

ENTERPRISE RESTRUCTURING AND EMBEDDEDNESS- A POLICY AND SYSTEMS PERSPECTIVE

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The first central objective of this paper is to analyse the *transition or evolution* of the system of innovation of industrialising and increasingly knowledge-intensive economies which might enable their successful adaptation to the processes of liberalisation, globalisation and the technological revolution of the last decade of the millennium. Successful adaptation of such economies generally requires not only the restructuring of business enterprises, including an enhanced rate of innovation, but also changes in the configuration itself of their national systems of innovation. Therefore the analysis here emphasises not only the characteristics of a national system of innovation (Nelson 1992, Lundvall 1992, Edquist 1997) but the process of transition of such systems (Galli & Teubal 1997, Andersen & Teubal in process).

A second central objective is to analyze the role of industrial and technological policy in enabling and stimulating such changes. There are many reasons why such policy might play a crucial role given the simultaneous need of enhancing both enterprise restructuring \ innovation and system of innovation configuration. Despite the well-known limitations of traditional market failure analysis, market forces by themselves may fail to undertake the required changes even within the domain where the market mechanism has a 'comparative advantage' over other mechanisms (This has been termed a "redefined" concept of market failure see Teubal 1997). In addition, there may be 'system failures' (OECD 199 and Teubal op. cit.). This paper will not deal with the justifications for policy but with the likely nature of the policy portfolio required to enable and stimulate desirable transitions of national systems of innovation.

In following an appreciative theory approach (Nelson & Winter 1982, Nelson 1995, 1997) and an emphasis on policy this paper follows a line of research initiated in previous work (Galli & Teubal op. cit., Andersen & Teubal op. cit., Teubal op. cit.). Again like in previous work this paper considers a number of *phases* in the restructuring of enterprises; and concomitant changes in the system of innovation which reinforce such a process. A major thrust in the analysis is the process (and nature) of successfully "embedding" the Business Sector into a broader subsystem involving greater complexity. In prior work this involved--beyond a first phase of autonomous restructuring-- a second phase involving the generation of a new hierarchical level to the subsystem, one populated by more complex entities--collective organisations which were termed Technology Centers (TC's). This paper further develops these while also considering other changes in the nature of the more open, complex and linked innovation system which is being generated in the wake of changes in the environment (e.g. the creation of new markets).

A major focus here and a clear extension over previous work is on the policy side of the transition of systems of innovation. The paper presents a *dynamic analysis* of Technological (and Industrial) policies directed to business sector restructuring in increasingly knowledge-based economies. More specifically (i) it simultaneously considers policies which are aimed to promote restructuring directly (e.g. horizontal programs supporting enterprise

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R&D) and policies aimed at influencing restructuring through changes in the national system of innovation e.g. the establishment of new technological infrastructure and new organisations housing them; and (ii) the sequencing of policies, and the policy portfolio required for the successful transition of the system.

As mentioned, the analysis is particularly applicable to interpret the experience of catching-up economies like Israel and other countries. The case of Israel is striking in that since the beginnings of an explicit policy for supporting civilian industrial technology in the late sixties through massive support of enterprise R&D, there was a systematic bias against technological infrastructure (TI, both *basic* and *advanced*--see Justman & Teubal 1995) at least till 1992 when a cooperative, pre-competitive R&D program was established and implemented. Other countries and regions have experienced opposite biases during the sixties and the seventies i.e. a bias in favour of Government Laboratories and Institutes and against direct support of innovation \ restructuring of the business sectors (see Lee 1997 for the case of Korea; and the policies of the Inter-American Development Bank towards Latin America during this period). Beyond this *activity bias*, the conceptual framework of this paper is applicable to analyse the *enterprise bias* of policy. In the Israeli case for example, while policy in the nineties has eliminated or partly eliminated the bias against TI it has still maintained the bias which also existed previously in favour of advanced, Schumpeterian enterprises and against what in this paper I have termed 'imitators' and 'laggards'. It is hoped that the framework of analysis presented here will help clarify the nature of the *activity* and *enterprise* biases in technology & industrial policy; and link these to the type of system of innovation characteristics which have emerged. Subsequent work will apply this framework to explicitly consider transitions to an Information Society (e.g. as described in EC 1996; OECD 1996).

In previous work we used the notion of Anticipated Institutional Change (AIC) to represent the package of policies leading to the establishment of TC's and new Technological Infrastructure². The term "anticipated" is intended to indicate that the scope and structure of the new infrastructure (and also of the organisation) is not entirely determined by explicit demands from the business sector. At the time when the new infrastructures are established together with the organisation housing them only advanced enterprises are aware of the need for these elements. One of the roles of Government is to anticipate and take into account future needs of the remaining enterprises of the Business Sector. The package of policies includes both changes in institutions including governance of the new organisation, facilitation of enterprise coordination, providing incentives for new technological infrastructures which are critical for the business sector as a whole, and other activities up to initial diffusion of the novel technological services flowing from the new infrastructure. These are supposed to generate the above-mentioned "(hierarchical) system effects" which could help the autonomous efforts of the business sector to initiate and sustain its own restructuring.³ In our

² The term TC (Technology Center) in this paper indicates the organisation resulting from a process of coordination and cooperation among firms whose objective is the generation of new technological capabilities relevant for the restructuring needs of the Business Sector. They are an example of "Basic Technological Infrastructure" (Justman & Teubal 1995). The Government does not usually own the TC--it is not necessarily a Government Laboratory-- nor is it the central actor in the process of its creation. It essentially is a facilitator of the process. Beyond this the term does not connote any specific organisational configuration. It could represent any one of a wide array of private or hybrid organisational forms. In a dynamic setting, a TC will also evolve and eventually it could become a "node" in a network linking business enterprises rather than a specific organizational locus housing new technological infrastructure.

³ Since these policies do not involve directly stimuli or incentives towards business enterprises they are referred to as 'indirect' policies i.e. working through system effects harnessed through the creation of a second hierarchical level to the NSI. Building the new NIS could also be visualised as generating a new "level playing field" for the business sector i.e. creating the conditions for everyone to be able to compete without discriminating

more complex policy framework AIC will continue to play a very important role although other policies and aspects of enterprise embeddedness in the newly created system of innovation will be considered as well. First, policies directly oriented to promote RBS - in this paper these will be Horizontal Policies (Teubal 1996a,7) which could trigger a collective, cumulative process of learning about how to effectively implement a restructuring process. Second, the activity of the new organisation which initially involves supplying novel technological inputs flowing from the new infrastructures, may lead to emergence of a market for such inputs (this could be important for the restructuring process. Finally, the rich set of policies and their phasing generate a new set of policy co-ordination, coherence and timing issues and thereby help unravel and make more explicit a number of critical dimensions and assumptions underlying an appropriate policy framework for Innovation System (IS) transition⁴. One potentially interesting implication concerns the nature and role of broad, horizontal policies in RBS and the balance between these and targeted & technology specific policies in NIS transition, a major issue in DifPolicies.⁵ In the conceptual model that follows targeted policies will play an important role even though we largely ignore explicit inter-firm differences in sectors and in technologies.

The conceptual framework to be presented recognises enterprise heterogeneity with respect to the restructuring process; and the important in not crucial role played by a set of advanced, innovator firms (“Schumpeterian entrepreneurs”). Moreover what strategies in response to changes in the environment are adopted by which firms “cannot be deduced from the knowledge of the state of the world and \or an unchanging rationality principle”(Dosi, Pavitt and Soete, 1990). It is clear that no simple classification e.g. based on high or low tech; nor positive profitable under the previous set of conditions facing the economy can tell us which firm will be “advanced” under the new circumstances

A major implication of the paper is the importance of visualising system of innovation transition as a process of diffusion of “restructuring” throughout the business enterprise sector. This requires an explicit “learning approach” (Teubal 1997a, 1998a) to policy. Two components of this perspective will be mentioned now: first, the need to generate “collective learning” from individual learning; and an explicit focus on codifying restructuring experience and generating a body of knowledge which enterprises which have not restructured could apply. It follows that ‘policy’ aimed at generating collective learning for cumulativeness in the restructuring process should include *program components* which systematise existing experience and codifies it according to a broadly accepted terminology which is also readily recognised by “users”.

2 The Nature of Business Sector Restructuring

Enterprise restructuring in response to the processes of liberalisation\ globalisation and new technological opportunities, could involve one or more of the following aspects-

- product specialisation, adoption of new technologies and enhanced world market orientation
- introduction of new functions(e.g. search, R&D) and associated routines(Teubal 1996,1997)

unnecessarily between large and small firms, foreign and domestic etc. This does not mean that some types of firms will not have an advantage over others in the new system nor that the process of selection could not lead to a large number of enterprise failure.

⁴ In principle the framework can also be extended to consider the policy implications of the potentially deleterious effects of IT such as social exclusion and unemployment. Future work will more explicitly deal with this issue (It will have to consider not only incumbent firms but also new firms as well as individuals).

⁵ See for example Soete and Arundel (1993). These authors use the terms general\specific to describe diffusion policies rather than horizontal\targeted policies as used here within a NIS perspective.

- organisational innovations such as Just in Time, Total Quality Management(Ishikawa 1985) , Business Process Re-engineering(Hammer & Champy 1993), Down(right)sizing, and Innovation Management Techniques(Green Paper 1996)
- collaborative structures, enterprise networking and links between enterprises and among these and other organisations \ institutions(for a summary of trends see Galli & Teubal 1997)
- shift to precision manufacturing and/or introduction of the ‘design’ function
- development of distinct dynamic capabilities(Teece & Pisano 1994, Teece et al 1995, Prahalad & Hammer 1990)
- Adoption of Information technologies together with enhanced training of employees, adoption of team-based incentives and enhanced employment of skilled personnel(E. Brynjolfsson 1996, Bresnahan 1996); etc

This is not a complete list nor are all items completely independent of others. Some may be relevant for the restructuring of some firms at certain times, others for other firms at other times. Not all firms attempt to restructure “to harness the forces of globalisation, deregulation, technology or demographics...”(Hamer and Prahalad 1994, chapter 12) and not all attempts to do so are successful. My objective here is not to survey the extensive literature on the various aspects of restructuring but rather to provide a broad overview to the type of changes I have in mind.

I implicitly assume firm heterogeneity at least in the sense that different groups of firms will restructure at different times and in connection with a different subset of restructuring components. Their decision will not only depend on the information they exogenously have but also on processes of *learning to restructure* the knowledge of which will flow from advanced or innovator firms(who restructure early) to imitator and laggard firms.

Most of the aspects of restructuring are *implicit* in the model--these are termed *general* ; their implementation can be visualised as depending on the knowledge and experience of enterprises including experience from others. Many of the organisational innovations and the introduction of new management routines seems to belong to this category. Full restructuring of any enterprise, however, is assumed in this paper to depend also on a *specific* aspect which involves the effective incorporation of a new (technological)input or new technological services into the organisation. This aspect is extensively discussed and made explicit in the paper(esp. section 3).The new inputs are assumed to be provided by the newly created TC rather than from imports since a necessary condition for its effective access and absorption by most business enterprises is geographical proximity of the source of supply. This is justified in terms of the need for user-supplier interactions, provision of close technical support and customised adaptation of the good or service which is both novel to the economy and relatively complex as far as effective adoption is concerned.⁶

The new technological input is assumed to be required for the restructuring of *all* enterprises-although in different configurations. In this sense it is of strategic importance for the economy and therefore some measure of policy targeting of the supply and diffusion of this input is inevitable.The input can be visualised as specialised measurement or design services which would enable, together with more general organisational changes, propel firms to introduce ‘precision manufacturing’ or to be involved in ‘product design’ .⁷

⁶ These requirements need not occur to the same degree in all cases but it is reasonable to assume that they are valid or quite common during the restructuring processes of industrialising, catching-up economies. Note that the literature on industrial districts has also assumed the importance of close user-producer relations(for the Italian case see Pyke et. al 1990, various articles).

⁷⁷ I mentioned that the TC represents a new hierarchical level of the evolving National System of Innovation. More generally this new hierarchical level would comprise both collective organizations\ institutions **and** markets

The above assumptions implies that it makes sense to talk about *a cumulative process* of learning to restructure since whatever the differences among enterprises concerning the general aspects, they always will confront a common problem of tackling with the specific aspect of restructuring. In terms of 'diffusion processes' the specific aspect involves directly the diffusion of 'artefacts' whereas all aspects of restructuring-both general and specific-also involve diffusion of knowledge (and \ or skills -see Metcalfe 1988).

