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Public S&T Policy and Technological Innovation in Poland, 1989–2000

Abstract

The main aim of this paper is to answer the following question: Can any interdependencies be identified between technological innovation in the Polish industry and science & technology (S&T) policy in the past decade? For this purpose, a model of the innovation scene with three main actors (industry, science and government) may be useful. The overall picture of technological change processes in Poland is ambiguous: neither bad, nor good; both negative and positive tendencies can be identified. A principle components analysis has been applied to describe a course of innovation performance. An interesting regularity can then be seen: innovation performance reacted in the same direction but with a one-year delay to macro-economic dynamics. So, the innovation activity followed a cyclical development of the national economy. In turn, S&T policy often was delayed (drifted with the cycle) and was pro-cyclical. Thus, in the period under analysis (1989–2000), real processes of technological change proceeded independently of the measures being undertaken by the government for science and technology but in accordance with phases of business cycle. It is difficult to observe any clear correlations between innovation activity and S&T policy. Concluding, technological progress was taking place in Poland under the influence of (a) macro-economic regulations, (b) market forces and (c) the inflow of foreign technical thought rather than being influenced by public S&T policy.

Introduction

The paper is based on my report, within the Macrotec project, on **Public policy and technological innovation in Poland, 1989–1999.** The main aim of the report was to analyse the role of public S&T policy in the process of technical change in the Polish economy in that period, with special reference to industry.

A purpose of this paper is to show principal results of an attempt to answer the question: **Can any interdependencies be identified between technological innovation in Polish industry and science and technology policy in the past decade?**

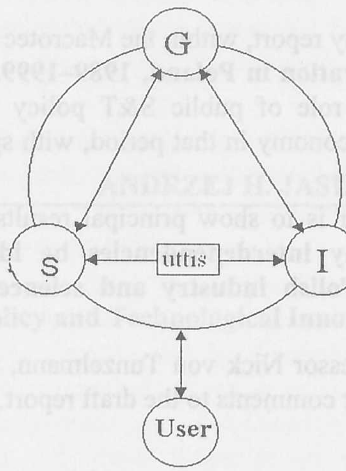
The author thanks Professor Nick von Tunzelmann, the project leader, and Dr Slavo Radosevic for their comments to the draft report.

1. A model of the innovation scene

For more adequate analyses of processes of innovation and technology transfer, a model of the innovation scene may be useful. The general inspiration here has been the concept of a Triple Helix (Etzkowitz and Leydesdorff 1995). The model assumes that there are three main actors on the scene: (1) **Industry** (companies), (2) **Science** (the R&D sector) and (3) **Government** (the state). Each has here an important role to play and none can be absent. So, if we treat the innovation like a theatre stage, then we shall be able to distinguish the actors who are in the foreground and those in the background. Having the three main actors mentioned above, we must not forget whom they play for. In this case, let us assume that the spectator is a buyer/user of an innovation mainly in a form of a new product. He/she may be a consumer or producer, other than the innovator.

Thus, the concept of a triangle inscribed into a circle may be constructed as in Figure 1. This theoretical model is very simplified and needs to be further refined. It is treated here as a method of analysis and does not contradict the concept of the national system of innovation (Lundvall 1992; Nelson and Rosenberg 1993; Tidd, Bessant & Pavitt 1997).

Figure 1. The innovation scene as a triangle inscribed into a circle



Where:

G – government; S – science; I – industry;
uttis – technology–transfer infrastructure

Source: Jasinski (1999).

The idea behind this triangle is, in short, that there are mutual relationships between the three actors, like negotiations, pressures and other interactions of various kinds. So, there exist here unilateral influences and multilateral interactions (feedbacks); there are direct and indirect influences. For example, among the indirect relationships can be included co-operation between science and industry via uttis.

