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December 1998

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MPRA Paper No. 63533, posted 11 Apr 2015 10:08 UTC

A LONG WAY TO GO:

The Hungarian Science and Technology Policy in Transition

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a preprint version of a chapter in:
Lorentzen A, Wiedmaier B, Laki M (eds): *Institutional change and industrial development in Central and Eastern Europe,* Aldershot: Ashgate Publishing, 1999, pp. 221-248

Budapest
December 1998

1 INTRODUCTION[1]

Neo-classical and mainstream economics focus on rational decision-making, assuming a given set of resources. It is a rather static approach as it tends to neglect changes in general, and technological changes – introduction of new products and processes – in particular, as subjects of other disciplines (engineering sciences, history or sociology). Further, this school of economic thoughts postulates a single, 'time-less' – that is, ahistoric – institutional framework, namely a sophisticated and inter-related system of perfectly and smoothly working factor and product markets. Therefore it is neither interested in the rich variety of economic institutions across countries nor institutional changes in a given economic entity – be it a region, a nation or a greater system – over time.[2]

Managers and policy-makers, however, do realise the importance of technological changes as a key factor to underpin the competitiveness of products, services, firms and even broader economic entities (regions, national economies, supranational 'alliances', e.g. the EU, NAFTA). They devise and implement strategies and policies, respectively, aimed at fostering the development and the diffusion of new products, services and production techniques. Managers are also aware of the decisive impacts of various institutional settings, especially those exposed to different environments via working for multinational companies and/or highly export-oriented ones.[3]

More recently technological and institutional changes are making inroads into the textbooks of different economics schools, to a significantly different extent, though. Some subscribers of mainstream economics mention innovation just as an exception to the rule, that is, an example of market failures. Other scholars, still following this tradition, have developed the so-called *new growth theory* in an attempt to incorporate research and development expenditures into the set of major variables of their models. What seems to be more promising is another school of thoughts, called evolutionary economics or economics of technological and institutional changes. Yet, *nomen est omen*: these new attempts are still evolving, and thus seem significantly less axiomatic. Even so, the basic theorems provide a more solid base to understand the process of innovation, and hence to devise adequate policies.[4]

These recent theoretical developments can be tested – corroborated or rejected – by analysing the on-going transition process in the former planned economies which also draws one's attention to institutional changes. The Central European cases, including the Hungarian one, highlight the importance of institutions even more sharply as they are of somewhat different nature in this large and diverse group of countries, given their different history. Briefly, before World War II there was a market economy in place in Central Europe – as opposed to most Eastern European countries and former Soviet republics – based on private property. These economies were linked to the wider

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[1] This chapter is a revised and updated version of a paper prepared for *Central and Eastern Europe: Institutional Change and Industrial Development,* a workshop organised by Aalborg University at Tannishus, Northern Jutland, Denmark, on November 20-23, 1997. Comments on the previous version by Mihály Laki, Anne Lorentzen, and Brigitta Widmaier are gratefully acknowledged. The usual disclaimer applies.

[2] For a more detailed analysis see Freeman [1994a], Nelson [1995], Nelson and Winter [1982] and von Tunzelmann [1995].

[3] Politicians and political scientists, of course, are also keen on institutional changes, broadly defined, for their own professional reasons.

[4] See, e.g. Ergas [1987], Freeman [1982] and [1995], Freeman and Soete [1997], Foray and Freeman [1992], Dosi [1988], Dosi [1992], Dosi *et al.* [1988], Dosi *et al.* [1994], Dosi and Nelson [1993], Lundvall (ed.) [1992], Mowery and Rosenberg [1989], Nelson [1993], Nelson and Winter [1982], OECD [1992], Rosenberg [1983].

European economic space via foreign trade, subsidiaries of, and joint ventures with, foreign firms operating there and subsidiaries of Central European firms active abroad. Then they went through two similar historical periods, namely the planned economy and right now the transition process, but again with some non-negligible differences. Hence three rather distinct socio-economic systems and their impacts on the national system(s) of innovation (or institutions, loosely defined) can be observed in these cases. In other words, it is a large, 'living', laboratory where evolving institutions, including re-emerging old ones, can be observed. Thus it seems worthwhile studying these cases in-depth as they might provide a number of important, perhaps eye-opening, lessons for more general theorising.

This chapter aims at analysing the recent institutional changes in Hungary from the point of view of science and technology (S&T) policy via pulling together some recent theoretical developments in the economics of innovation and a fairly descriptive approach. The underlying question is whether it is possible to devise a coherent, feasible S&T policy and implement it in an efficient, or at least satisfactory, way in a transition economy, or whether S&T policy, together with other major institutions, is also evolving. In other words, is S&T policy an outcome of conscious, well-designed and co-ordinated efforts (can it be?) in this period, or should it be seen as a resultant of deliberate and unintended consequences of actions and interactions of a host of actors?

Privatisation of the formerly state-owned enterprises and the establishment of new, privately owned firms are the core of transition towards market economy, thus one might except privatisation being the core of this paper, too. Further, firms are the engine of the innovation process, and hence might also be the 'driving force' of this chapter. Given the above aim and the selected method, however, neither the techniques (and results) of privatisation applied in Hungary, nor the role of firms in the innovation process will be analysed here.

The topics to be taken up are as follows: Theories and models of innovation as theoretical foundations for S&T policy are briefly outlined in section 2. Then the focus moves to Hungary in section 3, which describes the legacy of central planning. Recent changes in the science and technology institutional system are analysed in section 4, and policy conclusions are presented in the final section.

2 THEORETICAL FOUNDATIONS

2.1 The process of innovation and economic theories

Competition is a crucial idea both in neo-classical economics and economic reality. If we consider further basic notions, however, this harmonious relationship between reality and that kind of theory disappears. Competition, innovation, information (as well as knowledge and skills) asymmetries, disequilibria and profit opportunities are almost identical phenomena in the real world, in that they are various sides of a multi-faceted, complex, entity, called market economy.[5] They might seem to be different and separable when the very phenomenon of market dynamics is seen from different angles. This separation might be necessary and useful in order to better understand certain aspects of this complex process. Neo-classical economics, however, not only separates these features but

[5] Metcalfe and Georghiou [1998], referring to Richardson's book on Information and Investment published already in 1960, explain it in two plain sentences: "Without asymmetry there can be neither novelty nor variety. Indeed innovations and information asymmetries are proper synonyms and it should not be forgotten that a profit opportunity known to everybody is a profit opportunity for nobody." (p. 81)

constructs another world. It speaks of competition among identical firms ('representative agents') leading to general equilibrium (treating – or dismissing – disequilibrium as an exemption to the general rule of equilibrium).[6] This school of economic thoughts is centred around the notion of rational decision-making – optimal allocation of given set of resources –, while innovation – indeed change in general – are excluded from 'scientific' investigation as story-telling.