Horizontal sharing of Information \ knowledge

Numerous examples could be found about horizontal sharing (e.g. due to networking) and horizontal transmission (also beyond networks) of experience, information and knowledge that occurs in the wake of liberalisation of trade, globalisation, etc and of the resulting restructuring process just mentioned. ('Horizontal' sharing here refers to sharing by firms even when belonging to different sectors) Examples are experience about *how to* search for an appropriate new and more focused specialisation pattern (external consultants here may play an important role in this diffusion process); general knowledge \ experience about foreign markets and how to do business in these markets; knowledge about the new management and organisational routines required for R&D (or more complex forms of R&D); and experience from introducing and implementing new organisational technologies (e.g. the experience of Xerox in 'benchmarking' and of Kodak, GE, Rover & British Airways in introducing TQM was important for other firms that came afterwards see Garvin 1993, C.Carr 1996 and C. Wick & Stanton Leon 1993). In the context of this paper these 'diffusion' processes pertain to the broad aspects or dimensions of enterprise restructuring. An implicit assumption of this paper is that the domain of *potential* sharing of information & knowledge relevant to the restructuring of enterprises in industrialising and catching-up economies is broad. Actual sharing may depend on other factors as well-- including policies. In such countries the obstacles blocking the actual sharing of such information \ knowledge may be significant (few such routines were prevalent prior to the changes in the environment), and these must explicitly be addressed by policy. A condition for a successful restructuring policy would seem to be assuring that at the early phases significant flows (and horizontal sharing) information & experience about the above and about the various components of restructuring take place. Moreover, I submit that it is likely that consolidation of the above into a cumulative process of collective *learning* about restructuring has probably taken place in economies with successful BS restructuring⁸

The upshot is that enterprise restructuring could be a collective learning process of the business sector which is both cause and effect of successful National Innovation System transition. Restructuring should be viewed as a diffusion process-- not only of organisational innovations but also of knowledge & skills related both to artefacts & organisation and to other general aspects of restructuring.

3 Towards the 'Systems' Embeddement of the business sector-a Simple Model

linked with the provision of new restructuring-relevant technologies whether or not they are related to the shift to precision manufacturing. These technologies could include new design technologies, flexible manufacturing and new organizational\managerial techniques and processes. Not all of the requirements for restructuring involve actors or institutions belonging to the second hierarchical level of the innovation system. The assumption made here however is that some critical ones do. For a discussion of what constitutes a new hierarchical level, see Andersen and Teubal op. cit.

⁸ Government agencies implementing *horizontal restructuring policies (HRP)* to stimulate such restructuring may play an important role in generating this cumulative, experience - based, process through the creation of a 'policy implementation network' (Teubal 1997). It must be noted that the emphasis of this paper on these (horizontal) effects which straddle across sectors dovetails well with absence of *explicit* intersectorial differences. Despite this restriction other sources of enterprise heterogeneity are considered in this paper.

3.1 The issues

Business Sector restructuring depends ultimately on decisions of individual enterprises, but these are taken within framework conditions which include both the structure of the wider system in which they operate *and* government policies - both macro and meso\micro policies. The feasibility and profitability of restructuring, therefore, also depend on factors that transcend the scope and 'direct' efficiency of the restructuring efforts of individual enterprises even those efforts which are affected by the experience and knowledge received from other firms. They will also depend both on incentives & other policy actions and on 'higher level' organisations, institutions and even firms which both incumbents and government may be instrumental in bringing about.

Assume that a relatively small group of firms - advanced or 'Schumpeterian' entrepreneurs - will autonomously initiate restructuring before adaptations have taken place in the wider system and in policy. These firms may play a crucial role in NSI transition since--as described above-- they may induce *collective* learning and set in motion a cumulative process of restructuring in the sector^{9 10}. However, as suggested above, in a wide variety of circumstances the possibility and strength of the cumulative process that follows autonomous restructuring may critically depend on embedding the BS into a more complex system involving higher hierarchical levels. In the absence of such an embeddedness it may be that a large segment of firms will not restructure or will not do it effectively¹¹. This because of market failure, institutional constraints and absence of sufficiently strong 'system effects' (System Failures). System Failure is "failure to stimulate in a timely fashion emergence of a new component of the National System of Innovation which is deemed to be of strategic value for enterprise restructuring"(Teubal 1997b)¹². For example, non-availability in the geographical and cultural neighbourhood of these firms of new intermediate organisations or linking agents with whom to interact, learn and purchase new technological inputs may block the effective completion of restructuring even by relatively capable entrepreneurs. It may also block the introduction of the organisational changes which accompany and even constitute a central aspect of such

⁹ An interesting real world counterpart to the advanced firms segment could be the Japanese automobile assembling plants established in the UK during the last 10 years. Nissan and other producers (Toyota, Honda) spurred a revolution in other segments of the manufacturing sector by spearheading the introduction of new organizational and management techniques linked with three areas: a commitment to continuous improvement (Kaizen); cooperative relationships between workers, managers and suppliers; and pervasive measurement of all aspects of business (to identify both serious faults and what precisely needs improvement). The "restructuring" impact included an enormous increase in quality standards of suppliers (e.g. Lucas and GKN) and "horizontal" diffusion of such innovations to other companies such as Ford and Rover. See Financial Times (1996).

¹⁰ The collective learning process which took place was not limited to the motor industry. "Managers from all over the country flocked to Sunderland to visit the plant ...The Government has sponsored teams of experts to learn from Nissan and other Japanese carmaker (Financial Times, op. cit). The literature has also recorded numerous instances of 'collective learning' both within and across sectors e.g. B. Coriat (1995) analyzes the implications of a shift from a 'regime of specialization' to a 'regime of variety' in the French Automobile Industry, a specific instance of restructuring away from the Fordist model of organization. The new regime is sustained by new types of links particularly what he termed the 'network core' comprising manufacturers, their subcontractors and component makers. A main task is certification procedures "which are made up of codifications comprising part of the Product Quality Assurance procedure"(pp. 221,222). His analysis strongly suggests that 'collective learning' has been fundamental in the transformation of the industry; and that both have involved the creation of new networks. Diffusion processes may also be strongly influenced by collective learning. One such model can be found in Stoneman 1987(pp.68-75).

¹¹ Despite the important cumulative diffusion effects described above there still exists "a long tail of underperforming smaller companies". Moreover, "suppliers to UK car plants (with some exceptions) do not match the world's best".

¹² Market Failure *Analysis*—even the reconfigured one proposed in the above research- cannot be undertaken in the presence of system failures.

restructuring.¹³ The outcome might be a weak process of ‘follow-up’ restructuring ie. that following the autonomous restructuring process, and a truncated transition of the innovation system (Anderson and Teubal op. cit).

While existing work suggests the potential importance of “embeddedness” the process is not a simple one and involves much more than supply-push type actions. Effective embeddedness depends on a complex set of institutional changes and investments in new technological infrastructures as well as in diffusion of novel technological services and possibly market building.¹⁴ It follows that an orchestrated and coordinated set of policy measures is required not only to generate qualitatively new links among enterprises and between them and other agents and actors of the economy; but to create wholly new markets as well.

In Section 3.3 I will be analysing the notion of business sector embeddedness-- a *distributed capability* (including links with other institutions \ organisations) which enables continued and successful adaptations by business enterprises to changes in the environment. It is worth noting that the importance of the ‘embeddedness issue’ and of associated system effects might be even greater for transition of the innovation system towards a Learning Economy. This because of the skewed effects of IT: on the one hand it offers new opportunities for advanced entrepreneurs; on the other it may have a tendency to create new problems due to the fact that substantial numbers of firms (including SME’s), other organizations and regions could significantly lag in the adoption of the new technologies. Similarly with individuals in connection with the opportunities and threats opened up by IT relative to their level of skills. Thus the new technologies may lead to serious problems of social exclusion, lack of regional cohesion, and unemployment (see Wolff 1996, Papaconstantinou & Colecchia 1996; EC & OECD op. cit).

It follows that explicit attempts at strongly inducing restructuring of potentially fast learners within the less privileged segments of the business sector (and of individuals & society at large) should also play a central role in NIS transition, one that may be the key for high productivity, low unemployment and a lower level of social exclusion in Europe. This will tend to increase the importance of embedding the business sector into an even wider system while raising similar issues viz a viz individuals. The boundaries of the relevant Innovation System will also tend to be broader than otherwise, since not solving the social problem today may not make the system transition a sustainable one in the future.

3.2 Framework of Analysis and Restructuring Phases

The analysis of business sector restructuring focuses on the specific dimension which involves absorption within firms of novel technological inputs or services, previously not available in the economy. More specifically, assumptions are made about the extent by which firms are aware, have articulated their need, and are capable of absorbing the new input--conditions for shifting to the precision manufacturing configuration demanded by world markets.¹⁵

Three phases of restructuring are considered. Initial restructuring of the business sector takes place in the first phase; while emergence of a Technology Center supplying novel technological services (a critical aspect of restructuring) and of a Market for such services will

¹³ There is a vast literature on the relationship between technical and organizational change starting with Schumpeter himself. For recent work on how one type affects the other and/or the need of coordinated and complementary changes see Bresnahan 1996, and E. Brynjolfsson 1996. Despite ample recognition of this link little seems to have been said in the literature on the potential policy implications of this relationship.

¹⁴ The importance of providing external advice to SME’s well acknowledged (Vickery 1996) and embodied in Government Programs e.g. the EU’s Innovation Management Techniques support program.

¹⁵ Supply considerations for these inputs will be considered as well.

occur in Phases 2 and 3 of NSI transition, respectively¹⁶. The latter two phases involve embedding the enterprises of the business sector into a wider NSI involving the second hierarchical level previously mentioned, whose 'system effects'--if strong enough-- could pull the whole business sector through the process of restructuring. All three phases are assumed to be necessary for a successful transition of the NSI.

The business sector is composed mostly of incumbent firms --there is only marginal creation of new firms supplying the novel technological services (in Phase 3 of the transition process) and other consultancies supporting the restructuring of laggard firms¹⁷. But there is *no widespread creation* of new firms. Incumbent firms comprise three groups: advanced firms; potential imitators and laggards (a further distinction between 'mild' and 'severe' laggards will be introduced later on). Advanced firms will restructure in Phase 1 while imitators and laggards will -under a complete NSI trajectory-restructure in Phases 2 and 3 respectively. For our purposes here we assume--despite some other *implicit* distinctions - that there are no other differences among firms in the Business Sector which have to be made explicit e.g. according to economic sector, industrial branch or technology\markets.¹⁸

Phase 1

A1) A small segment of business enterprises (advanced firms) perceive or anticipate the changes in the environment and will autonomously *initiate* the restructuring process. While Horizontal Restructuring Policies could be implemented to reinforce the *broad* dimof advanced firms' restructuring , these firms must also possess capabilities for completing such a process (specific dimension). Some will find make-shift and imperfect solutions to their precision manufacturing needs--either in-house production or from external sources -- despite the fact that the new technological inputs are not yet readily available in the economy. Completion of restructuring of the remaining group of advanced entrepreneurs will depend on the domestic availability of the new inputs from local suppliers. Due to economies of scope this will depend on creation of a technological center(TC)¹⁹;

A2) Some Schumpeterian entrepreneurs also have the disposition and capability to cooperate among themselves to create such a center, but this will not be sufficient due to institutional obstacles and market failure;

A3) The timely implementation of Anticipated Institutional Change by the Government may lead to the creation of a TC. AIC will include changes in institutions, helping the coordination of private sector efforts, identifying and providing incentives to the establishment of new Technological Infrastructures which will generate the new required technological services; etc (see Galli &Teubal op.cit.). I assume that such an intervention will be forthcoming;

¹⁶ I already mentioned that Technology Centers are viewed here as resulting, in the first instance, from the coordinated actions of advanced firms to build private institutions\organisations to internalise external economies while exploiting economies of scope. I mentioned that AIC would still be required to enable or facilitate the process (like in the Swiss and Japanese cases as argued by Weder and Grubel, 1994). Moreover, subsidies may also be required if advanced entrepreneurs are few in number or if their disposition or capacity for cooperation is weak(This because policy should attempt that infrastructures serving the wide needs of the business sector be created). Thus promoting new institutions \organisations is complementary to public subsidisation i.e. they are not only nor always substitutes.

¹⁷ New Technology Based Firms and a Venture Capital supporting structure will explicitly be considered in future versions of the 'model' of this paper.

¹⁸ Subsequent work will attempt at integrating this kind of analysis which is essentially 'institutional oriented' to the 'technological regimes' and 'technology systems' literature (see B. Carlsson 1996 and F. Malerba & Orsenigo 1996).