Each of the main actors has a double role to play:

1) industry submits demands for new scientific-technological solutions and offers supplies of innovations, both to consumers and to producers;
2) science sells the results of the R&D work on its own initiative and replies to orders from industry, so science offers a supply of new scientific and technical achievements;
3) government mainly fulfils a regulatory function in the national economy but sometimes also plays a real role as a market participant (e.g. via public procurement).

And what about the user? He/she usually submits demands for innovations to industry. But to ensure an efficient functioning of the innovation scene, it should look like a modern, interactive theatre stage where the spectator acts as an active partner. In this case, a future user should play both inspiring and verifying roles in the innovation process.

To complete this picture, it must be added that, like in a real theatre, important roles are sometimes played by actors in the background. Here I refer to units which constitute a technology-transfer infrastructure (**uttis**). They facilitate both Science-Industry linkages, i.e. vertical technology transfer (TT) from Science to Industry, as well as horizontal TT between firms within Industry.

In most highly developed countries, uttis exist mainly in three forms: (a) science parks and technology/innovation centres, (b) bridging institutions, and (c) spin-off firms. Their potentially major roles result from the fact that an innovation 'stands on two legs': one leg still lies in R&D while a second already lies in production. Thus, a permeable transfer between the two spheres is very important here. In advanced market economies, good (i.e. wide and intensive) co-operation between the R&D sector and industry creates favourable conditions for technology transfer from science to the business sector and for TT among industrial enterprises, too.

The main relationships in the model may be shown in a simplified form :

I → S – a market-pull process of innovation

S → I – a science-push process of innovation

I ↔ S – an interactive process of innovation

S → G →
→ negotiations, pressures, lobbying etc.
I → G →

G → S science policy →
→ S&T policy
G → I industrial policy →

Each of the actors has been more deeply analysed in my report (Jasinski, 2001). Below are shown only selected principal findings.

2. Innovation performance and macro-economic performance

The overall picture of technological change processes in Poland is ambiguous: neither good, nor bad; both negative and positive tendencies can be identified. On one hand, we can speak about a certain slowdown in processes of innovation and technology transfer at the end of the decade of the 1990s. The symptoms are here declines in:

1) the share of R&D in innovation activities in industrial firms;
2) the number of enterprises taking part in the turnover of new technologies, both at home and with foreign countries, excluding FDIs;
3) the number of firms planning the introduction of innovations in forthcoming years;
4) and escalation of main barriers to innovate, such as (GUS 1998):
   - a lack of own financial resources in firms,
   - too high interest rates on bank credits,
   - high uncertainty levels of outlet,
   - a lack of in-house R&D bases.

At the end of the 90s, some negative phenomena even worsened. On the other hand, positive tendencies arose at the same time, namely the growth of:

1) the share of companies' R&D expenditures in GERD;
2) the number of in-house units and their research staff;
3) innovation intensity;
4) the contribution of new and modernized products;
5) the contribution of technologically advanced products;
6) the number of uttis, although their present number is still insufficient.

We must also remember that the inflow of foreign technical is thought to have intensified.

Summarizing, one can say that, at the beginning of the decade, a certain drop took place in the economy's innovativeness; afterwards, there was an intensification of firms' innovation activities, and then a slight mitigation at the end of the 90s. So, let us now try to analyse how innovation performance developed in the period of analysis.

There is no single, universal indicator of a country's innovation performance (Inn-perf). In order to describe it, four yardsticks were available to be taken into consideration:

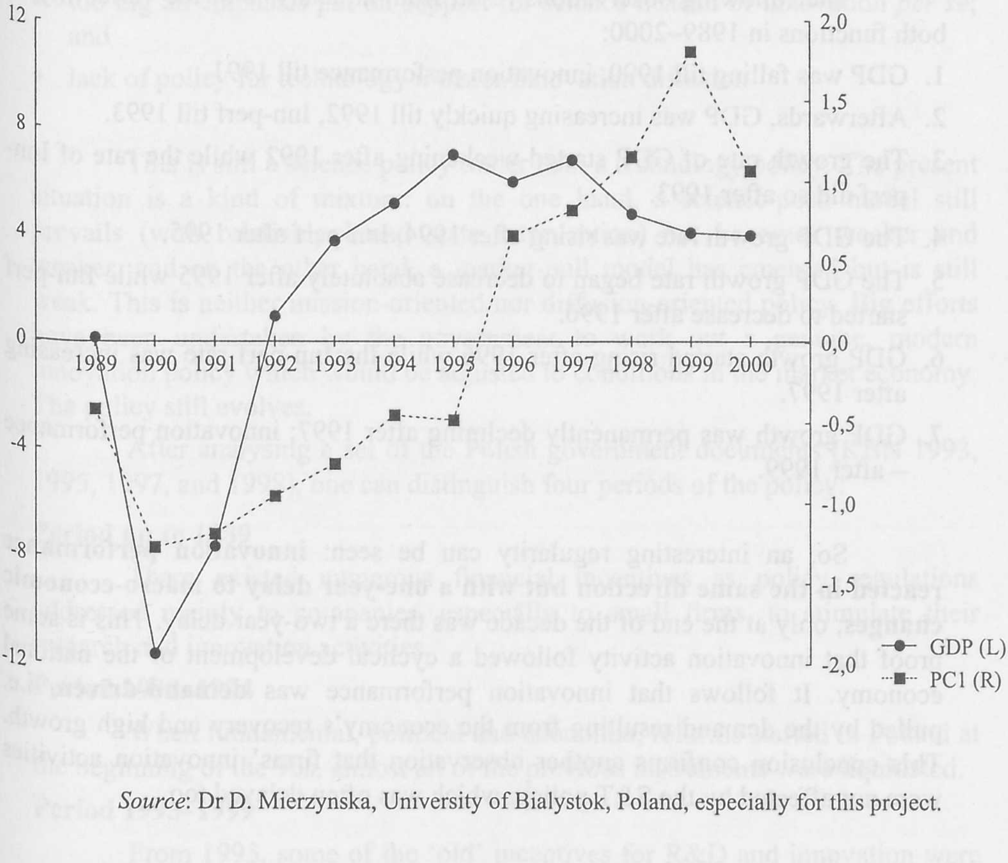
1) innovation intensity, measured as the share of firms' expenditures on innovation activities in aggregate industrial output;
2) the share of new and modernized products in aggregate industrial output;
3) the share of technologically advanced (i.e. high- plus medium-tech) products in aggregate industrial output;

4) the share of high-tech products in total exports.

A principal components analysis (PCA) was applied to choose a combination of those measurements which describes, in the best way, the course of a given phenomenon, in this case of innovation performance. A first principal component (PC1)[1], estimated here with the PCA method (see Morrison 1976), took the following values in 1989–2000:

1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
-0,41	-1,27	-1,19	-0,95	-0,76	-0,45	-0,48	0,66	0,83	1,15	1,81	1,07

Figure 2. Macro-economic performance and innovation performance



Source: Dr D. Mierzynska, University of Bialystok, Poland, especially for this project.

[1] PC1 has no name.

The calculations were carried out using a partial least squares (PLC) method. The percentage of variability of the analysed phenomena explained here by PC1 is 65%, i.e. sufficiently high. A curve of PC1, shown alongside a curve of gross domestic product (GDP) growth, is shown in Figure 2.

As seen, the growth of PC1 values shows many similarities to the dynamics of GDP growth. A curve here representing innovation performance behaves similarly to a curve representing macro-economic development, although PC1 responds to a GDP increase/decrease with some delay. It may be observed that, in years1998–1999, when GDP growth was declining, innovative performance was still growing by the force of inertia. However, data for 2000 confirm a certain decline in firms' innovation activities. So we can say that, in the 90s, innovation performance in Poland developed in parallel fashion – but with a slight delay – to the country's macro-economic performance.

