EUROPEAN COMMISSION / European Research Area / Social sciences & humanities

EUROPEAN POLICY BRIEF

Policy Incentives for the Creation of Knowledge: Methods and Evidence (PICK-ME)

Policy Incentives for the Creation of Knowledge, an EU-funded research project exploring the key role of public demand in innovation policies aimed at fostering the multifaceted dynamics of technological knowledge

June 2011

INTRODUCTION

Demand and innovation to cope with the crisis

The ongoing global economic crisis has seriously affected the performances of European countries, raising huge challenges to reach the target of increasing growth and competitiveness. Indeed, in the last year the Gross Domestic Product (GDP) has fallen at dramatic rates, creating the conditions for the upsurge of unemployment, above all in areas characterized by specialization in mature industries.

The efforts to achieve the objectives stated in the Lisbon Strategy can be particularly important in such situation. Indeed, the full implementation of a structural change process directed towards the establishment of the knowledge based society can help economic systems to recover from the dramatic effects of the recession, by creating new jobs and prospects for future sustainable development. A well articulated innovation policy may represent a key condition for countries to undertake a sustained growth path. However, the bulk of innovation and technology policies has been mainly designed by relying on a supply side perspective. In view of this, technology policies have mainly focused in contributing the creation of knowledge by providing funds to carry out R&D activities and by enhancing education and training for researchers.

The demand-side has instead long been neglected in innovation policy. Much effort is now devoted to raise awareness among policy-makers and the business community to the potential of public demand for innovation, above all with respect to the potential of Lead Markets for the innovativeness and competitiveness of Europe.

COOPERATION

This project PICK-ME has received funding from the European Union Seventh Framework Programme FP7/2007-2013 under grant agreement SSH-CT-2010-266959.

KEY OBSERVATIONS

The structure of knowledge interactions: a multilayered approach

In order to improve the understanding of demand-oriented innovation policies and the mechanisms of knowledge creation we firstly need to improve the characterization of innovation dynamics that will provide the basis to the design of policy measures. The rationale for traditional policies on the supply side essentially lied in the need for coping with market failures deriving from the inherent informational character of technological knowledge. Evolutionary based policies are instead characterized by an excessive trust on technological trajectories and a static view on the systemic ties among the wide set of innovating agents.

The recent efforts to apply the basic tools of complex system analysis to social sciences and to implement an actual economics of complexity may be particularly helpful for the purposes of the project. This frame recognizes the central role of innovation, both as the key explanandum and the basic explanatory variable in understanding the social and economic dynamics of a system. It actually assumes explicitly that innovation is the basic engine of the dynamics of social and economic systems. Innovation takes place in organized contexts characterized by qualified interactions among heterogeneous and creative agents that are able to act intentionally to innovate to face the risks of decline and take advantage of new opportunities. The outcome of their interactions is determined by the structured contexts into which they are embedded. At the same time however their actions and interactions do affect the structure of the system and hence ultimately the aggregate outcomes of the dynamics. In this approach neither interactions nor the organized structures into which they take place are exogenous, as they are determined internally by the dynamics of the system. The individual and intentional action of creative agents is central in the dynamics of the system, yet no individual agent can claim responsibility or even long-term sight on the eventual results of his or her action (Arthur et al,1997; Lane et al., 2009).

By acknowledging the inherent complexity of innovation dynamics, this approach would provide the background for the development of an extended and integrated framework for the analysis, assessment and design of demand-driven innovation policies. Particular emphasis will be given to the concept of coalitions for innovations. According to this view, innovation takes place when effective coalitions based on the purposed convergence of the incentives, the structured complementarities of the competences of a variety and multiplicity of heterogeneous actors, and the aligned and mutual directedness of their interactions emerge so as to enhance the cohesion of the group and organize the inherent complexity of the system around a common goal and shared objectives (David and Keely, 2003).

The case for an articulated and multi-layered demand-driven innovation policy then emerges. Most of the existing demand-oriented innovation policies has indeed exclusively focused on the identification of key industries or technologies able to address explicit or latent societal needs. However, the luckily ex-ante identification of successful technologies is not a sufficient condition

to foster innovation-driven competitiveness and growth. Demand-driven innovation policies should aim at the creation of systems of innovations, which should become the objective of intentional decision making at the policy level and of strategic action for corporations with the implementation of centred coalitions around technological platforms able to implement and guide the working of specific coalitions and collective entities clustered in geographical and technological space (Lane, 2002).

