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Innovation and Technology Policy (ITP) for catching up: a Three Phase Life Cycle Framework for Industrializing Economies

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Acronyms

A&T: Avnimelech and Teubal
BIRD-F: Bi-national R&D Fund
BS: Business Sector
GNP: Gross National Product
GVC: Global Value Chain
IE Innovative Entrepreneurship
IJC: Industry Life Cycle
IPO: Initial Public Offering (first time floating of SU shares in Capital Markets)
IC: Investment Company
ICT: Information and Communication Technology
IT: Information Technology
IVA: Israel Venture Association
ITP: Innovation and Technology Policy
KBE: Knowledge Based Entrepreneurship
LP: Limited Partnership (a form of VC organization)
MNE: Multinational Enterprises
M&A: Mergers and Acquisitions (mostly acquisition of domestic SU/SME by foreign corporations)
OCS: Office of the Chief Scientist, Ministry of Industry and Commerce (Israel)
P&R: Pietrobelli and Rabellotti
PE: Private Equity, Private Equity Company
R&D: Research and Development
SI System of Innovation
S/E: System-Evolutionary or System of Innovation perspective
S/T/E: Science, Technology, Education
S/T: Science, Technology
SBA: Small Business Administration
SBIC: Small Business Investment Companies
SCA: Sustainable Competitive Advantage
SF: System Failure
SME: Small and Medium Sized Enterprise
SU: High Tech Start Up company
VC/PE*: Context specific VC and/or PE and/or other private, equity-based infrastructures financing and supporting non-high tech innovative SMEs.
VC: Venture Capital, Venture Capital Company

Abstract

This paper outlines a dynamic, medium/long term Innovation and Technology Policy framework for industrializing economies directed to simulate innovation and to contribute to the eventual creation of high impact innovative entrepreneurial clusters. The paper is predicated on the assumption that while cluster creation policies are possible in many contexts they requires adoption of a System Evolutionary (S/E) perspective to Innovation and Technology Policy. Given the current 'entrepreneurial phase' of the ICT Revolution, support of 'Innovative SMEs' should be one of the axes of an overall strategy of development for a large group of industrializing economies. The three phase policy model proposed here starts with direct Government support, including *Horizontal* support to Business Sector R&D/Innovation and/or to innovative Small and Medium Sized Enterprise or Start Ups (Phase 1); and culminates with implementation of *Targeted* or other policies in support of Venture Capital (VC)/ Private Equity (PE) and possibly of other industries. Between these two central policy thrusts an intermediate phase 2 would be implemented with the objective of reinforcing innovation and creating other favorable conditions, including favourable 'demand' conditions and enhanced policy capabilities, for a successful transition to Phase 3.

The model is a generic model which allows for different variants reflecting different country contexts, although, throughout, it will emphasize the importance of direct Business Sector support mechanisms at least during Phases 1 and 2. The structure of the *policy portfolio* will depend on country characteristics and specific

institutions; and its changes over time will also reflect in part differences in the policy objectives from phase to phase.

As it stands the framework is neither 'formal' nor 'appreciative theory' that is theory which closely follows the facts. This is the result of the paucity of data and the impossibility of undertaking at this stage a cross-country comparative analysis of policy cycles. Still the model as it stands can provide useful pointers to policymakers in a variety of contexts.

1. Background and Objectives

This paper outlines a medium/long term ITP effort in industrializing economies directed to simulate innovation and to contribute to the eventual creation of high-impact, innovation-intensive clusters. The three phase policy model proposed here starts with direct Government support, including Horizontal support to Business Sector (BS) R&D/Innovation and/or to innovative Small and Medium Sized Enterprise (SME) or Start Ups (SU, Phase 1); and culminates with implementation of Targeted or other policies in support of Venture Capital (VC)/ Private Equity (PE) industries. The latter are part of a broader strategy in Phase 3 of creating or re-configuring innovative clusters in industrializing economies. Between these two central policy thrusts an intermediate phase 2 would be implemented with the objective of reinforcing Innovation and creation of other favorable conditions, including enhanced policy capabilities, for a successful transition to Phase 3.[1] In this latter phase the economy would experience an acceleration of innovation and, depending on context, of R&D; and in some very successful cases countries which a generation or two ago had low incomes per capita would attain R&D/GNP ratios of over 2%. The model refers only to one specific innovative SME oriented plan of action out of a Multi-Pronged Strategy for innovation-based Economic Development involving other components not considered in this paper. Thus, frequently and in parallel to the three phase model presented here, a different set of policies directed to (existing) large companies, would have to be implemented.

[1] For the definition of VC and PE see 1.1.3 below. There are other PE-based support systems for innovative SMEs e.g. Investment Companies.

Throughout, Innovation is being defined within a broad, Schumpeterian perspective.which includes but goes beyond that resulting from formal R&D activities.

The model is a generic model which allows for different variants reflecting different country contexts, although, throughout, it will emphasize the importance of direct BS support mechanism at least during Phases 1 and 2.[2] The structure of a country's *policy portfolio* will depend on its characteristics and specific institutions. Changes over time will reflect in part differences in the policy objectives from phase to phase; while differences in policy portfolios across countries will reflect inter-country differences in the combination of direct and *indirect support* (see below) of innovative SMEs during Phases 1 and 2, as well as in the mix of Phase 3 targeted policies. Thus in Phases 1 and 2 there may be country differences concerning programs in support of scientific research and University training etc.; while in Phase 3 countries would either implement targeted VC/PE policies only or these together with other cluster creation policies. Other policy portfolio differences refer to the mix of programs (e.g. horizontal versus targeted); the function or functions being supported (e.g. technology transfer, learning or R&D for phase 1); and the instrument(s) applied (e.g. subsidies, loans, tax benefits, etc.).

Support of specific activities or functions of individual firms represent a *direct* form of Government intervention in support of innovation and *innovative SME's* in the BS. Innovative SMEs should be linked to the concept of Knowledge Based Entrepreneurship (KBE) which is increasingly relevant for wide swathes of the SME business segment- both in low and mid tech industry, and in the software/IT and high tech industries.[3] Direct measures contrast with *indirect measures* such as promotion of activities in organizations or institutions supporting the BS (e.g. Universities, Technology Centers, Government Laboratories) and promotion of VC and/or PE.[4] Direct support during Phases 1 and 2 should emphasize innovative SMEs; while policies during the third phase of the Model would explicitly include other, not exclusively SME oriented, cluster creating policies.

The paper is predicated on the assumption that while cluster creation policies are possible in many contexts they requires adoption of a System Evolutionary (S/E) perspective to ITP (see next section). Previous work on clusters have emphasized the random nature of their particular geographical location (Florida and Kenney 1988) a fact which could be construed as implying, in accordance with the accepted view of policy makers, that cluster creation policies oriented to a particular location cannot succeed.[5] We would like to note that in a similar vein of thought neither targeted VC policies nor targeted policies in general have been assumed to be possible.[6]

Such conclusions contrast with previous work of ours on Israel's VC industry which suggests that failure of VC policies frequently resulted both from not adopting a S/E perspective and for visualizing VC/PE as a 'pool of money' rather than an industry (Avnimelech and Teubal (A&T)

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[2] In some variants the model is consistent with and part of an Economic Development Catching-Up process based on a shift from Imitation to Innovation . Idem with respect to a transition to the Learning or KBE.

[3] KBE is a much broader concept than high tech entrepreneurship. It is linked to the increasing importance of knowledge, links and networks in all BS or segments: low tech, mid tech and high tech. Knowledge is broadly construed to include knowledge form outside the firm as well as from endogenous R&D or learning; tacit and/or codified knowledge; knowledge accessed through the market or through personal, professional or business links/ networks, etc. KBE is related to the concept of 'knowledge operators' whose function is both integration of existing knowledge and creation of new knowledge. It is linked to the creation of innovative SME and SU companies and to the activation of networks of existing companies. In our conception, VC is important to 'trigger' a Innovative Entrepreneurship (IE)-linked evolutionary process. Also, the creation of VC companies frequently reflects a process of IE.

[4] The distinction between direct and indirect (or system or infrastructural) support was originally made in Justman and Teubal 1986 and subsequently by Lipsey and Carlaw 1997.It is also central in the conceptual model of transition of national SI presented in Teubal and Andersen 2001 where indirect measures would provide *system level support* to the restructuring of companies. VC/PE represent a *private financial infrastructure* to innovative SMEs/SU.

[5] This is also implied in Krugman's work and in Bresnahan, Gambardella and Sexenian's work on high tech clusters (Bresnahan et al 2001).

[6] This because frequently VC-directed policies failed and because direct Government venture investments were supposed to crowd out private VC thereby hindering their development (OECD, 2000). J. Matthews (personal communication) has pointed out the case of Taiwan's high tech cluster near Taipeh as a successful example of Government targeting.

2003b, 2004a,b; 2006a). Israel's success of the 1990s pertained both to VC emergence and to high tech cluster emergence (or re- configuration). In that country VC emergence was the main vector of cluster dynamics (A&T 2006a,c). Similarly, it is our view that VC/PE emergence may play important roles in the dynamics of innovative clusters in general including cluster emergence. In line with this view we tentatively hypothesize that absence or failure of VC/PE policies might contribute to explain failure in cluster creation/re-configuration –not only with respect to high tech but more generally in connection with innovative SME-clusters–.

1.1 Antecedents

1.1.1 Globalization and the Need to Adapt

Porter suggests that the process of Globalization, by generating global markets which in principle can be accessed by all agents, narrows the sources of Sustainable Competitive Advantages (SCA) of individual companies. In his opinion, this enhances the importance of clusters which (or particularly those which) contain idiosyncratic sets of resources. However, not any cluster will affectively provide indirect support to innovative companies, SMEs or sectors; in most cases existing clusters or agglomerations of companies would have to undergo significant restructuring. This view follows from another feature of globalization, namely the emergence of an increasingly harsh selection environment involving both high (expected) returns and high risk to invention/innovation/SU. This new environment is the result of global competition: while an innovator will in principle have access to the large global market he or she would also be subject to competition any time and originating from any one of a very large and increasing number of countries or regions. More specifically, we suggest that the development of VC, PE or other equity-based 'finance and support' mechanisms to SU/innovative SMEs may be critical; although the Israeli experience suggests that the effective development of such private support systems could be a complex, multi-phase process-with conditions generated in early Phases (1 and 2) enabling or making it possible to develop VC/PE industries in Phase 3. Such conditions will include existence of an adequate number of entrepreneurs/innovative SMEs prior to targeting VC/PE.

The harsh selection environment mentioned above is not unlike that facing Israel when it targeted a high-tech oriented VC industry during the early 1990s –25 years after implementing a direct BS R&D support program directed to individual companies–. This in part explains why that country's experience with VC/PE targeting could be relevant in other contexts particularly when success in the new industry to be targeted depends on a) generating a critical mass of resources, both financial and other; b) accessing sophisticated world class foreign agents and linking them with domestic ones and c) triggering a sufficiently potent self-sustained process of industry 'emergence'. Understanding the Israeli experience required adoption of a multi-phase Industry Life Cycle (ILC) framework of analysis which emphasizes the critical transition points in the evolution of high tech and the institutions and mechanisms financing and supporting that industry (A&T 2004a, 2003b). ITP played central roles not only in targeting VC but also in generating appropriate background and pre-conditions for a successful emergence process (A&T 2004a, 2005a,b; 2006b).[7]

While our perspective is consistent with Porter's there are important differences. While Porter states that under the new conditions SCA depends more than before on the clusters within

[7] We also contend that given the dynamic and uncertain globalized environment mentioned above, the existence of sophisticated and even profitable *domestic* market forces operating prior to the emergence of the formal VC/PE industry or in related areas may actually enhance rather than diminish both the justification for implementing targeted policies and the probability that such policies will lead to industry emergence. On the face of it this would contradict both the theory of support of infant industries (where the prior existence of 'strong' market forces would seem to pre-empt the need for policy, see Stoneman, 1987); and the underpinnings of a simple 'market failure' justification for policy e.g. relevance of the "R&D additionality" criterion (see A&T, 2005b).

which the firms are embedded, our paper emphasizes the potential relevance of a *policy led and VC/PE led* re-configuration of such clusters while emphasizing the pre-and background conditions which the BS or 'old' cluster (or agglomeration of firms) must fulfill before undergoing such a transformation.

1.1.2 Evolutionary Life Cycle Models

General

The paper proposes a 'Generic' Life Cycle model for ITP oriented to the emergence of VC and to the emergence or reconfiguration of innovation-based and high tech clusters. Life Cycle analyses have increasingly been applied to new areas starting in the 1930's with the analysis of trends in industry data e.g. sales. In the 1950s and 1960s several models in marketing were based on the life cycle concept. In part coinciding and in part following this work life cycle analysis was applied to patterns of international trade and investment (Vernon 1966); the evolution of firms and organizational learning (Kimberly and Miles, 1980; and Zollo and Winter, 2002); the introduction and diffusion of new products; and the evolution of new industries (Abernathy and Utterback, 1978; Klepper 1996) including VC industries (A&T 2006a). Life Cycle analysis of ITP has barely begun.[8]

Teubal and Andersen

Teubal and Andersen 2001 suggested a model of BS and SI transformation which also comprises three phases and whose policy components are not so different from the three phases of our generic policy model. In both models the objective (more explicit in this paper) is enhanced innovation in the BS. The focus of Teubal and Andersen's first phase is BS restructuring which comprises both an autonomous component (by 'advanced', though not necessarily largest, companies who are aware of the need to restructure) and a direct and horizontal support component. The second and third phase focus on indirect or infrastructural support leading to technological infrastructure[9] (such as collective R&D performing organizations) and New Markets respectively. Direct support schemes would continue operating during these phases albeit with a changed focus e.g. oriented to 'imitators' and 'laggard' companies (including SMEs) respectively. The most important differences with our paper pertain to phases 2 and 3: while Teubal and Andersen focus on Technological Infrastructure and on the restructuring of existing companies, this paper gives prominence to new company formation/entrepreneurship and to VC (supply and demand of inventions/innovations) although the support of Technological Infrastructure (source of new invention/innovation opportunities) is also considered explicitly. Another important difference concerns targeted programs: they play a more important and explicit role in our work due to the centrality of VC/PE (not considered in Teubal and Andersen) and other cluster creation policies such as targeting specific industries in Phase 3. This also explains why, in contrast to Teubal and Andersen, we posit a phase (Phase 2) were business and policy experiments are conducted.[10]

Avnimelech and Teubal

We mentioned already that our paper is linked to previous work of ours (A&T 2004a,b,c; 2003b) on the emergence of VC in Israel where a distinction was made between a 'background conditions' and a 'pre-emergence' phases on the one hand and a 'VC emergence phase' on the other. Success in VC emergence depends crucially on favorable conditions in the previous two phases. Our phase 2 is an extension of the 'pre-emergence phase' of that paper; but unlike it the experiments undertaken here are oriented to develop a capability to undertake targeted policies in

[8] For an early Life Cycle model of Horizontal incentives' policies in support of companies see Teubal 1997. Also for a life cycle analysis of Israel's ITP see A&T 2004c.

