INSTITUTE FOR WORLD ECONOMICS
HUNGARIAN ACADEMY OF SCIENCES

Working Papers

No. 172 October 2006

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R and D, and Competitiveness in the Enlarged EU. The Role of the State and Financing

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SUMMARY

Technological development during recent decades has led to increased world-market competition. The material-intensive, medium-quality products of a technological level with low intellectual content are not only loosing value at a rapid pace but even tend to suffer the absolute loss of their markets. The world-market position of the countries supplying such products is ever weaker.

During the 1990–2004 period, the efficiency of technological development and the innovative capacity of the economy had an ever stronger effect on world-market position. The tendency is also prevalent at the turn of the millennium. The EU countries dedicate different ratios of their GDP to R and D, and the efficiency of technological development also varies from country to country.

The enlargement of the European Union in 2004 has significantly increased the community's potential in terms of human capital, scientific research, intellectual products and qualified manpower. Despite the enlargement of the EU, its total R and D investment has only grown to a limited extent.

The state has the primary task to enhance scientific research and inventions by spending the highest possible amount on R and D to have results that can be turned into marketable products by innovation, thereby enabling the economy to catch up with the required level and to develop further. The products and services gained in this way lead to an increased world-market share and improved terms of trade. However, due to limited public financial resources the role of the corporate sector in financing R and D is ever increasing. This role can be greatly enhanced by any country if its economic policy and the characteristic features of its research policy are aimed at stimulating R and D.

INTRODUCTION

The impacts of the technological revolution have greatly transformed the whole environment of the international division of labour and the international economic, technological and scientific relations. As a result of the common impacts of the information and telecommunication revolution, from the strongly advocated but 'speculative globality', mankind has entered the era of actual globality.

Globalisation is accompanied by an accelerated rate of technological and scientific competition, influencing the political power potentials stronger than ever before and also determining the world-economic arena by the positions of the actors of economic and technological competition. The development, utilization and trade of the new technologies represent a qualitative difference in the traditional trade of goods and classical world-market competition. The new characteristic features of technology transfer greatly determine the international expansion of technological development.

The flow of the new technologies is based more and more on a steady contractual and institutionalised seller and buyer relation and regulates not only the buying and selling between the supplier and the buyer or user but also the conditions of how the technology is applied, the products manufactured are traded with, marketed and priced, the transferred technology operated and developed further. Technology transfer is an increasingly complex package. Machinery, equipment and fixed capital mainly represent a minor part of this package, while the technological, management services package and know-how the major part of it. With high technology requiring direct investments, another important feature is that the flow of technology depends more and more on foreign direct investments. The processes of adaptation are determined by the characteristics and impacts of the new technology, the specific features of the international economic and political relations as well as the internal tasks related to technological, economic and social adaptation.

The new technological transformation is led by a few industrial powers. At the beginning of the 21st century, the United States, Japan, Germany, Great-Britain and France represent one-fifth of the R and D activities and an approximately 70–80 per cent ratio of the technology transfer.

Evaluating the hierarchy of international technological development, the conclusion of our research work is that the scientific technological power potentials have created new dependencies, the main beneficiaries of which are the countries which are leading innovators.

From among the follower countries, the ones that have primarily been able to reinforce their world market positions are those whose economic policy and institutional systems are based on an innovation friendly environment and which actively stimulate the flow of technology, domestic adaptation and development and whose export policy has enabled them to join the international process of technological transformation.

The solution of the global problems, technological development and the new trend of the international division of labour require a more intense and organic technology transfer than ever before.

By the end of the last century, scientific and technological transformation already had an extremely strong international feature. Today, even the countries with the largest internal markets are unable to maintain the concept and practice of self-sufficiency in the field of science and industry. Protected industrial sectors and markets increasingly lag behind world standards. The international sources of the new technology are of ever higher

significance for each country. In the technology transfer of the industrially developed countries high technology is more and more determined by direct foreign investments which implies that the flow of high technology and direct foreign investments are ever more inseparable.

Analyzing the forms of international technological transfer, it becomes obvious that the establishment of the various forms of scientific, technological and industrial cooperation is strongly stimulated by the international trend of production, including the various international corporations operating in the field of research and development, the (often reciprocal) patent and license agreements and common production contracts as well as the international investments of the transnational companies.

With the transfer of modern technology, traditional vertical integration has lost its importance, while the various phases and functions of the production process are ever more significant. Information and telecommunication technology has a 'sine qua non' role in it.

Innovation, competition and technology transfer are not only interrelated but can also be reciprocally generated. While technology transfer is one of the main sources of innovation, the needs, criteria and results of innovation greatly determine the prospects of technology transfer.

