the reasons outlined above, there is gap between stage 1 of the incubation cycle (which tends to be grant-based and public) and stage 4 (private) - the problem that is also known as the "missing middle".

Figure 6.2 illustrates the phenomenon of the "missing middle" empirically for India (Dutz, 2007). It shows an abundance of later-stage and buy-out funding and a dearth of seed and early-stage venture capital.

Figure 6.2. India's venture capital and private equity landscape: skewed toward large and later-stage investment deals



Note: Those companies not listed here are known exclusively by their acronyms. APIDC = Andhra Pradesh Industrial Development Corporation; BCCL = Bennett Coleman & Co.; DFJ = Draper Fisher Jurvetson; GVFL = Gujarat Venture Finance Ltd.; IFC = International Finance Corporation; IL & FS = Infrastructure Leasing & Financial Services; PIPE = Private investment in public equity; SIDBI = Small Industries Development Bank of India; TDB = Technology Development Board; TePP = Techno-entrepreneurs Promotion Program; UTI = UTI Ventures.

Source: Venture Intelligence, World Bank.

The problem of critical mass

To understand the reasons for the "missing middle" problem in institutional infrastructure, let us examine the following dilemma of private venture capital. As a rule, the principal returns from investment in technology companies are realised after the early-stage financing, when the company is already sufficiently large to generate profits. Although no universal definition exists, we view early-stage deals as the first and second rounds of institutional funding for companies that are less than five years old and are not part of a larger business group. The companies are typically small, rarely exceeding $200 000, and thus generate disproportionately large transaction costs. Growth-stage deals are third and fourth rounds of funding, or first and second rounds of institutional investments for companies that are more than five years old or floated by large business groups and less than 10 years old. Late-stage deals are for companies that are more than 10 years old or pre-IPO (initial public offering) deals. Private investment in public-equity deals are investments in listed companies.

Consequently, there is a shortage of purely private, early-stage financing (illustrated by Figure 6.2 in relation to India) and provision of such financing has "public good" dimensions: while it is crucial for later-stage investments, it does not, in itself, generate sufficient commercial returns. Until both the

number and diversity of innovation start-ups and spin-offs reach a certain critical mass, the availability of purely private, early-stage finance will remain problematic. Advanced venture-capital industries (in the United States, the United Kingdom, Israel and Chinese Taipei) overcome this dilemma over a long period of time by developing a family of funds - seed funds, early-stage funds, later-stage and equity funds, where there is an implicit cross-subsidisation within one family of funds: from later-stage transactions (which generate higher returns) to early-stage transactions (which generate lower returns but which are necessary for the later-stage transactions to occur). However, in most countries, including many European economies, the number of start-ups has not yet reached the necessary critical mass, so public subsidy is widely used to address the "public good" nature of early-stage financing for new firms in high technology.

More generally, the key reason for the "missing middle" problem is that private support structures (*e.g.* specialised service providers, specialised infrastructure, venture capital, etc.) for technology entrepreneurship respond to, rather than create, commercial opportunities: they want a "piece of the action" but they do not create the "action" (*i.e.,* a cluster of innovation start-ups). This problem is the size of the market.

The synergy and co-evolution of public and private support structures is crucial to techno-entrepreneurship. Our hypothesis is that such co-evolution proceeds in three stages: during the first stage - let's call it the generation-of-diversity phase - support structures are idiosyncratic and, for instance, in middle-income economies, large conglomerates may play an important role at this time. During the second stage, pre-emergence and intense private-public institutional experimentation occurs: commercial and private actors develop a portfolio of institutions and programmes to address the critical mass problem. Finally, in the third stage, the critical mass is achieved and a fully-fledged private venture capital industry, including its seed and early-stage segments, as well as private, specialised service providers and infrastructure emerge.

Table 6.1. Israel's high-tech cluster: selected structural elements

	1969-1984	1985-1992	1993-2000
Number of high-tech start-ups created (venture capital-backed[1])[2]	136 (0)	349 (23)	2 436 (855)
Israeli venture capital fundraised/venture capital invested in Israeli start-ups (in USD million)[2]	0 / 0	~85 / ~50	7 480 / ~5 600
Number of IPOs at US (at EU and TASE) (in USD billion)[2]	14 (7)	19 (15)	101 (75)
Number of significant trade sales (M&As)[2]	0	2	91
Amount raised: public markets and Number of significant trade sales (M&As) (in USD billion)[2]	0.3	0.8	36.7
	1984	**1992**	**2000**
Share of ICT in manufacturing exports[3]	14%	28%	53%
ICT exports (in USD million) (in % of ICT sales)	~900 (50%)	2 711 (50%)	12 893 (59%)
Software development exports (in USD million) (in % of software sales)[3]	5 (4%)	135 (23%)	2 600 (70%)
ICT professional employees (thousands)[3]	~42.9	61.7	152.4
Patents issued in the U.S. (ICT patents issued)[4]	193 (44)	355 (89)	969 (417)
R&D in % of GDP (OCS R&D grants) (in USD million)[5]	2.4% (97)	2.6% (199)	4.5% (440)

2. By investment year.
3. IVC (2008).
4. CBS (2008) and estimates from IAEI.
5. USPTO (2008).
6. OCS (2008).

Source: Avnimelech and Teubal (2008a).

A three-phase policy model: Israel

As a summary, Table 6.1 indicates the central features of the emergence of Israel's entrepreneurial high-tech cluster (see also Avnimelech and Teubal, 2008a). The processes that took place in the emergence phase (Phase III) of this venture capital and high-tech cluster are much faster than those that took place in the previous eight years (*i.e.* Phase II, see the middle

column of Table 6.1) and much more so relative to the processes that took place during 1969-84 (Phase I). It is consistent with the view that the (accelerated) emergence of these new higher-level organisations was a market-dominated endogenous process; one that was fuelled by, among other things, innovation (and other) policies, throughout the whole 1969-2000 period.

Box 6.1 outlines the three-phase innovation policy model as applied to Israel, which culminated in the emergence of a domestic venture capital industry during 1993-2000. The three phases represent the innovation policy component of the corresponding first three phases of venture capital's industry life cycle (Avnimelech and Teubal, 2006). Thus, the first innovation policy phase took place during the venture capital's "background conditions phase"; the second policy phase was during venture capital's "pre-emergence phase"; and the third was during the venture capital's emergence phase (Avnimelech and Teubal, 2006). For each phase, we can find (i) a summary of the innovation policy programmes; (ii) the direction of their direct impacts; and (iii) some of the more "dynamic" impacts, particularly those favouring transitions to the subsequent phase.

Box 6.1. Israel's innovation policy cycle: policy and impacts

Phase I: Diffusion of R&D and generation of innovation capabilities (1969-84)

- Horizontal grants to business sector R&D: creation of R&D performing companies, of R&D/innovation capabilities, and of civilian high-tech industry and first start-up companies.

Phase II: Strengthening of business sector R&D and start-up/venture capital experiments (1985-92)

- Business experiments and informal venture capital activity: new model of start-up ("born global" with links to global capital/product markets).

- Restructuring of defence industries, including defence R&D, which also focused on civilian-relevant areas like communications, etc.

- Sharp increase in business sector R&D grants. Also, incubator and Magnet Program (which supports cooperative, generic R&D).

- A failed venture capital support programme (Inbal).

- Increased rate of start-up formation. While no private and professional venture capital market existed, there were a variety of start-up support mechanisms in operation or in experimentation, including angels, OCS subsidies, a few private venture capital funds, tax concessions to company R&D, a special form of venture capital that was oriented to finance groups of projects rather than firms, etc.