[9] See Justman and Teubal 1997.

[10] Targeted policies are in general more complex than Horizontal policies (see below). In an evolutionary setting, experience with Horizontal policies may contribute to or set the basis for the subsequent implementation of Targeted policies (Teubal 1997, 2002). Our phase 2 will also include explicit efforts at creating 'strategic' ITP capabilities.

Phase 3 not only in connection with VC/PE but also for high tech sectors/technologies or other components of innovative clusters. This paper is also an extension and attempt at generalizing (beyond formal R&D, high tech and high tech oriented VC) the ITP Life Cycle Model as applied to Israeli experience of the last 35 years. A summary of that experience will be presented in Section 3.

1.1.3 Venture Capital and its Role

Definition of VC and PE

VC companies are "independently managed dedicated pools of capital that focus on equity or equity-linked investments in privately held, high growth companies" (Lerner 1999, p. 349). This definition allows for two variants, a narrow and a broad one. The *narrow or strict definition of VC* –the relevant one for characterizing Israel's VC industry– involves a 'dominant' orientation to the *early stage* finance of *high tech SU* companies; while the broad definition –relevant for the purposes of this paper– also allows for a non-high tech and non early phase focus. Note that even under the broad definition of VC the focus still lies on high growth companies which in our context would be a subset of innovative SMEs (including high tech SU whenever this is relevant). PE is even a broader category since it *also* (in addition to VC) allows for non-Venture equity investments (i.e. not related to high growth companies) especially in private companies such as leveraged buy-outs and buy-ins, consolidations, mezzanine, distressed debt investments, etc.. Thus PE companies encompass both VC companies and other financial institutions whose dominant activity is late phase equity investments especially in non high tech industry and services. A common form of organization of VC is the Limited Partnership (LP) form, which is also common for PE whatever the definition used.[11]

Traditional Roles of VC

The traditional roles performed by VCs are: overcoming market failure associated with bank loans to SU companies; and also with respect to equity issues. A related role is providing Added Value to their 'portfolio companies'. We briefly refer to each one of these. The specific VC literature (e.g. Gompers and Lerner 1999, 2001) emphasizes the market failures associated with bank loans to SU. These derive from: asymmetric information, high market uncertainty, frequently unknown entrepreneur, uncertain markets and the fact that most of the assets of SU are intangible. Banks as institutions are not fit in terms of orientation, capabilities and strategy to extend loans under these conditions; and if they did the interest rate would have to reflect the extremely high uncertainties surrounding SU activity. VCs overcome these failures through equity finance rather than loans (in fact, *phased* equity finance) a fact that creates both an incentive and the feasibility (through board membership and control of the SU including replacing its CEO) to monitor and control entrepreneurs' actions.[12]

Some argue that VC plays a critical rule in the innovation process, not only as a source of finance to innovation but through *other functions* that lie at the core of high tech Development (Saxenian 1998, Florida 1987, Hellman 2000 and others). VC bridge between sources of finance, entrepreneurs, scientists, suppliers, and customers. According to Florida VCs are involved in four overlapping networks of agents related to the innovation process: financial institutions,

[11] There seems to be no information of the scope of the venture component of PE which, given the strict definition of VC, should be defined as early equity finance of innovative SMEs in mid tech, low tech and services areas. The term 'early' is meant to emphasize that the 'high growth' SMEs financed are "young". For high tech SU this means equity investments at the R&D or SU phase of such companies.

[12] Akerlof (1970) argues that asymmetric information can cause market failure in equity issues of young and risky firms. This will generally lead to Initial Public Offering (IPO) "underpricing' which VCs can help overcome through a mechanism called 'third party certification'. Third party certification has value whenever securities are being issued in capital markets where insiders of the issuing firm and the outside investors have different information sets concerning the value of the offering firm. The presence of VCs, as investors in a firm going public, reduces the under-pricing of an issue, reduces the underwriter spread charged by the investment banker handling the issue and increase the IPO valuation (Megginson and Weiss, 1991).

entrepreneurs, professional business services, and professional labor market. Moreover, according to Florida the United States (US) VC industry played a critical rule in the innovation process in the US and is one of the reasons why US hi-tech has become the world leader during the late eighties and early nineties.

VCs add value to their portfolio companies. From the literature and our interviews with Israeli VCs this is a result of *Management assistance/ training, Strategic involvement, assistance in Marketing, Headhunting,* and *Certification.* Management assistance/ training is required for those SU entrepreneurs who have little management experience; and there seems to be a consensus that lack of management skills is the most significant reason for SU failure. In some cases the VC have replaced managers or have they themselves on the temporary basis taken over this function.[13] VCs typically also add value to their portfolio companies through assistance in strategic decisions. Sapienza, Manrgart and Vermeir (1996) found that VCs believe that their *strategic involvement* is their most important role in adding value to their portfolio companies. Assistance in marketing e.g introducing the SU to clients or to lead users for testing the product;[14] and assistance in headhunting e.g. for a manager of a SU's new subsidiary in the US, have both been recorded as important in the Israeli context during the 1990s. The *certification function* –where a *reputable* VC vouches for the quality and potential of an unknown SU– could also be central for SU success. It underlies part of the other adding value functions just mentioned, as well as VC help in facilitating SU to go public or go through a Mergers and Acquisitions (M&A) process..

VCs can add value to the innovative SMEs in their portfolio because of their *Capabilities, Reputation* and *Networking*. Sapienza et al op. cit found that VCs with experience in the portfolio companies' industry generated more add value than VCs without such prior experience**.** Also VC capitalists with technology and entrepreneurial background generate more value added than VCs with financial background. VC reputation and close ties both with investment bankers and with hi-tech corporations underlie their capacity to add value to portfolio companies through facilitating an IPO, product testing, marketing and other functions. In addition VCs have both the *Motivation* and the *Power/Control* to operate in this way. Motivation because equity based finance generates a strong alignment of incentives between the VCs and its portfolio companies: the more the SU thrives and grows the more the VC will earn. Power/Control-because VC-SU contracts generally give VCs a greater share of power than the share of ownership it acquires (Gilson, 2003).[15]

Private Equity Support Systems and Industrializing economies

The traditional adding value roles of VC/PE suggest that either these or other equity-based (generally private) finance and support organizations *could play* important roles in promoting innovative SMEs and clusters in industrializing economies. This is the reason why our Three Phase ITP model includes an explicit phase oriented to the development of VC/PE or related industries. We now flesh out this line of thought and policy by fleshing out some *dynamic implications* of the added value roles played by equity-based finance systems (which roles have been emphasized in the literature). To some extent we will be shifting form a discussion of the impacts of individual VC companies to broader and even 'emergent' phenomena associated with the cluster as a whole.

[13] Interview with Matty Karp of Concord , a leading Israeli VC during the second half of the nineties.

[14] This is so even in areas where Global Value Chains (GVC) exist and even when the innovative SME is not formally part of the chain (see 1.1.4 below).

[15] Gompers 1994, 1995 and others compared VC-backed with non-VC backed SU. VC backed startups on average go public younger; have less under-pricing, cheaper underwriter costs and higher valuation at the IPO; and perform better after the IPO. The superior performances of such companies is due to VCs' good scanning, monitoring activities, reputational added value, networking added value and management added value.

1.1.4 Additional Roles of Equity-Based Private Support systems for Innovative SMEs

The distinctive features of industrializing economies require adapting and re-orienting the functions and roles played by VCs in connection with High Tech in the more advanced economies. The focus should shift to *VC/PE* i.e private, equity-based finance and support systems or infrastructures for innovative SME* including but not only VC and PE as defined above. We start by surveying some organizational forms beyond VC.

'Other' equity-based finance and support organizations

While there are examples of VC companies who invest in the 'early stage' of non-high tech areas such as retailing, medical and communications services it seems that most PE companies focus on later phase rather than early phase support of companies i.e. frequently their dominant strategy does not seem to be the finance and support of the early phase of high-growth companies (not even non-high tech ones). Part of the problem seems to be the lack of well developed exit mechanisms i.e. the equivalent of NASDAQ for mid/low tech companies (probably due to the fact that the potential capital gains from high tech SU are probably much greater than for mid/low tech innovative SMEs). There might be two solutions to this problem: creation of (e.g. regionally-based) exit markets; and identifying other PE based organizations/institutions that are less dependent on medium-term and /or capital gains based exits. Among the latter we have *Investment Companies (IC s),* '*captive' VC/PE funds*, and *Individuals (Angels*).

The activities of IC are based on owner resources or on external investors to whom, in contrast to LP VC/PE, there is no commitment to repay principal and returns after a fixed period of time. This equity-based system is therefore less dependent on public capital market exit mechanisms (IPO) and therefore is more adequate for the finance and support of innovative SMEs in industrializing economies. The real contribution of ICs will still depend on whether or not they provide significant 'adding value' functions beyond the equity investments themselves (a fact requiring significant non-financial capabilities).

Captive VC funds include corporate VC and VCs which are subsidiaries of other financial institutions. They are not organized as LP; and their investment objectives need not be exclusively maximizing financial returns. Thus a frequent objective of Corporate VC investments is the identification and generation of synergies with the parent firm. Intel Capital, one of the largest corporate VC funds, invests in companies whose outputs, if successful, will –among other effects– increase the demand for Intel products. Angels are independent but generally non-organized pools of VC. They played important roles in the background and pre-emergence phases prior to VC industry emergence in the US during the late 1960s. The scope of angel investments, even after establishment of the VC industry, is estimated to be up to ten times that of formal, independent VC.

To the above we should add *Government owned VCs and an assortment of Government assisted, private, equity-based finance (and support) organizations oriented to innovative SMEs.* Government-owned VCs have sprung in Europe and other countries in response to perceived 'early phase finance gaps' in the SU and innovative SME BS segments. Many seem not to have been very successful. Government assisted but privately owned equity based organizations include the well-know Small Business Investment Companies (SBIC) in the US, created in response to the Small Business Administration (SBA) Act of 1959. Those licensed were entitled to loans from the SBA or loans guaranteed by the SBA. In the 1960s and 1970s they accounted for about one third of total PE investments, but their share has been reduced considerably during the nineties with the enormous growth of LP organized VC organizations (Fenn et al 1995, p.4). They played an important role in the pre-emergence and industry emergence phases of VC in the US.

Roles of VC/PE* in the Learning Economy[16]

VCs and by extension VC/PE* could become a pillar of the Knowledge Economy through its effect in facilitating the provision of services to Innovative SME's and SU; by being a node of three overlapping networks; and because its capabilities are largely based on tacit knowledge. Moreover, by promoting SU they are promoting invention (and indirectly innovation and diffusion), self-organization and creation of new teams and tacit knowledge, and the continuous building of new markets. Interactive learning lies at the basis of these processes.

VC should be considered as a Service Sector which both substitutes and underpins other services industries and markets by bundling equity finance on the one hand with non-cash services to innovation SMEs and SU. Archibugui and Lundvall as well as numerous European Commission publications put a lot of emphasis on Services and the Services Sector; and on improving SME access to Business Services. However, there is no reference to VC; and the assumption is that Services markets 'work'. If services markets do not really work then the desideratum 'improve SME access to Business Services' would not be fulfilled a fact which will impair the transition to a Learning Economy. VC-SU transactions solve not only finance-related market failures but also failures in Business or Advisory/Consultancy services' markets; and (parly) in Knowledge/Technology markets. Either they substitute for transactions in these other markets; or they help SU to effectively make use of these other markets (which frequently involve complex contracting).[17]

VC *bundle* equity finance (which substitutes for the credit market) with some types of Advisory and Consultancy and other Business Services to SU. The latter are the non-cash, adding value contribution of VCs. The bundling is of a particular type. In contrast to the 'finance' contribution, the adding value contribution is generally provided without an explicit contract which specifies both the types of services and the timing of their provision. Alternatively it could be stated that the VC purchase of SU equity sets the basis for subsequent VC activity and VC-SU interaction which partly substitutes for explicit market transactions between these agents or even between SU and outside suppliers of knowledge and services. In other situations the VC, by virtue of its reputation and other inputs e.g 'Know Whom' and other information/services, contributes to a considerable reduction in transaction costs and to greater use of the market (rather than substituting for the market).

By the same token purchasing (selling) equity implies purchasing (selling) a share in the SU's Knowledge/Technology and even its Innovation Capabilities' assets.[18] VCs could therefore be visualized as being either 'intermediaries' in the market for Knowledge/Technology or substitutes for explicit transactions in these markets. Through both mechanisms they potentially facilitate the exchange of information and Knowledge/Technology despite that this in part is achieved be reducing 'regular' i.e. non equity-linked (or 'un-bundled') market transactions.

Innovative SME support: Roles of equity-based private support systems

The direct impacts of VCs of VC/PE* on SU or innovative SMEs may trigger 'dynamic processes' which impact the relevant clusters. These broader roles are summarized in the following Box.

[16] We follow Archibugui and Lundvall 2001 and the contributions to this book in our characterization of the learning economy.

[17] In his famous 1962 article, Arrow mentioned the difficulty of creating markets for information (Arrow, 1962).

[18] These are extreme instances of "bundling" of transactions. Needless to say, the implied transactions in the Knowledge and Services markets that accompany VC investments and exits do not substitute for the whole spectrum of such transactions involving SU companies.

BOX 1
HOW EQUITY-BASED PRIVATE INFRASTRUCTURES (VC/PE*) IMPACT INNOVATIVE SMES' CLUSTERS

Intermediation and Market Building

Source of External Capabilities

Facilitating Complex Contracting

Promoting International Links

Supporting of the Global Expansion of Promising Innovative SMEs

Contribute to Cluster Reputation

Facilitate the Transition to a Learning Economy

Source: General VC literature and interviews conducted during 1999 and 2000.

We briefly deal with each one of these.

Intermediation and Market Building

The enhanced access to business and advisory/consultancy services and to knowledge/technology that VCs or VC/PE* provide will contribute to the *emergence of new markets* in the relevant cluster. Moreover VCs help SU link to (existing) global product and global capital markets. This is particularly important for SMEs and clusters wanting to expand the range of markets in which they would like to operate e.g new markets for intermediate inputs which the Globalization process is opening (Teece 2000, Porter op. cit.). In high tech the link to global capital markets could become an important aspect of the strategy of penetrating global *product* markets (Teubal and Avnimelech, 2003).

Source of External Capabilities

VCs complement the capabilities of innovative SMEs, sometimes in those areas were entrepreneurs are less likely to be knowledgeable and capable e.g export marketing, know whom, management, etc. Such a state of affairs may be the outcome of co-evolutionary processes involving both sets of agents.

Facilitate Complex Contracting

This is particularly so in relation to marketing agreements, alliances, strategic partnerships, M&A, etc. many of these critical for fast access to global product markets. A central condition for success in many of these is prior experience which entrepreneurs frequently do not have. A VC or VC/PE* sector may or may eventually have such capabilities and thereby have a strong impact on innovative SMEs' quest to rapidly build global market share.