Technological development has the most favourable impact on economic growth and international competitiveness in the economies with high solvent demand for high-tech products, where the obsolete products are replaced to eliminate the increasing difference between the old and new technologies, the cost per product is reduced significantly, and the pressure of competition stimulates an intensive innovation activity.

Technological development during recent decades has led to increased world, market competition. The material-intensive, medium-quality products of a technological level with low intellectual content are not only loosing value at a rapid pace but even tend to suffer the absolute loss of their markets. The world-market position of the countries supplying such products is ever weaker.

The basic objective of the European Union's research and development policy is to promote the efficiency of R and D to the benefit of the member states by their common efforts and their R and D activity and international cooperation since national frameworks have proved to be insufficient to achieve such results. Such concentrated efforts in the international technological and world-market competition are ever more imperative for Europe since spending 2–3 per cent of the GDP on R and D represents an increasing challenge for it. The relatively less developed EU countries spend less than 2 per cent, while the United States, having a much higher economic, scientific and R and D potential, spends nearly 3 per cent, and Japan over 3 per cent on research and development.

1) The context of the research and development policy, innovation and competition in the European Union

During the 1990–2004 period, the efficiency of technological development and the innovative capacity of the economy had an ever stronger effect on world-market position. The tendency is also prevalent at the turn of the millennium. The EU countries dedicate different ratios of their GDP to R and D, and the efficiency of technological development also varies from country to country.

The R and D potential of the enlarged European Union. A comparison of the old and the new member countries

The enlargement of the European Union in 2004 has significantly increased the community's potential in terms of human capital, scientific research, intellectual products and qualified manpower. Despite the enlargement of the EU, its total R and D investment has only grown to a limited extent. In 2002, the EU-15 countries spent EUR 182.49 billion on R and D, while the EU-25 EUR 186.4 billion. In the EU-15, on average, the corporate sector financed 56 per cent of R and D and in the EU-25 55.4 per cent. From 1998 to 2003, in the EU-15 R and D expenditures grew by 4.3 per cent and in the EU-25 by 4.0 per cent annually.

The value of R and D investments. The share of the member states

The enlargement of the EU has not changed its R and D investment potentials significantly. Both the old and the new member states show a varied picture of the growth rates and their R and D investment ratios in the GDP. Germany ranks first by investing, in 2003, EUR 53.2 billion on R and D. This amount equals 29.2 per cent of total EU-15 investments and 28, 6 per cent of that of the EU-25. France ranks second with its 18.7 per cent ratio in the EU-15 and 18.3 per cent in the EU-15. With its 17.1 per cent and 16.7 per cent ratios, just behind France, Great Britain ranks third. Italy has the fourth largest R and D potential with its 8.0 per cent ratio in the EU-15 and 7.8 per cent ratio in the EU-25. The four leading EU countries represent 72.9 per cent of investments in the EU-15 and 71.5 per cent in the EU-25. In the EU-15, the value of total R and D investments is high in Sweden, the Netherlands, followed by Belgium, Finland, Austria and Denmark. In 2003, the total R and D investment of the new EU-10 only reached EUR 3.55 billion. This amount is much lower than the investments made by Denmark (EUR 4.9 billion). Among the new EU-10, Poland and the Czech Republic spend over EUR 1 billion on R and D each year. In 2003, Hungary spent EUR 708 million, Slovenia EUR 375 million and Slovakia EUR 164 million on R and D.

The growth rate of R and D, and the ratio of R and D investments in the GDP of the EU countries

In 2003, in the EU-15 the ratio of R and D investments in the GDP was 1.99 per cent and in the EU-25 it was 1.93 per cent. With its yearly 4.27 per cent (a 2001 figure), Sweden spends the highest ratio of its GDP on R and D. Finland spends 3.51 per cent (a 2003 figure), Denmark spends 2.6 per cent. Germany, Belgium, France, Austria spend 2–2.5 per cent. It is surprising that the Netherlands, having achieved outstanding results in the field of innovation and international competitiveness, only spends 1.9 per cent. (During the 1998–2002 period, this ratio dropped from 1.94 per cent to 1.89 per cent).

Among the new EU-10, Slovenia has the highest ratio by spending 1.53 per cent. The Czech Republic ranks second by spending 1.35 per cent. In 2003, Hungary did not spend even 1 per cent of its GDP on research and development, and in 2004, this ratio further decreased. Poland has an extremely low ratio of 0.59 per cent, which during the 1998–2003 period dropped even further. In the other new member states the ratio of R and D activity is rather low, except for Lithuania with its 0.68 per cent ratio in 2003, preceding Poland.

In absolute value, the total R and D potential of the new EU-10 is lower than that of Austria. In the long run the EU-10 are meant to cope with two disadvantages. With their GDP income lower than that of the old member countries, they can spend an even lower ratio on research and development.