- Also, learning from Inbal's failure and from other business experiments: identification of system failures (absence of significant venture capital) and selection of limited partnership form of venture capital organisation.

- A critical mass of about 300 start-ups became available by 1992, some of them of high quality (a few having IPOs on NASDAQ): increased demand for venture capital services. Once venture capital funding became available, it was able trigger a market-driven, virtuous venture capital/start-up co-evolutionary process.

- Background factors: liberalisation of trade, capital markets, foreign exchange market, etc.

- Very favourable exogenous conditions: liberalisation of global communications markets, new possibilities of immigration from the former Soviet Union, the beginnings of the software industry, etc.

Phase III: Targeting venture capital and an ICT-oriented, high-tech entrepreneurial cluster, together with accelerated growth of R&D and high-tech (1993-2000)

- Targeted support of venture capital (Yozma Programme), continuation of all innovation policy programmes, R&D Grants peaked in 2000: emergence of a venture capital industry and entrepreneurial cluster. Accelerated growth of start-up segment and high-tech, large numbers of IPOs and M&As, etc.

Phase I background conditions: diffusion of R&D and generation of innovation capabilities (1969-84)

The Horizontal Grants to Business Sector R&D programme began in 1969 with the creation at the Ministry of Industry and Trade of a specialised agency, the OCS. This programme was and continues to be the backbone of the country's R&D/innovation strategy. Until the early 1990s, more than 90% of OCS disbursements to civilian R&D came from this programme, which

supports the R&D activity of individual companies that are oriented to new/improved products and processes, and directed to the export market. In contrast to a targeted programme that is applicable to a specific industry or technology, a horizontal programme is open, in principle, to all firms whatever their sector, and to all R&D projects whatever their product class or technology. Horizontal programmes of this kind are market-friendly R&D support programmes, which give primacy to the bottom-up identification and generation of projects. In Israel, it extended a 50% subsidy to every R&D project that was accepted by the OCS, regardless of the firms' industry, product class and technology (Teubal, 1983).

Box 6.2. Phase I: Learning process

Intra-firm learning during horizontal programme implementation: early sub-period:

(i) Learning how to search for market and technological information,

(ii) Learning how to identify, screen, evaluate, choose and configure new projects,

(iii) Learning how to generate new projects, including more complex ones, and

(iv) Learning how to manage the innovation process (linking design to production and marketing, selection of personnel, budgeting, management of human resources, etc.).

Collective learning:

(i) Firms learn about the importance of marketing,

(ii) Firms learn how to establish and manage strategic alliances, both with domestic and foreign companies; and how to generate links to global markets, and

(iii) The OCS and the firms learn how to assess the quality and economic potential of various types of projects, and they also learn about R&D-related areas with potential sustainable competitive advantage.

The major objectives of the Horizontal R&D Grants Programme during early implementation were: (i) to promote collective learning about R&D/innovation; in order to encourage technological entrepreneurship, and (ii) to generate knowledge about potential areas where the country concerned might have or could develop a sustainable competitive advantage. R&D-performing firms mutually learn from each other and a lot of this learning relates not directly to technology or R&D proper, but rather to organisational and managerial factors. Box 6.2 provides a categorisation of

intra-firm learning processes, 238as well as instances of collective learning. Both are based on the Israeli experience for the 1969-84 period.

Phase II pre-emergence: strengthening of business sector R&D and start-up/venture capital experiments (1985-92)

The 1984 R&D Law further consolidated Israel's support of business sector R&D. The objective was to support knowledge-intensive industries, through expansion of the science and technology infrastructure and exploitation of existing human resources; and creation of employment, including absorption of immigrant scientists and engineers, etc. The outcome was a significant increase in R&D awards to industry and the emergence of software as an industry, which was a very significant event indeed. Box 6.3 and Table 6.2 present data on the new policies initiated in Israel during Phase II (policies that continued during Phase III). The table also shows data on the backbone, business sector R&D support programme, which was implemented throughout the three phases.

Box 6.3. Phase II: new innovation and technology policy programmes

1. Inbal (1991): a government-owned insurance company, which gave partial (70%) guarantees to traded venture capital funds. Four venture capital companies were established under Inbal regulations. This early venture capital support programme failed to create a venture capital industry or market.

2. Magnet Program (since 1992): a $60M a year horizontal programme supporting cooperative, generic R&D, involving two or more firms and at least one university.

3. Technological Incubators (since 1992): a programme supporting entrepreneurs during the seed phase, for a period of 2 years. The incubators are privately owned and managed. Both they and the projects themselves receive financial support from the government.

Table 6.2. Office of Chief Scientist (OCS) grants 1985-2003

In USD million

Year	Total grants (growth)	Grants to BERD (individual firms)	MAGNET budget	Technology incubators	Royalties	BIRD-F[1] awards
1985	106 (2.5%)	106	0	0	6 (33.3%)	n.a.
1986	110 (3.8%)	109	0	0	7 (16.7%)	n.a.
1987	113 (2.7%)	112	0	0	8 (14.3%)	n.a.
1988	120 (6.2%)	118	0	0	9 (12.5%)	n.a.
1989	125 (4.2%)	122	0	0	10 (11.1%)	n.a.
1990	136 (8.8%)	133	0	0	14 (40.0%)	n.a.
1991	179 (31.6%)	171	0	4	20 (42.9%)	12
1992	199 (11.2%)	177	1	16	25 (25.0%)	10
1993	231 (16.1%)	199	40	24	33 (32.0%)	12
1994	317 (32.2%)	172	10	27	42 (27.3%)	10
1995	346 (9.1%)	294	16	31	56 (33.3%)	12
1996	351 (1.4%)	279	36	30	79 (41.1%)	13
1997	397 (13.1%)	309	53	30	103 (30.4%)	12
1998	400 (0.8%)	305	61	30	117 (13.6%)	14
1999	428 (7.0%)	331	59	30	139 (18.8%)	9
2000	440 (2.8%)	337	67	32	135 (10.8%)	8
2001	431 (-2.0%)	328	64	32	145 (5.2%)	11
2002	383 (-11%)	291	58	27	153 (1.4%)	10
2003	369 (-3.4%)	283	53	26	133 (-5.4%)	11

1. A programme supporting cooperative R&D involving a US and an Israeli company.

Source: Avnimelech (2004).

Phase III emergence phase: the Yozma programme (1993-2000)

New national priorities emerged in Israel with the beginnings of the massive immigration from the former Soviet Union during the early 1990s. The government began searching for the means to employ the thousands of engineers who arrived in the country. Simultaneously, the military industries laid off hundreds of engineers and many start-up companies were created only to subsequently fail. In fact, an official report of the Jerusalem Institute of Management (1987) mentions that 60% of the technologically successful OCS-approved projects failed to raise additional capital for marketing and had to close their business.[1]

Officials in the Treasury and the OCS concluded that despite massive government support for R&D, there were clear "market and system failures", which blocked the successful creation and development of start-up companies. As a result, a shift in policy objectives gradually took place - from promotion of R&D to enhancement of start-up formation, survival and

growth. System failures related not only to insufficient sources of R&D follow-up finance, but also to weak management abilities, business know-how and non-market-directed developments. Eventually, policymakers believed that the way to overcome these deficiencies was to foster a domestic venture capital industry, which then became a strategic priority of the Government of Israel.