Promote International Links

Frequently clusters have dense internal links while external links are few and controlled by lead buyers, agents of foreign firms (Bazan and Navas-Aleman 2003) or anchor foreign assemblers operating in complex production systems industries (see Pietrobelli and Rabellotti (P&R), 2004). A cluster with an internationally oriented VC/PE or related private, equity based sector may make an enormous contribution in opening up. This would provide additional degrees of freedom to local innovative SMEs.

Support of Global Expansion of promising Innovative SMEs

Frequently, absent a VC/PE* sector, there would be a clear System Failure (SF) with respect rapidly building the global market share of promising innovative SMEs. As mentioned such an expansion might be impossible without the support of agents or firms external to the innovator SME, particularly since this requires access to Complementary Assets (Teece, 1986) and functional upgrading which has not been common in many clusters e.g. in Latin America (Bazan and Navas Aleman 2003 and P&R 2004, see below). This is particularly so in the new global environment with new markets emerging for intermediate inputs: VC/PE or related organizations may help such companies to shift from their traditional dependence on existing, quasi-hierarchical value chains to new markets for intermediate inputs (see 1.1.6 below).

Contribute to Cluster Reputation

Initial successes in transforming innovative SMEs into global companies will increase the reputation not only of the private, equity-based organizations involved but also, by signaling the existence of innovative entrepreneurs, of the high tech cluster itself.

Facilitate the Transition to a Learning Economy

Since private, equity-based support organizations are linked to users, producers, suppliers, financers, experts and partners their innovative SME support activities will contribute to the creation of new cluster links, both domestic and external. Moreover these organizations like the US machine tool sector in the 19th Century (Rosenberg, 1972) could constitute a *key sector* in the creation, diffusion and adaptation of tacit knowledge, codified knowledge and technology.

1.1.5 Cluster Development and Cluster Policies in Developing Countries: Latin America[19]

The P&R paper analyzes eleven Latin American clusters of Brazil, Chile, Mexico and Nicaragua while the Bazan and Navas-Aleman paper undertakes a deep analysis of the Sinos Valley footwear cluster in Brazil. All clusters are populated by large numbers of SMEs. Following. The 11 clusters are classified into four categories of industries: *Traditional Manufacturing* e.g. footwear, textile, tile and furniture; *Resource Based Industries e.g.* copper, marble, fruit; *Complex Production Systems' Industries e.g.* automobiles, auto-parts, aeronautics, electronic producer goods and consumer electronic; and *Specialized Suppliers*-Software. *Large buyers* have increasingly played important roles in the GVC of Traditional Industries; and so has the leading or *anchor firm* in Complex Production Systems' industries. In the latter industries the local network of suppliers-many of them SMEs and potentially innovative SMEs-is usually subordinated to foreign anchor firms who are repositories of significant design, technological and marketing capabilities.

The studies focus on identifying and explaining *cluster upgrading* defined as comprising both *product/process innovation* and *functional upgrading* (defined as a shift to higher value added functions like design, branding and marketing).The two factors emphasized in the analysis are *collective efficiency* (external economies and joint actions within the cluster) and different forms of GVC Governance. GVC Governance influences not only chain organization/coordination activities but also *upgrading and distribution of gains* along the chain. While the authors recognize that some advances in upgrading and growth have taken place, they also suggest that the potential opened by the globalization process has not, in most cases, materialized. This explains the attention given by P&R to *policy implications* of their analysis.

It is noted that 'many SME clusters are increasingly participating in GVC's which factor justifies the authors' above-mentioned focus as being key to understand the global pattern of

[19] This section is based on and to some extent closely follows the Bazan and Navas-Aleman 2003 and P&R 2004 papers. The latter paper summarizes the existing literature on non-high tech clusters including those in Latin American countries.

appropriation of returns to cluster activity. GVC analysis emphasizes how the relationship among the various actors in the chain affects their development; and related to this, the nature of GVC governance or coordination is central particularly decisions regarding what will be produced; how will it be produced; and how much will be produced. Coordination may occur through arms-length relations or non-market relationships. The specific questions asked are: (i) what type of chain do local firms operate in? (ii) How do different patterns of chain governance favor or hinder the different types of upgrading (process, product and functional)? (iii) what collective strategies/joint actions by local producers are being undertaken in *quasi-hierarchical chains* (chains are governed by global buyers)?[20] And (iv) under what conditions will chain leaders support the upgrading process of the firms that make up the value chain?[21]

Findings

The above two papers and the relevant literature quoted there stress the importance of quasi-hierarchical types of governance and buyer-driven chains. These are a growing phenomenon in part due to the increasing concentration of retailing in developed countries. For small firms in developing countries-participation in value chains is a way to obtain information about the upgrading necessary to gain access to the global market e.g. *about the standards that need to be met.*[22] However the authors emphasize the restrictions on upgrading imposed by lead firms in quasi-hierarchical chains.

In the footwear cluster of Sinos Valley GVC governance is mostly hierarchical with respect to exports to the US; and quasi-hierarchical with respect to exports to Europe. While innovation has been frequent functional upgrading has been rare in these chains, although –in comparison with the US– more of this exists in Europe oriented GVC and in chains linked to the domestic market. As of late a discreet 'underground revolution' within the cluster is taking place. It is based on local institutions who are undertaking *collective* functional upgrading efforts. This revolution however is threatened by internal rivalries within the cluster and by the strong commitment that some local producers still feel towards their global buyers. The Bazan *and* Navas-Aleman paper points out that while the Sinos Valley cluster succeeded in the past it has not been able to shift to *high quality footwear.* The implication is that ways have to be found either for changes in GVC governance or more broadly in the relationships between lead firms in hierarchical or quasi hierarchical chains and their suppliers in the cluster.[23]

Policy Implications

P&R conclude that the policy approach in most Latin American countries *lacks a comprehensive and consistent vision of local SME development and upgrading.* Policies are fragmented e.g. either address technical training or local cluster development or the development of domestic GVC suppliers. This is ineffective and a comprehensive S/E perspective to ITP, one focusing on a portfolio of coordinated policies rather than on individual actions/policies (see next

[20] The relevant literature has identified three or four types of GVC Governance: *Network:* cooperation among more or less equals, each one an independent firm; *Quasi-Hierarchy:* chains comprising legally independent firms with a leader (e.g. buyer) who sets the rules and has a high degree of control over upstream suppliers; and Hierarchy-when a firm is owned by an (usually) foreign firms. In addition we have *Market-Led* governance.

[21] Two theories about the role of chain leaders in promoting upgrading can be found in the literature: one suggesting that chain leaders naturally promote innovation and functional upgrading among small local producers; and an opposite view where participation in a quasi-hierarchical chain offers very favorable conditions for process and process upgrading; *but hinders functional upgrading.* It is also suggested that *networks are ideal for upgrading* but are unlikely to come about for developing country producers.

[22] It might also assure access to Complementary Assets (Teece, 1986).

[23] The authors do recognize however that GVC Governance may change over time because existing producers or their spin-offs may acquire new capabilities and explore new markets, resulting in changes in power relationships; because maintaining a quasi-hierarchical governance is *costly for the lead firm* due to losses in flexibility when confronted with new market conditions; and because firms and clusters operate in several types of chains simultaneously which means that skills acquired as a result of participation in one chain may be applied and adapted to supplying other chains. The P&R paper also points out that in market-based chains the extent of upgrading depends on the 'determination of SMEs' i.e entrepreneurship and management; and that loosening of vertical intra-chain ties through local initiatives creates "new opportunities for repositioning the cluster in world markets".

section). The authors also stress *Selectivity* i.e. which clusters to be supported; and a pattern of interventions which addresses a small number of essential priorities. This requires systematic mapping and analysis of candidate clusters, a requirement necessitating the allocation of adequate financial resources to the exploratory and diagnostics phase prior to policy implementation.

The menu of policies or policy actions comprises three groups: those that facilitate the development of External Economies e.g. specialized labor force; policies promoting linkages among firms e.g. networks and trust; collective projects, etc.; and strengthening of domestic power within the GVC.[24] Concerning the last point the authors point out that 'SME upgrading within hierarchical and quasi hierarchical value chains depends on the interest of chain leaders in getting involved and directly sustaining the process'. This will depend on many factors but policies such as those proposed in connection with Complex Production Systems' clusters (e.g. activation of appropriate intermediaries and government licensing of lead firms) may also make a contribution.[25]

1.1.6 Comments on Cluster Adaptation in Latin America

The P&R 2004 survey discussed above is commendable due to its comprehensiveness and attention to policy issues. Yet attention to additional factors analyzed in other literatures not considered by the authors could shed additional light both on the alternatives open to Latin American clusters and on the specific policy implications arrived at. We will refer to *Globalization Processes, the Systems-Evolutionary perspective to ITP,* and the *Theoretical Framework.* These will substantiate our view that a dynamic ITP cycle framework focusing on generating 'innovative SMEs' and on creating conditions, including policies, for the emergence of VC/PE or related industries could be a wellcome complement to their analysis.

As mentioned in 1.1 above Globalization is creating a new innovation and increasingly competitive environment which is redefining the conditions for SCA of firms, industries and clusters. The harsh selection environment characterized not only by high expected returns to innovation but also by high risk, is engulfing not only high tech industries but increasingly mid, low and service industries as well. It is not necessarily true any more that mid tech or traditional industries are low risk although the returns to innovation in these areas may be very high (the global market, in principle, is the limit). However, materializing this potential requires a rapid process of international expansion and building of market share. Private, equity-based finance and support systems for innovative SMEs, which in the last two decades were important for high tech industries, may increasingly become important for such expansion in non-high tech areas. A related development which further reinforces this view is the creation of new markets for intermediate inputs. This would open new opportunities for innovative SMEs who, by accessing such markets, might reduce their dependence on the quasi-hierarchical GVC to which many of these are presently attached. Again, accessing these markets is difficult especially for young innovative SMEs. VC/PE or other equity based systems may make significant contributions in this regard.

While the above trends supports Porter's view that clusters are more important than before, particularly for innovative SMEs, there may be limits to the type of cluster adaptation emphasized by the authors: joint action and enhanced collective efficiency on the one hand and enhanced links among *existing agents* on the other. In our view a more fundamental *re-configuration* may be required. We suggest that in many contexts the emergence of new privately owned finance and support infrastructures oriented to innovative SMEs may become a strategic priority. These will

[24] Each one of these groups of policies was analyzed in detail.

[25] The authors state that 'the evidence shows that Complex Production Systems' group of clusters offers the least opportunities for SME upgrading, because it is governed by the global logic of large transnational corporation and quasi hierarchical value chains'. But even here there are policies that could help like supporting network brokers to build bridges and negotiate with large value chain leaders; provide incentives to large firms to source locally, etc.

have the motivation, the capabilities, the power/control and the networks and reputation to access the complementary assets required for the rapid expansion of promising innovative SMEs.

Functional Upgrading as accessing 'Complementary Assets'

The basis for growth according to the authors is innovation (product and process) and functional upgrading. The analysis of functional upgrading could benefit from Teece's analysis of *Complementary Assets* (Teece, 1986). Some forms of functional upgrading e.g. marketing and international expansion require that innovative SMEs or other domestic companies access non-technological 'Complementary Assets'. According to Teece the difficulty facing these companies' access of Complementary Assets depends on their nature i.e whether they are general, specialized or co-specialized; and on the relevant knowledge *Appropriation Regime* (which depends not only on patent protection but on other factors e.g. the extent by which the relevant knowledge is Tacit or codified)[26] It is more difficult for *Specialized Complementary Assets* which require innovationspecific investments whose access by the market mechanisms may require 'complex contracting' with outside suppliers (high transactions costs and agency problems may arise). Access of complementary assets is also more difficult under a *Weak Appropriation Regime* since there is less time for the 'innovative SME' to access the assets first and then, through exports and international expansion, obtain profits before other competitors worldwide will irrupt into the scene.[27]

Teece proposes three strategies for accessing complementary assets: vertical integration, market transactions and a third group which includes *Strategic Partnerships* with larger firms who are also owners of complementary assets. The latter-which involve changes in the boundaries of the firm-also includes Alliances, Joint Ventures and M&A with such incumbents. *This strategy requires strong management (including Reputation and Business/Personal Networks)* and *complex contracting capabilities.* Innovative SMEs would normally not possess these capabilities, since they are basically acquired through experience.[28] But they could be key for the rapid international expansion which the new global context dictates.

These capabilities may be more important in the 'complex products' and 'Software' categories than in traditional products like footwear although they could be present in the latter category as well.

Policy Issues

The menu of choices proposed in the P&R article ignores the *dynamic links among policies* and the consequent possibility that policies may have to be *phased.* More specifically, the authors do not consider the possibility that *early policies might lead to feasibility and desirability of creating high impact new private, equity-based mechanisms of SME support; and that these may change the opportunity set opened to these firms*. This also holds for the engineering intensive Complex Products' Category where, despite the scant upgrading noted by the authors, there must be enormous opportunities for product and process innovations whose profitability, as mentioned above, may crucially depend on accessing the right complementary assets in time.[29]

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[26] These difficulties are compounded if the company is an innovative SME due to the difficulty of accessing financial resources.

[27] In Teece's framework a Weak Appropriability Regime may be due also to the strength of patent protection, etc. which obviously is less important here. We ignore for the time being Teece's third factor –stage of the ILC– and assume that the relevant products in innovative clusters of developing countries belong to the Mature Phase of the relevant market and industry (a successful process of cluster transformation and the emergence of a pool of innovative SMEs could change this).

[28] These may also be required in other market transactions when agency problems are present e.g. when accessing specific complementary assets.

[29] Complex production systems' goods offer many opportunities for innovation a fact duly pointed out by Rosenberg in various of his works (e.g. his work on 'focusing devices'). This because of the large number of components each of which could (within limits) potentially be improved; and because improvements in any component or subsystem offers new opportunities for improvements in others. The opposite view i.e. one of limited opportunities for upgrading in the complex production systems' clusters was explained by the authors as being the outcome of constraints imposed by anchor/leading firms. P&R recognize however that some policies may,

The VC/PE or other related mechanisms proposed in our ITP phase model for industrializing economies could generate greater independence and degrees of freedom for innovative SME suppliers (see 1.1.4 above). Through the Intermediation and Distributed Capabilities contributed to innovative SMEs these firms stand a change of effectively penetrating new markets. Moreover, given that private, equity-based support industries frequently lie at important network nodes, their creation will enhance the networking of such companies. It may lead them to participate in other GVC networks beyond the original one to which they were attached. Finally, through a variety of mechanisms, PE -based support and finance industries may also contribute to generate *domestic* anchor firms.

Thus in many contexts and in an integrated way with the policy conclusions suggested in the P&R article, creation of PE -based finance and support systems for innovative SMEs could become a strategic priority (see our Phase 3 in Section 4). Our previous work on VC industries oriented to high tech suggests, however, that the road to success in this regard is full of pitfalls. It requires not only a Systems perspective to ITP such as that underlying P&R's analysis but an Evolutionary perspective as well. Among other things this means that we should inquire about the background conditions for effectively targeting such private infrastructures. It also means that we should pay particular attention to the timing, context and design of the relevant targeted policy.