The enlarged European Union is suffering a huge disadvantage as against the United States. The US is one single country with one single economic unit, while Europe has no single economy and research potential. The EU-25 spend a lower ratio of their GDP on R and D than the US or Japan. The EU-25 spends 1.93 per cent, the US 2.76 per cent and Japan 12 per cent (2002 data).

R and D financed by the corporations

The state has the primary task to enhance scientific research and inventions by spending the highest possible amount on R and D to have results that can be turned into marketable products by innovation, thereby enabling the economy to catch up with the required level and to develop further. The products and services gained in this way lead to an increased world-market share and improved terms of trade. However, due to limited public financial resources the role of the corporate sector in financing R and D is ever increasing. This role can be greatly enhanced by any country if its economic policy and the characteristic features of its research policy are aimed at stimulating R and D. On average, in the EU-15, the corporate sector financed 56 per cent of R and D activities, while in the EU-25 slightly less, 55.4 per cent, only. (The new member states do not really modify this ratio, of course, because their ratios are rather insignificant.)

Involvement of foreign capital in R and D financing

Foreign investments determine R and D efficiency decisively. In the EU-15, 7.76 per cent of R and D being financed by foreign capital is a relatively high average ratio. In the EU-25, this ratio is 7.63 per cent, only meaning an ignorable difference. The various countries show, however, huge differences. In Lithuania, with 35.6 per cent the ratio of foreign capital is extremely high. Lithuania is followed by Austria, where the ratio of foreign capital reaches 21.7 per cent, enhancing Austria's high R and D performance. Cyprus, Estonia, Belgium, the Netherlands and Hungary represent 10–15 per cent. In Hungary, the ratio of foreign capital is somewhat over 10 per cent. The ratio of foreign capital is the lowest in Luxembourg, Germany and, surprisingly, the Czech Republic (1.6-2.7 per cent).

The total technological development potential of the EU countries is less than 60 per cent of the US potential, but by approximately 60 per cent higher than that of Japan.

In Germany, Great Britain, France and the Netherlands, the ratio of R and D in GDP is high (2,3–3,0 per cent). In Italy, Denmark and Belgium this ratio is under 2 per cent, while in the South European countries it is marginal, although increasing.

Economic performance can be enhanced by rationalized R and D activities and by shortening the time between research and investment. Such performance explains R and D efficiency, *i.e.* the high level of innovation and competitiveness in the Scandinavian countries and Ireland during the period between 1995 and 2004.

The factors determining R and D efficiency include the number, qualification and creativity of those working in the field of research and development. The number of scientists, engineers in the EU is over one million. The bulk of inventions proves that European researchers are rather efficient.

During the 1995–2004 period, the basic tendency is a shift in the role of the state to indirect incentives, stimulating technological development and creating the necessary framework for it. Direct government incentives are primarily based on regional subsidies and funds for certain high-risk and special public projects, such as environmental protection, water management, waste neutralization and recycling.

Over this period, the EU achieved improving results in the field of product innovation. The products newly launched on the market have an increasing ratio in total turnover. Comparing the EU countries to the international arena, it can be said that the ratio of the products in the mature and declining phases of the market-life cycle is high, making them vulnerable in world market competition.

R and D investments only represent one fourth of the innovation expenditure. The other innovation activities still require triple the amount of R and D investments to generate the expected market results. This means that the R and D activity is a key factor of technological and economic progress. The ratio of R and D investments within the innovation expenditure has decreased, while technology development and production preparation increased.

Technological development in the EU industries is being focused on product and technology innovation alike.

The generation of new products creates problems in the following three main areas:

1) Research deficit: insufficient R and D means that the new marketable solutions are missing.
2) Demand and acceptance deficit: there is no demand on the new products launched on the market or demand is delayed (problems of launching and pricing the new product on the market; unwillingness to accept novelties, *etc.*).
3) Lack of continuity: the basically new technological solutions break continuity, mean a breakthrough in innovation and lead to an innovation cycle.

The basic dilemma of innovation is represented by the rising costs of innovation and the ever shorter market-life cycles. With the market-life cycle of the new products being shorter, the companies need to achieve a faster return on their investments. While the capitally strong large enterprises enjoy a stronger position in the technology-intensive fields requiring higher investment per product, the small and medium enterprises may improve their chances to catch up with the required level by means of the ever more intensive utilization of the technologies developed.

Information technology (information processing) is a top priority in the EU's innovation investments. Other priorities included in the corporate plans are the automation of production, the introduction of new production procedures, as well as the upgrading of the functions of the existing products. The integration of the data processing, information and communication technologies is hoped to strengthen the EU's world-market position. For the medium enterprises this would mean that the disadvantages they previously suffered could be reduced and, in certain fields, even terminated.