¹⁹ Alternatively we may consider a two stage restructuring process--the first where cost is high and the second when it declines due to ready availability of the input from the collective organisation(TC).

A4) Potential imitators and laggard firms initially possess a lower degree of ‘felt need’ concerning restructuring and also weaker capabilities (throughout) for undertaking the process and in particular for accessing and effectively utilising the novel technological services required. A necessary but not always sufficient condition for overcoming such constraints is their embeddedness in a wider system, a process which will take place in subsequent phases.²⁰

Phase 2

A6) Experience with the restructuring of Schumpeterian entrepreneurs may generate a body of collective knowledge about restructuring which may enhance awareness and perceived need about restructuring among the imitator population of firms. Refocused Horizontal Policies promoting restructuring will enhance both the experience obtained and its codification into a more systematic and accessible fund of knowledge.

A7) However, due to weak restructuring capabilities, implementation of such restructuring is not automatic even after TC creation when the novel technological services may be offered for sale.

A8) More specifically it is assumed that a *proactive diffusion policy* should be implemented by the TC (probably backed up by Government incentives) in order to promote diffusion of the inputs to potential *imitators*. Proactive diffusion implies specific attempts at generating awareness and significant efforts at understanding the ‘what’ and the ‘why’ concerning the user needs of various categories of enterprises. It also could involve attempts at codifying such knowledge- especially about the interface between the new technological service configurations and the different types of users²¹ - and provision of ample technical back up to the transactions involved. Proactive diffusion policies will, therefore, contribute to building “demand” for the services on the part of potential imitators.

Phase 3

A9) While past experience with restructuring could contribute in a limited way to the awareness and capabilities of laggards, it is not sufficient to assure successful diffusion of restructuring among this (probably dominant) segment of firms. Nor will a simple continuation of the proactive diffusion policies successfully implemented in Phase 2 suffice;

A10) Non-automaticity of the diffusion process throughout the large and (potentially-as far as adoption behaviour is concerned) varied population of ‘laggard’ enterprises during phase 3, due to remaining ‘demand’ and ‘capability’ constraints, together with general efficiency considerations, justify attempts at creating an “organised market” (Lundvall 1985) for the novel technological input. Such a market will endogenize the process, but policies are required both to build the market and to assure that it promotes *wide* diffusion of the input. Market building policies should ideally be undertaken by the TC who in the process might have to be downsized.²² They will involve a continuation of policies for building demand which were undertaken in previous phases (“proactive diffusion policies”) to which will now be added policies to create new supply agents e.g. through the training of consultants and even transfer of bits of the infrastructure to private laboratories. These measures, even if successful, are unlikely to promote diffusion to all members of the relevant segment of laggard enterprises (they may take care of ‘mild’ laggards but will be insufficient for the restructuring needs of ‘severe’ laggards);

²⁰ This paper implicitly assumes a *policy subsystem* which is both forward looking and sufficiently responsive to emerging Business Sector needs. It should also possess capabilities for effectively designing and implementing relevant new policies.

²¹ We assume that such differences exist but are not made explicit in our appreciative theory exercise.

²² This raises issues concerning the incentives of the TC to promote market building, see also Justman & Teubal op. cit.

A11) For 'severe' laggards proactive diffusion by a reconfigured and probably down-sized TC may have to be continued. Moreover, all laggards will require *complementary SME - support policies*. These may include training policies, general SME management support schemes, and creation of an organisational\management\technological consultancy segment of specialised firms.²³

A summary of the demand and supply situation with respect to the new input (which was assumed to be an essential ingredient in the restructuring process) is shown in Table 1. Following our previous description a clear distinction is made between the situation facing the three segments of the Business Sector during the phase in which they are initiating their restructuring process. Such phases are shown in column 1: the first entry corresponds to advanced firms and to phase 1 (since, in the ideal transition, restructuring of such segment occurs in this phase); etc. Table 2 summarises the capacity to access and use the novel input x on the part of the corresponding enterprise segment. This capacity is only partial for imitators and laggards (in phases 2 and 3 respectively). The insufficiency occurs despite the fact that a Technological Center has arisen which supplies the input at the beginning of phase 2 (thus making it easier for imitators to access\use the input and to undertake the restructuring) while a full market for the input has emerged at the beginning of phase 3 which would further pave the way for firms to incorporate the input. The fact that, despite these constraints, imitators do undertake restructuring in phase 2 and laggards in phase 3 is due to Government Policy (including the policy of the TC) -which is also briefly described in Table 2. While a full discussion of policy follows in the next section, note in Table 3 the sequence of policies supporting a full process of BS restructuring (and NSI transition). All phases involve both Horizontal and Targeted policies. Figure 1 summarises a successful process of RBS.

3.4 Embeddedness

The embeddedness concept in this paper is intimately related to the implications of a successful transition of the national system of innovation. A business enterprise sector is said to be embedded within the NSI of which it is part whenever the institutions and links with other agents \ organisations of the systems, and their capabilities, provide business enterprises with flexibility and the possibility of speedy and continued adaptation in response to changes in the environment. The point here is that enterprise adaptation requires a set of *distributed capabilities* located in other agents\ organisations which enterprises have access to; and that this access requires appropriate institutions and links among the two sets of agents. It may also require a measure of capabilities within the enterprises themselves such as R&D capabilities implanted during the *initial* restructuring which follows drastic changes in the environment. Finally, it should be mentioned that embeddedness cannot provide an infinite capability to adjust to *any* change in the environment; rather it may do so for a limited set of changes which do not radically alter the prevailing techno-economic paradigm(Freeman & Perez 1988). This

²³ The policies undertaken will affect the selection process operating within the Business Sector. The new opportunities to absorb the new inputs and to undertake restructuring should not weaken the overall selection environment(already made harsher due to liberalization), only make it more efficient by creating a new 'level playing field' and enhancing opportunities for fast learners. The scope of 'slow-learner' exit is—to some extent—a policy decision which should consider broader national objectives including issues of cohesion,(thus the task of policy goes beyond the timely creation of the more complex system of innovation). Note that the initial gaps in the support system and "system failures" could imply that the market selection mechanism may be inadequate by itself to perform the job. Market selection may be much more effective after enterprise embeddedness has taken place(but as we have seen, it need not be the only criterion for selection under the new system of innovation).

means that the adjustments and adaptations of enterprises can be done within the existing configuration of the NS.

For simplicity my discussion of embeddedness in what follows relates to the NSI attained *after* a process of successful enterprise restructuring, although this could be easily extended to consider also embeddedness throughout the transition period as well (which was the meaning given to the term up to now). It is assumed that such a system is an appropriate reflection of the “new” techno-economic paradigm emerging before such a restructuring process took place (this follows Galli & Teubal). Therefore and in order to avoid confusion, the term restructuring is used for enterprise ‘adjustment’ during the transition period, while the term adaptations indicates enterprise adjustment to non-radical changes in the environment after a successful system transition that is after emergence of the relevant, ‘new’, NSI.

The links I refer to involve information flows, interactions and also ‘market transactions’; and the institutions governing these links include both formal rules of the game e.g. concerning the possibility to cooperate in the absorption and diffusion of new technology; and to patterns of behaviour. As mentioned, the impact of ‘embeddedness’ refers to the potential for subsequent enterprise adaptations along the basic evolutionary trajectories defined by the new system of innovation. To take a simple example if the Business Sector’s restructuring in the paper involves implantation of R&D capabilities, then *embeddedness* might facilitate forging strategic alliances with other companies. Thus ‘embeddedness’ within a particular subsystem facilitates those subsequent adaptations which do not require a radically changed subsystem (e.g. they may require other links within existing institutions but no radically new institutions nor other, different agents--e.g. Universities--over and beyond the ones--e.g. TC’s--created in the wake of the initial restructuring).

The framework of the paper is consistent with a view that embeddedness follows restructuring and is nurtured by it since it brings about the new in-house enterprise capabilities (“old set of agents”) which should be combined--for effective adaptation in the future--with the ‘distributed’ capabilities of the ‘new agents \ organisations’ (the TC’s in the paper’s framework) More generally, successful restructuring and the learning that follows; and the fact that it reflects the operation of new system effects (flowing from the newly created organisations of the system), provides the potential for subsequent enterprise adaptation. The sequence of events would look like this-

creation of new agents & institutions -----> (reinforcement of) enterprise restructuring (system effects) -----> business sector embeddedness----->successful enterprise adaptations.

More generally and realistically, embeddedness should not be viewed as attained following completion of restructuring. Restructuring takes place continuously during national system of innovation transition and it would seem natural to assume that the *collective capability* for subsequent enterprise adjustment is also acquired gradually. In other words, a more realistic view of embeddedness goes beyond the collective capability attained in its entirety at the final state of a process of enterprise restructuring. Rather, embeddedness of business enterprises could be visualised as a process encompassing progressively wider segments of enterprises *pari passu* with the process of enterprise restructuring.²⁴

Enterprise embeddedness might be an objective of policy, as part of or in addition to, the creation of a new system of innovation. This depends on the expected changes in the environment. When the paradigmatic changes in the environment are ‘once and for all changes’ then the embeddedness objective need not be considered explicitly—it would be part

²⁴ A last point is that so much business sector embeddedness can occur as there is diffusion of the restructuring process. Wide diffusion is required if the transition process is to lead to a new system characterized by significant business enterprise embeddedness.

and parcel of the enterprise restructuring process; when, on the other hand, these changes are foreseen to continue beyond the ‘initial’ paradigmatic change, then ‘one shot’ enterprise restructuring is not enough and the issue of a collective capability assuring subsequent adaptations(=*embeddedness*) should be explicitly addressed. Embeddedness in this case would not only be the outcome of a desirable restructuring process but would become an objective in itself.

Granovetter’s concept of Embeddedness

Granovetter 1985 contends that “...most behaviour is embedded in networks of interpersonal relations and such an argument avoids the extremes of under- and oversocialized views of human action”. The undersocialized view would correspond to the rational man of neoclassical economics acting impersonally in the market and maximising utility/profits without considering the opinion of others, nor social norms and values(beyond property rights), etc. The oversocialized view ‘..has long been the majority view among sociologists, anthropologists.....that such a behaviour was heavily embedded in social relations in premarket economies ...”. Granovetter’s view corresponds to an intermediate level of embeddedness of behaviour in social relations and interactions. He contends that embeddedness in market economies is more substantial than that allowed by economists including those of the New Institutional Economics school; and that there was less change(reduction) in embeddedness involved in the shift from a pre-market to a market economy. It is my objective to relate his and my notion of embeddedness.

Let us recall that the concept of embeddedness used here relates to the adaptive behaviour of enterprises *within the new National System of Innovation*, a possibility which depends on

- patterns of behaviour directly affected by social norms, social relations and institutions;
- the set of capabilities both within the enterprises themselves and those distributed among other organisations(e.g. technology centers);
- new markets.

The first aspect of enterprise embeddedness, which is not considered explicitly in this paper, coincides with Granovetter’s view: behaviour-including that involved in successful business enterprise restructuring- depends on pre-existing social norms and institutions (It also is part and parcel of the evolutionary perspective to economic growth e.g. Nelson, Metcalfe and Dosi et al op. cit). Several examples link this paper and Granovetter’s analysis in connection with this point. One refers to attitudes towards cooperation among business enterprises. An effective transition of National Systems of Innovation may have to involve endogenous generation of positive attitudes towards enterprise cooperation in order to assure ‘embeddedness’. These may be required e.g. to collectively absorb new technological capabilities within existing technology centers after system transition; or for the creation of new centers. Another instance are the user- producer links and relations which in an ideally successful NSI transition have developed between business enterprises on the one hand and the collective, infrastructural organisations on the other. Characterising these relationships as being influenced by social relations and social norms such as trust (rather than or in addition to the influence of new institutions) is perfectly consistent with this paper’s notion of “embeddedness”. A final example which transcends the specific model of the paper but which is part of the same overall framework of analysis relates to entrepreneurship. Embeddedness of the business enterprise sector within the new system of innovation which emerged after enterprise restructuring may require that negative social attitudes towards entrepreneurship (and towards making money) which may have existed previously be replaced by positive attitudes. An example of such changes would seem to be the attitudes of Israeli society towards technological, hi-tech

entrepreneurship: from ambiguous or even outrightly negative attitudes in the sixties and seventies, to extremely positive attitudes in the nineties.²⁵

Despite this there seems to be a major difference between Granovetter's concept of embeddedness and the explicit notion used here. My view of *e* relates to the degree of explicitness of the technological and economic constraints on behaviour beyond those associated with social relations, and social norms and values. In this paper *embeddedness* reflects not only a willingness to adapt on the part of business enterprises--given the social values, interactions and institutions of society- but also a collective capability to do so successfully. Moreover, this capability is an outcome of successful behaviour (restructuring) rather than a determinant of behaviour. The link between the two notions of embeddedness seems to be as follows: availability of the distributed capabilities at the end of the process of evolution of the system is facilitated or determined by embeddedness of restructuring behaviour within a favourable set of norms and values.