1.2 Specific Objectives and Structure of the Paper

- **Propose a generic three-phase ITP Cycle Model based on the S/E perspective and focused on innovative SMEs and on private, equity-based finance and support systems for such companies.**[30]

The focus on innovative SME's and their growth and development (rather than on SMEs in general as emphasized in the literature) is predicated on the assumption that this category of firms will continue to play important roles in innovation-based growth and in the growth of employment. As mentioned, this follows from the continued ICT Revolution which directly and indirectly is creating new business opportunities and new inducement mechanisms for innovative SMEs e.g new technological opportunities, the enhanced level or strength of competition which a global market entails (see 1.1.2 above and Lall and Albadalejo, 2003), and enhanced and growing international flows of knowledge and technology.[31] A related and linked factor is the persistence of the ICT and emergence of other Technological Revolutions: their effective economic exploitation, both in advanced and in industrializing economies, requires experimenting and applying the new technological knowledge in a broad front-a fact which further raises the value of creating innovative SMEs.[32]

The process of Globalization is bound also to change somewhat the mechanisms by which SMEs may contribute to economic growth-although this may depend on ITP policies such as those proposed in this paper. Most prominently, depending on case and context, it may increase the fraction of very good (and innovative) SMEs which potentially might achieve very high growth rates. Thus the expected impacts will be the result both of an increasingly important innovative SME segment and because a certain fraction of such companies will grow very fast and become

despite this, have an effect in inducing the leading firms or assemblers of the quasi-hierarchical GVC to collaborate in the upgrading of supplier SMEs. In our opinion, the real opportunities for innovative firms in these sectors may arise from 'partnering' with private, equity-based finance and support systems.

30 For related work without the sharp focus on industrializing economies which characterizes this paper see A&T 2006b.

31 SME survival will increasingly depend on being innovative, and increasingly innovation from the point of view of the domestic economy and industry may not be enough (SME innovativeness at the *global level* may be required).

32 There are well known limitations on the possibility or disposition of incumbent companies to adopt radical new technology. These include organizational and strategic rigidities, increased costs of coordination, the impossibility of providing high powered incentives; and increased obsolescence of existing products.

large. An excellent example of this is the high tech sector in the US where most of the leading companies such as Intel, Microsoft, Cisko and many others originated as VC-backed SU one, two or somewhat more decades ago.[33] The set of such companies seemed to have a macroeconomic effect on the US economy both directly through the high tech sector and indirectly through strong spillovers, to the economy at large. These facts suggest that with the right context and policies Globalization could provide very good innovative SMEs with a strong growth potential (which would only be materialized in a fraction of such companies). There are reasons to believe that this phenomenon is not privy to high tech; rather it seems to be increasingly relevant to innovative firms in mid and low tech areas and in services as well.

- **Develop a small number of additional variants of the generic model which suit the conditions of a non-insignificant group of industrializing economies.**

In this paper we focus first on the Israeli variant of the model (Section 3), which is the base upon which we subsequently theorize about the generic model (Section 4). A small set of variants or variant classes, tentatively reflecting types of industrializing countries, will then be proposed.

- **Analyze the conditions for success of the three-phase ITP model.**

This is a very complex subject which will only in part be pursued in this paper. A necessary though not sufficient condition for success is that the Phase Transition Conditions analyzed below in 5.1 hold-more frequently than not these may requirre a consistent policy by Governments to support BS innovation. In addition the policies, many of them Targeted Policies, implemented in Phase 3 must be successful e.g. they must lead to the emergence of a high impact VC/PE industry and possibly, to the emergence of other innovation intensive sectors and clusters. However targeted policies are complex and the way to success is fraught with obstacles; moreover due to the importance of context, the timing of such policies may be crucial. An important pre-condition for success is the development of ITP capabilities, particularly but not only 'strategic ITP' capabilities. We will briefly discuss this in section 5.3.

1.3 Method: Conceptual Theory with Examples

At this stage we have modest aims as far as method is concerned: to present a coherent theoretical framework of a dynamic, multi-phase ITP Cycle Model for industrializing economies which emphasizes innovative SMEs. As it stands the framework is neither a mathematical model (one form of 'formal theory') nor 'appreciative theory' that is theory which closely follows the facts. This is the result of the paucity of the relevant empirical information on ITP across countries; and the associated impossibility of undertaking at this stage a cross-country comparative analysis of policy cycles. Rather, the knowledge embodied here is a more preliminary form of theorizing than Appreciate Theory.[34] The reason for dealing with this form of theory is dual: first, to provide pointers to policymakers about potentially relevant policy profiles for their countries; second, to spur empirical research in the field. In this and in follow-up papers we will illustrate the framework with examples from Israel, Chile and Korea. In the future, the framework or a more advanced version of it may serve as a platform for conducting systematic research on dynamic ITP in other countries. At some point, through the interpretation of sets of cases, it may also generate a body of Appreciative Theory.[35]

[33] This point has been emphasized by Lerner 2002 who also emphasizes the role of VC in the process.

[34] We call it 'conceptual theory', which while based on knowledge about specific cases e.g. Israel, it is not an attempt to interpret information which was systematically collected on a representative sample of cases (i.e. one reflecting a particular context). For this reasons it is wrong to call it 'appreciative theory'. In fact it is a form of 'formal theory' albeit a non-mathematical one.

[35] In fact such a research which will eventually lead to additional Appreciative Theory knowledge cannot be undertaken without a well developed 'conceptual theory' of the sort that this paper proposes for ITP.

2. Theoretical Framework: The Systems-Evolutionary Perspective to Innovation and Technology Policy (ITP)[36]

The S/E *Approach* underlining this paper is not only a framework for understanding the 'real world' (e.g. Nelson 1994, Lundvall 1992, Edquist 1997) but also a framework underpinning the need, design and implementation of policy-particularly ITP ('normative aspects', see Metcalfe 1995; Teubal 1999, 2002).[37] Normative aspects go far beyond the *justification for Government intervention*, which is the major topic discussed in the literature. Thus a central focus of analysis is the configuration, structure and dynamics of ITP; the nature of SF (see below); and the *policy process.*

The *General Objective of ITP is* to *promote SI transformation by overcoming System (and Market) Failures.* Due to radical uncertainty, complexity etc. the nature of the desirable SI transformation cannot be determined within an 'optimizing' framework as was the case in early neoclassical analysis (Metcalfe 1995). Rather it should be determined by a set of *Strategic Priorities* (Teubal, 2002).[38]

[36] For a more detailed presentation see Teubal 2002 and A&T 2006b.

[37] Most Evolutionary/SI theories focus on understanding the real world (our 'positive aspects') rather than on policy ('normative aspects'). Moreover, with few exceptions and not unlike Neoclassical Theory, policy (particularly its 'incentives' component, less its 'institutions' component) is considered and area of application rather than a field of knowledge in itself (See Teubal 2002).

[38] A main issue is the appropriateness, robustness, adaptability, quality and degree of explicitness of the set of priorities arrived at in a particular context. A set of priorities should also be "feasible" and 'desirable'. We will not be able to deal with this issue here,

A *SF exists* when the existing System of Innovation –SI- will not, through its normal operation, achieve such a transformation. For example if the strategic priority is promotion of R&D/Innovation in the BS (*vision)* through development of a domestic VC industry (*strategy)*, a SF would exist if the operation of the existing system, particularly the BS (market forces), would not lead to this outcome. To overcome a SF pertaining to a particular context it is necessary that the ITP implemented address the *specific causes of the* SF. These could include:

- Innovation, Knowledge and Learning Externalities e.g. from R&D, Penetration of new Markets, Management, etc.
- Failure to assemble a critical mass of capabilities in a short period of time.
- Weak High Tech or KBE –due to cultural constraints, Bankruptcy Laws, etc.–.
- Limited SU Access to Financial Resources e.g. due asymmetric information, uncertainty, etc.
- Weak Supporting Structure e.g. Technology Centers.
- Weak Institutional Framework.
- Non existing or underdeveloped Networks.
- Co-ordination Failures.

The set of *specific SF causes* to be addressed will vary from country to country and from phase to phase (and so would the policies resulting from these objectives, for VC in Israel see 3.1 below). It is obvious that effective SI transformation requires looking at the whole system and at the broader domestic and external context. It also means that the success of any one program or policy action will depend on the simultaneous existence or non-existence of other policies so coordination and appropriate timing of policies should be explicitly considered. From this it follows that ITP should be viewed as an integrated whole that is a *portfolio* of incentives programs and changes in institutions.

Table 1

SCIENCE, TECHNOLOGY AND INNOVATION POLICY: EARLY NEOCLASSICAL AND EVOLUTIONARY PERSPECTIVES

	Neoclassical	Systems-Evolutionary
Behavioural assumptions	Maximizing agents under certainty Optimizing policy maker	Seeking/Adapting agents under uncertainty; adaptive policy maker
Processes and Equilibrium	Mostly static analysis. Focus on equilibrium which could be non-unique	Focus on evolutionary processes (involving variation, selection and reproduction) which frequently do not involve equilibrium situations; also importance of co-evolutionary processes. Importance of Emergent Properties and Emergent Structures
Technology/ Innovation	Codified Knowledge; innovation a result of formal R&D	A Result of both formal R&D, of other agents e.g. users; and of interagent interactions. Importance of Tacit Knowledge; Technology Life Cycles and Technological Revolutions
Competition	End-state equilibrium	A process ('dynamic competition')
Policy Process	Ignored	An important aspect of the policy framework. It may start with setting strategic priorities (strategic level of policy) and proceed to a phase of identifying SF and the design of specific interventions (incentives programs or changes in institutions)
Reason for public policy intervention	To compensate for market failures (i.e. externalities); there are no clear analytical links through time between incentives programs	To overcome specific causes for SF (which block the un-aided achievement of society's strategic priorities) A focus on learning and transformation of systems of innovation.
Type of policy preferred and nature of policy portfolio	Horizontal and non-targeted: i.e. patents, R&D subsidies, tax credits, etc.	Both Horizontal and Targeted (sector or technology specific), i.e. VC for SU; a mix between incentives and changes in institutions; a policy portfolio that changes over time (with links among programs)

Source: General Literature and Morris Teubal 's Lectures at the Hebrew University.

despite its importance. Rather, when describing the three-phase model, we will be assuming that the country concerned has identified a set of strategic priorities, which is 'reasonable', given the context in which it operates.

3. Summary of Israel's Three Phase ITP Cycle Model[39]

3.1 Summary of the Three Phases and Data

Box 2 schematically outlines the three phases ITP Cycle model as applied to Israel. This is only one out of a set of variants that the 'generic' model can generate. For reasons of space the presentation below is schematic. It is important to note that there must be other variants relevant to other countries wishing to develop VC industries.

The main ITP implemented in Phase 1 was the Grants to BS R&D. This was an Horizontal Program initiated with the foundation in 1969 of the *Office of the Chief Scientist (OCS)* at Israel's Ministry of Industry and Trade. An additional small but highly relevant program which started in the early 1980s was the *Bi-national R&D Fund (BIRD-F)* which supported collaborative R&D programs involving a US and an Israeli company. These programs were effective in diffusing R&D/Innovation in the BS; in developing Innovation Capabilities; and in forging business links and networks with the US. The policy portfolio of Phase 1 reflects Israel's special circumstances where, till Phase 3, the main considerations surrounding that country's Science, Technology and Higher Education policies were related to survival/defense and cultural considerations (rather than purely economic ones). It follows that such policies were not part of ITP which for our purposes should be circumscribed in this paper to 'economically motivated ITP.

[39] For further analysis see A&T 2005a, 2006bc.

Box 2
ISRAEL'S ITP CYCLE

Phase 1: Diffusion of R&D and Generating Innovation Capabilities (1969-1984)

Horizontal Grants to company R&D → *Creation of R&D performing companies and of civilian High Tech industry. First SU companies*.

Phase 2: Strengthening of BS R&D and SU/VC Experiments (1985-1992)

Business Experiments and Informal VC activity → *New Model of SU ('born global' with links to global capital/product markets),* learning* (various dimensions –see below–).

ITP: Sharp Increase in R&D grants, Incubator and Magnet program (supporting cooperative, generic R&D); First VC support program (Inbal) → *expansion of BS R&D → Increased rate of SU formation → increased Demand for VC services.*

Policy Learning*: Learning from Inbal's failure and from Business Experiments* → Identification of SF (absence of a significant VC industry) and Selection of LP form of VC Organization.

Phase 3: Accelerated Growth of R&D and High Tech (1993-2000)

Targeted Support of VC (Yozma Program); continuation of all ITP programs, R&D Grants peaked in 2000 → Emergence of a VC industry → Accelerated growth of SU segment and High Tech; large numbers of IPOs and M&A, etc.

Source: A & T.2004, 2006a.

Note: * Almor and Hashai, 2003.

Box 3 and Tables 2 and 3 bring data on policies initiated and/or implemented in Israel during Phases 2 and 3.

Box 3
ISRAEL: NEW ITP PROGRAMS IN PHASES 2 AND 3

1. Inbal (1991): a Government owned Insurance company, which gave partial (70%) guarantees to traded VC funds. Four VC companies were established under Inbal regulations. While the program failed to spur VC industry emergence the lessons learned from this first attempt to implement VC policies indirectly contributed to the design and implementation of Yozma (the successful targeted VC program).

2. Yozma Program (1993-1998): a one-shot targeted program involving $100M Government venture component 80M$ of which was invested in 10 Funds ($8M per fund a Fund of Funds function). 'Yozma Funds' were Israeli owned and managed; they operated in the local market; and they adopted an early phase investment strategy oriented to high tech SU. The Yozma Program was a high impact, targeted program which triggered both VC emergence and the associated re-configuration of Israel's high tech cluster. The Government investment component was privatized in 1997/1998.

3. Magnet Program (started in 1992): a $60M a year Horizontal Program supporting cooperative, generic R&D involving two or more firms and at least one University.

4. Technological Incubators (started in 1991): a program supporting entrepreneurs during the Seed Phase, for a period of 3 years. The incubators are privately owned and managed. Both they and the projects get significant financial support from the Government.

Source: A & T.2004, 2006a.

Table 2

ANNUAL OCS GRANTS, BIRD GRANTS AND VC INVESTMENTS 1970-2003

(million dollars)

	1970	1980	1985	1990	1995	2000	2002	2003
Total grants (M$)	2,5	98	107	136	346	440	375	369
Regular fund (M$)	2,5	98	106	133	294	337	291	283
Incubators (M$)	0	0	0	0	31	32	27	26
Magnet (M$)	0	0	0	0	16	67	58	53
Royalties (M$)	0	2	7	14	56	135	149	135
BIRD Grants	0	2	7	12	12	8	10	11
VC Investments (M$)	0	0	~5	~50	~400	3 100	1 139	1 011

Source: OCS (2003), BIRD (2003) and IVA (2003).