The following observations result from an analysis of the variability of both functions in 1989–2000:

1. GDP was falling till 1990, innovation performance till 1991.
2. Afterwards, GDP was increasing quickly till 1992, Inn-perf till 1993.
3. The growth rate of GDP started weakening after 1992 while the rate of Inn-perf did so after 1993.
4. The GDP growth rate was rising after 1994, Inn-perf after 1995.
5. The GDP growth rate began to decrease absolutely after 1995 while Inn-perf started to decrease after 1996.
6. GDP growth started rising after 1996 while the Inn-perf rate was increasing after 1997.
7. GDP growth was permanently declining after 1997; innovation performance – after 1999.

So, an interesting regularity can be seen: **innovation performance reacted in the same direction but with a one-year delay to macro-economic changes**; only at the end of the decade was there a two-year delay. This is some proof that innovation activity followed a cyclical development of the national economy. It follows that innovation performance was **demand-driven**, i.e. pulled by the demand resulting from the economy's recovery and high growth. This conclusion confirms another observation that firms' innovation activities were not affected by the S&T policy, which was often delayed too.

3. S&T policy and macro-economic performance

Several major features of Poland's public S&T policy can be identified in the 90s:

- lack of a long-term strategy for science and technology;
- wavering of the current policy;
- bad co-ordination between government agencies;
- relative decrease in budget R&D expenditures;
- quite strong policy centralization, including especially finances for R&D, and lack of a regional approach;
- too small support for applied research within funding decisions;
- too big an emphasis put on support for science instead of innovation *per se*; and
- lack of policy for technology transfer/innovation diffusion.

This is still a science policy rather than a technology policy. The present situation is a kind of mixture: on the one hand, a science-push model still prevails (with relatively broad state intervention) but becomes weaker and weaker, and on the other hand, a market-pull model has emerged but is still weak. This is neither mission-oriented nor diffusion-oriented policy. Big efforts have been undertaken by the government to work out a genuine, modern innovation policy which would be adjusted to conditions in the market economy. The policy still evolves.

After analysing a set of the Polish government documents (KBN 1993, 1995, 1997, and 1998), one can distinguish four periods of the policy:

Period up to 1989

There existed numerous financial incentives as policy regulations addressed mainly to companies, especially to small firms, to stimulate their research and innovation activities.

Period 1990–1994

When fundamental, political and economic, reforms started in Poland at the beginning of the 90s, almost all of the previous instruments were liquidated.

Period 1995–1999

From 1995, some of the 'old' incentives for R&D and innovation were restored; a list of fiscal preferences was even quite long.

Period 2000–

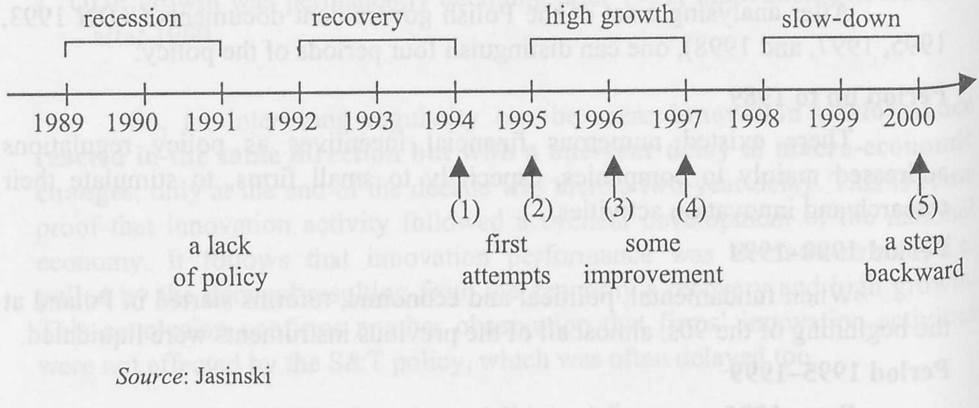
From the beginning of 2000, some of those tools were cancelled again and no new ones introduced.