Future-oriented technological development increasingly demands cooperation among the developers and users of the new technologies. The time and capital requirement of developing the research-intensive areas can be significantly reduced for each participant within the framework of such cooperation. Several enterprises lack the capital and know-how necessary to implement projects based on new technologies. Long-term technological development is mainly based on the contractual cooperation of the large enterprises.

The EU policy of technological development greatly contributes to overcoming the obstacles and risks restraining innovation. Figures show that in the processing industries of the EU countries, the volume and scope of the subsidies for innovation are of as high importance as the liberal market principle itself. Indirect market subsidy accompanies the conspicuously high ratio of direct project subsidy which means that a considerable part of the means of development are not distributed according to the 'watering can' principle, allotting an equal portion to all, but according to the nature of the project to be developed.

Technological progress is greatly dependent on the investments of the private enterprises in innovation, while basic research is conducted, the research and educational infrastructure is financed and modernized mainly from public funds.

As a reaction to the economic recession entailing a decline in profits at the beginning of the 1990s, investors started to rationalize their investments, with technological development emerging as the main focus of these investments becoming the basis or driving force of economic development. During the 2001–2003 recession, investments were, however, considerably reduced.

Technological progress has a manpower-replacing general effect in the EU too, leading to major staff reduction in the building and ceramics industry, iron and steel production, wood processing, agriculture and the food industry, and also in the trading and transportation services.

The market-oriented services, banking, insurance and consulting sectors, health care, education and scientific research make headway both in terms of employment and investment. In such public services as postal and telecommunications services, employment is rising. This means that employment, restructuring, growth and export potential primarily depend on the pace of technological development in which the state has an increasingly important role.

The main trend of modernization at present is and in the foreseeable future will remain determined by the investments made in the information and communication technology sector. Extremely high amounts are being invested in such technology in the field of postal services, office and IT equipment manufacturing by banks, credit institutions and insurance companies. The industrial sector also tries to overcome its difficulties by investing ever higher amounts in the application of information technology.

In the EU countries, each sector of the economy conducts activities for technological development. Although there is a considerable number of new inventions in each sector, the highest volume is, however, represented by the machine and automotive industries and the chemical industry.

The most important factors stimulating investment aimed at technological development are the results of technological development, marketable products with positive prospects, high profit, acceptance of the new technology by the employees, good financing opportunities and the framework of economic policy.

2) The main features of research and development policy in the EU countries and its main impacts on competitiveness

The national policies of technological development are rather heterogeneous, with varying scopes, means and impacts. The EU countries that have been more successful in technological development are those where the policy of technological development has mainly used indirect tools based on the driving force of technological development and not on unrealistic and costly preconceptions (Germany, Great Britain, the Netherlands).

Although the funds from Brussels for financing are limited, covering only a small ratio of R and D activities, EU programmes greatly enhance development in the various fields.

In the years after 2000, the future competitiveness of Europe's R and D, innovation and technologies are influenced by the new processes and contexts, and also by the changes that started previously. Economic policy and the policy of technological development stimulating R and D and innovation should react to these impacts.

The processes of globalisation, integration, regional and sub-regional development go hand in hand, strengthen or often, in a contradictory manner, hinder each other. The international flow of capital and the world trade of technologies as global processes are determined by the strategy of multinational corporations for expansion and for the development of respective places of business. This is the reason why technologies gain an ever increasing global involvement. Globalism and regionalism, the mutual relationship of the national states, their dependencies are taking a new shape. Efficient R and D, and innovation, increased competitiveness depend decreasingly on traditional factors.

The GDP per capita achieved, the assets accumulated and the existing material base are of ever less importance in catching up with the required standards and technological development. In this respect, the classical benefits offered by the respective locations and the traditional production factors are also loosing significance. Human capital, training and education, especially high-level vocational training, the concentration of R and D human potential are of growing importance for research and development, and as such for technological investments, too.

One of the key factors of development is how the process from R and D to introducing the new products and technologies can be made smooth and accelerated. Production and market infrastructures, similarly to technologies, inventions and procedures, are ever more important factors determining the place of business.

Europe's decline over the past two decades has primarily been due to not being able to establish the dynamic and attractive conditions that the US has created for the rapid implementation of R and D and innovation and for changing the technological structure. The US and the multinational corporations are at an advantage and Europe at a disadvantage; not only in terms of capital but of strategy and the flow of technology, too.

For long, Europe has not been able to face the challenges of increasing globalisation mainly because of its inflexible structures. The awareness that an innovation-friendly environment and economic policy are indispensable exists both in the EU and throughout Europe.