In evolutionary theorising, however, innovation – defined as "the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organisational set-ups" (Dosi [1988a], p. 222) –, is the hallmark of analysis. Innovation results in variety (diversity), and competition – both conducive to innovation and induced by innovation – selects among firms (or organisations, more generally).

In spite of the apparent similarity with biological processes, one should not mistakenly equate evolutionary economics with evolutionary biology. Freeman [1994b] highlights two fundamental differences. First, selection is at least partly conscious in the innovation process as decision-makers can choose between various 'mutations' (that is, new products, processes and organisational forms). Moreover, their expectations, hopes, plans and values also shape the 'evolution' of these 'mutations'. Therefore ethical and social considerations play an increasingly important role in the innovation process, notably in the development and utilisation of nuclear energy and biotechnology, as opposed to the process of biological evolution. Second, selection is taking place at a number of levels in the course of competition: among products, firms (organisations), sectors, regions, countries and socio-economic systems. There are some autonomous rules and laws of the selection process at these different levels, however, strong interrelations and interdependencies can also be observed: technological innovations are shaping not only their natural, but also socio-economic environment, while the success of innovations strongly depends on their environment, including the quantity, quality and distribution of accumulated capital in the form of production equipment, roads, railways, communications networks, bridges, etc., as well as institutions, policies, attitudes and norms. Therefore it would be as serious a misconception to copy biological analogies in economics as it is misleading simply 'importing' equilibrium models of mechanics – where they are appropriate and functional, no doubt – and centre economic analysis around them.

While rational agents in the models of neo-classical economics can optimise via calculating *risks* and taking appropriate actions, "innovation involves a fundamental element of *uncertainty*, which is not simply the lack of all the relevant information about the occurrence of known events, but more fundamentally, entails also (a) the existence of techno-economic problems whose solution procedures are unknown, and (b) the impossibility of precisely tracing consequences to actions" (Dosi [1988a], p. 222 – emphasis added). Thus the notions of *optimisation* or *maximisation become meaningless*.

As opposed to the 'time-less' world of neo-classical economics, "*history counts*: past technological achievements influence future achievements via the specificity of knowledge that they entail, the development of specific infrastructures, the emergence of various sorts of increasing returns and non-convexities in the notional set of technological options" (Dosi [1992], p. 183). In other words, technological change is a *cumulative*, *path-dependent* process, and hence increasing

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[6] Evolutionary economists strongly disagree with this vision of economic reality, e.g. Metcalfe and Georghiou [1998] opens by a simple, but powerful, blunt thesis: "Capitalism and equilibrium are fundamentally incompatible concepts." (p. 76)

returns are at least as important as diminishing returns.[7] Closely related notions, also in the heart of evolutionary thinking, are *learning by doing, using and interacting*. (Freeman [1994a])

Mainstream economics is mainly concerned with the availability of *information* (or information asymmetries in its jargon). Both the theoretical and empirical literature reflect, however, the growing recognition that the success of firms – regions and nations – depends on their accumulated *knowledge,* both codified and tacit,[8] and *skills* as well as *learning capabilities*. Information can be simply bought, and hence mainstream economics is comfortable with it. Knowledge – and *a fortiori* the types of knowledge required for innovation – on the contrary, cannot be mistaken with goods that can be purchased and used instantaneously; one has to go through a learning process to acquire knowledge and skills.[9] It obviously takes time and involves the process and costs of *trial and error*. Thus the uncertain, cumulative and path-dependent nature of innovation is reinforced.

Cumulativeness, path-dependency and learning lead to *heterogeneity* among firms, and hence another methodological cornerstone of mainstream economics, namely the axiom of 'representative agents', can be seen crumbling. Moreover, sectoral characteristics of the innovation process should also be taken into account while devising strategy or policy.[10]

A vast body of empirical literature has also clearly shown that innovators are not lonely (sometimes even depicted as lunatic) scientists. While some path-breaking scientific or technological ideas might come indeed from individuals, successful innovations can only be generated by a close collaboration of different organisations such as: university departments, government and/or contract research labs, firms and specialised service-providers. Forms of their co-operation can also be varied widely from informal communications at the one extreme through highly formalised R&D contracts to alliances and joint ventures at the other extreme.[11]

The above antagonistic differences in notions and assumptions applied in various schools of thought reflect, and result in, fundamental theoretical and policy divergence. Given the scope and nature of this study only the latter ones are discussed briefly below.

2.2 Implications for S&T and innovation policy

Policy proposals arising from the neo-classical paradigm are based on the so-called market-failure argument. Government intervention is justified on three interconnected grounds:

a) private firms would not engage in R&D to an 'optimal' extent because they could not appropriate all the benefits of their efforts (investments)

b) outputs are not predictable from inputs

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[7] In neo-classical economics, of course, the dominance of the latter is a crucial postulate.

[8] For a brief but highly informative discussion of codified and tacit knowledge - and the policy relevance of this distinction - see Lundvall and Borrás [1998] (especially pp. 31-33) and the literature they refer to.

[9] Borrowing a sparkling parable of Dosi [1988b], although there are market conditions of access to information e.g. there is a market for textbooks and economic conditions of access to higher education (the level of registration fees, the availability or scarcity of grants for students), "in any proper sense of the word, getting a PhD is not simply acquiring information, and it is even less true to say that there is a market for PhDs" (p. 1130).

[10] A seminal taxonomy developed in Pavitt [1984] identifies supplier-dominated sectors, specialised suppliers, scale-intensive and science-based sectors.