The first venture capital-targeted programme was Inbal (a failed programme supporting *public venture capital funds*, raising capital on the Tel Aviv Stock Exchange, TASE), whose implementation started in 1992. The second was Yozma, a successful programme implemented during 1993-97. As mentioned, this programme was credited with triggering the creation of a domestic venture capital industry and market. Tables 6.3, 6.4 and 6.5 show the strong acceleration of venture capital and ICT activity during the 1990s.[2]

Table 6.3. Venture capital raised and invested

Year	Venture capital raised (USD million)	Venture capital under management (USD million)	Venture capital invested (% of foreign)	Venture capital investment (% of GDP)
1991	58	80	n.a.	n.a.
1992	160	240	n.a.	n.a.
1993	372	612	n.a.	n.a.
1994	374	986	n.a.	n.a.
1995	156	1 142	n.a.	n.a.
1996	397	1 539	n.a.	n.a.
1997	729	2 268	440	0.41
1998	706	2 974	589 (36%)	0.54
1999	1 851	4 825	1 011 (43%)	0.9
2000	3 701	8 504	3 092 (59%)	2.6
2001	1 100	9 546	1 985 (59%)	1.65
2002	63	9 609	1 140 (58%)	0.96
2003	300	9 600	1 000 (61%)	0.84

Source: Avnimelech (2004).

Table 6.4. Capital raised by private equity/venture capital organisations in Israel, 1990-2000

In USD million

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Private venture capital	40	49	27	33	82	93	287	595	653	1 160	2 712
Yozma venture capital	0	0	0	149	40	15	30	19	0	0	0
Inbal venture capital	0	0	54	22	0	0	0	0	0	0	0
Other private equity	5	9	79	168	262	25	620	134	33	258	66
Total	45	58	160	372	384	133	937	777	686	1 418	2 778

Source: Avnimelech and Teubal (2006).

Table 6.5. ICT and software manufacturing: sales, exports and employees, 1990-2002

In USD thousands, unless indicated

Year	ICT sales	ICT exports	ICT employees (workers)	Sales per employee	Software sales	Software export	Software employees (workers)	Sales per employee
1990	3 300	2 100	32 000	103	400	75	5 000	80
1991	3 600	2 280	33 000	109	540	110	5 000	108
1992	4 000	2 660	34 200	117	600	135	5 500	109
1993	4 600	3 200	36 400	126	700	175	6 200	113
1994	5 200	3 750	37 600	138	800	220	7 000	114
1995	5 900	4 300	39 200	151	950	300	7 700	123
1996	6 500	4 880	42 000	155	1 300	600	8 500	153
1997	7 200	5 700	43 700	165	1 780	1 000	10 000	178
1998	8 000	6 550	45 600	175	2 350	1 500	11 500	204
1999	8 600	7 130	48 000	179	2 950	2 000	13 000	227
2000	12 500	11 000	54 800	228	3 700	2 600	14 500	255
2001	11 250	9 750	47 000	239	4 100	3 000	15 000	273
2002	10 000	8 800	43 200	231	2 800	1 900	13 200	212

Source:. Avnimelech and Teubal (2006).

This has been extensively analysed in previous work, including Avnimelech and Teubal (2005) and (2008b); and Teubal (2010b). Box 6.4 reproduces some of the main features.

Box 6.4. Design of the Yozma programme

- Fund of funds and direct investments in start-ups; a limited partnership-type of venture capital company favoured.
- A focus on early-phase investments in Israeli high-tech start-up companies.
- Targeted level of capital is 250M$ (government support - 100M$).This was the "critical mass" of venture capital supply deemed required for venture capital industry "emergence".
- Ten privately owned Israeli venture capital funds, each managed by a local management company (formal institution) and involving a reputable foreign financial institution.
- Government participation in each fund - $8 million (up to 40% of fund's capital).
- Strong incentive to the "upside" - a five-year option to buy the government's share at cost.
- Planned "privatisation" of Yozma fund and programme - privatisation was completed in 1998. Yozma became a catalytic programme.
- The Yozma programme attracted or induced the creation of a wide variety of agents, such as MNEs, foreign investment banks, a range of service providers, and eventually top-tier foreign venture capitalists. They triggered a strong process of collective learning, which together with other dynamic processes led to the emergence of an entrepreneurial ICT-oriented, high-tech cluster, and to a venture capital industry and market embedded in it.
- As part of this emergence, we observe a strong process of venture capital/start-up co-evolution during the 1993-96/7/8 period.

The three-phase model in the context of the recent literature

The three-phase model informed by Israel's experience could be interpreted in terms of Lerner's *fast growing entrepreneurship* (Lerner, 2009) or our techno-entrepreneurship concept.

Lerner states that "the first rationale for government intervention lies in the fact that there is a virtuous cycle in entrepreneurship and venture capital. Activities by pioneering entrepreneurs and venture capitalists pave the way for subsequent generations. There are many examples of pioneering firms that served as "pioneering academies" from which other entrepreneurs sprung". The classical example is Fairchild Semiconductor, whose alumni were Advanced Micro Devices, Computer Micro Technology, Cirrus Logic, Intel, LSI, and National Semiconductor - all key players in the industry during the decades to come.

Lerner points out to a number of reasons for this phenomenon (see Box 6.5).

Box 6.5. Virtuous cycles in entrepreneurship and venture capital

- Employees of large firms may be initially reluctant to join or create a start-up,
- Much of the entrepreneurial process is an art rather than a science. This would imply a learning-by-doing (and even a collective learning-by-others-doing) process,
- Entrepreneurs learn about the trade-offs associated with the involvement of seasoned venture capitalists in their ventures (*e.g.* balance between terms and conditions for the investment and an appreciation of the type of gains that are possible),
- Lawyers and accountants become familiar with the venture process and can better advise entrepreneurs and financiers alike,
- Institutional investors gain confidence, and
- Venture capitalists can more readily find peers with whom they can share transactions (syndication is very important).

Explaining why entrepreneurship promotion policies often failed, Lerner points out that building a venture capital industry is a long–term process, taking many years to yield tangible results. In the US about 20 years elapsed between the enactment of the SBIC programme and 1978, which is the date

recognised by historians as the birth of the modern venture capital industry in the United States. This implies that effective policy requires long-term commitment, indeed a commitment that is undaunted by initial failure. Conversely, policies may fail because of the short-term perspective of governments. Thus, in the case of the building of science parks in Malaysia, policymakers assumed that once completed, these parks would solve all problems immediately.

A major cause of failure is the way programmes are structured. Let us take, for example, Finland's programmes operated by FII (Finnish Industry Investment) and Sitra (the Finnish Innovation Fund). The ground rules of FII were that investments should be profitable in terms of a return above the inflation rate, while those of Sitra determined that the pace of investment be limited to whatever the fund received from selling or liquidating its earlier investments. These rules compromised the emergence of an early-stage venture capital market because you cannot expect a steady flow of profits in a cyclical market, especially for early-stage investments. FII shifted therefore to emphasise later-stage investments. Sitra, on the other hand, had ample funds during the upside but was dry of funds in the downside (2001-2) so that it was not able to fund anyone during the most critical period.

Other causes of failure mentioned by Lerner relate to programme size, in particular that of the government capital component of the overall promotion packet. Too large is bad and too small is also bad. If the government component is only a few million dollars, few venture capitalists or other investors will learn about the programme and, as a result, the possibility that such funding will serve as a stamp of approval to others will be remote. Furthermore, the companies receiving the funds are unlikely to have enough capital to move to the next stage. The minimum size for a venture fund is USD 60-70 million. There have been many times when the capital contribution of government when investing directly in a start-up or sponsoring a hybrid fund has been smaller than this amount.

