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Global Challenges and Policies of the European Union
– Consequences for the "New Member States"

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# MACROECONOMIC DIMENSION OF INNOVATIONS – SELECTED INSTRUMENTS OF STIMULATING INNOVATIVE ACTIVITY AND TRANSFER OF TECHNOLOGY

## 1. Introduction to national innovation system – relations among innovation, technology, science, institutions, economy

### 1.1. Significance of contemporary economics

The authors of the growth theories which are called "endogenous" [Verspagen, Wakelin 1997, p. 183] theories stress that development based on know-how[1] and technical innovations, not on capital accumulation, is the driving force of economy [*Green Paper*... 1995, p. 10; Kotler et al. 1999, p. 32].

Economic growth and technological progress which it implies constitute a process of continuous transformation, not a single adjustment to a long-term way of increase [Verspagen 2001, p. 24]. This transformation is possible mainly due to radical technical innovations which are determined mainly by efficient operation of high-tech sector and lead to structural changes [Verspagen 2001, p. 18]. Constraints of high technological development should not be sought in the access to natural sources, but in "creation" and utilising scientific knowledge and specialist skills [Christidis et al. (eds.) 2002, p. 38]. Therefore, investing in knowledge understood in its broad sense, especially in the fields such as ICT, biotechnologies or

[1] Know-how refers to skills, i.e. abilities to do something and at the same time it is a **knowledge** elaborated by particular enterprise or research team (definition according to B. Johnson and B.-Å. Lundvall, after [Lundvall 1998, p. 417]).

nanotechnologies, which are key fields for the operation of contemporary and future economy, is needed [Christidis et al. (eds.) 2002, p. 184].

The innovation contributes to economic growth by influencing micro- and macrosphere. In the former, it enables entrepreneurs to react actively to customers' needs which are more and more sophisticated. It is the indicator of the competitive position of a company in domestic and foreign markets.

Innovation policy performed in the macro scale entails the increase of employment and improvement of work quality, increase of multifactor productivity and it increases capital accumulation. Countries of the highest economic development owe it mainly to new products, processes and services based on high technologies, which develop due to properly interpenetrated and used knowledge which is a "component" used in production and which is its result at the same time [Arrow 1996, p. 9]. It was calculated that economic progress and improvement of the standard of living connected with it as well as increase of wealth were dependent on capital accumulation only in 13%, whereas the contribution of technology constitutes as much as 87% [Quah 2001, p. 5].

There are many economic theories in which innovation and technology constitute the basis. Depending on the approach, the key role is attributed to research and development works, human capital (knowledge and experience play significant role in this case), the so called "creative destruction,"[2] or public goods and infrastructure [Amable 1996, pp. 21-22]. However, in fact, these ideas merge and reflect sophisticated connections which stimulate economic development.

According to contemporary economy, economic development depends on quality changes, not quantity ones. For instance, the followers of sustainable development adopt such attitude.[3] Technological changes, concerning quality by themselves, constitute a basic impulse which causes further transformations of this type [Gomułka 1998, p. 24]. Entering into further discussion about it, it is necessary to state that limiting to sheer economic reasons for economic development limits the perception of this phenomenon to a vast extent. It is conditioned by something more than expenditure on R&D or more generally, capital investment. For instance, the culture of particular society (which is the source for the way of thinking and philosophy of life), institutions which link people, technology [Verspagen 2001, p. 5] (understood as technical knowledge which is the result of "human skills and abilities and which enables to face new challenges"[Okoń-Horodyńska 1996, p. 106]), i.e. "something" that is not rational for *homo economicus*, play important roles. Technology and

[2] The notion "creative destruction" comes from reflections of Schumpeter, who writes that development is "an impetuous change of circular movement way, which change does not have a continuous character, a disruption of balance" [Schumpeter 1960, p. 14].

[3] E.g. [Schlögl 2001, p. 19]; Jaworski [2001, pp. 326-327] gives examples of practical use of, i.a., biotechnology, nanotechnology, research on energy, materials, computer science in the establishment of economy based on a sustainable development.

institutions are changing as far as time and space are concerned, and what leads to growth in one area of economic activity does not need to lead to it in another [Verspagen 2001, p. 5], or what implies growth in one society (country, culture area) does not need to lead to it in another one. Therefore, treating innovations in absolute terms (as an absolute new novelty worldwide) is not always justified. Technology and innovation depend on particular society, on its experiences, habits, norms and they change together with them. They are also dependent on the readiness to apply knowledge which has been gained previously and on the ability to apply it in "establishing" technological progress.[4] Therefore we come to the conclusion that knowledge (including the technical one) can be common for all societies, however, the way and effects of its application are conditioned "locally". Therefore the following statement is true: "not each way of thinking results in the same level or grade of consideration"[5] and thus development.