In addition, there is a normative aspect in the embeddedness concept presented here since the related collective capability is determined by the desire to achieve a particular socially desirable goal—adaptability to subsequent changes in the environment. As part of the wider system from which such capabilities emerge it is important to mention explicitly, over and beyond new institutions in general, the dependence of enterprise embeddedness on the “new markets” for the strategic new inputs (this seems to be frequently forgotten both by neoclassical and evolutionary economists). They are “organised markets” which eventually achieve well functioning user-producer links.

I conclude that different objectives and perspectives explain the differences between embeddedness in Granovetter's analysis and in this paper. The objective here is to analyse the capacity of the business sector as a whole to adapt to changing circumstances and this inevitably requires adoption of a systems approach where each enterprise's contribution not only depends on norms and values, etc but also on his capabilities and on the capabilities and behaviour of other agents including non-enterprise organisations. The focus of Granovetter, on the other hand, seems to be the individual actor and his behaviour:--given what can be done (which remains implicit) what are the factors explaining his actual behaviour: pure rationality, institutions or social relations.

3.4 Conceptual Clarifications

Dynamic Role of Key Agents

A *dynamic role* in pulling the NSI forward --over and beyond the direct effect of whatever they are doing--is played by certain players or actors during the transition process. Such a role involves spillovers and enhanced innovation \ restructuring possibilities open to other agents in the future. *Advanced, Schumpeterian entrepreneurs (the “innovators”)* play such a role in two respects: they generate a fund of intangibles which is useful for other firms that restructure in the future; and their cooperative efforts also contribute to generate new technological infrastructure and organisational capital (as well as partial absorption of overhead costs for the former) for future use. A dynamic role is also played (subsequently) by the collective organisation housing these capabilities--the TC. Their Phase-2 proactive diffusion policy (see 4.1 below) not only helps the restructuring of “imitators” (direct effect) but also--through its demand creating impact--contributes to the creation of a market for the new inputs which may be crucial for extensive diffusion of restructuring during phase 3.

²⁵ This social acceptance of technological entrepreneurship in Israel seems to have been an important background factor behind the impressive growth of such ventures and of venture capital in this decade. See Gelvan and Teubal 1997. Future work will attempt to incorporate these phenomena within the conceptual framework put forward in this paper.

A very important issue is characterising these dynamic agents. Advanced (Schumpeterian) firms need not include firms which were profitable or dominant under the previous conditions, on the contrary such firms may be locked in a trajectory or strategy which fit the previous techno-economic paradigm.²⁶ Under the new circumstances incumbent enterprises will not undertake autonomously restructuring and may be slow-learners. Thereby, they would not fit the category of *key agents* since few spillovers could be expected from them--their indirect contribution to business sector restructuring would be feeble. Dosi, Pavitt and Soete's (1990, Chapter 8) analysis of what factors explain the adjustment strategies of firms provide insight into the potential complexity of the problem. Their basic question is what affects technological dynamism while the question I am asking myself here is a closely related one: how can we characterise the key-agents in NSI transition? One particular strategy which they analyse –Schumpeterian adjustment involving innovation\imitation\technological upgrading- bears a strong resemblance to the 'restructuring' notion of this paper.²⁷

Key actors make a potential contribution to the economy due to spillovers and generation of new capabilities ; but the “social” value of their current activity - depending on factors such as valuation of capabilities in capital markets- is usually not reflected as a measured and currently available (& fungible) addition to GNP or wealth. They create future options whose impact will also depend on complementary policies and on pertinent behaviour by new agents in the future. Despite the inherent difficulty of assessing the activities of key actors, they should be taken into account in policy and appropriate indicators of their potential contribution to the economy should be developed²⁸.

Coordinated Building of Supply and Demand

Successful restructuring involves the *coordinated building of demand and of supply* for new technological services. The problem is not only that of coordinating supply and demand; it is *of building both in a phased and coordinated way*.

During phase 1 the autonomous initiation of restructuring involves or leads to emergence of a demand for such services. Due to economies of scope in new capability development (or in the absorption of such capabilities from abroad) the appropriate and cost effective type of supply response is, very likely, not immediately available. This because such a response may have to overcome market failures and other obstacles associated with the collective effort to create the (local or semi-public) goods. It will take time and may also require Government assistance. Thus at sub-phase 1a supply adaptation takes place at the individual firm level

²⁶ This fits well with the idea put forward by Tilton(1971) and Abernathy & Utterback(1978) that incumbent firms were rarely carriers of new technology to an established industry even when such technology had subsequently a dramatic effect in changing the nature of the sector.

²⁷ Lipsey and Carlaw (1997) emphasises the 'structuralist view' that economies possess 'specific externalities' and technological complementarities. These may influence or determine which firms will restructure first.

²⁸ A parallel to key agents or activities of key agents may be found in some dynamic implications of growth and trade theory. Thus specialisation according to static comparative advantage may lead to a low-learning trajectory for the economy that is to a pattern involving low technological dynamism and to 'dynamic' inefficiency (see Teubal 1973, Dosi et al 1990 Ch 8.2 and some of the contributions of the new growth theory such as Lucas (1993) and Grossman and Helpman (1991)). Alternatively, specialising in high-learning sectors or activities may generate a fund of intangibles which potentially contribute to future “production possibilities” (and which are only imperfectly evaluated in the present). In contrast to neoclassical or advanced neoclassical models which generally focus on technological intangibles or in scale economies emerging in the process of “sectoral’ structural change” their role in NSI transition is to generate “cumulativeness” of the process not exclusively through simple learning processes but also through changes in the architecture of the innovation system. This explains the emphasis in generating links among different types of firms and between them and newly created institutions\organisations. Central to these are management and organisational routines. To a greater extent than in neoclassical or new growth theory models, focusing on dynamic agents and activities is only a precondition of cumulativeness.

where makeshift solutions are sought. But this is not an appropriate adaptation in the long run which requires collective generation of the new capabilities in order to exploit economies of scope (a TC enables precisely this). For this to happen in a timely fashion (sub-phase 1b), AIC may be crucial. Note that the disparity between supply and demand may temporarily increase once AIC is activated--since *expectations* of timely supply of inputs, with appropriate configurations and low cost, will reinforce the restructuring efforts of Schumpeterian entrepreneurs (Galli & Teubal op.cit).

Elimination of the above mentioned supply bottleneck through creation of a TC, will, in our model, generate a demand bottleneck. This because the new services are now available at marginal cost to all firms, not only the advanced ones. However, as shown, creation of demand need not be an automatic process and not all firms are aware of their needs for the input (laggards) or even if they were, are capable of accessing them and utilising them for precision manufacturing (potential imitators). Thus, the transition in Phase 2 and 3 could be understood in terms of effectively creating a demand for (or eliminating excess supply of) the new inputs which are critical for restructuring.

Policies may have to be implemented for this purpose. These should involve both horizontal incentives to directly promote the general dimensions of restructuring--albeit with a different focus and target population than those of phase 1--and a number of targeted policies. The latter involve both proactive diffusion (which is a demand creating process which accompanies sales and which also involves technical back-up) and market building policies, both of which may be undertaken in a decentralised fashion by the TC²⁹. While the proactive diffusion policies may be sufficient initially 'integrate' potential imitators into the new system, full-fledged market building and other policies may be required to make their embeddedness automatic and long standing; as well as to contribute to embedding laggards.³⁰

Key Sector Alternative to a TC

Emergence of new, collective organisations (the TC) is only one possible way to generate system effects based on the supply of new technological inputs for business sector restructuring. Another possibility is emergence of a key sector which would play a role similar to the US machine tool sector in the 19th. C. as analysed by Rosenberg (Rosenberg 1962). In our context, such a sector would comprise firms involved in specialised chip design and batch production services; in novel technological services associated with precision\quality production; in software & new communication services and products, etc. The new sector may emerge, as in Rosenberg's analysis, from vertical desintegration & innovation (e.g. which exploits an invention from an advanced firm) or from another process. It will eventually provide "depth" to the business enterprise sector and as such should be considered as an important change in the "architecture" of the NSI (see Andersen & Lundvall 1997). Frequently, full fledged markets may develop in some of these new products. It should be noted that the relevance of the key sector concept goes beyond the machine tool industry studied by Rosenberg (see data in Patel & Pavitt 1994). Such sectors could belong to the category of 'specialised suppliers' within the overall taxonomy put forth by Pavitt (1984) provided that

²⁹ Governments may have to actively support TC's in their market building process since such a social profit perspective on the part of these organizations may imply incurring 'private' losses. See Justman and Teubal 1995.

³⁰ Compared to Phase 2 an even more extreme and massive deficiency of demand could exist in phase 3. One aspect of the solution already mentioned is a new **social** institution--the market for the critical input. A differentiated market (see Teubal & Zuscovitch, op.cit) would support a set of specialized suppliers which would be able to cater to the *ongoing* needs of various types of users. This would provide both breadth of coverage, flexibility & adaptability to changes in technology and needs.

they involve new 'generic' inputs as well. I will be assuming that at least a subset of important inputs of such nature could develop into relatively well functioning markets.

With the key sector substituting for the TC it still may be useful to consider a distinction between an initial diffusion process comprising Phase 2 from emergence of a full fledged market for the new, generic, type of input in Phase 3. Rather than having a collective organisation being involved in initial activities (technology transfer and absorption from abroad; and initial diffusion) we would now have one or a small number of innovator firms launching the new inputs and, with the help of user feedbacks, initiating the process of applying the new technology. The subsequent market building phase would simply be represented by the take-off of the new technology in the wake of convergence to some kind of standardisation or even dominant design (Abernathy and Utterback op. cit.). Explicit supply based policies, such as those undertaken by the TC (training of existing consultancies; spinoffs from TC personnel, etc), would not be undertaken by firms-since this would normally mean creating new competitors³¹. But building of demand would still be a central aspect of firm strategy.³²

Policies may still be required for both of these phases. For example, enabling or facilitating coordination of the processes of backward disintegration which may lead to the establishment of new input suppliers (see Andersen and Lundvall 1995); and compensating for market failure which may be rampant at the initial phases of development of new key firms and the new generic technologies which they develop and diffuse (see also Teubal op.cit.).

4. Policy Issues and Policy Framework for Successful NSI transition

4.1 The set of policies and their deployment through time

The set of policies considered here includes the following elements:

- * Horizontal Restructuring Policies (HRP)
- * Anticipated Institutional Change (AIC)
- * Proactive Diffusion Policies (by the TC)
- * Market Building (by the TC)
- * SME-support schemes.

Annex 1 presents summary descriptions of a possible functional content of each policy.

From the point of view of beneficiary firms, HRP are focused according to transition phase: in phase 1- towards the restructuring needs of advanced entrepreneurs; in phase 2-to those of imitators; and in phase 3-to the needs of laggards which means that the HRP is transformed into an SME-support scheme (I assume that a dominant if not overwhelming share of laggard enterprises are SME's). Despite this focusing HRP are *horizontal* in the sense (i) that they are aimed at firms, according to general criteria, irrespective of industrial branch or technology area or type (see Teubal 1997); (ii) their objective is to provide support for general aspects of restructuring such as the introduction of new management \ organisational routines (e.g. TQM) or novel Socially Desirable Technological Activities of relevance to enterprise

³¹ Despite this firm cooperation -even among competitors- at the early stages of new market development, is common and may be important for the future development of the industry (See Langlois 1992 for an analysis of the early development of the PC industry). It is even conceivable that additional entrants may contribute to building the overall market for incumbent firms (this seems to be the case of laser based eye operation systems).