[11] Freeman [1995] provides a thorough literature survey, see also Lundvall and Borrás [1998], the papers on the role of networks in the 1991 October issue of *Research Policy* and the 'national innovation system' approach, e.g. Lundvall (ed) [1992], Nelson [1993] as well as the on-going OECD project on this topic.

c) there are indivisibilities in the process of innovation.

All in all, positive externalities, or spillover effects, do exist. In other words, the social return to R&D exceeds the private return, and thus supporting private R&D efforts improves aggregate welfare. Therefore public money can and should be used to subsidise private R&D to lower costs, to introduce an effective intellectual property right system in order to increase payoffs (improve appropriability) and/or generate technological knowledge at publicly funded universities and laboratories. An implicit assumption of this reasoning is that scientific research leads to technological development that, in turn, would automatically result in new products and processes, to be introduced by firms. This is the so-called linear model of innovation, where the wide variety of interactions among the players in a real-world innovation network is ignored.[12]

The market-failure justification for government intervention is heavily criticised by the evolutionary school on two grounds. First, it is inconsistent: following the axiom of trade theory that technology is a free commodity at world level, and can be moved without costs across national borders, governments must not use tax-payers' money to support the creation of new technology.[13] Second, it provides no guidance for policy makers:

> "While market failure provides a general rationale for policy intervention, it is inherently imprecise in its detailed prescription: a firm may spend too much or too little on innovation, it may innovate too quickly or too slowly, it may undertake excessively risky projects or be too conservative." (Metcalfe and Georghiou [1998], p. 81)

Evolutionary account of the innovation process leads to some sobering lessons: in a world of uncertainty policy cannot bring about the optimum either. The policy maker is not "a perfectly informed social planner correcting imperfect market signals to guide private decisions toward more desirable outcomes". (Metcalfe and Georghiou [1998], p. 94) Of course this is not easy to accept, especially for those trained in the paradigm of rationality, maximisation and optimisation:

> "For obvious reasons, many economists prefer models that provide precise policy recommendations, even in situations in which the models are inapplicable to the world of our existence. Our own view is that, rather than using neo-classical models that give precise answers that do not apply to situations in which technology is evolving endogenously, it is better to face the reality that there is no optimal policy with respect to technological change." (Lipsey and Carlaw [1998], p. 48)

Further, different forms of 'waste' seem to be unavoidable, e.g. duplication or even 'multiplication' of efforts, given the need to promote variety, as well as 'failures' stemming by definition from trial and error. These types of 'waste', however, are not only inherent in the innovation process, and hence to be accepted, but should be seen from a different angle, too. 'Errors' are in fact important pieces of information on where not to search (Metcalfe and Georghiou [1998], p. 78), while duplication of efforts in reality means learning, accumulating skills and experience in a wider circle. In other words, the more firms are engaged in the search process, the more input is generated for further innovation, and in the meantime diversity is also maintained.

Variety, selection and uncertainty also have repercussions on the very nature of policy. The relevant and potentially successful policy is an *adaptive* one, relying on and learning from feedback from the selection process to the development of further variation. (Metcalfe and Georghiou [1998])

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[12] Rothwell [1993] describes 5 generations of innovation models, and explains the importance of interactions, feedbacks, system integration and networking.

[13] "The 'free-riding', non-interventionalist government would just leave it to their domestic firms to tap into the free pool of global knowledge." (Lundvall and Borrás [1998], p. 44) For further critical remarks see op. cit. pp. 49-50, 52, as well as Lipsey and Carlaw [1998].

In other words, policy making is increasingly becoming policy learning; the process of policy formulation deserves as much attention as the process of innovation. (Lundvall and Borrás [1998], Teubal [1998])

Some more instructive policy implications can also be derived from evolutionary theorising: given the characteristics of the innovation process, public policies should be aimed at promoting learning in its widest possible sense, in other words competence building at individual, organisational and inter-organisational levels. Co-operation and networking among a host of actors, including not only researchers and producers but users, too, is a vital element in generating and disseminating knowledge. Commercialisation of R&D results and diffusion of innovations is not a smooth, automatic process. Therefore adequate policy tools should be devised and implemented to foster this process. To sum up, a system-approach is required whereby "policies recognise the division of labour in the generation of innovation-relevant knowledge, that no individual firm is self-sufficient in its knowledge and skills and that there are corresponding gains from linking firms with the wider matrix of knowledge-generating institutions" (Metcalfe and Georghiou [1998], p. 84). Indeed, a recent trend in science and technology policies of advanced countries is a shift from direct R&D support to infrastructure building, i.e. the promotion of linkages and the so-called bridging institutions among the players in the innovation process.[14]

Other policies, such as investment, privatisation, industrial, regional development, competition, trade, monetary, fiscal, education, labour market and foreign policies, also have certain bearings on innovation and diffusion, and thus should be co-ordinated.[15]

The following sections shift the focus towards the Hungarian case, and hence a more descriptive approach is applied.

3 THE HERITAGE OF CENTRAL PLANNING: FRAGMENTED S&T ORGANISATIONS

The Soviet model of both social and economic institutions, including state ownership, central planning, mono-party system, trade unions controlled by the Communist Party, etc., had to be introduced in Hungary, as in all other Central and Eastern European countries dominated by the Soviet Union, in the late 1940s. This abrupt change had far-reaching impacts on the every day life of people, the domestic and foreign politics of these countries, their economies, and hence their science and technology (S&T) systems as well. Several changes have occurred since the 1960s in Hungary. Most importantly the centrally set, mandatory plan targets were abolished as early as 1968,[16] and hence certain norms and attitudes prevailing in market economies disseminated widely

[14] Metcalfe and Georghiou [1998] provides an overview of S&T policies in EU member countries (pp. 85-93), see also further contributions in the special issue of *STI Review* on *New Rationale and Approaches in Technology and Innovation Policy* (1998, No. 22), as well as Lundvall and Borrás [1998].

This new approach can also be observed in a recently proposed distinction between science, technology and innovation policy. Dodgson and Bessant [1996] define science policy "concerned with the development of science and the training of scientists", while technology policy "has as its aims the support, enhancement and development of technology, often with a military and environmental protection focus". Innovation policy, however, "takes into account the complexities of the innovation process and focuses more on interactions within the system". (cited in Lundvall and Borrás [1998], p. 42)

[15] See also Havas [1995], Lundvall and Borrás [1998] and Radosevic [1994] for a more detailed discussion.

