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Technology and Specialisation: Strategies, Options and Risks

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Technical change and innovation have been powerful engines for enhancing 'dynamic' specialisation advantages of firms and industries and constructing 'differences' vis-à-vis competitors, achieving cumulative growth, rents and power. In a period of crisis, specialisation strategies can be conducted in ways that also enhance innovative specialisations and competitive advantages in the post-crisis period, facilitate repositioning strategies and underpin answers to severe global risks (e.g. energy shortage, climate change).

Specialisation strategies are based on technical change and innovation and they contain options and policy risks. Therefore, strategies have to consider the heterogeneity of research and technology specialisation patterns in the EU as well as divergent policy goals. Also, a distinct and adapted strategy is required responding to the related risks and opportunities. Eventually, the policy action should consider a risk management approach and draw on the concept of '"portfolio management" adjusted to RTD policies.

1. The heterogeneity of research and technology specialisation patterns in the EU, and policy goals

The lagging position of the EU in frontier technologies coupled to its internal diversity resulting from the different research and technological capabilities of its member countries are at the origin of many policy concerns at both the E.U. and the national level.

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In fact, the EU's position in emerging technologies is likely to replicate the experience with ICT and bring Europe once again in the position of a laggard. It appears that there is a structural barrier preventing Europe to become leader in emerging frontier technologies. In many areas European technology advancement appears to be comparatively either "too little" or "too late". What is the policy lesson? Is it possible to reverse this trend and how? Can either a positive or a negative answer be given at zero social cost or risk? If not, what are the policy implications?

External and internal divergences justify different mixes of approaches to specialisation rather than one-size-fits-all strategies. The EU's strategies are focusing on three major challenges:

- to make the EU "the most dynamic and competitive knowledge-based economy in the world",
- to narrow internal discrepancies and enhance convergence, and
- to deal with global risks and prevent large systemic risks in areas of major public concern such as energy and climate change.

However, issues to be dealt with are not only technological. They are more complex, linking effective governance, coordination of research and technology policy, knowledge building and the shaping of productive processes. In addition, knowledge and technology factors are not related to specialisation in a linear way, making the game of who can create competitive positions complicated. In fact, technology factors are integrated into the different parts of the complete value chain of firms in very different ways. The success depends on how technology inputs interact with very diverse locally available labour forces, capital or other inputs and, in particular, the prices of these. The reality shows that firms can achieve diverse combinations between technology and the various elements of their value chain and construct very different and unpredicted specific or niche competitive advantages.

2. Three different strategies

Different goals call for different technology- and innovation-related specialisation strategies. Three main strategies can be identified:

a) Strategies for technological leadership (strategies aiming at the frontier),
b) Catching-up strategies for (fast or slow) followers,
c) Preventive strategies to address global risks.

The implementation of all three types of strategy can take a more targeted (pro-active) or a more neutral (re-active) form. In particular, strategies to enhance specialisation in emerging technological fields (type a and b) raise a dilemma between selection and non-selection in the policy-making process. It can be argued that the goal to aim at the frontier and to address global

challenges seems to favour a policy mix with more pronounced targeted approaches, while catching-up strategies call for rather more horizontal policy mixes. However, it would be misleading to consider specialisation policies in absolute and/or dichotomic terms. In fact, even neutral policies include selections. What determines the success is the pragmatic mix between active and neutral approaches and the interactions between policy and its environment. Additionally, the more technologically advanced the environment is, the more these strategies coexist within the same national space, as they serve the parallel goals of the same actor.

In addition to the production of technology, specialisation policies should also give emphasis to diffusion aspects, which are often underrated. In the presence of weak trickle-down mechanisms, new technologies and knowledge will have a limited success in leveraging new specialisation, competitiveness and growth. Diffusion of technologies, for different reasons, is crucial for both, convergence strategies and strategies aiming at the frontier.