³² Key to market building by firms might be that the initiator\innovator key firms create a user-producer network while serving as the central node of this network (a PBX in the parlance of Teubal et al 1991). For different configurations of market building under different assumptions about interactions and innovation see Teubal & Zuscovitch 1996.

restructuring such as R&D and associated routines; and (iii), their objective is to generate a collective learning process which exploits the commonalities of the experience with restructuring across industrial sectors \ types of technologies (Teubal 1996a, 1997) . On the other hand AIC, proactive diffusion and Market Building policies are *targeted policies* in the sense that they promote diffusion of the strategic new input or technology (“novel technological services”) which policy makers, advanced firms and the TC (after its inception) have identified as being of critical importance for the restructuring needs of the Business Sector as a whole.³³ This means that policy makers no less than responding to felt needs of some firms also are anticipating the needs of others who presently cannot articulate their restructuring needs³⁴ or who require technical back-up in order to access required new technological inputs.³⁵

In Table 3 I summarize the deployment of policies at the various phases of the restructuring processes and for the various business sector segments. The diagonal is the central focus of the Table and its cells depict-- at each phase and for the business sector segment *whose restructuring is initiated then--* the set of horizontal and targeted policies implemented during an ideal NSI transition. The policies in each cell of the diagonal, if successful in implementing RBS of the relevant segment, influence the policies of the next cell. Moreover the targeted ones (indicated by*) *respond to* a felt need by the relevant business sector segment (located in the same cell) while at the same time anticipate the needs of firms belonging to a less sophisticated segment of the business sector (located in the next cell in the diagonal in SE direction).

Two additional aspects of Table 3 should be mentioned the first of which being policies stimulating networking of imitators and laggards already in phase 1 (and also to laggards in phase 2). This policy should be regarded as a preparatory type of policy which sets the stage for full restructuring later on. It is information intensive & a low-budget policy. Its main contribution would be to generate awareness of changes in the environment and assurance of the possibility of change (e.g. by demonstration) as well as a mechanism for the systematic collection of new, restructuring-relevant information. In the restricted sense given here to the term ‘stimulating networking’, the policy promotes and generally provides for a secretariat for a group of firms who are searching for such information e.g. about new markets and new technology. If successful they may induce laggards (imitators) to move forward into the

³³ In Andersen & Teubal op.cit. the targeted nature of AIC is discussed. In a multi sector setting where each sector or group of firms requires a different type of new technological input it is possible to implement a *semihorizontal* policy rather than a purely targeted policy that would stimulate different TC’s and different technological infrastructures. The Government may announce that any group of firms who got their act together would receive support (incentives, information, coordination, etc). Thus the Government need not know what specific input types are required by each branch of the business sector. It would, however, have to know about the broader general class of inputs to which each one of the specific types belong. Thus some targeting or prioritisation at a higher level of policy would still be required.

³⁴ A clear distinction should be made between ‘general need’ and articulated need \ demand for a particular new product; and this can be applied to the issue of restructuring . The possibility of the former without the latter has been pointed out in Teubal 1979 (‘low market \ need determinateness’) In our context this could mean a very general of fuzzy awareness of the necessity of restructuring on the part of enterprises without a clear idea that this implies the need to utilise and incorporate the strategic new technological input.

³⁵ It may be worthwhile to clarify a number of points. First, HRP while directly aimed at satisfying the ‘felt need’ for restructuring on the part of *some* business enterprises (the advanced or innovator segment) also involves anticipation of needs (Teubal op.cit). Second, the distinction between horizontal and targeted policies also corresponds to the distinction between the broad restructuring dimension and the specific one. Third, recent work on horizontal programs shows that these do not necessarily imply neutrality in incentives. Moreover, the learning processes involved during implementation (including enhanced Government capabilities to identify and locate market failure) may transform an horizontal \ neutral policy to a set of semihorizontal and even targeted policies. Finally note that the SME- support scheme combines horizontality with a strong demand-creating bias-a dimension which differentiates it, to some extent, from other horizontal support programs (See Annex).

imitator (advanced) category Success of these policies has been recorded in contexts such as Chile (PROFO Programs) and Norway (private communication by K.Smith).³⁶

Second, the table also indicates the phase when firms 'endogenize' their restructuring process e.g beyond phase 3 for laggards. Finally, note that the policies correspond to the initial conditions facing each segment at each phase I (Table 2). Initial conditions in phases 2 and 3 reflect the spillovers generated in phases 1 and 1, 2 respectively.

Figure 1 summarises the RBS process under a full NSI transition. The horizontal axis indicates time and the vertical one indicates the hierarchical level of the reconfigured NSI. At the first hierarchical level we observe a succession of restructuring processes starting at Phase 1 with that of advanced firms (represented by Ra); and followed by Ri and Rl (restructuring of imitators and then of laggards). At the second level establishment of TC during phase 1; its operation during Phase 2 and emergence of the new market M during Phase 3. The straight arrows indicate the direction of the impact on NIS transition of actions of key agents—both experience and knowledge *spillovers* (dashed arrows) and *supply\demand effects* (full-line arrows). Spillovers are shown at both NSI levels: at level one it is the restructuring experience of advanced enterprises which directly benefits imitators and indirectly, through the experience of imitators, laggards; at level two, the demand -creating implications of (and the experience with) the diffusion activity of the TC is that which contributes to the building of the market for the strategic new inputs, and through this, to the restructuring of laggards. The impacts of advanced firms through supply \demand effects are all indirect: they work through the establishment and operation of the TC. Thus Ra also contributes-through demand and the subsequent establishment of a TC-to the normal availability of the input to imitator firms in Phase 2, thereby making a further contribution to Ri in this phase.³⁷

The mobilisation and stimulation of the dynamic role of key agents by policy is also represented in the diagram (curved arrows with policy acronyms). Thus AIC reinforces the autonomous effect of demand for the new input and leads to an earlier and more effective TC which in turn, through S, contributes to Ri. Proactive Diffusion Policies (PD) undertaken by the same TC will contribute to generate the demand D for the new input (Phases 2,3). Note that the TC is both an endogenously-created key-agent(in part the result of policy) and an organisation directly involved in policy implementation.

³⁶ The Promotion of networks in Chile involves subsidising the manager of a network of similar firms with the objective of improving access to Government incentives; enhancing bargaining power of the SME's viz a viz large firms; improving the pattern of division of labour among firms in the network; diffusing organisational innovations, and collecting information(Thanks to G. Crespi for information about these networks). These policies are not, in most cases, identical or similar neither with pure user-producer networks nor with full- fledged networks of innovators (or flexible specialisation networks) discussed in the context of Industrial Districts (see Bianchi & Beellini 1991) as alternatives to the Fordist, mass production model of organisation. Such networks\network promotion policies which have been discussed in the European context are akin to aspects of the overall restructuring process proposed in this paper and not only to the preparatory stage of such a process as has been the intention here. The similarities with the model of this paper are found first and foremost as regards the imitator and laggard segments of the business sector where restructuring requires the implementation of 'system effects'. For example, policies to promote the creation of new 'networks of innovators' include the stimulation of collective institutions ("Service Centers" such as CITER established in Emilia Romagna in 1980 for new and weak companies in the textile and clothing sectors) to stimulate the creation, diffusion and utilisation of new technological and market information (e.g. trends in fashion designs and training to operate and use design workstations) and for overall coordination. In this paper these would correspond to (hierarchical) level 2 organisations such as our Technology Centers whose function is to assist RBS of imitators (and also of groups of laggards).

³⁷ Note that the establishment of a differentiated organised market (Lundvall 1985) contributes to Rl through the stimulation of both S and D and not only through a pure supply effect. The reason for this is that the specialised suppliers comprising the new sector both provide technical back-up to users and continuously learn how to couple the new technology to the needs of various classes of laggard firms.They, in fact, are creating 'demand'.

Overall, the Figure represents both innovation system transition and the enhanced embedment of business firms associated with such transition.

4.2 Synthesis of Policy Implications

A number of potentially interesting implications follow from the analysis.

1. The criticality of initial policies

Policies can be viewed as supporting or failing to support the materialisation of dynamic increasing returns to restructuring or alternatively to generate a cumulative process of change, one engulfing increasingly wider segments of the BS. Thus small initial differences in the appropriateness or in the efficiency of policy, due to path dependency, may have very significant long term implications. Also, absence of policy when autonomous restructuring is weak may fail to trigger NSI transition.

2. Successful initial policies build upon and reinforce the autonomous restructuring process of advanced entrepreneurs. They generally involve both horizontal and targeted programs.

Successful policies should initially be focused towards key agents (in our model, the advanced segment of entrepreneurs) who potentially generate spillovers which promote cumulativeness of the business sector transition process i.e. imitation by follower firms. This is consistent with the Evolutionary Theory presumption that ‘imitation’ is a major mechanism of economic growth (Nelson and Winter 1982) and with the fact that there are strong differences in the real world in the innovativeness of enterprises³⁸. To materialise this strategy, horizontal policies should be implemented since many restructuring problems are common to firms in different sectors and technologies although the specifics may differ from case to case and because at least some learning and some important spillovers straddle across sector and technology boundaries. Such policies are appropriate to stimulate the *broad* aspects of restructuring³⁹. Targeted policies, on the other hand, focus on the *specific* aspects of restructuring which means targeting an input \ technology of strategic importance for the economy. They are necessary since full RBS must involve both the general *and* the specific aspects of the process.

3. Horizontal Policies will evolve with experience and could contribute to variety.

HTP comprise a chain or string of interconnected programs supporting general aspects of restructuring whose enterprise focus evolves with restructuring experience. Thus during the successful innovation system transition case considered in this paper, a program supporting imitator firms will come after a program directed to advanced \ innovator firms. Its impact will depend on the experience accumulated from the restructuring process stimulated by the previous HTP program. Moreover, by focusing on different types of firms and even on different functions and organisational changes, the various programs play a role both in

³⁸ This is reflected empirically in the Innovation Surveys run in several countries in the last 4 years. In the Norwegian case when considering for example all manufacturing firms with more than 200 employees the innovation survey shows that a small percentage of such firms account for the majority of new products introduced in the 3 years before the survey was taken while about half of the firms have not introduced any new product whatsoever (thanks to K. Smith for this observation; see also Nas 1996). A related issue concerns the notion of a strategic industry (Nelson 1984): *this paper suggests that certain industries (or certain groups of firms) may play a strategic role in the transition of national innovation systems through restructuring experience spillovers without themselves necessarily being “strategic”-- in the sense of supplying goods of strategic value to the economy.* The model of NIS transition in this paper allows for differentiated enterprise categories based on the phase in which their restructuring is initiated, rather than on sectoral characteristics. Further work should allow for structural differences in “technology regime” as well (see Malerba & Orsenigo 1996 and Breschi & Malerba 1997).

³⁹ Notice that *focused* horizontal policies in Phase 1 differ from a policy of picking winners or of supporting National Champions, despite the fact that beneficiary firms are supposed to play a strategic role in business sector restructuring (strategic in the sense of the previous footnote).

catering to variety and in stimulating it (firm differences are partly endogenously generated by the restructuring process which in turn is stimulated by HTP). Variety is also promoted as a consequence of learning *during implementation* of a particular HTP program: eventually we should expect a set of different promotion schemes one for each sub- category of firm, state of core competencies & organisational capabilities (Teubal 1996b).⁴⁰

4. Targeted Policies stimulate institutions and infrastructure that perform both a demand satisfaction function with respect to advanced firms and a demand anticipation (and market building) function. viz a viz less sophisticated business sector segments.

In this model targeted policies involve either creation of a TC or subsequent implementation of policies by such “intermediate organisations”. TC creation satisfies the needs of advanced firms in Phase 1 and anticipates the “needs” of imitator firms in Phase 2. Similar considerations hold in connection with market building policies undertaken in Phase 2 - they partly respond to the contemporary needs of imitators, but on the other hand, they also anticipate the needs of laggards (some of which are not yet aware of the need to restructure).

5. The contribution of targeted policies to the embeddedness of business enterprises derives from a more complex innovation system involving new types of organisations and/or social institutions(indirect impact on RBS).

Embeddedness through a new market, for example, has scope, depth and flexibility implications which enables enterprises-particularly imitators and laggards- to continuously adapt in an endogenous fashion in response to changes in the environment (provided they are not radical changes). Both self organisation *and* Government Policy might be required.⁴¹

6. Appropriate timing and coordinated policy deployment are crucial

Due to cumulativeness of the processes of innovation system transition the timing of policies is crucial. For example, too early application of an SME- support scheme may be wasteful and risks at being non effective since the restructuring possibilities of these firms could be limited due to dearth of spillovers from advanced firms and absence of system effects. Second, undue delay in the implementation of Phase 1 targeted policies, by failing to reinforce autonomous restructuring, may reduce spillovers and what can be profitably be learned by other firms. It will also block the specific restructuring efforts of imitators. Thus timing of

⁴⁰ This will also involve less neutrality and more selectivity in incentives. Thanks to Keith Smith for having stimulated my thinking about the role of a specific horizontal programs in stimulating variety. My conclusion is that even in situations where a horizontal program is being substituted ,through learning, by a set of targeted programs there would still be room for a *downsized* horizontal policy scheme to allow for ‘random’ or ‘unexpected’ variety.