Lerner's analysis does not point out explicitly that building a critical mass of start-ups and associated deal flow is necessary for sparking and sustaining an endogenous entrepreneurial process. Moreover, there would seem to be no distinction between Phase II policies, which prepare the ground and build the institutional and other infrastructure (including a critical mass of start-ups) for an *Entrepreneurial System* or cluster, and Phase II-III policies, which are directed to induce an endogenous process of emergence of such a system/cluster.

Adapting the three-phase model

A policy-relevant adaptation of the Israel-informed three-phase model to economies with a relatively sophisticated innovation infrastructure - Argentina, Brazil, Chile, India, Mexico and Russia – has run into the following problem. One could say that, according to the model, they all are at Phase II – i.e. they have developed a variety of proto-clusters, as well as reasonably efficient and diverse public programmes to support these proto-clusters of techno-entrepreneurship and innovation. Yet, as one policy maker put it, they seem to "be stuck at this stage forever". One should note, however, that having made a transition to Phase II does not mean that an endogenous process leading to a transition to Phase III will emerge. The issue in Phase II is to achieve a minimum set of venture capital emergence conditions that, when achieved, could automatically, or with the help of policy, induce a successful transition to Phase III while triggering an endogenous growth process.

The central point is recognising that a successful outcome of the three-phase evolutionary Innovation Policy Model for such economies could be an *Entrepreneurial System* that comprises a *number* of (rather than a single) innovative and entrepreneurial clusters, of which one or more are in mid and/or low-tech and possibly one in high-tech. The main issues in this adaptation of the model are the following:

1. A successful outcome of a successful evolutionary process could be a multi-cluster innovation/entrepreneurial system.

   A new central component of this system - one which may or may not co-exist with the original model's high-tech innovation cluster/system - is one or more mid-tech innovative/entrepreneurial clusters. The sources of such clusters are:

   - Domestic SMEs supplying foreign MNEs that are located in the country (cases of Ireland, Singapore, etc) or large domestic companies. These could gradually become more innovative and entrepreneurial.

   - Similarly, innovative SMEs that result from capabilities acquired by supplying large foreign-based MNEs or global marketing chains who outsource in the country.

   - Networking and cooperation among pre-existing innovative SMEs, which operated either in a stand-alone or proto-cluster configuration (including previously extant clusters that have undergone or could undergo significant upgrading).

By and large the multi-cluster entrepreneurial system is a (adapted model) Phase III phenomenon, with Phase II and Phase II-III interface (framework) policies playing important roles in its emergence.

2. A broader view of innovation to include non-R&D-based innovation, technology adoption and diffusion, user innovations and changes in institutions.

3. A wider range of agents in the business sector. These might include ICT-oriented and high-tech start-ups (probably growing from a low base, as in Argentina, faster in routine software areas and slower in more innovative branded software and/or hardware areas); innovative SMEs in mid-tech areas, *e.g.* agricultural machinery; and large companies, such as TENARIS and INVAP in Argentina (while a special category would go to foreign MNEs operating in the country *e.g.* Intel in Israel).

4. Institutional changes, for example, to permit the operation of various types of innovation finance organisations (*e.g.* Limited Partnerships in Argentina); making bankruptcy laws more consistent with the requirements of start-ups and innovative SMEs; allowing governments to provide direct financial support to private companies, etc.

5. Experimentation with different types of innovation finance organisations (*e.g.* venture capital and private equity, and other types of financial institutions) and identification of those organisations that are well adapted to the local context and to the needs of domestic innovative SMEs. *Idem* with respect to the provision of technical services' support, including training, technology absorption and transfer, and R&D services delivered by technology centres, consultants, etc.

   Some of these services would be present during Phase II, with a strong government-owned/government-supported component of the relevant organisations. During Phase III, the public component (especially those becoming routine) would be gradually phased out and replaced by privately owned and managed agents who are operating in recently emerged venture capital/private equity/angels, etc., and technical services markets.

6. Dynamics of co-evolutionary process: This has not been investigated in depth in the standard three-phase model. They refer first and foremost to innovation-innovation finance co-evolution (including start-up/venture capital co-evolution) and possibly to co-evolutionary processes that involve innovative SME/start-up and technical services. These co-evolutionary processes would take place for each one (or for individual

subsets) of the innovative/entrepreneurial clusters that policy makers are striving to create in Phase III, as part of the expected multi-dimensional innovative/entrepreneurial system.

To illustrate, co-evolution between innovation (including innovating organisations) and innovation finance (including relevant organisations) involves two phases:

- A *qualitative* mutual adaptation component in which alternative types of venture capital/private equity/other financial mechanisms and types of innovative SMEs/start-ups mutually adjust to each other in terms of strategy/organisation/capabilities (with adaptations of the institutional framework also taking place). This would largely take place in Phase II, being one of the pre-emergence conditions of the standard three-phase model.[3]

- A quantitative scaling up process that is epitomised by start-up + venture capital + co-evolution in Phase III of the Israeli case.

7. Assuring an adequate flow of graduates and knowledge from the STE (Science, Technology and Economy) infrastructure and from abroad for Phase III. This may have important implications for Phase II STE policies.

8. Characterising framework programmes and their role in Phase II and in the Phases II-III interface (see next section).

9. Post Phase III "inclusive growth" considerations: A major point is that the range of dynamic agents that gives rise to innovative/entrepreneurial clusters (a Phase III outcome) is much broader than start-ups. For instance in Bariloche (Argentina), high-tech start-ups are now emerging around INVAP, a company that emerged from the large national laboratories and the university, which operate in the area; and in Brazil around Embraer (a Brazilian MNE). Also in Argentina, almost all applications for nano-tech funds come from researchers associated with INVAP or TENARIS (an Argentinian MNE in the seamless tubes area). This means that we need to take into account three types of agents in the business sector: high-tech start-ups, such as those underlying the analysis of the standard three-phase model); big R&D intensive export-oriented domestic firms like INVAP, which start to produce backward linkages (to which we may add those supplying inputs to MNEs operating in the country); and innovative SMEs in mid tech and traditional areas, such as those comprising the *agricultural machinery* mid-tech cluster in Argentina. These firms do not export, yet

they are highly dynamic firms that are expected to export. Some may also spearhead the emergence of new clusters.

Possible Phase II policies that might be considered by middle-income economies are:

1. Stage II venture capital policy.

   Beyond tax relief for investors, there are two main options: creation of a public or public/private early-phase-oriented fund or a public capital component acting as a fund of funds.

2. In general, a mix between horizontal and selective/targeted *direct* promotion of innovative SMEs/start-ups and/or support of technological incubators and science/technology parks.

   Serious attention should be given to subsidies/conditional loans/conditional grants, especially during the *infant phase* of diffusion of R&D/innovation in the business sector. A major objective (to be achieved in sync with other policies, *e.g.* in the regulatory sphere), would be to reach a critical mass or critical masses of innovative SMEs and the possibility of start-ups.

3. General innovation support schemes, possibly based on tax concessions (involving some control of relevant functionalities) for large, established companies.

4. Joint business (including SMEs) - STE sectoral funds/targeted programmes to finance user-driven generic or generic/regular R&D in nanotechnology, biotechnology, IT and mid-tech areas, through large multi-year consortia.

5. Cluster/sector-specific support schemes aimed at *existing* sectors or clusters for technological upgrade and collective generation of sector-specific public goods .

6. General STE reinforcement support, plus a component of policy-targeting of relevant infrastructures for the present and future.