Table 3

ALLOCATION OF OCS R&D GRANTS

(million dollars)

Year	Total Grants (Growth)	Regular R&D Grant	MAGNET Budget	Technology Incubators	Royalties (Growth)	BIRD-F Awards*
1985	106 (2,5%)	106	0	0	6 (33,3%)	NA
1986	110 (2,8%)	109	0	0	7 (16,7%)	NA
1987	113 (2,7%)	112	0	0	8 (14,3%)	NA
1988	120 (6,2%)	118	0	0	9 (12,5%)	NA
1989	125 (4,2%)	122	0	0	10 (11,1%)	NA
1990	136 (8,8%)	133	0	0	14 (40,0%)	NA
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 (-11,0%)	291	58	27	153 (1,4%)	10
2003	369 (-3,4%)	283	53	26	133 (-5,4%)	11

Source: OCS and BIRD.

Note: * A few million dollars till the early 1990s.

Tables 4-6 describe central features of Israel's new high tech Cluster of the 1990s which we have argued was propelled by targeting VC (The Yozma program, see A&T 2004a, 2005b,2006d). The high impact of Yozma was partly due to the strong reinforcement of the Grants to R&D policy after 1985 and to the implementation of the new set of policies during Phase 2 (Box 3 and Tables 2 and 3). The first table (Table 4) indicates capital raised by the emerging VC industry as well as other indicators which show the high VC-intensity of Israel (last column).[40] Table 5 proves that the phenomenon of high tech growth in Israel during the 1990s was not only a 'capital market phenomenon' since it was associated with a significant expansion in production, sales and exports of goods. Finally Table 6 indicates the main parameters of the new Silicon Valley type Cluster which emerged as a result of the concerted action of most of the policies mentioned above.[41]

[40] Numerous reports have shown that Israel is the most VC-intensive country in the world when this is measured as a share of GNP. This is even more so when calculations are based on a 'strict definition of VC' which is the central feature of Israel's VC industry.

[41] See Teubal and Avnimelech 2003.

Table 4

ISRAEL: VENTURE CAPITAL RAISED AND INVESTED, 1991-2003 PERIOD

Year	VC Raised	VC under Management*	VC Invested (% of foreign sources)	VC investment as % of GDP
1991	58	80	NA	NA
1992	160	240	NA	NA
1993	372	612	NA	NA
1994	374	986	NA	NA
1995	156	1 142	NA	NA
1996	397	1 539	NA	NA
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) and IVA.

Note: * Management companies that invested at the current year and with at least $3M available for investments at the end of the year.

Table 5

ISRAELI ICT AND SOFTWARE MANUFACTURING: SALES, EXPORTS (THOUSANDS US$) AND EMPLOYEES

Year	ICT Sales	ICT Exports	ICT Employees	Sale per Employee	Software Sales	Software Export	Software Employees	Sale 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: CBS and other sources.

In previous work of ours we extensively analyze the causes for the successful targeting of VC during 1993 (A&T 2005b; 2006a, b, d). Among the main causes of success we have: 1) the appropriate background and pre-emergence conditions which were created during Phases 1 and 2;[42] 2) a very successful 'design' of Yozma which, by overcoming the specific causes of SF and initiating a cumulative and autocatalytic process of growth, induced emergence of the VC industry (see also 5.2 below); and 3) the increasingly favorable external environment (expanding global markets) till the year 2000.

[42] See Box 2. Among these we should mention emergence of a critical mass of high tech SU which represented a strong unsatisfied 'demand' for the future VC industry; and the significant experimentation and learning by both Business and Government (about the appropriate structure of the VC industry aimed at one which fit well with the local context and institutions), etc.

Table 6

ISRAEL'S HIGH TECH CLUSTER - SELECTED STRUCTURAL ELEMENTS (1970S-1990S)

Accumulated during the decade	1990s	1980s	1970s
Number of SU creation	~2 500	~300	~150
Funds Raised by VCs: M$	~8 500	~50	0
Capital Invested in Israeli SU by VCs (inc. foreign): M$	~6 650	~50	0
Accumulated No of IPOs (high tech):	126	9	1
Accumulated VC-backed IPOs:	72	3	0
Accumulated # of significant M&As by MNE:	~75	0	0
Capital raised in NASDAQ in the decade: M$	~10 750	~50	~10
M&A: B$	~18 200	~0	~0
Figure for the end of the Decade	**1990s**	**1980s**	**1970s**
Number of International Investment Banks in Israel	N/A	1	0
Number of VC Companies	~100	2	0
Share of ICT Exports in Manufacturing Exports	54%	28%	~14%
ICT manufacturing Exports M$	12 950	2 450	350
Software Exports MS	2 600	75	0
Civilian R&D as Percentage of GDP	4,8%	2,8%	1,8%
ICT Employees (thousands)	152	~80	~60
ICT Skilled Employees (thousands)	57	37	~26
Patents Issued	969	325	140

Source: SU numbers come from three sources: CBS, OCS and IVA. Other information from other sources such as the US Patent and Trademark Office.

Note: * Frequently the figures in the box are approximations due to gaps in the availability of data, the existence of various sources of information (including fragmentary information from non-official sources).

3.2 The Wider Relevance of the Israeli Case

In the two sub-sections that follow we expand what was mentioned above in Section 1.1.

3.2.1 Top Tier Industrializing Economies have/could create SCA in Software and IT high tech and therefore in R&D and VC

Globalization is creating new opportunities for Software services, product Software and R&D-based IT industries which certain low cost countries with skills are (and increasingly will) exploit. The creation or expansion of such new industries within the top tier category of industrializing economies is linked directly or indirectly to a number of trends. We mention two: (i) the increased outsourcing of Software and IT services by large US corporations e.g. to Indian software/software services companies, a trend not abated by the 2000-2004 high tech crisis; and (ii) acceleration of the establishment of R&D Labs of leading Multinational Enterprises particularly in India and China. The Israeli experience and probably also the Korean, Taiwanese and Irish experience show that these and other trends and events could set the base for the *rapid* development of an indigeneously based IT industry in top tier industrializing nations. More specifically that experience suggests that, from a longer term perspective, future successful Phase 3 policies of some presently Phase 1 non-top tier industrializing economies could involve the development of high tech or a combination of high tech and other innovation intensive industries.

For those countries which are successful in adapting to the new set of circumstances the process of Globalization permits the access from abroad of an increasing share of the important elements and critical resources required for the establishment of a high tech cluster (even in the absence of well organized markets). The mechanism could be direct or indirect. We have argued elsewhere that the outsourcing of IT and software services could set the basis for the development of indigenous product software in countries like India e.g. many of the indigenous Indian companies in these areas (e.g. Infosys) have generated a reputation and have relatively deep knowledge of the needs of high profile MNE in the US (A&T, 2004d). Moreover, spinoffs and collective learning by engineers and managers employed in R&D labs of foreign MNE will contribute to the founding and growth of indigenous high tech companies.

An alternative *direct* effect of globalization is the gradual creation of global markets in what previously were critical though relatively non traded inputs and services.[43] The increasingly widespread access to e.g. consultancy services, marketing, technical assistance, markets for technology, etc. eliminates some of the obstacles which prevented high tech growth in a previous era. As part of this process we should also mention the predicted post crisis possibilities for M&A and IPO in Global Markets. Both have the effect of anticipating and enhancing the rewards from invention/innovation (Teubal and Avnimelech, 2003); and in the case of IPOs they could significantly enhance the possibilities of penetrating global product markets.

Having said that we should state clearly that the benefit from Globalization may, in most cases, crucialy depend on Government policies which judiciously combine and phase support for infrastructure, entrepreneurship and innovation. While complex, these policies like those directed to the creation of indigenous VC/PE industries or other private and equity-based infrastructures, may be extremely relevant for some countries during Phase 3; and could succeed.

3.2.2 Commonalities between a VC industry serving high tech SU companies and context-dependent VC/PE* industry configurations directed to innovative SMEs

This paper is predicated on the assumption that the three phase ITP model, initially suggested in connection with R&D support and VC finance of high tech SU, is also applicable to analyze direct and indirect Government support of innovative SMEs in industrializing economies. A major aspect is identifying the configuration of the VC/PE* which is appropiate for the finance/support of innovative SME's in a particular context.[44] Related to this, due to increasing prevalence of the high risk/high return environment, Globalization seemingly is increasing the *similarity* between those innovative SMEs (and sometimes the contexts in which they operate) and the high tech SU companies of advanced or peripheral countries like Israel. At the risk of being repetitious we summarize these below:

SMEs increasingly rely on (New) Knowledge

Enhanced Global Competition is increasing the reliance on Innovation and Knowledge not only technological knowledge but also knowledge related to markets/marketing, organization, management, etc.. This is increasingly true in mid and low tech as it naturally was and is in high tech industry.

Enhanced management skills, networking and reputation required for global competition[45]

Global competition implies not only that more knowledge will be required for decision making but also that significant management capabilities (including reputation and networking capabilities) may increasingly be required to implement the decisions e.g. in the area of complex contracting operating under conditions of uncertainty. Like with high tech SU some of these involve *extending the boundaries of the firm* through e.g. collaborations, strategic partnerships, M&A etc. Frequently these capabilities are not existent and cannot be generated within individual SMEs. This fact could hinder both their transformation into innovative SMEs and materialization of their high growth potential.

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43 This is Porter's argument discussed in 1.1.

44 What is required is a new Intermediation Form between the support structure and the corresponding innovative SME segment. This requires the mutual adaptation of supply agents (VC/PE*), demand agents (organization and orientation of SME segment) and institutional framework (Marcus and Teubal, 2005, in process). This mutual adaptation took place in the US prior to emergence of VC during the 1970s (see Gompers and Lerner 1999, 2001). Gompers 1994 mentions that the US VC industry also financed and supported high growth companies which are not high tech e.g. Federal Express and Starbucks.

45 See Lall and Albaladejo op.cit.

System Failures frequently block creation of an innovative SME segment. Solving them may require the development of VC/PE or other private, equity-based support systems

From the finance and 'other support' perspectives, the transformation of SME's into innovative SME's is not automatically assured due to pervasive SF. The information asymmetries, unknown firm and management, significant share of intangible assets, volatility of global markets and increasingly high share of intangible assets –which have been linked to imperfections in the credit markets facing high tech SU (Gompers and Lerner 1999, Chapter 1)– are also present also in relation to the broader category of 'innovative SMEs'. This also holds with varying intensity and focus in relation to imperfections in other markets such as Business Services and Knowledge/Technology. Let us denote the prevailing System/Market failures prior to the emergence of VC/PE (or other equity based institutions) by SF1. Our and the literature's analysis suggests how these institutions might overcome such failures.

SF1 should be distinguished from SF2 which are the System/Market failures blocking the successful emergence of the specialized, private, equity based infrastructurers which are supposed to overcome SF1. The literature on how VC/PE overcomes SF1 assumes that the new financial segment or industry already exists and is operating. This however, cannot be taken for granted; moreover previous work of ours demonstrates that –in connection with VC and high tech– overcoming SF2 requires overcoming simultaneously a large number of constraints (see A&T, 2005a). There are sufficient grounds a priori to assume that this will frequently also be the case in connection with the emergence of a venture-oriented PE or VC/PE* industry in industrializing economies.[46] This means that the private infrastructure of finance/support to innovative SME's might not emerge without a new set of Government Policies. If such policies succeed in overcoming SF2 the System of Innovation may be transformed into a high-impact system as far as the strategic priority "promotion of innovative SMEs" is concerned.

[46] Both VC and PE are specialized institutions or industries (rather than simply 'pools of money') where capabilities, strategies, learning processes and organization play will increasingly play crucial roles in overcoming SF1. Thus managers of these institutions should be knowledgeable of the technologies and markets of the companies they invest in ('*portfolio companies')*. They should also perform important certification and networking functions to assure the rapid international expansion of promising innovative SMEs. Due to the complex coordination problems which could arise in order to assemble a critical mass of these resources (see A&T 2005a for the case of Israel), it is likely that the unaided working of the market may fail. Moreover, due to path dependence, a failed market led process may pre-empt what could be a potentially successful policy-led process of emergence of the new support systems.

4. Towards a 'Generic' ITP Cycle Model

The explicit analysis of the background and pre-emergence conditions for the establishment of a VC/PE or related equity-based innovative SME support industry in industrializing economies is a central objective of this paper. This section pursues this objective within a S/E framework of analysis which, given the presumed prevalence of SF, is based on a ITP Cycle Model. A second very important objective of the paper is to identify conditions for success in that objective including e.g. an appropriate design for the VC/PE-directed ITP program, appropriate timing of implementation, etc. These will be analyzed in the next section.

The first task of this section is to identify both the *Overall Strategy* underlying our ITP Cycle Model; and the *Strategic Priorities* required for each Phase. We then proceed to characterize the distinctive policy portfolios of each phase.

4.1 Policy Objectives

4.1.1 Overall Strategy-An Innovative SME orientation

This paper is predicated on the assumption that for a large class of industrializing economies *one aspect* of their *overall strategy* should be generation of an Innovative SME segment. The overall strategy

would include other components as well.[47] For a *Follower Country Strategy* it **has** included e.g. in the Korean case the strategic priority of creating large firms; while in other cases, like Korea **nowadays** where the overall strategy is to shift to a *Knowledge Based Economy,* a strategic priority is generation of an important high tech SU segment.[48] In other countries like Argentina and Chile generation of a strong 'innovative SME segment' is or could be part of an overall strategy of stimulating innovation in general with more specific strategic priorities being the upgrading both of Natural Resource exploitation and of capabilities of Large Firms.[49]

Like with high tech SU in advanced countries, the role of innovative SMEs is to exploit the opportunities for innovation opened up by the Globalization process in a wide front. Within this broad strategy two targets should be identified: generating a pool of innovative SMEs; *and* stimulating SME company growth. While a large segment of Innovative SMEs is always important, it is thought that a strong growth and employment impact would require that *a fraction of Innovative SMEs become large companies.*[50]

4.1.2 Strategic Priorities

Promotion of an innovative SME segment is a strategic priority of Phases 1 and 2 while promotion of a VC/PE* industry is a strategic priority of Phase 3. Other such priorities refer to the Science, Technology and Education (S/T/E) infrastructure e.g. assurance during Phase 1 that a 'basic' infrastructure exists and is or will become operational. This will underpin both BS innovation and SME innovation during all phases.

During Phase 2, both as a stimulus to innovative SMEs and to innovation/learning in general in Phase 3, the basic national S/T/E infrastructure' (established in Phase 1) should be considerably reinforced. Moreover, following the 'supply-push' focus of these infrastructures in Phase 1 it should now add a measure of i) 'business orientation including efforts to build links with the BS (e.g. University-BS links); ii) focus on the needs of innovative SMEs. These changes should be accomplished without diluting quality of research, development, technology transfer or other functions performed. These aims could be achieved by establishing or expanding collective organizations such as Technological Centers; promoting collaborative innovation and collaborative generic R&D programs; etc.[51] Such efforts will underpin and scaffold Phase 3's innovative effort, thereby contributing to its acceleration. Gradual targeting of the technological infrastructure to areas

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47 An important additional component which is only addressed indirectly is generating the conditions for transition to a Learning Economy (Archibugui and Lundvall, 2001). The perspective of this paper is not only consistent with the broader Learning Economy perspective; it could pave the way for such a transition in Phase 3 (e.g. through VC/PE which are nodes of networking, interactive learning and tacit knowledge). Needless to say, however, that additional policies not specified here are also required. We can characterize some of these as being related to the broader interface between 'Economy' and 'Society'.

