Are innovation systems complex systems?

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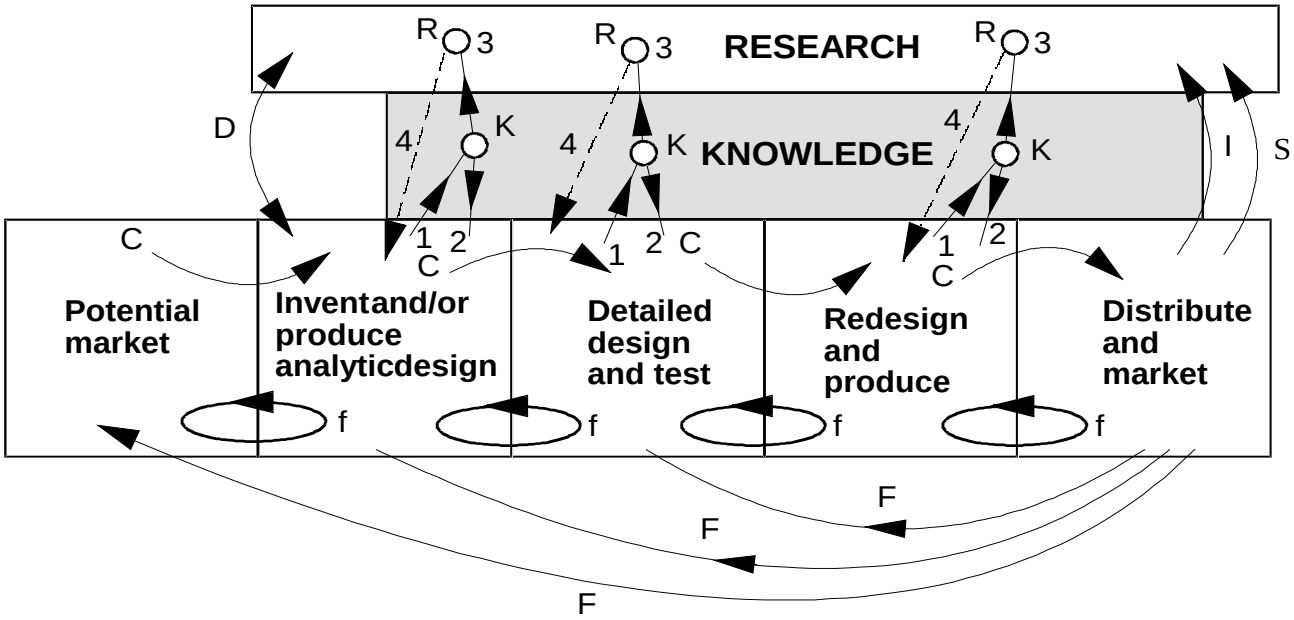
Innovation seen as an evolutionary process

- The “father” of the analysis of innovation in economics is without contest Joseph Schumpeter (1883-1950) who put forward the concept of “**creative destruction**”.
- Schumpeter (1935) distinguishes **five main types of innovation** :
  - (i) new consumptions objects;
  - (ii) new production and transport methods;
  - (iii) new markets;
  - (iv) new sources of production materials; and
  - (v) new market positions (e.g. monopolistic situation).
- This process rules the **historical evolution of capitalism** according to Schumpeter (1950).

Innovation as a complex process : the *chain-linked model* by Kline & Rosenberg (1986)



C	=	Central chain of innovation
f	=	Feedback loops
F	=	Particularly important feedback
K-R	=	Links through knowledge to research and return paths. If problem solved at node K, link 3 to R not activated. Return from research (link 4) is problematic - therefore dashed line.
D	=	Direct link to and from research from problems in invention and design.
I	=	Support of scientific research by instruments, machines, tools, and procedures of technology.
S	=	Support of research in sciences underlying product area to gain information directly and by monitoring outside work. The information obtained may apply anywhere along the chain.