7. Promoting multinational search networks through the activation of diasporas, implementing bi-national innovation support programmes, linking into EU programmes that are open to developing economies, sending students abroad, etc.

8. Promoting and developing international links and partnerships in business innovation and in innovation finance, *e.g.* reducing taxation and institutional constraints for the opening of offices of foreign venture capitalists, private equity funders, or other financial institutions.

9. A few possible Phase II-III interface framework policies:

   - Policy targeting of the emergence of high-tech and/or mid-tech innovative/entrepreneurial clusters. They have to be identified and specified (some capability may be required even for outsourcing this activity). Some of the new sectors/clusters will compete in global markets, while others might serve the local market or be involved in non-traded goods.

   - Policy targeting of relevant private innovation finance markets/sub-markets for innovative start-ups that are operating under radical uncertainty and in a turbulent environment, *e.g.* Israel's Yozma programme, which directly and indirectly induced the emergence of that country's high impact, entrepreneurial high-tech cluster.

   - Policies promoting both the domestic outsourcing by large companies and MNEs operating locally and of clusters based on these organisations, and upgrading of the relevant SMEs (some as a continuation of policies undertaken in Phase II).

   - Support and possible privatisation of some technical services markets, particularly those oriented to innovative SMEs. It would be expected that the growth of innovative clusters, through increases in the demand for technical services, would enhance the possibility of creating at least some private technical services markets. In these cases, it would also be possible to privatise all or part of the pre-existing Phase II technical services institutions.

Framework programmes as defining the transition from Phase II to Phase III

This section puts forward the hypothesis that the fragmentation of the institutional infrastructure for innovation represents a real constraint to endogenous growth and development. To put it another way, a key issue is the scaling of diverse yet fragile proto-clusters into globally robust, competitive innovation clusters. This section introduces the notion of framework

programmes, which provide an environment for micro-level changes to link up and scale up clusters.

Israel's Yozma programme (section on "A three-phase policy model: Israel") is a paragon framework programme. Other framework programmes have been implemented by successful catch-up economies, such as Chinese Taipei and Ireland (Box 6.6).

By the end of the 1970s, Chinese Taipei had already entered Phase II, with significant R&D capabilities such as the Industrial Technology Research Institute (ITRI) and the Electronic Technology Research Institute (ETRI). Yet transforming technology into actual creation proved difficult. For instance, the large Hinschu Science Park, opened in 1980, was unable to find tenants in spite of aggressive efforts to attract multinationals.

The Chinese Taipei framework programme (Saxenian, 2006) was conceived by the Minister without Portfolio, Kuo-Ting Li, with the aim of forming an alliance with foreign advisors and some members of the diaspora to establish a venture capital industry in Chinese Taipei. Li and his influential allies convinced the Ministry of Finance to introduce legislation to create, develop and regulate venture capital in Chinese Taipei, including comprehensive tax incentives and financial assistance. Institutions, such as a Seed Fund, provided matching capital contributions to private venture capital funds. Two American-style venture funds, H&Q Asia Pacific and Walden International Investment Group, were created and managed by a number of U.S.-educated Chinese living overseas who received invitations to relocate to Chinese Taipei. Once the first venture funds proved successful, domestic banks and large companies created their own venture capital funds; and once these started to pay off, even the conservative family groups decided to invest in such funds and information technology businesses. By the late 1980s when companies like Acer and the returnee company Microtek were publicly listed at the Chinese Taipei Stock Exchange, Chinese Taipei's venture capital industry took off.

A search network (*i.e.* a network to identify successive constraints and then the people or institutions that can help mitigate them), which consisted initially of key, dynamic and forward-looking members of the Chinese Taipei government and leading overseas Chinese engineers in Silicon Valley, was central to the emergence of the venture capital industry. This network did not have a blueprint, yet it did have a role model (Silicon Valley) and a clear idea of "what to do next". By defining each step along the road, the network became broader and eventually incorporated both sceptics and opponents.

As the examples of Chinese Taipei, Israel and Ireland illustrate, framework programmes have three distinct features that distinguish them from typical government policies and programmes (Kuznetsov and Sabel, 2011):

1. They start from existing institutions and programmes and reshape them.

   By linking the better performing segments of the private and public sectors, framework programmes contribute to alleviate existing institutional constraints and come with new solutions. They link exceptions from a general rule, which allows them to institutionalise their agendas. Both the Chinese Taipei venture capital programme and the Irish linkage efforts were initially viewed with scepticism; yet drawing on existing organisations and programmes, their champions created sustained dynamics (in backward linkages with venture capital development respectively) and won the sceptics over.

2. They start at the organisational periphery and are therefore less susceptible to rent-seeking.

   Public programmes and policies have three constituencies: users/clients, public sector bureaucrats and politicians. All three rely on government programmes as a source of rent-seeking: visible political pay-offs in the case of politicians, kick-backs in the case of public sector servants, and subsidies to maintain current business practices in the case of users. However by design, framework programmes do not have large budgets of their own: they rely on other programmes. In economic jargon, the motivational effect is the transformation from rents to quasi-rents - *i.e.* rents that are contingent on performance and effort. Framework programmes start small and require small amounts of public money, as well as substantial effort to get them established. As the Chinese Taipei example illustrated, for that reason, these programmes have not been taken seriously by established interests: they were contingent on the articulation of quasi-rents (which, by definition, require creativity and effort), rather than the simple capture of rents (Kuznetsov, 2009).

3. By linking better performing segments of an existing institutional framework and searching for out-of-the-box solutions to familiar problems, the institutional framework too is reshaped.

   There appeared to be no institutional space for a venture capital industry in Chinese Taipei in the 1980s, so tight was the grip of the large established agents (*i.e.* large firms and banks). The institutional framework for a venture capital industry and the venture capital industry itself emerged simultaneously through virtuous cycle dynamics.

As a consequence, the dynamic process that is triggered and sustained by these programmes has a broad impact on a large number of agents and variables, of which only a few are the direct objective of the policy itself. The others are the result of the endogenous processes triggered by the policy. Thus,

in Israel, the result of focusing on venture capital led Yozma to completing even more of the national innovation system by: (i) inducing large numbers of foreign agents, such as MNEs, venture company funds, investment banks, finance organisations, other services suppliers etc. to have a presence in the country; and (ii) building a large number of international linkages.

Framework programmes that are constructed from institutions already in operation, allow public and private actors to respond to the demands of the moment, without having to pretend that their initial choices somehow escape the ambiguity that confounds all others. Moreover - and crucially - they help the actors address the governance questions that their openness creates. And they do this in a way that also allows the actors to acquire the capacities that they need to reach their goals, even as they help them to establish the goals themselves. In this sense, they help create sets of incentives and capabilities that lead to effective action.

Israel and Chinese Taipei are special cases, indeed so unique that it would be pointless for middle-income economies to endeavour to replicate them. While replication may be pointless, the creation of country-specific framework programmes is certainly not (Kuznetsov and Sabel, 2011; World Bank, 2001, 2008).

Box 6.6. Example of a framework programme: Irish linkage promotion programme

In the wake of a highly successful FDI programme, Ireland faced the challenge of how to deepen FDI involvement and how to leverage the technology then in use to develop an indigenous technological capability. As a result, the Industrial Development Authority (IDA) took a calculated risk by bringing together a group of multinational companies and potential suppliers through a systematic search process that came to be known as the National Linkage Promotion Programme (1987-92). The key problem in developing potential suppliers is that one is "doomed to choose": one must choose among potential suppliers simply because developing large numbers of them is wasteful.