⁴¹ The literature on regional systems and clusters also emphasises the embeddedness attained by individual firms e.g. Malmberg and Maskell (1996) talk about firms embedded in a networked structure of customers, suppliers and institutions which both provide opportunities and exert pressures for knowledge accumulation. The tradition represented by the above authors also emphasises the importance of interactions and interactive learning; of proximity in space (also for economies of agglomeration); and even of embeddement of the regional system within an even wider system involving also cultural factors and other broader institutional variables. While the role of market forces in the operation of the system is recognised there seems to be an underemphasis in the role of markets as social institutions in generating enterprise embeddedness (i.e. greater stability in the face of changes; continuos product and process improvements, flexibility etc). Another major distinction with this paper (and with part of the industrial district and network of innovation literature) is the emphasis here in the dynamics of system change rather than on (the static) characteristics of a successful cluster or regional system. How did the Danish furniture industry evolve? It is clear that the story is more complex than a simplistic analysis of Marshallian external economies would seem to imply, since institutions to capture potential externalities must be allowed to arise endogenously as part of the process. Thus it may be important to make a distinction between hierarchical system effects--which help propel enterprise restructuring during the transition period - and the embeddedness feature which is then achieved upon termination of this period.

policies and more than this, the balance and coherence between horizontal and targeted ones (and between those aimed at different enterprise segments) are critical issues determining whether or not a cumulative restructuring process will emerge.

5 Policy Sequencing, Program Portfolio and Stylised Facts: Illustration and Applicability of the Framework.

5.1 Illustrations versus Application

Illustration

By an ‘Illustration’ of the model I mean, first of all, finding examples of a country which during a period of time (ideally a decade or more) either (i) actually implemented both categories of policies more or less as described in the paper; or which, *prima facie*, (ii) ought to have done so. There are various levels of ‘illustration’ which depend on availability of data, information and knowledge about the design and impact of specific programs.

There are three levels or modes of illustrating the model for catching-up economies

- 1.** Examples where policies directed to innovation were (or ought to have been) implemented simultaneously with policies directed to the supporting infrastructure. This excludes ‘pure policy sequencing’ which is defined as involving a first phase of support of innovation (infrastructure) exclusively followed by a phase of support of infrastructure (innovation). The point suggested in the paper is that in turbulent environments always or almost always there should be programs supporting both categories of activities;
- 2.** Examples of program sequencing where the desirability of the later policy is based on success of prior policies. Sequencing could happen among programs supporting innovation during a particular period; among programs supporting infrastructure, or it could involve programs belonging to both of these categories;
- 3.** Examples of individual program and/or the sequencing of programs which correspond quite closely to the ‘model’ presented e.g..
 - the programs supporting innovation directly are ‘horizontal’ while those directed to the supporting infrastructure involve greater selectivity and even ‘targeting’ of strategic technologies;
 - the targeted policies supporting the technological infrastructure (I) responded in part to pressures of advanced entrepreneurs; (ii) a broad infrastructure relevant for large segments of the business community was created; and (iii) this infrastructure facilitated the diffusion of “restructuring” \ innovation throughout the imitator & laggard population of firms;
 - Sequencing of horizontal programs supporting innovation or restructuring, starting with programs directed to advanced firms and continuing with programs oriented to diffuse restructuring throughout the imitator and laggard populations of firms.

The examples could be positive and also negative the latter being “normative measures that ought to have been implemented but were not”⁴².

It is important to note before attempting to find examples or empirical counterparts of the model that the amount of detail about the types of policies, their design and even their impact for “complete” counterparts of the model is considerable. In the interplay between generating a conceptual model and finding its potential domain of application in the real world the fit is always imperfect. In this case, we will see that the information available permits only a partial

⁴² Thanks to G. Dosi for this suggestion.

matching between the two. However, at the level of the individual program, the model suggests questions that could be raised when researching specific programs of technology policy.

Application

By ‘Application’ I mean, using the model’s perspective about successful business sector restructuring to (tentatively) characterise and assess the set of policies implemented by such countries in the last decade or two. The focus will be on the program portfolio and its changes through time. I will make tentative statements about a *policy bias* favouring innovation relative to technological infrastructure; and a policy bias favouring Innovators relative to imitators \ laggards.⁴³ This latter bias in policy—which could also be termed an *anti-diffusion policy bias*-- could result from Innovation \ Restructuring programs; from Technological Infrastructure programs (more generally, the technology support system); or both. In this paper an anti-diffusion bias in policy refers to *inadequate stimuli to the diffusion to imitators of “activities”* such as R&D or other Socially Desirable Technological Activities (SDTA, Teubal 1997a) or other components –including organisational aspects—of enterprise restructuring, rather than to the diffusion of technology per se.

A second dimension of Application relates to assessment of the set of policies undertaken by such countries during the period of time chosen to illustrate the model. Thus a bias favouring Innovation over Technological Infrastructure and a bias against Diffusion may seem to be good or bad from the point of view of growth or from the point of view of the type of Innovation System the country is aiming at (my example of Israel below may sharpen this point).

Needless to say, that determination of possible biases in policy and their assessment will be largely qualitative and speculative. The possible usefulness of applying this conceptual framework is to sharpen the questions to be asked about the general features and trends in a country’s policy and about the direction of its national system of innovation; and to introduce a dynamic and a systemic perspective to the policy discourse.

The examples shown below pertain to two countries: Israel and Chile. The above-mentioned “fit” is greater in the case of Israel than with Chile. So is my possibility at this stage of identifying biases and formulating an assessment.

5.2 The Case of Israel

Policy Portfolio and Activity Bias

During the last two decades Israel implemented a number of technology policy programs, most of them belonging to the category “Innovation or Restructuring” (I \ R) and a small number to the category of “Technological Infrastructure” (TI). The signs >, >> and < indicate programs or actions having a strong, positive impact on the activity affected by the program, a very strong one, and a negative one, respectively. The list includes the following:

- 1969\70: establishment of an horizontal “Industrial R&D Fund” extending grants to “classical” R&D i.e. to individual firms, for new or improved products\processes leading to greater exports. Since that time, this program constituted the dominant program in the Israeli civilian technology policy portfolio, certainly budget-wise (>>I \R);

⁴³ The above suggests that we should distinguish between at least two biases in technological policy: (i) activity bias; and (ii) enterprise bias. In my framework activity bias relates to the innovation \ technological infrastructure mix; whereas enterprise bias relates to the explicit and implicit preferences or focus favouring a group of firms which can be termed ‘innovators’ over ‘imitators \ laggards’. In Israel, an enterprise bias favouring “innovators” largely corresponds to a bias favouring high-tech industry i.e. unfavourable to mid and low tech industry.

- 1970-90: relative reductions in the share of Government support to technology centers(<TI)
- 1992-Establishment of the Magnet Committee extending grants to pre-competitive R&D performing consortia involving two or more firms and one or more Academic Institution(>TI)
- 1993-Creation of a Government-owned Venture Capital Fund (YOZMA) to promote Venture Capital investments in Israeli hi-tech, entrepreneurial enterprises(>> I \R)
- 1992-Implementation of a program of technological incubators(> I \R)
- 1993\6- Implementation of SME consultancy support schemes(> I \R).

The Israeli experience with technology policy seems to indicate a rather one-sided policy portfolio, at least during most of the seventies and eighties in favour of direct measures favouring Innovation \ Restructuring and against public support of technological infrastructure. It is worth noting that in the years of establishment of the “Industrial R&D Fund” at the Office of the Chief Scientist, Ministry of Industry and Trade, which extended grants to R&D, there was an actual reduction of support to those centers created during the 50’s and 60’s in the wake of Israel’s first wave of industrialisation (which focused on mid-and low tech sectors). There seems to have been a shift then from infrastructural to direct support of innovation \ restructuring (Teubal 1984). Moreover there was stagnation and even reductions in support for “basic” technological infrastructure during the eighties. During the 90’s the situation seems to have been moving more into balance--we are experiencing for the first time, with the activities of the Magnet Committee, a significant public effort in financing civilian technological infrastructure (Magnet’s budget for 1997 will lie between 50M\$ and 100M\$ out of the total budget of around 350 M\$ of the OCS)⁴⁴. It is important to note, however, that Magnet represents an ‘advanced’ type of TI --creation of generic capabilities in frontier technologies-- rather than “basic TI” which support SME’s and conventional industries more generally through technology centers who absorb and disseminate technologies developed elsewhere (Justman and Teubal 1995)

To summarise, *Israel in the 90’s does illustrate a country having a mixed technology policy program portfolio* with significant expenditures being directed both to Innovation \ Restructuring and to Technological infrastructure. *This was not the case during the 70’s and 80’s where there was a clear bias in technology policy towards Innovation and against Technological Infrastructure.*

Policy Sequencing

There are two possible sequences which can be used for illustration purposes and in order to set the stage for a discussion of Firm Bias. The first is a ‘positive’ example of a program sequence and the other a ‘negative’ one.

- the first is the 1992 implementation of a new program supporting pre-competitive, cooperative R&D (The Magnet committee program). This program followed after more than twenty years of implementation of the grants to “classical R&D” program which started in 1969;
- A negative example would be lack of coordination of the grants to “classical R&D “ program--which helped introduce the “R&D” function within an innovator (and to some

⁴⁴ The Ministry of Science has also, since 1994\5, initiated a program of mission-oriented research at Universities to the tune of 20 \25 M\$ per year. This program, being more closely related to industrial, economic and societal needs could also be included into what in the paper is termed Technological Infrastructure.

extent “imitator”) segment of enterprises-- with a policy supporting Technology Centers which would help diffuse “R&D” throughout the laggard segment of business enterprises⁴⁵.

The Positive Example

The second program should have “ideally speaking” been implemented earlier than 1992 (date when the so-called Magnet Committee began functioning) since there is evidence of a “strategic need” which failed to materialise due to deficiencies in the policy mechanism and the policy subsystem of the second half of the eighties.⁴⁶ The sequencing aspect comes from the fact that the second, cooperative \ pre-competitive R&D program builds upon the results of the first program. Firms participating in such programs should have in-house (“classical”) R&D capabilities in order to be able to commercially exploit the results of pre-competitive research. In other terms, we can say that the classical R&D support program created a market failure in pre-competitive, cooperative R&D which, albeit with a large delay, led to creation of the Magnet Committee.

The match between this example and other features in the model is good. Even though the technological infrastructure program is “horizontal” (it is not specific to sector or technology) rather than a full-blown targeted program directed to a specific technology, it implicitly involves higher selectivity than the classical R&D support program with its “neutral incentives”. This is due to the large (even enormous by standards of the regular R&D support program) size of the projects supported by Magnet.

The Negative Example

Despite the “success” of the grants to “classical R&D” in promoting this type of technological activity among high-tech industry and technological start ups since the early seventies-- it seemed to have failed to promote diffusion of R&D or other relevant technological activity to the mid-tec and low-tec segments of industry. This means either one of the following truncated sequences:

- lack of adaptation of the program to non adopters through e.g. program re-design and focus on activities which are less R and more Design&Development than the “R&D” which is routine in Electronics and in other hi-tech industries; through special catalytic incentives; or in terms of special efforts to generate projects and to trigger an innovation-related learning process in mid-tech and low tech industries (most imitators and laggards would belong to those industries). In terms of the paper, it meant- after the successful implementation of a program oriented to the innovator segment-- absence of a follow-up horizontal program directly supporting R&D or related technological activity of laggards;
- If “diffusion of R&D” to these sectors should have been done through Technology Centers rather than through another horizontal program directly supporting this activity among laggards (this is one of the widely recognised roles of such institutions at least in regards to mid and low tech sectors)-- lack of a clear policy which effectively supported such institutions as well as lack of coordination between R&D support and whatever fragmentary support for Technology Centers that existed. That diffusion could have been promoted in this way can be shown through the experience of a successful center-- the Plastics and Rubber Industry Center after its reorganisation in 1992. It not only performs R&D for its members but it also provides technological services, training and information as well as continuously being involved in absorbing technology from abroad and diffusing

⁴⁵ The problem here would seem to be more than simple lack of coordination; it rather reflects a lack of complementary policies supporting the wider diffusion of “R&D” through the population of ‘potential adopters’ of this activity.