As can be seen, a kind of wavering of current S&T policy took place. This was a short- term oriented policy. Perhaps the reason was a lack of any long-term strategy for science and technology in Poland, especially for the period of transition.

Now, we can try to compare the periodization of the S&T policy with phases of the economic cycle, which is shown in Figure 3.

CYCLE	POLICY	
	1) Up to 1989	numerous measures
1) Recession (1989–1991)		
	2) 1990–1994	a lack of policy
2) Recovery (1992–1994)		
3) High growth (1995–1997)		
	3) 1995–1999	many instruments
4) Slowdown (1998–)		
	4) 2000–	shrinking policy
	accompanied by a constant, relative decrease in GFR&D[2] through the whole period	

Figure 3. Macro-economic performance and S&T policy[3]



Source: Jasinski

[2] GFR&D means government funded research and development.

[3] 1994, 1995, 1996, 1997 and 2000 – dates when government documents put into effect.

Figure 3 shows that, in relation to the growth of the national economy, S&T policy was often delayed (drifted with the cycle) and was pro-cyclical. However, it should hold inversely: the policy should have been strengthened during the recession and in the period of slowdown.

4. The innovation scene in practice

Deeper analyses concerning the three main actors on the innovation stage allow us to formulate the following general observations:

1) The R&D sector as a source of technical change:

- insufficient structural change;
- inertia of the previous system that had prevailed for 45 years;
- an active attitude to defend the status quo;
- too slow and long-lasting a process of transition.

2) Firms as the location where most innovations are implemented:

- too small a demand for R&D and innovation;
- an underestimated role of technological change for long-term development;
- a lack of free capital for investment in R&D and innovation;
- too small a market compulsion to innovate.

3) Government as a potential catalyst of change:

a) Policy towards science:

- stability, i.e. no significant about-turns in science policy;
- a will to maintain and protect the R&D sphere;
- limitations in budget R&D expenditures.

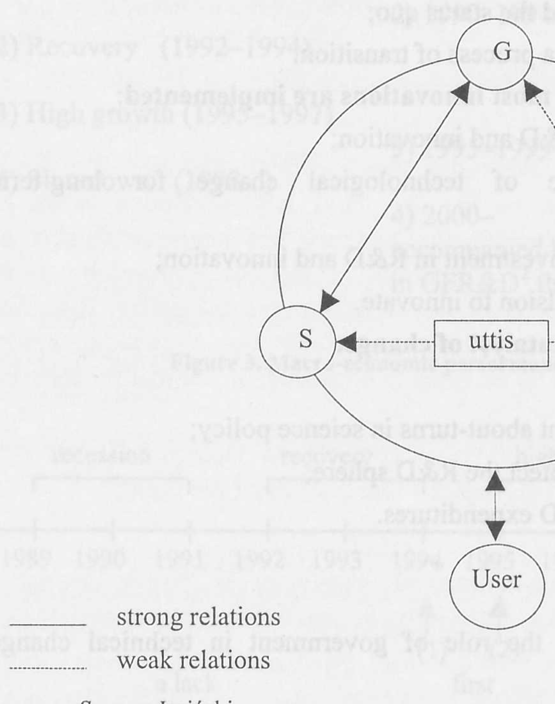
b) Policy towards industry:

- instability and wavering;
- a lack of clarity as to the role of government in technical change processes;
- a set of policy instruments having a one-sided character, mainly fiscal.

The observations made through this analysis prove that slow, gradual technological development was taking place in the Polish economy in 1989–2000. The progress was a result of activities of the three main actors and of the clash of positive and negative tendencies on the scene. It was and still is a difficult, long-lasting period of creative destruction. The transition from a centrally planned economy to an advanced market economy turned out not to be an easy and short process in the field of science and technology either.