[16] A more decentralised planning system, together with the so-called indirect economic control tools, on the whole giving more room of manoeuvring to companies, replaced the former system.

among enterprise managers. The standard of living was one of the highest among CMEA[17] countries. The political and economic transition process, of course, brought about much more important changes in the early 1990s. Yet, the legacy of central planning cannot be ignored even now. Hence it is worth highlighting some major characteristics of that period.

Central planning and the rationale of the so-called party-state did not allow to sustain the a complex set of various independent economic, social and political institutions, co-operating and co-evolving in a number of ways through horizontal links. Excessive centralisation of all social, cultural, political and economic activities required vertically organised, insulated sub-systems. Relationships among these sub-systems were only established at the very top level, e.g. R&D, production and trade functions were separated not only at firm level, but also at the level of the ministries, and hence co-ordination was only possible at the highest political level. Firms became mere production units, with no responsibility, and no means to conduct R&D, buy raw materials, trade their products or control their finance. As for international relations, the former intense trade and ownership links as well as R&D co-operation with Western firms were cut off, and Hungarian companies became dependent on other CMEA countries both in terms of raw materials and markets. Exports and imports, as well as domestic trade, were also separated from manufacturing firms, and were exclusively conducted by separate state-owned companies.

A rigid system of division of labour was also imposed on S&T organisations: basic research was assigned exclusively to research institutes of the Hungarian Academy of Sciences (HAS),[18] while applied research and development had to be performed by the so-called branch R&D institutes, supervised by branch ministries. Teaching, on the other hand, became the only task of universities, i.e. departments were not supposed to conduct research projects, and thus were not given resources for such activities. Horizontal links among academia and industry were also cut off.[19] R&D co-operation of Hungarian researchers with Western universities and research institutes was also controlled along political lines, and hence became much more difficult to maintain, thus weaker and weaker (as in the case of firms' co-operation with their Western partners).

The whole system, and thus the S&T subsystem has become far less rigid and more decentralised since the 1960s, e.g. HAS institutes were engaged in applied research and teaching, too, while university departments also started research projects. Yet, hardly any co-operation has evolved among these 'insulated' sub-sectors of R&D.

The highest authority for R&D policy-making was the Science Policy Committee, while science was administered by the HAS and technology by the National Committee of Technological Development (OMFB), set up in 1961.[20]

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[17] Council for Mutual Economic Assistance, the trade organisation of the former Soviet Bloc

[18] HAS was established in 1825 by a rich, enlightened aristocrat, István Széchenyi.

[19] Until the 1940s large companies had intense co-operation with universities. In addition to the usual way, that is, commissioning university departments to conduct certain research projects, some of these firms were actually spin-off firms from universities (e.g. MOM, an optical company), while others even set up new university departments (e.g. Tungsram established the nuclear physics department at the Technical University in Budapest).

[20] For an excellent, detailed analysis of the Hungarian R&D system and related issues see OECD [1993]. A shorter overview can be found in Balázs *et al.* [1990].

4 FINANCIAL AND INSTITUTIONAL CHANGES IN THE S&T SYSTEM

Although transition has brought about a number of crucial political and economic changes affecting the S&T system, no systematic science and technology, innovation or industrial policies have been implemented since the early 1990s.[21] For methodological reasons it is practically impossible to establish who have blocked various initiatives or why: policy-makers would not disclose any details of these day-to-day negotiations as some important details are confidential, while revealing other details would adversely effect their future 'battles' for funds and influence.[22]

One important reason must have been the lack of adequate funds. Most long-term policies, such as education, infrastructure, innovation, industrial, SMEs, regional, health care, and environment ones, would require either substantial investment projects or generous subsidies, or even both. The transition process, however, has hit most of Central European countries: instead of facing the 'problem' how to spend abundant financial resources they have to cope with significant budget deficits plus find means to tackle more urgent needs, such as rocketing unemployment. One might add, however, that lack of fund would require redoubled efforts to devise policies how to spend scarce resources, rather than not thinking at all on setting priorities.

Sometimes a lack of knowledge about up-to-date policy principles and methods also poses a significant problem, and hence prevents the introduction of them.[23]

As for S&T policy, OMFB [1995] even summarised and published the most common arguments put against a more pro-active S&T policy, together with counter-arguments, in an attempt to convince politicians and government officials that OECD and EU member countries are not following an extreme 'laissez-faire' ideology.[24]

Even this type of rather unusual reasoning has not been powerful enough. Some financial, institutional and organisational changes, though, have happened since the early 1990s. These are summarised in the following sub-sections.

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[21] Policy proposals, however, have been drafted, see, e.g. IKM [1993], IKM, OMFB, PM [1993], OMFB [1995].

[22] It would go beyond the scope of this paper to speculate about political reasons. At a rather general level, however, some, mostly ideology-driven, arguments can be summarised. Given the political and economic legacy of central planning most politicians have been either against any sort of strategic thinking conducted, and actions taken, by the government, or not wanted to 'fight' hopelessly for these ideas, like industrial policy, even if they believe in them. Policy-makers, for obvious reasons, have followed these lines. Ironically, though, quite a few politicians, as ministers, pursued rather etatist policies in their day-to-day decisions, sometimes with rather long-term repercussions, both in 1990-94 and 1994-98 when the two governments in power had rather different political backgrounds. A more detailed analysis of their economic policies, declared and actual ones, would, obviously, require a separate paper.

[23] For example a recent study, Glatz [1998] still treats 'science' as a separate entity, i.e. not in the broader context of innovation.

[24] The prevailing arguments against a more pro-active S&T policy were as follows: 1) Government actions in, or subsidies for, technical development is part of the 'socialist past' (i.e. should be discontinued). 2) Scientific results automatically generate technological development. 3) Know-how and other R&D results should be purchased from abroad (in other words, economic results cannot be expected from indigenous research). We should wait for economic successes that generate resources for technology-intensive development.