⁴⁶ See Teubal 1993 and 1997b

it within the sector⁴⁷. The center thus contributes to diffuse technological activities and to promote the restructuring of member enterprises⁴⁸.

Possible anti-diffusion biases

Despite a certain rectification in the 90's of the traditional Israeli technology policy bias against technological infrastructure there still seems to be a clear bias against diffusion both of Innovation \ Restructuring and of cooperative capability development(TI) to imitator and laggard enterprises. There is some evidence that these enterprises largely belong to the mid and low-tech industrial branches⁴⁹. This view emerges from the truncated policy sequencing of the "negative example" mentioned above⁵⁰. In addition, note

-- The Magnet Committee's focus on advanced rather than 'basic' TI. This imparts a hi-tech bias to the program⁵¹;

-- The policies of 1993 which successfully led, during a period of 4 years, to the establishment of a Venture Capital Industry in Israel-are inherently favourable to hi-tech entrepreneurship rather than to mid and low tech;

-- A similar situation seems to hold with respect to the Incubator Program.

The only program or set of programs which is eminently favourable to diffusion and to imitators and laggards are the consultancy schemes which came to existence in the early 90's. While these programs seem to have been very successful per dollar of public resources, the volume of such resources is extremely low(20-30 M\$ per year). Thus, although these programs represented a very important development it is doubtful that their impact has been such to balance the inherent pro-innovators bias of the other programs.

5.3 General Comments on Chile in the 90's

⁴⁷ The center's R&D performed for individual enterprises could be visualised as specific applications of (or services flowing from) the technological infrastructures absorbed in the organisation from abroad. In some cases it is a prelude for the eventual incorporation of in-house R&D activities within the participating enterprises. The Center would also help in establishing the necessary 'infrastructure' within the firm.

⁴⁸ This suggests that a network of Technology Centers could have generated broad restructuring among imitators\laggards.

⁴⁹ The share of R&D performing firms is relatively high in sectors like Office Machinery and Computers, Radio, Television and Communications--67 % in Norway(1990), 80% in Denmark(1992) and also in other European countries-- compared to other like food and beverages, textiles and wood and pulp industries(Nas 1996). The relevance of this data for the argument of the text is indirect: on the one hand it was already mentioned that "innovation \ restructuring" could involve --especially for mid-tech and low-tech industry-- not only R&D but also D&D and even Technology Transfer ; on the other, the argument cannot be sustained simply by comparing the extent of diffusion in some sectors relative to others. It would be necessary to compare actual diffusion of new technological activities to mid&low tech with an appropriate norm. Thus, evidence that the extent of diffusion of technological activities within such sectors in Israel is lower than in European countries might be indicative of a less than appropriate level of diffusion . Further work on this regard is obviously required.

⁵⁰ Even within the R&D grants program itself there are indications of bias against low-mid tech. For example, the share of "Electronic Equipment" R&D financed by Government was 21.9%in 1993 whereas the share of Food, Beverages and Tobacco was 5.9% in that year(Central Bureau of Statistics, 1993).Electronic Equipment is highly R&D intensive(the share in sales of current expenditures in R&D was 10.7% in that year) whose share of Government R&D disbursements was over 70%. The Food, Beverages and Tobacco industry on the other hand is either the lowest in the ranking or among the lowest on both counts. These figures in my opinion are not only indicative of a bias in extending incentives to R&D but are indicative of the fact that the relevant technological activity for the more traditional activities is not R&D. Similar biases can be found in other years as well.

⁵¹ Efforts were made in the design stage of Magnet to make it less inherently biased against imitator \ laggards and mid \low tech, to no avail. In particular, support to technology centers was explicitly excluded. This is quite in accord with the perceptions and preferences of most policy makers in Israel on issues of technology policy making.

The high growth of Chile in the last decade was accompanied by specific technology policy measures, particularly during the 90's. FONTEC- an horizontal program supporting technological activity within enterprises-- began operating in 1992\3 together with FONDEF which is a 'link' program supporting University research and technological development with the participation of enterprises of the business sector. It is worth mentioning that FONTEC supported technological development and technological modernisation more generally and not only "classical" R&D undertaken by individual enterprises. In this sense it was a flexible program which did take into account the wider needs of the business sector, most of which is and was 'conventional' rather than hi-tech. The program would thus support the technology adoption and absorption of individual enterprises(and, in some cases, of groups of enterprises) within conventional industry as well as the R&D efforts of electronics, biotechnology and other more advanced firms. FONDEF could be considered as one program supporting the technological infrastructure, although the main program within this category would seem to be the recently implemented FDI program.

This new, cooperative program("Fondo de Desarrollo e Inversiones) began operating in 1997. As with FONTEC it supports both cooperatively undertaken R&D as well as other technological activities e.g. the FDI may support a program where a group of firms creates a Technology Center to collectively absorb technology for the sector ("basic" TI)⁵².

Reflecting on these programs within the perspective offered by the paper (and the concepts introduced when analysing the case of Israel)- it is worth mentioning that --

- the timing of implementation of FONTEC on the one hand and FDI on the other is consistent with an appropriate program sequencing: having developed in-house capabilities at the firm level, successful enterprises would be poised to exploit the cooperative development of pre-competitive capabilities(through FDI);
- a seemingly relative absence of *activity bias* given the simultaneously implemented programs in the two main areas: "innovation"(FONTEC) and "technological infrastructure"(FONDEF & FDI);
- flexibility of FONTEC and of DFI as far as the type of technological activity supported,would seem to exclude significant *enterprise biases* --either against innovators or against followers- at least such that would arise structurally from program design⁵³

Having said that it is worth mentioning that absence of significant biases against diffusion in program design is not indicative of satisfactory diffusion of the new types of technological activity throughout the business sector. In fact, only a very small share of business enterprises have made use of FONTEC in the four first years of the program(1992-96). Although the initial 'diseconomies of small size and of limited learning' are, undoubtedly part of the explanation, there is always a possibility that R&D and other technological activity vital for competitiveness and growth will not reach more than a small share of enterprises, particularly SME's. The upshot is first, that a *bias against diffusion \ followers may also appear in the implementation of programs*. In Teubal 1997b and in connection with horizontal programs I ascribe this a policy failure characterised by non-adoption of a learning approach to policy.

⁵² Cooperative investments for 'market development' could also receive support from FDI. One such project supports marketing and logistics investments directed to create a massive 'fresh fish' market in the country.

⁵³ In this connection it is worth mentioning that the existing network of technology centers and institutes; the possibility of undertaking technological activity collectively even in FONTEC(despite this not being the central thrust of the program); and the relative proximity between FONTEC and DFI implies that individual enterprises without possibilities to undertake technological activity in-house could have done it collectively and/or with the help of a technological center. This possibility, which is important for conventional industry and SME's, was not a realistic one for Israeli firms in those industries.

The next few years will tell us if such an implementation anti-diffusion bias will also characterise the Chilean case.

5.4 More General Implications of the Argument

The conceptual framework of the paper suggests one possible way to assess the nature and biases of technology policy and the direction of change of national systems of innovation. A preliminary and qualitative application to the Israeli setting would suggest existence of two biases—a bias in favour of policies directly promoting innovation \ restructuring; and a bias in favour of advanced \ innovator firms and against follower enterprises (imitators and laggards). Both biases were present during the 70's and 80's. During the 90's, when important changes in policy took place, there was a belated and partial rectification of the first bias through the activities of the Magnet Committee. However, the bias against diffusion of new types of technological activity to followers (and indirectly, to mid-low tech enterprises) still remains despite some improvement.⁵⁴

The two biases could have had consequences. In Israel's case the bias towards innovation versus infrastructure suggests possible lost opportunities during the late eighties and a slower recovery (than what would have been the case) from the macroeconomic and Defence-related restructuring of the mid-eighties. If a civilian-oriented technological infrastructure support program would have been in place it might have been possible to generate a more effective adaptation of military capabilities to new products \ processes oriented to civilian markets for export. New patterns of cooperation (a new form of organisational capital) would also have emerged earlier in the Israeli scene and this would have represented a major shift in the Israeli national system of innovation. The cumulative effects of these changes could have been and anticipation of the high rates of growth achieved in the 90's e.g. Israel's success in exploiting the Internet and telecommunications revolution would, very likely, have been even greater than what it actually was.

The second bias would have eliminated a certain duality in the Israeli system of innovation—one where hi-tech firms restructured and adapted quite well while low-tech firms did so badly. This would have raised the rate of economic growth through a greater contribution of the low- and mid-tech sectors. It would have also made an important contribution to the employment problem and to regional development (since outlying development towns are particularly reliant on this type of industry).⁵⁵

The notion of policy sequencing (see Teubal 1996a) could also be applied to envisage possible directions of change in policies. In general, greater attention should be given to program follow-up and to the restructuring of existing programs in the direction of creating

⁵⁴ The pro-innovation bias of Israeli technology policy with the pro-technological infrastructure bias found during the 60's and 70's in other countries (Wong op. cit implicitly describes such biases in the imitation phase of Korea's industrialisation process, during 1962-1980). This bias would seem to follow from a linear view of the innovation process where innovation follows automatically from research performed at the supporting infrastructure (Universities, Government Laboratories, and Technology Centers). Moreover, several of these cases of anti-innovation policy bias (e.g. Latin America) also possessed a strong anti-diffusion bias. These cases illustrate the point that an anti-diffusion bias (in the sense of this paper, that is an enterprise bias against imitators) can be associated either with an activity bias favouring innovation (Israel's case) or with an activity bias favouring technological infrastructure.

⁵⁵ A major Government industrial policy program for regional development is the Law for the Encouragement of Capital Investments which provides significant subsidies on a neutral fashion to physical investments particularly in development towns. It is widely perceived that this program failed. My suggestion is that this failure is to some extent a system failure which related to other components of the system and to other technological and industrial policies. Thus, complementing the very expensive investments scheme with a very cheap SME consultancy scheme already during the 80's would have generated high economic and social benefits. Even more so if specific measures to promote diffusion of "innovation" and of "technological infrastructure" would have been adopted.

promotion schemes which could have a potential impact on diffusion. Beyond the specific instances already mentioned of absence of program sequencing I would like to suggest two possible areas of action:

- adapt the Magnet Committee(its design and its implementation) so that it also serve as an appropriate technological infrastructure program for ‘follower(largely small and medium) enterprises’ and for mid\low tech industry;
- create a follow-up to the SME consultancy schemes in the direction of offering incentives to acquire new technologies and technological capabilities; and \or to undertake D&D or R&D(part or all of this could be done by adapting the existing R&D grants program to the needs of these enterprises or sectors; and by linking and co-ordinating both programs).

It is clear that the above illustration have not exhausted all of the technology policy questions facing Israel. The ‘model’ is not and could never be that comprehensive to cover all of the technology policy issues of any country. Its purpose is to create a framework which facilitates an analysis of *some* issues which might be of important to policy makers. Needless to say, articulation of these and their translation into specific policy recommendations requires a lot of effort and access to much more data and information than that brought to bear here.

6. Summary and Link with Diffusion Policies

This paper presents an appreciative theory “model” of the transition of National Systems of Innovation which is potentially applicable to catching-up and increasingly knowledge intensive economies of varying characteristics such as Israel and Chile. In the paper, the process begins with advanced, Schumpeterian firms and proceeds gradually to engulf imitator and laggard enterprises. In the ideal or full transition trajectory, enterprises which are ‘innovators’ or ‘advanced’ are *key agents* in the sense that their restructuring actions directly and indirectly contribute to the restructuring of other enterprises. Spillovers from key agents are of two kinds: (horizontal) knowledge and experience flows about restructuring which create awareness of the need of and provide information and leads about possible restructuring configurations; and supply-demand effects associated with the timely provision of previously unavailable technological inputs which are critical for restructuring. The latter *system effects* are the result of fundamental changes in the overall system of innovation brought about by advanced entrepreneurs: their actions in the paper lead to the emergence of new collective organisations supplying such inputs.

The outcome of successful system of innovation transition is business enterprise “embeddedness” within a broader and more complex innovation system. From the point of view of business enterprises, this means a distributed set of capabilities throughout the system of innovation which will enable the implementation of successful adaptations to ‘turbulent environments’ in the future.