The three main groups involved in the programme were:

Government: It provided the political imperative and charged various state agencies with supporting the programme. Budget lines were established and the Department of Industry took a close interest in the programme's operation and effectiveness. Input at this level was essential to maintain political visibility and support for the programme. A total of eight agencies contributed staff and assistance, in part to help SMEs navigate the bureaucracy when seeking the best and most appropriate assistance. Staff members from each agency had to shed familiar bureaucratic routines and act entrepreneurially so as to make it possible to

fast-track the many applications for assistance and to fine-tune the services on offer to meet the specific needs of customers and their suppliers.

Industry, primarily MNCs (through FDI): The principal sector targeted was electronics, since it was the largest and most dynamic, and had the greatest propensity to source locally. Industry cooperation was sought and the MNCs, through the Federation of Electronic Industries, contributed to programme costs in the first two years. Companies were lobbied at high levels by senior agency executives and government ministers. Incoming companies were introduced to executives of the Linkage Promotion Programme so that local sourcing opportunities could be discussed and developed. MNCs were also asked to provide technical assistance, in association with state technical agencies.

SMEs: A rigorous assessment procedure was used to select participating companies. It included an analysis of existing or potential capabilities against perceived supply opportunities, a detailed examination of the financial management, and an assessment of the existing management and of the firm's potential.

An essential part of the programme was the development by the programme's executives of close relationships with key MNCs. Due to the number of agencies involved in the programme, a well-balanced and multi-faceted team of experts in management, business development, technical issues, accounting and banking was the key to success. This array of skills allowed the team to carry out the initial assessment and selection of suppliers (in close cooperation with the MNCs) and also to carry out early-stage development workshops with the SMEs.

Outcomes: Over the five years of the programme's operation, locally sourced materials in electronics increased from 9% to 19% of MNC purchases. While the total population of MNCs in Ireland was about 900, approximately 200 proved to be effective participants in the programme, both through purchases and their willingness to support it.

Source: Kuznetsov and Sabel (2011).

From high-tech to more inclusive growth: example of Israel

During the heyday of Israeli high-tech success, one of us suggested that Israel should adopt a broader R&D strategy to the one that existed at the time, which was focused on promoting high-tech (Teubal, 1999). It was argued that existing R&D support to the business sector was biased. Two alternative innovation policy visions/strategies for Israel were proposed in that paper. In Strategy I, high tech was considered a key, both to assure successful aggregate growth and to provide the solution to societal problems. In Strategy II, the alternative vision/strategy, which was by the author, asserted that while Israel did have a comparative advantage in high-tech, it was important to achieve a

balance between it and the mid- and low-tech sectors where most of the country's employment was located. It was also stated that these sectors had a strong growth potential, especially if, through adequate policies, they became sophisticated users of new technology.

The priorities suggested for mid- and low-tech development (Teubal, 1999) included a focus on learning, training and technology transfer, with the aim of generating world-class manufacturing capabilities in certain areas; and the strengthening of "clusters". A number of specific policies were also suggested, some horizontal and others targeted. These required a shift to a systems and evolutionary policy perspective that emphasised - beyond incentives and market failure - priorities, strategy, learning and institutions (Teubal, 1999).

Some of these and other inclusive growth issues were later taken up by Trajtenberg (2005). His first point is that, following the historical experience of economic growth, innovation in developing countries should be understood as involving much more than innovation in high-tech. His second main point concerns the high-tech bias of Israel's innovation policies and their implications in inclusive growth terms.

Trajtenberg rightly states that the Israeli case "exemplifies both the potential and the limitations of a high-tech strategy as a lever for economic growth".

The benefits from high-tech eluded the rest of the economy, a fact that gave rise to a "dual economy" and slow growth in the rest of the economy. We start with the "outcomes" of Israel's OCS-driven innovation policy, both for high-tech and for non high-tech.

During the last two decades, Israel's innovation policy gradually became an extreme version of high-tech bias with both the grants to company R&D programmes and the venture capital-directed Yozma Programme (which triggered the emergence of the highly successful ICT-oriented entrepreneurial high-tech cluster) being either strongly biased or exclusively oriented to this category of sectors. While the impact of these programmes was positive for the national economy, it and the programmes themselves reinforced the pre-existing bias against non high-tech. It also transformed Israel's growth profile into a less inclusive one.

While Trajtenberg's criticisms of OCS programmes and Yozma are partly correct, his analysis ignores a number of additional points of significance:

1. The OCS successfully addressed a clear market failure in the development of innovation capabilities, some of which were the result of export and global market penetration experiences by companies having received R&D grants.

2. These had a strong impact on domestic agents despite the absence of direct spillovers from using domestically generated innovative products (the latter being the focus of Trajtenberg's analysis and critique).

3. They eventually led during the 1990s and beyond to enormous national/macro benefits, *e.g.* absorption of immigrants, balance of payments and even economic growth impacts.

Our conclusion is that at least part of the biases of the venture capital-led developments of the 1990s should be regarded as the counterpart costs of such social benefits, even in the strong sense that without them the benefits would not have occurred. Moreover, an even greater source of OCS bias against non high-tech derived from the fact that, with minor exceptions, the programmes always supported R&D while ignoring what probably are the major sources of innovation in many traditional sectors, namely, design, engineering, technology transfer, start-up of new process equipment, etc.

Crucially, a consensus seems to have emerged during the last decade that Israel should also stimulate companies that produce locally on a competitive basis - whether for exports or the local market - thereby generating employment and enhancing the overall scope or base of economic growth (Hurvitz and Brodet, 2007). This view is not incompatible with a high-tech focus in innovation policy since there are variants to such a policy. Structuring a more inclusive growth-oriented innovation policy that considers both Israel's comparative advantage in high-tech and the requirements of inclusive growth, requires not only a restructuring of OCS programmes in the sense of moderating their extreme high-tech bias (some of this is already in process), but also considering in sync other policies pertaining to the wider economic and social system.

OCS-based policy has adapted, albeit with a significant delay, with a special programme that supports traditional industry, which started in 2005. Despite some growth in the programme, especially over last year, it still remains to be seen how effective it will be in counteracting the biases of the system. On the wider systemic front, a number of initiatives have been voiced, some of which may have been or are in the process of implementation. For example, towards end of the late 1990s, antitrust regulation became more realistic, in the sense that a situation of monopoly would henceforth be defined with reference to the global market, rather than the domestic market. This helped domestic companies grow. Other policies or suggested policies include: providing tax advantages to domestic M&As; promoting the establishment of "production companies" operating in the global input outsourcing market; promoting the development of suppliers to the MNEs active in the economy, and not only those involved in production like Intel; reversing the downward

trend in professional training and government support of this activity in mid to low-tech areas; and proposing a second phase of the existing Magnet Programme support, which is entitled Magnet B (Hurwitz and Brodet, 2007).

It remains to be seen whether or not Israel will manage to sustain aggregate growth while making it more inclusive. What is clear to us is that the complexity of the challenge is such that no significant change in policies will result without a rather fundamental change in the policy process. In the path leading to continued relevance in the face of the new challenges facing the country and economy, Israel's innovation policy (broadly conceived) should become more systemic and more evolutionary in its outlook, and should also benefit from a larger, more systematic and rapidly increasing body of policy-relevant knowledge.