The main factor for Europe to take off is the human potential, which precisely in the 21st century coincides with the factor that determines technological competitiveness. The 'trump' of Europe, including Western and Central Europe, is represented by the high level of European R and D in numerous areas, the relatively high level and broad system of secondary education and vocational training, the well-established structure of tertiary education and post-gradual training and their level which is also competitive in international comparison. The feeling of responsibility, the strategies, the economic policy and the financing role of the respective countries form the basis for this.

In Europe, several sub-regions have become development centres having the high level of infrastructure required by education, vocational training, research and innovation. These centres of attraction, with the Euro regions joining them, often become the centres of progress and breakthrough for whole regions. It is extremely important in the context of Central Europe, including Hungary.

On the threshold of the 21st century, the turning points in technological development not only change the various conditions of development but also the chances for reaching the required technological standards and competitiveness.

'Latecomers' also have new prospects to take off. The unavoidable need for adaptation, pressurized by globalisation, also entails the rising value of an innovation-friendly environment, society, economic policy, R and D and highly qualified manpower. The countries and regions that are faster and more efficient to react than their competitors may have a chance to break through and take off.

Since the above factors mainly depend on the economic policy, on R and D policy and technological development, small countries and those not being rich in the traditional production factors have new opportunities to take off. European integration is ever more open. On an increasingly open commodity, capital and services market the value of regional policies and R and D attracting ability is rising.

Since education, vocational training, and R and D strongly depend on national policies and systems, the educational system is based on a national framework and dimension in each country. Furthermore, the content and development level of the system vary from country to country. Therefore, with the traditional production factors, opportunities and conditions being levelled and the growing integration of the markets, the only real market factor, namely human capital, including the potential for technological development, is of ever higher importance. Whether Hungary is (also) ready to focus its economic and development policy, and priorities on the development of human capital will determine the country's international competitiveness.

R and D policies in the Western European countries are mainly not different in terms of the magnitude of capital invested or the investment's ratio in GDP, but in terms of the innovation friendliness of local environment and the ability to structure R and D potential properly and to implement the innovation process at high standards. The efficiency of technological development depends increasingly on the interconnection of technologies, the quality of forward and backward relations as well as the diffusion of R and D and innovation.

If Western and Central Europe wish to raise their competitiveness, they will need to eliminate several bottlenecks. With their information and communication technologies (ICT) they still greatly lag behind the US. One reason for this is the low level of the utilization and diffusion of physical ICT tools (PCs, electronic trade, telecommunications). The other reason is related to the qualification of the human factor, the inflexible nature of economic policy and the structural disadvantages need to be terminated. According to the European Information Technology Observatory (EITO), the USA dominates the lion's share over one-third of the ICT market, while the total share of Western Europe is 30 per cent.

Europe's disadvantage marked by its lower competitiveness is due to several reasons. First of all, it should be mentioned that no perfect comparison can be drawn since the EU is not one single country. Although during the 90s its internal market was established, the EU continued to be made up of heterogeneous regions with different levels of development. This means that for surviving in the international competition and reducing or eliminating the technological gap significant efforts should be made. The EU is far from being a 'technological community' that matches the US or Japan where corporations, laboratories, research centres and universities operate under the same legal framework and homogeneous conditions.

The EU lags behind because of its measurable per capita ratio of R and D investment in GDP. The ratio of human resources such as scientists, researchers and developers is extremely important. It is interesting to note that while in the Euroatlantic region nearly 40 per cent of R and D is financed by the state and 53–59 per cent by the business sector, in Japan the companies' stake is 73 per cent and the state covers merely 20 per cent.

In addition to the direct, measurable subsidies, the indirect subsidies are also of ever higher importance. In this respect, tax holidays may have the highest stimulating effect. In the EU countries the tax-holiday system shows a rather varied picture of 12 per cent to 400 per cent for innovation, investment, R and D staff increase, top priority research, copyrights royalties, investment in machinery and equipment, *etc.* Some member states (Italy, Spain) even have regional incentives. Furthermore, similarly to the OECD countries, the total amount of current R and D investments can be deducted from the tax base during the year when they are made. Indirect subsidies being similar to those of the major competitors are, presumably, not the reason for lagging behind standards but rather the scattered nature of the system and the capital to be invested.

There are also numerous other factors having an impact on R and D, among them the growth rate of Western Europe that was continuously low and lagging behind the US up to the mid-nineties. The 2001–2003 recession again had an adverse impact on investment which has even worsened due to such unexpected costs as that of the German reunification or the support to Central and Eastern Europe. The US or Japan have never had to incur such costs.