### 1.2. Institutions and economic development

"Old" institutionalists claim that "the established norms and principles governing people's behaviour and relations among them, which lead to activities ensuring them the establishment of better and better ways of solving problems in the changing conditions" constitute the institution [Okoń-Horodyńska 1996, p. 105]. The principle becomes an institution when society becomes convinced that it is "the best solution in the given conditions." If so, innovation is also an institution, because it is a norm which sets the direction of world development and at the same time it is a tool for replacing old habits with new ones. When one accepts the arguments of institutionalists it should be claimed that **innovation is an institution** and at the same time it depends on **institutions** in their broad sense.

Required behaviour of economic subjects, as far as technological progress is concerned, can be stimulated (extorted) by private and state institutions (institution as understood by "new" institutionalists[6]), e.g. government departments, which facilitate the flow of information [Mudambi, Navarra 2002, p. 638] and professional knowledge (more generally – communication), they can also establish directions

[4] The view of readiness to use the previously-gained knowledge and skills of using it in "establishing" technological progress. E. Okoń-Horodyńska quotes after J. Pajestka, *Determinanty postępu*, Warszawa 1997, p. 43, see: [Okoń-Horodyńska 1996, p. 106].

[5] *Institutional and Evolutionary Economics*, O.M. Hodgson, W.J. Samuels, M.R. Tool (eds.), Edward Elgar Publishing Limited, England 1994, pp. 302-305. Quotes after: [Gabryś, Okoń-Horodyńska 1996, p. 10].

[6] D.C. North, A. Schotter, R. Sugden, Ph. Mirowski, H. Demsetz, F. Hayek, M. Olson, R. Polsner belong to the so called "new" institutonalists. According to them an organisation (company, government, trade union, etc.) constitutes an institution. T. Veblen, belonging to the so called "old" institutionalists was a precursor of institutionalism (in general). W.H. Hamilton, J.R. Commons, J.F. Mitchel developed his ideas.

which support development of a scientific and technical idea (e.g. through legal protection of intellectual property, financing/co-financing R&D activity from public funds, educating skilled staff). The active initiative of state is justified in this scope, in particular due to disparities in the access to specialist knowledge and information as well as concentration and internationalisation of private research and development "industry," which eliminates small and medium-sized enterprises (which often have innovative ideas) from participation in this intellectual race. However, it should be stressed that globalisation is a desirable phenomenon for innovative processes, since it precipitates the change of scientific and technical idea. The state's task is to enable access to the results of research works to enterprises which are not able to conduct such activity themselves for various reasons. The state should also support participation of small and medium-sized enterprises in research and development projects. The role of the state in establishing the network of links facilitating development of innovative entrepreneurship is a prerequisite. Many innovations are of system nature [Wysokińska 2001, p. 118], and efficient communication and cooperation facilitate and precipitate their establishment.

## 2. National innovation system – further outline of a conception

National innovation system (NIS) is "a construction encompassing all institutional and structural factors which are linked with one another in the national economy and society, which jointly and individually generate, select and absorb technological innovations" [Okoń-Horodyńska 1998, p. 79].

Probably the aforementioned definition describes the concept of the national innovative system in the best way since it places emphasis on the dynamism of interactions taking place among three key elements of economy: society, institutions and innovation. It can be said that NIS is an attempt to understand sophisticated, chaotic and unpredictable relations taking place in economy and willingness to tame them in order to implement high quality characteristics to it. It seems that state is a subject which is able not only to initiate its establishment but also to manage it effectively (from the point of view of long-term investments) [Michie, Prendergast 1998, p. 404].

Through the participation in national innovation system, the state activates and allocates adequate resources in such a way as to reduce the risk of taking up innovation activity by economic entities [West 2001, pp. 24-25] and neutralises possible conflicts [Okoń-Horodyńska 1998, p. 43]. However, there is no single universal model of national innovation system, which could be transplanted from one country to the other. Each economy has its own principles, therefore one should have individual attitude to the NIS concept, and the two-dimensional nature should be taken into account at the system construction: national and cultural one (which is strictly connected with human factor – system of values, culture, etc.) and

an etatistic and political one (connected with the model and structure of authority). "The construction of the system, which would enable to focus endeavours of all entities on the implementation of objectives within particular strategic area, requires the establishment of cooperation between state institutions and private enterprises in such a way so that efforts of both of them complement each other" [West 2001, p. 25].