Enterprise Restructuring as a Diffusion Process

The restructuring process described above which leads to a new national system of innovation and to broad enterprise embeddedness could be viewed as a multifaceted, cumulative process of diffusion of new technological activities including associated management and organisational routines\capabilities; of new technologies; and even of new strategies of business enterprises. The process is close to Metcalfe’s broad view of the diffusion of technology which -following Layton’s view of ‘technology’(which includes artefacts, skills and knowledge components--see Metcalfe 1988, 1994). This is a broader set of processes than those underlying most artefact-focused diffusion models. The knowledge (and, to some extent-skill) aspect of diffusion in this paper is the *cumulative, collective*

learning to rest which accompanies a successful transition to a more complex and open national system of innovation. This is experience-based knowledge which straddles across technologies, sectors and types of enterprises. It plays a central role in enhancing the awareness, articulation of needs and absorption capabilities of enterprises in the business sector, both in regard to the general (largely organisational) aspect of restructuring and in regard to the specific, technological, aspect. The information sets facing the agents, which are relevant for their adoption (here innovation \restructuring) decisions, are definitely not exogenously given but depend endogenously on the diffusion process itself.⁵⁶

This diffusion *policy* perspective to enterprise restructuring that emerges -- seems to differ from other perspectives developed in Europe during the nineties (see "Oslo Manual" in OECD 1992, Soete and Arundel 1993, the Green Paper on Innovation -EC 1995). Soete & Arundel analyse the main characteristics of an integrated and systemic view of innovation and diffusion processes and then proceed to derive sets of relevant policies linked to each of these characteristics. Each set follows from a particular feature of the innovation\diffusion process (Soete and Arundel op. cit. Table 4, p.38). My contention is that additional insight might be obtained by utilising a broad 'diffusion of enterprise restructuring' perspective such as the dynamic policy perspective presented here.

Policy Implications

General

The basic outlook of a successful or "full" transition process establishes the need to act simultaneously in two distinct directions: (i) "direct" stimulation of innovation (the term used in the paper-"restructuring"- is broader than at least a narrow definition of innovation) and (ii) enhancement in the "supporting structure" (Lipsey and collaborators) or in the infrastructure supporting innovation (Justman and Teubal 1986). Correspondingly, NSI policies belong to two categories: horizontal policies and targeted policies. *Horizontal Policies* directly provide incentives to enterprise restructuring and contribute to generate the knowledge which links the restructuring experience of advanced firms with those of imitators and laggards (and also similar links among follower enterprises); while—in this paper-- targeted policies stimulate emergence of new collective organisations and technological infrastructure which supply novel inputs for the specific aspects of enterprise restructuring. *Targeted Policies* reinforce innovation \restructuring over and beyond what would be achieved without policy or by applying horizontal policies which directly support such activities.

Different countries--in response to the changes in the environment-- may have to undergo different forms of restructuring, and these may imply the need to re-orient or create different types of infrastructure or supporting structure (e.g. a venture capital industry in some cases rather than new forms of technological infrastructure like in this paper). But still, most countries will need a certain mix between the two broad categories of activity and of policies. This suggests that there might be some useful implications of the paper even for instances of advanced industrial nations (or for regions or particular sectors within such countries). For example, it may be futile to consider "innovation policy" separately from "technological infrastructure" policy or policies directed to other elements of the structure supporting enterprise innovation. Moreover, that there are critical issues of design, timing and co-ordination of the various programs \ policies which have to be solved in order to generate a

⁵⁶ The notion of 'artefact' in this model should include both new technology \inputs and new organisational routines. It follows that the 'knowledge' aspect relates to the interface between adopters and their characteristics on the one hand and the characteristics or configurations of the various kinds of technological and organisational 'artefacts' on the other.

cumulative process of restructuring. This paper suggests lines of reasoning which may help to tackle some of these issues in various contexts

The dichotomous policy and enterprise taxonomy suggests the possible existence of biases in the technology policy portfolio of countries (*activity* bias and *enterprise* bias). Thus a country may have a bias favouring enterprise innovation over policies promoting the technological infrastructure; and simultaneously having an anti-diffusion bias in the sense that both policies supporting innovation \ restructuring directly and policies promoting the supporting structure are focused on innovator enterprises rather than on follower enterprises. In my opinion, this type of analysis of biases in technology policy is potentially applicable also to advanced countries.

Achieving Cumulativeness

Viewing the transition as a cumulative process is one ‘evolutionary’ feature of the framework presented in this paper. Technology policy should contribute to generating effective links between *early experience* in diffusion (or in restructuring) of advanced, Schumpeterian firms, and *subsequent restructuring* of imitator and laggard enterprises. This presupposes emergence of a more or less codified body of *knowledge* about this process, one that could be easily and efficiently accessed and implemented by a variety of economic agents. It also implies implementation of an effective *sequencing* of Innovation \ Restructuring programs -horizontal programs directed to business enterprises. Each such program should be focused on a particular segment of non-restructured enterprises; should be implemented at a particular phase in the process; and should make use of the experience accumulated in previous programs. Effective program sequencing (for true cumulativeness and broad diffusion) requires that the experience of previous programs be codified and systematically transformed into a body of knowledge about restructuring (collective learning)⁵⁷.

Promoting Diversity and the Role of Horizontal Programs

A policy implication raised by Soete and Arundel in view of the “uniqueness of the development & diffusion process of each innovation “ is the need to find a balance between a range of specific programs supporting diversity and more general policies (Soete & Arundel op.cit.). This fits well with the set of policies considered whose objective is to generate enterprise restructuring which is the source of variety in the paper (since variety enhancement is a major objective of Evolutionary Technology Policy the objective of achieving restructuring fits very well with such an objective). A mix between horizontal and targeted programs is generally required for this purpose, since as mentioned, restructuring requires both the promotion of innovation directly and the promotion of the supporting structure. Moreover, by setting the analysis within a systemic and dynamic context it is possible to clarify further the requirements for effective variety enhancement. For example, the mix of targeted and horizontal policies and the nature of the programs in each one of these categories will have to vary through time in response to changes in economic conditions brought about by the policies themselves. Thus, along a successful transition of NSI it may be important to shift targeted policies from a focus on building new technological infrastructure to one of building new markets; and the enterprise activities selected for promotion by means of horizontal policies may have to shift from R&D (including associated management routines) to product design and \or the absorption of new technology.

In addition our policy framework clarifies the nature and role of horizontal restructuring policies (HRP) and their role in generating variety. Their importance has been underestimated

⁵⁷ An aspect of this process of knowledge creation and diffusion is the generation of pools advisors and consultants to the business sector. This has not been made explicit enough in this paper.

in the past due to the focus on specific technological development\diffusion programs (given the inherent specificities of technology).⁵⁸ . First a reminder on the nature of these policies. HRP stimulates adoption and diffusion of new technological activities such as R&D or design (including the new management routines or organisational forms) across sectors and technologies. Horizontal programs are of *flexible application* i.e. they may cater to different restructuring needs of firms even in the context of a single program⁵⁹; and, while open to all firms, they are *focused* at each phase to a different segment of the business sector.⁶⁰ In evolutionary terms horizontal policies play an important role in the system of innovation by representing *new mechanisms to promote variety* (through restructuring) after the strengthening in the selection environment of the country-- that follows the processes of liberalisation, globalisation, and openness to the technological revolution-- has made variety enhancement a critical component of survival and growth. More specifically, horizontal policies provide opportunities for the successful transformation of firms whose characteristics are not detectable a-priori by policy makers (and which therefore could not, at least in an early stage, be catered by a distinct program). Fundamental uncertainty about the sources of new variety would seem to justify the need for horizontal programs both in respect to the restructuring of incumbent firms and for the promotion of entrepreneurship and new start ups.⁶¹

A major weakness of the paper is absence of an explicit mechanism of selection and absence of an analysis of the selection process itself - both of which are due to the appreciative mode of analysis adopted. Despite this the elements of what could be considered "evolutionary competition policy" (Metcalf 1996) do exist: rules, promotion of variety, and the promotion of technology support systems. The last two have already been considered since they represent the core of the policy analysis of the paper. On the other hand, the change in rules e.g. openness to competition by foreign firms, implicitly underlies our analysis since they lie at the source of the need to change the national system of innovation. By focusing on the transition process, this paper has implicitly assumed a change in the rules of competition (moreover, frequently countries in an open international system cannot effectively control many of the rules which govern competition at home). Formal analysis will have to consider this explicitly.

Another major challenge of future work is to consider the policy implications of other sources of variety among firms in the Business Sector e.g. related to economic sectors and core technologies. This will undoubtedly alter the balance between horizontal and targeted policies. The insights obtained may help bridge the gap between "theory" (in this case, appreciative

⁵⁸ In previous work (Teubal 1996, 1997) I mentioned the underemphasis given by neoclassical and evolutionary economists alike on Horizontal Technology Policies (HTP). There seems to be a common reason for underemphasis of horizontal policies, one that is probably misplaced once one recognises both the fundamental uncertainty surrounding innovation\diffusion and ignorance of policy makers.

⁵⁹ Such a flexibility has characterised the New Technology (NT) Program for Northern Norway, a successful regional restructuring program (Step, 1996). Thanks to K. Smith for having pointed out this feature.

⁶⁰ Initial focusing of horizontal programs to an advanced or Schumpeterian segment of firms is a central feature of the policy framework of this paper. The NT program was directed to innovative firms only and in a second phase a subset of focal firms was picked out for special treatment. It could be justified in terms of identifying potential for generating dynamic effects and thereby generating the cumulative process mentioned above in the text. Note that the shifting enterprise target also implies a change in the structure of the activities or functions promoted, in the incentives provided and in other related actions. I should also mention that firms' focusing within an horizontal program could be based on general criteria for participating in Government Programs and thereby is consistent with programs which are open to all firms. It should not be confused with a policy of supporting national champions.

⁶¹ Thus, horizontal programs could be viewed as supporting the random component of variety while targeted policies would support the systemic component. See Nelson 1994.

theory) and the practice and practical needs of industrial -technological policy promoting the transition of National Systems of Innovation.

ANNEX 1; SUMMARY DESCRIPTIONS OF POLICIES

1 Examples of Horizontal Restructuring Policies (HRP)

1.1 Phase 1-aimed at Advanced Firms

Assumptions: Awareness of need to restructure and fairly widespread R&D. Also the beginning of a new strategic outlook in many firms and new forms of organisational learning. Despite autonomous restructuring activity there are widespread institutional constraints and market failures blocking effective and full implementation of the process.

Functional areas supported(one or more)

- Search and introduction of search function
- Enterprise R&D and product design
- Cooperative, precompetitive R&D
- Precision manufacturing and new process technology
- Export marketing
- Organisational learning and introduction of sophisticated new routines & processes
- Generation of distinct, dynamic capabilities
- Links and Collaborations (Universities, Government Labs, Technology Centers; other firms)

1.2 Phase 2- aimed at Potential Imitators

Assumptions: Some awareness but lack of capabilities to undertake change. R&D is not widespread; and pervasive market failures in innovation and in introduction of new routines. Also, very strong failures in connection with the diffusion of new technology (and associated routines)

Functional Areas Supported (one or more)

- Search
- Links with new external sources of technology
- Utilisation of external consultants
- Links with Technology Centers and Universities
- Networking with other enterprises
- Technology Transfer and Absorption (including training)
- Product Design and Enterprise R&D
- Organisational Learning (greater emphasis than for advanced firms, especially of less sophisticated capabilities)

1.3 Phase 3: aimed at Laggards(mainly SME's)

- *Major Functions only weakly covered in previous phases*

Training,preparation of business plans, diffusion of basic management techniques (managing cash flows, inventories etc) and organisational routines.

- *Consultancy*
Stimulating the emergence of a specialised consultancy segment and market to help articulate demand (importance of geographical and cultural affinity); promoting links with consultants and with external sources of information and advice.
- *Networking with other enterprises*
- *Enhanced support of technology transfer and absorption*
Incentives, information, and technical back up.
- *Special Financial aid* (to compensate for inherent capital market imperfections)

2.Proactive Diffusion Policies(Specific new inputs)

- requires technical back-up to users
- The TC should identify and adapt right configurations of service for each user type building demand through learning by interaction and adaptation)
- involves also strong incentives to use new technological services

3.Market Building Policies

- involves building demand (see above) and building supply
- building supply through training of new consultants, spinoffs of TC personnel, making existing equipment available to consultants, etc.
- pursuing a positive social profit policy despite potentially negative private profits .

4.Networking etc Policies(for Laggards and Imitators)

- Collaborative search for new information on markets and technology
- collaborative search for new orders and collective division of labour in producing commissioned orders
- collective transfer and adoption of new technology
- developing problem solving capabilities collectively
- provision of information, coordination and institutional help
- incentives for creating and maintaining a Secretariat for each network.

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