Naturally, the level of training and education, the implementation of life-long learning and the infrastructure and labour-market related regulations are of extremely great importance. Enhancing innovation by risk capital, reduced bureaucracy and an inventor-friendly patent system are factors not to be ignored, either. The behaviour of the managers leading strategic companies, the impact of national and EU competition policies and the social perception of technological development are also crucial elements. The role of the state and society in catalysing development is of primary importance.

3) The transformation of the economic role of the state and the factors of technological development

The role of the state has the strongest and a greatly indirect impact in areas where

* development has a long-term time requirement,
* the result has an impact on multiple areas,
* private developments are not profitable or may not yield private profit,
* development is necessary due to social criteria and development projects require large-scale institutional coordination, and
* demands and orders are from the public sector or the military industry.

The impacts and consequences of the scientific technological revolution go far beyond the scope of technological development in the narrow sense of the word and have an impact on the economic processes, the economic environment, the behaviour of the actors and the activities of the governments. The main areas of restructuring or transformation are:

* economic strategy,
* change in the ratio of the production factors,
* modification of the criteria for the investment decisions, and
* transformation of the institutional system of the economy.

All over the world, technological development has a dynamically growing role in economic strategies. This global feature is due to the increased ratio and role of R and D, know-how and innovation in value adding. All this is also reflected in the

production factors ratio shifting to the intellectual capital. Being aware of its importance, the industrially developed countries specify their strategies for technological development and innovation together with their objectives and tools in their act(s) on innovation, technological policy, research and development. The significance of these acts lies in specifying the role of basic and applied research, stipulating the conditions of subsidies, determining the objectives of the development strategy of the government and the basic features of the policy of technological development and specifying the relevant public institutional system. The investment acts and financial regulation also have a determining role in stimulating innovation and developing favourable conditions for it. Today, the conditions enhancing innovation and coordination are of great importance in the technologically developed countries.

The main factors of improving competitiveness

All the benefits and positive effects granted so far by the Framework Programmes are partly valid for the new EU-10, including Hungary. Due to their special situation small countries have their own specific experiences.

The main effective strategic pillars of research and technological development policy in small countries are:

* catching up actively with the required standards and
* diffusion orientedness.

Catching up actively with the required standards also means

* learning, accepting, adapting and further developing the new knowledge that is generated and can be utilised in a selective way,
* utilizing the existing and potential comparative advantages meant by the size and characteristic features of the respective small country,
* taking into consideration the structural features of the respective countries,
* producing original results based on the specific features of the country.

When small countries are trying to catch up actively with world standards, right selection is imperative and should be based on the following:

* advantageous domestic features,
* traditional professional cultures,
* opportunities provided by the internationally recognized and competitive R and D bases and their further development.

The experiences of small countries with regard to the Framework Programmes so far show that the other pillar of a successful policy of research and technological development is diffusion orientedness, focusing on the new results of R and D and on efficiently utilising and diffusing the new technologies.

According to experiences in the developed countries of Western Europe, long-term priorities are meant mainly the following areas:

* information and communication technologies,
* biotechnology,
* environment protecting and environment-friendly technologies,
* technologies using new materials.

Primarily in Denmark, the Netherlands and Hungary food processing should be included in this category.

Over the past years, efforts have been made to enhance progress in the following areas:

* place the technological evaluation systems on a qualitatively new basis,
* apply regulatory systems stimulating the purchase and sales of technology,
* common actions of governmental and regional bodies and institutions, and co-operation with the R and D organisa-

tions, universities and the private corporate research sector,

* conduct technological impact analyses to support decision-making, and
* promote the patenting of domestic inventions abroad.

Developing and consistently enforcing the economic policy and national strategy of the state is imperative.

4) The role of the state. The main context of an efficient R and D policy and international competitiveness

(1) During the 1998–2004 period, the relationship between an efficient R and D policy and technological development, the innovative capacity of the economy and its competitiveness on the world market grew stronger due to the increasing value of innovative potential. The EU countries spend different ratios of their GDP on R and D, therefore, there are huge differences in their R and D efficiencies.

(2) Over the past years, the EU countries have recognised that the international competitiveness of their economies cannot be enhanced by defensive strategies, therefore, they need an expansive innovation strategy aimed at creating new markets by means of attractive novelties. With regard to specialization this strategy should take into consideration the structural impacts of the international division of labour, and especially the changes in the benefits from exports and imports and should also explore new, future oriented areas.

(3) The expansive innovation strategy is based on two pillars:

a) the basis of know-how necessary for technological development can only be ensured by an ever more intensive and wide-ranging R and D activity;

b) adequate economic development can only be achieved if know-how is not only created but is also utilized through innovation recognized by the market.