Ch. Edquist lists basic processes which occur in innovative systems. They are the following [Edquist 2003, pp. 17-19]:

1) research and development activity, creation of new knowledge, in particular in engineering, medicine and natural science,

2) developing employees attitudes which facilitate innovative and research and development activity; promoting attitudes of constant education, enabling improvement of professional skills, etc.,

3) looking for completely new trade areas,

4) paying more attention to matters referring to products quality,

5) creating new, and transforming the existing organisations stimulating development of innovative attitudes as e.g. entrepreneurship, constructing new research and development entities, etc.,

6) networking,

7) establishing the following institutions – intellectual property right, tax and environment protection law – which contribute to catalyzing innovative processes and changing those which slow them down or limit them,

8) incubator activity – ensuring access to proper infrastructure to entrepreneurs who perform innovative activity,

9) financing activity which enables to assimilate and commercialize new knowledge,

10) consultancy services, in particular technological and legal advice, transfer of technologies, etc.

### 2.1. Science and R&D activity and formal and informal connections between science and industry

There is no doubt that knowledge is the basic element of innovative activity, since it creates new foundations, new technologies, through which the needs of consumers are met and the principles of markets operation change. Therefore, contemporary attitude to the NIS concept pays a lot of attention to science and research and development works. Particular business entities are guided by various reasons and they do not always realise the established economic (macroeconomic) objectives of strategic nature. For instance, it is not easy to convince private investors as far as incurring expenses for long-term, risky undertakings of innovative nature is concerned. Basic research does not enjoy popularity, since does not lead to specific technical solutions. From the point of view of the whole economy, this activity is needed as theoretical and mental work broadens the scope of knowledge,

which at particular moment is probably perceived as having too few values, however, within a longer period of time, accumulated experiences will support the activity of taking new challenges. The state must take the responsibility for this activity. Public expenses for research and development will be profitable – rate of return totals 56% (the so called social benefits). For comparison, rate of return from development outlays incurred by private sector amounts to only 25% [Sawyer (ed.) 2001, p. 177]. Main arguments for the state's participation in this type of activity are benefits generated by it to the whole economy: the aforementioned increase of knowledge, training and further development of graduates from universities, creation of new research tools and research methodology, establishment of a network of connections and cooperation (including interactions with society), setting new companies. However, it does not mean that the state should not encourage a non-public sector to participation in research projects, quite the opposite. Private enterprises should be engaged especially in further stages of research works. There are at least two reasons for that. First, entrepreneurs are more willing to participate in projects in relation to which the certainty of profit realization is higher. Accuracy of estimating risk, costs and possible income is higher in case of experimental and applied research, therefore the cooperation of industry with research entities should be directed towards it. Secondly, in the majority of cases, academics do not have knowledge and experience which is necessary to estimate commercial success of a particular technology. There are a number of other arguments which are in favour of this type of cooperation [Lambert 2003, pp. 23-24]: enterprises' access to the results of interdisciplinary works of research teams, to which they did not have access due to high costs; the increase of research capital owing to the possibility of financing research from public funds (the majority of research entities operate by state universities); risk dispersion.

Formal connections science–industry, such as: common laboratories, spin-off companies, research contracts and common licence initiatives constitute a small percent of the total cooperation forms. Industry more often cooperates with science through the use of informal connections from which professional knowledge of practical and commercial "tinge" arise [*Benchmarking Industry-Science*... 2002, p. 22].

### 2.2. Selected tools stimulating public and private innovative activity

**Tax policy, subsidies, government grants and creation of innovative attitudes**

The government conducts innovative policy through a proper selection of instruments stimulating business entities to take up research and development challenges. Empirical research indicate that improper use of them does not need to lead to the realization of intended objectives. It turns out that, for instance, direct government subsidies for research and development and tax incentives (which are also designated for this objective) constitute substitutes for each other, therefore the

increase of effectiveness of one instrument leads to the increase of effectiveness of the other. Apart from that, tax policy in this respect should be stable and long-term, which will ensure the possibility of planning returns from investments in the long period. In the sector of small and medium-sized enterprises, tax instruments, through the establishment of additional resources of capital for their disposal, rather precipitate development works conducted by them so far than lead to a sudden inflow of interest of new, ambitious R&D projects.