In other words, in this approach technological innovations are the outcome of intentional actions. Three dimensions deserve careful attention, i.e. the individual dimension, the systemic dimension, and the dynamic feedbacks between individual actions and the structure of the system in which they occur. This will lead us to frame the analysis of demand-driven innovation policies by articulating their effects on the different components of complex systemic dynamics of innovation :

- Demand and the direction of research and innovation efforts;
- Demand and regional patterns of education and research infrastructure (university-industry relationships);
- Demand and patterns of academic publications;
- Evolution of demand and the dynamics of knowledge-base in knowledge intensive sectors (within and cross sector studies involving ICTs, Biotech and Nanotechnologies);
- Evolution of demand, sectoral development and the organization of innovative activities (integration versus technological alliances or the like);

RECOMMENDATIONS FOR POLICY-MAKERS

The need for a complexity-based approach to a demand-driven technology policy

Innovation and knowledge creation have long been regarded as key factors in the process of economic growth. A well established body of both theoretical and empirical literature has indeed pointed to the key role played by the development of technological knowledge in shaping the competitiveness and the long run perspective of growth of countries.

In this direction, a shared view emerged according to which a well articulated innovation policy represents a necessary condition for countries to undertake a sustained growth path. However, the bulk of innovation and technology policies has mainly been designed by relying on a supply side perspective, which implicitly assumed the creation of technological knowledge as an outcome of a process in which knowledge already available, stemming from past R&D activities, and R&D personnel represent the main inputs. In view of this, technology policies have mainly focused in contributing the creation of knowledge by providing funds to carry out R&D activities and by enhancing education and training for researchers.

The demand-side has instead long been neglected in innovation policy, as policymakers, academics and the business community have mostly emphasized the benefits of supply side strategies. Only recently the debate about innovation policy has gradually begun to focus on the role of demand, both public and private, in spurring innovation and technology creation. Much effort is now devoted to raise awareness among policy-makers and the business community to the potential of public demand for innovation, above all with respect to the potential of Lead Markets for the innovativeness and competitiveness of Europe (European Council, 2006).

The basic tenet of our project is that no demand policy can succeed if it is not coupled with effective policies aimed at supporting specifically the generation of technological knowledge and sequentially the eventual introduction of technological innovations. The poor appreciation of the central role of the generation of technological knowledge for the actual introduction of technological innovation and sequentially for the final growth of output can be considered the main cause for the failure of demand pull policies. Traditional demand-pull policies have been based upon the expectations of the automatic embodiment of superior technologies driven by investments. A demand-pull policy without a clear base upon knowledge and innovation policies may risk to stir just inflation. Demand policy can yield positive outcomes in terms of growth of output and total factor productivity only when and if it is coupled with a sequence of knowledge and innovation policies. There is no chance of success for a demand policy that is not based upon a well focused knowledge policy and coupled with an effective and directed innovation policy.

The Economic Complexity of Technological Change

Complexity is emerging as a new unifying theory to understand endogenous change and transformation across a variety of disciplines, ranging from mathematics and physics to biology. Complexity thinking is primarily a systemic and dynamic approach

according to which the outcome of the behavior of each agent and of the system into which each agent is embedded, is intrinsically dynamic and can only be understood as the result of multiple interactions among heterogeneous agents embedded in evolving structures and between the micro and macro levels.

According to the theory of complexity, emergence is a phenomenon whereby well-formulated aggregate behaviors arise from localized individual behaviors. Innovation can be seen as the combined result of the action of individual and heterogeneous agents with the structural characteristics of an organized system that is able to amplify and make consistent their action. The analysis of innovation as an emergent property of a system enables to combine the individualistic analysis of innovation as the result of intentional decision making of agents with the holistic understanding of the properties of the system into which such innovative action takes place and actually makes it possible.

To investigate the determinants of the actual creativity of agents three steps are necessary. First, the incentives to change must be identified and qualified. Agents are reluctant to change their production and utility functions and a specific motivation is necessary to induce them to try and change their routines. Second, the localized context of action and the web of knowledge interactions and externalities into which each agent is embedded are crucial to make their reaction actually creative, as opposed to adaptive, so as to shape the actual effects of their endogenous efforts to change their technologies and their preferences. Third, the sequential process of feedbacks that make the creative reaction a sustained process must be identified. The creative reaction of each agent in fact is not a punctual event that takes place isolated in time and space, but rather a historic process where the sequence of feedbacks plays a key role (Arthur, 1990).

The analysis of the effects must include, next to the introduction of innovations that increase the efficiency of the production process, the structural consequences upon the context of action. The successful introduction of new localized technologies, in fact, changes the structure of the system and hence the flows of knowledge externalities and interactions. This dynamic loop exhibits the characters of a recursive, non-ergodic and path dependent historic process. This approach enables to move away from the static, low-level complexity- of general equilibrium that applies when both technologies and preferences are static, or the smooth and ubiquitous growth based upon learning processes and spontaneous spillover of the new growth theory. It makes it possible a significant progress also with respect to evolutionary thinking where the causal analysis of the determinants of the generation of innovations is reduced to the random walks of spontaneous variation.

This approach provides the tools to grasp the dynamics of technological change as an endogenous and recurrent process that combines rent-seeking intentionality at the agent levels with the appreciation of the knowledge externalities and interactions that stem from the structural characters of the system.