Conclusions: towards diagnostic monitoring of innovation policy

Although clearly a special case, the Israeli experience with entrepreneurial systems analysed in this paper is important not only because it "succeeded" (in a direct sense, yet not in an inclusive growth sense), but also because it involves a relatively new perspective on innovation policy broadly defined and on what could be considered one of its central components - venture capital policies. Following a number of papers (Avnimelech *et al*., 2010; Rosiello *et al*., 2010) and the wisdom from Lerner's book on entrepreneurship (Lerner, 2009), we present two dynamic sequences below: the *conventional* view and the "*policy is endogenous or systems/evolutionary*" view:

- Conventional view: venture capital →start-up →emergence of a private *venture capital market*.

- Evolutionary view:

  - Phase II: various policies →critical mass of start-ups,

  - Phase II-III interface: framework policy (*e.g.* Israel's venture capital-directed "Yozma") →, and

  - Phase III: venture capital/start-up co-evolution →endogenous process of emergence of new *private venture capital market* embedded in new *entrepreneurial high-tech cluster*.

The cases of Israel and Chinese Taipei illustrate how private techno-entrepreneurship and the institutional infrastructure that supports it emerge together, as two sides of the same collaborative process. Diagnostic

monitoring and the generation of relevant micro-economic data to discern heterogeneity are part of this collaborative process. This paper is one input to a new generation of innovation projects by international organisations (see World Bank, 2008 for an example of Argentina's innovation project) that are explicitly designed around this collaborative process of co-emergence between private techno-entrepreneurship and the institutional infrastructure that supports it.

Given that Israel's policy was strongly biased towards high-tech, its inclusive growth issues should be considered as post-Phase III policies. For other middle-income economies that aspire to develop innovative entrepreneurial clusters in mid- and high-tech, inclusive growth considerations should be part of their overall strategy of innovation, either in Phase II or even before.

From a "policy as an endogenous variable" perspective, the paper emphasises both policy learning in a very broad sense to include understanding the "needs" of stakeholders as well as anticipatory thinking and analysis of possible public policy implications, and a willingness to adapt policies to what was learned. Some or most of it involves co-evolutionary processes between innovation policy on the one hand and innovation (including innovative organisations) and private innovation finance on the other. A major impact is the high ramping up of business innovation during phases I and II *i.e.* even before the substitution of public support of business innovation with private support by venture capital. Its impact is to contribute significantly to the creation of critical mass. To put it another way, the policy making process in Israel (also in the case in Chinese Taipei) was an open-ended one, in the sense that each subsequent step relaxed constraints, forged new alliances and presented opportunities and challenges not contemplated at the previous steps.

How to learn from surprises, good and bad? A key emerging procedure is *diagnostic monitoring*: the systematic evaluation of a portfolio of projects, programmes and policies to detect errors as each of the projects evolves, and to correct the problems, including weeding out the projects that are proving inefficient, in light of the implementation experience and other new information (Kuznetsov and Sabel, 2011). Diagnostic monitoring requires specialised data. The paper reveals, once again, the lack of systematic evidence about the processes that lead to the generation of endogenous momentum and entrepreneurship in middle-income economies. The partial adaptation of the three-phase model (section on "A three-phase policy model: Israel") to such areas is based on circumstantial evidence rather than on the *structured and integrated* evidence that underpinned the Israeli case. The key issue to be analysed and monitored is heterogeneity: of firms, of public sector organisations and of the institutions in the institutional infrastructure for techno-entrepreneurship. Venture capital itself is a highly heterogeneous

whole, just as the projects and capabilities required at different phases of the incubation cycle are themselves highly differentiated. However, macro-level indicators and league tables, such as the competitiveness rankings of countries or knowledge assessment methodology (KAM, 2011) portray developing economies precisely as what they are not: homogenous wholes.

Notes

1. The reportedly weak impact of OCS support was probably also due to "technology biases" in the approval process of OCS R&D grants.

2. Within an updated and adapted conceptual framework, Yozma is a framework programme (see section on "Adapting the three-phase model") whose implementation defines the initiation of Phase III. In this sense, Yozma should be regarded as a Phase II-III interface programme, with its design having been undertaken in Phase II and its implementation in Phase III.

3. This condition pertains to identifying the "new financial intermediary that solves the market failure in innovative finance of SUs" which appears in the literature (see e.g. various Gompers and Lerner papers, among others).

References

Abernathy, J. and M. Utterback (1978): "Patterns of Industrial Innovation", *Technology Review*, June-July, pp. 40-7.

Allen, P. (2004), "The Complexity of Structure, Strategy and Decision Making", Chapter 5, Evolution and Economic Complexity, J. Metcalfe and J. Foster (eds.), Edgar Elgar Publishing Limited, Cheltenham.

Antonelli C. and M. Teubal (2008), "Venture capitalism as a mechanism for knowledge governance: the emergence of the markets for knowledge intensive property rights", *Journal of Institutional Economics*, 4, pp. 163-82.

Antonelli C. and M. Teubal (2009), "Venture Capitalism, New Markets and Innovation-Led Economic Growth", *ICER Working Papers* 03/2009, ICER, International Centre for Economic Research, Turin, forthcoming in J. Krafft (ed.), Edward Elgar.

Avnimelech, G. and M. Teubal (2004), "Venture Capital - Start Up Co-evolution and the Emergence and Development of Israel's New High Tech Cluster", *Economics of Innovation and New Technology*, 13 (1), pp. 33-60.

Avnimelech, G. and M. Teubal (2006a), "The Emergence of Israel's Venture Capital Industry: How Policy can Influence Cluster Dynamics", in P. Braunerhjelm and M. Feldman, *Cluster Genesis: Technology-Based Industrial Development*, Oxford University Press, Oxford.

Avnimelech, G. and M. Teubal (2006b), "Creating venture capital industries which co-evolve with High-Tech: Insights from an Extended Industry Life Cycle (ILC) perspective to the Israeli Experience", *Research Policy*, Vol. 35(10), pp 1477-98.

Avnimelech, G. and M. Teubal (2008a), "From Direct Support of Business Sector R&D/Innovation to Targeting Venture Capital/Private Equity: A Catching-Up Innovation And Technology Policy Life Cycle Perspective", *Economics of Innovation and New Technology*, 17(1), pp. 153-72.

Avnimelech, G. and M. Teubal (2008b): "Evolutionary Targeting", *Journal of Evolutionary Economics*, 18 (2), pp. 151-66.

Avnimelech, G. and M. Teubal (2009), "The Co-evolution of ICT, Venture Capital and Policy in Israel during the 1990s", manuscript.

Avnimelech, G., A. Rosiello and M. Teubal (2010), "Evolutionary Interpretation of Venture Capital Policy in Israel, Germany, UK and Scotland", *Science and Public Policy*, 37(2), March.

Bresnahan, T. and A. Gambardella (eds.) (2004), *Building High-tech Clusters: Silicon Valley and Beyond*, Cambridge University Press.

Bresnahan, T., A. Gambardella, and A. Saxenian (2001) "Old Economy inputs for New Economy outputs: Cluster Formation in the New Silicon Valleys", *Industrial Corporate Change*, 10 (4), pp. 835-60.

Breznitz, D. (2007), "Industrial R&D as a national policy: Horizontal Technology Policies and industry-state co-evolution in the growth of the Israeli software industry", *Research Policy*, 30, pp. 1465-82.

Breznitz, D. (2008), *Innovation and the State, Political Choice and Strategies for Growth in Israel, Chinese Taipei and Ireland*, Yale University Press, New Haven and London.

Carmell, A. and C. de Fonteney (2004), "Israel's Silicon Wadi" in Bresnahan and Gambardella (eds.) *Building High-tech Clusters: Silicon Valley and Beyond*, Cambridge University Press, June.