48 Korea's strategy of Economic Development of the last decades is not reflected in our Three Phase Model in a central way, given its emphasis on large company conglomerates (chaebol's) throughout. In their original model we can identify an Imitation/Catching up Phase and an Innovation phase, the latter starting during the 1980s (Kim 1997). While overall growth performance was outstanding the limits to the model began to show up in the early 1990s and especially during the 1997 crisis (Kim & Nelson 2000, introduction and Chapter 11). The present restructuring and re-orientation of the System of Innovation represents a shift from Phase 2 of the *Imitation → Innovation (or Catching up) model* to Phases 2-3 of our model which is much more adapted to the ongoing Globalization Processes. The new strategy that emerged from the 1997 crisis was a *Knowledge Based Economy* strategy where the country is paying very strong attention to technological entrepreneurship and high tech start up companies (Dahlman and Andersson 2003).

49 For these countries the 'innovative SMEs' strategic priority is intended both to make a strategy based on exploitation of Natural Resource more effective and to avoid its limitations (both physical and others). It would also be directed to avoid the limitations of a strategy based solely on the Large Firm segment of the economy. As mentioned in Section 1 the current phase of the ICT Revolution (which we may term the 'entrepreneurial phase') requires large numbers of innovative SMEs to effectively exploit its economic potential.

50 See 1.2. This objective would also facilitate a renewal of the Economic Elites of the country whenever these are linked to ownership and management of large companies. Such a renewal may in turn be important both for keeping the market economy efficient (avoiding its sliding into 'crony capitalism') and for maintaining a vigorous democratic political system (an assumption here is that a measure of insulation between the economic and the political sphere is important for democracy).

51 Like for VC/PE a minimum of diffusion of R&D/Innovation may be required for effective pre-competitive collaborative infrastructure development (a 'demand' effect). Under these conditions, establishing such technological infrastructures will generate a strong impetus to regular R&D/Innovation-and a pattern of co-evolution may thus also come into being.

or industries of national importance (see below) will also contribute to the acceleration of innovation and learning in Phase 3 and to a successful transition to a Knowledge-based or Learning Economy.

Finally, achievement of Phase 2 priorities/targets requires bolstering policy capabilities. These would enable policy makers to face the policy challenges of Phase 3 (and Phase 2) particularly with respect to targeting specific areas, industries and clusters. The policy capabilities required are *strategic capabilities;* they should enable setting the above strategic priorities and translating them into programs and policies (Teubal, 2002). Explicit efforts should be undertaken in this direction. Important examples are Korea's post 1997 beefing up of its strategic capabilities (Dahlman and Andersson op. cit)[52] and Finland's efforts during the 1980s and beyond.[53]

The objectives and Strategic Priorities for each phase of the Generic ITP Cycle are shown in Box 4.

Box 4
OBJECTIVES AND STRATEGIC PRIORITIES OF A GENERIC ITP CYCLE

PHASE 1: CREATING AN INNOVATIVE SME SEGMENT THROUGH DIRECT and INDIRECT SUPPORT OF INNOVATION/R&D

Strategic Priorities/Targets

Business Sector

- Significant Diffusion of Innovation, including adoption and dissemination of new technologies and applied R&D, in the BS without discriminating against (or positively favoring) SMEs.
- Creating a mass of Innovative SMEs and, indirectly, sufficient 'Demand' for Phase 2 ITP.
- Wide experimentation with different types of innovation, companies, sectors, technologies, etc. (generating 'variation').
- Promote Learning to Innovate/R&D (including Collective Learning).

Supporting Structure

- Assure existence and operation of a 'basic' set of S/T/E institutions.
- Create (or adapt) a network of Technology and Innovation support Institutes; and their activation with a view of supporting the future (and do some extent the present) needs of an Innovative SME sector.
- Promote Mission Oriented technological infrastructure in a small number of areas or sectors of vital importance to the economy (e.g. major export sectors).
- Selected and phased liberalization and opening up; and selected nurturing of international business links.

[52] The Korean policy framework to effectively make the transition to a Knowledge Based Economy involves consolidating a vision and planning with regard to four major areas: Incentives and Institutional Regime; Education, Training and Human Resource Management; Information Infrastructure; and the Innovation System. New mechanisms have been created to identify the details of the vision/strategy. Also new procedures of evaluation and ministerial coordination have been put in place. Note that the policy framework of Korea is broader than that of our ITP Cycle model which focus on one of the four areas (Innovation System) more than on the others.

[53] See Yla-Antilla and Lomola 2003. The changes in Israeli Policy which led to emergence of the VC industry (Phase 3) were the result of a shift to an entrepreneurial style of ITP in the early 1990s and to the actions of Key Agents rather than to the explicit creation of a new policy system or new procedures for policy making. While this has been very successful during the 1990s it is doubtful whether the policy infrastructure which exists is sufficient to effectively confront all the new challenges confronting the country today (see 5.3 below).

Box 4 (continuation)

PHASE 2: CREATING CONDITIONS FOR ACCELERATING INNOVATION: SUPPLY, DEMAND AND POLICY CAPABILITIES

Strategic Priorities/Targets

- Promoting Technological Infrastructure(increasingly of a mission-oriented nature);
- Facilitating KBE;
- Generating a 'Strategic ITP Capability' and a Platform for Implementing Targeted Policies.

Tasks: identifying areas/sectors with potential SCA, promote experiments in the BS, tentative/test targeting initiatives, etc.

- Continued growth of Innovative SMEs while assuring a critical mass of such companies and sufficient "Demand" for VC/PE* ('sufficient demand' to trigger emergence of such private infrastructures).

PHASE 3: ACCELERATION OF INNOVATION/LEARNING and TRANSITION TO A KNOWLEDGE-BASED ECONOMY

Strategic Priorities/Targets

- A significant increase in the share of R&D (or "innovative effort")* to GNP, in some cases to over 2%; the share of National R&D performed by the BS (in some cases to 60% or more); and in the share of BS R&D financed by the BS itself (to 2/3 or more in some cases.
- Develop a 'globally linked' domestic VC/ PE* industry and market adapted to finance and support innovative SMEs. Depending on context, this could rely more or less extensively on policy and on foreign companies.
- Rapid Growth of an Innovation intensive BS including a dynamic SME segment and in some cases, of High Tech Industry.
- Accelerating creation and growth of R&D intensive and innovation intensive companies; and providing conditions for the fast growth of a subset of them.
- Achieve significant (or non-insignificant, depending on case) world market shares in a number of innovation-based sectors.
- Assuring the successful co-evolution between the Science, Technology and Higher Education infrastructure/support structures and the BS.

*as with the Catching-Up model at this phase the R&D measure could be much more important than what it was during previous Phases.

4.2 Policy Portfolios

4.2.1 Phase 1: Creating an Innovative SME segment through Direct and Indirect Support of Innovation/R&D

Box 5
PHASE 1 POLICIES

Direct Support of BS

- Incentives to Innovative activities in SMEs and to Innovative SMEs (various possible functions and instruments) through Horizontal program or a mix between Horizontal and Targeted programs;
- Adoption of a learning approach to program implementation.

Indirect Support of the BS

- A basic network of S/T/E institutions and organizations which could serve the needs both of BS innovation and of innovative SMEs (present and future). Depending on context it could include reform and adaptation of existing organizations.
- Incentives to and institutional changes in support of the above network. Levels and rate of changes of support strongly dependent on initial conditions and specific context.

Institutional reform and liberalization

- Strongly dependent on context (e.g. gradual liberalization of foreign trade and capital movements; reforms in corporate governance, intellectual property, capital market regulations, etc.

From the direct Government BS support viewpoint the main priorities and targets of Phase 1 are: promote BS innovation/R&D, create a mass of innovative SMEs, and undertake experimentation in a wide front. This requires implementing Horizontal programs although in some cases, when sectors and clusters with clear SCA have been identified, there should also be a small number of Targeted Programs as well.[54]

Horizontal programs are not only well adapted to promote *individual and collective learning* (Teubal 1996,1997; A&T 2006b); they are also ideal for a) experimenting with new options in terms of type of innovation, company, technology, markets etc. *(generating Evolutionary "variety");* and b) facilitating the identification of areas of potential SCA for the economy in question. The latter, together with proof of SF, would be the basis for targeting specific sectors with high growth ('*selection'/ 'reproduction')*.

4.2.2 Phase 2: Creating conditions for Accelerating Innovation: Supply, Demand and Policy Capabilities

While a shift to *targeting* is probably important to facilitate the widespread diffusion of innovation and learning, its implementation requires a significant re-inforcement of policy capabilities. Another reason for enhanced capabilities is the increased scope of Phase 2's policy portfolio and the enhanced needs of coordination among its various components.

[54] In Chile already in Phase 1 (starting early 1990s) it was possible and even desirable to implement targeted policies directed to the Copper, Forestry & Fisheries areas, since it became increasingly clear that already then the country enjoyed a sustainable competitive advantage in those clusters. For an interesting discussion see Katz, 2005.

Explicit efforts at developing new policy capabilities would include actions such as assembling high capability teams of policy makers, academic consultants and stakeholders; undertaking search and research about policies implemented in other countries, their effectivness and how impact relates to context; and experiments (and learning) relevant for the new phase (Phase 3) of targeted policy. Linked to these are additional actions explicitly directed to generate *organizational routines* and other capabilities (e.g. employing and training human capital) particularly for the *Strategic ITP level*.[55] Israel's experiments by private agents and Government which preceded VC targeting are one possible profile of this effort (see 5.3 below). The case of Chile is wholly different since a major policy capabilities' role there was played by a **private, non-profit** institution oriented to experimenting and targeting (Fundacion Chile). This institution generated a capability to adopt/adapt sophisticated foreign technology in part through sophisticated contracting and partnering with foreign technological suppliers. This has led both to the spinning out of new companies and to inducements for the creation of new sectors (e.g. Salmon farming, where Chile is a world leader). This activity is continuing at present and will undoubtedly contribute to Phase 2/3 policy capabilities of that country.[56]

Box 6
PHASE 2 POLICIES

- **Horizontal and (gradually through time) Targeted support of Technological Infrastructure** e.g. collaborative, generic R&D; Sector Specific Technological Centers; Mission-Oriented Generic Research programs and networks, etc.
- **Link Programs:** University-Industry; Science-Technology; Technology-Innovation; Country-Major Foreign Partners/Markets.
- **Expansion of Direct Support of innovative SMEs:** (while assuring non-discrimination with respect to SMEs and positive orientation towards KBE); higher and increasing selectivity of Incentives in response to Collective Learning in Phase 1.
- **Specific programs directed to high tech or KBE** e.g. Technological Incubators.
- **Creation of a** *Strategic Innovation Forum* with the objective of setting new priorities and programs/policies for Phase 3.

- Introduce policy evaluations and new mechanisms for the coordination of policies
- Identification of the potential and *conditions required for emergence of a VC/PE sector*
- Studies for the identification *of other areas of potential SCA*
- Assuring a *favorable environment and support for business experiments*/learning about new areas/sectors
- *Identify areas of SCA which also have "Class A" market Forces* ('*selection')*
- Identification and stimulation of *Key Agents*
- *Identify alternative policy profiles for targeted support* of selected areas
- *Experimental implementation of Targeted Programs* in selected areas; possible participation of world class experts and actors in the relevant areas
- Gradual *building- up of Strategic ITP level routines and capabilities*

- **Initiating Design and Tentative Implementation of Targeted Programs** in a subset of such areas (towards 'reproduction').

[55] Major functions to be performed at this level are: identification of new Strategic Priorities, ascertaining the specific causes of SF (if it exists); and translating the outcome into a restructured country policy portfolio.

[56] Presentation by Dr. Bitran CEO of Fundación Chile, March 2004.

4.2.3 Phase 3: Acceleration of Innovation/Learning and Transition to a Knowledge-Based Economy

Targeting during this phase should not be circumscribed to VC/PE*; it could, depending on context, be directed to specific sectors (specific High Tech or other sectors) or to other components of innovative clusters.[57]

Box 7
PHASE 3 POLICIES/PROGRAMS

Targeted Programs

- VC/PE* directed program aiming at Industry Emergence and/or creation of the relevant market (evolutionary selection and reproduction).
- Directed to innovation-intensive sectors/clusters with potential SCA and with Class A market forces (evolutionary selection and reproduction).
- Directed to generic, cooperative research in emerging technologies of relevance to existing or new sectors with PC.
- Catalytic Support of Technological Infrastructures of wide significance e.g. broad band, etc.

Widespread diffusion e.g. through Horizontal and/or targeted programs of R&D/'innovation' throughout the BS; and throughout the various regions of the country. This will include:

- Downsized Horizontal support programs with greater emphasis on incentives' selectivity.
- (possibly) Broad Based Tax benefits to R&D performed in the BS; etc.

Scanning and Searching the external and internal environment to identify further required changes in the National System of Innovation.

Strong Development of the Science and Technology (S/E) Base aiming at generating a virtuous co-evolutionary process with the BS; and at enhancing international links in S/T.

4.3 Possible Variants to the Generic Model

The model purports to be quite general in the sense that it *allows a number of variants* which reflect a) the particular conditions prevailing in different industrializing economies; and b) different evolutionary paths up to Phase 2 which imply different opportunities for Phase 3 policies. Moreover, in the Korean and Chilean cases a measure of *overlap of phases* would seem to be desirable. Let us be reminded that any support of innovative SMEs, of VC/PE, etc. must be accompanied by a measure of support of the S/E base (including high level training engineers and scientists). Differences in these complementary measures would also be reflected in different variants or variant classes.

[57] This was not the Israel's case during Phase 3. Lately we have seem a gradual movement towards targeting biotech (e.g. the Nofar sub-program of the Magnet Program) but nothing similar neither in scope nor in impact to the targeting of VC in the early 1990s.

Phase 1

Variant 1A: Weak initial S/T Base and low (initial) numbers of Innovative SMEs

In this case Phase 1 should start with a two pronged effort-substantial direct support to innovative SMEs; ***and*** a significant effort at upgrading the S/T Base. Within this general class of situations there could be significant differences among countries which would reflect the initial structure of the SME segment (technology level, industrial branch, size, etc.) and the broader policy and institutional structure. The implication would be different portfolios of Phase 1 policies reflecting different types of SF.

Moreover, SME support may take different forms: support for technology transfer, and/or technology adaptation and learning; and/or training of personnel; and/or support of advisory and consultancy services; etc.. Differences may also be due to the instruments or *support mechanisms* used.[58] A major task would be to identify a small set of policy profiles suitable to this Class of variants.