4.1 Finance of R&D

4.1.1 Shrinking R&D funds

R&D expenditures have significantly dropped since the late 1980s. Whereas 2.3% of GDP had been devoted to R&D in 1988, this ratio fall to 0.7% by 1996. Given the shrinking GDP[25] and the rather high rate of inflation in this period,[26] it is a dramatic drop in real terms, indeed. According to a recent CSO estimation, using the so-called purchasing power parities method, R&D expenditures in real terms in 1996 were a mere 36% of those in 1990. (OMFB [1997], p. 27)

To compare, EU countries on average spend around 1.8-2% of their GDP on R&D.[27] This is already a huge difference, moreover, their GDP per capita is three times higher than the Hungarian one.

Table 1: Gross domestic expenditure on R&D (GERD) in Hungary, 1988-1996, current prices

GERD	1988	1989	1990	1991	1992	1993	1994	1995	1996
billion forints	32.8	33.8	33.7	27.1	31.6	35.3	40.3	42.3	46.0
GERD/GDP (%)	2.3	2.0	1.6	1.1	1.1	1.0	0.9	0.8	0.7

Source: Central Statistical Office, *Tudományos kutatás és kísérleti fejlesztés*, various years

Inevitably, R&D personnel have also been cut quite drastically, by some 60% compared to 1988. Aggregate figures, as always, hide important differences. In some cases this cut means the necessary streamlining. In some other cases, however, it represents a severe loss of useful knowledge and skills developed and accumulated over time. In other words, it would not be possible to reproduce these intangible assets immediately once funds were made available. There are no reliable estimates readily available on the share of necessary streamlining and severe loss.

The composition of the total R&D personnel has also changed so that the number of researchers and engineers exceeded that of the supporting staff. Again, the overall picture is mixed. In some cases it is a step towards increased efficiency, but in other cases it causes inefficiency at a social level. When highly qualified scientists have to perform simple tasks, instead of spending their time on resolving scientific problems as they are trained for because of the lack of supporting staff, that is obviously a waste of scarce and expensive resources.

Table 2: R&D personnel in Hungary, 1988-1996, full-time equivalent

	1988	1990	1992	1994	1996
Total R&D personnel	45,069	36,384	24,192	22,008	19,776
of which Scientists and engineers	21,427	17,550	12,311	11,752	10,408
Other staff*	23,642	18,834	11,881	10,256	9,268

Source: Central Statistical Office, *Tudományos kutatás és kísérleti fejlesztés*, various years
* Includes technicians, assistants, administration, etc.

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25 In real terms GDP dropped by some 20% by 1992 compared to the 1988 level due to the so-called transformation recession. Although the late 1990s saw significant growth (e.g. above 4% in 1997), the GDP is likely to reach the 1988 level in real terms only in 1999. (author's calculation based on CSO data for 1987-97 published in the *Statistical Yearbook of Hungary 1997* and the government's estimation for 1998-99).

26 The rate of inflation (consumer price index) has been fluctuated between 20-28% a year until the mid-1990s, and was still around 18% in 1997. (Central Statistical Office Yearbooks)

27 The European Commission urges them to increase this ratio in order to catch up with the US and Japan. (EU 1996) The latter two countries spent 2.5-2.8% of their GDP in 1985-1996. (OECD [1998])

4.1.2 Unexpected shift in the sources of R&D expenditures

Given the experience of market economies, some observers and politicians have expected enterprises to play a decisive role in financing and executing R&D, and, in turn, the government to withdraw. Quite the opposite shift has occurred for obvious reasons, and hence not really surprising. Two major elements of the relevant arguments are discussed here.

Most Hungarian companies are suffering from the loss of markets for two principal reasons, namely the collapse of CMEA, their former major market, and swift import liberalisation. Hence their sales had dramatically declined (by 15-75% in various industries) by the early 1990s compared to the last pre-transition years, 1988-89. Shrinking revenues, in turn, prevent them from generating adequate funds for R&D (see Table 3) and investment.

Another element of the explanation is that privatisation only started in 1990, and it has taken time to find investors. In most cases radical re-structuring was necessary both in the organisational set-up and in the product-market mix of these companies in order to prepare for privatisation. Therefore managers were not really in the position to make decisions on long-term issues, including the design and implementation of innovation strategies, for two reasons. First, it would have been somewhat hostile to the would-be owners to tie their hands, which, in turn, would have made the relationship between the (prospective) owners and managers somewhat uneasy. Not surprisingly, managers did not want to cause these types of conflicts. Second, managers were overwhelmed by the preparation for privatisation (re-structuring, cost-cutting, etc.), i.e. by short-term issues. In brief, uncertainties related to the would-be privatisation of companies also hindered innovation until the mid-1990s.[28]

One might find an apparent paradox here: firms do not spend a lot on R&D, yet, fierce competition – loss of former markets, import liberalisation – compel them to introduce new products and/or processes. Indeed, they do so – otherwise would not survive – but in most cases these innovations are not based on their own R&D projects. Quite often they rely on technologies provided by parent companies or other foreign partners, e.g. in a subcontracting agreement. Foreign firms not only encourage their Hungarian suppliers to introduce new products, processes and managerial techniques, but sometimes they even provide licences and know-how free of charge.[29] In other words, R&D expenditures cannot be used as a proxy variable for innovation.

Finally, the significant differences behind these aggregate figures should also be noted. Foreign-owned firms do spend more on R&D than indigenous ones,[30] moreover, they can also rely on the R&D results achieved, or bought, by their parent company.

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[28] For a detailed analysis of these issues see György and Vincze [1992], Havas [1997b], Havas and Inzelt [1994], Inzelt [1994], Inzelt *et al.* [1991], Tóth, G. L. [1994] and Vincze [1991].

[29] For such cases in the automotive industry see Havas [1997a].

[30] According to a recent CSO census, cited in Inzelt [1998], manufacturing firms located in Hungary spent on average 0.86% of their revenues on R&D in 1995. This ratio was 0.97% for (partially or wholly) foreign-owned firms on average, but 1.59% for firms in which foreign ownership was above 75%. Fully Hungarian-owned manufacturing firms, however, only spent 0.64% of their revenues on R&D.