Cimoli, M., G. Dosi and J. Stiglitz (2007), "Institutions and Policies Shaping Industrial Development: An Introductory Note", paper prepared for Task Force on "Industrial Policies and Development" within the Initiative for Policy Dialogue (IPD), Columbia University, New York.

Dutz, M.A. (2007), *Unleashing India's Innovation: Toward Sustainable and Inclusive Growth*, World Bank, Washington, DC.

Fagerberg, J. (2002), "A Layman's Guide to Evolutionary Economics", *TIK Working paper* 17, ideas.repec.org/p/tik/wpaper/17.html.

Gompers, P.A. and J. Lerner (1999), *The Venture Capital Cycle*, The MIT Press, Cambridge, MA.

Gompers, P.A. and J. Lerner (2001), "The Venture Capital Revolution", *Journal of Economic Perspectives*, 15(2), pp. 145-68.

Gompers P.A. and J. Lerner (2004), *The Venture Capital Cycle*, Second Edition, The MIT Press, Cambridge, MA.

Gompers, P., J. Lerner and D. Scharfstein (2005), "Entrepreneurial Spawning: Public Corporations and the Genesis of New Ventures, 1986-1999", *Journal of Finance*, 60, pp. 577-614.

Halperin, A., and E. Berman (1990), "Skilled Labour, Security and Growth", in D. Brodet., M. Justman and M. Teubal (eds.), *Industrial-Technological Policy for Israel*, Jerusalem Institute for Israel Studies, Jerusalem (in Hebrew).

Hodgson, R. (2006), "Building Robust Innovation Systems: 'Sticky' People and all that Jazz", presentation at Seoul Innovation Conference, November.

Hurvitz, E. (chair) and D. Brodet (ed.) (2008), *Israel 2028: Vision and Strategy for Economy and Society in a Global World*, US-Israel Science and Technology Commission, March.

Fagerberg, J. (2002), "A Layman's Guide to Evolutionary Economics", *TIK Working paper* 17, ideas.repec.org/p/tik/wpaper/17.html.

Fagerberg, J., D. Mowery and R. Nelson (eds) (2006), *Handbook of Innovation*, Oxford University Press, Oxford.

Knowledge Assessment Methodology (KAM) (2011), available at www.worldbank.org/kam, accessed 28 February 2011.

Kuznetsov, Y. (2009), "Which Way from Rent-Seeking? Schumpeterian vs. Weberian Public Sector", Mimeo, World Bank, Washington DC

Kuznetsov, Y and C. Sabel (2011), "New Open Economy Industrial Policy: Making Choices without Picking Winners", PREM Note, World Bank, Washington DC, forthcoming.

Lerner, J. (2009), *The Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed - and What To Do About It*, Princeton University Press, Princeton, New Jersey.

Mason, C. and R. Harrison (2003), Closing the Regional Equity Gap? A Critique of the Department of Trade and Industry's Regional Venture Capital Funds Initiative, *Regional Studies*, 37(8), pp. 855-68.

Potts, J. (2000), *The New Evolutionary Microeconomics: Complexity, Competence and Adaptive Behaviour*, Edgar Elgar, Cheltenham

Rodrik, D. (2003), In Search of Prosperity: Analytic Narratives on Economic Growth, D.. Rodrik (ed.), Princeton University Press, Princeton, New Jersey.

Rodrik, D. (2007), *One Economics, Many Recipes*, Princeton University Press, Princeton, New Jersey.

Rosiello, A., G. Avnimelech and M. Teubal (2009), "Towards the Framing of Venture Capital Policies: A Systems Evolutionary Perspective with Particular Reference to the UK/Scotland and Israeli Experiences", *Journal of Evolutionary Economics*, 2010, Special Issue, forthcoming, proceedings of the International Schumpeter Society Meeting, Rio de Janeiro July 2008.

Sabel, C. (2007), "Bootstrapping Development: Rethinking the Role of Public Intervention in Promoting Growth", in *On Capitalism*, V. Lee and R. Swedberg (eds.), Stanford University Press (2007), pp. 305-41.

Sabel C. and A. Saxenian (2008), "A Fugitive Success. Finland's Economic Future", *SITRA Reports* 80, www.sitra.fi/julkaisut/raportti80.pdf?download=Lataa+pdf.

Saxenian, A. (1998), *Regional Advantage: Silicon Valley and Route 128*, Harvard University Press, Cambridge, MA.

Saxenian, A. (2006), *The New Argonauts: Regional Advantage in a Global Economy*, Harvard University Press, Cambridge, MA.

Sercovich, F. and M. Teubal (2011), "Structural Change and Innovation Policy: Catching Up Issues in Evolutionary Perspective", forthcoming (in edited volume in honour of S. Lall).

Teubal, M. (1982), "The R&D Performance of Young, High-technology Firms: Methodology and an Illustration", *Research Policy*, 11, pp. 333-346.

Teubal, M. (1983), "Neutrality in Science Policy: The Promotion of Sophisticated Industrial Technology in Israel", *Minerva*, 21, pp. 172-79.

Teubal, M. (1987), *Innovation Performance, Learning and Government Policy - Selected Essays*, The University of Wisconsin Press.

Teubal, M. (1993), "The Innovation System of Israel: Description, Performance and Outstanding Issues", in R. Nelson (ed.), *National Systems of Innovation: A Comparative Analysis*, Oxford University Press, Oxford and New York.

Teubal, M. (1997), "A Catalytic and Evolutionary Approach to Horizontal Technological Policies", *Research Policy*, 25, pp. 1161-88.

Teubal, M. (1999), "An R&D Strategy for Israel", Economic Quarterly, 46, pp. 359-383, November (in Hebrew).

Teubal, M. (2008), "Direct Promotion of Commercial Innovation (CI) in Least Developed Countries: A Systems Evolutionary (S/E) Perspective", background paper for UNCTAD Least Developed Countries 2009 report.

Teubal, M. (2010), "Notes on Innovation-Innovation Finance Co-evolution", presented at Hohenheim University, Stuttgart, October.

Trajtenberg, M. (2005), "Innovation Policy for Development: an Overview", paper prepared for the LAEBA 2005 second annual meeting, Buenos Aires, Argentina.

Wong, P.K. (2003), "From Using to Creating Technology: The Evolution of Singapore's National Innovation System and the Changing Role of Public Policy", in S. Lall and H.W. Urata (eds), *Foreign Direct Investment, Technology Development and Competitiveness in East Asia*, pp. 199-238, Edward Elgar, Cheltenham.

Wong, P.K. and A. Singh (2010), Public Innovation Financing Schemes in Singapore, typescript

World Bank (2001), *Mexico: Think Globally, Act Locally*, Decentralised Incentive Framework for Private Sector Development, World Bank, Washington DC.

World Bank (2008), "Argentina, Unleashing Productive Sector Innovation", Project Appraisal Report, World Bank, Washington DC.

World Bank (2010), *Innovation Policy: A Guide for Developing Countries*, World Bank, Washington, DC.

From:

Promoting Inclusive Growth

Challenges and Policies

Access the complete publication at:
https://doi.org/10.1787/9789264168305-en

Please cite this chapter as:

Teubal, Morris and Yevgeny Kuznetsov (2012), "Sequencing public interventions to support techno-entrepreneurship", in Luiz de Mello and Mark A. Dutz (eds.), *Promoting Inclusive Growth: Challenges and Policies*, OECD Publishing, Paris.

DOI: https://doi.org/10.1787/9789264168305-8-en