Direct subsidies give broader control over the establishment of private sector attitudes. However, it is a discretionary instrument, the application of which creates a problem: how much a state, by interfering in market mechanisms, successfully establishes directions of research, which will be the basis of the future development of the country. It is also important to follow certain principles in relation to maximum financial thresholds of this instrument, since excessive "generosity" decreases its effectiveness drastically. OECD suggests a 13% share of state in research and development expenses of the commercial sphere [*Science*, *Technology*…, 2001, p. 64].

General types of instruments used by government in financing public research activity encompass the so called institutional resources and resources for the implementation of particular projects [*Governance of Public Research*…, 2003, p. 83 ff.]. The first ones are allocated to research and development entities (mainly to universities, governmental scientific centres, etc.) annually, according to their competence. The way of allocating resources to particular tasks depends on a given entity (of course within the limits of generally conducted research and development policy of the country). It is the main mechanism of financing basic research. The aim of the second one is encouraging institutions to take specific R&D undertakings. Entities willing to participate in such programmes must apply for resources and must prove that they are able to perform the task and apply money in compliance with their purpose. Significance of this tool is increasing in contemporary economy.

The private sector participates in financing public activity of R&D more and more often, especially in Canada, Finland, France and Germany [Sporek 2006, pp. 165-171]. The government can get flexibility of the conducted research and development policy in three ways [*Science, Technology*…, 2001, p. 68]:

- directing research tasks to entities which react to changes more quickly, which in practice means the increase of research activity of industry, decreased engagement of governmental R&D entities and universities; however, it questions ambitious, long-term development programmes;
- using the policy of short-term contracts and research grants. However, the threat of diminishing the mission of long-term development appears here as well;
- reforming public research and development entities, through the change of the management structure, system of research progress assessment, or financing (in this case there is no erosion of long-term research).

Contemporary economic experiences show that achieving good research results by governmental research and development entities is not enough. Technology

present "within four walls" of the laboratory must be applied in practice, and then must be successful on the market. Engaging private entrepreneurs from the very beginning of establishing innovative idea, establishing the so called spin-offs and licensing achievements of science facilitate this way of thinking [Sporek 2007, pp. 15-25]. Institutions of technologies transfer, which seek trade areas for particular technologies, play an indispensable role as well.

*Spin-off* is a general term referring to new, innovative enterprises which usually come from universities. They owe their highly competitive position at the market to modern technology established as a result of university research. University employees of a given department constitute staff of the enterprise. Due to the fact that completely new technologies constitute the only asset of spin-offs, they need to have a proper business plan and recapitalisation in order to obtain successful commercialisation of product or technology. They use connections with the parent entity by using its knowledge resources often, providing it with the source of income from the licensed technology at the same time. They also generate income for their suppliers. Spin-offs remain small companies for many years, however, they have a very high rate of survival in the early years of operating in the market (much higher than "ordinary" companies). They transfer technology and knowledge from the public sector to economy.

**Legal conditions of diffusion of specialist knowledge and transfer of technologies**

It is commonly thought that the legal system limits the possibilities of transfer of knowledge and technology, since, by giving intellectual property securities (patents) to inventors and companies, they become strategic resources of a particular company, the resources of which sometimes are not used for many years. As a consequence, competition is limited and the economy does not use achievements of contemporary science to such extent as it could do without using legal protections. On the other hand, legal regulations eliminate the uncertainty of activity to some extent. Thanks to them we are able to foresee "intentions" of our competitors, and therefore, we can estimate the risk and manage it properly [Waarden 2001, p. 770]. Patents provide research and development entities with capital inflow, which can be invested in new undertakings. It seems that protection of this kind is necessary.

The following can be presented as solutions supporting the establishment of facilitating conditions based on legal tools: shortening procedures connected with obtaining legal protection and reducing costs connected with them, state's subsidies for this kind of assistance, obtaining protection when one agrees to seek practical applications of prepared solutions of the new idea [*Science*, *Technology*... 2001, p. 73], obtaining the right to a patent by the university when it participates in projects commissioned by the government, and obtaining the right by the inventor engaged by the public R&D entity. It should be stressed that the policy of legal instruments must be skilfully integrated into social conditions linked with innovative activity.

Granting unlimited rights to intellectual property (especially to scientists working by the government order, whose research is financed by public funds), when their work is poorly paid can cause outflow of modern technology beyond borders of the country, making it impossible to achieve inner benefits from market penetration of new technology and diffusion of knowledge included in licenses. Many OECD countries assumed that intellectual property belongs to entity where a particular inventor works. Such a solution does not deprive him of the right to obtain, for instance, royalties.

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