However, not just the government can be blamed for the slow progress in processes of innovation and technology transfer. All the actors share some responsibility for it. There was also a lack of sufficient co-operation between them on the innovation scene. As regards the government's attitude, which is the main subject of our interest here, co-ordination was lacking in activities of various agencies responsible for science and technology policy and for its adjustment to macro-economic policy. Of course, the state may only support market mechanisms of technological change. Therefore, we have now the following practical state of the innovation scene (see Figure 4).

Figure 4. A model of the innovation scene in practice



Source: Jasiński.

The other two players, apart from the government, behaved in different ways:

- science – *active* defence of the status quo;
- industry – *passive* attitude towards R&D and innovation.

As a result, the three actors have not created a harmonious, integrated bond. Links between them, except for science-government relations, are rather weak. Industrial firms are scarcely interested in co-operation with uttis. Public R&D institutions have not yet learnt to co-operate closely with private enterprises, and *vice versa*. Additionally, consumers and other users of innovation are too rarely drawn into the research process. Therefore, our model of the innovation scene is still fragmented. This is, to some extent, a relic of the past when all the actors were, in principle, separated from each other.

So, a general picture of the innovation scene in Poland looks as follows:

1) **Industry** submits too small a demand for R&D and new scientific-technological solutions; also, it offers a relatively small supply of modern products;
2) **Science,** being insufficiently stimulated by industry to greater effort, offers too small a supply of scientific and technical achievements of the highest level;
3) **Government** is not able enough to couple science policy with industrial policy into a comprehensive S&T policy. Public policy towards the R&D sector is mainly demand-oriented while policy towards industry is mainly supply-oriented, and it is not so easy to reconcile one with the other. In addition, the state does not know how to integrate S&T policy with macro-economic policy in a contemporary market economy. Moreover, the government does not adequately „take care" of uttis and of consumers as innovation users;
4) **Uttis** still are sparse and weak; some of them are not expansive enough and tend to disappear from the market,
5) **Users** in Poland were often neglected by all the actors. Users do not yet have a sufficiently strong position in the market, and their pressure on industry is not powerful enough.

5. Conclusion: Main interdependencies

It may be concluded that, in the period under analysis (1989–1999), real processes of technological change proceeded *independently* of the measures being undertaken by the government for science and technology but in accordance with the phases of business cycle. So, we could observe:

- a drop in innovativeness in the period of recession in the Polish economy;
- its activation during the recovery and high growth; and
- again a reduction with the economy's slowdown.

We can clearly see **interdependencies between innovation activities and macro-economic performance**, measured by the GDP growth rate. The activities thus became:

- weaker and weaker following a deepening recession in 1989–1991;
- stronger and stronger during the recovery (1992–1994) and high growth (1995–1997);
- stabilised in the period of slowdown (1998 –).

Certain relationships can be identified between innovation performance and macro-economic policy. Generally speaking, macro-policy developed as follows:

- The first years of transition (1990–1994) saw restrictive policies, strong budget constraints imposed on companies, full openness for competitive imports. This led to radically new situations and difficulties for firms to innovate.
- Three years of high economic growth (1995–1997) saw more moderate policies, pro-investment, speeding up privatisation favourable to FDI inflows. This led to easier conditions to implement innovations by using both domestic and foreign sources of technological change.
- A period of slowdown (1998–) again witnessed more restrictive policies, budget limitations, orientation to inflation squeeze rather than job creation. This reduced the spectrum of possibilities for enterprises to innovate.

However, it is difficult to observe any clear correlations between innovation activity and S&T policy, or between the latter and macro-economic policy. Hence there has been a two-dimensional situation in the field of technical change in Poland. On the one hand, market forces are still too weak and market mechanisms not fully efficient: a relatively big share for the state sector, a weak SME sector, a shaky equilibrium in some markets, a high level of monopolization, etc. On the other hand, there is the government which is still learning how to conduct S&T policy in the transition from a centrally planned economy to a free market, but is not consistent enough in doing so. However, a positive evolution has taken place in the government's approach: from a belief in a role of the invisible hand of the market in the process of technological change, to an appreciation of a role of science and technology policy for the development of a modern economy. This growing awareness among politicians of the role of public S&T policy was a kind of driving force of this evolution.