(4) During the period 1998–2004, EU enhanced its product innovation significantly. The market expanded not only as a result of the novelties but also as that of the large-scale innovation of the products already existing on the market. The ratio of the products which have been launched on the market started to increase their market share in total turnover. Based on international comparison, the ratio of the products in the mature and declining phases of the market-life cycle in the EU countries is relatively high, making them extremely vulnerable in world market competition.

(5) Since the continuous effort of over 80 per cent of the product developers is to modernize and upgrade the product structure, the feasibility of production has an ever increasing role in ensuring technological and economic competitiveness. With the automation of production and the introduction of modern technologies the objective is to enhance the flexibility of production. This applies not only to the production process but also to modern data processing, information and communication technologies aimed at rationalising corporate management. In most recent years, this has been the main source of rationalisation in the EU countries.

(6) The investments in research and development only represent one fourth of the innovation expenditure. Triple the amount of R and D investments should be spent on other investments aimed at innovation until innovation yields a real market result. This shows that R and D is a key but not sufficient factor of economic progress. The ratio of R and D investments in the innovation expenditure has decreased, while that of technology development and product preparation increased.

(7) The main problems related to generating new product arise in three areas:

a) research deficit: insufficient R and D means that the new marketable solutions are missing;

b) demand and acceptance deficit: there is no demand on the new products launched on the market or demand is delayed (problems of launching and pricing the new product on the market; unwillingness to accept novelties, *etc.*);

c) lack of continuity: the basically new technological solutions break continuity, mean a breakthrough in innovation and lead to an innovation cycle.

(8) The highest investment (also) during the coming years will be made in data processing, followed, in corporate plans, by the automation of production, the introduction of new production procedures, the upgrading of the various functions of the existing products. The introduction and diffusion of the communication technology will result in the establishment of in-company and inter-company communication systems. The integration of data processing, information and communication technology is hoped to strengthen the EU's world market position.

(9) These technologies are significant not only because they increase the efficiency of the corporate office management activity with a positive effect on production but may also significantly improve the pace of reaction and efficacy of research and development, corporate management, planning and innovation activities.

(10) Future-oriented technological development increasingly demands cooperation among the developers and users of new technologies. The time and capital requirement of developing research-intensive areas can be significantly reduced for each participant within the framework of such cooperation.

(11) The EU policy of technological development greatly contributes to overcoming the obstacles and risks restraining innovation. A comprehensive analysis of the figures shows that in the processing industries of the EU countries, the volume and scope of the subsidies for innovation are as important as the liberal market principle itelf. The conspicuously high ratio of direct project subsidy means that a considerable part of the means of development are not distributed according to the 'watering can' principle, but according to the nature of the project to be developed.

(12) Since the research and development policy of the state may only cover a smaller ratio of the risks meant by innovation, the major ratio should be covered by the companies. It is considered in the EU that the policy of technological development should create the most favourable conditions for technological and economic development, improve the scientific and technological information supply to the actors of the economy, promote the improvement of their risk-taking capacity and show the future trend of technical development and the market opportunities as precisely as

possible. This is completed by the diffusion-oriented stimulation of technological development also using the tools of project orientation. The R and D framework programmes of the EU have played an extremely important role in it.

(13) According to the economic political analyses the conditions, climate and environment determined by the economic policy for the innovation activity will strengthen the position of the EU countries in terms of technological development and world market competitiveness. A stimulus to the efficiency of the activity to be conducted for technological development is expected from the fiscal and competition policy regulating it.

(14) The long-term growth rate to be expected in the EU is not much higher, therefore

a) the importance of increasing relative profitability will grow (both in production and marketing),

b) the advantages from specialization can be increasingly utilized,

c) the flexibility of offer will be increased, and

d) the innovation activity will be strengthened.

(15) Over the past 20 years, the technological development of several sectors of the European Union has lagged behind the US and Japan in global competition. The reason has not primarily been the lack of Europe's innovative capacity, since there are numerous inventions in Western Europe (especially in the machine, automobile and chemical industries), but rather the relatively more limited R and D investments, the lower ratio of those employed in the R and D sector, the scattered nature of investments, the different regulators and the lack of synergy. During the first half of the nineties, the low growth rate and the integration of the Eastern part of Europe represent the factors that have caused the EU's disadvantages, the dependence of the region as against major competitors.

(16) The canvas in the EU, naturally, shows a mixed picture. The good performance of the countries that can be considered successful in the competition (Great Britain, Finland, Ireland, Sweden and the Netherlands) can be improved by the efficiency of capital adequacy, the human resources and the state policies as well as corporate initiative, while any of these factors being absent deteriorates the chances of the other member countries to catch up with the required standards.

(17) The EU has identified two objectives, namely, the improvement of its international competitiveness and the termination of the technological gap among the member countries.