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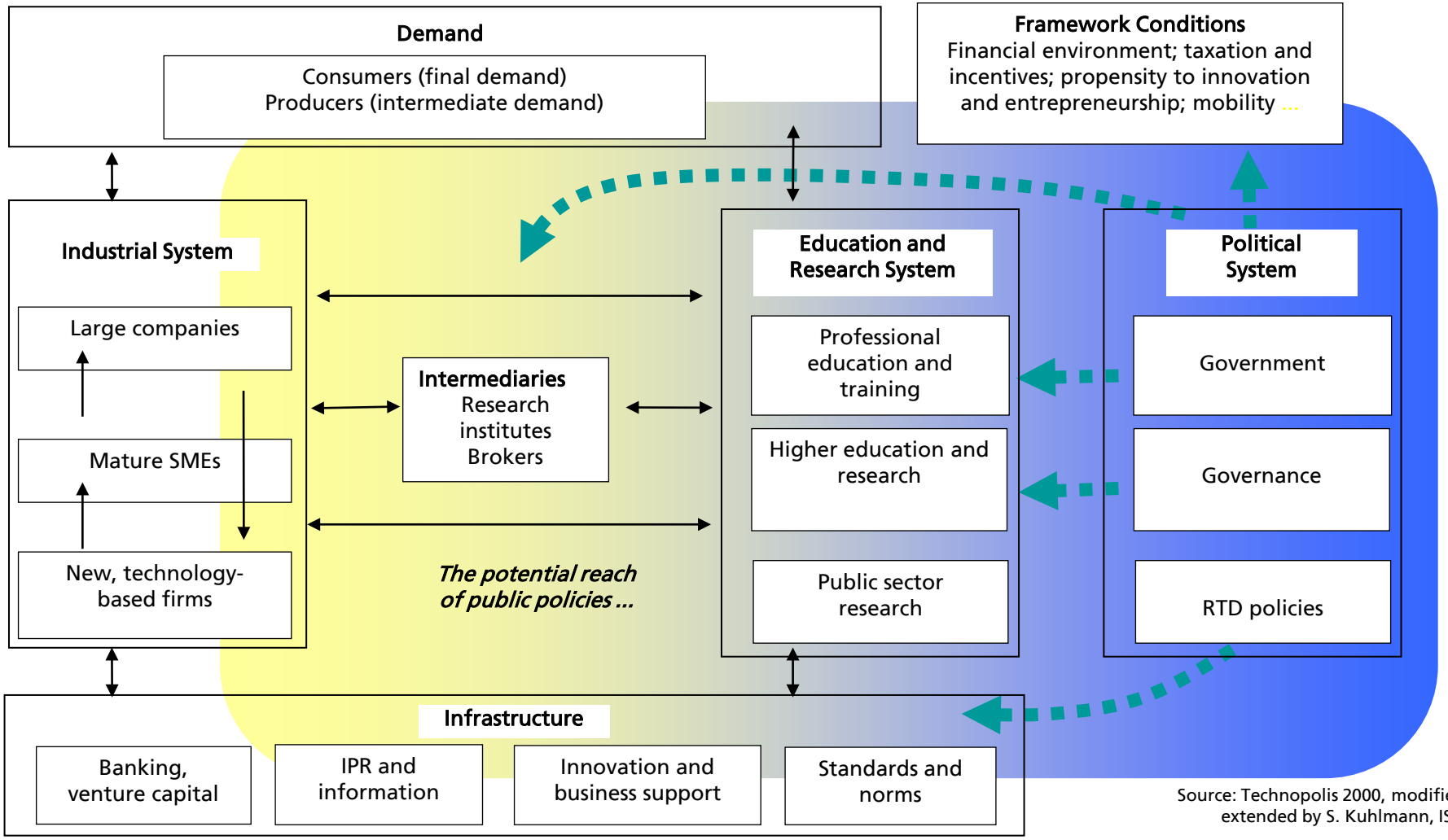
Innovation systems : some definitions according to evolutionary economists

- "(...) *the* ***network of institutions in the public and private sectors*** *whose activities and interactions initiate, import, modify and diffuse new technologies.*" (Freeman, 1987)

- "(...) *the elements and relationships which interact in the* ***production, diffusion and use of new, and economically useful, knowledge*** (...) *and are either located within or rooted inside the borders of a nation state .*" (Lundvall, 1992)

- "(...) *the national institutions, their incentive structures and their competencies, that determine* ***the rate and direction of technological learning*** (...) *in a country .*" (Patel and Pavitt, 1994)

Innovation systems : a heuristic approach



Source: Technopolis 2000, modified and extended by S. Kuhlmann, ISI

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Innovation systems may be complex systems since they are based on complex behavioral patterns

- No firm seems to be able to innovate without interactions with the “outside world”. Innovations appearing as “autarkic may be extremely rare if not impossible.

- A “trial and error” process can be found in every “innovation story” : a “first shot” success may constitute a very unlikely exception.

- Underlying selection phenomena which concern : ideas, production and delivery processes, technologies, marketing approaches, types of collaborations and even actors (e.g. unsuccessful firms).

Innovation systems may be complex systems since they are characterized by non-linear and non-predictable choices

- Strong heterogeneity of actors (e.g. firms, academic institutions, public actors, intermediaries, individuals, etc.) induces a strong heterogeneity of preferences and behaviors.

- In the real world there is no perfect competition (e.g. full availability of information, atomistic markets, unbounded rationality, etc.) such as (neo-)classical economics pretends.

- Within an innovation system, every individual actor builds up its individual model of the “surrounding world” and consequently it can be assumed that ‘elements’ of the system act as best as a kind of ‘crowd’.

Implications for policy making (under the assumption that innovation systems are real complex systems)

- Innovation-supporting policies should focus on issues related to actors' coordination rather than on optimization and efficiency.

- Only holistic innovation policies may be successful in the long-term and policy instruments must aim at providing good contextual conditions, rather than trying to manipulate individual behaviors.

- Due to the non-linearity of innovation processes (which lead to mainly unpredictable events) the incentives mobilized by innovation-related policies should target marginal systemic effects rather than huge changes.

Thank you for your attention

Questions and comments are welcome :

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