Variant 1B: Strong S/T Base and large numbers of Innovative SMEs

Some countries e.g. Russia already have a strong S/T Base which means that, when first implementing our model, the required complementary policies directed to the basic S/T/E infrastructure (including Universities) will have to be of a more restricted scope than those required without such a base e.g. Chile. Moreover an important part of the effort should be directed to *adapt* existing institutions to the market economy and Globalization contexts, including but not only towards higher levels of Business Orientation. If the country already has a pool of innovative SMEs and a strong culture supporting technological entrepreneurship it may even be possible to proceed directly to Phase 2 (alternatively, Phases 1 and 2 may overlap).

Phase 2

Variants 2A: Alternative types of Experimentation and of Agents involved

Cases which illustrate alternative profiles include Israel (discussed above extensively and in A&T, 2004c); and Chile (briefly discussed above).

Variants 2B: Scope of Explicit Efforts at Developing 'Strategic ITP capabilities'

Explicit and extensive efforts (including creation of new formal institutions) where developed in Korea and in Finland (see above). This contrasts with Israel's experiments and problem solving activities which led to the new 'strategic priority': emergence of a domestic VC industry. In Israel no explicit Strategic ITP Level routines were created in the early 1990s nor were there explicit investments in creating such a profile of policy capabilities which could serve the country's future targeting needs.

Phase 3

Variant Classes 3A: Policy Led Emergence of VC/PE industry*

This variant is likely to be relevant for countries where emergence of a VC/PE* industry is a strategic priority and were SF block the autonomous emergence of the industry. Some countries

[58] In this paper we focus on subsidies or grants to innovation rather than other tools such as tax benefits -which have been found of doubtful value as promoters of R&D (see e.g. Metcalfe 1995 and Stoneman 1987); or loans (which could involve both high transactions costs and weak incentives for risky innovation. For our purposes subsidies/grants includes also 'non-refundable loans' (loans which are not returned if the innovation fails commercially) and royalty schemes (where the quid pro quo is royalties on sales from the innovation being subsidized). Probably the best case for tax benefits to R&D is in Phase 3 where the issue is 'massification' of an already quite well developed process of diffusion of R&D.

might benefit from VC/PE* industries developed elsewhere although at present it might still be difficult to develop a VC/PE market without an important domestic VC/PE industry component (see also 5.1 below).[59] But this may change as VC industries of the US and other countries (including Israel) are increasingly becoming global. This means that in the future the focus in other countries might lie in the development of a domestic VC/PE market with a significant foreign supply component. For the time being the focus of this paper will be on development of a domestic VC industry (which does not of course exclude policies for bringing foreign VCs into the country as part of the overall process). Success will usually require other complementary incentives programs or other Government action. In Israel such policies were already implemented during Phase 2.[60] Other countries could distribute the complementary programs and actions between Phases 2 and 3.

Another sources of variation is related to the nature and design of targeted policies. These may vary from country to country. In contrast to other VC directed policies prevailing at the time, Yozma included an explicit Government venture investment component whose function was twofold: a) provide incentives to the upside through a combination of Fund effect and a call option on the Government's share; and b) to signal foreign investors that Israel was determined to develop its high tech and VC industries. In contrast to this, VC policies of other countries frequently involved tax concessions (e.g. on VC raised or VC investments) and Government guarantees without an explicit venture contribution; or if a Government venture contribution existed it took the form of a Government-owned VC company (see OECD reports on the subject).

Variant Class 3B: Market Led Emergence of Domestic VC/PE industry*

Alternatively Phase 3 may involve a market led process of emergence of VC/PE industries. This of course does not mean that policy is not important as the US example shows (AKT, 2005). What it means is that there might have been other high impact S/T/E policies which indirectly favored VC there; and that there was no targeted or major VC/PE directed policy.

Variant 3C: Other Targeting

Beyond targeting VC/PE some countries may target specific sectors during Phase 2, both non-high tech and high tech. A domestic VC industry and/or market may facilitate the process by reducing capital market imperfections, a major market failure justifying Government intervention in support of infant industries. This was not the case of Israel at least till the year 2000.[61] Other countries may also target specific innovation-intensive sector e.g. wireless communications in Korea or Biotechnology in several European countries and Industrializing economies.

[59] In both the Israeli and US cases the development of the local VC/PE industry coincided with the development of the local market. This is obvious for the innovator country (the US) but not so for Israel which is a follower country. It would seem that foreign VC/PE would be reluctant to come to many countries without suitable domestic VC/PE companies to partner with. Thus VC/PE industries may be characterized by an important 'non-traded good' feature with regard to as yet underdeveloped VC/PE export markets. Thus some domestic supply component may be required for the development of a domestic VC/PE market.

[60] These included expansion of the grants to R&D program; a Technological Incubators Program which promoted new SU entry; and a generic, cooperative R&D program (see Box 3).

[61] Although targeting of technologies did occur in the Military (especially during late Phase 1 and Phase 2) and this had a strong effect on civilian oriented high tech during Phase 3.

5. Conditions for Success in Implementing the Three Phase Model

We consider three sets of conditions: necessary conditions for phase transitions; development of new 'targeting' policy capabilities in Phase 2; and appropriate context, timing and design of VC/PE* targeted policy.

5.1 Phase Transitions: Necessary Condition

A main issue is identifying the conditions under which the early phase of strong Government support of SME innovation and learning would create conditions for the subsequent emergence of a private VC/PE* industry or innovative cluster more generally speaking during Phase 3. We suggest three necessary conditions: a) a minimum level of diffusion of innovation and associated capabilities throughout the BS, both the SME and other segments; b) emergence of 'demand' for the finance and other services provided by a VC/PE industry;[62] and c) generation of a policy makers' capability for undertaking 'targeted' policies. We here expand on the first two.

A minimum of innovation capabilities (condition a) is required for the economy to be able to exploit the ongoing Technological Revolution and Globalization process which are opening large numbers of new technological and business opportunities; and in order

[62] This demand would originate in the innovative SME segment established during Phase 1 and 2 and as a result of new entrants.

to effectively access and exploit the constantly increasing global pool of knowledge and technology (A&T 2004a).[63] Also the share of those capabilities which are enshrined in existing companies some of them large will enhance the potential pool of technological and KBEs that may be spinned-off from such organizations. They may, like in the case of high tech in Israel during the 1980s and 1990s and of India currently, be an important source of new innovative SMEs in the economy the impact of which could be strongly felt in subsequent phases.

A sufficient level of pre-existing 'demand' for VC/PE* services (one which flows from the critical mass of innovative SMEs generated during phases 1 and 2) is an important if not critical facilitator of phase 3 policies in support of the creation of a VC/'PE* industry. Both Israel's success and the failure of other countries' attempts at developing VC or 'venture' PE industries in countries like Germany (Black and Gilson 1998, 1999; Hellman 2000), OECD countries (OECD 1996, 1997; 2000) and Chile[64] underlie the centrality of 'deal flow', 'entrepreneurship' or 'mass of SU or innovative SMEs' for the successful implementation of VC –or PE– directed policies (A&T 2005a). This need not sound as totally obvious since frequently radical or major innovations (and VC/PE could be considered as such in the 'social technology'[65] area for the economies in question) have led to the creation of new markets and industries supposedly without pre-existing demand. Moreover in principle a new domestic industry could be based on the export rather than the domestic market. So the issue is 'what is distinctive in VC/PE which seems to foreclose such a situation'?

In the VC (and to some extent the PE) area there are three major groups of reasons. *First*-during VC emergence, the industry (to a large extent) produces a *non-traded good* i.e. VC services are difficult to export and to import. This means that a domestic industry requires a domestic market and vice-versa (this will gradually change with experience and maybe, with further deepening of the Globalization process). *Second*, market building may be slow and difficult and may fail. There are many examples of major/radical inventions which have anticipated their time or which have outright failed; only a subset of such inventions succeeded i.e managed to create a market. The *third* is a group of reasons related to the special characteristic of the global VC industry which is a cyclical industry (Avnimelech 2004). It follows that VC emergence has to proceed fast before the next crisis; and the chances that this will be the case are higher if there exists pre-existing demand.[66] Moreover by shortening the time and increasing the profitability of the first exits of the fledging VC industry, a strong pre-existing demand will assure, through a 'reputation effect' generated by successful exits, that a higher share of global resources of 'intelligent' VC will flow to the country in question. Finally, VC is a social technology a fact which is likely to impair its effective diffusion beyond the 'inventor' country (see Nelson, 2002). This 'supply side' constraint makes it even more important to effectively tackle the previous two factors by weakening the constraint on rapid VC emergence that originates on the 'demand side'.[67]

5.2 VC/PE Targeting: Timing, Context and Design

The nature of effective targeted policies under the current Technological Revolution and trends in Globalization differ substantially from the policies actually implemented and analyzed some decades ago e.g. in the analysis of infant industry promotion in the International Trade

[63] A constant flow (rather than a fixed set of) new technological opportunities is a pre-condition for emergence of a VC oriented to SUs whose function is to transform these opportunities into business opportunities (Kenney, World Bank Report 2003). Presumably this will also be the case in relation to PE and innovative SMEs.

[64] A Chilean Government program implemented in early in the present decade (personal communication).

[65] For the notion of 'social technologies' and the differences with physical technologies see Nelson 2002.

[66] Pre-existing demand is also important to initiate a process of 'endogenous creation of demand' by facilitating the initiation of a virtuous VC-SU co-evolutionary process. See A&T 2004a.

[67] The importance of the third group of reasons depends on context. Only some may be strongly relevant to non VC private, equity-based infrastructures.

literature; and in the analysis of infant industry promotion in Brazil and Korea (see for example Westphal 1990 and Kim 1997). The framework of past research was not explicitly a S/E framework; and the context was one of either import substitution policies or strong protection of the domestic market (like in Korea). The latter provided a reasonable time frame for the infant industries promoted to exploit economies of scale and of learning.

In the new context a major issue is to identify which industries or clusters should be targeted.[68] Due to the dynamic environment and strong and increasing global competition the set of realistic options for any one country may be less clear than what it was for Japan in the 60s and 70s and for Korea ten years later.[69] For this reason *a strategic ITP process* should be initiated which addresses the issue of how to identify areas with a potential SCA. Promotion of innovative SMEs is one aspect of this process of eventually identifying suitable candidates for targeting. This because the activity of these companies, especially if undertaken on a wide front, could lead to new innovative goods, product classes and even sectors (alternatively we could say that such SME's undertake 'experiments' which could lead to subsets of areas with potential SCA). It should be noted here that the active agents of innovation emphasized here are not large firms such as those which spearheaded Japan's (and Korea's) post World War Two targeted industry development processes.[70]

Once an industry/cluster to be targeted has been selected it will be important to rapidly build capabilities; and (global) market share. Only then will it be able to confront potential competition from new entrants; and to overcome the inevitable cycles which affect many sectors (e.g. VC/PE, semiconductors; traditional sectors, etc.).

Lessons from Israel's Experience

There are lessons to be derived from the analysis of Israel's targeted VC policies of 1993-1997 both for VC policies of other countries and for ITP targeting in general. In previous work we strongly argued that program success was linked very closely to the context and timing of policies; to program design; to complementary policies and to conditions of implementation (see A&T 2004b, 2005a, 2006b).

The Timing of Policies

Right timing was important due to both the internal and external environments of the country. The earlier the timing of the targeted policy the greater the risk that domestic demand (for the services of the future VC industry) would not have had enough time to build up to the level which, in conjunction with the policy-induced increases in 'supply', would trigger a cumulative process of VC emergence. On the other hand, the shorter the period between the initiation of such a process and the next downturn of the world VC industry (i.e. the later the targeted policy) the less the time period available for industry emergence and for a significant high tech impact to materialize.

How Yozma Overcame the System Failure[71]

A good 'design' of a targeted policy directed to a particular industry/cluster must ensure that the *specific causes* for the SF responsible for blocking emergence of the new industry, are

[68] This was less of a problem for postwar Japan (and for Korea in the 1970s) than what it is nowadays. It however is less controversial with respect to the desirability of targeting VC/PE or related industries given its role of being a relatively 'generic' private support infrastructure for innovative SMEs.

[69] For a discussion of Japan's experience see Komiza,1988.

[70] The emphasis on innovative SMEs' role is not to exclude the important role that large firms might play in spurring innovation and growth. Rather the objective is to emphasize i) that in the present 'entrepreneurial phase' of the ICT revolution, entrepreneurship and innovative SMEs may be the source of new sectors with potential SCA; and ii) that they may also be the source of innovative large firms (i.e. some may grow very fast) as well.

[71] See also A&T 2005b, 2006b,d.

adequately addressed. Yozma's design (and implementation) did in fact do the job for Israel's VC industry and high tech cluster: each specific SF cause (SFj) was addressed by one or more design features and/or implementation solutions. The set of SFj and some instances how Yozma overcame them are shown below (for further details see A&T 2004c).

- SF1: Difficulties in accessing intelligent and reputable foreign partners
  - Active search and interaction with highly qualified and reputable foreign VCs.
  - Sharing risk with private investors (government share in Yozma funds was 40%).
  - Upside incentive to private investors in Yozma funds (mostly attractive for highly skilled professional VC agents).
- SF2: Assembling a Critical Mass of Capabilities
  - Required participation of professional foreign VC/PE companies in each Yozma funds (as LP).
  - Required participation of capable local agents (individual and institutions) as general and limited partners.
  - Selection of Yozma VC management company candidates according to their background and potential.
- SF3: Critical Mass of Financial Resources
  - Direct government VC investment through Yozma Venture Fund ($20M); Government Fund of Fund investment ($80M) in 10 privately owned VC management companies (Yozma funds); It leveraged an additional $150M of private funds (foreign and local); The total of $250M was sufficient to trigger a cumulative emergence process.
- SF4: Coordination
  - Involving Agents (domestic and foreign) on the one hand and Financial Capital on the other.
  - Intensive interactive prior to policy implementation: This involved Government officials, agents from Israel's high tech and financial sectors; and individuals and organizations from abroad.
  - With other Policies.
  - Parallel implementation of complementary ITPs (expansion of R&D grants program, MAGNET program and Technological Incubator program).
  - Investment Coordination in early operation of Yozma Funds.
  - Participation of OCS representative in the board of Yozma Funds.
- SF5: Selection of VC strategies consistent with strict definition of VC
- SF6: Assuring Fast Learning
- SF7: Country/Government Signaling
- SF8: Selection of VC Characteristics

It is clear that overcoming the SF facing Israeli Policy makers in the early 1990s required attention to be given to a) achieving fast a critical mass of highly qualified domestic VC managers that would be willing to enter the industry; b) idem with respect to world class foreign players who would be willing to partner with the Israeli ones; c) coordinating these two resources in an effective way and in a short period of time; d) signaling that Israel was serious about developing its VC and high tech industries (see 3.4 above); and e) promoting collective learning in the new industry/market.