Table 3: Breakdown of GERD in Hungary by sources, 1988-1996, per cent

Funding sources	1988	1989	1990	1991	1992	1993	1994	1995	1996
Business	52.1	45.5	38.8	40.3	31.3	28.6	28.7	36.1	37.4
Government	45.7	52.4	58.6	55.8	62.9	65.1	63.0	55.1	51.2
Other*	2.2	2.1	2.6	4.2	5.8	6.3	8.3	8.8	11.4

Source: Central Statistical Office, *Tudományos kutatás és kísérleti fejlesztés*, various years
* Includes foreign sources plus some non-profit, non-government organisations, e.g. foundations

Short-term issues, that is, radical cost-cutting to avoid insolvency and preparation for privatisation, prevent companies from elaborating and implementing mid- and long-term actions, such as innovation and investment. The number of R&D units operated by firms, therefore, sharply decreased in the early 1990s, yet, considerably increased by 1996, almost reaching again the 1988 level.[31] In 1997-98 a number of large, foreign-owned firms have either substantially increased R&D spending at their existing R&D units (e.g. GE-Tungsram, Knorr-Bremse, Ericsson) or decided to set up new R&D facilities (Audi, Nokia). The expanding number of R&D units in higher education is also worth noting.

Table 4: Number of R&D units, 1988-1996

Type of organisations	1988	1990	1992	1994	1996
Research institutes	69	69	68	63	73
Higher education	944	940	1071	1106	1120
Firms	235	174	98	183	220
Other*	75	73	50	49	48
Total	1323	1256	1287	1401	1461

Source: Central Statistical Office, *Tudományos kutatás és kísérleti fejlesztés*, various years
* Includes R&D units operated at/by national and regional archives, libraries, museums, hospitals and ministries

Foreign aid projects have also eased the severe financial situation to a certain extent. Although foreign funding has increased significantly in relative terms (a significant part of 'Other' sources in Table 3 comes from abroad), these grants have not been able to counterbalance the aforementioned dramatic drop in R&D expenditures, given their low weight. Nonetheless, they have made a significant impact via diffusing new methods to allocate grants (e.g. emphasis on individual projects rather than financing institutes, the importance of project assessment and monitoring). It is also of importance that some vital projects have been continued and significant new ones could be started due to these funds.[32]

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[31] Besides economic reasons behind these changes, there might be some methodological ones, too. Given the organisational and ownership changes occurring on a massive scale, quite a few companies might have not been reached by the Central Statistical Office. Moreover, a number of those reached by the CSO survey might not have answered. The situation has become more settled by the late 1990s, and CSO has also learnt important methodological lessons. Thus more recent statistics provide a more sound base for analysis.

[32] As the Cold War ended, radical changes have also occurred in international scientific and technological relations. Hungarian researchers and R&D institutes can now join mutually advantageous international projects. Hence basically all major international programmes and organisations, such as the 4th and 5th EU RTD Framework Programmes, COST, PHARE ACCORD, EUREKA, CERN, OECD, NATO Scientific Projects and ESA are now open for Hungarian participation.

4.2 Renewed financial support schemes

The most promising development in the transition period has been the renewal of some former R&D schemes and introduction of new programmes (but as already stressed, allocating shrinking funds in real terms). In most cases applicants can initiate projects in any discipline, technology or sector, i.e. the so-called 'bottom-up' approach is applied. In other words, the formerly prevailing 'top-down' approach, whereby government bodies selected certain disciplines, technologies or sectors eligible for R&D subsidies, has been abandoned. Another major institutional change has been the setting up of councils to allocate grants or favourable loans, relying on a peer review system. The three most important funds are as follows:

- Higher Education Development Fund (FEFA) to finance the development of the infrastructure of higher education. It is administered by the Ministry of Culture and Education.
- National Scientific Research Fund (OTKA) to finance basic research. It is administered by the OTKA Office.
- Central Technological Development Fund (KMÜFA), administered by OMFB, to promote technological development.

4.2.1 The role of OMFB

OMFB operates a number of support schemes using KMÜFA money to improve R&D infrastructure, finance applied R&D and the so-called national projects. Grants or favourable loans awarded through these schemes are available for practically all Hungarian researchers or organisations (firms, university departments, other R&D units). Before providing some details of these schemes it should also be stressed that KMÜFA used to be financed directly via a special levy, and hence was not part of the budgeting process, but now is financed from the central budget. This way spending of the tax revenues can be controlled by the Parliament, and hence it can be regarded as a step forward.

This change also raises questions, however, whether sufficient funds are allocated for R&D in the complex bargaining process in which the central budget is set. Table 5 clearly shows that KMÜFA funds varied quite substantially in 1991-97. Until 1994 roughly the same amount was available in nominal terms, that is, a marked drop in real terms. 1995 saw a dramatic decline even nominally, which was not compensated by the modest growth in 1996. Then a further increase in 1997 meant to reach again the 1992-93 level, nominally. Long-term issues, such as innovation, would require a bit more stable environment and less hectic financial decisions, to say the least.

Table 5: KMÜFA funds, 1990-97 (million Ft)

	1991	1992	1993	1994	1995	1996	1997
Residue from the previous year	1,314.8	5,122.4	3,057.3	1,769.2	2,472.8	3,417.1	4,225.1
'Fresh' funds from the central budget	8,253.5	4,814.6	6,786.5	7,139.5	3,485.6	4,158.4	5,947.0
Total	9,568.3	9,937.0	9,843.8	8,908.7	5,958.4	7,575.5	10,172.1

Source: OMFB [1998]

R&D infrastructure projects. This 'bottom-up' scheme was introduced in 1991. Major goals include (a) to upgrade the R&D and educational infrastructure, e.g. to provide grants to purchase

PCs and various instruments, and (b) to facilitate the dissemination of R&D results, e.g. grants to attend conferences abroad if the applicant's paper is accepted, and contribution to organise conferences in Hungary. A growing amount had been spent until 1994, and then a marked decrease occurred (Table 6) because procurement of instruments has been supported from other sources since 1995.

Table 6: Spending on R&D infrastructure projects, 1991-1997 (m Ft)

1991	1992	1993	1994	1995	1996	1997
397	2,162	2,977	2,151	852	307	331

Source: OMFB [1998]

Applied R&D projects. This is another new 'bottom-up' scheme, also introduced in 1991. Project proposals are evaluated by independent technical and financial experts in three rounds. In most cases an interest-free loan is provided. The amount spent under this scheme has varied from 600 million to almost 4 billion forints since 1991 (Table 7).