(18) The main tools of the European R and D policy, the so-called Framework Programmes which finance specific long-term research activities based on the community's cooperation, as a maximum, up to 50 per cent of their value. The previous five such programmes and the current 6th Framework Programme have yielded numerous successful projects and results although they can also be problematic and are often highly criticised. The deficiencies of the European research and development activity have been recognised: there is a need to improve the capacity of Western Europe to produce new technologies and rapidly apply the new technologies emerged. Therefore, future oriented technological development requires an ever higher degree of cooperation between the developers of the new technologies and their users.

(19) As far as the role and potential of R and D is concerned, over the past decade, the EU has also had to face

further major changes. Amid increasing globalisation (accompanied by continuous market liberalization) the reduced technological and political sovereignty and the gradual loss of national control have become ever more obvious. The EU countries have made efforts to counterbalance this competition by trying to support the microeconomy, the companies instead of the macroeconomy (the main elements of which have already been raised to a supranational level due to the Economic Monetary Union). The establishment of transnational corporations in Europe should also urge the governments and the EU to support the innovation capacity of the local small and medium enterprises that are their suppliers. This might become a new aspect of technological policies (already indicated in the 5th Framework Programme).

(20) With the enlargement of the EU, the community's R and D potential has increased significantly, however, but not in terms of new investments but the scientific capacities and human capital of the EU-10 employed in research and development.

(21) Within the new EU-10, it is imperative to strengthen R and D, increase R and D investments and also improve efficient utilization. R and D results should be converted into competitive products, and this requires the establishment of an organic innovation process.

(22) In education, vocational training and further training the disadvantage of the new EU member states is not as high as in terms of per capita GDP production. In certain fields they even enjoy an advantageous position as compared to several old member states. The quantitative and qualitative increase of human capital is the major condition to achieve an advantageous economic position to be handled as a top priority by economic policy and financing. Education and the training of human capital are key factors for the EU-10, among them Hungary, to make progress. With the improvement of the quality of the labour-force potential they also establish long-term growth. On the EU average, raising the duration of education by one more year equals a raise in productivity by over six per cent. There are, however, ratios higher than this.

(23) According to international surveys and the opinion of the European Commission, the current R and D policy of the Union is insufficient and requires reforms. In this reform, it is worth and necessary for the new EU-10 to develop their own concept and strategy.

(24) The establishment of the European Research Region is still in its initial phase. First of all, the tendering systems should be updated and financing made more transparent, faster and more simple. In the European Research Region the work of the Corporate General Directorates responsible for research, education and innovation should acquire a more organic content within their institutional operation.

(25) Productivity in the EU is lagging behind the US significantly. This disadvantage could be reduced by the faster diffusion of information and communication technologies and by increasing their innovative impact. The same applies to the new EU-10. Although the growth rate of the investments in the new EU-10 is steadily higher than in the former EU-15, their structure should continuously be improved, focusing on value-adding activities.

(26) It should be taken into consideration that in the developed EU countries, a high ratio of GDP is generated by the highly productive non-material services, primarily within the R and

D activities and innovation. The economic political incentives and corporate strategies of the new EU-10 should be focused on this.

(27) It is necessary although not really sufficient to increase R and D investments and ensure R and D human resources. It is indispensable to improve the utilization of R and D investments and rapidly introduce the results of R and D (also) in the new EU-10. The EU is at a disadvantage primarily because the innovations are introduced at a rather low pace. The improvement of the investment climate, the predictability and the consistency of economic policy are imperative for the EU-10, among them Hungary, to eliminate their disadvantages.

(28) Finally, the social effects and acceptance of the new technologies should be duly emphasized. One of the two major issues arising here is that in most areas technological development has a manpower-replacing effect. This means that the efficiency and competitiveness of the production sector can only be achieved for a huge social price to be paid by the loss of jobs and rising unemployment. This is obviously against the other major issue, the EU's objective of job-creating integration. The other side of the coin is the above mentioned social perception not to be ignored due to the strengthening environment and consumer protection.

(29) The governments of the EU member states and the European Commission should take into consideration the new criteria if they really wish to conduct a future oriented R and D policy. The changes support the EU's rising awareness that R and D is not merely a technocrat issue but an area that requires a complex approach. The improvement of competitiveness not only requires adequate economic conditions but also the social acceptance of innovation, an environment that is open to novelties and a value oriented society.

(30) The economic role of the state in improving R and D, innovation and competitiveness is not reduced but transformed in the EU countries. Those countries can make progress that recognize the importance of human capital and stimulate, *i.e.* rationally finance and assist the common process of education, vocational training, R and D, and innovation.

(31) The national policy of education and science and the strategic role of the states based on national resources and financing play a key role in what position they can achieve in the world economy of the 21st century.

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