Given the trends in Globalization and associated opportunities and threats for developing new innovative industries (a global market on the one hand, global competition on the other) these conditions seem to us to be of wider applicability. For example, the *speed of emergence* (and attaining rapidly a non-insignificant market share) could be a critical factor in the success of targeted policies directed to innovative infant industries, including high tech ones. Otherwise, new competitors might emerge which could considerably erode the benefits to be achieved domestically. *Strong participation of foreign players* in the infant industry may therefore be imperative in many cases e.g. to effectively and speedily access foreign markets; to engage in complex contracting (such as alliances) etc.. Since speedy market coordination may be unrealistic Government should take an active role in *coordinating both domestic and sophisticated foreign agents*. Moreover, effective coordination in this sphere cannot be separated from the provision of adequate incentives to both domestic and foreign players. This means that both sophisticated incentives and other important features (policy selection, signaling, coordination, etc.) must characterize targeted program design (Yozma's incentives to the 'upside' are very suggestive about a possible means of attracting world class foreign players).

5.3 Policy Capabilities and Virtuous ITP-business/SME co-evolution[72]

The third necessary factor for a successful transition from Phase 1/2 to Phase 3 largely concerns the need of adopting a *strategic view* of ITP (see next section) and the related need to implement targeted policies. Targeted policies seem to be inherently more complex than horizontal policies and therefore require a longer and more complex preparatory period. There are clearly a priori reasons for this particularly in contexts with very little experience with innovation and ITP. Moreover, based on the comparison between the horizontal support to R&D which started in Phase 1 and the successful targeted support of VC of Phase 3, this has been the case in Israel.

A summary statement about this policy capabilities requirement is that the BS on the one hand and policy institutions and capabilities on the other *should co-evolve* (A&T, 2005a). This process is a specific instance of the co-evolutionary processes between technology, industry structure and institutions analyzed by Nelson (see Nelson, 1994).[73] A condition for a virtuous co-evolutionary process is that the BS experience of Phase 1 is brought to bear in policy decisions of subsequent phases thereby providing a justification to the Galli and Teubal assertion of some time ago that policy institutions are part of the national SI (see Galli and Teubal, 1997). The outcome would be a chain of *successful* ITP policies/ programs involving Phases 1-3 (see A&T, 2003b) which we may term ITP1, ITP2 and ITP3. To this sequence corresponds a chain of System/Market failures SF1, SF2 and SF3. *Unlike SF1, SF2 and SF3 would be caused by policy rather than being the 'cause' of policy* (Lipsey and Carlaw, 1997).

Sustaining a virtuous business-ITP co-evolutionary process however also requires explicit investments in specific competences not directly related to past policy experience. The missing components are in part related to the experiments proposed for Phase 2 (oriented to obtain additional knowledge); and in part related to other investments e.g. in human capital. The additional 'knowledge' concerns assessments about the economic potential of existing activities and resources; about current and expected changes in the environment facing the country or system (external and internal); and about implications for policy e.g. what new priorities should be aimed at and what are the associated SF. The ITP strategic level will include *search* oriented to the generation of new potential trajectories and opportunities for the system; and oriented to identify the specific causes of SF. These should be present at least at discrete intervals, throughout or increasingly throughout the process (they will become critical in Phase 2).

[72] For additional details see A&T 2003b.
[73] For further discussions see 5.3 below.

In Israel both policy institutions and personalities played crucial roles in assuring a virtuous ITP-high tech/SU co-evolutionary process which covered Phases 1 and 2. The OCS which is a specialized institution devoted to supporting BS R&D and to the creation and support of high tech industries was specifically created to implement the R&D grants program; and through time it became the locus of new experienced-based capabilities. Moreover, the last Chief Scientist of phase 2 (who identified the new system requirements enabling high tech SU to exploit the new opportunities opened up by globalization) was also the main actor behind the design of the Yozma Program. His success in identifying the new 'SF' would be impossible without the accumulated experience and knowledge of the OCS. Undoubtedly in other contexts there must be other profiles of virtuous business-policy co-evolution.[74]

Further work on how to develop a strategic ITP level should follow a Dynamic Capabilities approach (Teece et al 1997 among others). The most promising approach in our opinion is that of Zollo and Winter 2002. A central issue is how their Organizational Knowledge Cycle which focuses on 'operational learning' and generation of Dynamic Capabilities related to operational routines could be adapted or linked with other perspectives in order to explain emergence of ITP strategic level capabilities and routines.[75]

[74] By a virtuous ITP-High Tech co-evolutionary process we mean a chain of complex dynamic links where Government not only responds successfully to 'current' SF but indirectly (maybe somewhat unintentionally) is also instrumental in creating a 'future' SF to which it also responds successfully. The link between SF today and SF in the future is the process of business sector (in most cases, high tech) restructuring induced by the policy response, generally a new ITP program, to the current SF. A *virtuous* ITP-High Tech co-evolutionary process requires that the Government identify SF and craft an adequate policy response; and that business/high tech (and other components of the system) adapt, thus effectively canceling the constraint to growth represented by the original SF. It also requires that the new, restructured & more sophisticated high tech sector which emerges from this first round of policy making and policy impact be capable of exploiting a new set of opportunities that exogenously makes its appearance (provided a suitable policy response is found to a new System Failure that stands in its way). Israel's experience suggests that a virtuous co-evolutionary process may require i) a specialized policy institution in charge of national ITP (like Israel's OCS); ii) strong accumulation of 'policy capabilities' through time; and iii) a political process such that the aforementioned agency not be captured by private interests and lobbies.

[75] The new perspectives should focus on non-marginal changes (e.g. shift from operational to strategic routines); on other patterns of behavior which are not routines' based; on the role of search and external information; and on high levels of 'intentionality' (in contrast to pure experience accumulation).

6. Conclusions and Future Challenges

We have presented the outline of what may be an important category of dynamic, Systems-Evolutionary policy initiatives for industrializing economies in the area of innovative SME support and in the related area of VC, PE or other related PE-based finance and support infrastructures. Given the current 'entrepreneurial phase' of the ICT Revolution, support of 'Innovative SMEs' should be one of the axes of an overall strategy of development for a large group of industrializing economies. These ITP initiatives are embedded within a three phase cycle framework, initially suggested by the Israeli experience. A major link connects the early (Phase 1) support of innovation in general and innovative SMEs in particular to the subsequent (Phase 3) emergence of innovative or high tech clusters and transition to a Knowledge-Based or Learning Economy. PE, VC or other equity-based private support systems would play important roles in the above transition.

The strategic priorities of ITP and the SF to be overcome vary from phase to phase in our three phase model. In Phase 1, where a significant innovative SME segment may not exist, the objective is to diffuse innovation/R&D through the BS without discriminating SMEs, and in fact, positively favoring such enterprises. More frequently than not this requires direct Government policy in support of innovation in the BS. This support should be significant and consistent over time: rather than crowding out the possibility of developing a domestic VC industry and/or market it would contribute to create background and

pre-emergence conditions for the emergence of such a support system (A&T, 2006b). The tools used include an important component of Horizontal support schemes focusing on different functions associated with Innovation; and applying different instruments although there may be clear advantages to subsidies, grants or conditional loans over regular loans and tax benefits. In some countries like Russia in the 1990s and in Israel in the 1970s a strong pre-existing S/T/E 'base' makes direct support of innovation in the BS the main axis of support (although continued support of the 'base' will be required, possibly through continued implementation of existing mechanims of support). In other countries like Korea in the 1970s, Phase 1's policy portfolio includes a strong component of support of the S/T/E base i.e. in variants such as these, the direct innovation support schemes must be accompanied by strong support of the 'base'.

Phase 3 involves the acceleration of innovation which frequently may include a strong formal BS R&D component. As mentioned, a major component at this stage is creation-through 'targeting' of a VC/PE or other related PE-based 'innovative SME' support infrastructure. The paper strongly suggests that a condition for the successful policy-led emergence of such private infrastructures or support industries is the prior development of sufficient 'demand'. This would imply that the Innovation and Technology Policies implemented in Phases 1 and 2 must have succeeded in generating a significant 'pool' of innovative SMEs (those 'demanding' the services of the new infrastructures). Moreover, given the complexity of the 'targeting' requirement, a transition to Phase 3 requires new policy capabilities which in part have to be developed in Phase 2. These will enable Phase 3 formulation of an explicit strategy with new priorites which reflect the changed domestic circumstances (partly the result of past policies). The strategy will also partly reflect a consensual vision of the future configuration of the system of innovation, one which also takes into account the expected changes in external conditions. In Phase 2 it will be important to conduct experiments both at the level of the BS and at the level of the Government. BS experiments concern the new sectors to be developed in Phase 3 possibly including PE based innovative SME support systems and possibly other innovative or high tech sectors. An environment favourable to these experiments should be assured (e.g. enhanced liberalization and deregulation, some adaptation of tax and other institutional structures to international norms, etc.). Finally, it must be said that in many contexts and beyond the experiments mentioned above, it would be desirable to develop new 'strategic' ITP 'routines' and 'capabilities. These together with the above experiments and the policy experience from Phase 1 will enable the Government to identify and select sectors with potential long run competitive advantage. Phase 3 targeting will focus on a subset of such sectors.

Implications

From a S/E perspective, the ITP framework proposed could be considered a *Cluster Creation Policy framework.* Moreover, as suggested by the Israeli experience and due to the processes of Globalization, VC and/or PE and/or other private, equity-based infrastructures could play important dynamic roles in the emergence of new innovative clusters (high tech or non-high tech) or in the adaptation and *re-configuration* of existing ones. In our three phase model targeting such private infrastructure segments or industries is a central component of Phase 3 which is also characterized by a significant increase in the share of R&D (or innovative effort) in GNP.

The above is pertinent to the adaptation and development of SME intensive clusters in Latin America. The strategic priority of 'generating an important and growing segment of innovative SMEs' which characterizes our three phase model and which also plays an important role in the literature (e.g. of P&R, 2004) may very well require an ITP cycle phase which focuses on the generation of new and private, equity-based finance and support systems for such companies. The implied cluster re-configuration will go beyond that contemplated in the above paper and even beyond R. Sabel's recommendation for Italian Clusters.[76] What is needed is *a new set of highly*

[76] Lead lecture at a clusters conference held at the University of Modena and Reggio Emilia, September 2003.

capable independent agents with *strong motivation, capabilities* and *power* to support, in a distributed capabilities mode, the process of international expansion and functional upgrading of innovative SMEs.

The new equity-based finance and support mechanisms generate a new variant of the market-based and/or network based GVC so much emphasized in the analyses of Latin America, one which could substitute for existing hierarchical or quasi-hierarchical types. It is based on partnering innovative SMEs with other *external* private loci of complementary capabilities and power, based on a clear incentives alignment and on a common interest of fully exploiting the opportunities opened up by Globalization and the Technological Revolutions. Such 'partnership' would create new degrees of freedom to innovative SMEs and reduce their dependence on foreign buyers and importers. It could lead to the de-construction of existing GVC and their substitution by others, including those oriented to new global markets for intermediate inputs. If successful the two sets of agents would eventually co-evolve and generate a cumulative process of cluster growth.

Another important aspect of Phase 3 (and Phase 2) policies could be summarized by the term 'Evolutionary Targeting', to contrast to the targeting supposedly undertaken by post WWII Japan and by Korea in the 1970s and 1980s. Evolutionary targeting involves a number of crucial steps. These include-creation of 'background contitions' for the future (Phase 3) emergence of equity-based private support systems for innovative SMEs; systematic 'search' for areas/industries (beyond the private support systems) who potentially could enjoy a SCA; experiments about possible configurations of the subset of 'selected' areas/industries (private support systems and others); and identification of possible SF. All or most of these should take place in Phase 2, prior to the massive targeting to be undertaken in Phase 3. Moreover, the 'industry emergence' oriented targeted policies should be implemented at the right time and within an appropriate context; their design should consider not only incentives but also capabilities, issues of organization and critical mass, the possible collaboration of foreign partners, complex coordination needs, country signaling issues, etc.. Last but not least, the implementation of a targeted program should assure the institutional set up and coordination required to prompt a strong process of collective learning. This tall order would assure a cumulative process of emergence of new private infrastructures and industries.

Limitations of the Analysis

It would be presumptuous to assume that any model, much more this one which purports to be of 'generic' value, could provide a high impact recipee for ITP in all cases. Our model has ignored some important aspects of the real contexts facing industrializing economies. I will mention two: the link with Macroeconomic Conditions and Policies; and a deeper analysis of the Institutional Context.

Macroeconomic conditions and polices both influence the 'needs' or 'objectives' of ITP policy as well as the resources available to implement them. The restrictions imposed by the Macro environment in Latin America have been pointed out by Kosacoff 2000, Cimoli and Katz 2003; and P&R 2004. A more positive example is that of Israel's OCS which, during the macroeconomic instability of the mid 1980s, aided enterprises and their efforts to minimize loss of capabilities. A second weakness is the under-specification of the relevant institutional environment, which includes not only that underlying innovation and technology (e.g. patent laws) but also the BS as a whole (e.g. corporate governance, capital market regulations, communications' regulation, bankrupcy laws etc.) and even society e.g. norms of behaviour, entrepreneurship, personal and social networks, etc. (see e.g. Kuznetsov 2003, 2004). Both of these weaknesses underscore even more the objective of this paper: it is *not oriented to generate policy recipes*. Rather the objective is to underscore some general principles (with illustrations) of what policies could be and of how to go about to generate truly context-specific ones. A deep understanding of the local macroeconomic and institutional

context –including the possibility of change– which goes much beyond the content of this paper is critical for the successful design and implementation of high-impact ITP.

The Challenge: A Policy Role for Evolutionary/ Schumpeterian Social Scientists

Our paper is predicated on the assumption that Evolutionary and Systems of Innovation theory can be fruitfully applied to the study of ITP for industrializing economies. Rather than taking a *minimalist* position of how such theories relate to policy we assume an *integrated view.* Under this view it is not enough that economists or social scientists provide policy makers knowledge about the 'positive' implications of different policy actions; they should also interact with them and provide knowledge relevant to the identification and characterization of System and Market failures (and associated 'strategic priorities'). Moreover, they could contribute to generate a framework of analysis or platform for the design of policies that might overcome such failures. This view is consistent with the basic tenets of Evolutionary and Systems of Innovation theory since there, as in this paper, *interactions* are a critical component of the operation and transformation of Innovation Systems (in this case interactions between policy makers, the business community and academics with specialized knowledge). Another commonality between a S/E perspective and our integrated view of policy is the focus on *dynamic processes* e.g. the interactive policy process that should precede major strategic initiatives. Needless to say that playing this role is difficult since it strays from the conventional position of both neoclassical and evolutionary economists, one that implicitly seems to assume that policy is simply a trivial *application* of knowledge about the world. It also explains why this paper is essentially a non-mathematical instance of what in evolutionary parlance is termed 'formal theory', one which is supposed to set the stage for broader and systematic empirical analysis leading to context-related 'appreciative theory'. Thus while the researcher might be intimately convinced about the 'usefulness' of our approach it should be clear to him that the research trajectory leading to the creation of methodologically acceptable 'knowledge' in the field is a long and tortuous one.

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