Innovation as an emergent property

In our approach, innovation is an emergent property that takes place when complexity is organized, i.e. when a number of complementary conditions enable the creative reaction of agents and makes it possible to introduce innovations that actually increase their efficiency. The dynamics of complex systems is based upon the combination of the reactivity of agents, caught in out-of-equilibrium conditions, with the features of the system into which each agent is embedded in terms of externalities, interactions, positive feedbacks that enable the generation of localized technological knowledge, the introduction of localized technological change and lead to endogenous structural change. The process is characterized by path dependent non-ergodicity.

This approach builds upon five basic points:

i. The distinction between ex-ante and ex-post is crucial. Bounded rationality limits the foresight of agents. Economic agents however are credited with the basic capability to react to unexpected changes in their economic environment by changing their technology. Agents try and change their technology when their performances are both below and above their expectations.

ii. Their reaction can be either adaptive or creative. Occasionally, when the context is favorable, their reaction becomes creative and they can innovate. When the organization and composition of the economic structure and the quality of the external conditions add to the characteristics of the individual firms to explain whether, when, how and why their reaction can be either adaptive or creative. The levels of knowledge externalities and the quality of the generative relations that take place in the context into which firms are localized, determine the actual chances that the reaction of firms leads to the actual introduction of innovations.

iii. Their reaction is localized by the irreversibility of their tangible and intangible inputs as well as by their competence based upon learning processes and rests upon the recombinant generation of knowledge that is both internal and external. Innovation emerges as the result of the fertile interaction between the knowledge characteristics of the context and the competence of the individuals.

iv. The introduction of innovations changes the structure of the economic system into which firms are embedded, including the availability of knowledge externalities and the quality of generative relations. These in turn affect the direction and the rate of the economic dynamics. Occasionally, loops of systemic positive feedbacks between structural and technological change lead to the emergence of innovation cascades and Schumpeterian gales of innovations.

v. The interaction between technological and structural change engenders dynamic processes that are non-ergodic because history exerts a strong effect in shaping their dynamics. History matters in influencing the dynamics of economic processes but innovations, introduced along the path, can alter it. History matters, yet small events can change it.

RESEARCH PARAMETERS

Specific Objectives

According to the building blocks of our analysis out-of-equilibrium conditions push agents to react.

Their reaction builds upon localized learning processes. It can lead to the actual introduction of productivity enhancing innovation if and when the local context is structured as an organized complexity where knowledge feedback, interactions and externalities support the recombinant generation of new knowledge and hence innovative effort of firms.

The introduction of innovations is an emergent property of an organized complexity that brings together the individual efforts and the quality of the contextual feedbacks.

The introduction of innovations in turn affects the structure and architecture of the local innovation systems.

New innovation systems emerge and other decline. Resilience and persistence both at the system and the firm level shape the change of the structure of the system and lead to path dependent dynamics.

In order to gain a better understanding of such dynamics, the research project will be articulated in the following tasks:

- To develop a taxonomy of policies to foster innovation, with a particular focus on demand-driven innovation initiatives
- To develop new databases and elaborate new indicators for analyzing and assessing the impact of demand-driven innovation policies at different government levels;
- To analyse the influence that demand has on the introduction of technological innovations when and if the generation of knowledge can actually take place, both from a quantitative and a qualitative viewpoint, including such key issues as the evolution of education and research systems and the location choices of skilled work force and of multi-national corporations;
- To investigate the interplay between demand-driven knowledge activities and the dynamics of both pure and pecuniary knowledge externalities, and how these affect local performances in Europe and the diffusion of knowledge;
- To assess the relationship between the evolution of demand and the dynamics of knowledge-base in knowledge intensive sectors, with a particular emphasis on development and the organization of innovative activities;
- To extract policy guidelines for public administrations practitioners in order to support them in the future design and implementation of innovation strategies at different levels;
- To diffuse the project results to policy makers at European, national and regional level, to promote the efficiency of future policies for the support of innovation activities and regional economic development.

Operative Objectives

These tasks will be pursued by implementing the following activities:

- Detailed modelisation of the impact of both direct and catalytic funding schemes on the rate and direction of innovation activities at the regional, national and European level;
- To develop a public database including detailed information about already implemented demand-oriented innovation policies so as to measure and monitor their influence on innovation activities;
- To develop a comprehensive database concerning knowledge indicators, like patents, publications, skilled labour force, suitable for advanced analyses in terms of research topics and technological fields at various levels of aggregation;
- To provide decision makers with policy recommendations in order to support them in the future design and implementation of regional, national and European demand-oriented innovation strategies. Specifically, best practices and scientific support to policy activities will be provided.
- To disseminate the policy implications to practitioners and policymakers at different government levels (local/regional/national/European), in order to provide them with tools to develop improved innovation policies in the future.

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Funding Scheme

EU 7th Framework Programme
THEME [SSH-2010-1.1-1]
[Demand-driven research and innovation policies for growth, welfare and wellbeing]

Duration

January 2011 – December 2014

Budget

EU Contribution: EUR 1.838.817

Website

http://www.gredeg.cnrs.fr/projets/pick-me/index.html

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