(a) Strategies aiming at the frontier

The rationale:

- Early specialisation in emerging technological and the related productive areas leads to significant benefits of both economic and non-economic nature,
- Frontier technologies develop over many decades and historical experience shows that rarely, if ever, such technologies can develop without strong public support mechanisms,
- Risk-aversion policies leading to latecomer positions in core technologies often have adverse implications for growth, employment and competitiveness, which last for a long time, are difficult to reverse and affect economic and social performance.

The dilemma: Specialisation strategies aiming at the frontier unavoidably raise a selection dilemma: which areas to enhance? The Lisbon strategy implicitly calls for policies to develop capabilities on those scientific and technological trajectories, the dynamics of which drive forward economic growth and welfare. Hence, the various high-tech areas (and, selectively, for medium to high-tech) implicitly occupy a central place in the implementation of the Lisbon and ERA strategies. In fact, various thematic areas and other initiatives constitute significant priorities of the Framework Programme or of the EU's broader research and technology policy.

The risks: Technology and innovation policies along these directions imply different risks. Policies aiming at frontier technologies face increased risks because of weak path-dependencies. The high uncertainties for private

actors in such situations can make intervention appropriate, but not necessarily any less risky.

The options: To deal with such risks, policy could be structured along three broad axes:

a) To target 'winning situations', by leveraging the success of clusters of market players in particular technological, knowledge and specialisation areas, based on market-led pre-selection, the evolving market evidence and in cooperation to market agents. What matters is to spark and to underpin a self-sustained cumulative development of new specialisations.
b) To broaden the policy spectrum by "evolutionary targeting"[2], in the sense e.g. to assure a critical mass of capable market agents, to target the emergence or to leverage the success of new multiagent structures (or clusters) in particular areas, and
c) to combine a) and b) with smart policy initiatives and specialisations.

The concept of smart specialisation[3]:

- indicates a successful fine-tuning of policies envisaging the creation of innovative competitive units, clusters and/or regions,
- implies interventions and, hence, some explicit or implicit targets coupled to an intended concentration of resources in some form,
- makes necessary financial support mechanisms, which can generate extensive positive social externalities in the future,
- assumes that there are criteria to judge which specialisations and, consequently, which policy targets are smart.

The weak point is that, in particular regarding new technological areas, smart policies can be acknowledged as such only after their success becomes visible, while ex ante it is very difficult to define success criteria and to assess the combined outcome of market and policy processes.

b) Preventive strategies to face global risks:

In this phase, societies are faced with the need to develop technological solutions for dealing with qualitatively new global risks (climate change, energy, environmental issues), which enter more and more in the world

[2] Avlimelech, D., and M. Teubal (2008), "Evolutionary targeting", Journal of. Evolutionary Economics, 151-166.
[3] D. Foray, 'Les nouveaux centres mondiaux dans le domaine de la recherche et de l'innovation: vers une economie de la spécialisation intelligente (FutuRIS, 2008)' and 'Understanding "smart specialization" (July 2008)'.

agenda[4]. The crisis accelerated this process. In fact, what is at stake today for leading actors differs from the race to create new knowledge as an engine for growth? The difference is that there is an urgent social demand to find solutions within predetermined time limits, if social costs have to be kept within an acceptable range.

One difficulty is that in the case of expected global risks it is inherently difficult to have an ex ante measure of what is success or failure. How to measure future costs and benefits e.g. from the development or not of alternative energy technologies? Nevertheless, policies of selection and risk taking are necessary - 'non-selection' will also have risks and costs. The risk of inaction or of delay in the support of advancing critical technologies could be larger than the cost of action. It could be significant in terms of growth, income, employment, competitiveness, market positions and environmental degradation. It could have adverse economic and social effects nationwide and EU-wide.

In such a blurred landscape, a significant difference between more targeted and neutral specialisation strategies might be that for the latter, broader systemic failures to meet timely major risks, can become a certainty rather than being only a probability. The issue is that additional criteria for decision making are necessary, but of which kind?

c) *The catching-up and the convergence issue*:

In contrast to advanced technology systems, the absence of co-evolutionary processes between technologies, institutions, business activities and public policies in technologically weaker players increases the policy risks and uncertainties, in particular in the case of more targeted interventions. Equally, in weak technology systems the cause-effect relationship between specialisation and technological mastery is reciprocal. For technology specialisation to be transformed into competitive advantages there is also need of a sufficient level of expertise over the broader scope of the related technological base. Hence, while the weak market signals increase the unpredictability of where it might be good to specialise, policies regarding followers should be flexible, gradual and avoid the risk to prevent or to deter efforts to build capabilities and specialisations in promising fields.