Table 7: Financial support for applied R&D projects, 1991-1997 (m Ft)

1991	1992	1993	1994	1995	1996	1997
586	2,653	2,087	1,881	1,908	1,189	3,861

Source: OMFB [1998]

Target-oriented national projects. This is a 'top-down' scheme, as opposed to the aforementioned ones. It was introduced in 1992. Four major goals were selected to be supported from public funds: deposition of nuclear waste (165 million forints were spent up to 1996 and none in 1997), development of geographic information systems (589 million forints), food processing and packaging technologies and machinery (342 million forints), and automotive technologies (140 million forints).

Besides these aforementioned schemes, 2,046 million forints were spent to *promote the competitiveness of Hungarian exporters through technological development* in 1990-97, and 207 million forints to finance *patent application fees* abroad in 1992-96.[33] *Innovative SMEs* have also been eligible for financial support since 1989 (297 million forints were spent in 1990-96). 780 million forints were granted to finance the *National Informatics Programme* in 1990-97. A new scheme was introduced in 1996 to support those Hungarian researchers who participate in a project financed by the 4th RTD Framework Programme of the EU, with 122 million forints being spent in 1996-97. Regional innovation initiatives are supported from 1997, together with the regional chambers (327 million Ft). The development and diffusion of information and communication technologies is also promoted by a new scheme launched in 1997 (459 million Ft spent).

Finally, the *Ministry of Industry and Trade* also administers applied R&D funds available from the repayment by firms of former R&D loans provided by the ministry.[34]

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[33] The former scheme was introduced in 1986, while the latter one in 1992.

[34] Prior to the introduction of the aforementioned new schemes, i.e. until the early 1990s, KMÜFA had been allocated among various ministries to fund R&D projects initiated by organisations supervised by them.

4.3 Legislation for a new S&T policy framework

New legislation on higher education and on the Hungarian Academy of Sciences became effective in 1994.[35] These steps certainly contribute to the formulation of a new framework for science policy. Yet, some other bills have also to be passed in order to provide a sound legal and institutional basis for technology and innovation policies. In other words, the current challenge is to build a new environment conducive to technological changes, broadly defined, in a comprehensive, systematic way. Current changes in legislation are summarised in the following subsections.

4.3.1 Act on Higher Education

The Bill on Higher Education was passed in early 1994. The new Act has strengthened universities' autonomy. Among other changes, PhD degrees now are awarded by them, as opposed to the former system, when HAS used to exercise this right. Curricula are evaluated by a new body, called National Accreditation Committee, in a systematic way, and thus it is hoped that the level of higher education will be improved.

Another significant change is that all universities, previously operated under the control of a number of different ministries, are supervised by the Ministry of Education. The 'Hungarian Rectors' Conference' has also been set up as an independent association of universities. Its major role is to act as an advisory body to the Ministry of Education in professional, scientific, legislative and organisational issues concerning higher education. Universities are also encouraged to co-operate with each other and with HAS research institutes through new financial schemes.

4.3.2 New legislation on HAS

A Bill on HAS had already been prepared before 1990, i.e. prior to the political changes, marked by the 1990 general elections. Nonetheless, internal conflicts, namely those between HAS headquarters and research institutes, on the one hand, and between members of HAS and researchers employed by HAS institutes, on the other, as well as ideological battles in the Parliament blocked the legislation procedure for almost five years. Eventually the new legislation was enacted in May 1994.

The new Act changed the structure of the highest authority of HAS. Previously the General Assembly only consisted of members of HAS, now delegates of scientific degree holders also join this body, and have 50 per cent of votes. The Act also stipulates a guaranteed annual support from the central budget. The network of HAS research institutes is subordinated to the HAS and governed by the 'Council of Academic Research Institutes'. Research institutes, however, enjoy a certain degree of autonomy. Financial support is allocated by three research councils on the basis of research evaluation. A new scientific degree, namely 'Doctor of Sciences' is awarded by HAS. It is a prerequisite for becoming a member of HAS. Co-operation with universities is also promoted by this Act.

4.3.3 Intellectual Property Rights

A number of measures have also been taken to strengthen intellectual property rights. Under the previous law so-called process patents also used to be registered in Hungary. Hence pharmaceuticals companies, for instance, were able to 're-invent' drugs by finding new methods to produce molecules known from others' medicines. Obviously it was cheaper than to develop original drugs or pay a licence fee. Since July 1994, however, this 'smart' method cannot be applied any more. Sales of software packages, audio tapes and CDs are also checked regularly, and illegal copies are destroyed in a demonstrative way.

4.3.4 Reorganised government bodies

Major government bodies have also been reorganised. Hence the role of the government in R&D and innovation is still evolving.

The former Science Policy Committee was dissolved in 1994, its secretariat moved from the Prime Minister's Office into the Ministry of Culture and Education, and a new committee, chaired by the Prime Minister, was set up. It was reorganised again in February 1999.

OMFB has also been reorganised. In 1990-94 its President was a member of the cabinet in the capacity of a minister without portfolio, responsible for technological development. In the new organisational set-up it was supervised by a designated member of the cabinet from 1994 to1998,[36] and by the minister of economic affairs from January 1999. Besides the usual tasks, such as elaboration of technology policy, provision of financial support for technological development, and the organisation of international S&T relationships, a new responsibility has been added, namely to conduct technology assessment and technology audits. Strategic issues are decided upon by the Council, consisting of representatives of certain ministries and independent experts who are appointed by the Prime Minister for three years.

The foregoing subsections suggest that important organisational and legislative changes have occurred in recent years. Yet, more co-operation and co-ordination among the major players would be desirable. That would promote commercialisation and diffusion, what is perhaps the most important task for any S&T policy, but it is definitely 'the' crucial task in Hungary.

4.4 New initiatives to promote commercialisation and diffusion

Central planning has had far-reaching bearings on the Hungarian R&D and innovation system since the late 1940s. The most important one has been the lack of economic exploitation of the internationally respected R&D results achieved by Hungarian scientists and engineers.[37] Thus it is of crucial importance to introduce innovation policy tools capable of promoting the commercialisation and diffusion of new technologies.