On the basis of this, it seems established that technological progress was taking place in Poland under the influence of (a) macro-economic regulations, (b) market forces and (c) the inflow of foreign technical thought, rather than being influenced by public S&T policy. The policy was not compatible with macro-policies. This confirms the primary hypothesis that technical change is as much influenced by macro-economic and other indirect policies, as by explicit S&T policies.

6. Policy recommendations

The policy recommendations which result from the above analysis concerning Poland to be discussed below may also be useful for other countries in transition. The proposals apply mainly to public S&T policy.

First of all, **a good climate for innovation** is necessary and should be created by macro-economic policies oriented towards growth, employment, equilibrium and market competition. Such a climate ought to create general economic conditions favourable to technological change.

A country's long-term **strategy for science and technology** is equally important. The government should impose realistic strategic goals and be responsible for their consistent execution. Current S&T policy ought to result from the strategy.

Referring to our model of the innovation scene, the government should:

- act for consumer protection/education together with fostering market positions and influencing the power of the consumer as the main user of innovations;
- run such a policy which will stimulate on the one hand firms' demand for R&D, and on the other, a supply of new scientific-technological solutions offered by the R&D institutions;
- importantly support the establishment and development of uttis which will strengthen science-industry linkages.

However, the greatest challenge in this field in Poland seems to be answering the question of how to gain more money for R&D from outside the state budget? Given that the country's expenditures on research and development are drastically low, government appropriations for R&D should start rising quickly but under two conditions:

1) the private sector's spending on research should rise more quickly; and
2) any net increase of the budget expenditures will go towards R&D in companies.

At the same time, some improvements should appear in the science sector in a double sense:

1) the share of the enterprise sector in R&D expenditures should rise; and
2) the share of applied research and experimental development should increase, too.

Nevertheless, the key method of counteracting the decline in R&D expenditures in Poland seems to be an activation of firms' research and innovation activity. An innovation-oriented entrepreneur/firm should now be the main object of S&T policy, and not a scientific institution. The science sector ought to be treated – in this context – as the key element of the firm's environment. So, a re-thinking is needed among policy-makers. The scale of state intervention in the S&T system ought to shrink together with:

- a strengthening of market forces/mechanisms in the process of transition;
- a growing role of the private sector in R&D spending; and
- an increasing share of the banking system in financing R&D and innovations.

Science and technology policy should have a more regional character, i.e. it should become decentralized and regionally diversified. This will serve (a) to limit territorial disproportions in R&D potential and (b) to create regional systems of innovation.

Finally, an integration of S&T policy is needed via **five Cs**. This means that policy will have the following features:

1) **Co-ordinated**: S&T policy should be well co-ordinated, with various government agencies responsible for science and technology closely co-operating with one another.
2) **Correlated**: science policy should be correlated with technology/innovation policy. As Poland now needs not more scientific discoveries but more practical applications of R&D results in a form of new products or processes, policy priorities must be placed on applied research, and especially on experimental development and implementation work.

3) **Comprehensive**: important components of the S&T policy-mix should be policies for: (a) high-technology sectors, (b) technology transfer in a broad sense, i.e. including uttis and FDIs, and (c) R&D and innovation in small and medium-sized enterprises, especially private. Policy instruments ought to be much more differentiated; not only fiscal but also other financial tools plus organizational measures, training, etc.
4) **Compatible**: S&T policy should be compatible with or adjusted to the macro-economic policy-mix. Government documents concerning macro-policy and S&T policy must be prepared in parallel.
5) **Coherent**: Polish S&T policy should be coherent with the EU policy for research and technology development (RTD). Such coherence is of significant importance in the process of Poland's accession to the European Union and afterwards, too.

As a result of these strategies for integration, all connections in the model of the innovation scene will be strong enough and help ensure its smooth operation. The economy's innovativeness should increase considerably.

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