Notwithstanding successful examples, horizontal policies appear to be a less risky approach for technologically weaker systems. They generate decentralised selection mechanisms, learning processes and a diversification of specialisation patterns, while they also facilitate innovative forms of combinations between technological knowledge and local factor capabilities.

[4] "European research policy … besides the pursuit of scientific excellence, should support knowledge advancement and dissemination and underpin policies … in fields of major public concern such as health, energy and climate change" (ERA Green Paper).

From a different perspective, however, EU's strategic choices regarding frontier technologies or technologies targeting global risks should avoid restraining followers from developing new capabilities for these countries' technology areas. Technological evolution and application are non-deterministic and even what appears as duplication often creates diversity and distinctive capabilities and/or new opportunities. In other words, although targeted policies can be appropriate in a positive sense (e.g. to support the acceleration of technological advancements), they can have adverse effects if their consequence is to raise barriers, to concentrate resources in leading areas, to exclude certain actors, to limit windows of opportunity, the building up of new capabilities or the development of specialisations of followers in promising technology areas.

3. What are the choices and how to deal with the risks?

Frontier research is not a question of the spending as a percentage of GDP but of having smart goals and policies as well as appropriate, absolute amounts of financial and human resources. Evidence shows that voluntary top-down approaches have often failed, but also that neutral policies often have a failure cost, but that this is less transparent. The success of both, target-related and neutral strategies depends largely on the articulation of the policy mix and the definition of the objectives.

Faced with these different asymmetries of information, risks and opportunities, policy making can be addressed as a risk management issue drawing on the idea of *'portfolio management'*, adjusted to RTD policies. Portfolio management approaches favour variety and selection mechanisms. It can reduce risks and assess the multiple research and technology objectives on the basis of such criteria as financial cost, probabilities of success, externalities and/or social costs and benefits. The question is how to shape targets and choices, to better reflect a politically decided balance of policies, social risks and benefits. In view of the three major EU challenges the question are: if and what new policy concepts have to enrich or to enhance the existing policy-making process, and how policy could better succeed in organising a flexible and diversified framework and implementing specialisation targets.[5] Success is determined by the co-evolution of a range of elements, such as:

- An appropriate coordination at European level of public organisations, business firms and research communities,

[5] Pro-active policies at the EU (and national) level can aim at a 'research friendly ecology' (Georghiou, 2007), combined selectively with a 'cluster-specific environment'.

- The design of priorities on selected areas and a package of policies to support the research activities of firms and organisations and to cooperate closely with the business sector and the scientific community in detecting needs, capabilities, technological trends, key discoveries, possible advancements,
- For the evaluation of success, the selection of priorities as well as other policy strategies has to consider externalities - positive as well as negative ones - like climate change, energy supply and environment issues. Within the concept of portfolio management, the effects of these externalities have to be explicitly taken into account,
- The broadening of criteria on the basis of which the success of research and technology specialisation policies can be assessed,
- The enhancement of variety creation and the selection and support of differentiation elements vis-à-vis competitors.

The ERA can facilitate the development of a range of high-tech milieus with internal and external interactions, linkages with business partners, public research organisations and communities of joint research and technology targets. Such poles of excellence could support the promotion of emerging new technologies with crucial economic and/or social implications. The development of such high-tech milieus is justified from the critical mass of resources (financial and human, physical and soft infrastructures) which are needed but cannot be provided in the framework of existing policies at lower levels of governance. In such a way, the ERA can enhance research and technological change, enabling both the leveraging of continuous change, adaptation, and competitive strengthening of industrial structures as well as the unfolding of emerging new technology fields.