Following the above realisation the Hungarian government has decided to establish new types of applied R&D institutes. The aim is to facilitate a closer, mutually beneficial co-operation among universities, R&D institutes and industry, following the German Fraunhofer Institutes' model. These new institutes are partially financed by the *Zoltán Bay Foundation*.[38] Three Bay institutes have been inaugurated since 1993, devoted to biotechnology (in Szeged), logistics and production technologies (in Miskolc), and materials sciences (in Budapest).

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[35] For a more detailed description on the new legislation on HAS and higher education see Balázs [1994].

[36] It was not stipulated in the government decree on the responsibilities and organisation of the OMFB who was to be its minister. In practice it was the minister of industry, trade and tourism.

[37] Havas [1994] discussed this general problem using the example of laser technology.

[38] Zoltán Bay (1900-1992), working for a major Hungarian company, Tungsram, as a physicist, made the first ever radar contact with the moon in 1946. A few years later he emigrated from Hungary to the USA.

The *Hungarian Innovation Association* has established its own *database* of development capacities (skills of R&D and engineering consultancy groups) in an effort to act as a catalyst between technology suppliers and users. Another major step taken by them has been to found a *Business and Innovation Centre* in Budapest together with the *Chamber of Small and Medium-Sized Enterprises*, the *Hungarian Chamber of Commerce* and *Innotech kft*., relying upon a *PHARE* grant.

Liaison offices and science parks have also been set up at technical universities to facilitate academia-industry relations. Preliminary experience, however, suggests that it takes time to find an appropriate mission, strategy and internal organisation, let alone adequate funds and skilled managers, for these new institutions amidst the complexity of the transition process.

The Hungarian Foundation for Entrepreneurship has set up a number of regional offices to help establish new businesses and the diffusion of information on new products and technologies.

Several foreign funds have helped to set up information and knowledge transfer organisations. As a systematic, thorough evaluation of their activities has not been conducted, it is not known whether these organisations are effective. Sporadic evidence, e.g. interviews with their directors, indicates that firms frequently use their free services, especially information services. In other words, firms are happy to have a free lunch but nobody knows whether fledgling SMEs or the government will be able to finance these organisations (through fees and/or grants, respectively) once foreign aid projects conclude.

5 POLICY CONCLUSIONS

Although innovation is a fairly complex, non-routine, non-foreseeable socio-economic process, and hence no panacea can be prescribed for how to foster it, some policy conclusions can be drawn from recent research projects.[39]

Evolutionary economics, based on thorough empirical analyses of the innovation process, has provided a new policy rationale, a different one from that based on neo-classical economics. This new approach is gaining ground in more and more advanced countries. Some important organisational and legislative changes have occurred in Hungary, too, on the whole in line with the recent international trends. Yet, a deliberate, systematic innovation policy is still lacking for a number of reasons. The heritage of the former socio-economic system, current economic and social difficulties caused and/or revealed by the transition process, and partly ideological, partly socio-psychological stands against the apparently increased role of government all constitute obstacles on the road. Moreover, there are vested interests against concerted efforts. In short, there is a long way to go. There is a lot to learn from recent theoretical results and policy approaches, and an even more demanding task is to devise and implement a coherent socio-economic strategy with innovation in its centre.

5.1 Methodology of policy making

History clearly shows the interdependence of technical, economic and social change. Policy decisions should, therefore, be based on an *integrated approach*, taking into account the systemic aspects of the relationships of technology, competitiveness and growth together with the importance

[39] This section draws on Havas [1995], as well as on empirical and policy studies mentioned in references.

of social, institutional and cultural factors in a country's ability to profit from technological change. Techniques and methods to support this approach include:

- regular conduct of *foresight studies* to identify critical issues, major technological. market and social trends so as to improve quality of life and competitiveness;

  Foresight exercises are aimed at achieve a cultural change; better communication, mutual understanding and co-operation between the scientific community, industry and government departments. The first Hungarian Technology Foresight Programme was launched in 1997, to be completed by 1999.
- strong(er) representation of *local and regional interests* so as to harmonise those with the national ones.

Policy decisions should be integrated in a technical (pragmatic) sense as well:

- innovation, industrial, investment, privatisation, competition, trade, monetary, fiscal, education and labour market policies must not be devised, implemented and evaluated separately since all have considerable impact on enterprise behaviour, and hence innovation;
- former and current actions should also be seen in an integrated way: (a) the legacy of previous measures simply cannot be ignored, moreover, (b) an extensive use of information on their impacts is inevitable when designing the new ones, i.e. regular *monitoring* and e*valuation* of all the major policy measures should be devised.

5.2 Policy measures

Experience of successful countries suggests two major lessons: *(i)* it is the *firms'* task to undertake the bulk of innovative activities, however, *(ii) governments* can, and indeed should, also play a vital role by shaping the institutional characteristics of the *national system of innovation* and providing favourable *international relationships* within which it operates. The overall, twin, objectives are to improve international competitiveness of firms and the economy as a whole and to enhance the quality of life. The above '*networking' activities* can considerably contribute to achieving these ultimate goals via creating environments conducive to innovation. This includes the task *A)* to establish an appropriate physical and institutional infrastructure to advance the *generation of new technologies, skills and knowledge* as well as *B)* to facilitate the *diffusion*, that is, both adoption and adaptation, of technologies in order to improve the system's ability to take advantage of technological change. Recent analysis has, however, strongly indicated that innovation is an interactive process, and hence the earlier distinction between the creation of technologies and their diffusion cannot be held. It is, therefore, of utmost importance to devise and implement an integrated policy approach in this sense as well.

Transition poses specific challenges, too. A major one is that financial difficulties together with exaggerated market ideologies might lead to policy suggestions aimed at further 'marketisation' of R&D. It seems needless to stress that this would be a fatal misconception.

It is also of importance to learn from the mistakes made by industrialised countries' governments. Hence the Hungarian government should **avoid**: 1) policies that seek to pick winners, and 2) creating 'islands' of innovation through selective support of certain high technology industries.

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